# Water—The Choice for Long-Term Health

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The debate on what kind of water is the best choice for long-term consumption has raged on and on. There are advocates of using only distilled water and that anything less is impure and unnatural. There are others who solemnly warn that sickness and early death will surely come from drinking distilled water for more than a couple of months. There are others who say that minerals should be added to the water. And others who say your water should be structured to make it "wetter." It should be oxygenated and energized. And then there are some who say it doesn't matter what kind of water it is as long as you drink enough it will cure almost all diseases—you're not sick, you're thirsty. What is the truth? Does anyone really know what kind of water is best for you? Has anyone looked at this problem scientifically and done controlled studies with animals and people to see what really works in reality, not just in theory?

## *The Need to Purify Our Water*

### Chlorine and Chloramine

In most parts of the world it is assumed that you should not drink the water coming from the tap. In America we have strived to provide tap water that is safe to drink. One of the greatest achievements in the last century has been the provision of clean water and hygienic sewage treatment. While we have achieved a bacteriologically safe water, we have made a different sort of problem with the chemicals added to the municipal water..

The first problem with municipal water is the chlorine. Chlorine is a cheap, effective disinfectant. It kills the germs that spread disease through the water supply to susceptible people. Chlorine can also combine with organic chemicals to form byproducts such as trihalomethanes (THM) and haloacetic acids, which have been linked to reproductive disorders and cancer. A population-based case-control study in Nova Scotia and eastern Ontario found more than a two-fold increased risk of stillbirth for women whose residence's had 80 ppb THM level or higher (1). Note: the EPA limit is 80 ppb total THM. Two other studies that measured reproductive outcomes have not found such dramatic results, but did find some evidence of adverse effects at high exposures to some disinfection by-products (2, 3).

A case-control study in Iowa found a 2.4-fold elevated risk of rectal cancer among men, but not women, who had long-term exposure to chlorinated surface water and had a low fiber diet, compared to men with no exposure to chlorinated surface water and a high fiber diet. Men with a high fiber diet and exposure to chlorinated surface water did not have elevated risk of rectal cancer either, indicating that dietary factors can help decrease the risk of detrimental effects of environmental chemical exposure (4).

A pooled analysis of 6 case-control studies of bladder cancer found that men, but not women, who were exposed to any THM (1 ppb compared to no exposure) had a significant 24 percent increase in risk of bladder cancer (5). A very recent study from Spain found significant increased risk of bladder cancer upon exposure to water with levels of THM commonly found in industrial countries. Drinking it, bathing and showering in it , and swimming in it all increased risk of bladder cancer (6). It is important to note here that drinking the water is not the only way to get THMs into the body. The use of hot water for washing hands and bathing or showering causes THMs to vaporize so that they can be inhaled and then go directly into the bloodstream through the lungs (7). Showering with chlorinated water is probably the greatest exposure route (8).

The disinfectant byproducts mentioned above occur with minute levels of organic molecules present in the water. What happens when you drink chlorinated water, mixing it with saliva and stomach solution that is very rich in nitrogen-containing organic molecules that can react with chlorine? Do any similarly toxic byproducts get formed right in your own stomach?

It turns out that this question was studied in the early 90s. Chlorine isn't simply oxidized to a chloride ion. It is a very reactive molecule (thus its disinfecting properties) and it does react with molecules in your stomach. Chlorinated water reacted with the various amino acids forming organic chloramines (9, 10). The toxicity of these compounds isn't clear, but the above cited results might include not just the effects of disinfection byproducts made at the water treatment plant, but also those made right inside the people drinking the chlorinated water. When the EPA conducted a 2-year rat and mice study of chlorinated and chloraminated water they found higher incidence of mononuclear cell leukemia in female F344/N rats at mid- and high-dose levels for both chlorine (leukemia rates: control, 8/50; low-dose, 7/50; mid-dose, 19/51; high-dose, 16/50) and chloramine (leukemia rates: control 8/50; low dose, 11/50; mid dose, 15/50; and high dose, 16/50) (11). No other lesions or neoplasms were found that were clearly associated with the drinking water in the male rats or the male or female mice, so this evidence was called "equivocal." Immune suppression (reduced spleen weights, macrophage activity, and antibody production) was also seen when rats were given drinking water containing chlorine or monochloramine at levels much lower than the EPA 2-year study (12). How do these high-dose short-term studies correlate to our experience with chronic low-dose exposures? The cited studies on bladder cancer and colon cancer are part of the answer. Chlorine and chloramine are both highly reactive substances that do not belong in drinking water.

Some communities, in an effort to reduce the amount of disinfectant byproducts, have switched to chloramine. Typical reductions in THMs range from 40 to 80 percent http://sfwater.org/detail.cfm/MC_ID/13/MSC_ID/166/MTO_ID/399/C_ID/2213. Large amounts of this water will appear green rather than blue. Chloramine is a combination of chlorine and ammonia which does not evaporate from the water like chlorine, making it a stable disinfectant. It can be removed with activated carbon filtration devices, but it requires a much longer contact time to do so compared to chlorine removal, on the order of 5 to 10 minutes. So, common tap filters do not remove chloramine effectively from the tap water. Chloramine must be removed from water used for aquariums and kidney dialysis. Reverse osmosis units do not remove chloramine, but rely on carbon filtration and ion exchange resins to remove it before the RO treatment. Chloramine actually damages the RO membranes. The activated carbon can oxidize the chlorine atom, if contact time is long enough, and then a cation exchange resin can absorb the ammonia.

There have been some reports of dermatitis and respiratory conditions being worsened by exposure to chloramine-treated water, particularly during bathing and showering. Even workers at a swimming pool who did not get into the water had increased respiratory symptoms as a result of the air near the pool 12030720 17107995. Unfortunately, chloramine still generates many of the same toxic compounds in our bodies, but at a slightly lower level than chlorine.

So, the bottom line with chlorine is that it kills germs, but it is a highly reactive chemical that generates potentially carcinogenic compounds in the water or in your body. It needs to be removed from the water before drinking it. Chloramine also is very reactive and generates carcinogenic compounds. Many of the byproducts of these disinfectants are not even known. Chloramine is not removed by standard carbon filters, but requires special attention.

## Fluoride

Next to chlorination, fluoridation of the public water supply has been hailed as one of the great public health victories of the last century. But there is a lot of controversy about water fluoridation, to put it mildly. No study has demonstrated that fluoride is an essential nutrient for people. Above very trace levels the research is accumulating that fluoride has a very toxic effect on many systems of the body.

Added fluoride compounds have been shown not to be necessary for healthy bones and teeth. Data from the World Health Organization (shown in Figure 1) shows that in Europe, where fluoridation is uncommon, the rates of cavities among children has decreased as much in recent years as in areas where fluoridation is practiced (13). So, the claim that fluoride in the water is beneficial has really not held up to independent scientific scrutiny.

Furthermore, there are adverse effects of taking in too much fluoride. First, systemic fluoridation leads to more brittle, fragile bones (14). Eighteen studies are cited on Fluoride Action Networks' website showing that fluoride would increase bone mass density but reduce strength of the bone at the same time, due to fluoride-caused defects in the bone structure.

Fluoride combines readily with low levels of aluminum in drinking water and tends to accumulate in the brain. Levels of aluminum in the brains of rats drinking distilled water with sodium fluoride added had twice the amount of aluminum in their brains as control rats, and rats drinking water laced with aluminum fluoride had even higher levels (15). Neurotoxic morphological changes were seen in brain tissue of the rats in both the sodium fluoride and aluminum fluoride groups compared to the control rats, including changes similar to what is seen in Alzheimer's disease. And the level of fluoride used in this study? It was 0.95 ppm fluoride, the same level as what is recommended by public health officials to "protect teeth".

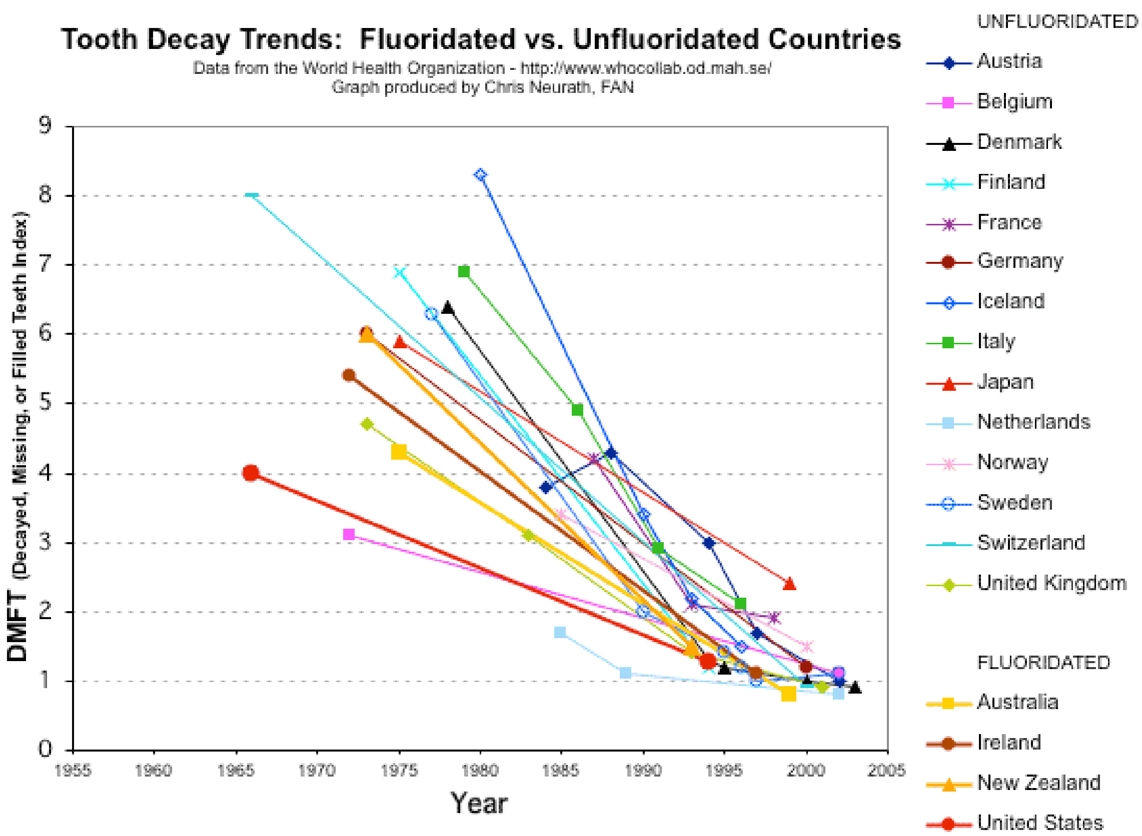



**Figure 1. Tooth Decay Declines in All Nations Regardless of Fluoridation Status.**

Second, fluoride and iodine, both being halogens, compete for uptake by the thyroid gland. This results in hypothyroidism in some cases. In China high fluoride intake (0.88 mg/L drinking water, slightly lower than the public health level of 1 mg/L here in the USA) exacerbated low iodine intakes, resulting in lower IQs among school age children (16). Lower IQ was found in children with normal levels of iodine and "high" levels of fluoride, but it was much worse when "high" fluoride levels were combined with low iodine levels. In another Chinese study a dose-response relationship was shown between levels of fluoride in the drinking water (mostly below the current EPA limit of 4 mg/L) and IQ of school age children (17). These studies indicate that even accepted levels of fluoride in the water may affect children's intelligence, and that fluoride has a direct effect on the central nervous system's development.

There are quite a few more possible detrimental effects of fluoride consumption. Fluoride accumulates in the pineal gland in the brain, causing lowered melatonin secretion in pre-pubertal gerbils and earlier onset of sexual maturation in female gerbils (18). Whether this effect occurs in people is unknown. Fluoride may be a contributing factor to a very rare bone cancer called osteosarcoma. Research results in this area have not been consistent. Fluoride can cause an elevation in blood sugar levels, exacerbating diabetes in rats (19). Young adults with dental fluorosis were found to have a significant correlation between plasma fluoride levels and impaired glucose tolerance. When water without excess fluoride was provided the impaired glucose tolerance was normalized (20). Interestingly, iodine has been reported to have the opposing effect of decreasing blood sugar levels. Fluoride is known to inhibit many enzymes from their normal activity, including the deiodinase which converts T4 into T3 in peripheral tissues, which results in symptoms of hypothyroidism even though the pituitary gland is not out of normal functioning range, judging by the TSH value.

In spring 2006 the National Research Council issued a report on their review of the EPA's safe limit of 4 mg/L fluoride. Their conclusion was that the current limit is too high, but they were not commissioned to determine a new lower safe level. One of the committee persons was Dr. Kathleen M. Thiessen, a senior scientist at SENES Oak Ridge, Inc., Center for Risk Analysis. In an interview she made this comment: "The concentration of fluoride that's used for supposedly the benefits is also in the range where adverse health effects are seen or begin to be seen. There's an overlap of the so-called beneficial range and the so-called adverse health effect range. And that's no margin of safety" (21).

How is fluoride removed from water if it is present? The best ways are with a reverse osmosis system or a water distiller. There are a few specialized filters available that are designed to remove fluoride, but generally filters do not remove fluoride from the water supply. The resin that removes fluoride and arsenic works best at acidic pH, which is not commonly found in the public water supply as it is corrosive to the piping.

## Arsenic

Arsenic is an element that occurs naturally in the earth's crust. Arsenic is also used industrially, another potential source of contamination. Ground water can contain arsenic in unhealthy levels. Arsenic is odorless and tasteless, so it can only be detected by chemical analysis of the water. The EPA states, "Non-cancer effects can include thickening and discoloration of the skin, stomach pain, nausea, vomiting; diarrhea; numbness in hands and feet; partial paralysis; and blindness. Arsenic has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate." (22) The maximum contaminant levels is set at 10 ppm (10 mg/L), while the maximum contaminant level goal is 0 ppm. There isn't really a benefit to having arsenic in your drinking water at any level.

Since arsenic is a semi-metal it can be difficult for filters to remove it. Standard carbon filters do not remove it. ResinTech's SIR900 media, which is specific for lead, arsenic, and fluoride, works best at slightly acidic pH, which is usually not the case for ground water. Reverse osmosis does a good job and distillation performs very well for removing arsenic.

## Emerging Pollutants

A new class of pollutants has been added to our environment with the advent of the chemical age—pharmaceuticals, personal care products, and industrial-source pollutants. A lot of effort has gone into making the waste streams of American industries be much cleaner. However, little has been done about consumer-generated pollution. What happens to the drugs we take? Only a small amount is utilized by the body and the rest goes to the sewer treatment plant. And all of the things we put on our bodies and in our hair also end up the same place.

Ingredients from pharmaceuticals and personal care products have been found in rivers and streams worldwide as noted in Table 1. Waste treatment plants catch some of these compounds but they are not designed (yet) to handle the many drugs that come their way. While these drugs get diluted in the water, the effect on the environment is not yet known. Fish from a stream in northern Texas that received effluent from a STP (sewage treatment plant) had SSRI antidepressants detected at levels greater than 0.1 ng/g in all the examined tissues in four separate species (23), demonstrating that some of these chemicals can bio-accumulate. Could it do the same to those who drink this water? The cholesterol-lowering drug gemfibrozil was found to concentrate in goldfish over 100-fold, using environmentally relevant concentrations, and caused a 50% decrease in testosterone (24). The non-steroidal anti-inflammatory drug diclofenac, mentioned a few times in Table 1 and very common in surface waters globally, caused the same kind of negative side-effects in brown trout at environmentally relevant concentrations as seen in mammalian species (25). A mix of pharmaceuticals can cause complex and unpredictable effects, as illustrated by toxicity studies with the fresh-water zooplankton Daphnia magna. Exposure to a single pharmaceutical in the range of 1-100 µg/L caused no effect. But a mix of 36 µg/L fluoxetine and 10 µg/L clofibric acid caused significant deformities, while a mix of 3 to 5 antibiotics, total antibiotic concentration 30-500 µg/L, changed the sex ratio of offspring (26). As Olive Wendell Holmes, MD said, "If we doctors threw all our medicines into the sea, it would be that much better for our patients and that much worse for the fish." Turns out he was more right than he knew, for most of our medicines do go to the fish. And what is bad for fish can't be good for us, either.

**Table 1. Global Detection of Pharmaceuticals in Sewage Treatment Plant Effluent and Surface Waters.**

| ***Location*** | ***Sampling*** | ***Comment*** | ***Ref.*** |
|---|---|---|---|
| UK | 12 pharmaceuticals screened in STP effluent | 10/12 found. Propanolol (beta-blocker for hypertension), diclofenac (NSAID), ibuprofen, mefenamic acid, dextropropoxyphene (opioid | (27) |

| ***Location*** | ***Sampling*** | ***Comment*** | ***Ref.*** |
|---|---|---|---|
| | | pain drug), trimethoprim, erythromycin, acetyl-sulfamethoxazole, sulfamethoxazole, tamoxifen | |
| Western Europe | 36 pollutants screened in STP effluents | Benzotriazoles, benzothiazole-2-sulfonate, diclofenac, carbamazepine (anti-convulsant) found at 1-10 µg/L. Half of detected pollutants not removed by treatment | (28) |
| southern France | 16 pharmaceuticals screened in drinking water reservoirs and STP effluent | Acetominophen, caffeine, diclofenac frequently found | (29) |
| Upper Detroit River | 17 pharmaceuticals screened in STP effluent | 15 of 17 detected | (30) |
| South Korea | 14 pharmaceuticals screened in surface water and STP effluents | Iopromide, naproxen, carbamazepine, caffeine frequently found | (31) |
| UK rivers | | Ibuprofen, acetaminophen, and salbutamol found in all locations sampled | (32) |
| Nevada, New England, Michigan | Azithromycin (antibiotic) and urobilin (breakdown product of hemoglobin), used to detect human waste | Azithromycin and urobilin found in many of the 21 sources tested | (33) |
| southern Ontario | 28 pharmaceuticals surveyed in 7 rivers | 14 detected including carbamazepine and monensin | (34) |
| Italy | STP effluent | 19 pharmaceuticals detected. Most abundant were atenolol, ciprofloxacin, furosemide, hydrochlorothiazide, ofloxacin, ranitidine, sulphamethoxazole | (35) |
| Lower river Tyne, UK | STP effluent and surface water | 11/13 pharmaceuticals found in 9 STP samples. 7 found in 18 surface water samples | (36) |
| Finland | 7 STP effluents and 3 rivers receiving STP effluent | All 7 STP effluents contained all 5 screened pharmaceuticals (ibuprofen, naproxen, ketoprofen, diclofenac, bezafibrate). Found in rivers, too. | (37) |
| USA | Run-off from crops irrigated with treated wastewater | Found pharmaceuticals (e.g. carbamazepine, gemfibrozil, carisoprodol), insect repellent, alkyl phosphate flame retardant chemicals | (38) |
| Berlin, Germany | Screened 10 pharmaceuticals in STP effluent and surface water | Found some at µg/L concentration in effluent, lower levels in surface water | (39) |
| Santa Ana River, California | Screened 5 pharmaceuticals, hormones, and metabolites of the surfactant alkylphenol polyethoxylate | Ibuprofen found in STP effluents, surfactant metabolites detected in effluents. | (40) |

| ***Location*** | ***Sampling*** | ***Comment*** | ***Ref.*** |
|---|---|---|---|
| Nether-lands | Surface, drinking, and ground water samples | 56 samples analyzed, pharmaceuticals found in almost all surface, groundwater, and in some drinking water samples | (41) |
| Louisiana and Ontario | Screened 9 pharmaceuticals and personal care products | Naproxen detected in Louisiana STP effluent and in surface water at both sites. Triclosan (antibiotic in personal care products) found in Louisiana STP effluent | (42) |
| Switzer-land | Screened 6 pharmaceuticals in 3 STP effluents, 2 rivers and Lake Greifensee | Found all 6 pharmaceuticals in STP effluents. Some persisted in surface waters. | (43) |

STP = sewage treatment plant

## Minerals and Metals in the Water

Are minerals and metals in your water beneficial to you? The answer might depend on which minerals or metals you are talking about. Calcium carbonate and magnesium oxide are the two most common and abundant minerals found in ground water. They are basically rock minerals. The calcium and magnesium are not very usable from these sources and might cause more harm than good.

It is believed that all calcium from food and supplements must be ionized first before absorption. This is the general pathway for mineral absorption, except for chelated minerals, which are absorbed via amino acid uptake pathways. However, experimental evidence for this assumption is based on the report of a single experiment in 1967 by Ivanovich and coworkers. In this report there was **one** person who had hypochlorohydria (produced little or no stomach acid) who, when treated with a drug which stimulated gastric acid secretion, had increased calcium absorption from calcium carbonate (referenced in (44)). Based on this single report came the belief that acid was required for calcium absorption. More recently Kanerva and coworkers fed calcium carbonate to rats in the duodenum, thus by-passing the stomach and its acid. Though dissolution of the calcium carbonate prior to feeding did increase the absorption of calcium, the researchers found that the calcium carbonate was absorbed even without being dissolved beforehand (45). This seems to indicate that the entire molecule was being absorbed as the calcium carbonate salt. Evidence of this exists in people as well. Bo-Linn and coworkers showed that calcium absorption from calcium carbonate was the same whether the pH in the stomach was maintained at pH 7.4 or pH 3.0. They concluded that gastric acid doesn't play a role in normal calcium absorption (46). Maybe the calcium is ionized in the acidic microlayer at the small intestinal wall before being absorbed. But maybe not all of it is ionized before absorption.

So, what happens to this calcium carbonate that is absorbed intact? Does it accumulate and contribute to disease processes? Evidence for this is based on personal testimonies, rather than controlled studies. A review of the scientific literature did not find a link between hard water and arthritis, gall stones, kidney stones, or arteriosclerosis (hardening of the arteries). The health reformers Norman Walker and Paul Bragg strongly recommended using only distilled water to get rid of the inorganic minerals. Their recommendations were based on their own experience and the experience of those around them. All of the conditions attributed to hard water are complex and multi-faceted and require multiple dietary and lifestyle changes to reverse. It is simplistic to say that they are due to the inorganic minerals in the water.

Having said this, some people have experienced relief of arthritic pain using distilled water and then seen it come back when they use well water again. So, while there is not hard proof that ground water causes these conditions, it might be helpful to use water without inorganic minerals in it to reverse these conditions, along with a comprehensive diet and lifestyle program.

### How to Purify Water

In summary of this section, we want to remove chlorine or chloramine, fluoride, arsenic, lead, industrial organic pollutants, pharmaceutical residues, viruses and bacteria, and rock minerals from our drinking water. There isn't a single process that does all of this. Activated carbon does an excellent job with organic contaminants, but doesn't do much with mineral or metal contaminants. Certain filter resins remove some minerals (arsenic, fluoride, lead) under acidic conditions. Reverse osmosis units rely on activated carbon to remove the organic contaminants. RO units do purify the water well, but bacterial fouling can be a problem, resulting in reduced performance. The best method is to combine an activated carbon filter and distiller to fully remove all of these contaminants. This method yields pure water consistently.

Using an activated carbon filter and a distiller gives you water that you can have confidence in. You know that it is pure water and there are no contaminants in it.

## *Low Mineral Water*

Now that you know why and how to get pure water, you may wonder about what you have done. Is this pure water aggressive? Will this pure $H_2O$ leach minerals from my body? Should I add some minerals back to my water? I thought our bodies could only use organic minerals from plants? We will look at these questions in this next section.

Until recently we did not have much information on this question. We advised people as we have been taught—pure water is not aggressive, it will not leach beneficial minerals from your body and there are no negative long-term consequences from drinking pure water. However, in recent years the issue of pure water (called low mineral water) has been examined globally due to increased use of purified water via desalination plants. Worldwide more than 6 billion gallons of desalinated water are made every day. The World Health Organization (WHO) convened an expert panel in 2003 to look at the question of nutrients in water. Their report (47), "Nutrients in Drinking Water" was published in 2005, and is available from their website at www.who.int/water_sanitation_health/dwq/nutrientsindw/en/. Unfortunately, many of the original studies on this subject were done in Russia, so they are not directly accessible to us English speakers. The main question that the WHO report was this: What are the health consequences of drinking desalinated water that has been modified in mineral content?

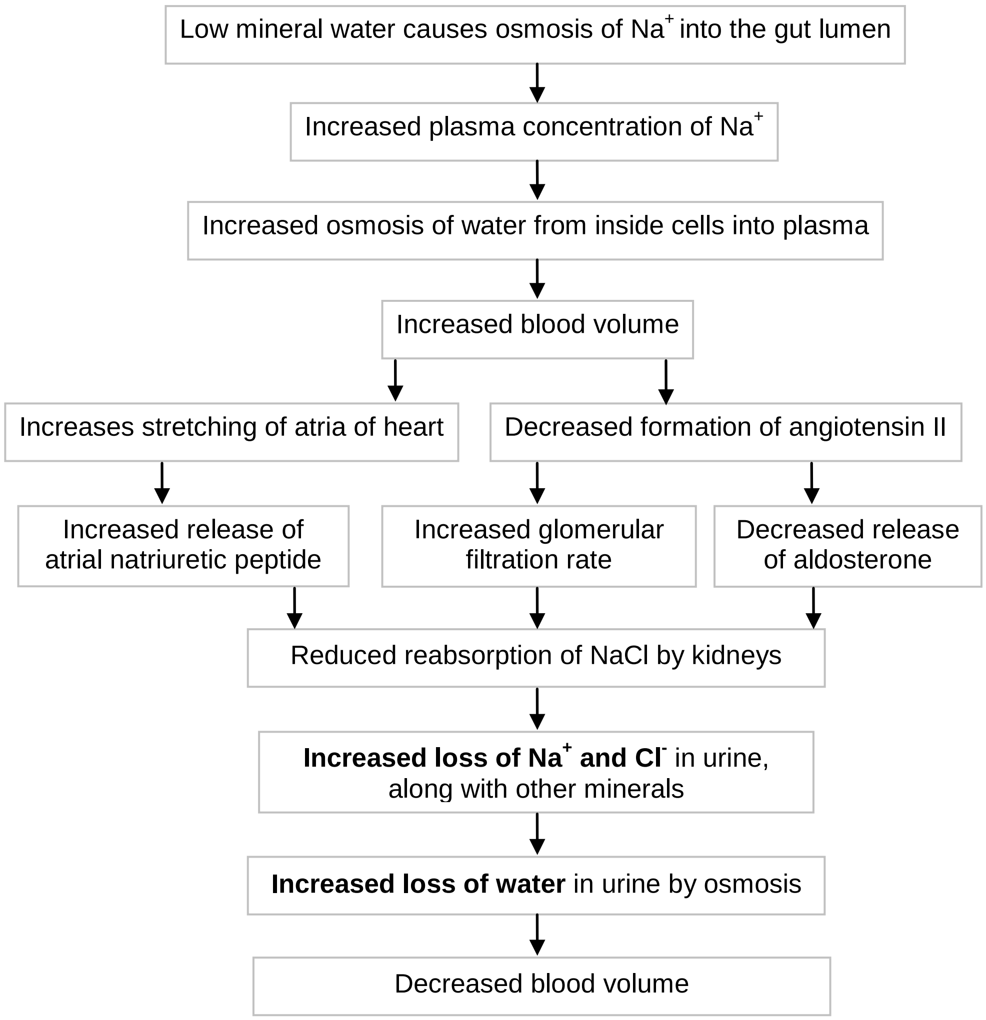
## Aggressive Water

The first question to deal with here is the aggressiveness of purified, low mineral water. Opponents of distilled water argue that distilled water is aggressive, acidic, and takes minerals out of the body. In the desalination industry it is an industry-wide rule that water must be partially remineralized before being sent down the distribution pipeline because the purified water is too aggressive and will cause severe corrosion of the pipeline. This fact makes it very clear that low mineral water is indeed aggressive in nature. This fact cannot be disputed. One report from a desalination plant in Cyprus producing over 10 million gallons of purified water per day found that iron was being leached into the water supply. By alkalizing the water through more lime, carbon dioxide, and magnesium sulfate the iron corrosion was stabilized (48).

So, we've seen that low mineral water is aggressive in pipelines. How does it react in an animal or in people? In Russia Rakhmanin carried out a one-year experiment with rats using low mineral water. Negative effects were found. These rats had an increase of extracellular body water, increased sodium concentration in the blood, increased urine output, and increased losses of sodium and chloride ions in the urine (49). There were also hormonal changes including reduced secretions of tri-iodothyronine and aldosterone, and increased secretion of cortisol, and morphological changes in the kidneys. There was evidence of reduce skeletal ossification of rat fetuses of the dams given distilled water during the one-year study as well. Many of these same findings were repeated in human volunteer studies—increased urine production (almost 20%), increased body water volume, increased sodium concentration in the blood, decreased potassium concentration in the blood, and increased elimination of sodium, potassium, chloride, magnesium, and calcium ions from the body (49).

The physiological mechanism for these changes is understood. It is theorized that the pure water causes an influx of sodium ions into the gut due to osmosis. Whenever there is excess sodium in the gut it causes a cascade of responses in order to maintain balance in electrolytes, as shown in a current anatomy and physiology textbook (50).

**Figure 2. Mechanism for Mineral Loss Due to Drinking Distilled Water.**




The excess sodium in the gut increases blood sodium levels and pulls water from intracellular fluid into the bloodstream. This increased volume then raises levels of atrial natriuretic peptide, decreases formation of angiotensin II, and decreases aldosterone secretions by the adrenal cortex. These three responses cause a greater loss of sodium and chloride ions and water through the kidneys into the urine in order to reduce blood volume. This cascade of homeostatic control was designed to take into account different levels of electrolyte intake, and works well, especially for elevated intakes. However, when no sodium was initially taken in, yet more was excreted this creates a problem that has to be re-corrected, which the body happily does, though not perfectly. So, there is some hard data showing that there are extra losses of minerals as a result a drinking low mineral water. In spite of these homeostatic controls, minerals really can be removed from the body by distilled water. This is a major finding, because advocates of distilled water claim that the minerals in the body are protected in some way from being taken out by distilled water. It is a nice idea, but these animal and human studies argue that it really doesn't work that way.

## Forms of Minerals and their Bioavailability

So, low mineral water can remove minerals from the body. So, should we add some minerals back to our pure water to make it more alkaline and less aggressive? But doesn't the body only use organic minerals? Can the body utilize ionic minerals found in water or are they just deposited in the wrong places? What form of minerals would be best in water?

Before we can discuss what the body does with the minerals in the water, we need to look at the four different forms of minerals that exist. There are mineral forms that do not dissolve in water, organic minerals, coordination complex minerals, and ionic mineral salts.

Calcium carbonate and magnesium oxide are very sparingly soluble in water—basically rock. These mineral salts are poorly absorbed but common sources of minerals for the body. Calcium carbonate is not the best form of calcium to have in your water. Under conditions of low gastric acidity (like on an empty stomach or between meals) calcium carbonate present in water may not be ionized before being absorbed. Studies have shown that small neutral calcium salts, such as calcium carbonate can be absorbed as a whole intact molecule (45, 51). Most of this will be cleared through the urine, but in some people a very small amount may accumulate in the body, leading to arthritic pain and other problems. So, calcium carbonate and magnesium oxide are bad forms of minerals to have in your water.

A few minerals will form a covalent bound to a carbon atom, as found in thyroid hormones and selenomethionine. These are truly "organified" minerals. The mineral is not available from these compounds except by cleavage via a specific enzyme. Although iodine and selenium exist as organic forms in the body, they can be taken up by the body in their ionic forms, sodium selenite and potassium iodide. If this weren't true, there would be no way for sodium selenite to be harmful in large doses, which it is. If potassium iodide couldn't be taken up, then iodized salt would have had no influence on goiter at all. But it does; fractional iodide absorption is generally greater than 90 percent.

Many minerals will form a coordination complex with organic molecules. These complexes are more fragile than covalent bonds, but vary in strength, depending on the organic molecule. Examples are the cobalt in B-12, iron in hemoglobin, magnesium in chlorophyll, zinc in metalloproteinases, various minerals with EDTA (a chelator), calcium oxalate (in rhubarb, spinach, and chards), calcium, magnesium, and zinc phytates, and all forms of amino acid chelates. These are very common forms of minerals, which are classified as "organic." Absorption of minerals from coordinate complexes depends either on the absorption of the organic part (the mineral just tags along), or the minerals can be removed from their complex, become ionized, and be absorbed as ions. Minerals can be removed from these types of complexes without destroying the entire molecule. For the body to re-use the minerals from these complexes the mineral must be released into an ionic form. Magnesium is easily removed from chlorophyll, while minerals are difficult to remove from EDTA, from phytate, or from oxalate. So, absorption of minerals from coordination complexes depends on the specific organic molecule in question.

The last forms of minerals are those that exist loosely bound in biological fluids as ionic electrolytes. This includes sodium, chloride, potassium, and some magnesium (magnesium chloride, magnesium sulfate, and others) and calcium (calcium citrate, calcium chloride, and others). Breast milk contains free ionic minerals as well as organic and complexed minerals (52-57). Your blood and cells contain free ionic minerals. Even carrot juice contains ions. If it didn't you wouldn't be able to pass a current through it and light up a little water tester light with it. But you can. It lights up very well. The body is well designed to take up ionic minerals. This is established human physiology, not theory, despite what we may have been taught by many natural health advocates.

The fact that the human body can freely utilize ionic minerals is an important point. They are not dead minerals. In fact they are very critically important for transmitting electricity in our bodies. Every nerve signal and muscle contraction depends on ionic minerals. Ionic minerals are very much a part of human life.

So, the issue of minerals is more complicated than simply organic or inorganic minerals. There are four different kinds of mineral bonds with varying degrees of usefulness. It isn't accurate to call any of these different mineral types living or dead. That is a false classification or simplification that has been passed down to us. It is easier to grasp, and motivates people to eat raw fruits and vegetables, but it is still wrong. We need to understand that ionic minerals are beneficial and part of us all of the time.

## Studies of Mineral Absorption from Water

Now that we have established that the body can absorb ionic minerals and utilizes ions all the time, we can look at some specific studies regarding mineral absorption from water. Animals who were given zinc or magnesium in their drinking water had much higher levels of zinc and magnesium in their blood than a comparison group that was fed much higher levels of these minerals in their food but provided with low-mineral water to drink (58). Another animal study by Kondratyuk (cited in (49)) divided the animals into 4 groups. The experimental groups were (1) tap water, (2) low-mineral water, (3) low-mineral water supplemented with iodide, cobalt, copper, manganese, molybdenum, zinc, and fluoride, and (4) low-mineral water supplemented with these same elements but at ten times higher concentration. The low-mineral water (group 2) had a 19% lower hemoglobin content compared to the tap water. Differences were even greater when compared to the supplement groups. There was also up to six-fold differences in mineral concentrations in muscle tissue between the different groups. This experiment clearly demonstrates that these minerals were bio-available from water in an ionic form.

Now, there are quite a few human studies that have looked at mineral absorption from ground water. Even though magnesium oxide and calcium carbonate are not the desired form of minerals, people still received some benefit from them. First, there are over 80 population studies in the past 50 years that have looked at hard water and the incidence of ischemic cardiovascular disease. The balance of the studies indicate that increased magnesium intake from hard water is better for heart health than softened or low-mineral water. So, water is a convenient and useful source of minerals, especially of ionic minerals.

## Health Effects of Low Mineral Water

A population study was carried out in the Soviet city of Shevchenko, where the water supply was distilled water that had been partially remineralized but was still low in total dissolved solids (TDS) and calcium. It was reported that the population there had a decreased activity of alkaline phosphatase, lower levels of serum calcium and phosphorus, and enhanced loss of bone mineral (49). Women, and especially pregnant women, experienced the biggest differences from normal.

Another study from Russia, from the Ust-Ilim region, compared the populations in two cities that were supplied with different water—one with low TDS, low calcium, and low magnesium, and the second one with higher TDS, calcium, and magnesium in the water. Other mineral levels in the water were also determined. The population in the area supplied with the lower mineral water showed higher incidence rates of goiter, hypertension, ischemic heart disease, gastric and duodenal ulcers, chronic gastritis, cholecystitis (inflammation of the gall bladder) and nephritis (inflammation of the kidneys) (49). Children in this area with the low mineral water had slower physical development and more growth abnormalities, newborn mortality rates were higher, and pregnant women had more edema and anemia. Clearly, the minerals in the water were benefiting this population.

In another Russian study women living in four Siberian cities, which had increasing amounts of calcium and magnesium in their water, were followed for health outcomes. In the two cities with the lowest levels of water minerals there were more cardiovascular problems, higher blood pressure, headaches, dizziness, and osteoporosis compared to the two cities with the highest levels of water minerals (49).

## Health Effects of Low Mineral Water in a Well-Nourished Population?

Now, would these effects be seen in a population that is well nourished, getting adequate minerals from their foods? And especially, would these effects be seen in a population eating a whole foods diet that is very high in fruits and vegetables?

I think no, these problems really wouldn't be as common in a population that is well-nourished. By far the majority of our minerals come from our foods, not from our water. But, remember that the studies showed that low mineral water caused an extra loss of sodium, chloride, potassium, magnesium, and calcium ions from the body. Low mineral water isn't neutral, but it pulls out minerals from the body. So, instead of adding extra 40 mg of magnesium and an extra 100 mg of calcium from the water, a person drinking distilled or RO water will have to make up that much and more, due to the extra loss of minerals. Over time this could have an impact. Not everyone will be affected, but people drinking larger amounts of water or getting fewer minerals from their foods will be impacted first.

In addition to other people's studies, we are conducting one study ourselves to see if the kind of drinking water used makes a difference. In an ongoing bone health study, our initial screening survey of 57 small-framed women following the Hallelujah Diet showed that only 14 had good bone density, with 43 in the less than optimal range. Exercise is a very important factor, and some women admitted not getting enough exercise. Thyroid function and dietary iodine intake may be a factor as well. Sunshine is also vitally important to your bones, but distilled water could play a factor, too. Most dietary factors were very similar in this group of women following the Hallelujah Diet, including drinking distilled water. Low mineral water isn't neutral; it pulls out minerals from the body. As these women change to drinking remineralized water, make sure they are getting enough exercise and sunshine we hope to see a marked improvement in their bone health over the next three years.

My conclusion here is that distilled water is a great step in obtaining pure uncontaminated drinking water. But it isn't good to stop there. Distilled water, and other low mineral waters, are not neutral waters; they actually take away from you, whereas water with optimal concentrations of ionic minerals in it actually supply your body with good building material.

## A Solution to Improve Low Mineral Water

So, what would be the optimal kind of water for long-term health? First, we start with water purified with activated carbon and distillation. This is consistently the purest, safest water you can obtain.

But don't stop there. Now you need to add back in the stuff you really want from your water. An optimal water contains ionic minerals (not rock minerals), is slightly alkaline, and is preferably structured to increase absorption. In looking at optimizing water several parameters were included—pH, total dissolved solids (TDS), oxidation-reduction potential (ORP), and surface tension. Acid-base balance is determined by pH; water below pH 7 is acidic and aggressive. ORP measures the balance between antioxidants (with reducing ability) and oxidants; the higher the ORP, the fewer antioxidants are present. Surface tension measures the structuring of the water. A collaboration of scientists has found evidence that water doesn't always exist in its rigid tetrahedral structure, but exists in chains and rings as well (59, 60). Increasing the proportion of water which is in chain or ring structures lowers its surface tension, making it more easily absorbed and assimilated.

Table 2 shows a comparison between the properties of a few different kinds of water and distilled water with different products added to it, including WaterMax. As mentioned distilled water is slightly acidic, has a high ORP value and a low TDS value. The Evian water is not acidic, but still has a high ORP value. As mentioned above, minerals found in ground water are not in optimal forms for use by the body. ConcenTrace, a product sold to remineralize water, does improve the TDS value, but the water is still acidic and has a high ORP value. Willard Water, a product sold to alter water's structure, does elevate the pH and lower the ORP value, but the TDS value is still low. WaterMax meets the desired criteria of high pH, low ORP, and high TDS.

**Table 2. Comparison of Water Properties.**

| ***Water*** | ***pH*** | ***ORP, mV*** | ***TDS, ppm*** |
|---|---|---|---|
| Distilled Water | 6.11 ±0.20 | 162.67 ±17.01 | 0.90 ±0.10 |
| Evian (French Alps mineral water) | 7.66 ±0.17 | 150.27 ±2.47 | 373.3 ±17.2 |
| ConcenTrace Trace Mineral Drops | 6.40 ±0.09 | 153.17 ±6.79 | 191.3 ±15.8 |
| Willard Water, Formula XXX | 9.45 ±0.08 | 33.63 ±3.23 | 97.1 ±9.0 |
| WaterMax | 8.19 ±0.13 | 67.17 ±5.11 | 202.0 ±22.3 |
| WaterMax, double strength | 8.74 ±0.03 | 57.20 ±3.34 | 518.7 ±.10.5 |

Furthermore, as shown in Figure 1, WaterMax lowers the surface tension better than Willard Water, indicating that it does a more complete job at making water "wetter." ConcenTrace and Willard Water have minimal impact on the structure of distilled water. Using double strength of the WaterMax will further structure the water.

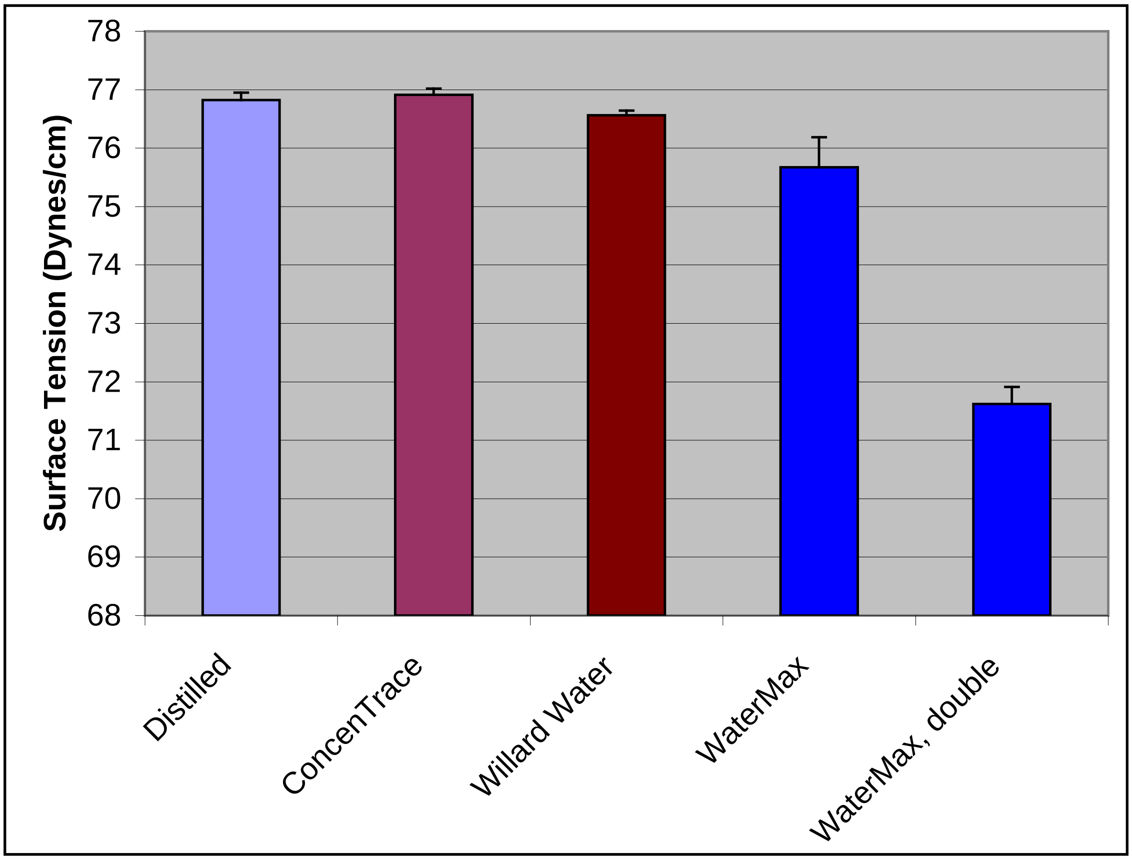



**Figure 1.** Surface Tension of Water Products. Systematic equipment error shows all surface tensions about 4 dynes/cm higher than actual value.

In conclusion, there is evidence that low mineral water, including distilled and reverse osmosis water, is not optimal to health. It is aggressive in pipelines, and is still aggressive in removing minerals from the body, as shown both in animal studies and human volunteers. Minerals in ionic form can be utilized from water; in fact, some ions occur naturally in foods and in our body fluids. Not all minerals in our bodies are organically bound. Drinking distilled water will not have as much effect on someone who gets plenty of minerals from their food, but it is important to remember that distilled water works against your mineral balance, not for you. The optimal water is free from pollutants, fluoride, and chlorine, and has sufficient nutritional minerals in it to make it passive rather than aggressive. The solution to this is to add WaterMax to your distilled water. WaterMax alkalizes the water, provides minerals in amounts and forms which benefit the body, provides antioxidants, and improves the hydrating ability of your drinking water. It's a good choice for long-term health.

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