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## Heart Disease, Soft Drinks and Copper

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Recently a popular news story warned that high, long-term consumption of sweetened beverages such as soft drinks and soda may increase health risks. A study published in the journal *Circulation* ([ahajournals.org/journal/cir](http://ahajournals.org/journal/cir). Malik, VS, et al. 2019) found that sugar-sweetened beverages as well as artificially sweetened beverages were associated with mortality rates. The study consisted of over 37,000 men and over 80,000 women who were followed for over 20 years. Their conclusion found that consumption of the sugar sweetened beverage was associated primarily with cardiovascular mortality.

### Heart Disease in Men and Women

Typically heart attacks occur more in men than women depending upon age. The average age for men having heart attacks is about 66 years compared to women whose average age is 70. Heart attacks can happen at any age and in either sex, but the rate is similar or equal in both men and women after 60 years of age. In fact heart disease is the number one cause of death in both sex. The study published in *Circulation* also found that women fifty years and older, who consumed diet drinks had a 29% increased risk for heart attack and 23% increased risk for stroke.

### High Fructose and Heart Disease

It seems that high fructose intake is the underlying factor in contributing to many of these statistics. The American Journal of Clinical Nutrition (Stanhope, KL, et al, 101, 2015) reported that the consumption of beverages containing 10, 17.5 or 25 percent of fructose produced a linear dose-response increase in factors contributing to cardiovascular mortality. Risk factors include, lipid and lipoprotein abnormalities, uric acid, triglycerides, cholesterol, and apolipoprotein.

The American Heart Association (AHA) published their recommendations for the reduction in the intake of added sugars found in soft drinks and processed foods.

They state in the journal *Circulation* that "High intakes of dietary sugars in the setting of a worldwide pandemic of obesity and cardiovascular disease has heightened concerns about the adverse effects of excessive consumption of sugars." The mean intake for all persons was found to be over 22 teaspoons per day. However, it appears that in the age group between 14 to 18 years, consumption is about 34 teaspoons per day. High fructose corn syrup used in most sweetened beverages is playing a role in the epidemics of insulin resistance, obesity, dyslipidemia and type 2 diabetes. (Johnson, RK, et al. Dietary Sugars Intake and Cardiovascular Health. A scientific statement from the American Heart Association. *Circulation*. Circ. [ahajournals.org](http://ahajournals.org). June 2010).

### The Fructose Copper-Connection

So what is the connection between fructose and heart disease? The answer may lie in the fact that fructose is known to antagonize the mineral copper. It has been well documented that adding fructose to the diets of animals induces copper deficiency. (Klevay, LM. Adding Fructose to diets of animals can induce copper deficiency. *J. Biomed and Pharmacol.* 2018). Although the same has not been sufficiently studied in humans, the response of humans to a high fructose intake is not unlike the response to copper deficiency caused by high fructose intake in animals.

### Copper and Heart Health

Copper is a constituent of many important enzymes including cytochrome c oxidase, superoxide dismutase (cytoplasm), ceruloplasmin, dopamine B-hydroxylase, lysyl oxidase, tyrosinase, and monoamine oxidase. It is involved in oxidoreductase activity, electron transport, free radical scavenging, neurotransmission as well as immunity. As stated by DiNicolantonio, "in relation to ischemic heart disease (IHD) the heart is one of the major organs affected by copper deficiency and produce almost every risk factor for IHD." He lists the detrimental health effects of copper deficiency;

high cholesterol, poor glucose tolerance, abnormal ECG activity, increased LDL and triglycerides and lowered HDL, increased susceptibility of lipoproteins and tissues to oxidative damage. Increased blood pressure, plasminogen activator inhibitor type I, early and advanced glycation end products, atherosclerosis, fatty liver degeneration, cardiac hypertrophy and cardiomyopathy, optic neuropathy, iron overload and connective tissue damage (DiNicolantonio, JJ, et al. Copper deficiency may be a leading cause of ischemic heart disease. *Open Heart*, B.M.J, 2018).

High dietary fructose intake is associated with non-alcoholic fatty liver degeneration (NALFD) in animal models and is thought to be due to poor copper status. Patients with NALFD have been found to have low copper availability. Liver and serum copper levels are found inversely correlated with the severity of NALFD. (Song, M, et al. Copper-Fructose Interactions: A Novel Mechanism in the Pathogenesis of NALFD. *Nutrients*, 10,11, 2018).

Lee, SH et al. reported their findings of low hair copper and its relationship to the risk of developing NALFD. Individuals with lower hair copper concentrations were found to have higher blood pressure and increased body mass index and waist circumference and lower HDL. Those who had NALFD were found to have significantly lower hair copper levels. (Lee, S, et al. Low hair copper concentration is related to a high risk of nonalcoholic fatty liver disease in adults. *J.Trace Elem. Med Biol* 50, 2018.)

### **Factors Contributing to Copper Deficiency**

Copper should be adequate and in proper balance with other nutritional minerals for normal copper related functions. However, an antagonistic relationship exists between copper and other nutrients that can lead to an imbalance or copper deficiency, and are presented here:

<https://traceelements.com/Docs/The%20Nutritional%20Relationships%20of%20Copper.pdf>. Copper deficiency can also be caused by genetic predisposition and malabsorption conditions. Bariatric surgery can also be a major cause of acquired copper deficiency contributing to hematological and neurological symptoms. (Yarandi, SS, et al. Optic neuropathy, myelopathy, anemia and neutropenia caused by acquired copper deficiency after gastric bypass surgery. *J. Clin. Gastroent.* 48, 2014.)

### **Copper Deficiency and Cardiac Disease**

A study by Kedzierska, et al. found that plasma copper concentration can significantly affect activity of

the erythrocyte sodium transport system, and that copper supplementation may have therapeutic benefits for hypertensive patients. Higher activity of Na/K ATPase, Na/Li and Na/H exchanger was seen in the erythrocyte membrane in the presence of low plasma copper. (Kedzierska, K, et al. Copper Modifies the Activity of Sodium-Transporting Systems in Erythrocyte Membrane in Patients with Essential Hypertension. *Biol. Trace Elem.Res.* 107, 2005).

Reviewing results from HTMA studies at TEL, we typically see copper deficiency in patients with hypertension and metabolic syndrome. Most patients with hypertension do in fact show an elevated tissue sodium and potassium concentration along with a low tissue calcium and magnesium. The benefits of copper supplementation not only lies in the increase of copper-activated free radical scavenging enzymes such as superoxide dismutase (S.O.D.) and increased availability of nitrogen oxide, but in its calcium retention effects as well. An increase in tissue calcium would aid in the reduction of sodium retention and thereby reduce elevated blood pressure.

### **Heart Disease and Gender**

The development of heart disease is known to differ between men and women. However, copper imbalance may be a key factor in both. The fact that men tend to have a greater incidence of heart attacks at an earlier age than women may rest in metabolic types. Men tend to naturally be more sympathetic dominant with lower tissue copper concentrations while women tend to be more para-sympathetic dominant with higher tissue copper. However, after menopause women develop heart attacks at a similar rate as men. This is due to the reduction in estrogen which often corresponds to a reduction in copper retention. Often mineral patterns of women before and after menopause show a shift in their mineral patterns from para-sympathetic toward sympathetic dominance along with a lowering of copper and elevation of their zinc-to-copper ratio.

### **Hair Zinc and Copper Levels and Predisposition to Heart Disease**

Zinc and copper concentrations were measured in the hair and urine of patients who were hospitalized for myocardial infarction (MI). Mineral concentrations were also determined in the patient's descendants and compared to a control group who had no family history of MI. Zinc was found to be higher and copper lower in the descendants of patients with MI suggesting a consistent rise in zinc and lowering of copper reserves in genetically predisposed individuals. The study suggests that in MI patients, a genetic disorder of mineral imbalance at a younger age can be

used in predicting susceptibility to heart disease in individuals prior to onset and diagnosis in asymptomatic patients. (Taneja, SK, et al. Detection of Potentially Myocardial Infarction Susceptible Individuals in Indian Population: A Mathematical Model Based on Copper and Zinc Status. Biol.Trace Elem. Res. 75, 2000).

**Conclusion**

It should also be noted that excess tissue copper can result in decreased zinc-activated S.O.D. activity and thereby, may contribute to hypertension and elevated cholesterol and triglycerides as well. This biphasic effect emphasizes the need to assess individual needs and treat the patient accordingly, instead of merely treating symptoms. HTMA can be used as a screening tool for the assessment of copper status and more importantly, copper's relationship to other nutrients.





