

Role of Selenium in General and Oral Health

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Abstract

In human biology, selenium is an important trace mineral. The highest sources of selenium include nuts, offal, eggs, fish, and chicken. The Recommended Dietary Allowance (RDA) for selenium in children aged 1-3 years is 20g/day; for children aged 4–8 years, it is 30g/day; for children aged 9–13 years, it is 40g/day; for children aged 14 years and beyond, it is 55g/day; for pregnant women, it is 60g/day; and for breastfeeding mothers, it is 70g/day. They provide numerous health benefits, including for the immune system, reproduction, mood, thyroid function, cardiovascular disease prevention, and cancer prevention. Selenium deficiency has been associated with an increased risk of death, as well as reduced immune function, antiviral capacities, and cognitive impairment. It is a naturally occurring component of human enamel and dentine that helps to reduce the duration and severity of oral mucositis. Some researchers discovered that selenium's caries-promoting effect reduced fluoride's

caries-preventive function, while others discovered that has a significant impact on the degree of susceptibility to dental caries. Organoselenium sealants are used to prevent the formation of tooth cavities and plaque. Acute toxicity is linked to a concentration of 400-30,000 g/L, chronic toxicity is linked to a concentration of 500-1400 g/L, and toxicity is not linked to a concentration of 1400 g/L. As a result, it is critical to comprehend the benefits and downsides of selenium, which aids in overall and oral wellness in our bodies.

Keywords: Selenium, Recommended Dietary Allowance, oral health, toxicity

Introduction

Selenium is a non-metal element found in the earth's crust. It is found in higher concentrations in sedimentary, volcanic, and carbonate rocks (50-90 g/kg). It exists in various chemical forms. These include such as selenite, selenate, and Selenium, also associated with sulfur-containing compounds. Selenium is also a component of

selenocysteine which, when present in proteins, is called selenoproteins ^[1]. In animals and humans, respectively, there are 30 and 25 selenoproteins. Many of them are antioxidant enzymes that protect the body from oxidative stress ^[2]. They require less in our human bodies, and a deficiency of it can have serious health consequences in humans, such as Keshan disease (endemic cardiomyopathy). Glutathione peroxidase (GPx), thioredoxin reductase (TrxR), and iodothyronine deiodinase (IDD) are all antioxidant enzymes that contain it ^[3]. The study of Selenium has been of massive interest because of its antioxidant activity and possible protective effect against cancer and other chronic diseases.

It is a crucial component for animal and human growth. Low selenium levels, on the other hand, have been linked to a higher risk of death, impaired immunological function, and cognitive decline. It is required for male and female reproduction, reduces the risk of autoimmune thyroid illness, and has antiviral properties when taken as a supplement. At higher concentrations, it possesses toxicological properties ^[4]. Selenium's semiconducting qualities make it helpful in industrial applications such as photocopiers, light detectors, rectifiers, stainless-steel fabrication, ceramic colors, and rubber vulcanization. It is also helpful in biology and agriculture due to antidandruff shampoos, fertilizers, pesticides, and animal feeds ^[5,6].

Dietary Source of Selenium

Nuts, offal, eggs, fish, and poultry are the highest sources of selenium in the UK diet (EMV, 2002), followed by bread, meat products, fish, poultry, and eggs in decreasing order. Beet leaves, cabbage leaves, and onions, for example, contain up to 50% selenium. It's possible in the form of selenite ^[7]. There is a dearth of knowledge about Selenium levels and the diverse species of Selenium that can be found in different foods.

Recommended Dietary Allowance (RDA)

For both men and women, the RDA is 55 µg (0.7 micro mols) per day. Although selenium intake varies by geographic location, there is no evidence of average intakes below the RDA in the United States or Canada ^[8]. Groups of people by age: 20 µg /day for children 1–3 years old; 30 µg /day for children 4–8 years old; 40 µg /day for children 9–13 years old; 55 µg /day for adults 14 years and older; 60 µg /day for pregnant women; 70 µg /day for breastfeeding women.

Function Of Selenium In General Health: Many of the selenoproteins are essential to human health, and their functional effect is as follows ^[9]:

1. Glutathione peroxidases (GPxs) Hydrogen peroxide, lipid hydroperoxides, and (GPx4) phospholipid and cholesterol hydroperoxides are all removed by an antioxidant method. Cardiomyopathy is caused by a lack of GPx1 (cytosolic), which decreases retroviral virulence by inhibiting viral mutations.

In colon crypts, GPx2 (gastrointestinal) possesses an antiapoptotic effect and aids in maintaining intestinal mucosal integrity.

Extracellular fluids include antioxidants called GPx3 (plasma). The kidney produces GPx3 in the blood and protects the thyroid against hydrogen peroxide in the thyrocytes and follicular lumen.

The membrane-associated phospholipid GPx4 (phospholipid) is present in high quantities in the testis and is required for sperm motility and viability.

2. Thyroid hormones T3 and reverse T3 are produced by iodothyronine deiodinases (rT3)

3. Selenoprotein P (SEPP1) is a major source of selenium in the blood and a reliable indication of selenium deficiency. Selenium is transported from the liver to the brain, testicles, and kidneys through plasma; it possesses antioxidant properties and is required for brain function.

Spasticity, aberrant movements, and spontaneous convulsions are all symptoms of male fertility deficiency in mice.

4. Thioredoxin reductases (TrxR) have a wide spectrum of redox-active substrates, including thioredoxin, which is essential for DNA synthesis.

5. Anti-inflammatory selenoprotein S (SEPS1) is found in the endoplasmic reticulum and protects cells against stress-induced apoptosis. They were connected to insulin sensitivity and glucose metabolism.

6. Selenoprotein N (SelN) is an endoplasmic reticulum (ER) protein that regulates calcium mobilization during muscle development. Myopathies, such as multiminicore disease, are caused by mutations.

Deficiency of Selenium In General Health

1. Immune function: Selenium deficiency leads to loss of immunocompetence along with inefficiencies in cell-mediated immunity and B-cell function^[10]. This can increase the transcription of receptors for the growth-regulating cytokine interleukin-2 (IL-2) on the surface of activated lymphocytes and natural killer cells (NK cells), allowing them to interact with IL-2^[11]. T-cell activity is activated and the immunological response is controlled by the enzyme selenocysteine synthetase 2 (SPS2)^[12].

2. Viral infection: Beck and colleagues demonstrated that innocuous viruses may become virulent in a selenium-deficient host, which is likely to facilitate the development of endemic human selenium-deficiency cardiomyopathy, known as Keshan Disease.

3. Reproduction: Selenium is necessary for testosterone synthesis or the production and normal development of spermatozoa^[13], making it important for male fertility. Women who had first-trimester or recurrent miscarriages experienced substantially lower serum selenium, according to Barrington^[14,15].

4. Mood: Low plasma Se levels in the elderly were found to be strongly linked with senility and hastened cognitive decline,^[18] and supplementation with Se decreased intractable epileptic seizures in children. The concentration of selenium in Alzheimer's sufferers' brains was just 60% that of controls^[16,17]. Low selenium levels were linked to a higher prevalence of depression and other negative mood states including anxiety, disorientation, and aggression in three different investigations^[19,20].

5. Thyroid function: The plasma T3:T4 ratios in young Scottish individuals were as low as those observed in older people, according to Arthur JR. Selenium treatment lowered plasma thyroxine (T4) levels, enhanced deiodinase activity, and improved conversion to the active hormone, T3, in a limited sample of individuals^[21].

6. Cardiovascular Disease: By decreasing hydroperoxides of phospholipids and cholesteryl esters associated with lipoproteins, GPx can fight oxidative alteration of lipids and platelet aggregation. As a result, oxidized low-density lipoproteins accumulate less in the arterial wall. GPx is required for the metabolism of hydroperoxides generated by lipoxygenase and cyclooxygenase pathways during eicosanoid production^[23].

7. Cancer: Clark and colleagues in the United States conducted the Nutritional Prevention of Cancer (or NPC) Experiment, which was the first double-blind, placebo-controlled intervention trial in a western community to test the concept that selenium supplementation may lower cancer risk^[24].

Role In Oral Health & Diseases

The blood levels of Selenium in patients with premalignant lesions such as oral leukoplakia and oral malignancies were shown to be lower than in healthy people. There was a decrease in Selenium-containing

glutathione peroxidase levels in such individuals, as well as an increase in oxidative stress ^[25].

It was shown that lower Selenium concentrations resulted in higher oxidative stress in bodily tissues, which had unintended negative consequences. To decrease oxidative stress in premalignant lesions such as leukoplakia, OSMF, and oral cancer patients, nutritional supplementation with trace minerals such as Selenium is a key reason ^[26].

Effect on dental health

A study specifically looked at the anti-inflammatory and antioxidant effects of Selenium in individuals who had oral mucositis as a result of high-dose chemotherapy. According to the researchers, sufficient Selenium supplementation might have cytoprotective and antiulcer properties. They concluded that selenium might help these individuals lessen the length and severity of oral mucositis ^[27].

1. In human teeth: Selenium is a natural component of enamel and dentine in human teeth. The concentration of Selenium in deciduous teeth was greater than in permanent teeth. Despite this, there is no discernible trend in the increase in selenium concentration of enamel with increasing age ^[28].

2. In Saliva: Hadjimarkos et al. researched to determine the content of Selenium in saliva taken from children aged 11 to 12 years old. Selenium concentrations range from 1.1 to 5.2 ppb in all of the samples, with a mean of 3.1 ppb. There were no differences in selenium concentrations between boys and girls ^[29].

3. In human milk: Even a little amount of selenium in the teeth might enhance caries susceptibility. As a result, the amount of Selenium in human milk is critical in the development of caries risk. In a study of 25 breastfeeding women of poor socioeconomic position, the mean

selenium concentration of the milk samples was determined to be 0.021 ppm ^[30].

4. The relationship between egg, milk, and water and dental caries: A study carried out in Oregon is considered to be a nonseleniferous area. It involved 2,069 children of 14 to 16 years of age in their three respective regions. They found that reduced content of Selenium was present in egg and milk in Klamath than Jackson and Josephine; respective study regions. Moreover, the selenium content in the water of all these regions is very low in all three areas. Most of the Selenium concentration is found in the egg yolk ^[31].

5. Dental Caries in South India: Children from South India have a high prevalence of dental problems. Diet, availability of sticky carbohydrate-rich food, presence of specific trace elements like Selenium, and relative humidity in that area may all impact them ^[32].

6. Interaction between selenium and fluoride: Fluoride's caries-preventive action was inhibited by selenium's caries-promoting effect ^[33]. Selenium may play a role in reducing the risk of dental caries attack ^[34].

7. Organoselenium sealants inhibit dental biofilm: Organoselenium sealants prevent bacterial biofilms by covalently attaching organo-selenium compounds to various substrates. As a result, SeLECTDefense™ sealant is used to prevent dental cavities and plaque development by oral pathogens by preventing bacterial adhesion and biofilm formation by the two most common oral pathogens, *S. mutans*, and *S. salivarius*. This suggests that the caries-inhibiting action of this sealant is extremely effective and long-lasting ^[35].

8. Colloidal selenium nanoparticles in chitosan: Chitosan's antibacterial properties against *S. mutans*, *L. acidophilus*, and *Candida albicans* can be related to its cationic nature. Bacteria's cell wall structure and cell membrane can be degraded by cationic compounds ^[36].

9. Intracanal dressing: The insertion of Se on calcium hydroxide whether as an intracanal medicine alone or in combination with other medications induced anti-inflammatory responses in periapical tissues following Root Canal System cleaning and shaping operations^[37].

Toxicity of selenium

The toxicity of Selenium can be Acute or Chronic.

Acute poisoning is usually caused by a single dosage that causes symptoms within minutes to hours of consumption. Chronic poisoning, on the other hand, includes lesser quantities repeated over time, with signs and symptoms appearing over days or longer. Acute toxicity is related with 400-30,000 g/L, chronic toxicity is associated with 500-1400 g/L, and toxicity is not associated with 1400 g/L^[38].

Selenium poisoning is evaluated primarily on the individual's indications and symptoms rather than test values^[39]. Hair loss, darkening of nails, metatarsal cramps, tiredness, and malaise are all symptoms of chronic poisoning. Symptoms such as anagen phase widespread alopecia and pulled hairs; nails: all nails had 3 mm of the typical nail at the base but were enlarged distally, and yellow did not notice nail alterations until 49 days after initial presentation^[40]. The volatile metabolite dimethylselenide^[41,42] is responsible for the strong garlic-like odor that is present in both acute and chronic poisoning. This stench has also been reported in the breath of people who have been exposed to low levels of toxins.

Conclusion

Selenium is the first trace element that appears to be connected to an increased risk of tooth decay. On the one hand, the prevalence of dental caries and the individuals' urine selenium concentrations were found to be directly related. The mammary gland's role in selenium metabolism was discovered, as well as the effect of

dietary selenium on children's dental caries susceptibility. Inadequate selenium supplementation reduces male fertility and has an impact on the immune system, anxiety, depression, heart disease, and cancer risk. Excessive selenium supplementation can cause antiviral disease and eventually poisoning.

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