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REPORT

Chromium: An Element Essential to Health

By Dale Kiefer

Chromium, the metallic element once believed to be toxic, is in fact essential to health. In the mid-twentieth century, scientists put laboratory rats on a diet devoid of chromium. The unfortunate rodents quickly developed glucose intolerance, a condition that often precedes the development of type II diabetes in humans. Researchers then switched the animals' feed to brewer's yeast—a rich, natural source of chromium—and the rats' health promptly returned to normal.

Later, a similar effect was documented in humans. Reports began to appear in the medical literature describing patients who developed glucose-handling disorders and abnormalities of the motor and sensory nerves after prolonged nose-tube feedings with a liquid nutrient formula that was believed to supply all necessary nutrients. Chromium deficiency was eventually recognized as the cause of the symptoms. Patients recovered after at least 150 micrograms (mcg) of trivalent chromium was added to the formula.¹⁻³



Regulating Glucose and Lipid Metabolism

Chromium is now generally recognized to play an important role in glucose and lipid metabolism.⁴⁻²⁴ Chromium supplementation has the effect of normalizing blood sugar levels. Elevated blood sugar, or hyperglycemia, responds positively to chromium supplementation. Hyperglycemic patients given chromium after receiving a dose of glucose, or simple sugar, experienced a drop in blood sugar levels, while patients with low blood sugar, or hypoglycemia, experienced a normalization of their blood sugar levels after receiving chromium.²³

Chromium is believed to form an integral component of so-called glucose tolerance factor, a proposed metal-protein complex sometimes referred to as chromodulin.²⁵ It is responsible for activating insulin receptor kinase, thereby increasing insulin sensitivity.²⁴ High blood sugar is a damaging hallmark of diabetes. When cell membranes are sensitive to the presence of insulin, they are more receptive to insulin's efforts to usher glucose molecules out of the bloodstream and into cells, where glucose is then burned for energy.

Without adequate chromium, insulin evidently becomes ineffectual. As glucose piles up in the bloodstream, the pancreas produces ever-greater amounts of insulin, to little avail. In essence, chromium acts like a kind of doorman. While insulin escorts glucose to "doors" in the cell membrane, chromium (probably joined with protein fragments) rings the doorbell, and perhaps holds the door open by activating receptors, while insulin ushers its precious cargo into the cell. Without chromium's help, membrane portals simply fail to open. Blood sugar levels remain stable when adequate chromium is present.

Chromium occurs in two chemical forms, called trivalent and hexavalent. The hexavalent form is usually a byproduct of the metallurgy industry (for example, chrome automobile parts). It may indeed be toxic if inhaled. Although it is not recommended for ingestion, when the hexavalent form is consumed orally it is quickly converted into the harmless, bioavailable trivalent form. Chromium intended for dietary supplementation is always trivalent. In contrast to hexavalent chromium, trivalent chromium is an essential micronutrient that is exceptionally well tolerated.¹⁻²⁵

Are We Starved for Chromium?

Although still somewhat controversial, chromium supplementation is believed by many reputable scientists and physicians to be an important tool in the war on diabetes and obesity. By promoting normal glucose metabolism, chromium supplementation may allow diabetics to reduce their dependence on, or avoid altogether, medications to control hyperglycemia. This glucose normalization effect has been demonstrated in species such as rats, cats, pigs, and sheep, as well as in humans.²⁶⁻²⁸



Unfortunately, some physicians are unconvinced that chromium is a necessary, helpful supplement. Their reticence is likely due to the existence of some small studies that used chromium doses that were too small to provide an effect, or studies that suffered from simple defects in design. That, at least, is the opinion of one of the world's leading chromium researchers, Dr. Richard Anderson.

Dr. Anderson is a nutritional research scientist with the US Department of Agriculture's Agricultural Research Service. For decades, he has studied chromium's role in glucose and lipid metabolism. As early as 1981, Dr. Anderson published a report declaring that chromium is essential for proper glucose and lipid metabolism.²² Furthermore, in 1986, Dr. Anderson noted, "The dietary chromium intake of most individuals is considerably less than the suggested safe and adequate intake."²³ He went on to note that our rampant consumption of refined sugar further depletes chromium stores. As sugar intake increases, more chromium is expended by the body in an effort to metabolize that sugar, resulting in a spiraling need for still more chromium.²⁰⁻²⁴



Although modern multivitamins often contain at least trace amounts of chromium, inferential evidence suggests that many of us are nevertheless deficient in this crucial element. In Thailand recently, scientists measured the chromium present in gallstones and bile from patients in three Asian cities. They concluded that patients from Bangkok had consumed higher levels of chromium than their counterparts in the other locales. Since gallstones may take many months or years to form, they provide an intriguing snapshot of long-term trace metal status. Bangkok residents had lower levels of total cholesterol, triglycerides, and hemoglobin A(1C) (an indicator of uncontrolled blood sugar) than Asians with consistently lower intakes of dietary chromium.²⁹

Of course, not every patient presents with gallstones. Moreover, there is currently no reliable method of assessing an individual's chromium level. Increased loss can be monitored in the urine, but adequacy of chromium in the bloodstream must be inferred. Some scientists are convinced that the need for chromium increases as glucose intolerance and diabetes develop. It is believed that intense exercise, pregnancy, and traumatic injury also increase the body's demand for chromium.⁴

Dr. Anderson writes, "Insufficient dietary chromium is associated with maturity-onset diabetes and/or cardiovascular diseases." This alarming pronouncement takes on still greater significance in light of his observation that "Dietary chromium intake in the US and other developed countries is roughly half of the minimum suggested intake of 50 micrograms."²¹ Scientists, including Dr. Anderson and his colleagues, are actively seeking to understand precisely how chromium renders assistance. It is clear, however, that chromium, regardless of the details of its activity, enhances insulin's activity, and is crucial to normal glucose and lipid metabolism.

Given the alarming rise in cases of insulin resistance and diabetes in the US, it may be prudent to increase one's level of chromium to stave off symptoms of metabolic syndrome, such as increased glucose intolerance, excess weight gain, elevated blood lipids (cholesterol and triglycerides), and low levels of high-density lipoprotein (HDL) cholesterol. All of these parameters are potentially harmful if left untreated.³⁰⁻³⁴

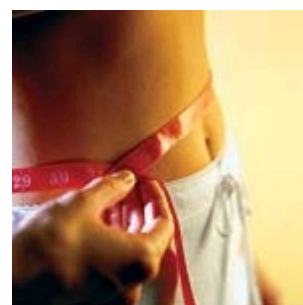
Positive Effects on Cholesterol, Fat Loss

No less an authority than Dr. Richard Atkins, the founding father of the current low-carb revolution, called chromium "the most pivotal nutrient involved in sugar metabolism." Dr. Atkins went on to point out "more than 90% of all Americans are deficient . . ." ³⁵ Besides normalizing glucose and insulin levels, supplemental chromium evidently lowers harmful total cholesterol and triglycerides, while raising beneficial HDL cholesterol. There is even evidence to suggest that chromium promotes fat loss and lean muscle mass retention.^{12,15-17}

Whole grains and mushrooms contain trace amounts of chromium, but only if they are grown in soil containing the mineral. Similarly, seafood and some meats may contain chromium, but only if the source animals ate foods containing chromium. Brewer's yeast is the only food source rich in this essential nutrient. Unfortunately, brewer's yeast lacks a certain appeal as a dietary source, particularly when you consider that chromium stores must be replenished frequently. That is why many experts recommend daily chromium supplements.

Some notable studies have indicated an improvement in the ratio of body fat to lean muscle during and after chromium supplementation in humans. Dr. Anderson writes, "[Chromium] supplementation may be useful to direct . . . fat loss with the retention of lean body mass and to ameliorate many manifestations of aging."³⁶

In an interview with Life Extension, Dr. Anderson scoffed at researchers who claim to have found no such effect. "Some of these studies are too short term to see any effect . . . they're poorly done studies," says Dr. Anderson. He notes that a recent report, which analyzed all the available data on the issue of fat loss and lean muscle retention, concluded that chromium supplementation had no significant effect. "Insignificant weight losses?" asks Dr. Anderson. "They found a [0.3 to 0.8] kilo-per-month loss. That's about eight pounds per year. In five years that adds up to 40 pounds [of fat loss]. That's not insignificant. To say that's insignificant is bizarre."



His incredulity is understandable. In one study of 20 overweight African-American women, researchers found that "fat loss was significantly greater, and non-fat body mass loss significantly less, with

chromium intake.” In this randomized, double-blind study, subjects took either 600 mcg of chromium nicotinate or placebo for two months. Groups were then switched for two months, without their knowledge. Those receiving chromium began taking placebo, and vice versa. All subjects also engaged in a modest diet and exercise regimen throughout the study period.¹⁶

Perhaps the most intriguing aspect of this clinical trial was the finding that subjects on chromium lost fat but retained lean muscle, in contrast to those on placebo, who lost fat and muscle. Researchers also noted that during the placebo phase, fat loss was significantly less among women who received placebo first than among those who received chromium first, indicating a carryover effect from chromium supplementation. These women continued to lose proportionally more fat, even during the placebo phase. None of the women experienced significant adverse effects from taking 600 mcg of niacin-bound chromium.¹⁶



Dr. Anderson is also skeptical about some scientists' claim that chromium does not affect glucose metabolism. “Those are usually people who haven't done much work in the field,” says Dr. Anderson. Citing one meta-analysis that claimed to find no significant effect, Dr. Anderson pointed to “many problems” with the design of the analysis. “Nobody is going to convince me there aren't any beneficial effects. Many of these are lousy studies; lots of them aren't giving enough [chromium]. . . they're too short term, or they use healthy normal subjects. You must have impaired glucose tolerance to see an effect. More than 30 studies have demonstrated an effect.”

In addition, the number of individuals with impaired glucose tolerance is alarmingly high in the US and abroad, says Dr. Anderson. “People with impaired glucose handling, metabolic syndrome, and diabetes—you're talking about a very high percentage of the population. I'd say 25-35% is a very conservative estimate.” Metabolic syndrome, also known as Syndrome X, is a combination of medical conditions characterized by abnormal glucose metabolism, elevated insulin levels, excess weight and abdominal fat distribution, disturbances of normally healthy lipid levels, and high blood pressure—all of which are associated with the subsequent development of type II diabetes and cardiovascular disease.

While diabetes and cardiovascular disease are well-recognized threats to overall health, some researchers believe that elevated blood sugar—even absent these other conditions—contributes directly to aging. By interacting with proteins and nucleic acids, excess glucose molecules wreak havoc with tissue elasticity and normal function.³³ Thus, controlling blood sugar may actually put the brakes on the aging process, and should be an essential component of any life-extension strategy.

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Safe and Well Tolerated

But what about safety and tolerability? According to Dr. Anderson, “chromium is much safer than just about anything we [put] into our bodies.” Putting his money where his mouth is, Dr. Anderson takes 200 mcg of supplemental chromium every day, plus the amount present in his daily multivitamin. “If I had diabetes, I’d take 200 mcg at least two or three times daily,” he adds.

In light of research by Dr. Anderson and other scientists, the USDA’s Food and Nutrition Board revised the dietary reference intake (formerly the recommended dietary allowance, or RDA) for chromium in 2001. Noting that there have never been any reported adverse effects from high dosages of chromium, the board declined to establish a tolerable upper intake level for chromium. By default, the government has acknowledged that there is no known dose of supplemental chromium that is too high to be safe.

The dietary reference intake level of chromium currently is 35 mcg per day for adult men and 25 mcg per day for adult women. Because pregnancy and lactation are known to deplete chromium stores, taking 30 mcg daily is recommended for pregnant women, and women who are breastfeeding should take at least 45 mcg daily. Dr. Anderson postulates that doses well above these recommended minimum levels may be necessary to treat chronic diseases. Citing a study conducted in China, he notes that patients there received up to 1,000 mcg of chromium per day, a dose that proved “highly effective” in relieving many of the symptoms of type II diabetes.³⁶

Reiterating his conviction that chromium supplementation is safe, Dr. Anderson says, “Chromium is one of the safest nutrients we have.” As further proof, he points to the new government-issued guidelines for chromium consumption. “There’s no upper limit for chromium. At the highest levels tested there’s no toxicity . . . it’s safer than water.” That may sound like hyperbole, but there is an empirical basis for this claim. As Dr. Anderson notes, there is no discernible toxicity when one consumes 100 times the dietary reference intake of chromium. By contrast, consuming 100 times the daily requirement for water, were it physically possible to do so, would certainly be toxic.



Niacin Reinforces Positive Effects

In addition to reducing high blood sugar, elevating low blood sugar, decreasing dependence on supplemental insulin, and aiding in weight loss and muscle building, chromium supplementation may also play an important role in lowering high blood pressure and preventing heart disease. These effects are especially dramatic when niacin is taken along with chromium. Niacin, or vitamin B3, tends to

reinforce chromium’s beneficial effects, especially on the lipid profile.³⁷⁻⁵⁰

Physicians have known for years that lowering so-called “bad” LDL cholesterol is of paramount importance if one is to avoid heart disease risk. Cholesterol is manufactured by the body and is a necessary and natural component of cell membranes and steroid hormones. It is also present in some foods we consume. But excess cholesterol promotes atherosclerosis, whether it is a genetically determined consequence of cholesterol overproduction by the liver or the result of dietary overindulgence. And atherosclerosis generally yields disastrous health consequences, ranging from heart attacks to stroke.

In 2001, the National Cholesterol Education Program (NCEP) issued NCEP-III, a series of new guidelines for the aggressive management of cholesterol and triglycerides.⁵¹ NCEP-III is a clarion call for doctors to treat elevated LDL and triglycerides more aggressively, with prescriptions for diet, exercise, and drug therapy. One of the more striking features of NCEP-III is its reclassification of the status of HDL (high-density lipoprotein). HDL is beneficial because it acts to transport cholesterol out of the arteries and back to the liver where it can be cleared

CHROMIUM AND THE BRAIN

Chromium may be responsible for yet more beneficial effects within the body. A decade ago, one scientist postulated that aging is associated with a decrease in insulin activity in the brain. This hypothesis presumes that by improving insulin’s effectiveness, the hypothalamus, an important control center within the brain, should remain in a “more functionally youthful state.”⁵⁹ Chromium supplementation, it was noted, might well rejuvenate the hypothalamus of older individuals.

More recently, other researchers have proposed that chromium may have an antidepressant-like effect. Scientists at the Oxford University in England recently demonstrated in laboratory animals that supplemental chromium enhances the activity of neurochemicals associated with mood control. They believe that chromium facilitates the transport of certain amino acids within the brain and central nervous system. Further

from the body.⁵² NCEP-III raised the limit at which a person's HDL is to be considered too low. In effect, NCEP-III placed new emphasis on the importance not only of lowering total cholesterol and LDL, but also of raising HDL.⁵¹ Physicians are slowly recognizing that low HDL may be just as unhealthy as high LDL.

research into this intriguing effect is pending.⁶⁰

The good news is that niacin and chromium both raise levels of "good" HDL while lowering "bad" LDL and triglyceride levels. Niacin alone may raise HDL by as much as 15% while lowering total cholesterol and triglycerides by up to 20% and 40%, respectively.⁵³ While doctors have known this for more than 30 years, some have resisted prescribing therapeutic doses of niacin, probably because of side effects caused by early forms of the vitamin. Some patients have experienced flushing of the face and neck or other side effects from high-dose niacin therapy. But dosing and formulation changes have provided a form of niacin that is both effective and well tolerated.^{40-42, 47}

In fact, the simple nutrient niacin is so good at improving one's lipid profile that it inspired one researcher to declare: "[Niacin] is the most effective agent available for increasing HDL levels while lowering levels of LDL and triglycerides, and improving other lipid risk factors such as lipoprotein(a)."⁴² Expensive statin drugs are most commonly prescribed to treat lipid imbalances, but physicians are beginning to recognize that niacin is one of the most effective, inexpensive treatments available for lipid therapy.^{44,48,49}

Unfounded Concerns

Some researchers have expressed concern that supplemental chromium may increase oxidative stress among diabetics. But at least one research team found the opposite effect among patients with high levels of HbA(1C), a reliable indicator of chronic hyperglycemia.¹¹ In any event, it has also been shown that simple antioxidants such as resveratrol, which is derived from plant sources, readily neutralize the kinds of excess free radicals presumed to be caused by high-dose chromium supplementation.⁵⁴⁻⁵⁸



Chromium clearly plays an important role in normal carbohydrate and lipid metabolism. It is equally clear that many millions of people are likely to be deficient in this essential micronutrient, and would therefore benefit by adding supplemental chromium to their daily diet.

CHROMIUM SUPPLEMENTATION LOWERS DEPRESSION-ASSOCIATED CARBOHYDRATE CRAVINGS

A double-blind, placebo-controlled study presented on June 2, 2004, at a conference of the National Institutes of Mental Health New Drug Evaluation Unit found that supplementation with chromium picolinate decreased carbohydrate cravings in people with atypical depression. Atypical depression is a frequently undiagnosed type of depression characterized by carbohydrate cravings, mood swings, and weight gain, among other symptoms.

One hundred thirteen atypical depression sufferers at several centers received 400 micrograms of chromium for two weeks, followed by four weeks of 600 micrograms of chromium or a placebo. Individuals who reported the highest level of carbohydrate craving experienced the greatest reduction in symptoms. They found that carbohydrate cravings were significantly reduced among those who received chromium. Mood swings and fatigue were improved among the chromium takers as well.

Researchers have hypothesized that chromium's role in insulin function may be its link with carbohydrate cravings and atypical depression. Insulin's effect on metabolic function may improve brain serotonin levels that, when low, are associated with carbohydrate cravings and depression. Carbohydrate consumption may be an attempt to stimulate insulin, which elevates brain serotonin levels. Chromium, however, increases the body's insulin response, which may fight carbohydrate craving and depression.

References

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