Under-Appreciated Mineral Enhances Cognition, Bone and Joint Health

By Alexander G. Schauss, PhD, FACN

Boron is perhaps one of the least known and underappreciated minerals. Its bone- and joint-supporting abilities are often neglected in favor of calcium, when in reality it works with calcium to maintain healthy bones. Few individuals are aware of the other ways boron is important to health, including a surprising ability to enhance cognition. Because boron is so important to many aspects of health, it is particularly troubling that many individuals are deficient in this important mineral, increasing the risk of osteoporosis and arthritis.

Since 1923 boron has been recognized as an essential nutrient for plants. Among plants the deficiency of boron is the most common deficiency of any trace element.

Boron is not pervasive in the human diet. Instead it is found in significant amounts in only a few foods, leading off with apples (42.5 micrograms/gram of dry weight) and continuing down through soy meal (28 ug/g) then grapes, tomato, celery, almonds, broccoli, bananas, wines and honey (7.2 ug/g).

Today it is known that boron is present in body tissues and fluids found in the human body primarily as boric acid.[1] The Tolerable Upper Intake Level for boron set by the Food and Nutrition Board of the Institute of Medicine for boron has been established at 20 mg/day for adults over the age of 18 years.[2]

I first discussed boron, a little known trace element at the time, during the first national conference on nutrition and behavior held in 1982 at The University of Texas at Austin's LBJ Auditorium. I will never forget looking out over a confused audience of nearly 1,000 attendees as they glanced at each other and wondered why would anyone talk about a trace element for which there was no evidence of essentiality in any animal or in humans.

In the auditorium was Curtiss D. Hunt, PhD, a scientist studying trace elements at the US Department of Agriculture (USDA). He was surprised that anyone appreciated boron's potential role in human health and had gathered enough data to keep an audience of nearly 1,000 scientists and health practitioners interested in the subject for more than half an hour.

Unlike 25 years ago, boron is now known to play a role in numerous metabolic processes affecting the health of animals and humans.[3]

Bone-Building Nutrient

Boron's role in human health is now known to be diverse. Inadequate boron intake is involved in inflammatory processes, including joint swelling, restricted movement, as well as body temperature, antibody production, blood hemostasis, serine protease (which is linked to platelet aggregation), activity of lipoxygenase (an enzyme that helps control inflammation) and metabolism of leukotrienes, chemical mediators of inflammation.[4] However, perhaps boron's most well-known role in health is its ability to maintain the bones and joints.

In the audience at that 1982 conference was Forrest Nielsen, PhD, who at the time worked at the USDA's Grand Forks Human Nutrition Research Center in North Dakota. In subsequent years, Nielsen would demonstrate that boron deficiency combined with insufficient magnesium intake contributed to detrimental changes in bones due to suboptimal bone formation and maintenance.[5] He and his colleagues demonstrated that inadequate boron intake depressed plasma ionized calcium and calcitonin and elevated plasma total calcium and urinary excretion of calcium. Today we know the mechanism of action better based on the discovery that boron deprivation in humans causes increased urinary calcium excretion.[6]

In addition to how suboptimal boron intake adversely affects bone health, boron and/or magnesium deprivation also causes changes that are seen in women with postmenopausal osteoporosis. This is because boron and magnesium are needed for optimal calcium metabolism. Without sufficient intake of both elements, bone loss is accelerated, which over time results in excessive bone loss that can lead to osteoporosis in men and women.

Other research done with chickens demonstrated that boron supplementation stimulated the growth and partially corrected leg abnormalities in vitamin D3/cholecalciferol-deficient chicks.[7] This suggested that one of the functions of boron appears to be its involvement in bone mineralization and structure. Years later it was shown that indeed this is true in pigs, whose metabolism and physiology is much closer to that of humans.[8]

When this discovery was factored into the incidence of osteoarthritis worldwide based on World Health Organization (WHO) statistics, it was discovered that people living in areas of the world with high levels of boron in the soil (and hence local foods) had a much lower incidence of arthritis, compared to those living in areas that had deficient levels. For example, the country with the highest arthritis incidence in the world, Jamaica, also had the lowest concentration of boron in the soil found in any country in the world.[9]

Part of the reason for this inverse relationship was more recently made clear with the discovery that dietary boron had a similar effect as supplementation with estrogen in humans.[10] What is known today is that large amounts of dietary boron can benefit vitamin D3 and calcium status in humans.[11]

Surprising Role in Hormonal Health

To understand this relationship between boron to calcium and vitamin D, some steroid chemistry must be explained. Boron is necessary for the formation of specific steroid hormones. A clinical trial has demonstrated that both 17-beta-estradiol and testosterone levels significantly increase in postmenopausal women consuming 3 mg/day of boron for 7 weeks.[12] In this study, boron supplementation caused a twofold increase in testosterone concentrations and a significant increase in calcium retention. In another study, men given 10 mg of boron a day for 4 weeks experienced a significant increase in 17-beta-estradiol levels and an increase in plasma testosterone.[13]

Boron's ability to play a role in the formation of specific steroid hormones partially explains its effect on arthritis. Boron can complex with hydroxyl groups and form corticosteroids, which are known to alleviate symptoms associated with rheumatoid arthritis. Research performed in Australia demonstrated that when there were high levels of boron in the soil and water, the number of cases of musculoskeletal diseases was found to be 50 percent lower in areas that had low boron concentrations in water and soil.[14]

It is now believed that high levels of dietary boron can postpone the onset and lessen the severity of arthritis, which has already been demonstrated in experiments in rats, partially due to the inhibition of T-cell activity, associated with arthritis, and the modulation of serum antibody levels.[15]

Boron also has been shown to lower plasma lipid levels, possibly by decreasing lipid accumulation and promoting cholesterol removal for tissue although far more research needs to be done to explain how this works.[16]

Brain-Boosting Actions

Boron is much more than another mineral—it is a dynamic trace element when consumed in physiologic amounts that can affect a broad range of life processes involving macrominerals, energy substrates such as glucose and triglycerides, amino acids and proteins, free radicals and even estrogen. Any one of these processes cannot only effect the composition but also the function of numerous body systems.[17]

One of the most interesting aspects of boron's range of nutritional benefits is its positive effect on the brain and central nervous system. Inadequate boron intake can contribute to a lack of energy, ability to stay focused on tasks and mental alertness. To demonstrate this, I had a class of students taking a heavy load of second and third year med school courses participate as volunteers in a randomized, double-blind, placebo-controlled study, to help them gain practical experience in learning how clinical studies are designed.

The goal was to evaluate the effect of boron on mental alertness. Students received either a placebo capsule or 3 mg of boron daily for three months. Neither the students nor I knew which student received the placebo and which student received the boron. After just one month I was fairly certain which students were taking boron supplements rather than the placebo based on my observation of their level of alertness and participation in class discussions. At the end of the study I discovered that I had correctly selected 92 percent of the students on boron based on my observations during class. When the code was broken and we found out whom had taken what, it supported not only their own impression as to whether they were on boron supplementation or placebo, but also mine as well. The difference was obvious to almost every student.

The explanation for these results was that inadequate boron intake lowered the activity in brain regions associated with alertness. This has been shown experimentally in humans who were carefully monitored for changes using an electroencephalogram (EEG) following boron supplementation.[18]

Widespread Deficiency

Many people ask: “Can’t foods rich in boron meet my requirements for boron?” Unfortunately, the level of boron in a food depends on geographical factors, and worse, very few foods containing physiologically adequate levels of boron exist in the food supply chain to meet our needs. Even an apple, a good source of boron, can have very low levels of boron depending on whether it is grown in a dry or wet climate.

In early 1982 I was traveling from a nutrition conference in Australia to another nutrition conference in New Zealand. As luck would have it I found myself sitting next to a professor from Australia who was traveling to the same conference. I looked at the conference program and noticed he was going to discuss the role of trace elements in the development and treatment of arthritis in sheep. I found the title of his presentation quite puzzling as the conference was about human health, not sheep’s.

What I quickly learned from him was that New Zealand had less then three and a half million people living in the country, yet it had over 65 million sheep. Hence, sheep were important to New Zealanders. What I also did not know was that sheep experienced the same kind of osteoarthritis that humans did.

What caught my attention was what he would discuss at the conference, and what I was privy to learn from his years of research: boron levels in the plants the sheep consumed determined the incidence and severity of arthritis. As a result of years of meticulous record keeping, he had observed a clear association between boron intake and osteoarthritis in sheep.

His research contributed to the growing evidence that certain rainy regions of New Zealand deficient in boron had much higher levels of arthritis not only in

sheep but humans as well. It was in these areas of the country that the incidence of severe arthritis was dramatically high. By comparison, the driest parts of New Zealand, which experienced far less leaching of boron out of the soil, had much lower incidences of arthritis among sheep, with only the mildest symptoms associated with arthrosis (a joint disorder).

His astute observation led to a series of experiments. Sheep suffering from arthritis and grazing on land depleted of boron were given boron supplements. The animals showed marked improvements in mobility. In addition, the most surprising discovery was that the offspring had somehow acquired some protection from arthritis development later as adults when they continued to receive boron supplementation. Even more important was the recognition that this research might have implications in humans.[19]

Boron Supplementation

Because boron is rapidly absorbed and then excreted in the urine, its potential for toxicity in humans is of the lowest order. There is no evidence of toxicity in humans when given 10 mg of boron daily for long periods.[20] However, in individuals with kidney problems, boron intake, like any intake of a mineral supplement, particularly potassium, should be carefully monitored as impaired kidney function could reduce excretion resulting in boron accumulation.

Conclusion

Boron is one of the most important minerals involved in bone and joint health. Its role is likely as important as calcium and vitamin D. Furthermore, boron can increase mental alertness, reduce inflammation and help in the metabolism of key hormones. The widespread boron deficiency that exists throughout the United States and the world indicates that supplementation with this often overlooked mineral may positively affect many aspects of health.

Alexander G, Schauss, PhD, FACN

Alexander G. Schauss, PhD, FACN is the Senior Director of the Natural and Medicinal Products Division of AIBMR Life Sciences, Inc., in Puyallup, Washington. He also is a Fellow in the American College of Nutrition and a former Clinical Professor of Natural Products Research and Adjunct Research Professor of Botanical Medicine at the National College of Naturopathic Medicine in Portland, Oregon. Additionally, his extensive experience includes time spent as a member of the National Institutes of Health (NIH), Office of Alternative Medicine Advisory Council, the Ad Hoc Developmental Planning Committee of the NIH Office of Dietary Supplements, and as a reviewer of botanical standards and information monographs for the U.S. Pharmacopoeia Convention (USP). Previously, the U.S. government appointed him to represent the United States as a voting member of the World Health Organization's Study Group on Health Promotion. In 2005, Dr. Schauss received the Linus Pauling Lecture Award "for contributions in the medical sciences" from the American College for the Advancement of Medicine.

For more information about Dr Schauss, see:
http://www.traceminerals.com/research/dr-shauss-articles

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