

Dietary electrolytes requirements and optimal intakes for health

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The major electrolytes in the body serve to maintain body homeostasis. Accordingly, the elements in the human body in concentrations greater than 0.01% by weight that conduct electricity are (in order of concentration): calcium (Ca), phosphorus (P), chloride, potassium (K), sulphur, sodium (Na) and magnesium (Mg). These elements correspond to the elements in seawater, although the relative concentrations differ: chloride, Na, Mg, sulphur, Ca, K and P (in order of concentration). The sea has a higher content of Na and Ca compared to our extracellular fluids. In vertebrates, the amount of Ca in the body is higher than the concentration of Na, which is entirely due to the skeleton. The evolution of organisms from the high-Ca, high-Na environments to the low-Ca, low-Na environment of dry land required physiological and morphological adaptations. Humans have developed physiological mechanisms to maintain a constant, relatively low level of Na in the body. We have also developed mechanisms to increase the Ca and P input in the body when the need arises, as the accumulation of Ca and P is essential for the survival of vertebrates on land.

Our diets are now vastly different from those of early mammals, who were predominately vegetarian insectivores. We have reversed our dietary ratios of Ca:P and Na:K, and reduced our Mg intake. Our ancestors began to add meat to a plant/insect based diet 1.8–1.6 million years ago and eventually their diet consisted of 50% meat and 50% plants. The Na content of this diet was under 1 g salt per day (17 Na mmol/day) and the K content 16 times greater than this. Now our Na intake is 10 times this whilst our K and Mg intakes are lower than that of Na. Our Ca intake was reduced with the move from uncultivated grains with a Ca:P ratio of one, to cultivated grains with a Ca:P ratio of 0.08 (one twelfth this amount).

Denton (1) has suggested that because we have salt-specific taste buds and there is a propensity for animals to ingest a wide range of Na concentrations, the preference for salt is a hedonistic characteristic, which may once have been useful for survival. Others suggest that hedonism for salt is an acquired characteristic because there is an aversion for salt in low-salt eating populations (2).

Salt was found to be useful in the preservation of food and it is known that highly salted food suppresses the salt taste receptors in the mouth, so that food without salt tastes insipid and unappetizing to those accustomed to salted food. There is evidence from animal studies that the preference for salt can be altered by introducing salt into the biscuits given to chimpanzees. When the salt was taken out of the biscuits the chimpanzees lost weight, preferring to do without rather than eat salt-free biscuits (2).

There is also some evidence for an appetite for calcium (3). It is not known to what extent our current food supply, with the current level of intake and altered ratio of dietary electrolytes, affects our appetite for electrolytes, but it does increase our risk of cardiovascular disease and osteoporosis. There is overwhelming evidence that the Na contributes to the age-related rise in blood pressure and that K, and to lesser extent Ca and Mg act to lower blood pressure. In addition to this, the calcium and sodium content of our diet, within the context of our current dietary and sedentary lifestyle, contributes to the development of osteoporosis.

Our current dietary intake meets our basic physiological requirements for electrolytes to keep us alive, but is not conducive for optimal health ie prevention of cardiovascular disease and osteoporosis which occur mid to later life. Dietary recommendations for electrolytes need to consider both level of intake and ratios that optimise health.

References

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