Journal of Trace Elements in Medicine and Biology 41S (2017) 1–88

Journal of Trace Elements in Medicine and Biology

journal homepage: www.elsevier.com/locate/jtemb

Joint 16th International Symposium on Trace Elements in Man and Animals (TEMA-16), 12th Conference of the International Society for Trace Element Research in Humans (ISTERH 2017) and 13th Conference of the Nordic Trace Element Society (NTES 2017)

Saint-Petersburg, Russia, 26–29 June, 2017

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0946-672X/

O-1-001

'Macro effects' of 'micro elements': Trace elements in demography, populational health, and economics

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Multiple studies have demonstrated significant effects of both essential and toxic trace elements in a particular organism. However, data on demographic effects of trace elements are insufficient. The objective of a series of studies performed during the last decades (2000s–2010s) was to assess the element status of Russian population its interaction with demography. Based on data from hair trace elements content in more than 60,000 adults and 15,000 children the rate of trace element deficiency and excess in Russia was evaluated. It has been revealed that high content of hair toxic trace elements is associated with reduced birth rate, increased mortality and morbidity. The impact of Hg and Pb on the costs of IQ loss in children was evaluated. In turn, essential trace element deficiency (Se) is associated with decreased life expectancy and higher morbidity and mortality. At the same time, the relationship with demographic parameters was more significant after consideration for interaction (ratios) between particular trace elements (e.g. Hg/Se). The potential benefits of trace element status regulation are discussed.

http://dx.doi.org/10.1016/j.jtemb.2017.03.013

O-1-002

Functional genomics of mammalian selenoproteins

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Selenium has both beneficial and toxic effects in human health. The importance of having adequate amounts of this micronutrient in the diet is primarily due to the fact that selenium is used in selenoproteins in the form of selenocysteine. In this presentation, discussion will be focused on evolution and function of selenium utilization in mammals. Comparative and functional genomics methods allow assessing the use of selenium at the levels of proteins, cells, organs and entire organisms. The most challenging is the functional analysis of about a half of mammalian selenoproteins, for which no function is currently known. New functions are also being discovered for previously characterized selenoproteins, such as reversible regulation of actin through methionine-R-sulfoxidation. More generally, selenoproteins with known functions are oxidoreductases, and the tight link between selenium and redox biology offers an opportunity to better understand selenoproteins and use this information to examine questions central to the redox control of cellular processes.

http://dx.doi.org/10.1016/j.jtemb.2017.03.014

O-1-003

New perspectives of functional genomics of selenoproteins in food animals

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Swine and poultry are two major food-producing species, and can also be used as models for human medicine. We have studied regulations and functions of selenogenome and selenoproteome of pigs and chicks by dietary intakes of Se, vitamin E, and fat. No universal mechanism was found for a global regulation of the genome or proteome by dietary Se in pigs. Both Se deficiency and excess exerted dual effects on gene transcripts of various selenoproteins. In the high fat-induced obesity, *SELENOI* and *SELENOV* exhibited the strongest correlations with the obesity-related gene expression and phenotypes of pigs. The Se excess was diabetogenic, resulting in hyperinsulinemia and altered insulin signaling and energy metabolism in pigs. The classical Se/vitamin E deficiency diseases of chicks were associated with down-regulation of GPX1, GPX4, SELENOF, SELENON, SELENOP, and SELENOW in the liver, muscle, and pancreas, activating the p53/caspases/COX2/FAK/PI3K/Akt/NF-κB, and p38 MAPK/JNK/ERK signaling pathways. Dietary vitamin E deficiency elevated the production of GPX4, along with mRNA levels of 6 selenoproteins, in tissues of chicks.

http://dx.doi.org/10.1016/j.jtemb.2017.03.015

O-1-004

Dual role of selenium in health and disease

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The relation between selenium and the etiology of human diseases is still partially unclear, appears to have a Janus-faced nature and is influenced by the chemical form of the element. While selenium was suggested to decrease cancer risk by observational studies and a randomized controlled trial (RCT), recent large RCTs showed no effect or even adverse effects of selenium on cancer risk, suggesting that the earliest studies were affected by exposure misclassification or unmeasured confounding. RCTs also showed no influence of selenium on cardiovascular risk and an adverse effect on diabetes risk. Conversely, RCTs indicated a beneficial effect of selenium on Keshan disease, a cardiomyopathy described in low-selenium areas in China, though the etiology of this disease is still not entirely elucidated. Selenium may also be involved in the etiology of neurological disease. This dual and intriguing activity of selenium on human health shown by epidemiologic studies is mirrored by laboratory studies. Thus, there is the need of a reassessment of what constitutes a safe intake of selenium in humans.

http://dx.doi.org/10.1016/j.jtemb.2017.03.016