WHO Report

Nutrient Minerals in Drinking Water and the Potential Health Consequences of Consumption of Demineralized and Remineralized and Altered Mineral Content Drinking Water

Charge to the expert group

The group was asked to examine several issues relating to the composition of drinking water that has undergone significant treatment relevant to drinking water guidelines aimed at protecting and enhancing public health:

- What is the potential contribution of drinking water to total nutrition?
- What are the drinking water intake requirements for individuals considering climate, exercise, age, etc.?
- Which substances are often found in drinking water that can contribute significantly to health and well-being?
- Under what conditions can drinking water be a significant contribution to the total dietary intake of certain beneficial substances?
- What conclusions can be drawn on the relationship between calcium, magnesium and other trace elements in water and mortality from certain types of cardiovascular disease?
- For which substances, if any, can a case be made for supplementation of mineral content in treated drinking water from the public health perspective?
- What is the role of fluoride in drinking water with respect to dental benefits and dental fluorosis and skeletal fluorosis?

Drinking water as a source of essential minerals

With all of these considerations in mind, the following nutrients commonly found in drinking water at potentially significant levels and of particular interest in this assessment are:

- Calcium
- Magnesium
- Fluoride
- Sodium
- Copper
- Selenium
- Potassium

The Water Quality Association's comment letter (and supporting documents) to the World Health Organization addressed the draft paper *Nutrient Minerals in Drinking Water and the Potential Health Consequences of Consumption of Demineralized and Remineralized and Altered Mineral Content Drinking Water.* That document suggests a direct correlation between softened water and an increase in heart disease.

According to the WQA, the importance of this paper to the POU/POE industry is profound and, "while the paper appears to be a fairly thorough review of available literature by a group of very respected scientists and experts in the fields of epidemiology and nutrition, the WQA is worried that it may precipitously and inappropriately affect both consumer attitudes and the directives and regulations of governments."

"Opponents of our products have already jumped on this preliminary report to assail the use of water softeners," the association reports.

The following text is excerpted from the WHO draft report. The entire report is available on the WHO website, http://www.who.int/water_sanitation_health/dwq/nutconsensus/en/ where it may be downloaded free of charge.

Water hardness and cardiovascular disease

Over 80 observational epidemiological studies have been reported in the published literature since 1957 relating water hardness and cardiovascular disease risks. Most, but not all, of the studies found an inverse (protective) association between cardiovascular disease mortality and increased water hardness (measured by calcium carbonate or another hardness parameter and/or the calcium and magnesium content of water). The associations were as reported in countries throughout the world by different investigators with different study designs. Both population and individual-based studies have observed benefits. The most frequently reported benefit was a reduction in ischemic heart disease mortality. In addition, there is supporting evidence from experimental and clinical investigations suggesting a plausible mechanism of action for calcium and magnesium. The significance of the epidemiological findings is that beneficial health effects can possibly be extended to large population groups on a long-term basis by adjusting the water quality.

The strongest epidemiological evidence for beneficial effects was for drinking water magnesium concentrations; there was also evidence but not as strong for drinking water calcium concentrations. Magnesium and possibly calcium may be effective in reducing blood pressure in hypertensive individuals. Studies have shown magnesium exerts multiple cellular and molecular effects on cardiac and vascular smooth muscle cells, which is a plausible basis to explain its protective action. Treatment of suspected myocardial infarction cases with intravenous magnesium salts dramatically reduced mortality due to arrhythmia and infarction thirty days post therapy. Other micronutrients and trace elements have not been extensively considered in these epidemiologic studies, but nutritional studies suggest that some may have an indirect or direct beneficial role associated with their presence in drinking water. On the other hand, a recently published study in Finland suggested that

iron and copper in drinking water might be associated with increased risks of heart attack. More studies are needed to better understand the possible risks and benefits of these essential and other trace elements found in water.

Hard water is a reliable and stable source of calcium and sometimes magnesium although the absolute and relative concentrations will vary greatly by source. Consumption of moderately hard water containing typical amounts of calcium and magnesium may provide an important incremental percentage of their daily intake. Inadequate total dietary intakes of calcium and magnesium are common worldwide. Therefore, an incremental contribution from drinking water can be an important supplement to approach more ideal total daily intakes. Moreover, hard water can reduce the losses of calcium, magnesium and other essential minerals from food during cooking. If low mineralized water is used for food and beverage production, reduced levels of Ca, Mg and other essential elements would also occur in those products. Low intakes would occur not only because of the lower contribution of these minerals from water used in beverages, but also because of the high losses of the minerals from food products (e.g., vegetables, cereals, potatoes or meat) into water during cooking.

The group concluded that there is sufficient epidemiological evidence of an inverse relationship between calcium and magnesium concentrations in drinking water and ischemic heart disease mortality, and that consumption of water containing calcium and magnesium, and therefore also the reintroduction of Mg and Ca into demineralized water in the remineralization process would likely provide health benefits in those consumer populations. There are no known harmful human health effects associated with the addition of calcium and magnesium within a large range and the nutritional benefits are well known. In addition, limited but suggestive evidence exists for benefits associated with other diseases (stroke, renal stone formation, cognitive impairment in elderly, very low birth weight, bone fractures among children, pregnancy complications, hypertension, and possibly some cancers). Adding calcium and magnesium to the demineralized water would be a relatively inexpensive preventive intervention that does not require individual behavioral change, and it is already done as part of many water treatment processes. The intervention could not only provide health benefits but also help reduce medical care costs.

Epidemiological studies in the United Kingdom, United States, Sweden, Russia and France, and research on changes in calcium/phosphorus metabolism and bone decalcification provide information about drinking water levels of calcium and magnesium (and water hardness) that may provide beneficial health effects. It has been suggested that reduced cardiovascular mortality and other health benefits would be associated with minimum levels of approximately 20 to 30 mg/l calcium and 10 mg/l magnesium in drinking water. The percentage of the recommended daily allowance (RDA) of calcium and magnesium provided by drinking water at these minimum levels will vary among and within countries. Thus, lower levels in water may be sufficient to provide health benefits in some areas, but higher levels may be beneficial in others. Some limited information suggests that the desirable levels may be higher in some circumstances. Overall health benefits will be dependent upon total dietary intakes and other factors in addition to water levels. Because the exposure-response information is limited, further analyses, and possibly additional studies, are needed to determine the levels of calcium and magnesium that may provide most favorable population benefits in each location.

Recommendations

There is a need for more precise data on the impact of fluid composition and intake, including water and other aqueous beverages, on nutrient intake under a broader range of physiologic and climatic conditions for sensitive population segments in order to more precisely evaluate the importance of minerals in drinking water on mineral nutrition.

Studies on the mineral nutritional content and adequacy of world diets should be conducted so that adequacies and inadequacies can be documented and mitigated.

National governments and water suppliers should be encouraged to practice stabilization of demineralized water with additives that will increase calcium and magnesium levels and to conduct studies that monitor public health impacts.

Community and bottled water suppliers should provide information to the general public and health professionals on the composition of water for constituents including possibly beneficial substances. Water bottlers should also consider providing waters with mineral compositions that are beneficial for population segments.

Additional studies should be conducted on potential health consequences associated with consumption of both high and low mineral content waters in addition to consideration of water hardness. When studies are conducted, investigators should consider exposures to both calcium and magnesium levels in addition to other minerals and trace elements that may be present in hard and soft waters

Unless properly stabilized, demineralized and some natural waters are corrosive to plumbing resulting in damage to the plumbing systems and also potentially increased exposure to metals such as copper and lead. Properly stabilized water should be provided by suppliers, and appropriate plumbing materials should be used.

Information should be provided on methods of application of home water softening devices so that consumers will also have access to mineralized water for drinking and cooking.

In the revisions of the GDWQ, WHO should consider the beneficial roles of nutrient minerals and also water hardness characteristics when it establishes numerical drinking water guidelines for those substances. Chemicals used in the treatment of drinking water should be assured to be of suitable quality for that application so as not to contribute unacceptable amounts of potentially harmful chemicals to the finished water.

Additional epidemiologic studies of populations that consume low mineral or demineralized water need to be conducted. Studies should be focused on consumption of low mineral content or distilled waters by population subgroups.

Investigators may take advantage of natural experiments (communities changing water sources and treatment) to conduct population intervention studies to evaluate potential health impacts. For example, studies could compare communities before and after changing source waters, or the introduction of treatment technologies that significantly change water composition.