

# Role of Pure Sodium Salt on Neurological Disorders

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## ABSTRACT

Neurological diseases incidence and prevalence is increasing at an alarming rate globally leading to number of deaths. According a study, burden of neurological disease in US was about \$800 million in 2014 with about 32% population suffering from one or more of >1000 neurological disorders. Despite comparative poverty in developing countries, incidence of neurological diseases is comparatively lower than the developed countries. Consumption of pure sodium salt in developed countries appears to be one of the major culprit disturbing serum magnesium levels compared to developing nations where consumption of natural salt (a rich source of magnesium) is still common.

**Keywords:** Neurological disease; Serum

## INTRODUCTION

According to a 25 years study [1] on global burden of neurological diseases published in 2015, these diseases comprised 16.8 per cent of global deaths with 36.7% worldwide increase from diseases like Alzheimer's and Parkinson's disease, stroke and epilepsy between 1990-2015. The most prevalent neurological disorders were tension-type headaches (about 1,500 million cases), migraine (about 1,000 million), medication overuse headaches (about 60 million), and Alzheimer's disease and other dementias (about 46 million cases). The rates of cases per 100,000 was 15.7 per cent higher in Parkinson's, 2.4 per cent in Alzheimer's, 3.1 per cent in motor neuron disease, and 8.9 per cent higher in brain and nervous system cancers. Sodium rich diet has been linked to an increased risk of cerebrovascular diseases and dementia [2]. It is also observed that high sodium diet reduces blood flow in the brain of mice and perhaps this the reason for brain damage [2,3].

Vasily Vlassov, Professor at the National Research University Higher School of Economics in Russia propounded longer life expectancy for the main cause of increase in neurological disorders compared to several decades ago vis-à-vis increasing deaths [4]. According to New American Neurological Association Study, burden of neurological diseases was nearly \$789 billion in 2014. In 2011, US had about 32% of the population suffering from one or more of the >1000 neurological diseases [5].

The number of deaths in England relating to neurological disorders rose by 39% over 13 years while deaths in the general population fell by 6%, a new analysis of mortality has indicated. Deaths of people with epilepsy increased by 70% between 2001 and 2014,

with mortality in the most deprived areas nearly three times that in the least deprived [6].

India is estimated to have prevalence of neurological diseases on the average of 23940 per million populations and a total of about 30 million in 2014 which amounts to about 2.4% of the population [7].

World over salt is consumed on daily basis and plays a vital role in health determination based on over or under consumption. From time immortal, human beings are dependent upon natural sources of water like springs, lakes, and rivers rich in micro and macro-nutrients as well as natural salt obtained from lakes, sea or rocks containing large number of essential trace elements, micro and macro-minerals. This natural dependence has played decisive role in the biological evolution of human body. In last 6-7 decades, there have been large scale changes in dietary pattern and large section of global population has moved from natural water to processed water and natural salt to table salt for various reasons. This dietary movement has deprived the population from daily regular intake of trace elements, micro and macronutrients.

Magnesium, a trace element and constituent of natural salt, plays fundamental role in maintaining good health. According to Mayo Clinic Laboratories magnesium serum concentration between 1.7-2.3 mg/dL is essential for adults; some experts consider serum magnesium levels to be <1.8 mg/dL in the hypo limit. Hypomagnesaemia is one of the many causes associated with central nervous system and peripheral nervous system disorders. Magnesium deficiency is a little understood health problem and largely overlooked at initial stages of treatment by general practitioners despite the fact it is root cause of many obvious diseases like chronic diarrhea, muscle cramps, apathy, anxiety,

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osteoporosis, hypertension, asthma, and irregular heartbeats besides major neurological disorders like Alzheimer's, Parkinson's, dementia, stroke and epilepsy [4,8].

### Analysis and inference

An astronomical gap between prevalence of neurological disorders in developed countries like US and UK and developing countries like India compel etiology study for the disease. It will not be fare to ignore hypomagnesaemia responsible for large scale prevalence. Table 1 shows the daily recommended requirement of magnesium at different ages and Table 2 shows good natural sources of magnesium. Table 3 depicts magnesium contents of various salts.

Above data led to the conclusion that rich and fanciful diet is not alone sufficient to keep neurological disorders at bay. Despite availability and intake of natural sources and supplements for countering magnesium deficiency, there is increasing prevalence of the disease in developed countries. It is because everyone in developed countries also can't afford magnesium supplemented food on regular basis unless magnesium deficiency is diagnosed. It means there is "something" else which is triggering the onset of disease and that "something" best appears to be magnesium deprived everyday consumed table salt. In India also, incidence and prevalence of hypomagnesaemia related neurological diseases spread from urban to rural areas with the onslaught of iodised table salt [9] through state promulgation of ban on natural salt consumption. Very remote rural population which is economically poor still consume natural sea salt being cheaper in cost compared to branded iodized salt and as a blessing in disguise they are almost untouched by the rampant neurological diseases of city dwellers.

So far US Food and Drug Administration could understand and identified 60 elements of the natural salt as essential nutrients [10].

**Table 1:** Recommended Daily Allowance (RDA) of magnesium in USA.

| Age               | Male   | Female | Pregnancy | Lactation |
|-------------------|--------|--------|-----------|-----------|
| Birth to 6 months | 30 mg  | 30 mg  |           |           |
| 7-12 months       | 75 mg  | 75 mg  |           |           |
| 1-3 years         | 80 mg  | 80 mg  |           |           |
| 4-8 years         | 130 mg | 130 mg |           |           |
| 9-13 years        | 240 mg | 240mg  |           |           |
| 14-18 years       | 410 mg | 360 mg | 400 mg    | 360 mg    |
| 19-30 years       | 400 mg | 310 mg | 350 mg    | 310 mg    |
| 31-50 years       | 420 mg | 380 mg | 360 mg    | 320 mg    |
| 51+ years         | 420 mg | 380 mg |           |           |

**Table 2:** Good natural sources of magnesium per 100 g.

|                                                                                                                    |        |
|--------------------------------------------------------------------------------------------------------------------|--------|
| Almonds                                                                                                            | 270 mg |
| Pumpkin seeds                                                                                                      | 262 mg |
| Dark Chocolate                                                                                                     | 176 mg |
| Peanuts                                                                                                            | 168 mg |
| Popcorn                                                                                                            | 151 mg |
| Other great sources include flaxseeds, sunflower seeds, chia seeds, cocoa, coffee, cashew nuts, hazelnuts and oats |        |

**Table 3:** Magnesium contents of Salts.

|                     |                   |
|---------------------|-------------------|
| Himalayan rock salt | 106 mg per 100 g  |
| Celtic salt         | 300 mg per 100 g  |
| Table salt          | 1.39 mg per 100 g |

In June 2016, the US National Research Council labeled just 29 of these 60 micro and trace elements as "possibly" or "probably" essential and beneficial to human health. These include bromine, boron, chromium, calcium, copper, fluoride, iodine, iron, manganese, magnesium, molybdenum, potassium, phosphorus, selenium, silver, sulphur, and zinc. 14% fraction of natural salt comprising of MMTE that contains these 29 identified essential elements is large enough to ignore and neglect.

Manufacturing of iodized salt removes micro and macro-minerals and trace elements from sea salt and rock salt that contribute about 14% by weight. These micro and macro-minerals and trace elements are removed from the regular diet and substituted with pure sodium salt.

This large substitution of essentials minerals and trace metals by NaCl causes major changes in electrolyte composition leading to impairment of various fundamental processes, which have been identified to be more than 300, in the human body such as functioning of Na-K pump, Calcium pump and various thermodynamic and biological functions of the body system that are largely dependent on the concentration of various components.

Functional impairment of various body systems has been attempted on the basis of principles of physics. For example, heat and mass transfer across the cell changes drastically with changes in electrolyte composition causing impairment of neuron conduction in nerve cells. Heat movement in human cell can be illustrated by the following differential heat conduction equation [11]:

$$\frac{\partial}{\partial x} [K(x,t) \frac{\partial \theta(x,t)}{\partial x}] = \rho(x,t) C(x,t) \frac{\partial \theta(x,t)}{\partial t} \quad (1)$$

where  $K(x,t)$  is space and time dependent thermal conductivity of cell internal fluid

$\rho(x,t)$  is space and time dependent density of cell internal fluid

$C(x,t)$  is space and time dependent specific heat of cell internal fluid

$\theta(x,t)$  temperature of cell internal fluid at any instant  $t$  and position  $x$

It is evident from the above mathematical formulation that thermodynamics of whole body changes with change in concentration of cell internal fluid  $\rho(x,t)$  and composition of body electrolytes leading to changes in specific heat  $C(x,t)$ , and thermal conductivity  $K(x,t)$ . These physical changes are responsible for malfunctioning of various fundamental body processes like  $\text{Na}^+/\text{K}^+$  pump thereby causing malfunction of glands and body organs with manifestation of many diseases like type-2 diabetes and other NCDs.

Similarly, transport mechanism of main electrolyte ions  $\text{Na}^+$  and  $\text{K}^+$  within nerve cell can be formulated as below [12]:

$$\frac{J_{\text{Na}^+}}{q} = D_{\text{Na}^+} \nabla \text{Na}^+ + \text{Na}^+ \mu_{\text{Na}^+} E \quad (2)$$

$$\frac{\partial \text{Na}^+}{\partial t} = -\nabla \cdot \frac{J_{\text{Na}^+}}{q} \quad (3)$$

$$\frac{J_{\text{K}^+}}{q} = D_{\text{K}^+} \nabla \text{K}^+ + \text{K}^+ \mu_{\text{K}^+} E \quad (4)$$

$$\frac{\partial \text{K}^+}{\partial t} = -\nabla \cdot \frac{J_{\text{K}^+}}{q} \quad (5)$$

Where

$\text{Na}^+$  and  $\text{K}^+$  are concentration of Sodium and Potassium ions in the nerve cell respectively

$q$  is elementary charge on the Sodium and Potassium ions respectively

$J_{\text{Na}^+}$  and  $J_{\text{K}^+}$  are electric currents due to Sodium and Potassium ions in the nerve cell respectively

$E$  is the electric vector

$\mu_{\text{Na}^+}$  and  $\mu_{\text{K}^+}$  are mobility of Na and K ions respectively

$\nabla\text{Na}^+$  and  $\nabla\text{K}^+$  are concentration gradients of  $\text{Na}^+$  and  $\text{K}^+$  ions within nerve cell respectively

$\nabla$  represents divergence

$t$  is the time at any instant

Equations (1) to (5) clearly show effects of changes in electrolyte composition on performance of  $\text{Na}^+/\text{K}^+$  pump. Performance degradation of  $\text{Na}^+/\text{K}^+$  pump disturb transmission of brain neurons signals which produce an electrical spike called action potential (AP). After an AP, the  $\text{Na}^+/\text{K}^+$  pump resets the arrangement of  $\text{Na}^+$  and  $\text{K}^+$  ions back to their original positions so that the neuron is then ready to relay another AP when it is called upon to do so. So, the  $\text{Na}^+/\text{K}^+$  pump has a “housekeeping” role rather than a direct role in brain signaling; this is the long-held, entrenched viewpoint [13,14]. However, novel research upon cerebellar Purkinje neurons suggests that the  $\text{Na}^+/\text{K}^+$  pump may have a direct role in brain coding and computation [15].

Similarly, functioning of other transport pumps like calcium pump and proton pump gets impaired due to imbalances in body electrolytes.

Precisely controlled movements of ions into and out of cells and organelles are essential for all life. For example, in cells ion flows mediate processes as disparate as signaling, pH balance, volume regulation, and the cell cycle, and in higher organisms they underlie fertilization, immune responses, secretion, muscle contraction, and all electrical signals in nerves, muscles, and synapses [15].

Recently, Sodha and Agarwal [16] have studied ambipolar diffusion in gaseous plasmas consisting of electrons and ions of multiple varieties that has perfect application to human cells more specifically  $\text{Na}^+/\text{K}^+$  exchange pump where we encounter four types of positive, and negative ions and neutral particle namely  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$  and P. Similarly proton pump and calcium ( $\text{Ca}^{++}$ ) pump also present brilliant example of ambipolar diffusion. Interestingly, human body needs more than 80 trace elements, micro and macronutrients for perfect functioning thus making physical processes undergoing within the body at various levels becomes extremely complex and sensitive to even minute disturbances.

Complete supplementation of MMTE is not only difficult but expensive as well and thus out of reach for everyone. Finally it is concluded that pure sodium salt play vital role in the prevalence of neurological diseases and needs to be replaced by natural sea

salt or rock salt in combating prevalence of neurological diseases world over. In such circumstances, it is much better to use natural salt instead of pure sodium table salt that may contain other non-communicable diseases also.

## CONFLICTS OF INTEREST

There is no conflict of interest.

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