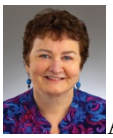
Aunt Cathy's Guide to Nutrition: **10/2015**

Chromium


Aunt Cathy

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Chromium is an important nutrient that has been in the news recently. There have been some unsubstantiated claims for supplemental chromium as a weight loss or muscle-building aid, and careful studies have NOT found it to be helpful for these uses.

However, chromium adequacy IS important for controlling blood sugar and fat metabolism (including triglyceride and cholesterol metabolism), and the diet of many Americans contains considerably less chromium than is recommended.

Current expert opinion is this:

1. Inadequate chromium intake can certainly contribute to high blood sugar (diabetes), to high blood triglycerides, and to cholesterol problems.

A high triglyceride level in a person with diabetes is considered an important risk factor for stroke. **In a study of men and women with diabetes who had high triglycerides, providing supplemental chromium just at the standard intake level of 200 mcg/day resulted in a significant improvement in triglyceride levels.** (For those who are interested: The study was randomly assigned placebo-controlled trial with a crossover design)

The form of chromium used in that study was "**chromium picolinate**." It appears that not all forms of chromium supplements are equally well absorbed and utilized by the body. The picolinate form has been shown to be one of the best absorbed sources.

Chromium chloride, the form used in many multivitamins is less well absorbed. There is much interest now in studying the relative safety and the absorbability of the various chromium–containing compounds now used as supplements. There are also several large NIH studies underway exploring chromium supplementation in a variety of medical conditions. Stay tuned . . .

2. Many people in America eat a diet that does not provide enough chromium because much of the grain products we use have been "refined."

The refining process removes many important vitamins and minerals in grain, including chromium and magnesium in particular, but many others as well. Most are not added back when the product is "enriched."

For example, **only iron, and three B vitamins (thiamin, riboflavin and niacin) are added back to original levels.** [Since 1998, folic acid is now added to grain products in the US at a level above the original grain content.]

The "germ" of the grain is the nutrient-dense part … that's the part that will become the baby plant. The rest of the grain is starch for fuel for the baby plant, and a fibrous protective bran coating. Guess which part we remove from the grain when we refine it! If you guessed the bran and the germ, you'd be right.

That means that we eat a lot of processed grain foods that contain just the starch calories and the few added-back nutrients mentioned above. That's it. **We don't add back the many micronutrients that are necessary to properly metabolize the starch, and we do not add back the bran fiber and its many heath-related benefits.** These include increasing the feeling of **satiety** associated with eating it and (possibly) assisting in helping us limit our intake of less satisfying sources of starch calories.

In spite of recommendations, most Americans eat few **whole grains and legumes**. Interestingly, **when people with diabetes are fed a diet that is rich in foods that are "high in fiber", their blood sugar control often improves.** This is often attributed to the effects of the fiber itself on absorption of carbohydrate in the intestine.

However, along with that effect there is the "accidental" **great improvement in chromium and magnesium intake with a diet that is high in fiber-rich foods, and both of these nutrients have a role in blood sugar control and in many metabolic pathways.** In other words, there are many players on the team supporting healthy blood sugars; it makes sense to assure that all are present in appropriate amounts.

Eating lots of foods with refined sugar and flour -- even “healthy” non-sugary carbohydrate foods like rice or pasta -- increases the body's need for chromium. This is because chromium is needed in order to use carbohydrate for energy, and these refined foods are not good sources of it. If one cannot use the carbohydrate for energy, it is converted to fat and stored for later.

The richest food sources of chromium are: brewer's yeast, wheat germ, and oysters. Broccoli, cheese, prunes, peanuts, whole grain cereals, mushrooms, asparagus and peas are also sources.

3. If a supplement is used, how much is recommended?

For healthy people, there is no apparent advantage associated with taking more than the recommended **"adequate and safe" range of 50-200 mcg/day**, although studies suggest that levels up to twice this amount may be helpful for some people with diabetes.

This amount, even with a high fiber diet, is not dangerous. An interesting question is: “Do people with diabetes actually need more chromium than other people, or does people’s poor chromium status contribute to their developing the diabetes?”

That has not been evaluated yet. It may be that they do better with a higher supplement level because their chromium stores are quite low and giving just a regular maintenance dose may not get them up to speed.

In any case, ASSURING ADEQUACY instead of assuming adequacy is the way to go. However, as with all minerals, excessive chromium can be toxic. Toxic chromium levels are usually only seen with **accidental food contamination**, not from a generous intake of chromium-containing foods. One would not overdose on chromium from eating a big bunch of wheat germ.

But it may be possible to cause chromium poisoning from **excessive use of chromium supplements**. It also appears that **excessive** supplementation may interfere with absorption of other important nutrients. So the safest course is to avoid **supplementation** above the recommended 200 mcg upper level unless advised to do so by a physician.

10/2015 CB Note:

Lots of new research has come out since I first wrote this paper a few years back.

I do plan to update it, but for the moment I have attached some references and conclusions from just the past year you can see that this is an even bigger topic now, and there are a couple of new supplemental forms of chromium of interest, such as chromium mallate.

[The complete abstracts are also available if you want to see them … just ask.]

The important thing is that I haven't seen anything to make me take away anything I said above … there are just more evidence that it is important to assure adequacy of chromium for everyone, with special attention to people with diabetes.

Recent Abstracts (Shortened versions)

Sci Rep. 2015 Oct 22;5:15606

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Chromium exposure and incidence of metabolic syndrome among American young adults over a 23-year follow-up: the CARDIA Trace Element Study. Sci Rep. 2015 Oct 22;5:15606. doi: 10.1038/srep15606.

Studies suggest that chromium deficiency is associated with elevated levels of fasting blood glucose, circulating insulin, cholesterol and triglycerides, and decreased proportion of lean body mass. However, data directly relating chromium levels to metabolic syndrome (MetS) risk are lacking. … Toenail chromium levels were inversely and longitudinally associated with incidence of MetS in American young adults. This inverse association was mainly explained by its relation to blood lipids.

Metab Brain Dis. 2015 Oct 19.

Chromium supplementation improved post-stroke brain infarction and hyperglycemia.

Hyperglycemia is common after acute stroke and is associated with a worse outcome of stroke. Thus, a better understanding of stress hyperglycemia is helpful to the prevention and therapeutic treatment of stroke. … Daily chromium supplementation increased tissue chromium levels, attenuated brain infarction, improved hyperglycemia, and decreased plasma levels of glucagon and corticosterone in stroke rats. Our findings suggest that stroke rats show disturbance of tissue chromium homeostasis with a net loss through urinary excretion and chromium mobilization and loss might be an alternative mechanism responsible for post-stroke hyperglycemia.

J Nutr. 2015 Oct 7.

Risk of Type 2 Diabetes Is Lower in US Adults Taking Chromium-Containing Supplements.

Dietary supplement use is widespread in the United States. Although it has been suggested that chromium has potential beneficial effects in type 2 diabetes (T2D) in in vitro and small in vivo human studies, chromium supplementation in diabetes has not been investigated at the population level.The objective of this study was to examine the use and potential benefits of chromium supplementation in T2D by examining NHANES data… CONCLUSIONS: Over one-half the adult US population consumes nutritional supplements, and over one-quarter consumes supplemental chromium. **The odds of having T2D were lower in those who, in the previous 30 d, had consumed supplements containing chromium.** …

PLoS One. 2015 Sep 25;10(9):e0138646.

A Dietary Supplement Containing Cinnamon, Chromium and Carnosine Decreases Fasting Plasma Glucose and Increases Lean Mass in Overweight or Obese Pre-Diabetic Subjects: A Randomized, Placebo-Controlled Trial.

Our aim was to evaluate the effects of 4-month treatment with a dietary supplement containing cinnamon, chromium and carnosine in moderately obese or overweight pre-diabetic subjects, the primary outcome being change in fasting plasma glucose (FPG) level. Other parameters of plasma glucose homeostasis,… **CONCLUSIONS: Four-month treatment with a dietary supplement containing cinnamon, chromium and carnosine decreased FPG and increased fat-free mass in overweight or obese pre-diabetic subjects. These beneficial effects might open up new avenues in the prevention of diabetes.**

Curr Opin Clin Nutr Metab Care. 2015 Nov;18(6):588-92.

Chromium, zinc and magnesium status in type 1 diabetes.

Chromium, zinc, and magnesium are involved in insulin signal transduction, glucose metabolism, and cellular antioxidative defense. This review details the statuses of chromium, zinc, and magnesium in type 1 diabetes patients…. SUMMARY: Many studies indicated positive correlations between decreased levels of serum chromium, zinc, and magnesium and poor glycemic control. **The supplementation of type 1 diabetes patients with zinc, magnesium, and chromium may help to control diabetes and prevent diabetes-related oxidative injuries, but require further study.**

Nutr Metab (Lond). 2015 May 22;12:19.

Chlorogenic acid/chromium supplement rescues diet-induced insulin resistance and obesity in mice.

… These findings underscore the important role that **chlorogenic acid and chromium play in maintaining glucose metabolism and insulin response in mice fed a high-fat diet.**

Curr Top Med Chem. 2015 Aug 26.

Organoselenium Small Molecules and Chromium(III) Complexes for Intervention in Chronic Low-grade Inflammation and Type 2 Diabetes.

There is growing evidence to suggest that chronic, low-grade inflammation occurs in abdominal obesity, insulin resistance, type 2 diabetes mellitus and related complications, and that pro-inflammatory cytokines play an important role in the onset and progression of type 2 diabetes. These findings consequently provide new opportunities for the use of anti-inflammatory strategies to correct the metabolic disorders. … **Here, we review recent advances in development of organoselenium small molecules and chromium(III) complexes to intervene in chronic low-grade inflammation and type 2 diabetes, and discuss their mode of action, potential molecular mechanisms and toxicity.**

J Trace Elem Med Biol. 2015 Oct;32:66-72. doi: 10.1016/j.jtemb.2015.05.006. Epub 2015 May 28.

Beneficial effects of oral chromium picolinate supplementation on glycemic control in patients with type 2 diabetes: A randomized clinical study.

Chromium is an essential mineral that contributes to normal glucose function and lipid metabolism. This study evaluated the effect of chromium picolinate (CrPic) supplementation in patients with type 2 diabetes mellitus (T2DM). … **CONCLUSIONS: CrPic supplementation had a beneficial effect on glycemic control in patients with poorly controlled T2DM, without affecting the lipid profile. Additional studies are necessary to investigate the effect of long-term CrPic supplementation.**

PLoS One. 2015 Jul 17;10(7):e0133374.

The Effects of Leucine, Zinc, and Chromium Supplements on Inflammatory Events of the Respiratory System in Type 2 Diabetic Rats.

Diabetes mellitus is a major cause of serious micro- and macrovascular diseases that affect nearly every system in the body, including the respiratory system. Non-enzymatic protein glycation due to hyperglycaemic stress has fundamental implications due to the large capillary network and amount of connective tissue in the lung. … **The present results demonstrate beneficial effects and amelioration of inflammation in the respiratory system of type 2 diabetic rats by leucine, zinc, and chromium supplements, probably due to their hypoglycaemic and antioxidant properties. Using safe and effective nutritional supplements, such as leucine, chromium and zinc, to replace proven conventional medical treatments may help to control diabetes and/or its complications.**

Nutr J. 2015 Feb 13;14:14.

Effect of chromium supplementation on glycated hemoglobin and fasting plasma glucose in patients with diabetes mellitus.

Chromium (Cr) is a trace element involved in glucose homeostasis. We aim to evaluate and quantify the effects of Cr supplementation on A1C and FPG in patients with T2DM. **CONCLUSIONS: Cr supplementation with brewer's yeast may provide marginal benefits in lowering FPG in patients with T2DM compared to placebo however it did not have any effect on A1C.**

PLoS One. 2015 May 5;10(5):e0125952.

Type 2 diabetic rats on diet supplemented with chromium malate show improved glycometabolism, glycometabolism-related enzyme levels and lipid metabolism.

Our previous study showed that chromium malate improved the regulation of blood glucose in mice with alloxan-induced diabetes. The present study was designed to evaluate the effect of chromium malate on glycometabolism, glycometabolism-related enzymes and lipid metabolism in type 2 diabetic rats. Our previous study showed that chromium malate improved the regulation of blood glucose in mice with alloxan-induced diabetes. The present study was designed to evaluate the effect of chromium malate on glycometabolism, glycometabolism-related enzymes and lipid metabolism in type 2 diabetic rats. …The results indicated that the curative effects of **chromium malate on glycometabolism, glycometabolism-related enzymes and lipid metabolism changes are better than those of chromium picolinate and chromium trichloride.** Chromium malate contributes to glucose uptake and transport in order to improved glycometabolism and glycometabolism-related enzymes.

Biol Trace Elem Res. 2015 Nov;168(1):181-95.

Evaluation of 90-day Repeated Dose Oral Toxicity, Glycometabolism, Learning and Memory Ability, and Related Enzyme of Chromium Malate Supplementation in Sprague-Dawley Rats.

Our previous study showed that chromium malate improved the regulation of blood glucose in mice with alloxan-induced diabetes. The present study was designed to evaluate the 90-day oral toxicity of chromium malate in Sprague-Dawley rats. … The results indicated that supplementation with chromium malate did not cause measurable toxicity and has no obvious effect on glycometabolism and related enzymes, learning and memory ability, and related enzymes and lipid metabolism of female and male rats. **The results of this study suggest that chromium malate is safe for human consumption.**

Chemosphere. 2015 Aug;132:101-7.

Association of trace elements with lipid profiles and glycaemic control in patients with type 1 diabetes mellitus in northern Sardinia, Italy: An observational study.

Sardinia is an Italian region with a high incidence of type 1 diabetes mellitus. This study aimed to determine the associations of trace elements with lipid profiles and glycaemic control in patients with T1DM. … **In conclusion, the results of this study indicate that trace elements show different associations with lipid levels and glycaemic control in T1DM. Zinc, Fe, and Se were associated with lipid levels whereas Cu and Cr were associated with HbA1c%.**

Med Hypotheses. 2015 Jul;85(1):45-8.

Dietary chromium supplementation for targeted treatment of diabetes patients with comorbid depression and binge eating.

Dietary chromium supplementation for the treatment of diabetes remains controversial. The prevailing view that chromium supplementation for glucose regulation is unjustified has been based upon prior studies showing mixed, modest-sized effects in patients with type 2 diabetes (T2DM). Based on chromium's potential to improve insulin, dopamine, and serotonin function, we hypothesize that chromium has a greater glucoregulatory effect in individuals who have concurrent disturbances in dopamine and serotonin function--that is, complex patients with comorbid diabetes, depression, and binge eating. We propose, as suggested by the collective data to date, the need to go beyond the "one size fits all" approach to chromium supplementation and put forth a series of experiments designed to link physiological and neurobehavioral processes in the chromium response phenotype.

BMC Complement Altern Med. 2015 Feb 5;15:16.

Anti-diabetic potential of chromium histidinate in diabetic retinopathy rats.

Chromium (Cr) is commonly used as a complementary medicine for diabetes mellitus. Several studies suggest that Cr intakes may improve glucose metabolism and decrease oxidative stress. Therefore, we aimed to assess the effects of chromium histidinate (CrHis) supplementation using a range of reliable biomarkers of oxidative damage and histopathological changes in rats with diabetic retinopathy. … **CONCLUSIONS: These results verify that CrHis has critical beneficial effects against retinal complications**. Although detailed studies are required for the evaluation of the exact mechanism of the ameliorative effects of CrHis against diabetic complications, these preliminary experimental findings demonstrate that CrHis exhibits antidiabetic effects in a rat model of diabetic retinopathy by regulating the glucose metabolism and suppressing retinal tissue damage.

J Inorg Biochem. 2015 May;146:97-103.

Controlling diabetes by chromium complexes: The role of the ligands.

…. **Recent efforts have been made to develop new chromium complexes with novel ligands. Although fair amounts of reviews have been published to emphasize the biological activity, preclinical and clinical information of chromium picolinate, this mini-review is trying to cover the entire picture of updated research efforts on various chromium complexes highlighting the role of ligands**. …

Biol Trace Elem Res. 2015 Jul;166(1):7-12.

Is the Pharmacological Mode of Action of Chromium(III) as a Second Messenger?

Although recent studies have shown that chromium (as the trivalent ion) is not an essential trace element, it has been demonstrated to generate beneficial effects at pharmacologically relevant doses on insulin sensitivity and cholesterol levels of rodent models of insulin insensitivity, including models of type 2 diabetes. The mode of action of Cr(III) at a molecular level is still an area of active debate; however, the movement of Cr(III) in the body, particularly in response to changes in insulin concentration, suggests that Cr(III) could act as a second messenger, amplifying insulin signaling. The evidence for the pharmacological mechanism of Cr(III)'s ability to increase insulin sensitivity by acting as a second messenger is reviewed, and proposals for testing this hypothesis are described.

Adv Biomed Res. 2014 Nov 29;3:235..

Chromium level in prediction of diabetes in pre-diabetic patients.

Chromium supplementations (Cr) have been shown to exert beneficial effects in the management of type-2 diabetes. Prevalence of Cr deficiency in pre-diabetic patients is not well-understood, therefore, the aim of this study was to evaluate the extent of this prevalence…. **Conclusion: The levels of Cr deficiency are relatively common in patients with pre-diabetes, and it is necessary to screen patients with diabetes and pre-diabetes according to the American Diabetes Association guidelines, with regard to the Cr level and action should be taken to eliminate the Cr deficiency in these patients.**

Cir Cir. 2014 Jan-Feb;82(1):119-25.

Micronutrients and diabetes, the case of minerals.

Minerals are essential nutrients for the body, are of inorganic nature which gives them the characteristic of being resistant to heat, are involved in a lot of chemical reactions in metabolism, regulating electrolyte balance, in maintaining bone, in the process of blood clotting and the transmission of nerve impulses, particularly its role as enzyme cofactors confers a key role in various physiological processes. Glucose homeostasis involves a fine coordination of events where hormonal control by insulin plays a key role. However, the role of minerals like magnesium, zinc, chromium, iron and selenium in the diabetes is less obvious and in some cases may be controversial. This review shows the knowledge of these five elements and their correlation with diabetes.