Essential elements and Vitamin D in children, 2016

In 2016, the monitoring was carried out in five localities – Prague, Liberec, Ostrava, Žďár nad Sázavou, and Kutná Hora. The target population were children aged five and nine years. The study cohort consisted of 419 children (162 five-year-olds and 257 nine-year-olds). The samples collected were 419 blood serum specimens, 418 whole blood specimens, and 400 urine specimens. The whole blood and urine samples were analysed for selected essential trace elements (iodine – I, manganese – Mn, selenium - Se, and zinc – Zn), and blood serum was analysed for a vitamin D metabolite - 25-hydroxyvitamin D (25(OH)D).

Iodine levels

To monitor iodine saturation, ioduria or the urinary excretion of iodine is used as an indicator. The urinary iodine level of 100-199 µg/l set by the World Health Organization [1] is considered as sufficient and that in the range between 100 and 299 µg/l is seen as satisfactory and characteristic of a population without iodine deficiency. A urinary iodine level below 100 µg/l indicates insufficient iodine saturation. The results obtained in children pointed to the problem of iodine oversaturation. The median ioduria was 248 µg/l. The optimum urinary iodine level was found only in one of four children, i.e. in 102 of 400 children. Iodine oversaturation (ioduria above 300 µg/l) was recorded in 34% of children. As few as 7% of children had insufficient iodine saturation. The five-year-olds had statistically significantly ($p<0.05$) higher urinary iodine levels than the nine-year-olds (279 µg/l vs. 265 µg/l).

Tab. 1 Ioduria in children, 2016

Number of children	400
	µg/l urine
Geomean	239
Median	248
25th Percentile	177
75th Percentile	338
95th Percentile	496
Minimum	44.5
Maximum	1 321
	µg/g creatinine
Geomean	242
Median	237
25th Percentile	182
75th Percentile	325
95th Percentile	519
Minimum	63.8
Maximum	1 461

Manganese and selenium

Manganese is one of the elements needed in small quantities to help regulate body functions, but which may become toxic at intakes above the optimum level. Particularly serious are the negative effects on the development of the nervous system in childhood. The median blood manganese level in children was 14.1 µg/l. No significant age related difference was observed. No safe blood manganese level has been set from the perspective of public health protection.

Selenium is an essential mineral, which is necessary for reproduction, thyroid hormone metabolism, DNA synthesis, and protection from oxidative damage. Selenium was analysed in the whole blood, which reflects rather the long-term saturation. The median blood selenium level in children was 92 µg/l, i.e. was slightly higher in comparison with 2008. The reference concentrations are reported to be in the range from 80 to 250 µg/l of the whole blood [2]. Eighty-one percent of children had the blood selenium levels in this range. Selenium deficiency (below 80 µg Se/l of blood) was diagnosed in 19% of children. None of the study subjects showed severe selenium deficiency (below 40 µg Se/l of blood). The blood selenium level was significantly positively influenced by the consumption of sea fish and seafood. The five-year-olds had statistically significantly ($p<0.05$) lower blood selenium levels than the nine-year-olds (90.2 µg/l vs. 93.8 µg/l).

Tab. 2 Manganese and selenium levels in children's blood, 2016

	Mn	Se
Number of children	418	
	µg/l	
Geomean	14.2	91.3
Median	14.1	92.0
25th Percentile	12.2	82.3
75. percentil/ 75th Percentile	16.2	101
95. percentil / 95th Percentile	20.1	116
Minimum	7.67	59.7
Maximum	28.0	155

Serum 25(OH)D levels

The serum 25(OH)D levels were first measured as part of the biological monitoring in 2016. They reflects both the amount produced endogenously in the skin and intake with food and food supplements. What is the sufficient vitamin D supply in the body (measured by the serum 25(OH)D levels) has not yet been unambiguously defined. Levels below 25 nmol/l are traditionally considered as deficiency in Europe. The Committee on Reference Dietary Intakes of the US Institute of Medicine defines the limit for vitamin D deficiency risk to be 30 nmol/l. Many experts consider 50 nmol/l [3] to be a reasonable limit for a sufficient Vitamin D supply; however, the Working Group of the Endocrine Society Clinical Guidelines Subcommittee recommends a serum 25(OH)D level of 75 nmol/l [4] as effective for disease prevention.

Of the total of 419 five-year-olds and nine-year-olds included in the study, only 143 (34%) had the optimal serum 25(OH)D level of 75 nmol/l. No significant age related difference was observed. The serum 25(OH)D level is known to have a marked seasonality and to vary with sunlight intensity.

Tab. 3 Levels of blood serum 25-hydroxyvitamin D in children, 2016

	All year	Winter	Spring	Summer	Autumn
Number of children	419	66	124	85	143
	25(OH)D nmol/l				
Geomean	61.3	54.6	48	69.8	73.7
Median	63	56	49.8	67.8	78.7
25th Percentile	48.6	45.1	39.6	60.2	61.1
75th Percentile	82.7	66.7	62.5	86.7	91.3
95th Percentile	104	93.4	86.4	113	111
Minimum	12.1	23.7	12.1	19.6	21.2
Maximum	147	114	104	139	147

Similarly to other studies, major vitamin D deficiency was observed in the winter and spring months. In the spring, only as few as 14% of children had optimal serum 25(OH)D levels and more than one third of children did not reach a sufficient vitamin D supply in the body. The median 25(OH)D level was 49.8 nmol/l in the months March to May while in the period September to November, the respective level was 78.7 nmol/l.

References:

[1] WHO (2007). Assessment of the iodine deficiency disorders and monitoring their elimination. WHO, Geneva: 1–107.

[2] Thomson C.D. (2004). Assessment of requirements for selenium and adequacy of selenium status: a review. Eur J Clin Nutr, 58(3): 391–402.

[3] Bouillon R., Schoor N.M. Van, Gielen E., et al. (2013). Optimal Vitamin D Status : A Critical Analysis on the Basis of Evidence-Based Medicine. 98(August): 1283–1304.

[4] Holick M.F., Binkley N.C., Bischoff-Ferrari H.A., et al. (2011). Evaluation, treatment, and prevention of vitamin D deficiency: An endocrine society clinical practice guideline. J Clin Endocrinol Metab, 96(7): 1911–1930.