Module 2: Nutritional Aspects of Bone Health

Trying to decipher the world of nutrition is often a difficult task. There are many interactions that take place when we eat something. Not only is the food we consume broken down into its essential elements, but various endocrine and organ reactions are occurring. Trying to eat something in an attempt to improve your health or enhance some bodily structure, is not as easy as you would think.

First, it must be recognized that just because we eat something this does not mean it makes it to the cell where we need it. After we take something into our mouth **(ingestion**), we begin **physical digestion** with chewing, known as mastication. We also begin **chemical digestion** with salivary amylases and lipases which breakdown complex carbohydrates, and lipids or fats, respectively. Then the stomach goes to town, churning and burning and breaking down proteins. It gets passed on the small intestine with chemical help from the liver, gall bladder and pancreas where the vast majority of **absorption** occurs. This is the movement of small particles called monomers into the bloodstream. Monomers get transported into a cell in a process called **utilization**. It is these last two processes that are the most important because unless something makes it into the cell, *and* is actually used, the previous steps do not matter!

How the chemical agent or fuel gets utilized is a function of the stresses and needs of the body. Thus, exercise and stress can affect how are nutrients are used. By stressing our bones, we give it the stimulus for certain cells (osteoblasts) to take up calcium and phosphorus, and all the other necessary ingredients for bone to build up the new bone and breakdown the old bone (Fox, 2016).

Remember the Holistic Perspective - Confusing at Times

The holistic perspective was mentioned with lowering the bad, synergizing with the helpful, and raising the good. You would think that is easy with nutrition, thinking, “I will consume more foods that are good, and less that are bad.” Unfortunately, it is not that simple, and there are many facets of nutrition to which we need to simultaneously pay attention. This complexity and multifaceted nature of nutrition is why you hear of so-called, “scientific fact” changing across time! The above-mentioned digestive processes can be promoted or inhibited by various agents, as well. For example, something in spinach known as an oxalate can bind calcium, and prevent its release into the system so that no absorption occurs. Something like wheat bran, an insoluble fiber, can actually inhibit calcium absorption of any food it is eaten with, but only in its pure form! Likewise, caffeine, red meats and high-salt foods seem to lower calcium stores. Note that it is not in the *scope of practice* of this author to give clinical

nutritional advice, so please consult with a physician, registered dietitians, and national organizations specializing in osteoporosis.

Too much of a Good Thing- is not a Good Thing

This old saying is quite true when it comes to enhancing bone density via nutrient intake. There are several nutritional agents that are beneficial for bone when taken in the proper quantity. While protein a necessary component of a bone enhancing diet, too much is not good, especially when it comes from animal sources. Too much protein can increase the sulfates in the blood, which can cause the calcium in bones to leach out. In a study performed by the *Harvard Medical School*, known as the *Nurses' Health Study II*, researchers followed 116,686 women for 10 years. They found that those women eating red meat at least five times a week were more likely to have bone fractures than women who ate red meat once a week.

Another nutrient, the mineral fluoride, is also in this "too much of a good thing is not a good thing" category. Fluoride is often associated with keeping the teeth free from cavities or plaque. Some fluoride is also very good for the bones. A study from Finland (2000) found that women who drank fluoridated tap water had reduced risk of hip and spine fractures than those drinking bottled water. Too much fluoride, however, negated these positive effects.

Two of the most recognized supplement agents for bone are vitamin D3 (calcitriol) and calcium. Several studies have reported on the dangers of high doses of these key bone nutrients, and how they actually may not reduce fractures, but may even increase them. This finding has not been verified by all sources, but it is interesting, and obviously flies right in the face of the so-called standard knowledge on calcium intake.

In an NIH fact sheet, several studies on Vitamin D intake were reviewed, and found only small increases in bone mineral density in institutionalized older adults, but not in community-dwelling people, and there was no reduction in falls, and no reduction in fractures. Another study found if vitamin D levels were low or high, there was a greater risk of frailty (see list of references). This finding was in agreement with a Lancet article in 2013, and another Journal of American Medical Association (JAMA) article in 2010 that found high doses of Vitamin D associated with more falls and fractures. In addition, vitamin D in high doses can be toxic, can cause hypercalcemia (high blood calcium levels), and this can cause deposits in the arteries and kidney stones. High calcium has also been associated with heart problems, and bowel issues. A study on women worldwide found in the countries that consumed higher levels of calcium tended to have more fractures per 100,000 person-years. In addition, high

sodium intake is not only related to high blood pressure, but also high urinary calcium which is indicative of bone mineral loss, and may cause kidney stones (Woo, 2009).

Guilty of Guilty Pleasures?

Some of the things we enjoy, often called the guilty pleasures, may actually be bad for the bone health beside other systems. Alcohol in excess interferes with the absorption of calcium and vitamin D. Lowering your limit down to one drink a day may improve the bone density. Smoking also interferes with nutrient adsorption and utilization and is associated with reduced bone mass density.

Two beverages commonly consumed by people worldwide, coffee, and soft drinks also have evidence to show they are not beneficial for bone health. A recent epidemiological study performed in Sweden on 31,527 women ages 40 to 76, found that women who drank 330 milligrams or more of caffeine in a day, roughly four cups of standard coffee, had an increased risk of bone fractures. Interestingly this same relationship did not ring true for tea drinkers. It is believed that the lower (typically half) caffeine content in tea is the reason.

The famous *Framingham longitudinal study* also looked at bone mineral density in the spines and hips of women (n= 1413) men (n= 1125) and compared this to the soft drink consumption. The data showed that cola and diet cola, and no other soft drinks, were associated with bone loss in women. The researcher believes the phosphorus in colas may be factor, not the caffeine. It is also speculated that the sodas may substitute for milk drinks which would enhance the bone density.

Some of the things we consider good for us may not be so great if you are a candidate for osteoporosis. Sodium is one of the most important minerals we can consume. However, excess sodium in the diet will cause you to excrete calcium in your urine and perspiration. Fiber is also good for our digestive system and it can lower risk factors for heart disease, but wheat bran eaten at the same time as calcium consumption can bind it prevent absorption. **Oxalates** also found in spinach, rhubarb, sweet potatoes, and bran fiber will also interfere with calcium absorption but only when eaten at the same time as the calcium.

What about Enhancing the Positive?

While much of the public seems to be interested in avoiding the negative, proactive “health care” advocates and coaches will want you to gravitate toward the good as well. What seems to be good for overall health is also good for bone health- fruits and vegetables. A diet low in fruits and vegetables may lead to mild acidosis which may contribute to bone loss. Of course, very good sources of calcium can be found in vegetables, not just dairy products.

On the positive side, several studies have mentioned how **beneficial gut microbes** may to help calcium absorption. A study in 2017 researchers found prebiotics may enhance the absorption of calcium in the gut and metabolism to improve bone health (Whisner & Castillo, 2017).

Supplements are vastly overdone by much of the public, but they do serve a valid role when ensuring the proper intake of a given substance. Make sure to pay attention to the seven recommendations for calcium supplementation. *The Fantastic Four*- as termed by this author- consists of two vitamins and two minerals. Most people identify the importance of Vitamin D for bone health. It is important that Vitamin D be the active form- calcitriol- known as D3. What most people don't realize is Vitamin K plays a significant role in bone mineral content of the two primary minerals of bone- calcium and phosphorus make up the fantastic four.

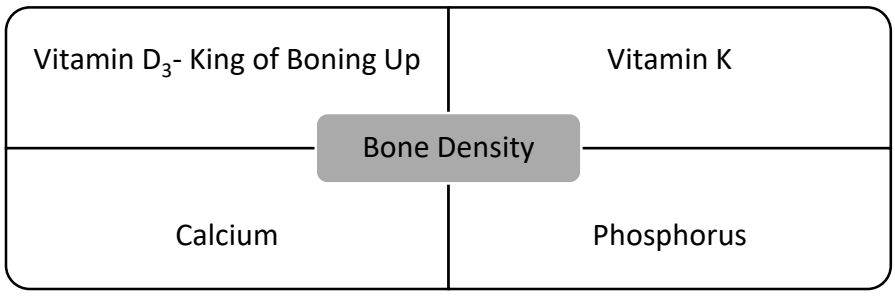

Figure 1: The Fantastic Four nutrients for healthy bones- 2 vitamins and 2 minerals

Calcium and phosphorus have antagonistic effects on the absorption of each other so make sure you are taking them in a 2 to 1 ratio (respectively Ca 2: Phosphorus 1) and you are not mega dosing either. There are many types of calcium supplements out there and some are better absorbed than others. In general, most individuals over 50 need between 1000 and 1200 milligrams per day (mg/d), and growing children (9-18) should consume about 1300 mg/d. Adults between 18 and 50 can keep it to about 1000 mg/d. The supplements on the market often exceed these levels but remember- just because it goes in your mouth does not mean it makes it to the cell.

Support Crew for Dem Bones

In addition to the *Fantastic Four*, other vitamins, minerals, and even phytochemicals should be part of the complete nutritional program to enhance bone health. Vitamins A and C, both of which are also associated with antioxidant activity also can be helpful for bone health. Be careful not to overdose on the Vitamin A since it is detrimental in high doses. Magnesium, zinc, copper, sulfur, are good major minerals to take, and silicon, strontium and boron are trace minerals that help bone health.

Phytochemicals are plant chemicals that have very beneficial effects in humans. Much of the public may have heard about the role of phytochemicals in heart disease, cancer, and maybe weight

loss. **Polyphenols** found in red wine, grapes, berries and other red, blue, or purple foods are beneficial as are **phytoestrogens** found in soy products. Phytochemicals that support the thyroid and parathyroid glands, which control calcium blood levels and thus bone mineral content are also recommended for bone health.

Going to the Medicine Cabinet to Bone Up

Again, it is not in the authority of the author to recommend medicines or even supplements that have curative purposes. This section is only trying to make you aware of the mechanisms some drugs use to prevent or reduce osteoporosis. There are many drugs on the market to help fight osteoporosis. Where most of the older generation drugs were designed to slow breakdown, the more recent ones are designed to rebuild bone, thus reverse this degenerative disease! Bisphosphonates such as Fosamax or Boniva are designed to slow the bone loss. Teriparatides, Denosumab and Abaloparatides may actually act to rebuild the bone mass back.

Parathyroid hormone (PTH) is often thought of as the enemy when it comes to bone density. The main reason is because in order to raise blood calcium levels it will remove it from bone. However, it actually increases the reabsorption of calcium by the kidneys and stimulates vitamin D3 (calcitriol) to absorb more calcium in the gut. Thus, it conserves or enhances calcium availability. Because of this, PTH is used as a therapeutic agent to enhance bone anabolism. Vitamin D3 has many different effects and reduces osteoblast apoptosis or cell death, thus keeping the bone builders around longer.

Eat This, Not That! (See the Video Segment)

There is a lot of advice out there on how to eat for increasing your bone health. It is best to keep things simple. In attempt to do this, I will replicate a past title by Men's Health- **Eat This, Not That**. Basically, I am showing a food that could potentially be detrimental to bone health and one that is beneficial to bone health. The motive of this was to gradually transition someone's food choices toward those that provide calcium, magnesium, phosphorus, or Vitamin D, C and various antioxidants vs those that diminish the stores of nutrients that build bone.

Trying to radically change someone's diet will often end in failure and rejection of change altogether. Interestingly, a few minor changes across time can make major differences in your bone health and much easier to tolerate mentally. There are a few central features that should be recognized and then the variety of foods that satisfy those features are numerous.

A couple of guiding principles to the foods that should be consumed for stronger or better bones include going for foods with calcium, phosphorus, magnesium, and fluoride for minerals, A, C, and D for vitamins, and phytochemicals, especially those that reduce oxidation to tissues (antioxidants).

Another set of guiding principles is about what can rob your bones of calcium. These include foods that are high in sodium, those that contain oxalates and phytates, those with wheat bran, and caffeinated and sodas with phosphoric acid and caffeine.

This video discusses why one food or drink might be chosen over another. It also tried to use foods that you could substitute for another. For example, you may want a pickle on the side of a sandwich. Wild berries or cherries could substitute. A cold-water fish like tuna, or salmon may substitute for a hamburger. What is odd is that something like instant macaroni and cheese is actually better than whole wheat bread for your bones, but no one would argue whole wheat is better for your overall health.

EAT this, NOT that- Video Segments

Table 1: Segments included in the EAT this, NOT that video

1	**Introduction**
2	**EAT Oranges and Cherries NOT Apples**
3	**EAT Berries NOT Pickles**
4	**EAT Nuts NOT Chips**
5	**DRINK Orange Juice NOT Caffeinated Sodas**
6	**DRINK Milk NOT Coffee**
7	**EAT Coldwater Fish NOT Hamburger**
8	**EAT Good Fats NOT Bad Fats**
9	**EAT Yogurt/Avocado Dips NOT Bean/Legume Side Dishes**
10	**DRINK Red Wine NOT Spirits**
11	**EAT "Anytime" Greens NOT Spinach**
12	**EAT Mac n' Cheese NOT Whole Wheat Bread**
13	**EAT Cheese and Marinara Sauce NOT Ranch Dressing**

The thirteen segments mentioned above are all under a minute except the introduction. While there is no perfect diet for osteoporosis, trying to keep toward the main guidelines and making some simple substitutions can do your bones a lot of good.

A Review of Major Concepts in Module 2

Please take a moment to review each of the following questions below. Taking time to answer the questions below will assist you in your learning of the material presenting in this module.

1. What is the difference between ingestion, digestion, absorption, and utilization?
2. What does the phrase- *too much of a good thing is not a good thing*- mean in nutrition?
3. What does smoking, or a high consumption of coffee, alcohol, and red meat do to bone health?
4. Why is spinach both good and bad for bone building?
5. Name two vitamins and two minerals that are beneficial for bone health.
6. Name two phytochemicals that are beneficial for bone health.
7. What is the difference between bisphosphonates and teriparatides, or Abaloparatids in their physiological actions?
8. Name three actions of parathyroid hormone to increase blood calcium.