Dietary exposure to mercury in the Slovak Republic

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Summary

The aim of the paper has been to assess the exposure of the Slovak Republic population to mercury from foods and beverages during the period from 1990 to 2004. Estimated doses of dietary mercury were based on mercury findings in analysed commodities and the respective data on consumption, and were calculated for an average inhabitant and for children of various age groups. For the survey, analytical findings in total of 53 203 samples of foods and beverages, collected at agricultural holdings, food industry enterprises, the retail network and households were utilized. Two types of consumption models have been used, for the average consumer we used HBS-based model (HBS - Household Budget Survey) as well as the model of consumption based on rational diet, and for children we used models based on rational diet. The exposure values were also expressed in terms of their share on the provisional tolerable weekly intake value (PTWI; 5 $\mu g.kg^{-1}$ body weight per week). The evaluation suggested relatively low dietary exposure to mercury in the Slovak Republic, with rather stable trend of values during the period of observation. The PTWI value was not exceeded, and weekly intake based on HBS-based consumption model (average inhabitant of the Slovak Republic) ranged between 3.3% and 12.5% PTWI using mean findings; the corresponding values for median and the 95th percentile values were between 1.5% and 8.5%, and between 9.8% and 35.0%, respectively.

Keywords

mercury; intake; exposure assessment; food; PTWI

The current use of mercury is rather widespread. This element is being used in electrical engineering and chemical industry for the production of fungicides, of the colour agent cinnabar, of thermometers, barometers, light bulbs, detonators, batteries, in the paper industry, in welding, in dentistry and medicine [1].

In the general environment, the most frequently it is present as elementary mercury (Hg^0), or in the bivalent form (Hg^{+2}) as a constituent of inorganic compounds, but it may also be a constituent of organic compounds. Air pollution with mercury is the result of burning fossil fuels, production, smelting, refining processes, as well as of the natural evaporation from the Earth crust. In the air, mercury is frequently found in elementary and bivalent form, in both cases as vapours, dissolved in airborne particles or adsorbed to the surface of dust particles. Mercury enters surface water from industrial production in the form of salts [2]. In the nature, mercury gets transformed from one form to another. In water, inorganic mercury gets converted into highly toxic alkyl compounds by the action of a variety of microorganisms [3]. These forms (e.g. methyl mercury) are accumulated and concentrated in the aquatic food chain (fish, molluscs, crustaceans and other water organisms), reaching concentrations significantly above those found in the general environment [4]. Therefore, consumption of fish and seafood represents a significant source of the exposure to more toxic organic mercury [5, 6]. On the other hand, in the tissues of mammals, organic mercury, in particular methyl mercury, is converted to inorganic substances, but not vice versa. Inorganic forms induce the synthesis of metallothioneine and get concentrated in kidney and liver [3]. Higher mercury content was also found in some edible mushrooms [6].

The primary route of exposure to mercury is inhalation. Another significant route is ingestion. It has been estimated that humans absorb < 10% of elementary mercury ingested, whereas methyl mercury may be absorbed to as a high extent as 90% [7]. Elementary mercury applied to the skin undergoes virtually no absorption (infants being an exception to this rule). Elementary mercury is also

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less toxic when it is ingested by food. However, inhaled mercury vapours are strongly toxic [3]. For the majority of people in developed countries, an important source of exposure to mercury is inhalation of mercury vapours from dental amalgam. Exposure to the effects of methyl mercury is mostly through food. The daily intake of mercury from fish and sea products has been estimated at 3 μg, there of 20% in inorganic form, with methyl mercury making up as much as 80% [5, 6].

In the body, catalase oxidises elementary mercury to bivalent mercury. Significant amounts of free mercury may pass the brain-blood barrier and cause lesions in the central nervous system tissue [7]. During pregnancy, inorganic mercury salts do not pass effectively from mother to child. Organic mercury compounds however, are fat-soluble and show a strong ability to cross biological membranes (e.g. placenta, blood-brain barrier) [3, 4]. In the body of foetus, methyl mercury causes development disorders of the nervous system and retarded mental development; at the same time, mothers of affected children need not show any signs of mercury intoxication [7]. These organic compounds get concentrated in the fat tissue and in the brain [8]. Chronic exposure may also affect the kidney and result in proteinuria. Mercury also inactivates a number of enzymes. However, the most significant effects of mercury intoxication are the already mentioned impacts upon the central nervous system [7, 9].

The objective of the study was to assess the dietary exposure of population of the Slovak Republic to total mercury. Another objective of the paper was to assess the dietary exposure of children, as the potentially risk group. The observation of the exposure levels was done for the period from 1990 to 2004.

MATERIALS AND METHODS

The evaluation was focused on the third step of risk assessment - exposure assessment [10]. For the assessment of dietary exposure to mercury, we utilized the extensive Database on Occurrence of Contaminants in Food (Centre for Evaluation of Contaminant Occurrence, Bratislava, Slovakia) as well as professional experience acquired from a variety of projects (Partial Informational System on Contaminants; Partial Monitoring System "Food and Feed Contamination"; projects of the National Programme on Health Support). Mercury was chosen as one of many parameters monitored, due to the results of long-term toxicological studies, references on health risk, international recommendations and course of the food surveillance system in the Slovak Republic. Also, the list of priority contaminants in foods set up by GEMS FOOD WHO was used [11].

During the period 1990-2004, a total of 53 203 samples of basic food raw materials, foods and beverages have been analysed for mercury occurrence. Samples were collected in the territory of the Slovak Republic at agricultural holdings, food industry enterprises, the retail network as well as households. The following institutions participated in the sampling and analyses: State Veterinary and Food Administration of the Slovak Republic (Regional Veterinary and Food Administrations, State Veterinary and Food Institutes); Food Research Institute, Bratislava, Slovakia; the Dairy Research Institute, Žilina, Slovakia; Administrations of Public Health; and Slovak Medical University, Bratislava, Slovakia. Since 1994, laboratories of the agriculture sector have been involved in the national system AQA (Analytical Quality Assurance) for food, and since 2000, they have regularly taken part in the international competency tests focusing exclusively on food analyses, in the FAPAS (Food Analyses Performance Assessment Scheme) programmes, and in the GEMS/Food (Global Environmental Monitoring System).

The paper presents results of evaluation of annual time series of estimated exposure doses of total mercury ingested via dietary pathway. The exposure values are expressed as related to body weight of consumer in μg.kg^{-1} bw per week (bw - body weight). For the assessment, data on chemical residua in each analysed food type were combined with data on consumption of the respective food commodity to produce an estimate of contaminant intake via the dietary pathway (Eq. 1),

$$E = \sum_{1}^{n} \frac{I_n \times C_n \times d}{w} \qquad (1)$$

where E is exposure [μg.kg^{-1} bw per week], I - consumption [kg], C - concentration [μg.kg^{-1}], w - average body weight [kg], d - number of days, i.e. $d = 7$; n - the order of particular commodities and the respective findings; 1, 2, 3 - the mean, median and 95th percentile values of mercury concentration, average body weight - 70 kg (for average inhabitant); for children: 18 kg (children aged 4-6), 33.5 kg (children aged 7-11), 47 kg (children aged 12-15) [12].

The exposure doses of dietary mercury were calculated for average consumer in the Slovak Republic as well as for selected age categories of children (pre-school children, younger school-age children and senior school age children).

Commodities analysed in the survey were divided into 93 groups (Tab. 1).

For concentration data, the analytical data from National inspection as well as from the monitoring programme have been utilized. Mean and median values as well as the value of the 95th percentile of all total mercury findings obtained during each year of the observation period have been used for the assessment. For samples with non-detected concentrations of mercury a 50% of the limit of quantification value was used.

For the consumption data, the following models of consumption have been used: HBS-based consumption model (HBS - Household Budget Survey) for the average inhabitant, consumption model based on rational diet for an adult inhabitant, consumption model based on rational diet for children (Tab. 1).

Tab. 1. Consumption models as used for assessment of dietary exposure to total mercury [g per person per day].

Commodity	HBS-based model (average consumer)	Models based on rational diet			
		Adult consumer	Children (aged 4–6)	Children (aged 7–11)	Children (aged 12–15)
Beef and veal	6.046	42.61	20.449	24.858	28.114
Pork	27.976	16.08	27.153	30.700	35.028
Mutton	0.040	–	–	–	–
Other meat	0.666	–	–	–	–
Offal and bones	0.998	–	–	–	–
Chicken	24.496	22.02	12.951	14.534	16.535
Hen meat	1.592	–	1.545	1.636	1.627
Goose meat	0.337	–	–	–	–
Duck meat	1.029	–	–	–	–
Turkey meat	1.896	–	–	–	–
Poultry offal	3.048	2.57	–	–	–
Poultry products	3.018	–	–	–	–
Canned meat	4.126	–	4.286	6.929	8.5
Meat preserves	0.219	–	11.342	11.948	13.301
Canned poultry	0.227	–	–	–	–
Durable sausages	4.706	–	–	–	–
Soft sausages	11.068	9.80	0.607	1.075	1.385
Small meat products	13.134	–	7.143	8.571	11.429
Boiled meat products	4.477	–	–	–	–
Special meat products	0.984	–	–	–	–
Smoked meat	3.478	7.46	1.071	2.143	2.857
Other meat products	2.054	–	–	–	–
Marine fish	3.074	23.55	–	–	–
Freshwater fish	0.669	–	–	–	–
Smoked fish products	0.257	–	–	–	–
Marinated fish products	1.079	–	–	–	–
Canned fish products	3.357	–	0.171	0.263	0.348
Special fish products	0.970	14.15	–	–	–
Milk	184.603	221.69	81.290	86.419	90.298
Hard cheese	4.659	13.43	5.584	7.084	8.186
Soft cheese	0.214	–	3.571	7.143	7.143
Mould cheese	1.404	–	1.126	1.657	2.119
Processed cheese	4.655	5.43	–	–	–
Other cheese	1.361	–	–	1.309	1.580
Fermented milk products	24.793	50.00	51.557	55.179	60.893
Ice creams	6.171	–	–	–	–
Cottage cheese	6.174	31.70	5.431	7.021	8.694
Cream	6.671	1.27	1.869	2.269	2.902
Canned milk products	1.370	–	–	–	–
Savoured milk products	0.729	17.14	0.068	0.109	0.109

Tab. 1. continued

Commodity	HBS-based model (average consumer)	Models based on rational diet			
		Adult consumer	Children (aged 4–6)	Children (aged 7–11)	Children (aged 12–15)
Powdered milk products	0.442	–	–	–	–
Baby foods	0.619	–	–	–	–
Eggs	19.779	44.25	6.218	7.332	9.929
Egg products	1.395	–	–	–	–
Edible vegetable oils	22.356	18.74	7.820	10.849	12.763
Margarines	13.370	1.43	0.624	0.832	0.932
Butter	6.438	23.70	12.176	14.917	17.316
Lard	1.781	1.49	3.402	4.733	5.720
Bread	122.795	107.14	84.147	145.710	212.239
Rolls	33.149	45.00	21.559	22.456	22.649
Fine pastries	8.413	21.57	37.846	66.562	74.020
Vegetable products	4.429	43.14	9.319	12.628	15.325
Cabbage	14.351	15.12	9.370	10.509	12.405
Pulses	2.355	2.86	12.210	14.962	16.944
Fruiting vegetables	35.840	131.85	25.886	35.688	40.248
Leafy vegetables	1.983	5.55	0.334	0.361	0.364
Root vegetables	12.075	50.39	30.441	35.167	37.820
Potatoes	72.104	211.59	48.127	70.764	92.503
Mushrooms	0.520	–	–	–	–
Legumes	0.213	–	–	–	–
Fruit products	2.475	154.60	15.575	20.515	20.954
Grapes	2.661	47.31	21.429	21.429	21.429
Pomaceous fruits	39.547	43.02	33.534	33.840	33.840
Stone fruits	9.949	–	12.217	13.665	14.388
Citrus fruits	16.839	3.97	9.685	9.805	9.813
Bananas	10.737	32.23	17.143	21.429	21.429
Tropical fruits	1.872	–	–	–	–
Berries	5.912	–	–	–	–
Nuts	1.805	–	0.268	0.336	0.336
Sugar	39.507	31.43	8.681	11.602	12.215
Chocolates	7.123	–	3.571	7.143	7.143
Candies	6.795	11.43	–	–	–
Cocoa powder	1.638	6.19	1.097	1.196	1.982
Wafers	5.415	–	16.786	22.143	22.143
Cereal products	74.268	–	56.368	78.848	91.374
Condiments	0.763	1.57	0.071	0.129	0.148
Mustard and other ingredients	3.905	0.25	0.615	0.684	1.152
Delicatessen products	2.306	–	–	–	–
Jams and marmalades	4.747	–	1.230	1.711	2.068
Preservatives	5.794	2.18	0.442	0.662	0.811
Salt	4.942	8.05	3.145	3.939	4.802
Other foodstuffs	4.804	3.25	0.723	0.870	1.012
Coffee and coffee substitutes	4.304	0.77	0.188	0.249	0.249
Tea	0.803	5.34	0.185	0.237	0.237
Soft drinks	238.493	121.43	10.714	10.714	10.714
Beer	47.068	–	–	–	–
Spirits	7.479	–	–	–	–
Wine	16.795	14.29	–	–	–
Syrups	12.438	6.88	2.844	3.581	3.650
Dumplings	3.320	–	–	–	–
Powdered soup	1.856	–	–	–	–
Ready-to-eat meals	1.147	–	–	–	–
Dish portion	0.360	–	–	–	–
Total amount	1330.099	1696.91	763.204	989.044	1154.114

HBS-based consumption model

Data on consumption of average inhabitant in the Slovak Republic are based on household budget survey data (HBS) from Statistical Office of the Slovak Republic [13]. Household budget survey assumes per-capita food consumption based on expenditure and income of the selected households. The selected households were household budget correspondents during two consequent months. They provided information about their expenditure and income in gross values (the first month) and detailed divisions, data of household structure and housing conditions (the second month). Natural incomes, income in kind as well as expenditures for food commodities, non-alcoholic and alcoholic beverages in restaurants, cafes, bars, confectioneries and canteens have also been included for the assumption of consumed commodities. Within the model, the values of the consumed commodities were expressed in net values, i.e. in terms of edible share of the particular commodity. In general, however, models are only an approximation of the reality which often brings about a certain level of inaccuracy within the assumption. The weakness of this model is the fact that there is no information of the food actually consumed by the individual members of the household and the other part of the purchased food, which was wasted.

Consumption model based on rational diet for an adult inhabitant

The model was derived from rational nutrition menu based on recommended dietary allowances (RDA) for an average adult inhabitant of the Slovak Republic through diet modelling. For modelling, data of the Slovak Food Composition Database (Food Research Institute, Bratislava, Slovakia) as well as the nutritional software Alimenta 4.2 (Food Research Institute, Bratislava, Slovakia) were utilized.

Consumption model based on rational diet for children

As a separate objective, also dietary intake of total mercury had to be calculated for children of various ages. Since there are no statistical data on the consumption of various age categories available, these values could only be estimated based on modelled consumption for children, referring to recommended dietary allowances (RDA) and serving sizes for three age categories of children.

The obtained values of exposure doses were subsequently compared with the value of provisional tolerable weekly intake (PTWI; 5 μg.kg^{-1} bw per week) defined by the international Joint Expert Committee on Food Additives and Contaminants (JECFA FAO/WHO) [14]. Also, one part of the study was focused on contribution of the selected commodity groups to total weekly intake of mercury from food and beverages.

RESULTS AND DISCUSSION

Ranges of assessed exposure doses of mercury for estimated consumption models of the average adult and selected age groups of children in

Tab. 2. Dietary intake of mercury [μg.kg^{-1} bw per week] for average inhabitant of the Slovak Republic (HBS-based model of consumption and model of consumption based on rational diet; mean findings, median findings and 95th percentile) within 1990–2004.

	HBS - based model			Model based on rational diet		
	Mean	Median	95th percentile	Mean	Median	95th percentile
1990	0.556	0.304	1.561	0.756	0.407	2.101
1991	0.626	0.426	1.748	0.743	0.478	2.102
1992	0.439	0.302	1.113	0.625	0.415	1.584
1993	0.324	0.232	0.794	0.405	0.217	1.250
1994	0.320	0.218	0.852	0.441	0.247	1.353
1995	0.454	0.218	0.974	0.523	0.225	1.025
1996	0.218	0.123	0.621	0.323	0.189	0.938
1997	0.207	0.109	0.592	0.331	0.184	0.993
1998	0.235	0.144	0.750	0.412	0.223	1.322
1999	0.276	0.232	0.716	0.332	0.167	0.780
2000	0.347	0.213	0.784	0.387	0.154	0.992
2001	0.216	0.077	0.694	0.357	0.140	1.090
2002	0.236	0.080	0.732	0.367	0.194	1.097
2003	0.197	0.097	0.791	0.370	0.179	1.280
2004	0.166	0.081	0.489	0.319	0.180	0.697

Tab. 3. Dietary exposure of children to mercury [μg.kg^{-1} bw per week] (model of consumption based on rational diet, mean, median, 95th percentile of mercury findings) within 1990–2004.

	Children (aged 4-6)			Children (aged 7-11)			Children (aged 12-15)		
	Mean	Median	95th percentile	Mean	Median	95th percentile	Mean	Median	95th percentile
1990	1.055	0.636	2.799	0.754	0.450	2.015	0.619	0.368	1.651
1991	1.419	0.948	3.709	1.043	0.691	2.743	0.866	0.559	2.334
1992	0.821	0.567	2.040	0.597	0.415	1.486	0.504	0.354	1.244
1993	0.570	0.294	1.553	0.423	0.209	1.144	0.354	0.175	0.962
1994	0.534	0.303	1.544	0.374	0.212	1.085	0.311	0.176	0.901
1995	0.607	0.268	1.085	0.400	0.191	0.769	0.321	0.161	0.635
1996	0.381	0.230	1.108	0.273	0.160	0.804	0.230	0.132	0.676
1997	0.392	0.235	1.251	0.284	0.171	0.925	0.237	0.145	0.780
1998	0.413	0.274	1.307	0.293	0.187	0.941	0.244	0.153	0.789
1999	0.294	0.176	0.831	0.210	0.124	0.602	0.175	0.102	0.507
2000	0.271	0.120	0.859	0.191	0.085	0.637	0.159	0.070	0.547
2001	0.341	0.123	1.044	0.263	0.092	0.823	0.233	0.080	0.739
2002	0.492	0.189	1.084	0.345	0.130	0.798	0.287	0.106	0.688
2003	0.330	0.160	1.166	0.234	0.116	0.847	0.199	0.099	0.735
2004	0.311	0.141	0.806	0.220	0.097	0.576	0.184	0.080	0.478

the Slovak Republic during the period of observation, calculated from mean and median findings as well as the 95th percentile, are shown in the Tab. 2 and 3.

Mercury exposure trends for HBS-based consumption model

The estimated value of exposure doses of mercury for HBS-based consumption model of the average inhabitant of the Slovak Republic during the period of observation suggests a relatively low level of contamination of foods and beverages as well as a relatively stable exposure trend (Tab. 2, Fig. 1). PTWI value for mercury was not exceeded.

In general, higher mercury exposure doses were calculated during the first years of observation, which was most markedly reflected in respect of the 95th percentile: the exposure doses ranged between 0.489 μg.kg^{-1} bw per week in 2004 and 1.748 μg.kg^{-1} bw per week in 1991. In terms of mean mercury findings, exposure dose values ranged between 0.166 μg.kg^{-1} bw per week in 2004 and 0.626 μg.kg^{-1} bw per week in 1991; median concentrations gave slightly smaller exposure doses, between 0.077 μg.kg^{-1} bw per week in 2001 and 0.426 μg.kg^{-1} bw per week in 1991.

The higher values of the exposure doses were due to mercury concentrations in meat, fish and fish products. Also, high mercury intake originated from soft drinks due to the consumption of significant volumes of this commodity. Exposure dose values remained stable during the last years of observation, showing a tendency to a slight reduction.

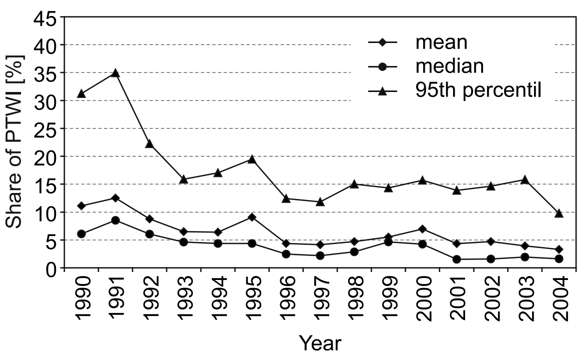

Fig. 1. Time series of the dietary exposure to mercury (share of the PTWI value; HBS-based consumption model; average consumer).

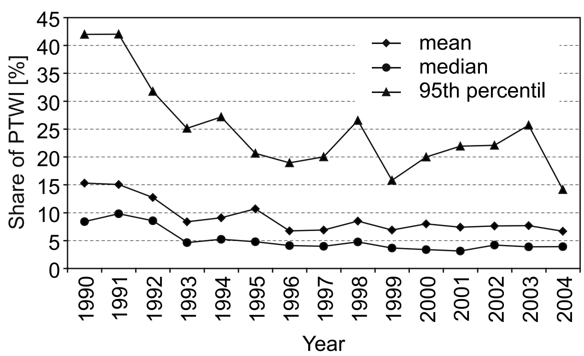

Fig. 2. Time series of the dietary exposure to mercury (share of the PTWI value; consumption model based on rational diet; average consumer).

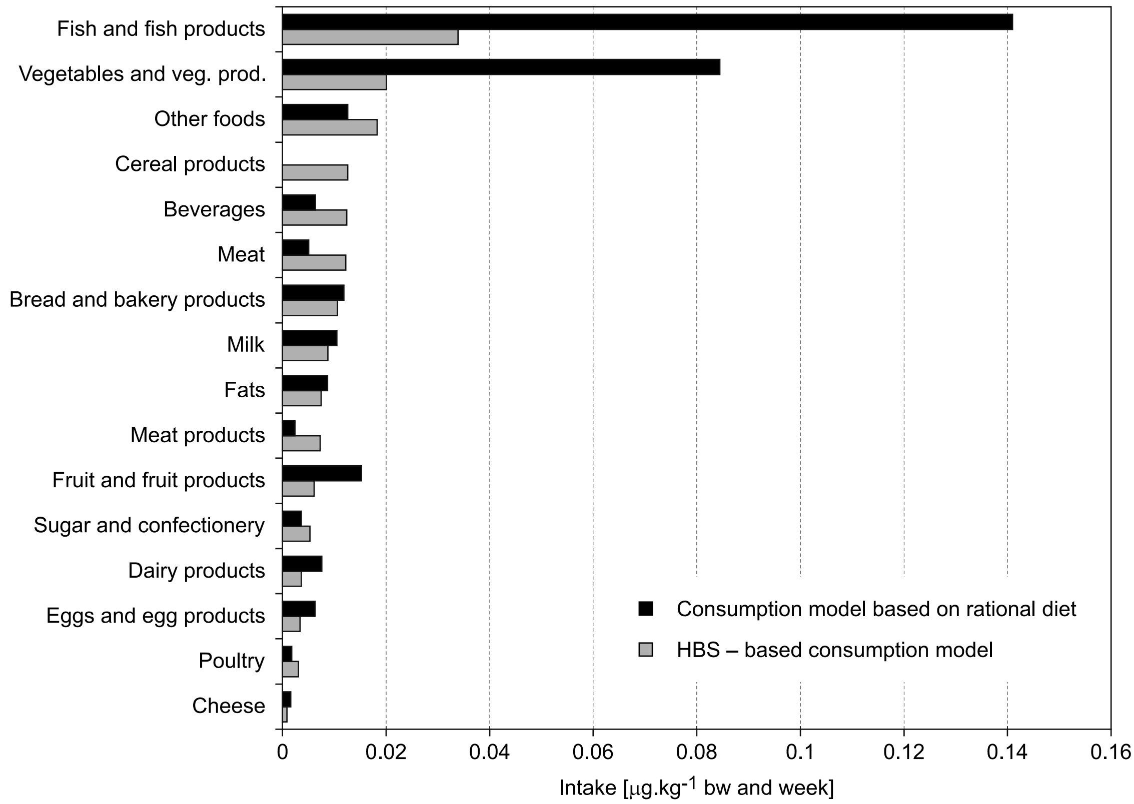

Fig. 3. Mercury intake from individual commodities (average inhabitant, HBS-consumption model, consumption model based on rational diet, mean value of mercury findings in analyzed food commodities in 2004).

The smallest values of weekly intake in terms of mean findings and 95th percentile were calculated for the last year of the reference period (2004).

Mercury exposure trends for consumption model based on rational diet

During the period of observation, the mercury exposure doses were slightly higher for consumption model based on rational diet in terms of mean and median findings, showing similar trends (Tab. 2, Fig. 2). In terms of mean findings, they ranged between 0.319 μg.kg^{-1} bw per week in 2004 and 0.756 μg.kg^{-1} bw per week in 1990, with the corresponding figures for median concentrations being between 0.140 μg.kg^{-1} bw per week in 2001 and 0.478 μg.kg^{-1} bw per week in 1991.

The exposure doses were markedly higher when the values of the 95th percentile were used. Nevertheless, the PTWI value was not exceeded. The exposure doses ranged between 0.697 μg.kg^{-1} bw per week in 2004 and 2.102 μg.kg^{-1} bw per week in 1991. The higher values of exposure doses obtained for consumption model based on rational diet were due to the substantially higher modelled intake values, in particular of commodities such as marine fish and potatoes (Tab. 1.). For the last years of the observation period, the exposure of the population to mercury remained stable and low in general.

Assessment of mercury intake from particular commodities (Fig. 3) calculated from data of HBS-based consumption model and mean findings in 2004 suggests that the most significant sources of the exposure doses of mercury included fish and fish products, which accounted for 20.4% of the overall weekly intake (0.166 μg.kg^{-1} bw), followed by vegetables and vegetable products (12.1% of the weekly intake).

In case of consumption model based on rational diet, the major contribution (44.2%) to the weekly intake (0.319 μg.kg^{-1} bw) came again from fish and fish products. Vegetables and vegetable products contributed by 26.5% to the overall mercury intake.

However, it should be underlined that, according to model based on rational diet, consumption of commodities such as fish, vegetables and vegetable products is rather high, due to which they also contribute most to the overall intake of mercury. In respect to commodities such as mushrooms (which were considered a part of the group of vegetables and vegetable products), game, as well as the majority of commodities of the groups of fish and fish products, the higher exposure doses were due to higher concentrations of mercury in them.

Mercury exposure of selected demographic groups

The values of mercury exposure doses for children of different age groups calculated for the period of observation are presented in Tab. 3.

In accordance to the value of PTWI, the obtained results indicate that the most heavily burdened were pre-school children (aged 4-6), for whom mercury exposure doses made up between 5.4% and 28.4% PTWI (taking mean findings as the basis) or between 2.4% and 19.0%, and between 16.1% and 74.2% (taking median concentrations and the value of the 95th percentile, respectively). Children of the younger school age (aged 7-11) were less heavily burdened, with the values of the weekly exposure doses making up between 3.8% and 20.9% (based on mean findings), 1.7% and 13.8% (based on median concentrations) and 11.5% to 54.9% (based on the 95th percentile values). So far, the least heavily burdened population of children were the senior school-age children (aged 12-15) with the weekly mercury intake ranging between 3.2% and 17.3% PTWI (based on mean findings), between 1.4% and 11.2% (based on median findings), and between 9.6% and 46.7% (based on the 95th percentile values).

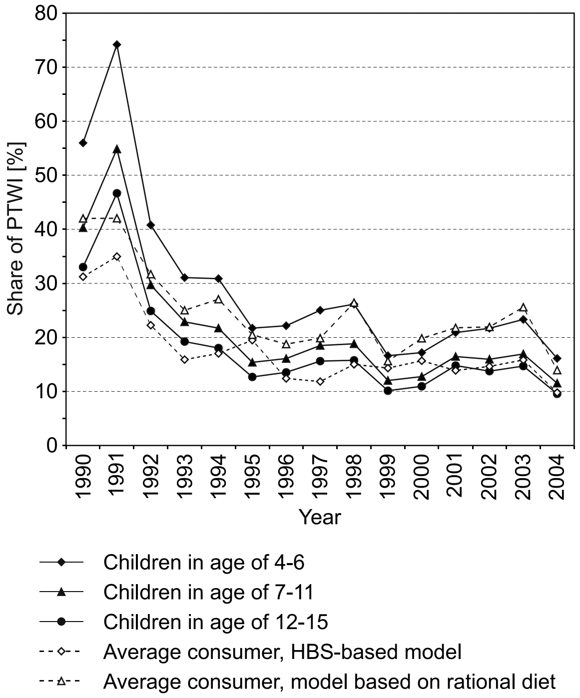

Fig. 4. Time series of the dietary exposure to mercury (share of the PTWI value; values of 95th percentile of mercury concentrations; comparison of the selected age groups of children with the average consumer).

Compared with the mercury exposure doses for the average inhabitant, those calculated for pre-school children and the younger school-age children are higher (Fig. 4). It should however be stressed that the consumption model for the age groups of children and the average consumer suggests the highest consumption of food relative to body weight (in terms of $g.kg^{-1}$ bw) for the younger demographic groups. Therefore, the mercury exposure doses are also highest for those groups.

Comparison of the estimated data of dietary exposure to mercury, or other contaminants in general, between countries is complicated. One of the reasons is that various countries have rather complex and very different systems of the exposure assessment. For example, different methodologies for the evaluation of the dietary intake were used. Some of the observations were based on the results of household budget survey, the others on food balance sheet either on the results of a 24-h recall. Preparation of samples of food commodities is also different and, within the total diet study, commodities are prepared (washed, peeled, or cooked) before the analysis of the mercury occurrence. On the other hand, in case of the market basket survey analysis of the mercury, occurrence have been determined in raw commodities. The average body weight data used for the calculation of the exposure doses are also different in various countries. The assessed exposure doses may therefore vary by countries, and these variations may occur as a consequence of different methodologies. However, they are mainly related to specific eating habits of particular regions. In coastal regions, where the consumption of fish and other seafood is higher, these values are also at a high level. Another reason of the variability is the level of contamination. In the Slovak Republic, the portion of fish consumption in the national diet is only 0.9%, but still their contribution to the overall weekly intake of 0.166 $\mu g.kg^{-1}$ bw is up to 20.4%. Appropriate country for comparison of the results of exposure assessment in the Slovak Republic could be the Czech Republic, due to their similar dietary habits. Based on the results of recent surveys in the Czech Republic, dietary exposure level to mercury was low (1.9% PTWI). The weekly exposure doses for adult consumers based on rational diet data in the period 1994–2005 ranged between 0.035 and 0.07 $\mu g.kg^{-1}$ bw [15], while in the

Slovak Republic these values were higher (ranging between 0.319 μg.kg^{-1} bw per week in 2004 and 0.756 μg.kg^{-1} bw per week in 1990). The exposure of the average inhabitant of the Slovak Republic in 2004 was 0.166 μg.kg^{-1} bw per week (3.32% of the PTWI). Both in the Slovak Republic as well as in the Czech Republic, the relatively stable trends of mercury intake doses were noticed. According to recent study of dietary exposure to mercury in Poland, the reported values in the eastern region of the country ranged between 4.08 and 6.65 μg per person per day (10–16% PTWI). The reported results were similar to those published earlier from other regions of Poland [16]. In Denmark, the mercury intake was 18 μg per person per day [17]. The recent study from Cyprus reported average total Hg intake of 0.610 μg.kg^{-1} bw per week (12.2% PTWI) for the average body weight 70 kg [18]. In France, the exposure dose was 14 μg per person per day [19]. Assuming the average body weight of the consumer was 60 kg, the share of this value on PTWI would be 28%. The exposure doses in Spain were lower than expected, considering the high consumption of fish and fish products in this country. The reported exposure value was only 4 μg per person per day [20], which would be only 9.33% PTWI for a consumer weighing 60 kg. In Germany, assumed exposure dose was 6.9 μg per person per day [21] and in the Netherlands - 2 μg per person per day [22]. Although the reported values were below the PTWI limit for the total mercury, if the ingested mercury was in the more toxic, organic form (methyl mercury), the share of some of the evaluated doses might exceed the PTWI [23]. For example, share on the PTWI in Denmark would be 131.25% for a consumer weighing 60 kg.

CONCLUSIONS

The exposure of the population of the Slovak Republic during the period of observation did not reach values which might be associated with an increased probability of health risk. During the period of observation, the exposure to mercury of the population of the Slovak Republic was stable and low, showing a slightly decreasing tendency. Nevertheless, mercury will remain a focus of the organizations of food surveillance and the results obtained from the localities monitored during the observation period represent a basis for the calculations of exposure dose trends as well as for the identification of significant sources of dietary exposure. Thus the calculated time series enable the responsible assessment of health hazards from chemicals present in foods and beverages, as well as the formulation of recommendations for government's health policy and recommendations for changes in dietary habits in the interest of the population health. The study confirms the importance of organized and planned monitoring of food contaminants involving data interpretation, with potential impacts upon legislative feedback.

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