HEALTH RISKS FROM DRINKING AND BATHING WATER POLLUTION, 2019

In 2019, 95% of the Czech population was supplied with drinking water from public water mains. Data on drinking water quality have been obtained since 2004 using the drinking water information system (IS PiVo) administered by the Ministry of Health, which includes all water mains and other methods of public drinking water supply in the Czech Republic. The source of data is primarily analyzes provided by operators, the execution of which in the prescribed frequency and scope is required by applicable legislation; only a small part of the data was obtained by the hygienic service within the state health supervision. Only the results of analyzes performed in laboratories with a valid certificate of accreditation, authorization or proper operation of the laboratory may be entered into the system. Data on emergency water quality are not included in the processing of data on drinking water quality. Quality indicators are assessed in accordance with Decree No. 252/2004 Coll., as amended, which lays down hygienic requirements for drinking and hot water and the frequency and scope of drinking water inspections. This Decree transposes European Council Directive 98/83 / EC.

In 2019, a total of **4,073 water mains** were monitored. The overwhelming majority of the water mains (3,802) were smaller, i.e. serving less than 5,000 population; out of them 3,285 serve less than 1,000 population. Only 271 water mains were classified as larger (supplying over 5,000 pop.) but served 80% of the Czech population connected to the public water supply systems.

1. Drinking water quality

In 2019, about 37 thousand samplings were made and more than one million pieces of data on drinking water quality indicators were thus obtained. The maximum limit values (MLVs) for the indicators with significance for health were exceeded in 1,987 cases. Failure to comply with the limit values (LVs) for the drinking water quality indicators relevant to the sensory properties was reported in 5,703 samples analysed. In larger water supplies, MLV and LV were exceeded in 0.09% and 0.4% cases, respectively. Similarly, in smaller water mains, the respective rates were 0.5% and 1.7%.

The data obtained show that there was a gradual moderate improvement in the quality of drinking water distributed by public water supply systems. This applies to the nationwide results processing and it is not excluded that in some water mains could be a significant deterioration or (more likely) improvement. However, in 2015 this trend stopped when more MLVs non-compliances was observed than in previous years. The main cause was initiating of monitoring of a wider spectrum of pesticides and their metabolites and therefore more frequent findings of higher concentrations.

The highest frequency of exceedances of NMH was always found for drinking water produced from underground sources; the reason is both a much higher number of these mostly very small resources and a less sophisticated treatment.

The frequency of non-compliance with the limit values increases with the decreasing size of the water supply system (with the decreasing number of supplied inhabitants). In larger water mains, the highest limit value is most often exceeded for chloroform (1.7% of samples), a by-product of water chlorination. NMH for chlorates (5.4%), nitrates (2.3%), trihalomethanes (1.4%) and arsenic (0.7%) were most often exceeded in smaller water mains. The relatively

higher frequency of exceeding the limit values also for uranium (2.3%) is due to the low number of samples and monitoring of uranium especially in high-risk water mains.

In drinking water, individual pesticides are determined according to their probable occurrence in a given source. In 2019, approximately 55,000 determinations were performed in larger water mains and over 180,000 determinations in smaller water mains (160 parent substances) or their metabolites (43 relevant, 9 irrelevant metabolites). The limit value for acetochlor ESA was most often exceeded; in larger water mains 24 exceedances from 652 determinations, in smaller water mains 189 from 2,747 determinations). Also the above-limit values of alachlor ESA, acetochlor OA, dimethachlor ESA, hexazinone, desethylatrazine and other pesticides were found.

Nitrates and chloroform (a disinfection by-product) are the most problematic contaminants of drinking water in terms of health risk. Exceedance of the limit value of nitrates (50 mg/L) was found in 1.5% of cases. Approximately 9,000 inhabitants were supplied with drinking water, where the average annual nitrate concentration reached or exceeded the limit value. Chloroform content above the limit value (30 /g / l) was found in 1.5% of cases; about 41,000 inhabitants were supplied with drinking water, where the average annual concentration of chloroform reached or exceeded the limit value.

The health significance of the optimal content of calcium and magnesium in drinking water is well documented. Monitoring shows that only 27% of the population is supplied with drinking water with the recommended optimal calcium level (40 - 80 mg/L) and only 5% of the population with optimal magnesium level (20 - 30 mg/L). Only 27% of the population is supplied with water with optimal hardness (2 - 3.5 mmol/L), softer water is supplied to 64%, harder to 8% of the population. Therefore, in the vast majority of cases, reduction of the content of these elements by domestic water treatment is undesirable.

The new Atomic Act 236/2016 Sb. and its Implementing Decree 422/2016 Coll., in force since 2017, has significantly reduced the obligation of water supply operators to regularly measure the content of natural radionuclides in drinking water. Therefore the results obtained under this new legislation cannot be considered nationwide representative. From previous years of monitoring, it is known that the content of natural radionuclides in water has long been unchanged. Radiation in drinking water is usually due to the presence of radon; the contribution of other radionuclides (radium and uranium isotopes) is very low. Both the ingested and inhaled intake of radon (Rn-222) from drinking water results in an estimated effective dose of 0.06 mSv/year on average, which is around one hundred times lower than that from radon entering buildings directly from the ground. The overall intake of radionuclides from drinking water results in an estimated average effective dose of 0.07 mSv/year.

Granted exemptions

In 2019, an exception for health-relevant indicators approved by the public health protection authority was applied to 133 water mains. A milder hygienic limit than stipulated by Decree No. 252/2004 Coll., was most often permitted for acetochlor ESA (67 water mains supplying a total of 170,000 inhabitants). An exemption was granted for 27 water mains (7,000 inhabitants) due to the above-limit nitrate content. According to the data in the PiVo database, a total or partial ban on the use of tap water as drinking water was applied in 11 water mains (2,000 inhabitants) for at least part of 2019.

2. Exposure to contaminants from drinking water

For selected health risk contaminants (arsenic, chlorethene, nitrites, nitrates, aluminium, cadmium, manganese, copper, nickel, lead, mercury, selenium, chloroform) the population burden on these substances from drinking water intake was assessed. Of the contaminants evaluated, nitrate is the highest; drinking water from public water supply systems averages 7 - 10% of the acceptable daily intake[1] (ADI) of nitrates (with 1.5 Litres of tap water consumed daily). In chloroform, and in smaller water systems also in arsenic, an average drinking water supply of about one percent of the total daily tolerable intake was found. Concentrations of other contaminants assessed in drinking water often do not exceed the limit of determination limit of the analytical method used and therefore exposure to these substances cannot be quantified. However, it can be said with certainty that the average exposure is less than 1% of the relevant exposure limit. This also applies to pesticides and their metabolites.

The mean intake of nitrates from drinking water in the Czech Republic accounts few percent of the overall acceptable daily intake; nevertheless, about one third of the supplied inhabitants are supplied with drinking water that accounts for more than 10% of the acceptable daily intake of nitrates. If the nitrate content was as high as the limit value (50 mg/L), such drinking water would contributed with consumption of 1 L/day for an adult to an overall acceptable intake by 21%, with a consumption of 2 L/day by 42%.

The assessment of exposure to individual drinking water contaminants for which exposure limits are set does not indicate the likelihood of damage to health in terms of non-carcinogenic effects. However, it is possible that when an exemption should be granted, the public health authority designates a vulnerable group of consumers (usually infants and young children or pregnant women), and this group is then excluded from the supply or consumption of such water is limited to prevent damage to health.

3. Cancer risk from drinking water

To estimate incremental cancer risk from chronic exposure to organic compounds (1,2-dichloroethane, benzene, benzo[*a*]pyrene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, bromodichloromethane, bromoform, chloroethene /vinyl chloride/, dibromochloromethane, indeno[*1,2,3-cd*]pyrene, tetrachloroethene, and trichloroethene) from drinking water intake, the linear no-threshold model was used in accordance with the health risk assessment method. For the calculation of the annual contribution to the estimated incremental cancer risk, an average body weight of 70 kg, mean life expectancy of 70 years, lifelong exposure (converted to annual exposure and risk), and a mean daily intake of 1.5 L of tap water per person were considered. The theoretical incremental cancer risk from chronic exposure to carcinogens from the public water supply system was computed as the sum of the effects of all compounds according to the US EPA recommendations. From this calculation, it follows that the drinking water intake might theoretically result in two incremental cancer cases per 10 million population per year.

The calculations of exposure and risk were carried out according to a standard procedure. Nevertheless, the considered exposure factors always imply a certain level of uncertainty, e.g. due to the limited spectrum of the monitored substances with significance for health, individual variation in tap water consumption and absorption of the monitored substances in

[1] The overall acceptable/tolerable daily intake of a contaminant is its total intake from food, drinking water, dust etc. that does not pose a health risk even if considered on a lifelong basis.

the body, etc. They might result in risk underestimation or overestimation. Inhalation and dermal exposure that are similarly significant as the ingestion of some contaminants were not taken into account, as specific data is missing on the use of water in Czech households.

4. Water quality in public and commercial wells

As part of the nationwide monitoring, the PiVo information system also collects data on the quality of drinking water coming from public wells and individual sources used for business activities, for the performance of which drinking water (commercial wells) must be used. In 2019, 5,866 water samples from 296 public and 2,177 commercial wells were evaluated. The maximum limit values of health-relevant indicators were exceeded in 0.8%, and the other limit values in 3.7%. There were relatively numerous findings of non-compliance with the limit values of microbiological indicators of drinking water quality, such as coliform bacteria (10%), intestinal enterococci (4%), Escherichia coli (3%). Among other indicators, the limit values of pH (15%), manganese (11%), iron (7%), nitrates (4%), alachlor ESA (3%), uranium (2%) were most often exceeded.

5. Drinking water related human health impairment

With regard to acute health damage by reason of the drinking water consumption (poisoning, infectious disease), information is based on a direct report from the regional public health authorities on recorded infections, poisonings or other illnesses occurring in connection with the quality and use of drinking water from monitored water supply systems and public (or publicly used) wells. In 2019, four such events were recorded and reported in four regions. It was one confirmed epidemic from a public water supply system in the Pardubice Region, in two cases it was a commercial well (Plzeňský and Liberecký Region) and in one case a well used for individual supply (Moravian-Silesian Region).

6. Monitoring of the bathing water quality

Health risks of recreational waters leaving aside the drowning and injuries are mainly associated with contamination by pathogenic microorganisms, development of algae and in some places also with cercarial dermatitis (manifested by intense itching). Mass occurrence of cyanobacteria and algae, and significant pollution of natural and anthropogenic origin may also negatively affect the attractiveness of recreational waters for bathers. Systematically monitored is the occurrence of indicators of fecal contamination (E. coli and intestinal enterococci), cyanobacteria and algae, natural pollution and pollution by wastes. Monitoring results are evaluated mainly on the basis of the last sampling with exception of fecal pollution indicators, at which the classification of data for the previous four years after each bathing season has been performed.

Recreational water quality data have been entered in the Information System throughout the bathing season. The public health protection authorities evaluate the data on a regular basis according to the Regulation 238/2011 and relevant guidelines rating the areas on a scale from 1 to 5. The most recent recreational water quality data are accessible by the public at the websites of the regional public health agencies, National Geoportal INSPIRE maintained by the CENIA agency and Bathing water portal. There have been over 250 rated bathing waters in recent years (2016 - 257, 2017 - 251, 2018 - 268 and 2019 - 271). The biggest problem of domestic natural waters remains the mass occurrence of cyanobacteria forming water flowers,

especially during the summer months and early autumn. In 2019, the number of localities with a mass occurrence of cyanobacteria was similar to the period up to 2017. Their number therefore decreased compared to 2018. The increased occurrence of cyanobacteria in 2018 was probably related to very warm weather, which may have accelerated their development. As in previous seasons, deteriorating assessments due to findings of faecal pollution indicators were less frequent. Cases of cercariae dermatitis confirmed by the finding of cercariae in snails were reported from one locality in 2019. At another locality, there were cases of a skin disease which, according to symptoms, corresponded to cercariaus dermatitis, but its causative agents were not found in snails.

According to the EU requirements, a report is annually drawn from the collected data and sent to the European Commission. This report, which includes only major bathing water in the wild (a large number of people buy it under Directive 2006/7 / EC), is based primarily on the results of monitoring faecal pollution indicators. According to EU criteria, the quality of recreational waters in the Czech Republic can be assessed as relatively good. At the beginning of the monitoring, the proportion of compliant bathing waters was low due to the large number of sampling waters. Gradually, the number of bathing waters that complied with EU limit requirements increased. While in 2004 it met 49% of the total number of monitored swimming pools, in 2011 it was already 87%. The number of reported bathing waters to the EU has fallen from 176 in 2004 to 153 in 2018 and 2019. Since 2012, the European Commission has been evaluating and classifying bathing waters under the new rules set out in Directive 2006/7 / EC (see Section 9 of Decree No. 238/2011 Coll.). In the years 2012 - 2019, the majority of bathing waters in the Czech Republic - approximately 90%, complied with the new EU limit requirements (at least acceptable water quality was included); in 2019 it was 141 of the total 153, i.e. 92.2%.