**CALCIUM TO MAGNESIUM RATIO:**

Both calcium and magnesium are involved in numerous metabolic functions and are absolutely essential for the maintenance of a healthy body. Calcium is considered the **backbone mineral** because of its role in the formation of skeleton and teeth. Magnesium is called the **natural tranquilizer** due to its relaxing action on nerves and muscles. The biological functions and the therapeutic uses of these minerals are shown below:

**FUNCTIONS:**

Both minerals require each other for their absorption and utilization and must be provided in adequate amounts. Depending upon the physiological environment, there are cases in which the roles of these two minerals are antagonistic to each other. Magnesium is located inside the cell (intracellular) while calcium is predominantly located outside the cell (extra cellular). Consequently, the role of magnesium in intracellular metabolic functions, such as energy production, respiration, and muscle contraction-relaxation is antagonistic to calcium.

**Calcium**

- Development and maintenance of bones and teeth (about 99% of body calcium is in bones and teeth)
- Blood clotting
- Muscle contraction and relaxation
- Transmission of nerve impulses
- Enzyme activation for production of gastric juices
- Fat, protein and carbohydrate metabolism
- pH balance
- Etc.

**Therapeutic Use**

- Arthritis, osteoporosis, rheumatism, other bone disorders, dental decay, epilepsy, insomnia, nephritis, pre-menstrual cramps, stress, constipation, muscle pains, high blood cholesterol, regulation of heart beat.

**Magnesium**

- Development of bones (about 70% of body magnesium is in the bones)
- Crucial part of many enzymes involved in energy production and respiration
- Transmission of nerve impulses
- Muscle relaxation
- Regulation of body temperature
- pH balance
- Release of nerve tension
- Absorption and utilization of calcium, phosphorus, sodium, potassium, vitamins C, E & D etc.
**Therapeutic Use**

- Arteriosclerosis, heart attacks, Infant death syndrome (SIDS), hypertension, bone fractures, epilepsy, diabetes, alcoholism, kidney stones, leg cramps, nervousness. Let us briefly examine the role and relationship of these two minerals in known clinical studies:

**Regulation of heart beat:**

The heart is a muscle and its primary function is to pump blood throughout the body. The heart is composed of billions of cells, each of which works as an electrochemical generator, and contains both calcium and magnesium. On the outer surface of the heart cells, thin fibers made of a substance called “actin”, continually expand and contract in unison with the heartbeat. The actin fibres are stimulated by calcium, and then relaxed by magnesium. An electrical charge produced by magnesium then pushes the calcium to the opposite side of the cell. Thus, calcium helps to produce the heartbeat and magnesium regulates it.

**Myocardial infarction (heart attack):**

Several researchers have shown that a heart failure involves drastic changes in the concentration of cardiac electrolytes. During cardiac stress, some of the magnesium is moved out of the cell accompanied by an influx of calcium into the cell. Thus, the cardiac muscle shows a 20% decrease in magnesium and a 4 1/2-fold increase in myocardial calcium. The loss of magnesium and an influx of calcium seriously disrupt the energy potential of the affected muscle. Increasing the level of magnesium can prevent the situation. In clinical practice, intravenous or intramuscular administration of magnesium salts has proven very useful and is highly regarded. It is known that magnesium therapy is the most effective to protect myocardial integrity during cardiac arrest. It is interesting to note that in Canadian surveys of postmortem tissue composition, about 24% less magnesium was found in ischemic hearts than in non-cardiac cases.

**Atherosclerosis (Heart Disease)**

A highly dietary intake of magnesium has been attributed to why heart disease is virtually unknown among Bantu tribesman of South Africa, while the disease is prevalent among white South Africans. Clinical studies have revealed that the Bantu’s serum magnesium level is about 11% higher than in the white South Africans. The Bantu’s high dietary intake of magnesium is largely attributable to intake of unrefined cereals such as maize meal, which have high magnesium content and also has a high fiber content. Also, it has been shown that the ability of high-fat diets to induce atherclerosis is prevented by a high magnesium dietary regime.

**Hypertension (high blood pressure):**

For many years, hypertension has been associated with sodium. Consequently, substituting potassium in the diet treats the disorder. However, most of us do not realize that magnesium is also considered a well-known vasodilator. The anti-hypertensive effect of magnesium is achieved by a direct effect on the vascular wall or is mediated through the central nervous system. Magnesium competes with calcium for binding sites and the net result is that magnesium reduces the calcium-induced contractions. It is well established that magnesium infusions can cause vasodilatation and reduce hypertension in humans.
**Urotholis (kidney stones)**

Canadians appear to have a very high incident of kidney stones and the occurrence is particularly high in Newfoundland (11, 12). In U.S., South Carolina has the highest urolithiasis rate. South Carolina also has the highest U.S. rate for cardiovascular deaths (10). Both Newfoundland and South Carolina regions have “very soft” drinking waters with little magnesium (11).

In Canada, calcium urolithiasis accounts for 70 to 80% of the total kidney-stone problems (12). In the U.S., about 67% of all kidney stones are composed of calcium oxalate or calcium hydroxyapatite (11).

Several researchers have used the magnesium/calcium ratio as an index of susceptibility of urine to form kidney stones in patients (10, 13, 14). In general, patients with a urinary magnesium/calcium ratio of 0.7 is normal, whereas a value lower than 0.7 may be considered as stone forming. The ratio is especially low in the Canadian “Kidney Stone Patients”, indicating inadequate magnesium intake. The oral magnesium supplementation has proven very effective in the prevention of kidney-stone formation (14).

**Infant Death Syndrome (SIDS or Crib Death):**

Magnesium deficiency has a primary role in sudden unexpected infant-death syndrome. The sequence-ofevents are as follows:

Magnesium deficiency causes calcium-dependant release of histamine that, in turn, induces increased release of acetylcholine (especially at high calcium/magnesium ratio).

The increased amount of acetylcholine leads to symptoms of neuromuscular hyperirritability and convulsions that can lead to reduced heart rate (15).

The sudden-death syndrome is puzzling since no recognizable allergens are involved. The symptoms are acute respiratory distress, and include bronchospasm, shortness of breath and eventual circulatory collapse. Hypomagnesaemia is observed throughout this syndrome.

Therefore, the role of magnesium in the infant-death syndrome is very significant.

**Nutritional status of magnesium:**

The recommended dietary allowance for magnesium is 300 to 450 mg/day. There are several factors including pregnancy, rapid growth, or a high intake of protein, vitamin D, calcium, fat, carbohydrates or alcohol that will increase the requirement for magnesium.

Surveys of dietary magnesium intake from different countries show a prevalence of lower magnesium intake than the desired levels. In Newfoundland, the intake is only 50% of the recommended amount (16, 17). Other reports (4) show that hospital and institutional diets contain only 61 and 68% of the recommended intake, respectively. In other studies (18, 19), it was found that the intake for pregnant women was only 45 to 60% of the recommended allowances. There is definite evidence that magnesium intake is sub optimal or marginally inadequate in regions of the Western World (20). The occurrence of hypomagnesaemia in humans, due to low magnesium intake and due in part to factors such as; prolonged use of diuretics; alcoholism, pregnancy etc. are shown to be more prevalent that generally believed (21).
Contribution of drinking water:

Drinking water can significantly contribute to magnesium intake and hard waters can supply 9 to 29% of the daily magnesium intake (23). Because of the metabolic antagonism between magnesium and calcium, the ratio between these two minerals in the drinking water is of considerable significance.

In a survey of 25 U.S. cities, the lowest death rates from coronary disease were found in areas where the drinking waters supplied more magnesium and less calcium than the U.S. average (24).

Australia has the highest cardiovascular death rate in the world and also consumes some of the world’s softest drinking waters. On the other hand, the Western region of Texas has the hardest drinking waters and the lowest cardiovascular mortality rates in the United States (25).

The relationship between death rates from coronary heart disease and the dietary calcium/magnesium ratio in several countries is shown in the following figure:

![Graph showing the relationship between death rates from CHD and Ca/Mg ratio in diet](image)

The high mortality rate in Finland is associated with a high calcium/magnesium ratio (26), while the low mortality rate in Japan is related to a low calcium/magnesium ratio as well as to the “protective” effect conferred by the alkalinity (carbonate-bicarbonate content) of water.

Calcium to magnesium ratio:

From the information presented here it is apparent that the ratio between calcium to magnesium is very important in dealing with the causes and prevention of a number of disorders including myocardial infraction or arrhythmia, atherosclerosis, hypertension, urolithiasis, and infant-death syndrome. In all cases, a lower calcium/magnesium ratio or a higher magnesium/calcium ratio is desirable. This need is further underscored by the fact that magnesium intake is generally sub optimal and that hypomagnaesmia is more prevalent than generally believed.
The recommended dietary allowance (RDA) for calcium is 800 mg/day, whereas for magnesium it is 400 to 450 mg/day. Only about one-third of magnesium is absorbed from dietary sources.

Therefore, a daily magnesium intake of 1200 mg/day is recommended by some researchers (22). The traditional ratio of approximately 2 parts calcium to 1 part magnesium needs to be upgraded to increase magnesium intake in view of the overwhelming beneficial role of magnesium. The ideal ratio for most people’s needs is an equal ratio of calcium and magnesium.

The absorption and metabolism of calcium and magnesium is one of mutual dependence and therefore, the balance between these two minerals is especially important if calcium consumption is high, magnesium intake needs to be high also.

**Vitamin D:**

Vitamin D is necessary to enhance calcium absorption; vitamin D works with the parathyroid hormone “PTH” to regulate the amount of calcium in the blood. It also stimulates the production of a calcium binding protein (CABP) in the intestinal wall that helps absorption.

**References:**