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Review

The role of selenium in human conception and pregnancy

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Abstract

Selenium (Se) is a trace element essential for the appropriate course of vital processes in the human body. It is also a constituent of the active center of glutathione peroxidase that protects cellular membranes against the adverse effects of H₂O₂ lipid peroxides. Epidemiological surveys have demonstrated that selenium deficiency in the body may contribute to an increased risk for certain neoplastic diseases (including colonic carcinoma, gastric carcinoma, pulmonary carcinoma and prostate carcinoma), as well as diseases of the cardiovascular, osseous and nervous systems. Apart from its cancer prevention and antioxidative activities, selenium protects the body against detrimental effects of heavy metals and determines the proper functioning of the immunological system.

Furthermore, selenium plays a significant role in the undisturbed functioning of the reproductive system. Many studies have addressed correlations between its intake and fertility as well as disorders of procreation processes. Selenium deficiencies may lead to gestational complications, miscarriages and the damaging of the nervous and immune systems of the fetus. A low concentration of selenium in blood serum in the early stage of pregnancy has been proved to be a predictor of low birth weight of a newborn. A deficiency of this element may also cause infertility in men by causing a deterioration in the quality of semen and in sperm motility. For this reason, supplementation in the case of selenium deficiencies in the procreation period of both women and men is of utmost significance.

Section snippets

Biochemical properties of selenium

Selenium was discovered in the year 1817 by the Swedish chemist Jöns Jacob Berzelius. Initially, it had been perceived as a toxic element, but after 140 years, a study by Schwarz and Folt [1] demonstrated that Se is essential for human biology. Today, it is acknowledged as a trace element fundamental to human health.

Selenium is absorbed from food in the form of inorganic compounds like selenites (Me_2SeO_3) and selenates (Me_2SeO_4) or organic links – selenomethionine (SeMet) and selenocysteine...

Selenium sources in the human diet

For humans, a source of this microelement is foodstuff of both plant and animal origin, and marginally – drinking water. High quantities of selenium are provided by, among others, cereal products, seafood, haslets, eggs, yeast, tomatoes, asparagus, garlic, broccoli, nuts (especially Brazilian nuts), and turnip cabbage. Although more selenium is found in products of animal origin, the best sources of this element are wheat and other plant products owing to its better bioavailability [3]. The Se...

Human selenium status

The nutritional status of selenium can be assessed by determining Se levels in blood (whole blood, erythrocyte, serum or plasma), urine, nails and hair. Serum or plasma selenium reflects short-term status as opposed to erythrocyte selenium which reflects long-term status [9]. There is a marked variation in Se intake and status from one part of the world to another. Furthermore, it is often difficult to compare results because of variations in methodology in different laboratories. Because of...

Health impact of selenium

This element, as a constituent of selenoproteins, activates anti-carcinogenic factors, prevents diseases of the cardiovascular systems as well as exhibits anti-proliferative and anti-inflammatory activities [31], [32]. Furthermore, it stimulates the immune system and acts antagonistically to such heavy metals as: arsenic, cadmium, lead and mercury [33], [34], [35]. Selenium deficiencies are mainly developed due to insufficient content in diet, but also as a result of disorders in its transport...

Phospholipid peroxide glutathione peroxidase and thioredoxin reductase in spermatogenesis

Proper spermatogenesis requires two selenoproteins: phospholipid peroxide glutathione peroxidase – PHGPx and selenoprotein P. In the testes, selenium occurs mainly in the PHGPx form, namely in the form of one of the selenium-dependent antioxidative enzymes. TrxRs was additionally detected in the testes of mature male mice. Its high quantities may be observed in maturing spermatides, whereas its reduced expression – in mature semen [38]. Scientists have advanced a hypothesis that both...

Selenoprotein P in the testes

The second significant component of the selenium pool in the testes is selenoprotein P. Its deficiency in a group of knockout mice (deprived of this selenoprotein) has induced numerous disorders of the structure of the spermatozoa tail: improper mitochondrial membranes, disorders in the morphology of axonema microtubules, and improper morphology of the links of the central and main section of the spermatozoon. Symptoms of selenoprotein P deficiency were the same as in the second group in which...

Selenium and testosterone

Tests conducted on rats by Behne and co-workers [56], [57] suggest that selenium may also influence the biosynthesis and secretion of testosterone. These authors have demonstrated that in the case of an insufficient supply of this element with diet, it is first delivered to testes and then to other tissues. A

reduced level of Se was noted in the testes of hypophysectomized individuals. However, its level increased upon the administration of testosterone, which points to either an indirect or...

Correlations between estrogen and selenium in menstruation cycle

Despite sparse information on the relationship between female sex hormones and selenium status, research conducted with healthy women point to a correlation between estrogen content and selenium content as well as GPx activity depending on the phase of the menstruation cycle [59], [60]. Both selenium concentration in the serum and GPx activity in the serum and erythrocytes are at their lowest in the early follicular phase, whereas they are at their the highest in the pre-ovulation phase, and...

Selenium in ovulation

Although reduced fertility in women is often linked with insufficient body saturation with selenium, its role in this process still remains unknown. Perhaps it is due to the fact that selenium is a co-factor of antioxidative enzymes that are responsible for the neutralization, elimination and prevention of synthesis of reactive oxygen species (ROS) [61], [62]. Through ROS, the oxidative stress affects oocytes. It has been observed that the first meiotic division in these cells is induced by an...

Selenium and female infertility

In one of the sparse human studies, Paszkowski's group [67] observed a lower selenium concentration in the follicular fluid of women with unexplained infertility, compared to women who were infertile due to other reasons. Simultaneously, no differences were demonstrated in either selenium concentration in the serum or GPx concentration in the serum and the follicular fluid between the analyzed groups of women. According to these authors, the results obtained suggest that the antioxidative...

Selenium status in pregnancy

Pregnancy is an exceptional condition of enhanced demand for various nutrients. Physiological changes proceeding in the body of a pregnant woman caused, for example, by a high concentration of progesterone, include a reduced bioavailability of some dietary components and an increased demand for them owing to a developing fetus. Deficiencies of mineral elements and vitamins in this period may contribute to the occurrence of perinatal complications, fetus necrobiosis, congenital organ defects in...

Implications of selenium deficiencies on the fetus

Deficiency of selenium in pregnant women may lead to dysfunctions in the nervous system of a developing fetus. Cengiz et al. [76] demonstrated a positive correlation between a low concentration of this element in the serum of pregnant women and the occurrence of neural tube defects, especially anencephaly and rachischisis (a type of birth defect that causes abnormal formation of the spinal column), in their progeny. It ought to be emphasized, however, that the development of the nervous system...

Preeclampsia

Maternal selenium status may contribute to the incidence of the preeclamptic state (EPH gestosis). Conflicting results have been found in research examining the serum concentrations of selenium in preeclamptic women. Some studies have observed a reduction in concentrations of selenium in plasma or

serum [79], [80], and others have reported an increased selenium concentration in preeclamptic woman than in normal pregnant women [81], [82]. Gromadzińska et al. [81] observed higher concentrations...

Cholestasis

Authors of some studies point also to a correlation between selenium deficiency and the incidence of cholestasis in pregnant women. The pregnant women with cholestasis were characterized by a lower selenium concentration in the blood and by a lower activity of GPx in erythrocytes than the healthy pregnant women. In patients with intrahepatic cholestasis of pregnancy the low concentration of selenium (possibly disturbed function of the microsomal cytochrome P-450 system, also controlled by...

Gestational diabetes mellitus

Diabetes is one of the most common diseases developing in pregnant women. Due to insulin-resistance and the increased demand for insulin in the period of pregnancy, some women suffer from debilitated glucose tolerance, which may transform into gestational diabetes mellitus (GDM). Selenium is speculated to be essential for the proper glucose uptake, the regulation of the cellular absorption of glucose and reduction of insulin resistance. Contrary to those expectations, recent epidemiological and ...

Thyroid dysfunction

Selenium, as a component of selenoproteins, plays a significant role in the biosynthesis of thyroid hormones.

In women who are at the reproductive age, hypothyroidism has an indirect or direct impact on their fertility, course of pregnancy and the development of the child. The development of the central nervous system takes place in the first and second trimester of pregnancy and is determined most of all by the transport of the mother's thyroid hormones through the placenta [94]. A hormone...

Effect of tobacco, alcohol and polycyclic aromatic hydrocarbons on selenium status in pregnancy

The course of pregnancy is also negatively affected by tobacco smoking. Toxic substances present in tobacco smoke intensify oxidative transformations and exert adverse effects on fetus development. Frequent smoking and exposure to environmental tobacco smoke during pregnancy may cause reduced availability of selenium to fetus tissues, preterm delivery, preterm rupture of fetal membranes, reduced birth weight of the child, hypotrophy, and many other severe disorders in the period of intrauterine ...

Conflict of interest

The authors declare that there are no conflicts of interest....

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2022, Science of the Total Environment

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...Factor 1 mainly loaded on Se, accounting for 89.1 %. Se is beneficial for the human body and plant growth because it enhances immune function and improves antioxidant ability (Chen et al., 2009; Pieczyńska and Grajeta, 2015). Plants normally obtain Se from soil parental materials, especially selenate, which is the most available species in the soil for plant (Eiche et al., 2015; Qin et al., 2013)....

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