Minerals and Disease

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This paper is a review of hair tissue, diet and lifestyle analysis this author has been engaged in since 1974. The original involvement with hair mineral analysis occurred in an effort to avoid osteoporosis, a familial trait of several generations; the goal has been achieved. During this period, the diet and lifestyle of many clients were anlaysed, some several times. An earlier report gave details of the procedures and methods used.[1] The interest and usefulness of this procedure is being recognized by an increasing number of health practitioners. This is reflected in the 17 papers and two editorials published on the subject in this Journal since 1985.[1-19] Laboratories such as Anamol of Concord, Ontario, recently added the minerals boron,[20] silicon[21-23] and strontium[24,25] to the earlier 16 essential minerals that it analyses. Antimony, barium and silver have likewise been added to the earlier five toxic minerals. Normal ranges were established in the early 70s using healthy volunteers. They are revised as a result of world-wide research[4] in this field. During these years, the importance and functions of the essential minerals and the harmful effects of toxic ones, continues to be documented.[26-30] This paper will report on the results of the author's most recent 1,000 clients. The sample included well people, but the majority had one or more health problem. The relationship between ever increasing degenerative diseases and dietary changes of this century will be indicated.

A 45 year old man today has a life expectancy of only about two additional years over a man that age in 1900. Control of communicable diseases accounts for most of the improved life span. This, in spite of the impressive advances made in public health measures and medicare. The highly technical type of medicine practiced today, threatens our ability to pay. The *diseases of affluence*, are clearly on the rise. In 1900 cancer killed one in thirty; today it is one if five. Cardiovascular Disease (CVD) at the beginning of the century was responsible for one death in 7; today it is one in every two. The five most prevalent diseases are: heart disease, cancer, diabetes, obesity and osteoporosis. Only industrial societies, rich in animal products and highly processed foods, can afford our lifestyle. A hundred years ago when these diseases were rare, two thirds of our protein was from plant sources; today that proportion has reversed due to a greater consumption of animal foods.[31]

The inadequacy of the Western diet compared to that of the Primitive, was thoroughly researched and reported almost fifty years ago by Price.[32] The powerful food industry has succeeded in giving most, a false sense of security concerning our present diet. It has been ably assisted by very persuasive lobbies, and prestigious well-paid nutritionists, promoting milk, meat and man-made foods such as hydrogenated fats and oils. The public was assured that all one needed to stay healthy, was to eat a varied diet consisting of five food groups (meat, milk products, grains, vegetables and fruit). We were informed that taking supplements was a waste of money and that sugar plays a valuable role in any diet. Such widely accepted views were believed by most of the medical establishment; fortunately they were successfully challenged by many independent workers and writers. Orthomolecular-minded health practitioners have espoused a much more nutrition-minded view.[33-44] It is obvious that our food supply has been debased by chemical additives, antibiotics, coloring agents and excessive processing. It is a far cry from the ancestral diets that kept our forbears free from the degenerative diseases so prevalent in today's industrialized societies.

A recent trend that some *main-stream* scientists and doctors are slowly, but sure accepting, is the importance of optimum and clinical nutrition. Epidemiological studies, such as the China Health Project are playing a vital role.[42] It is worth noting that in present day rural China, degenerative diseases are

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relatively rare. In urban centres, where Western food is becoming popular, they are increasing. The Chinese eat less total protein, but much more from plant sources. Calcium intake is less than half of ours, yet they seldom suffer from calcium related cardiovascular diseases and osteoporosis. The most plausible explanation is that the Chinese are not burdened with excess phosphorus which depletes minerals such as calcium. Westerners have doubled their consumption of phosphorus in the last 50 years.[43] It comes not only from animal products but soft drinks, preserved foods, food additives, dairy substitutes, wheat germ, Brewer's yeast, lecithin and some vitamin-mineral supplements. The ratio of phosphorus to calcium in meat and fish averages 26:1. Thirty-one commonly eaten vegetables had close to the R.D.A.s recommended 1:1.[41]

The disturbed P:Ca ratio may produce a low level of hyperthyroidism. This causes a loss of bone calcium which the parathormone drives into the cells of muscle, arteries and soft tissues. A surplus of parathormone increases the absorption of toxic aluminum. This metal has been implicated as a *cross-linker*, contributing to premature aging, senility and Alzheimer's Disease. It is worth emphasizing that aluminum was in excess in 24% of those tested. The increased incidence of the most common degenerative diseases coincides with increased consumption of phosphorus-rich foods.[45,46]

The Chinese consume only 15% of their calories as fat compared to America's 39%. This has a bearing on poor mineral balance since fat is fibre and nutrient deficient. More than 50% of America's diet calories come from sugar, fats, alcohol and simple carbohydrates — all lacking in vitamins, minerals and fibre.[47] Man manipulated foods such as hydrogenated fats (margarine), contribute to the diseases of affluence.[48]

According to a U.S. Department of Agriculture survey, 90% of Americans have diets deficient in chromium.[49] Our survey (Table 1), revealed that 63% were low in this very critical mineral. These results could be predicted considering that more than half of our food is chromium deficient. Simple carbohydrates are soon changed to glucose. Chromium and insulin act together to control rising blood sugar. Chromium combines

Table 1
Percent of 1,000 Clients Deficient in 16 Essential Minerals

No.	Mineral	% Deficient
1	Chromium (Cr)	63
2	Magnesium (Mg)	49
3	Calcium (Ca)	46
4	Potassium (K)	39
5	Selenium (Se)	38
6	Copper (Cu)	37
7	Manganese (Mn)	36
8	Zinc (Zn)	36
9	Cobalt (Co)	30
10	Iron (Fe)	27
11	Lithium (Li)	25
12	Molybdenum (Mo)	20
13	Vanadium (Va)	18
14	Sodium (Na)	9
15	Nickel (Ni)	6
16	Phosphorus (P)	3

synergistically with niacin (B_3), and the amino acids glutamic, glycine and cysteine (glutathione) to produce the complex, GTF (Glucose Tolerance Factor).[50] Maturity Onset Diabetics are likely to have either a defect of GTF metabolism or increased GTF requirements.[28] Pregnant women have need for increased chromium since it is necessary for the fetus. If deficient, it could lead to diabetic conditions.[49] Many people, especially women, suffer from extreme fatigue which could be due to insufficient chromium. There is convincing evidence that chromium increases high density lipoproteins (HDL) and depresses low-density lipoproteins (LDL). This mitigates plaque build-up and atherosclerosis.[51] Chromium in the tissues of the people of Thailand, where CVD is very low, was higher than any other group.[52]

Almost half (49%) of those tested were below the normal range of hair magnesium. Seelig pointed out that this mineral occupies only 0.1% of bone composition compared with 20.2% calcium. It is nevertheless, critically important in bone formation.[43] It plays a key role in cellular metabolism and many enzyme systems. It is an intracellular mineral required for the conversion of glucose to glucose-6-phosphate. This is the first step in carbohydrate metabolism. It is essential in

the Kreb's cycle in which pyruvate is changed to coenzyme A. Magnesium is involved in protein formation, DNA production and the control of energy through ADP and ATP.

Deficiency symptoms include poor appetite, irritability, weakness, muscle tremor, tetany, twitching, numbness, tingling, confusion, disorientation, personality change, learning disability, apathy, memory loss, skin lesions, elevated cholesterol, cardiovascular changes, tachycardia, elevated parathyroid hormone, pancreatitis and stress.[28] In addition to having too little magnesium in the average diet,[43] the following reduces its absorption: "alcoholism, malabsorption, diuretic therapy, burns, surgery, diabetic acidosis and coma, cirrhosis, hepatitis, hyperaldosteronism, hyperparathyroidism, Addison's disease, epilepsy, eclampsia, kidney disease and oral contraceptives".[28]

It has been firmly established that areas of "hard" water, usually high in calcium and magnesium have a lower incidence of CVD. Magnesium causes muscles to relax. Sudden deaths from heart attacks, by young and otherwise healthy young men especially, have extremely low levels of this mineral.[28] Researchers concluded that low levels of magnesium in arteries result in progressive vasoconstriction leading to coronary arterial spasm and finally sudden-death ischemic heart infarction. Irregular heart beat (arrhythmia) has been linked to a deficiency of magnesium.[53] Other diseases linked to low magnesium are: cancer,[54] urolithiasis,[55] hypertension, insomnia and menstrual cramps.[56] Seelig believes that excessive phosphorus in relation to calcium, causes progressive hyperparathyroidism leading to bone loss and calcification of the soft tissues. Research has revealed that those suffering from Chronic Fatigue Syndrome (CFS), have low levels of intracellular magnesium.[57] Low magnesium combined with excess vitamin D induces calcification.[58]

A calcium deficiency of 46% is in the same range as magnesium. Osteoporosis in our society, especially in women after menopause, is a widespread problem. The bones of older women are often so brittle that they break from the slightest blow or fall. The Chinese, whose calcium intake is less than half of ours, consume no dairy products nor calcium supplements, yet suffer very little from this debilitating condition.[43] The explanation — they consume a third less protein most of which is from plant sources. Our diet and lifestyle results in an excess of acid forming minerals such as phosphorus, sulfur and chlorine. Concomitantly, we have insufficient alkaline forming minerals such as calcium, magnesium, manganese, potassium, zinc and iron. Acid-forming foods are: meat, poultry, fish, milk products, grains, soft drinks and food additives.

Excessive consumption of acid producing foods, results in metabolic acidosis. When this occurs, the parathyroid hormone stimulates the removal of calcium from the bones and teeth (osteolysis), to buffer or neutralize the excess acidity. After many years, such calcium loss results in depleted bone, bone weakness and structure.[59]

Vitamin D (calciferol), probably should have been classified as a hormone. It is rarely deficient, if the skin is exposed to sunshine for as little as 15 minutes a day. It is changed by the liver and kidneys to the active form, 1,25-Vitamin D_3.[28] It has long been recognized that cod and halibut liver oil are rich in vitamin D_3. Hans Selye in his classic book, *Calciphylaxis*, drew attention to this phenomenon in which insoluble calcium salts are deposited in the soft tissues of the body. He was able to do this by giving analogues of this synthetic vitamin D (D_2). Conditions similar to hypertension, cerebral sclerosis, arthritis, kidney stones, chronic bronchitis and even cataracts, were induced by Selye. It was learned about 1928, that vitamin D_2 (ergosterol), could be produced cheaply by irradiating yeast. Unfortunately, it produced some serious side effects. It was widely used in supplements for both humans and animals and added to many foods, especially all milk products. Kummerov gave excessive vitamin D to swine. They developed vasular lesions, similar to human arteriosclerosis.[60] Fortunately, it appears that the over fortification of foods with this unnatural product has decreased. Liver oil or skin exposure to sunshine is recommended. Excessive vitamin D should be avoided; for those who are house-bound or cannot tolerate direct sunshine, supplemental vitamin D is recommended.

The level of calcium in the blood is controlled to within 3%. When more calcium is

required, vitamin D increases the absorption of calcium in the gut. When this is insufficient, calcium is taken from the bones (osteolysis).[28] Extracellular levels are in the order of a thousand times greater than intracellular calcium.[61] When excess calcium gets into the cell, it combines with organic phosphates, such as adenosine triphosphate (ATP), interfering with normal oxidative phosphorylation. The end result is a significant loss of energy.[62] Calcium deficiency is often accompanied by a shortage of magnesium. This along with excess fat, refined carbohydrates and phosphorus, results in the pathogenesis of chronic cardiovascular, renal and skeletal diseases, so well documented by Selye.[43]

Dr. G. Gordon, formerly director of Mineralab, has listed potential contributors to a negative calcium balance. Some are: excess or insufficient vitamin D, too much dietary phosphorus, impaired glucose metabolism, alcoholism, sedentary lifestyle, metabolic acidosis, hypoparathyroidism, and/or hyperparathyroidism, exposure to toxic metals, chronic use of drugs such as diuretics, certain food factors in cocoa, tea and red wine.[63] When calcium is leaving the bones, it may settle in the soft tissues, such as the hair. When abnormally high, it indicates a need for more calcium.

A deficiency of calcium has been related to a higher incidence of colon cancer. When calcium levels in the gut are adequate, it binds with the bile salts to remove them in the feces. Calcium also lowers the parathyroid hormone which also promotes cancer.[64] Cancer of the breast, prostate, ovary, uterus and pancreas correlates positively with a high fat consumption.[65] It is likely that insufficient calcium is related to excess phosphorus.

More than a third (39%) of the sample, were lacking in potassium. A shortage of this mineral in relation to sodium, is implicated in hypertension, arrhythmia and extreme fatigue. Thiazide diuretics are widely used to control hypertension. This may lead to excess uric acid and gout, elevated cholesterol (LDL) and the risk of a heart attack.[66] Hypertension is usually associated with excess sodium. The accompanying chloride ion in table salt, is also implicated as well as a lack of potassium.[67] Early in this centruy, Gerson, prescribed a diet high in vitamin A and potassium, but low in sodium. He successfully treated a number of diseases including hypertension and cancer.[68] The sodium-potassium pump controls what enters and leaves the cells. When potassium is deficient, it results in excess sodium entering the cell. This interferes with cell metabolism, especially protein production, loss of energy and increases water retention (edema). The primitive diet was low in sodium; the body is equipped to prevent the loss of this mineral. It is obvious that whole natural foods are preferable to man-manipulated ones. When fruit or vegetables are canned or frozen, there is a significant loss of potassium.[28]

More than a third (38%) of those tested, lacked selenium. It has been known for a long time, that animals in selenium-poor countries such as New Zealand, must have the element added to their feed.[59] Its essentiality in humans, was established as recently as 1957. In areas in China where selenium is very low, children and pregnant women especially develop a circulatory condition called Keshan disease. China is now adding it to salt for humans in certain low selenium areas.[70]

Convincing evidence shows a negative correlation between selenium intake and cancer of the breast, colon, pancreas, prostate, lung and bladder.[71] This may be due to its powerful anti-oxidant ability to detoxify harmful metals such as mercury and proliferating free radicals. One of the key elements of glutathione peroxidase, is selenium. This mineral along with vitamin E appears to strengthen the immune system.

Copper deficiency at 37% is serious enough to examine closely. The typical American diet contains only about 50% of the RDA (2 mg/day); consequently these results should not be surprising.[72] Copper is involved in more than a dozen enzymes such as superoxide dismutase (SOD). Rats fed a copper deficient diet had reduced bone mineral content and strength.[73] It is a cofactor for the enzyme lysyl oxidase, which produces collagen and elastin so essential for strong flexible connective tissue.[74] Copper is required in the oxidation of vitamin C. Excessive vitamin C may deplete the body copper stores, which along with iron help

produce hemaglobin. A lack of copper could lead to an enlarged heart, weak blood vessels and elevated blood cholesterol. Excess zinc aggravates copper deficiency. Copper containing SOD is a "remarkable substance" for treating arthritis.[28] Stomach ulcer patients have been found to have 23% less copper than normal in their bodies.[75] Dr. Carl Pfeiffer found that young schizophrenic women, usually had extremely elevated copper levels.[76] Zinc and copper are required for the conversion of thyroxin (T4) to tri-iodothyronine (T3) which prevents hypothyroidism. One worker in this field estimated that as many as 40% in our society, suffer from a degree of this debilitating condition.[77] Wilson's disease, caused by a genetic defect, leads to storage and accumulation of copper in the liver, but not circulating ceruloplasmin-bound copper in the blood. A hair analysis would not reflect this condition. Klevay and colleagues at the U.S. Agriculture Research Laboratory surveyed the typical American diet and found the favorites were: Swiss steak, sausage, veal and poultry; milk and eggs; white bread, crackers, noodles and cereal; potatoes, other vegetables and butter; pies and puddings; coffee and sugar.[78] Copper-rich foods are: liver, fish, nuts, legumes and green vegetables.

Manganese deficiency at 36%, closely follows copper. Gordon reported that hair samples from 50 people living in Villacabamba, a remote mountainous area of Ecuador, showed a 20% deficiency of manganese. In comparison, 90% of a large sample of Americans lacked manganese. Villicabambans along with the Hunzas of Pakistan and some Georgians of the former U.S.S.R. are amongst the healthiest, long-lived people on earth. Apparently, the closer one's diet is to primitive man, the more adequate is the level of manganese.[63] Most of the manganese (10-20 mg) is in the bone, liver and kidney.[79] It is an essential part of several critical enzymes involved with energy production, bone formation, protein and fat metabolism. Manganese modulates neurotransmitter activity related to nerve-muscle disorders, such as Tardive Dyskenesia. This disease is exacerbated by certain tranquilizers, which increase the need for extra manganese, chloine and niacin (B_3). It, along with vitamin K is necessary for the production of prothombin, a protein required for blood clotting. A deficiency of manganese results in abnormal bone and cartilage and disk degeneration.[80] Other manifestations include impaired glucose intolerance, birth defects, growth retardation, reduced fertility, brain function and inner-ear imbalance. Severe manganese deficiency produces epiliptic seizures, arrhythmias, weight and hair color loss and dermatitis.[81,82]

Cancer cells, triggered by viruses and chemicals, had little or no magnesium-superoxide dismutase, the enzyme required to protect the mitochondria from free radical superoxides.[83] Dietary manganese deficiencies can exacerbate the toxic effects of soft tissue calcium. It can be used more safely than calcium antagonists, such as verapamil.[28] At least half of the manganese in the typical diet is lost when whole grains are replaced by refined ones.[84] Best sources are: nuts, whole grains and legumes.[28]

Zinc, like manganese, was deficient in 36% of the sample. The typical American diet is low in this mineral; one survey found 68% of adults, consumed less than two thirds of the RDA.[85] The milling of wheat results in an 80% loss of zinc.[86] It is part of more enzyme systems than the rest of the micronutrients combined. It is necessary for protein and DNA synthesis, insulin activity, normal taste, healthy nerve and brain tissue, would and burn healing, bone structure and the immune system function.

An Egyptian and Iranian study of dwarf males indicated that their diets were high in the zinc-binding phytates from unleavened bread and the habit of clay eating (geophagia) in certain rural areas. They were not only small in relation to their age, but lacked sexual development. Hair analysis results revealed very low levels of zinc; when supplemented with the mineral, normal growth and development followed in a few months.[87] Zinc deficiency during pregnancy increases the risk of miscarriages and birth defects. Alcohol creates a shortage of zinc; hence alcohol consumption during pregnancy should be avoided.

Calamine lotion, a mixture of zinc and ferric oxide, was used for centuries by the Egyptians on skin to promote healing of burns and other lesions.[88] There is convincing evidence that supplemental zinc hastens

bone healing.[89] Zinc deficiency reduces the thymus gland's ability to produce T-cells. Esophageal cancer patients were zinc deficient. Excess zinc depresses copper, resulting in possible CVD.[90]

The highest level of zinc is in the seminal fluid produced by the prostate gland. Sexually active men risk greater loss of zinc than women. This could explain why most older men suffer from prostate problems which usually leads to cancer of that organ.[90] Acne is a troublesome problem for many teenagers; it responds favorably to supplemental zinc. It also helps reduce body odor, boils, leg and gastric ulcers.[92,93] Many people who lose their taste acuity as they age, respond favorably to extra zinc.[94] A lack of zinc and macular degeneration are linked.[95] Eczema may respond to supplemental zinc. This mineral is required in the production of prostaglandin, especially the antiinflamatory (PGE-1).[41] Zinc absorption may be inhibited by excess sugar and/or copper, insufficient hydrochloric acid (Achlorhydria) and/or pancreatin enzymes. It it essential for insulin production; this may explain the high incidence of maturity-onset diabetes amongst alcoholics.[28] Severe food allergies may result in an inflamed gut and lessened zinc absorption. Meat should be a good source of zinc but its high level of phosphorus may render it unavailable. Rich sources are: liver, oysters, nuts, legumes and whole grains.[28]

Cobalt, deficient in 30% of the sample, is part of vitamin B_{12}, or cobalamin. Daily requirement of cobalt in B_{12}, is only 0.04 mcg.[29] A severe lack of B_{12} may result in pernicious anemia. This is caused by a lack of the intrinsic factor, normally produced by the stomach mucosa. B_{12} deficiency could result following stomach surgery, aging with reduced gastric acid and pepsin or the use of the drug cimetidine.[41] Dr. A. Gaby uses B_{12} injections successfully to treat fatigue, shingles, hepatatitis and bursitis. The myelin sheath surrounding nerves and the spinal cord, requires B_{12}. When deficient, it can result in a slow deterioration of the nervous system. This can result in numbness and prickly sensations of the extremities, burning feet, forgetfulness, depression and other related problems.[96] The body needs only 3 mcg daily. For severe deficiencies, B_{12} is best injected. Supplemental B_{12} taken orally is poorly absorbed. A suitable alternative to intravenous infusion is B_{12} taken sublingually. Best sources of B_{12} are: liver, soy products such as tempeh, meat, milk, eggs, brewer's yeast and sunflower seeds. Strict vegetarians may be lacking in this vitamin. Foods high in cobalt are: sea foods, grains, oils, nuts, meat, vegetables, fruit and dairy products.[97]

More than a quarter of those tested lacked iron. This is one mineral which has been recognized as essential since 500 BC.[8] Blood testing for iron has long been used by alopathic practitioners. There is evidence that hair analysis for iron will indicate a tendency towards an imbalance, before serum changes can be detected.[8] Iron absorption usually decreases with age, often due to a lack of stomach acid and pancreatin.[41] Excess sugar, white flour and fat, leads to iron deficiency.[98] Dairy products, such as milk and cheese, already low in iron, can reduce its absorption as much as 80%; tannin in tea has a similar effect.[8] There appears to be a strongly held belief that one must eat meat to obtain sufficient iron. The Chinese on a vegetarian type diet, receive nearly twice as much iron as Americans on a more animal-based diet. Iron deficiency can lead to diarrhea, gas and stomach cramps.[99] Iron supplements should be in the chelated form; inorganic iron may result in constipation. Best sources of iron are vegetables, legumes, meat, poultry, sunflower seeds, red wine and grains. Fruit aids in its absorption because of its vitamin C content.[28]

One quarter of those tested were low in lithium. Its ranges in the hair have been established but more work is required for verification. It is believed to stabilize seretonin neurotransmitters.[100] Horrobin reported that lithium may be required in the conversion of linolenic acid (LNA) to the very important prostaglandins.[101] Lithium is a standard treatment for manic depressives.[102] Adequate lithium is present in most drinking water.[103]

One out of every five tested, were low in molybdenum. It is concentrated in the liver, kidneys, adrenal gland, bones, tooth enamel and skin.[28] Scientists in New Zealand, discovered that low molybdenum, increased dental carries.[104] In parts of China, where soil molybdenum was very low, there was an

increased incidence of esophageal cancer. A lack of this mineral is associated with sexual infertility. Best sources are: buckwheat, brown rice, oatmeal, wheat germ, legumes, organ meat, sunflower seeds and cottage cheese.[29]

Vanadium was low in 18% of those tested. The clinical significance of hair vanadium has not yet been proven. It is a catalyst for oxidation-reduction processes and in bone formation. It is highest in cartilage, bone and tooth dentine.[105] Where there are large deposits of vanadium, there is a corresponding lower rate of heart disease.[28] When deficient, the level of cholesterol and triglycerides tend to increase. Best sources are: whole grains, soybeans, oils, eggs, rice and vegetables.[28]

Sodium was deficient in only 9% of those tested. Sodium and potassium are important electrolytes, necessary for maintaining proper osmotic pressure of body fluids. Sodium is present in blood, lymph, muscles, nerves and in the formation of saliva and digestive enzymes. The problem for most is that we consume 10-20 times more than is required. Excess sodium combined with too much phosphorus, insufficient calcium, magnesium, zinc and potassium results in adrenal insufficiency. This in turn, may lead to such disorders as allergies, psychological problems. hypoglycemia, weight control and fatigue.[106] Sodium is used to enhance food flavor and as a preservative. Foods contributing to excess sodium are: processed meat and fish, baked goods, cheese, french fries, potato chips and softened drinking water.[28] Only 6% tested were low in nickel; its significance in humans has only recently been established. It is believed to be essential for cell wall membranes.[107] Dietary nickel has not resulted in toxicity. Excess nickel fumes from industry, auto exhaust and cigarette smoke may contribute to lung cancer.[108] Best sources are grains, vegetables; poor ones are animal products and white bread.[28]

Virtually everyone tested (97%), had sufficient phosphorus. It is an important part of our bones; it is equally essential in the important enzymes, mono, di, and tri adenosine phosphates, which store and release energy for bodily functions. Nucleo proteins are the major components in the nuclei that control cell division, reproduction and heredity. Fats require phosphorus to produce necessary phospholipids, such as lecithin. It combines with the B vitamins such as B_3 (niacin), to form nicotinic adenosine dinucleotide (NAD). This is essential for good digestion and emotional health. Excess phosphorus, combines with calcium, forming insoluble salts in the intestine and urinary tract. When these are excreted, minerals essential for bones and teeth are lost. This also contributes to degenerative diseases such as kidney damage and osteoporosis. A high protein phosphorus containing diet increases urea, which is a diuretic. When urea enters the kidneys, the result is a loss of water along with important minerals. Proteins break down to amino acids, which are absorbed into the blood stream. This creates a condition of excess acidity which is neutralized as calcium is removed from the bones and teeth (osteolisis). Ideally, the ratio of P:Ca should be 1:1; it is closer to 1.5:1. This is due largely to our high meat, and milk-based diet. Soft drinks and food additives also contribute to a surplus of phosphorus. Best sources are: fish, meats, poultry, eggs, legumes, milk and milk products, nuts and whole grain cereals.[28]

Close to one quarter (24%) tested had high levels of aluminum (Table 2). There is a significant association between this mineral and Alzheimer's disease. When discovered in 1907, it was extremely rare; it is now considered the fourth most prevalent cause of death. High levels of aluminum found in the brains of victims, interfere with choline transport. This results in a deficiency of acetylcholine, a characteristic of this disorder.[109] Autopsied brains of those dying of this disease, have unusually high levels of aluminum along with neurofibrillary tangles.[110]

Table 2
Percent of Clients with and Excess of One or More Toxic Metals

No.	Mineral	% High
1	Aluminum (Al)	24
2	Cadmium (Ca)	6
3	Lead (Pb)	5
4	Mercury (Hg)	4
5	Arsenic (As)	1
	Total	**40**

The rapid development of Alzheimer's disease during this century, coincides with the availability of widespread use of this metal. It is present in most baking powder, tabel salt, many antacids (such as Mylanta), buffered aspirin, tea, some tap water, fabric softeners, anti-perspirants, some pickles and processed cheese. It is also present in asphalt, cooking utensils, aluminum foil, beer and soft drink cans, and liners for fruit juice containers.[110]

Whether or not we absorb aluminum, instead of excreting it, depends largely on our diet. Typically, we favor acid forming foods, over alkaline ones. An animal based diet, high in phosphorus, creates low calcium and concomitant hyperthyroidism. This results in increased absorption of aluminum — a vicious cycle. Virtually all of those tested who had high aluminum, were also low in essential minerals, especially calcium and magnesium. When they took steps to avoid aluminum ingestion and increase their essential minerals, aluminum was reduced to a safe level in a few months. Excess aluminum can also bind phosphate in the GI tract, which can cause problems such as aching muscles, rickets and osteoporosis.[110]

Cadmium above the safe level, occurred in 6% of those tested. It is believed to be the most toxic metal, especially if inhaled as with cigarette smoke. It is related to hypertension, kidney and liver damage, cancer and anemia. Adequate levels of the essential minerals and vitamin C, reduces its absorption and hastens its excretion. Major sources, in addition to tobacco, are highly processed foods, pesticides, soft drinks, soft water, galvanized pipes and solder joints in copper plumbing.[28,29]

One in 20 of those tested had unsafe levels of lead. Schroeder hypothesized that lead in water pipes and wine vessels, may have contributed to the decline of the Roman Empire.[111] Industrialization, resulted in a significant acceleration of lead mining, smelting and general use. Hair analysis, developed in the 1960s, is the simplest and most accurate way of detecting occult lead toxicity. Its use has spread rapidly to many countries.[112] Research showed a strong correlation between concentrations of toxic metals in the hair and various organs of the body. It was reported in 1974, that lead concentration was lowest in people in rural and highest in urban areas.[113]

The average lead body burden in our part of the world is 240 mg for a 70 kg man; this is 120 times higher than in prehistoric times.[114] It was learned that children are especially vulnerable to damage from either airborne or ingested lead. It most affects the nerves, through interference with energy production, and the release of neurotransmitters.[80] The many reports of the deleterious effects, alarmed the public and governmental agencies sufficiently to act decisively; its use in household paint and gasoline are being phased out.

Acute lead toxicity may lead to encephalopathy. Chronic lead exposure is of greater concern; it can lead to learning disability in children, who are relatively more vulnerable than adults.[115] Other lead sources are: drinking water from leaded pipes or soldered copper pipes, organ meat, painted glassware and pottery, some toothpaste, newsprint, paint and putty, car batteries, tobacco, lead shot and mascara.

An excess of mercury was present in only 4% of the sample. Outright poisoning, which affects the nervous system (the mad hatters) is quite rare today. Low level exposure has always been part of man's existence; mercury is leached from the rocks and soil to drinking water and natural bodies of water, where it is picked up by plants, fish, wildlife and man. Those creatures near the top of the food chain have the highest levels; examples are tuna, halibut, and swordfish. Bottom feeding fish and the crustacea, tend to be lead accumulators. It is also deposited over the earth from volcanic ash, forest fires, coal, wood and oil burning.

Chronic mercury poisoning is a more recent phenomenon. A factory in the Minamato area of Japan, dumped large amounts of waste mercury into the bay. It was changed by living organisms to methyl mercury, a much more toxic form. Tragedy struck in 1946 when 46 people died; babies were born defective and many suffered as a result of eating the contaminated fish. It also comes from some insecticides, mercury treatment of seeds, cosmetics, fabric softeners, fungicides, mercurochrome, calomel, hemorrhoid suppository preparations and sewage sludge.[29]

At present there is a controversy over the possible adverse effects from the use of mercury in dental fillings. Excessive mercury in the body can harm the liver, kidneys, pancreas, bone marrow, aggravate hypertension and diabetes.[80] Huggins, a dentist in Colorado, has been one of the chief spokesmen for promoting the end of mercury for dental repairs.[116] Amalgams consist of a mixture of mercury (about 50%), silver, copper, tin and zinc. Two or more positively charged minerals in close proximity, and in the presence of saliva, produce galvanic currents. This can cause a breakdown of the fillings; the pressure of chewing promotes the production of methyl mercury. Both the current and methyl mercury in the mouth can be measured. When the readings indicate a possible problem, amalgams are removed sequentially and replaced by non-toxic composite materials. Prior to removal, patient history and several tests including a hair mineral analysis, are done. Following removal, patients are given dietary guidelines to help in the detoxification program.[117] Huggins and others report improvement in alleviating conditions such as neurological, cardiovascular, immunological, allergies, environmental sensitivities, and many others.[116] Skin patch tests, blood counts, urine tests are used to verfy toxicity and its control. Other dentists say that more scientific research is necessary. The Federal Nation's Institute Conference of July, 1984 stated, "there is no documented evidence for discontinuing the use of dental amalgams".[118] It is significant that as of March, 1991, FDA has not given the use of amalgams their approval.[119] A recent report indicates that Sweden has banned mercury fillings and the U.S. FDA now requires that dentists must inform their patients that amalgams contain mercury.[120]

Arsenic, described as a metalloid, was high in only one percent of the sample. It has been shown to be essential for four animal species. Arsenic quickly leaves the blood to be deposited in the vital organs.[28] Earlier in the century, it was widely used in pest control, medicines and, purportedly to poison unwanted family members. During the 1950s, its use in agriculture was curtailed, when more effective organic compounds were introduced.[111] Arsenic affects the thyroid, brain, skin, hair and nails and can cause cancer. Symptoms of toxicity are fatigue, loss of the sense of pain and gastroenteritis. Arsenic depletes the body of phosphorus and may result in heart abnormalities.[29] Relatively small amounts have always been consumed through the food chain from the natural leaching of rocks and soils. Humans add to that by the burning of wood, coal and oil.[111]

The elevation of one of more toxic metals in hair specimens tested at Mineralab in Hayward, CA, averaged a very high 61%. By comparison, our sample averaged a lower but still high 40% (Table 2). The small sample from the primitive Villicabambans had an exceedingly low figure of less than 5%. These data clearly demonstrate the damaging effect of careless industrialization. Beasley stated, "The Office of Technology Assessment estimates that for every person in the Nation, a ton of hazardous waste is added to the environment every year. These hazardous wastes, usually unwanted by-products of industry, utilities and the military, are fouling the nation's air, water, and soil to an alarming extent."[121] Beasley summarizes the state of nutrition in America as follows, "Millions of individuals involved are already afflicted with nutrition-related illnesses, from anemia to cancer. Millions more are troubled with undiagnosed symptoms — fatigue, anxiety, headaches, nervousness, eating or drinking disorders — that malnutrition often plays a role in. And millions more are headed down this same broad road."

The erroneous idea that our health depends largely on the knowledge and skill of our doctor is undergoing a fundamental and positive change. The new paradigm is that we are partners with medical practitioners in our quest towards optimum health.

The benefits from this approach is illustrated in recent statistics. Death from heart disease in our part of the world for people from the age of 30 to 59 declined by 39% from 1970 to 1985. Similar but less dramatic results were achieved in western but not eastern Europe. Some of the lifestyle changes are weight reduction, smokin cessation, exercise and dietary changes.[122] The growing interest in hair analysis is but another example of people taking an increasing interest and involvement in their own health care.

This paper chronicles many of the relatively recent developments towards a better understanding of the part played by both essential and toxic minerals. This increased knowledge should result in significant advances towards better health and a sense of well-being. As we approach the 21st century, there is a great need to improve our environment, diet and lifestyle. This should assist in curbing the high cost of medical care, the steady increase in degenerative diseases, mental problems and even violence, in our society. To achieve this, the emphasis must be reversed from curing diseases to prevention.

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