ENVIRONMENTAL HEALTH MONITORING SYSTEM

Summary report 2022

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CONTENT

1. INTRODUCTION

The Environmental Health Monitoring System is a comprehensive system of regularly conducted collection of exposure and health data, and assessment of risks and effects on public health. The National Institute of Public Health (NIPH) provides information to public health authorities and state administration, including relevant governmental administration. Monitoring outputs are sent to European information networks and databases, and fulfils international conventions as well as European Union requirements; it is implemented through Resolution 369/1991 of the Government of the Czech Republic and its individual subsystems have been active since 1994. Monitoring has, as an activity of the healthcare sector, been enshrined in Act 258/2000 Coll., as amended, and is constituent part of the Health 2030 Strategic Framework.

The annual monitoring report for 2022 provides information from six sub-programmes:

- **Health effects and risks of air pollution**

Air quality is described in urban and rural environments subjected to varying load, particularly in the case of pollution caused by aerosol particles, nitrogen dioxide, and polycyclic aromatic hydrocarbons. It shows long-term air pollution trends in common urban residential locations and residential locations with industrial or traffic load. The estimate of health effects and risks from airborne pollution was expanded this year to include the effects of ozone.

- **Health effects and risks of drinking and recreational water pollution**

This report provides a standard set of data on possible health effects from exposure to monitored substances, including pesticides, in drinking water from public water supply systems in the Czech Republic. Included is an overall assessment of recreational water quality in the 2022 season.

- **Dietary exposure**

The Chapter presents evaluation of the biennial period 2021/2022 as regards intake of nutrients from the entire food consumption basket, showing long-term trends and comparing detected population nutrient intake against recommended values.

- **Human biomonitoring**

Studies in human biomonitoring made it possible to process new reference values for the body levels of monitored toxic chemicals in the Czech population.

- **Population health status surveys**

The report includes the development of overweight and obesity - as well as abdominal obesity - based on NIPH cross-sectional studies of the middle-aged population over the past 20 years.

- **Professional exposure and health risks**

This report contains routinely processed data on numbers of employees exposed to harmful substances and factors in occupational environments, and the trend of occupational diseases.

The program targeted at the effects of community noise on health and wellbeing has been suspended.

QA/QC quality assurance of laboratory work providing data for the Monitoring System is part of the programmes of the organisations to which the laboratories are affiliated. These are laboratories belonging to health institutes, other institutions or private concerns. The primary elements of safeguarding analysis quality in the Monitoring System laboratories are accreditation or authorisation. Most of the participating laboratories subscribe to accreditation methods according to CSN EN ISO/IEC 17025.

2. HEALTH EFFECTS AND RISKS OF AIR POLLUTION

Key findings

Although 2022 was rated as a favourable year overall in terms of air quality, most of the measured locations exceeded the WHO recommended pollutant concentration limits; aerosol particles ($PM_{2,5}$ fraction) came out worst in the comparison. The number of days and areas with elevated concentrations of ground-level ozone has increased with the higher frequency of sunny to tropical days.

Estimates of the proportion of deaths due to long-term exposure to aerosol particles in the total number of deaths ranged from zero in urban locations with no traffic to around 10% of premature deaths in the most heavily industrial and traffic-laden locations (with the highest average annual concentrations of this pollutant).

The theoretical increase in cancer risk due to exposure to outdoor air pollutants has remained essentially unchanged for several years; in 2022, estimates of cancer risk ranged from 2 cases per 100 million to 5 cases per 100 000 population, depending on how loaded the location was. Exposure to carcinogenic polycyclic aromatic hydrocarbons is the largest long-term contributor.

Subsystem I includes evaluation of the impact of selected indoor and outdoor air quality indicators. Outdoor air quality is evaluated for the most health relevant pollutants: aerosol (or also suspended) PM_{10} and $PM_{2,5}$ particles, nitrogen dioxide (NO_2), metals (arsenic, cadmium, nickel, lead), benzene and benzo[*a*]pyrene (BaP). Basic information on ambient air quality is obtained from a core network of up to 150 measuring stations in inhabited locations, most of which are managed by the Czech Hydrometeorological Institute (ISKO CHMI). From this network, data from stations measuring basic pollutants and, selectively, heavy metals, polycyclic aromatic hydrocarbons and benzene were included for processing in 2022. A total of 19 measuring stations are operated by health institutes (CS-MON). Air quality measurements cover, at least to a minimum extent, almost 100 sites and 10 Prague districts.

2.1 Air pollution in cities

In cities and urban agglomerations, the main sources of air pollution are transport and associated processes (primary combustion and non-combustion emissions: resuspension, abrasion, corrosion, etc.) and emissions from small energy sources. Transport is the major source of nitrogen oxides (NO_x) coarse (PM_{10} a $PM_{2,5}$), fine ($PM_{1,0}$) and ultra-fine aerosol particles, chromium, nickel, lead (resuspension), volatile organic compounds - VOCs (petrol engines), polycyclic aromatic hydrocarbons – PAHs (diesel engines), and in total very significant emissions of greenhouse gases – carbon monoxide and carbon dioxide (approx. 10^2 to 10^3 g CO_2 / 1 km / vehicle). Small, locally significant energy sources burning gas and solid fossil fuels can be a non-negligible source of nitrogen oxides, carbon monoxide, PAHs and aerosol particles with a significant proportion of ultra fine particles. Small industrial plants are a source of aerosol, odorous substances, metals and VOCs. A separate issue is the vicinity of large industrial and energy sources or areas significantly burdened by long-distance transmission, both of which significantly affect air quality in the Ostrava-Karviná and North Bohemian agglomerations. What also should be mentioned is the problem of secondary pollutants, including ozone (O_3 from emitted precursors NO_x a VOCs).

Data on mass concentrations are available mainly for the basic pollutants measured, which include PM_{10} ($PM_{2,5}$) and nitrogen dioxide NO_2. Data on other pollutants are added depending on the number of measuring stations. Evaluation included data on the level of background pollution in the Czech Republic obtained primarily from respective measurement programmes at EMEP stations (Cooperative program for the monitoring and evaluation of the long-range transmission of air pollutants in Europe) operated by the CHMI in Košetice and Bílý Kříž and other suitably located stations. Data from extremely congested stations ("traffic hot spot") in Prague, Brno, Ústí nad Labem and Ostrava are used to assess the impact of traffic load.

The number of measuring stations whose data were used to assess potential population exposure and health impacts for individual pollutants is listed in Tab. 2.1.1.

Tab. 2.1.1 Number of measuring stations included in 2022

Pollutant	**No of stations**	**Pollutant**	**No of stations**
PM_{10}	136	NO	71
$PM_{2,5}$	79	NO_X	73
NO_2	71	CO	12
PAU	48	O_3	55
Benzene	33	SO_2	45
Metals in $PM_{10/2,5}$ *(As, Cr, Cd, Mn, Ni, Pb)*			53/3

As had been the case for several years previously, the measured values in 2022 were significantly influenced by the current microclimatic conditions. This is particularly the case for aerosol particles, PAHs and nitrogen oxides. Longer summer droughts are particularly significant. The Preliminary Air Quality Assessment Report for 2022 [1] by the Czech National Centre for Climate Change rates this year as favourable in terms of air quality. However, it states that at the end of the year, air quality deteriorated at most stations compared to previous years, due to higher emissions from local domestic heating, probably due to the energy crisis. In small settlements, average November concentrations of benzo[a]pyrene from local heating were the highest in five years, according to the report.

Outdoor air quality can be assessed in two ways. The first focuses on the assessment of pollutant concentrations at individual stations. In the second, air quality is assessed in different types (categories) of urban and other locations, defined according to certain criteria. These include the intensity of surrounding traffic, the shares of different types of heating sources and the potential burden of a major industrial source, thus describing the burden in representative types of cities. In both cases, the basic description is based on the air pollution limits set out in Annex 1 of the Czech Air Protection Act No 201/2012 Coll., as amended. However, the assessment also respects the recommendations of the WHO (update September 2021, see Table 2.1.2) and/or the reference concentrations (RfC) determined by the NIPH[1]. The distribution of locations and their characterisation is shown in Tab. 2.1.3.

Tab. 2.1.2 Health protection guideline values (WHO AQGs) and interim targets

Pollutant	**Averaging time**	**Interim target**				**Air Quality Guideline value AQG**
		1	**2**	**3**	**4**	
$PM_{2,5}$ [µg/m^3]	year	35	25	15	10	5
	24 hours^a	75	50	37,5	25	15
PM_{10} [µg/m^3]	year	70	50	30	20	15
	24 hours^a	150	100	75	50	45
O_3 [µg/m^3]	main season^b	100	70	-	-	60
	8 hours^a	160	120	-	-	100
NO_2 [µg/m^3]	year	40	30	20	-	10
	24 hours^a	120	50	-	-	25

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[1] *The current authorisation is contained in Section 27(6) of Act No 201/2012 Coll, https://szu.cz/tema/zivotni-prostredi/ovzdusi/2847-2/referencni-koncentrace/ (in Czech)*

SO_2 [µg/m^3]	24 hours[a]	125	50	-	-	40
CO [mg/m^3]	24 hours[a]	7	-	-	-	4
Guideline values remaining in effect						
NO_2 [µg/m^3]	1 hour	-	-	-	-	200
SO_2 [µg/m^3]	10 minutes	-	-	-	-	500
CO [mg/m^3]	8 hours	-	-	-	-	10
	1 hour	-	-	-	-	35
	15 minutes	-	-	-	-	100

Tab. 2.1.3 Categories (types) of measuring stations according to the pollution sources and load

Category	Characterization
1	Urban background without major sources (parks, sport grounds, etc)
2	Urban residential with local sources REZZO 3, traffic up to 2 thous. vehicles/24h
3	Urban residential without local sources, district heating, traffic up to 2 thous. vehicles/24h
4	Urban residential with both local and district heating, traffic 2-5 thous. vehicles /24h
5	Urban residential with both local and district heating, traffic 5-10 thous. vehicles/24h
6	Urban residential with both local and district heating, traffic over 10 thous. vehicles/24h
7	Urban residential with more than 10 thous. vehicles/24h, transit roads (hot spots)
8	Urban industrial with significant effect of industry, traffic up to 10 thous. vehicles/24h
9	Urban industrial with significant effect of traffic(10 – 25 thous. vehicles/24h)
10	Urban industrial with highly significant effect of traffic (over 25 thous. vehicles/24h)
11	Rural background - forests, parks (out of inner city), grasslands, uncultivated grounds, meadows, etc)
12	Rural agricultural – impact of agricultural source – cultivated grounds
13	Rural industrial – influence of industry outweigh the effect of traffic
14	Rural industrial with traffic load - influence of traffic outweighing industry
15	Rural residential with low-level effect of traffic (up to 2 thous. vehicles/24 h)
16	Rural residential with medium traffic load (2 – 10 thous.vehicles/24h)
17	Rural residential with high traffic load ((> 10 thous. vehicles/24h)
18	Rural non residential with traffic load (> 10 thous. vehicles/24h), no residential buildings

2.1.1 Substances monitored across the board

In 2022, compared to 2021, the level of outdoor air pollution (aerosol particles of both monitored aerosol particle fractions, NO_2, As, Cd) worsened slightly across the board, with persistent status for BaP, benzene, Cr, Pb, Ni and Mn. The higher frequency of sunny to tropical days translates into the increase in the number of days and areas with elevated ground-level ozone concentrations. This corresponds with mild (the same as the 2012 to 2021 period), above-average winter temperatures and reduced occurrence of unfavourable dispersion conditions. The situation was still significantly affected by both the waning epidemic of COVID-19 and the energy crisis, which forced some households to heat more frequently with various types of solid fuels in wood stoves and boilers. In fact, the crisis also affected areas with heavy traffic burden. In 2022, the measured concentrations of:

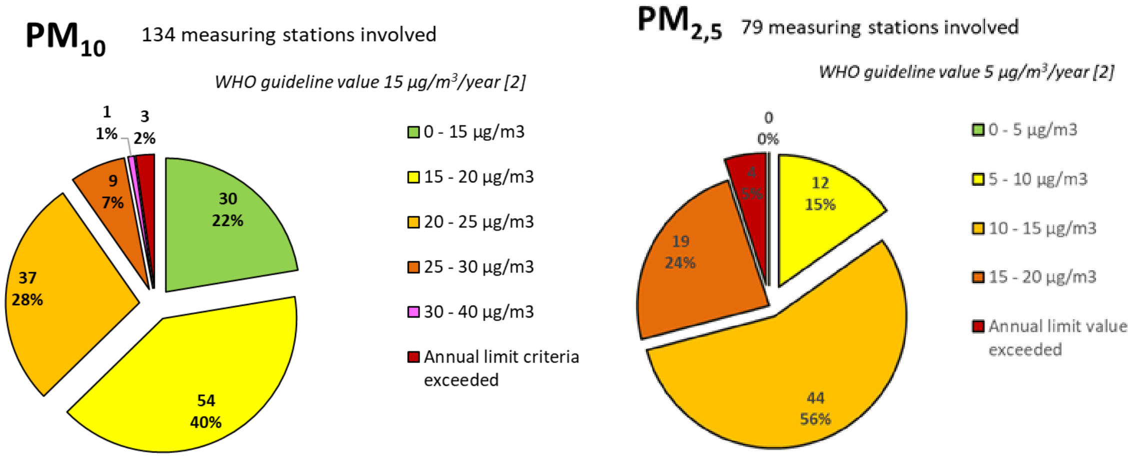
- **sulphur dioxide and carbon monoxide** rarely exceeded 25% of the WHO recommended 24-hour concentration;

- **ozone** exceeded 120 µg/m^3 for the daily 8-hour moving average at least once in 2022 at all but two stations. Values above 70 µg/m^3 annual mean were measured at a total of 8 background stations. The highest value was measured at the station Prague 4 - Libuš (ALIB) – 177 µg/m^3/8h. Comparison with the WHO AQG cannot be made due to lack of data;

- **nitrogen dioxide** at EMEP background stations did not exceed 5 µg/m^3/year. The WHO annual AQG of 10 µg/m^3 (from September 2021) was exceeded at 54 stations (76%) in 2022, and the daily AQG of 25 µg/m^3 was exceeded at least once at 61 (97%) urban stations. It was at ALEG station (Prague 2 – Legerova) that the concentration was exceeded the highest number of times – 292 (83 %).

- **PM_{10}** exceeded the WHO guideline annual mean value of 15 µg/m^3/year at 77% of the assessed stations (Fig. 2.1.1.1). Compared to 2021, air pollution by PM_{10} increased slightly. Exposure to PM_{10} thus can still be assessed as fluctuating and in the Moravian-Silesian Region as being increased by about 5 µg/m^3/year in the long term (Fig. 2.1.1.2). One of the reasons for this may be the persistent long-term precipitation deficit, which partially compensates for the influence of warm winters. The values in the winter period, 2022, are also likely to be related to the energy crisis, which has affected areas with extensive traffic burden. The trend of the environmental burden by PM_{10} aerosol particle fraction in inhabited locations has been decreasing over the last ten years, see Fig. 2.1.1.3.

Fig. 2.1.1.1 Number of measuring stations at intervals of annual average aerosol particle concentrations, 2022



- **$PM_{2,5}$** exceeded the WHO guideline annual mean value of 5 µg/m^3/year at all the stations evaluated (Fig. 2.1.1.2). The average share of $PM_{2,5}$ in PM_{10} ranged from 55% at urban stations to more than 80% at industrial sites. This parameter primarily depends on the composition of co-sources, but also has a significant seasonal dependence; higher values of $PM_{2,5}$ (≈ 90%) are found in the heating season and during periods of unfavourable dispersion conditions. The evolution of the estimated annual mean concentration of $PM_{2,5}$ in inhabited locations since 2000 is shown in Fig. 2.1.1.3.

Fig. 2.1.1.2 Annual average concentrations of PM_{10} for the individual categories of measuring stations, 2022

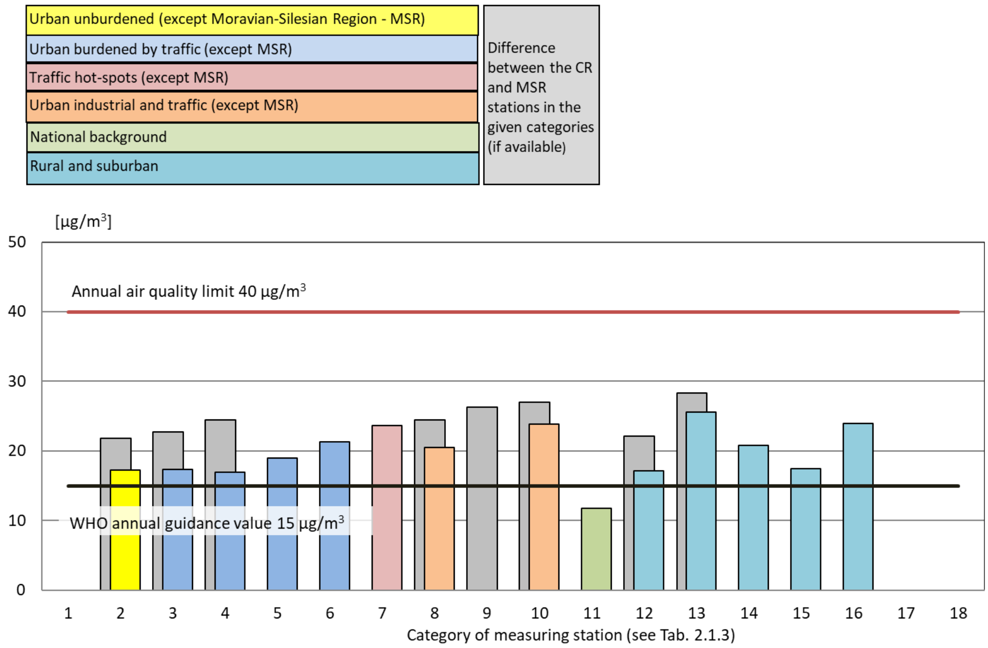
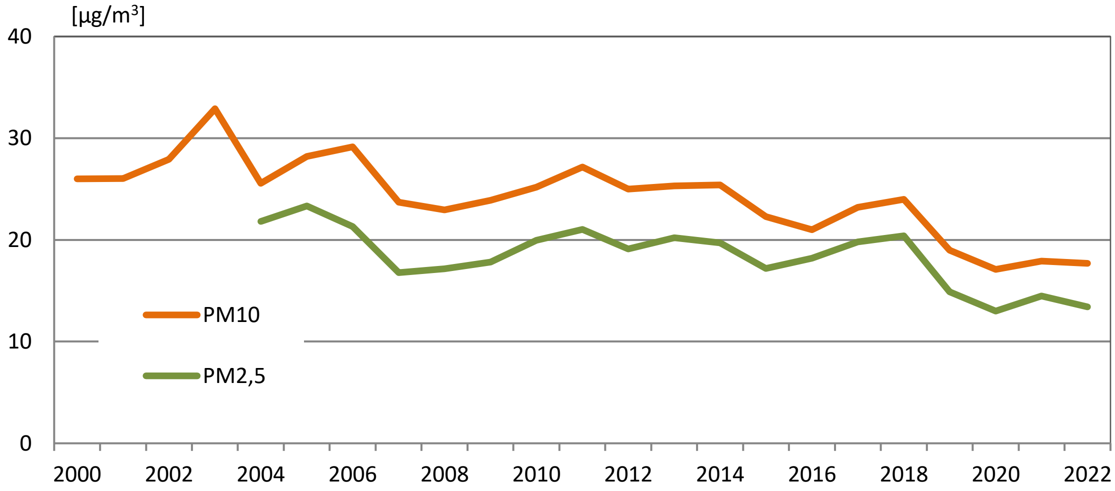


Fig. 2.1.1.3 Development of annual average PM_{10} a $PM_{2,5}$ concentrations in common urban environment, 2000-2022

Estimate calculated for urban residential locations of categories 2 to 5 based on the categorization of measuring stations (see tab. 2.1.3), without stations in the Moravian-Silesian Region



2.1.2 Metals in PM_{10}

The level of air pollution by most of the metals monitored is without significant fluctuations in the long term in the urban non-industrial locations assessed. However, the assessment of the monitored metals for 2022 is significantly affected by the failure of the ICP-MS measurement systems operated by the Czech Hydrometeorological Institute (CHMI). Thus, for some stations, data (Cr, Mn, Cu, Zn, Fe, V, Co and Se) are only available for the first two quarters of 2022. Of the 55 stations for which at least partial data are available for 2022, only 37 stations have evaluable data for arsenic, cadmium, nickel and lead, and only 21 stations have evaluable data for chromium and manganese (Tab. 2.1.2.1). The good alignment of the annual arithmetic and geometric mean values for these metals indicates the relative stability and homogeneity of the measured values without large seasonal, climatic or other fluctuations. In the case of nickel and arsenic, the values are likely to have declined further in recent years (Fig. 2.1.2.1).

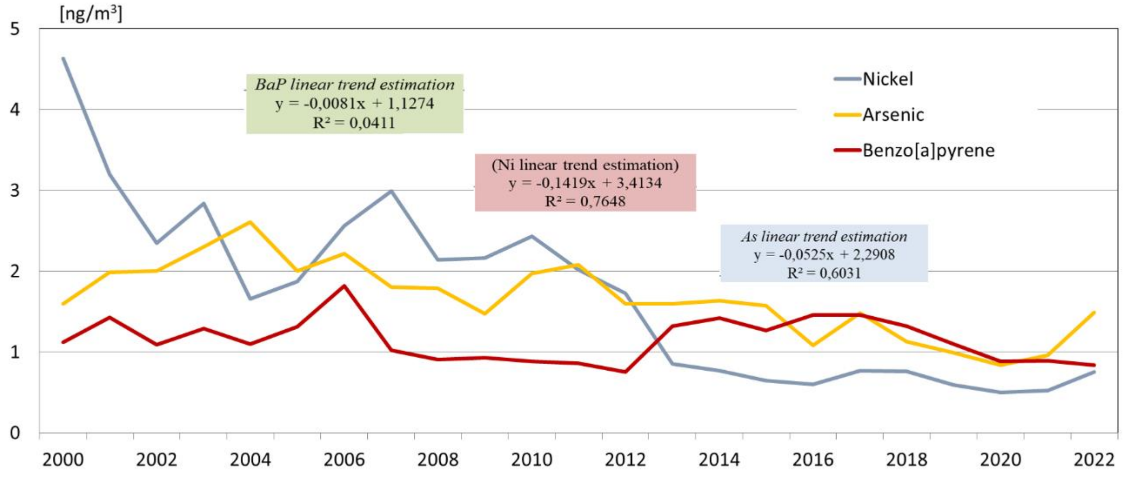
Tab. 2.1.2.1 Average annual concentrations of metals in PM_{10} (in ng/m^3)

Measuring station category	**As**	**Cd**	**Cr***	**Mn***	**Ni**	**Pb**
All stations (N=37)	1,78	0,25	1,17	6,45	0,99	7,28
Urban stations (categories 2-5, see Tab. 2.1.2)	1,49	0,06	1,27	6,44	0,75	4,62
Rural background	0,57	0,07	-	-	0,25	2,06

** data included from only 21 stations, data from background stations not available in 2022*

Compared to rural background station values, concentrations of As, Cd, Cr, Mn, Ni and Pb were approximately 3 to 4 times higher in inhabited locations in 2022. Elevated arsenic values can be found mainly in the vicinity of major industrial sources at the stations in Ostrava (metallurgy) or in locations with a majority of solid fossil fuel combustion. Higher concentrations of other metals are locally limited in occurrence and significance. The industry-burdened areas in the Ostrava region are characterised by elevated Ni, Mn, Cd, Cr and Pb values, and the area around Tanvald by higher Cd values. Elevated values of Pb are found in connection with old ecological load (Příbram and surroundings) and Ni in the vicinity of new industrial production (small and medium metal production sites).

Fig. 2.1.2.1 Trajectory of annual average nickel, arsenic and benzo[*a*]pyrene concentrations in common urban environment, 2000-2022

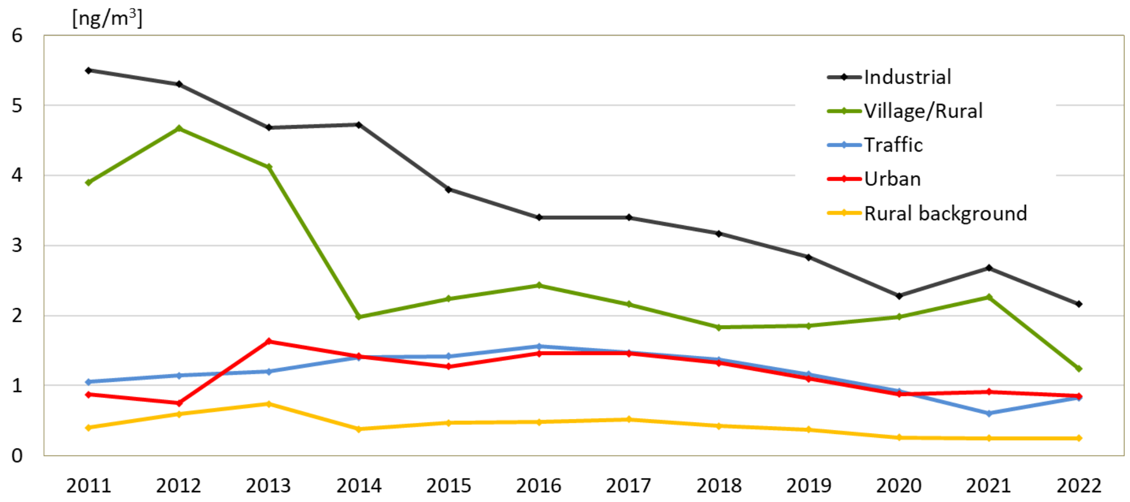


2.1.3 Polycyclic aromatic hydrocarbons (PAHs)

The higher molecular weight fraction of PAHs is mostly bound to very fine, submicron aerosol particles with a diameter of 0.5 to 0.8 µm, others may occur as vapours. Many of these are mutagens and carcinogens. **Benzo[*a*]pyrene** (BaP) is generally used as an indicator of PAH air pollution. Estimates of annual mean values in the air of inhabited areas have varied between 0.75 to 1.8 ng/m^3 with a non-significant downward trend since 2000 (Fig. 2.1.2.1).

A comparison of the concentration characteristics of PAHs at stations in different types of urban locations (see Fig. 2.1.3.1) shows that the two main sources of PAH emissions are, mostly in combination, domestic heating and transport. In the Ostrava-Karviná agglomeration, these sources are supplemented by emissions from large industrial units as well as from long-distance transport. The winter period is characterised by episodes of higher values in general, but in the Moravian-Silesian region in particular due to transfer from Poland. This is due to the increased demands on (even small) solid fuel energy sources, as well as the fact that the removal of PAHs by physicochemical processes in the atmosphere is much slower. However, by the end of 2022, air quality deteriorated at most stations compared to the previous four years.

Fig. 2.1.3.1 Development of average annual concentrations of benzo[*a*]pyrene at different types of measuring stations in 2011 – 2022



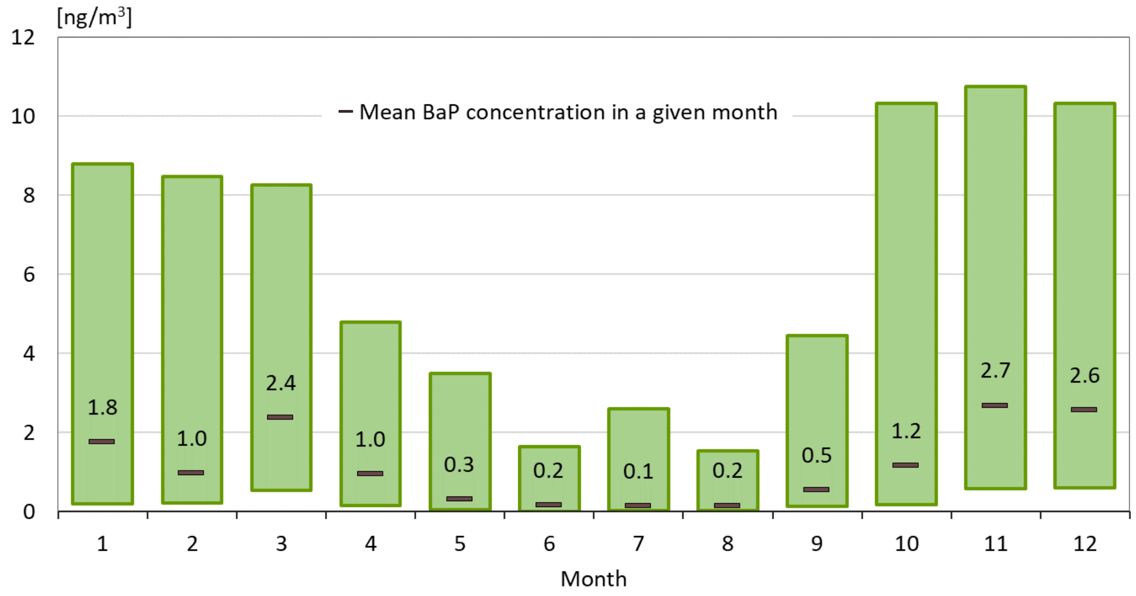
Note: Category of measuring stations: Industrial 8-10, Village/rural 12-17, Transport 4 - 7, Municipal 2-3, Rural background 11 (see Tab. 2.1.3)

In urban/rural locations with a significant share of small energy sources, and unloaded by industrial sources and transport, annual mean benzo[*a*]pyrene concentrations ranged from 0.3 to 2.91 ng/m^3 (representative of small settlements with a predominance of local sources in the valley is Kladno-Švermov with an annual mean value of 2.91 ng/m^3).

In urban locations with major traffic load, the values in the summer period were below 0.1 ng/m^3, the annual mean value for this type of locations was 0.83 ng/m^3.

In industrially exposed locations (chemical industry, metallurgy, etc.), especially in the Ostrava-Karviná region, the annual mean values were two or more times higher (1.64 to 6.03 ng/m^3). In addition, winter 24-hour maxima of tens of ng/m^3 were measured. (Fig. 2.1.3.2). In summer, the measured values there ranged most often from 0.1 to 5 ng/m^3; an exception is the station in the emission siding of the Liberty Ostrava (formerly ArcelorMittal), industrial complex in Radvanice-Bartovice (TORE) with higher BaP values. The mean annual value in 2022 for the category of urban locations affected by industry was estimated at 2.16 ng/m^3.

Fig. 2.1.3.2 Range of average monthly benzo[a]pyrene concentrations in the common urban environment of the Czech Republic, 2022



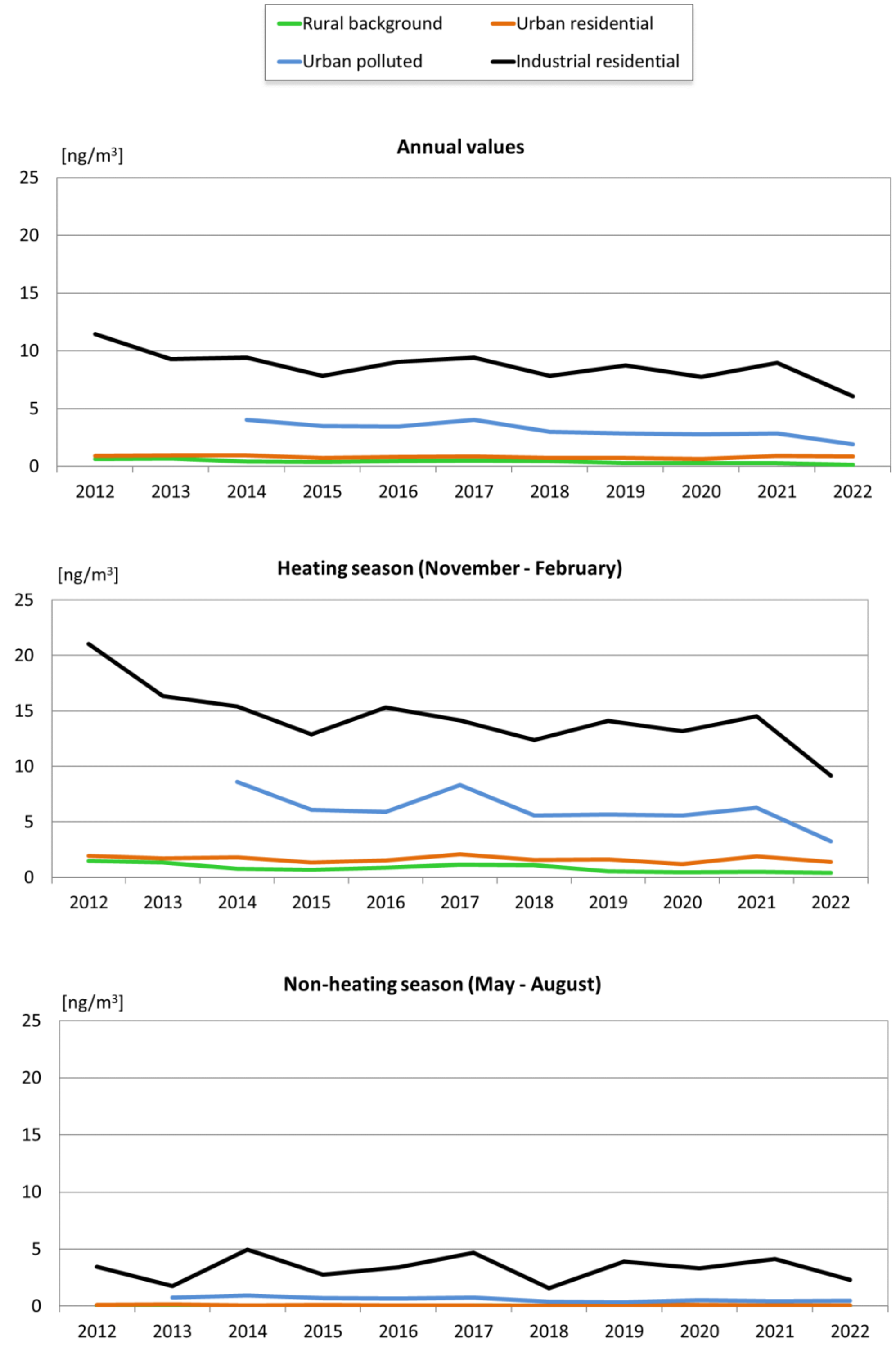
In addition to the annual averages, Fig. 2.1.3.3 shows a more detailed pattern of BaP concentrations from 2013 to 2022 in different types of urban locations, showing two basic energy seasons – heating and non-heating. It includes the background station Košetice (JKOS), the urban transport station NIPH Prague (ASRO), the urban industrial-residential station Karviná ZÚ (TKAO) and the combination of extensive industry and domestic heating – Ostrava-Radvanice station (TORE). Importance of both small energy sources and long-distance transport is illustrated by the order of magnitude differences between seasons.

The annual averages at the national background station in Košetice between 2013 and 2022 ranged from 0.13 to 0.68 ng/m^3 (minimum in 2021, maximum in 2013); in the non-heating season, values near the limit of quantification (0.05 ng/m^3) were measured; in the heating season, values ranged from 0.42 to 1.36 ng/m^3.

At the urban medium-traffic-burdened station in Prague 10, annual mean values since 2013 have ranged from 0.65 to 0.95 ng/m^3. The year-on-year decrease is particularly evident in the heating season. Although the values measured in the non-heating season are comparable to those in Košetice, they were more than three times higher in the heating season in 2022.

A different trend can be observed at two stations representing different levels of industrial burden in the Moravian-Silesian Region, i.e. the municipal station in Karviná and the station in the emission siding of the Liberty Ostrava plant in Ostrava-Radvanice. In Karviná, the situation can be described as stable with higher values in the heating season (3.23 ng/m^3 in 2022). The non-heating season there is characterised by a range of values from 0.28 to 1.36 ng/m^3. However, at the Radvanice station, even in the non-heating season, the monthly average concentrations did not fall below 1.6 ng/m^3 and in the heating season, the daily maximum values were usually more than 20 ng/m^3.

Fig. 2.1.3.3 Average annual and seasonal concentrations of benzo[*a*]pyrene at selected categories of measuring stations, 2012-2022



PAHs mixture consists of a number of substances, some of which are classified as carcinogens that vary in their significance of health effects. The estimate of the total carcinogenic potential of the mixture of PAHs in air is based on a comparison of the potential carcinogenic effects of the monitored PAHs with the severity of benzo[a]pyrene, one of the most toxic and best described representatives. It is expressed as the **toxic equivalent of benzo[a]pyrene (TEQ BaP)** and it is calculated as the sum of the products of the toxic equivalency factors (TEFs) established by the US EPA (Tab. 2.1.3.1) and the measured concentrations.

Tab. 2.1.3.1 Toxic Equivalent Factors (TEFs) for carcinogenic polycyclic aromatic hydrocarbons

	TEF		**TEF**		**TEF**
Benzo[*a*]pyrene	1	Benzo[*b*]fluoranthene	0.1	Dibenz[*ah*]anthracene	1
Benzo[*k*]fluoranthene	0.01	Benzo[*a*]anthracene	0.1	Indeno[*1,2,3- c,d*]pyrene	0.1
Chrysene	0.01	Benzo[*j*]fluoranthene	0.1		

TEQ BaP values show large differences between the measured areas. The level of the burden of directly unaffected background locations in the Czech Republic can be estimated from the value of the annual TEQ BaP arithmetic mean at the background station in Košetice – 0.41 ng TEQ BaP/m^3 in 2022. In 2022, the highest value of TEQ BaP/m^3 of 8.19 ng was measured at the Ostrava Radvanice station (11.95 ng of TEQ BaP/mm^3 in 2021). However, annual mean values above 2 ng/mm^3 are found at all stations in the Moravian-Silesian Region in the long term. In other parts of the country, TEQ values ranged from 0.5 to 1.5 ng/m^3, regardless of the level of traffic load. The potential impact of small local solid fuel sources in small inhabited locations is again well illustrated by the value of 4.5 ng TEQ BaP/m^3/year at the station in Kladno-Švermov.

2.1.4 Volatile organic substances – benzene

In 2022, benzene concentrations were monitored at 33 CHMI stations. The data confirm the fundamental importance of chemical and industrial production and, secondarily, transport (despite the significant reduction of benzene in motor gasoline) as important sources of VOCs, and benzene in particular.

In 2022, annual average benzene concentrations in urban locations ranged from 0.7 to 4.6 µg/m^3. The annual arithmetic mean at background stations reached 0.65 µg/m^3. At urban stations not burdened by industry and traffic and at traffic-burdened locations, the range of annual averages was between 0.7 and 1.6 µg/m^3 with a mean value of 1.1 µg/m^3. However, the highest values of annual averages – up to 4.6 µg/m^3 at the Ostrava - Přívoz station in 2022 – have been found in the long term in industrially loaded urban locations (chemical industry, metallurgy).

2.1.5 Concentrations of pollutants compared to WHO AQGs

In 2022, the WHO guideline value for PM_{10} was exceeded at 77% of the assessed urban stations. The WHO guideline value of 10 µg/m^3/year for nitrogen dioxide was not exceeded at only 17 measuring stations, mostly those of background significance. In comparison with the guideline values, $PM_{2,5}$ performs the worst, where the WHO guideline was exceeded on average by at least a factor of two at all the assessed stations, both in the inhabited locations and at background stations.

For benzo[*a*]pyrene, the value of 1 ng/m^3/year was exceeded at 15 stations, in industrial locations by several times. Similarly as in the case of $PM_{2,5}$, BaP exceeded the recommended values mainly at stations in the Moravian-Silesian Region.

2.1.6 Comprehensive air quality assessment

Comprehensive air quality assessment was carried out in 2022 in a standard way for the defined types of urban locations (see Tab. 2.1.3). However, some types of urban locations are not always covered by measurements across the full spectrum of pollutants assessed. The missing values have been replaced by an estimate of the median burden in urban locations in categories 2–5 for the substance in question, i.e. an estimate of the median value in less industrially and traffic exposed residential areas.

The first method of assessment is based on the Air Quality Index (AQI_A). Its calculation is based on the established annual air quality limits. It includes nitrogen dioxide, PM_{10} and/or $PM_{2,5}$, arsenic, cadmium, nickel, lead, benzene and benzo[*a*]pyrene. The annual mean AQI_R values and the values of the ratio of the annual mean to the limit value fairly accurately represent the differences in local abundance and significance of the co-occurring source types and their impact on air quality.

At a general level, the 2022 AQI_A value in almost all urban location types remains comparable to 2021, or remains within one class at most. In areas with solid fuel sources with local impact, the AQI_A value ranged between air quality Class 1 and 2 (0.50 to 1.98, i.e. suitable to moderately polluted air quality). The mean AQI_A values in urban locations, distributed according to traffic intensity (0.70 to 1.79), confirm the major role of the impact of solid fuel combustion in domestic heaters as a source of urban air pollution. The long-term beneficial effect of the milder winters of 2013-2022 was disrupted, especially at the end of 2022, by the energy crisis. The local impact of emissions from industrial sources in the Ostrava-Karviná area is reflected in the maximum AQI_A values, which reach Class 3 to Class 4 (AQI_A Class 3 – moderately polluted air to Class 4 – polluted air).

Separately, the sum of the share in the annual average to the air pollution limit value is assessed – the hazard quotient (HQ). This has the highest BaP in the long term. The annual average BaP at the background stations represented 25% of the limit value; on the other hand, the maximum value of limit drawing was found in the Radvanice industrial site at 600%. In a more detailed view, the annual average PM_{10} concentration at urban background sites drew the limit value to approximately 65%; however, in the Moravian-Silesian region the drawing of the limit value was increased (by up to 10%). For $PM_{2,5}$, the urban background locations varied by units of percentages, with above-limit drawing recorded only in urban industrial locations in the Moravian-Silesian Region. The maximum values of the share of annual averages and the limit value are also reached here by annual averages of BaP. Tab. 2.1.6.1 shows the values of the share of the annual mean concentration of pollutants and their air pollution limit value at the respective most polluted measuring station in 2022, supplemented by the data from 2021.

Tab. 2.1.6.1 Share of pollutant annual mean concentrations and the limit values at the most polluted stations in 2022, comparison with 2021

Pollutant	Share of the highest mean annual concentration and annual limit value in %; year 2022 (year 2021)	Pollutant	Share of the highest mean annual concentration and annual limit value in %; year 2022 (year 2021)
PM_{10}	78 (86)	**NO_2**	98 (95)
$PM_{2,5}$	103 (133)	**As**	88 (55)
BaP	603 (890)	**Cd**	44 (38)
Ni	20 (16)	**Pb**	11,5 (11)
Benzene	92 (66)		

2.2 Health effects of air pollution

2.2.1 Exposure of the population

The health effects of air pollutants depend on their concentration in the air and the length of time people are exposed to these pollutants. Actual exposure varies considerably over the course of a day, a year and over an individual's lifetime, and varies according to occupation, lifestyle, and/or concentrations in different locations and environments.

The existing variability (the range of concentrations characterising the level of air pollution in inhabited areas, e.g. nitrogen dioxide and PM_{10}) and therefore the potential range of exposure of the population is presented in Tab. 2.2.1.1.

Tab. 2.2.1.1 Estimated air pollution by NO_2 a PM_{10} in urban environment and national background (in µg/m³), 2022

Pollutant	National rural background	Urban environment		
		Minimum value	Average value	Maximum value
NO_2	4,6	9,2	14,4	39,3
PM_{10}	11,8	11,4	18,2	31,3

2.2.2 Air pollution health impact

Aerosol particles

Aerosol particles in inhaled air have a wide range of effects on the cardiovascular and respiratory systems. Due to their systemic pro-inflammatory effects, oxidative stress and effects on lipid metabolism, contribution to atherosclerosis including calcification of the cardiac artery, effects on the electrical activity of the heart muscle and other effects, they are considered to be the most important environmental factor impacting mortality. Aerosol particles individually, as well as the entire mixture of outdoor air pollutants, have been listed as Group 1 proven human carcinogens contributing to lung cancer by the World Health Organization's International Agency for Research on Cancer (IARC) since 2013.

Long-term exposure to elevated concentrations results in increased mortality from cardiovascular and respiratory diseases, including lung cancer, and associated reduced life expectancy, increased morbidity from respiratory diseases, increased incidence of chronic bronchitis symptoms and reduced lung function in children and adults. In addition, there is mounting evidence on the effect of particulate matter exposure on the development of type II diabetes, neurodevelopment in children and neurological disorders in adults [3]. No safe threshold concentration has yet been established for exposure to aerosol particles in air. It is believed that the sensitivity of individuals in a population has such a large variability that the most sensitive are at risk of effects even at very low concentrations. With chronic exposure to $PM_{2,5}$, reductions in life expectancy start to occur from annual average concentrations as low as 5 µg/m³ (corresponding to the updated WHO guideline value of 2021).

Short-term exposure to elevated concentrations of aerosol particulates contributes to increased morbidity and mortality, particularly from cardiovascular and respiratory diseases, increased hospital admissions for cardiovascular and respiratory diseases, increased infant mortality, increased incidence of respiratory symptoms and deterioration, particularly in asthmatics, and changes in lung function detectable by spirometry.

A quantitative estimate of health effects due to air pollution was made for exposure to aerosol particles. A key indicator of the health effects of long-term exposure is the estimate of the number of premature deaths for the adult population over 30 years of age, excluding external causes of death (accidents, suicide, etc.). This indicator includes both premature mortality for individual causes of death (cardiovascular or respiratory diseases, lung cancer, etc.) and deaths due to short-term exposure to particles. The concentration-effect function recommended by the WHO HRAPIE project [4] was used for the estimation.

The baseline assessment is based on the WHO recommendation [2] for an annual value of PM_{10} (AQG) of 15 $\mu g/m^3$ and for an increase in total (natural) mortality of the exposed population by 4.0% for every 10 $\mu g/m^3$ of the annual average PM_{10} concentration above this value.

The estimated mean concentration of PM_{10} aerosol particles for the urban environment in 2022 was 18.2 $\mu g/m^3$. The total (natural) mortality rate of the Czech population was therefore increased by 1.28% due to long-term exposure to aerosol particles.

Given that the average annual concentrations of this pollutant (and therefore potential exposure) at stations in different types of locations varied over a range, the estimate of the proportion of premature deaths due to PM_{10} exposure in the total number of deaths ranged from 0% in urban locations with no traffic to 9.7% in the most heavily industrial and traffic-loaded locations.

When applying an annual PM_{10} mass concentration baseline of 0 $\mu g/m^3$, a procedure that is often used (i.e. assessing the total burden, including the fraction of naturally occurring aerosol), results in multiply higher values (which often makes it impossible to compare values freely published in different studies with each other). The basal total (natural) mortality rate of the Czech population would then be increased by 6.5%, and the estimate of the share of premature deaths due to PM_{10} exposure in the total number of deaths would range from 4.5% in urban locations with no traffic to 12.5% in the most industrial and traffic-laden locations.

Nitrogen dioxide

Nitrogen dioxide, as a component of combustion emissions, is highly correlated with other primary and secondary pollutants, so it is not clear whether the observed health effects are due to the independent effect of NO_2 or rather to a mixture of substances, in particular aerosol [4], hydrocarbons, ozone and other substances [2]. The main effect of short-term exposure to high concentrations of NO_2 is an increase in airway reactivity; the WHO recommended value of 200 $\mu g/m^3$ for a 1-h NO_2 concentration is also derived based on the effect on reactivity changes in the most sensitive asthmatics. Residents of large urban agglomerations significantly affected by traffic are most exposed to nitrogen dioxide. For children, exposure to higher levels of NO_2 means an increased risk of respiratory disease due to reduced immunity to infection, and reduced lung function. The values of the annual averages show that for residents in traffic-loaded parts of e.g. the Prague agglomeration, a decrease in lung function, an increase in respiratory diseases, an increased incidence of asthma and allergies can be expected in both children and adults.

Although quantitative relationships between exposure and health effects of NO_2 (e.g. effects on total, cardiovascular and respiratory mortality) have been specified, the degree of overlap between these effects and those of other air pollutants cannot be clearly established. Therefore, the experts recommend assessing the health impacts of air pollution based on relationships for suspended particles, in which the effects of other pollutants are included [4].

For the annual average concentration, the updated WHO 2021 air quality guideline for Europe gives a recommended value of 10 $\mu g/m^3$. The guideline value has been changed based on a relatively large number of new studies that have provided additional support for the association between long-term nitrogen dioxide concentrations and total and respiratory mortality.

Ozone

Ground-level ozone is not emitted to the atmosphere but is formed by photochemical reactions of nitrogen oxides and volatile organic compounds. Ozone air pollution, which is a typical component of summer smog, can reach health-impacting levels, particularly in summer. Ozone is a strong irritant to the conjunctivae and respiratory tract, and at higher concentrations causes breathing difficulties and inflammatory reactions of the mucous membranes in the respiratory tract. People with chronic obstructive lung disease and asthma are particularly sensitive to ozone exposure.

Chronic ozone exposure increases the frequency of hospitalizations for worsening asthma in children and for acute exacerbation of cardiovascular and respiratory diseases in the elderly [4]. Short- and long-term ozone exposure affects respiratory morbidity and mortality. The SOMO35 parameter, defined as the annual sum of the daily highest 8-h moving average values exceeding a concentration of 70 µg/m^3, is used to assess long-term ozone exposure. For each day, the maximum of the 8-h moving average is selected and the values above 70 µg/m^3 are added up over the whole year.

To estimate the impact of O_3 on mortality from respiratory disease in persons over 30 years of age, a relative risk ratio of RR = 1.014 (95% CI = 1.005, 1.024) is used to reflect a 1.4% increase in this mortality rate for every 10 µg/m^3 of maximum daily 8-hour moving average O_3 values for the months of April to September [4]. The free software AirQ+ [5], developed by the WHO European Regional Office, was used for the final calculations. Because the mortality data were substantially affected by the COVID-19 pandemic in the past years, it is not possible to relate the obtained concentration data to the real exposed population. Thus, the output of this processing is the attributive population risk values in percent (Tab. 2.2.2.1).

Tab. 2.2.2.1. SOMO35 values and population attributable risk of death from respiratory disease due to ozone exposure in CR, 2022

	Minimum value	Average value	Maximum value
SOMO35 values	1 680	5 197	7 118
Attributive risk (in %)	0,64	1,96	2,67

Carbon monoxide and sulphur dioxide

Air pollution from carbon monoxide and sulphur dioxide does not pose a significant health risk in the measured settlements, although in the case of sulphur dioxide the threshold of effect for 24-hour concentrations has not yet been established by epidemiological studies.

Metals

There is very little scientific evidence on the health effects of exposure to trace metals in ambient air. Epidemiological studies have shown that $PM_{2,5}$ may affect the cardiovascular system through, among other things, the presence of metals, especially transition metals such as chromium, nickel, cadmium, manganese and mercury [3]. Since the widespread introduction of unleaded petrol, lead determined in aerosol samples is not a substance of health significance in terms of direct exposure from air. Even in terms of carcinogenic effects, the concentrations of cadmium, nickel, lead and arsenic detected do not pose a significant health risk in most areas.

2.2.3 Health risk assessment of carcinogens

Estimates of the theoretical increase in the probability of cancer due to long-term exposure to outdoor air pollutants were made for arsenic, nickel, cadmium, benzene and benzo[*a*]pyrene. The estimate is based on the non-threshold theory of carcinogen effects and considers a linear dose-effect relationship. Unit Carcinogenic Risk (UCR), which represents the magnitude of the risk of increasing the probability of cancer with lifetime exposure to 1 μg/m^3 of an airborne carcinogen, were used for the calculation. The unit carcinogenic risk values (Tab. 2.2.3.1) were taken from WHO materials [2], and from other sources, e.g. US EPA.

Tab. 2.2.3.1 Unit carcinogenic risk (UCR) values for the monitored substances with carcinogenic effect

Pollutant	**Arsenic**	**Benzene**	**Benzo[*a*]pyrene**	**Benzo[*a*]anthracene**
UCR	1,5E-03	6,0E-6	8,7E-02	1,0E-04
Pollutant	**Nickel**	**Benzo[*k*]fluoranthene**	**Benzo[*ghi*]perylene**	**Dibenz[*ah*]anthracene**
UCR	3,8E-04	1,0E-05	1,0E-06	1,0E-03
Pollutant	**Cadmium**	**Indeno[*1,2,3-cd*]pyrene**	**Chrysene**	**Benzo[*b*]fluoranthene**
UCR	4,9E-04	1,0E-04	1,0E-06	1,0E-04

For residents of each type of urban location, lifetime exposure to the monitored substances was considered at the level of annual arithmetic averages for the year 2022, and individual risk rates were calculated. The results are summarised in Tab. 2.2.3.2, in which the individual risk level is presented for the selected pollutants evaluated, for a) based on concentrations at the national emission-free background stations, for b) for the inhabitants of the least burdened urban location type (minimum risk value) and for c) for the inhabitants of the most burdened urban location type (maximum value). The average individual risk value was then calculated based on the concentrations of carcinogens in all urban site types.

Tab. 2.2.3.2 Estimation of individual risk of exposure to the most important carcinogens in outdoor air, in number of cancer cases per 1 million population, 2022

Pollutant	**National rural background**	**Urban environment**		
		Minimum value	**Average value**	**Maximum value**
Arsenic	0.80	0.92	2.67	7.88
Nickel	0.08	0.13	0.34	1.54
Cadmium	0.02	0.04	0.12	1.08
Benzene	3.6	4.2	7.2	27.6
Benzo[*a*]pyrene	21.8	28.7	98.3	525

The theoretical increase in cancer risk due to exposure to outdoor air pollutants has remained essentially unchanged for several years, ranging from 10-8 to 10-4 for individual carcinogens. Specifically, in 2022, the estimate of cancer risk ranged from two cases per 100 million to five cases per 100,000 population, depending on the location burden. Exposure to carcinogenic polycyclic aromatic hydrocarbons is the largest long-term contributor. Values representing an increase in lifetime cancer risk of almost one case per thousand inhabitants were reached in the most burdened industrial urban locations.

References:

[1] Czech Hydrometeorological Institute. 2023. „ Preliminary assessment of air quality in 2022“, https://www.chmi.cz/files/portal/docs/tiskove_zpravy/2023/TZ_Predbezna_zprava_s_hodnocenim_kvality_ovzdusi_za_rok_2022_isko.pdf

[2] WHO Global Air Quality Guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. A brief overview. 2021. Copenhagen: WHO Regional Office for Europe.Licence: CC BY-NC-SA 3.0 IGO.

[3] WHO. Review of evidence on health aspects of air pollution – REVIHAAP Project, *Technical Report*. 2013. WHO Regional Office for Europe. Copenhagen, Denmark.

[4] WHO. Health risks of air pollution in Europe – HRAPIE project, Recommendations for concentration-response functions for cost-benefit analysis of particulate matter, ozone and nitrogen dioxide, WHO Regional Office for Europe, 2013. Copenhagen, Denmark.

[5] WHO Regional Office for Europe, European Centre for Environment and Health. 2019. AirQ+: software tool for health risk assessment of air pollution. Bonn (Germany): WHO Regional Office for Europe. http://www.euro.who.int/en/health-topics/environment-and-health/air-qualityactivities/airq-software-tool-for-health-risk-assessment-of-air-pollution

3. HEALTH EFFECTS AND RISKS OF DRINKING AND RECREATIONAL WATER POLLUTION

Key findings

From the data obtained from the nationwide monitoring it follows that the gradual improvement of the drinking water quality from public water supply systems between 2004 and 2015 stopped in the following years. The main cause is the monitoring of a wider spectrum of pesticide substances with more frequent cases of exceeding the limit values.

In terms of health risks thus far recognised, the most problematic contaminants in drinking water are nitrates and chloroform resulting from the process of water disinfection. Drinking water from public water mains causes average absorption of 6–9% of the total amount of nitrates and 1% of chloroform, which can be ingested daily without health consequences. The average intake of individual pesticide substances from drinking water does not exceed 1% of their exposure limit.

According to a calculated estimate, carcinogenic substances contained in drinking water from Czech Republic water mains can cause about 2 cases of cancer per year; however, other models show up to 100–200 such cases.

Since 2004, data on drinking water quality has been obtained using the drinking water information system (IS PiVo) which is administered by the Ministry of Health and includes all water systems and other public drinking water supply methods in the Czech Republic. The source of this data is mainly from analyses provided by operators. The implementation, frequency and scope of these analyses is prescribed by valid legislation; only a small part of the data has been provided by the public health service under national health supervision. Only analyses performed by validly accredited and authorised laboratories with correct operational procedures can be entered into the system. Processing of data on drinking water quality does not include data from emergency situations, which are minimal in the database. Water quality indicators are assessed according to Decree No. 252/2004 Coll., as amended, which establishes hygiene requirements for drinking and heated water, and the frequency and scope of drinking water control. This decree transposes the European Council Directive 98/83/EC.

According to the Czech Statistical Office, approximately 96% of the Czech population is supplied with drinking water from the public water supply. According to data obtained from IS PiVo, 38% of the population in 2022 was supplied with drinking water produced from underground sources (3,537 water systems), 38% of the population from surface sources (327 water systems) and 24% of the population from mixed sources (215 water systems). Data on the number of residents supplied may not be completely accurate.

In 2022, a total of 4,079 public water supply systems were monitored[2]. The majority (3,805) are small water supply systems supplying 5,000 or fewer inhabitants, of which 3,287 water supply systems supply less than 1,000 inhabitants. Only 274 water mains belonged to the large category with more than 5,000 inhabitants supplied. However, these water supply systems supply the vast majority of the population of the Czech Republic (approx. 80%) connected to the public water supply system.

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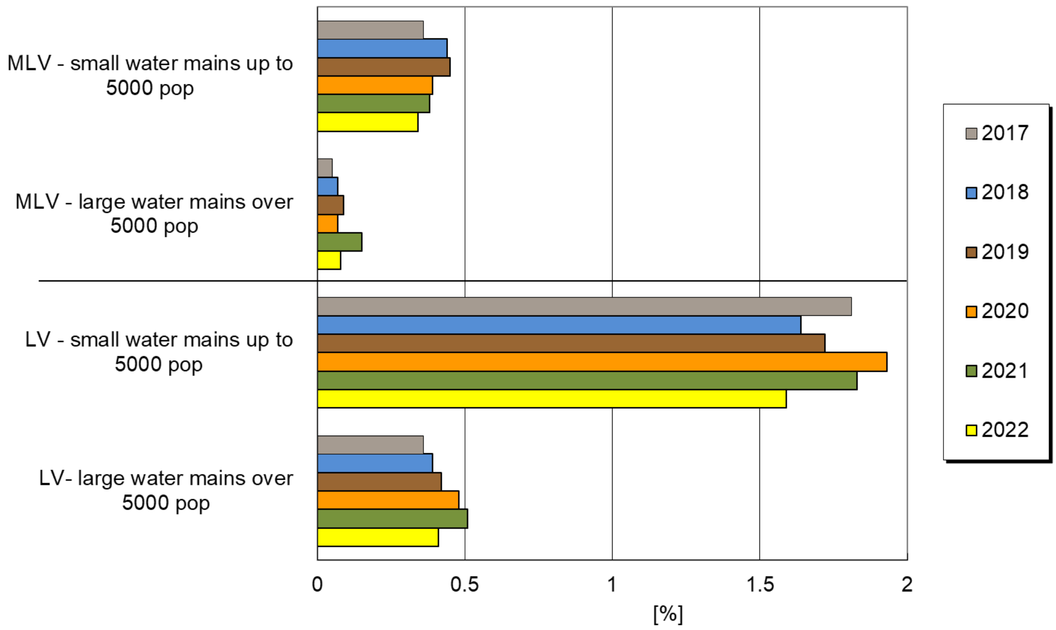
[2] *The base units for assessing drinking water quality according to Ministry of Health Decree No. 252/2004 Coll., as amended, are supplied areas; this is effectively an identical concept to that of a public water mains. The only difference is if one water mains network is supplied by multiple sources with markedly different quality which are not mixed prior to entry into the consumption system. In such an event the water mains are divided into several supplied areas in which the water quality is approximately the same.*

3.1 Drinking water quality

In 2022, the results of more than 38,000 drinking water samples were entered into the IS PiVo database, yielding approximately 1.3 million values of individual water quality indicators. A total of 298 indicators were monitored, including 202 different pesticide substances. Not all indicators are monitored in all water supply systems. The limits of health-significant indicators (limited by the maximum limit value[3], MLV) were exceeded in a total of 1,901 cases. The limit values[4] (LV) of the quality indicators, which mainly characterise the organoleptic properties of drinking water, were not met in 5,572 cases. In large water supply systems for more than 5,000 inhabitants, MLV was found to be exceeded in 0.08%, and LV in 0.4%, of determined samples. In small water supply systems supplying less than 5 thousand inhabitants, MLV and LV exceeded 0.33% and 1.6%, respectively. The development of drinking water quality supplied by public water supply systems using the development of exceeded limit values in large or small water supply systems between 2017 and 2022, is shown in Fig. 3.1.1.

Fig. 3.1.1 Frequency of non-compliance with the maximum limit values (MLV) and limit values (LV) according to the size of water supply system, 2022



The frequency of non-compliance with the limit values increases with the decreasing size of the water supply system (with a decreased number of supplied inhabitants). **In larger water supply systems**, the highest limit value is most frequently exceeded for chlorates and chlorites (1.5% of cases in 2022) and for chloroform (1.05%), which is a by-product of water chlorination. Its concentration depends, among other things, on the residence time of the water in the network and on the water temperature, which explains the higher incidence in large water supply systems with longer networks, than in smaller water supply systems. Large water supply systems also often use raw surface water, which despite water

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[3] MLV is the limit value of the content of health-significant drinking water markers. Exceeding this limit excludes water as fit for consumption, unless dictated otherwise by a public health protection body.

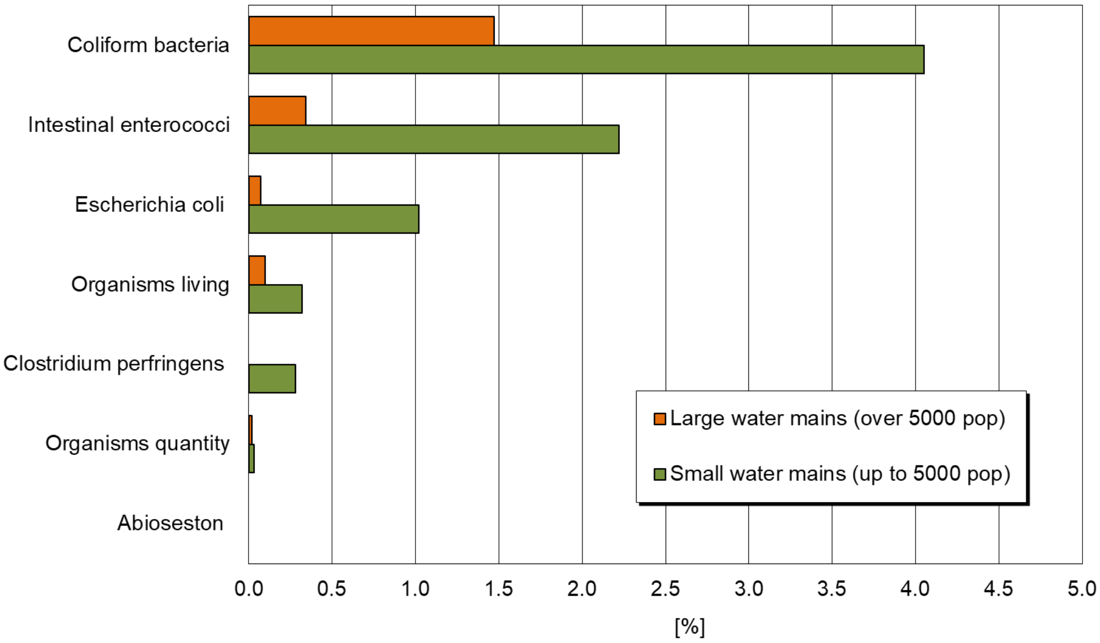
[4] LV is the limit value for markers that particularly define organoleptic properties of water. Exceedance usually does not present acute health risk.

treatment contain more natural organic substances from which chloroform (and other disinfection by-products) are formed.

In small water supplies, the MLVs were most often exceeded for chlorates and chlorites (4.3%), nitrates (1.1%), chloroform (0.99%) and arsenic (0.67%). The relatively higher frequency of exceeded limit values for uranium (1.5%) is due to the low number of samples and uranium monitoring in mainly at-risk water supplies.

Above-limit content of coliform bacteria was detected in 1.4% of samples from larger, and 4.6% from smaller water supply systems. The frequency of exceeded limit values for microbiological indicators is shown in Fig. 3.1.2 and for health-significant chemical indicators in Fig. 3.1.3.

Fig. 3.1.2 Frequency of non-compliance with the limit values for microbiological and biological indicators, 2022



Individual **pesticides** are determined in drinking water according to their probable occurrence in a given source. In 2022, roughly 90,000 determinations were made in large water supply systems and over 283,000 determinations in smaller ones. A total of 202 pesticide substances (parent substances and their relevant[5] and non-relevant[6] metabolites) were analysed. The limit value for parent substances and relevant metabolites is 0.1 µg/l, whereas the limit values for non-relevant metabolites are set individually by the public health protection authority based on a health risk assessment. In larger water supply systems, the limit value for acetochlor ESA (0.84%) and for dimethenamid ESA (0.42%) was exceeded in 2022. In smaller water supply systems, the highest limit values were exceeded for alachlor ESA (3.8%), acetochlor ESA (2.9%), pesticides in total (0.5%), desethylatrazine (0.5%) and bentazon (0. 4%). The frequency of non-compliance with limit values for the most frequently detected pesticide substances in drinking water is shown in Fig. 3.1.4.

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[5] *Pesticide metabolites which are similar to their parent compounds (identical limit value = 0.1 µg/l).*

[6] *Pesticide metabolites with much lower toxicity compared to their parent compounds.*

Fig. 3.1.3 Frequency of non-compliance with limit values for chemical substances (excluding pesticides), 2022

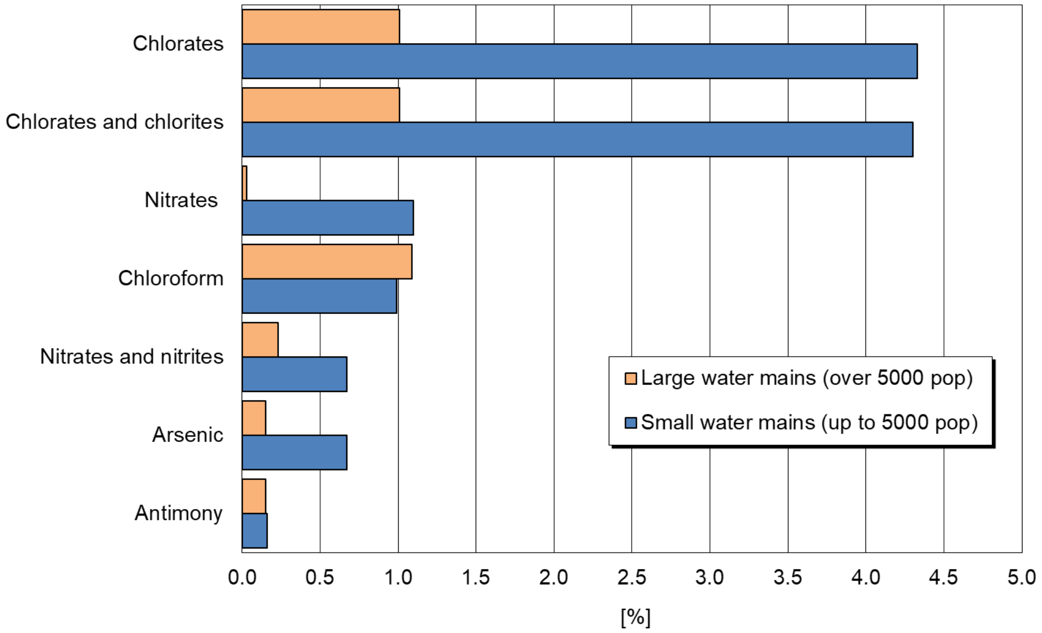
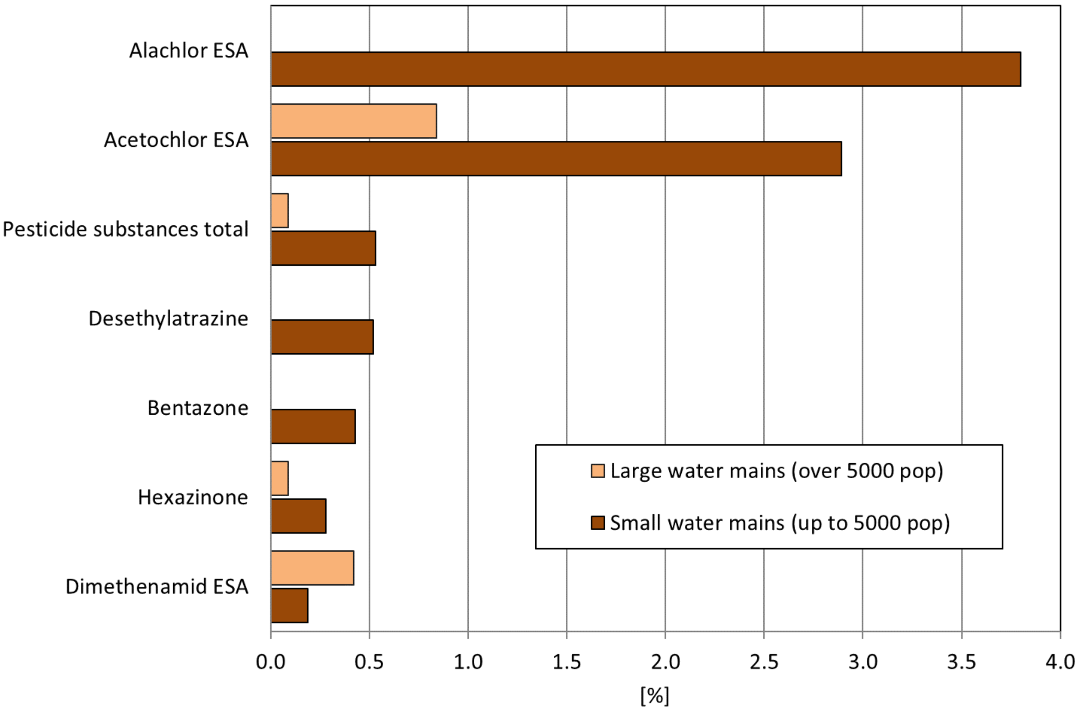


Fig. 3.1.4 Frequency of non-compliance with the limit values for most common pesticide substances, 2022



The active substance acetochlor, the breakdown of which produces acetochlor ESA, has been banned in the EU since 2013 for use as a herbicide due to probable carcinogenicity and damage to hormonal balance. Alachlor was also withdrawn from use as an active substance in 2008. These substances have seeped into the groundwater through leaching, where they degrade very slowly.

Nitrates and chloroform (by-products of water disinfection) are the most problematic drinking water contaminants in terms of known health risks. Exceeding the limit value of nitrates (50 mg/l) was detected in 0.9% of cases. Approximately 2.3 thousand inhabitants were supplied with drinking water where the average annual concentration of nitrates reached or exceeded the limit value, in the case of small water systems. Chloroform content in excess of the limit value (30 µg/l) was detected in 1% of all determined samples. Approximately 5,000 inhabitants were supplied with drinking water where the average annual concentration of chloroform reached or exceeded the limit value.

Since 2018, in addition to chlorites, **the content of chlorates** in drinking water has also been monitored. These arise as a by-product of water disinfection, especially with sodium or calcium hypochlorite. The elevated content of chlorates in drinking water is a problem almost exclusively of small water supply systems, where hypochlorite is widely used as a disinfectant. According to an NIPH study from 2019–2020, there are several reasons for this: the use of hypochlorite after the expiration date or its storage in unsuitable conditions and subsequent chemical reactions, and also unnecessary over-chlorination of water. The situation is improving gradually, although not continuously, thanks to reasonably easy remedial measures (instructions for the operators/personnel of the water supply). The frequency of non-compliance with the NMH for chlorates has decreased in small water supplies from 5.5% of samples in 2018 to 4.3% in 2022, although in 2021 it was only 3.1%.

The health significance of optimal **calcium and magnesium** content in drinking water is indisputable. Monitoring reveals that only 24% of the population is supplied with drinking water with the recommended optimal concentration of calcium (40–80 mg/l). The vast majority of the population is supplied with water with a low magnesium content and only 6% of the population receives an optimal concentration (20–30 mg/l). 28% of the population is supplied with water with optimal hardness (2–3.5 mmol/l) whereas 65% have softer water. Deliberate reduction of the content of these elements by domestic water treatment is therefore undesirable in the majority of cases.

The content of **radionuclides** present in drinking water causes an average effective dose of approximately 0.07 mSv/year, of which the average radiation from water due to the presence of radon Rn-222 (effective dose from ingestion and inhalation) is estimated at 0.06 mSv/year. Effectively, 7% of the general limit (1 mSv/year) stipulated by Decree No. 236/2016 Coll., on Radiation Protection, is drawn from drinking water intake.

Approved exceptions

In 2022, 107 water mains were subject to an exception of non-compliance with the limit values of health-significant indicators, as approved by the public health protection authority. A more lenient hygiene limit than that stipulated in Decree No. 252/2004 Coll., in its current version, was most frequently allowed for pesticide substances (74 water supply systems), such as acetochlor ESA (43 water supply systems supplying a total of 38,000 inhabitants) or alachlor ESA (16 water supply systems, 8,000 inhabitants). An exemption was granted for 26 water supply systems (26,000 inhabitants) for exceeded nitrate content.

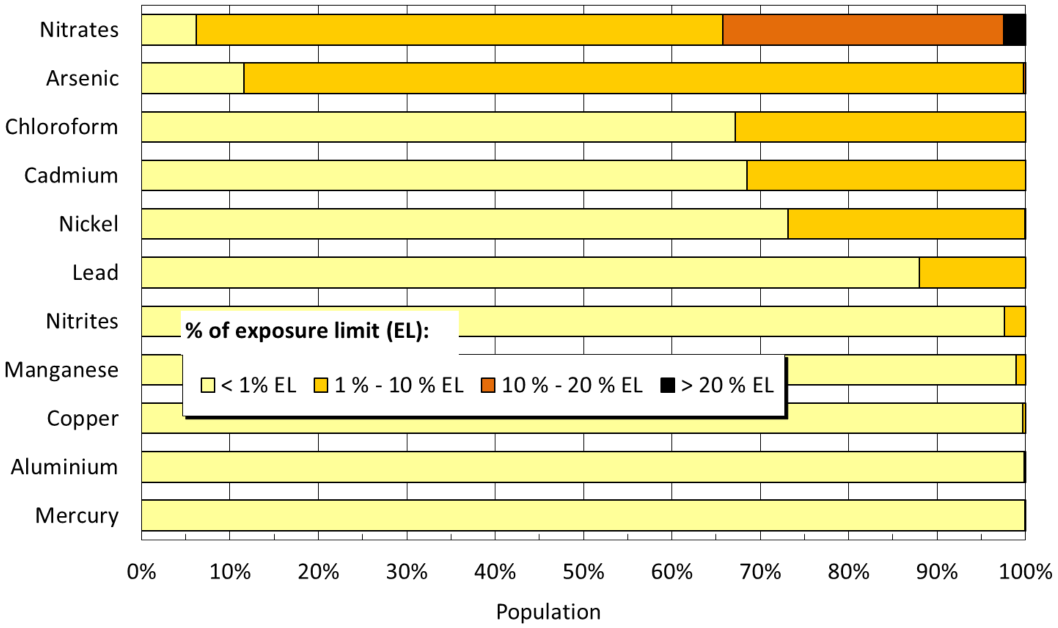
According to EU Directive 2020/2184, it is not possible to grant an exemption for an unlimited period of time for health-risk drinking water contaminants (NMH indicators), but only for a maximum of two to three years.

3.2 Exposure to contaminants from drinking water

For selected health-risk contaminants (arsenic, chlorethene, nitrites, nitrates, aluminium, cadmium, manganese, copper, nickel, lead, mercury, selenium, chloroform), for which an exposure limit (safe daily intake) is set, the population burden from drinking water intake was evaluated. Of the evaluated contaminants, nitrate input is the highest; by drinking water from public water mains, on average[7] 6–9% of the total daily acceptable supply[8] of nitrates is drawn (assuming daily consumption of 1.5 litres of tap water). For chloroform, arsenic and nickel, the average intake from drinking water was detected at about one percent of the tolerable intake. The concentrations of the other evaluated contaminants in drinking water often do not exceed the detection limit of the analytical method used, and therefore exposure to these substances cannot be quantified. However, it can be stated that the average exposure is less than 1% of the relevant exposure limit. This also applies to pesticide substances and their metabolites in water.

Although the average intake of nitrates in drinking water represents only a few percent of the total daily acceptable intake for the inhabitants of the Czech Republic, roughly a third of the population supplied by public water supply receives more than 10% of the total acceptable intake of nitrates in drinking water every day. If the nitrate content was at the level of the limit value (50 mg/l), such drinking water would contribute 21% to the total acceptable intake of nitrates for an adult with a consumption of 1 l/day, and 42% with a consumption of 2 l/day. The distribution of the population according to the amount of exposure to selected contaminants from drinking water in 2022 is shown in Fig. 3.2.1.

Fig. 3.2.1 Distribution of the Czech population by the magnitude of exposure to chemicals from drinking water, 2022



The exposure calculated from the average consumption of 1.5 litres of drinking water from the public supply networks.

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[7] *The extent of contaminant exposure in the Czech Republic was calculated by use of median concentrations in water mains, acquired from annual water samples. Mean exposure for all water networks was calculated using the number of consumers, resulting in approximately 7–8 % of the daily acceptable intake. The 90% quantile of nitrate concentrations yields 9–10 % values.*

[8] *The total acceptable/tolerable daily contaminant intake (exposure limit) is an intake of foods, water, dust etc., which according to current data does not represent health risk during lifetime exposure.*

Assessment of the amount of exposure to individual substances in drinking water, for which an exposure limit is set, does not reveal the probability of health damage from non-carcinogenic effects. However, if an exemption is granted, a public health authority may determine, on the basis of a health risk assessment, that a group of consumers is at risk (usually infants, young children or pregnant women), and that such an intake of this water for these groups is then restricted or excluded to prevent health damage.

3.3 Theoretical increase of cancer cases

To calculate the theoretical increase in the probability of developing cancer due to chronic exposure to organic substances (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, trichloroethene) from drinking water supply, a linear no-threshold model was used according to the health risk assessment method. An average human weight of 70 kg, a mean life expectancy of 70 years, a lifetime exposure (calculated to annual exposure and risk) and a mean drinking water consumption of 1.5 litres per day were used to calculate the annual contribution of the risk increase estimate. Since there is insufficient data on the effects of the monitored substances in the concentration mixtures in which these substances are found in drinking water, a simple addition of the effects of individual substances was considered according to the recommendations of the US EPA.

The exposure and risk calculations were carried out according to standard procedures. However, the exposure factors used are always limited by a certain degree of uncertainty, such as the limited spectrum of monitored health-significant substances, individual amounts of drinking water consumed from water networks, different rates of absorption of the monitored substances in the body and different exposure frequency. This may have led to over or underestimation of the issue. Inhalation and dermal exposures, which for some contaminants are of similar importance as oral intake, were not taken into account because there is a lack of specific data on domestic Czech population water usage.

Based on the calculation of theoretical increase in the probability of developing cancer due to chronic exposure to routinely monitored carcinogenic substances in drinking water, consumption of drinking water from the public water supply can contribute by approximately two cases per 10 million inhabitants (the population of the Czech Republic is 10.5 million).

At the beginning of 2020, a study [1] was published which for the first time attempted to estimate the impact of the by-products of drinking water disinfection on the health of the population on a European Union (EU) level. A study was made of the occurrence of bladder tumours, in which a relationship to disinfection by-products has been epidemiologically proven. The study was based on available information on the occurrence of trihalomethanes (THM) in drinking water in EU countries in 2016, taking THM as a proxy for the entire mix of by-products and the dose-effect relationship derived from epidemiological studies. For the Czech Republic, it was calculated that 138 cases (95% CI: 70–204) of bladder tumours will arise annually as a result of exposure to disinfection by-products in drinking water: this is 5% of cases of this tumour that are newly diagnosed every year nationwide.

3.4 Water quality in public and commercially used wells

As part of nationwide monitoring, the PiVo information system also collects data on the quality of drinking water from public wells and individual sources used for business activities, for the performance of which drinking water must be used (commercial wells). In 2022, approximately 5,000 water samples were taken from 252 public and 1,930 commercial wells. The limits of health-significant indicators were exceeded in 0.6% of the relevant determinations. There were relatively numerous findings of non-compliance with the limit values of all microbiological indicators of drinking water quality, such as intestinal enterococci (3.9%), coliform bacteria (8.5%) and *Escherichia coli* (2.1%). Of the other indicators, limit values of pH (13.6%), manganese (10.2%), chlorates (8.1%), chlorides (5.0%), nitrates (2.3%), acetochlor ESA (3.8%) and alachlor ESA (1.9%) were not observed.

3.5 Indicators of direct health damage from drinking water

From direct reports of the municipal hygiene department workers of the regional hygiene stations about possibly recorded infections, poisonings or other diseases that occurred in connection with the quality and use of drinking water from the monitored water mains and public or other wells used for public supply, it emerged that three such incidents were reported in 2022. These comprised one highly suspected and two confirmed epidemics from drinking water. Water from a well intended for public supply was the cause of a norovirus epidemic in the Liberec region and in all probability an epidemic of unknown origin (AGI) in the Pardubice region. An epidemic in the Ústí region was caused by contamination of the internal drinking water distribution system of an industrial building.

3.6 Monitoring the quality of recreational water

Health risks from recreational waters, aside from drowning and other injuries, are mainly associated with contamination by pathogenic microorganisms, the development of cyanobacteria and algae, and in some places also with cercarial dermatitis (manifested by intense itching). Mass occurrence of cyanobacteria and algae as well as significant pollution of natural and anthropogenic origin can also negatively affect the attractiveness of recreational waters for bathers. The occurrence of indicators of faecal pollution (*E. coli* and intestinal enterococci), cyanobacteria, algae, natural pollution and waste pollution is systematically monitored. Monitoring is evaluated largely on the basis of the most recent samples, apart from faecal pollution indicators which are analysed after each bathing season by analysis of data from the previous four years.

Data on the quality of bathing water during the bathing season are sent to the information system. Authorities for the protection of public health regularly carry out a summary assessment according to Decree No. 238/2011 Coll., as amended, to provide relevant methodological recommendations and indicate the quality of bathing water using a five-point scale. The current quality of bathing water is available to the public on the websites of the Ministry of Health, Regional Hygiene Stations and the Bathing Water website. Bathing water quality during the 2010 to 2022 period is shown in Fig. 3.6.1, where localities are characterised by the worst ratings during the bathing season. There are around 280 evaluated bathing waters in recent years (2020 – 275, 2021 – 284 and 2022 – 285).

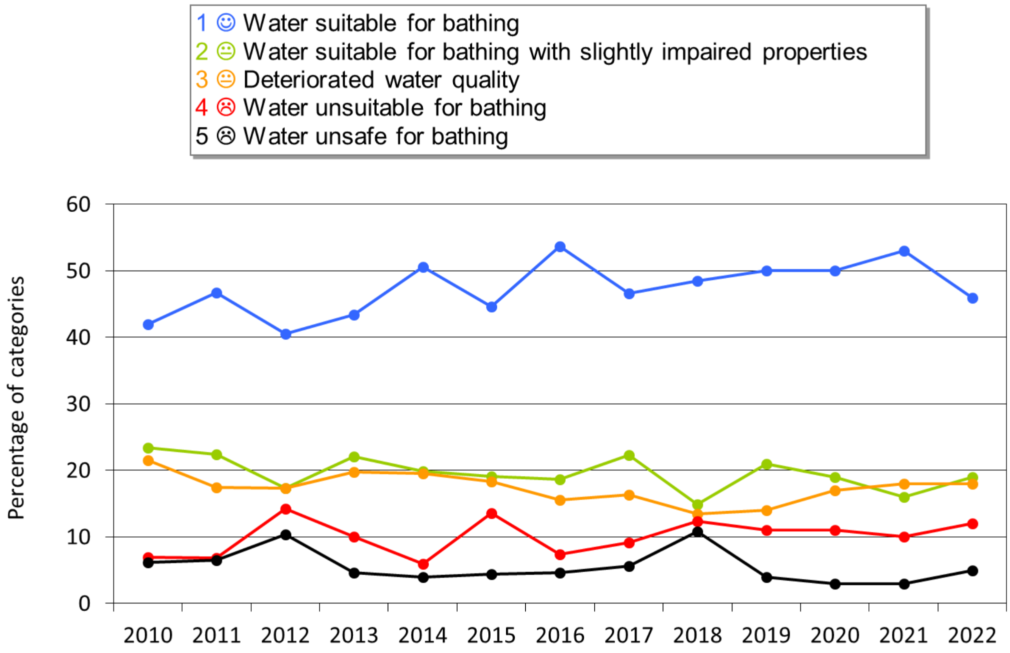
The biggest problem of nationwide natural waters continues to be the mass occurrence of cyanobacteria blooms, especially during the summer months and at the start of autumn. In 2022, the number of locations with a mass occurrence of cyanobacteria was similar to previous years (except for 2018, when their development was apparently accelerated due to very warm weather). Decreased evaluation due to findings of faecal pollution indicators was less frequent than in previous seasons. Cases of cercarial dermatitis confirmed by the finding of cercariae in snails were reported in 2022 from two reservoirs. In at least two other monitored bathing waters, there were cases of skin disease, the symptoms of which corresponded to cercarial dermatitis, although its causative agents were not found in snails.

According to the requirements of the EU, a report is prepared annually from the obtained data, which is sent to the European Commission. This report, which includes only the most important bathing waters in rural areas (according to Directive 2006/7/EC, a large number of people bathe in these waters), is based primarily on the results of monitoring indicators of faecal pollution.

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 satisfactory bathing waters was low due to the considerable number of waters with insufficient sampling.

The number of bathing waters that met the EU limit requirements gradually increased. While in 2004, 49% of the total number of monitored swimming areas complied with the requirements, in 2011 this reached 87%.

Fig. 3.6.1 Development of bathing water quality by the summary assessment based on national criteria, percentage of categories, 2010 – 2022



The number of reported bathing waters to the EU, where water quality is monitored, has fallen from 176 in 2004 to 156 in 2022. Since 2012, the European Commission has been evaluating and classifying bathing waters in the EU according to the new rules set out in Directive 2006/7/EC (viz § 9 of Decree No. 238/2011 Coll.). In the 2012–2022 period, the majority of bathing waters in the Czech Republic complied with the new EU limit requirements (classified at least in the category of acceptable water quality) at approximately 90%, and in 2022, specifically 143 out of a total of 156, or 91.7%.

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4. COMMUNITY NOISE AND HEALTH

The program is in intermittent mode.

5. DIETARY EXPOSURE

Key findings

Dietary intake of many important minerals is lower than recommended in the Czech population. By comparison with international recommendations, the estimated intake:

- *of calcium was low in all age groups, with the lowest values in people over 60 years of age (90% of women and 80% of men had low intakes),*
- *of magnesium was insufficient in the whole population, except for children aged 4–6 years; the lowest values were recorded in adolescent girls aged 15–17 years and older women,*
- *of iron was lower in half of women of childbearing age and in half of children aged 7–10 years,*
- *of potassium was deficient in those over 14 years of age.*

On the other hand, sodium intake was excessive, especially in men (over 90% of men aged 15–59 years had higher than recommended intakes).

If the consumption of each food group corresponded to the recommendations of the food pyramid, the situation would improve substantially for most population groups.

In recent years, there has been no unauthorised genetically modified rice or GM rice products on the market in the Czech Republic.

A total of five sub-projects were underway in the 2022 monitoring period. The initial project was a **food sampling system** based on methodological requirements for dietary exposure assessment based on the principles of the Total Diet Study (TDS). Sampling is carried out to represent the "usual Czech diet" and food sampling sites are continuously rotated to achieve proportional coverage of all regions of the Czech Republic.

Another part of the subsystem is devoted to monitoring **the occurrence of foods based on genetically modified organisms** (GMOs). In this case, the main concern is the implementation of the precautionary principle in relation to the possible presence of unapproved GM products not tested for health on the market, which is linked to quality control in the sense of consumer deception. The presence of GMOs must be compulsorily labelled.

Monitoring of **selected toxigenic moulds in foodstuffs on the Czech market** is also repeated regularly. Specialised mycological testing is carried out, which is aimed at describing and characterising the risk of toxinogenic fungi. In the Czech Republic, there are virtually no current data on the extent of qualitative and quantitative contamination of food with fungi, nor data on the occurrence of producers of significant mycotoxins in food. The project tries to describe the current situation related to climate change and food imports from different parts of the world. The last data were presented in 2021.

An extensive part of the subsystem is long-term monitoring of **dietary exposure of the population to selected harmful chemicals**. It is firmly anchored in a number of Czech regulations (e.g. Act on the Protection of Public Health No. 258/2000 Coll. as amended, Government Resolutions No. 323/2021 and No. 200/2022) and in EU regulations, of course. It uses the TDS design, which is methodologically harmonised in the EU (EFSA). It is particularly suitable for chronic dietary exposure monitoring. It differs from conventional food inspection in it covering the whole pattern of consumer behaviour (including culinary food preparation) and dealing with the whole range of foods normally consumed (not just the risk groups). It is therefore a cost-effective way to perform more accurate characterisation of health risks to the population. In 2022, the first year of a two-year sampling period (2022–2023) was conducted. Results will be completed and published in 2024.

The last part of the subsystem focused on **the assessment of nutrient supply**. This section provides information from the population nutrition perspective and focuses on characterising the health risks associated with inadequate intakes of selected nutrients.

All of these sub-projects respond to the requirements of national legislation, European Union legislation, the interests of NGOs and, of course, the general consumer public. There is a growing interest in the relationship between food, nutrition and health. Activities are seen as the management of health and hygiene uncertainties, in other words, primary prevention in the field of public health.

5.1 Sampling system for foods representing the usual diet of the population in the Czech Republic

Food sampling was carried out in 20 quota-selected locations of the country (Tab. 5.1.1), taking into account the population size (Tab. 5.1.2), divided into 4 territorial regions (quadrants).

Tab. 5.1.1 Food sampling locations in the market network, 4 stages of 2022

11.1.-22.2. 2022	22.3.-3.5. 2022	24.5.-20.9. 2022	11.10.-22.11. 2022
Jindřichův Hrad. (3x)	Č. Budějovice (3x)	Beroun (3x)	Soběslav (1x)
Praha (3x)	Jičín (3x)	Přelouč (1x)	Kamenice n. Lipou (1x)
Chrudim (3x)	Uničov (1x)	Hořice (1x)	Online (1x)
Mikulov (1x)	Litovel (1x)	Online (1x)	Kladno (3x)
Hustopeče (1x)	Online (1x)	Ostrava (3x)	Prostějov (3x)
Online (1x)	Kyjov (3x)	Jihlava (3x)	Brno (3x)

Tab. 5.1.2 Selection of shopping places and number of food purchases according to the size of the municipality [1]

Municipality	% pop.	No. of shopping places	No. of purchases
Over 100 000 *pop.*	22	6	18
50 000 – 99 999 *pop.*	11	4	12
20 000 – 49 999 *pop.*	12	4	12
10 000 – 19 999 *pop.*	9	2	6
5 000 – 9 999 *pop.*	10	4	12
2 000 – 4 999 *pop.*	11	4	12
To 1 999 obyv./*pop.*	25	8*	24
Total	**100**	**32**	**96**

In each selected location, sampling is carried out in three or one shop, depending on the size of the location, in order to maintain a proportional representation of shop sizes according to actual consumer preferences. The number of sampling points is based on capacity/financial possibilities in order to build on the previous sampling system and to be representative of the national territory.

Due to the increasing number of consumers shopping for food on the Internet, online purchases have been newly included. During the two-year monitoring cycle (2022/2023), food is sampled in 96 different shops, in 40 locations across the country and 8 online purchases are made to include the expected effect of the size of the locations and the type of shops. Sampling is carried out at 4 periods during the year due to possible seasonal changes in food supply (purchases are usually made during the main season of consumption of the particular food).

5.2 Targeted monitoring of food hygiene and health safety in the Czech Republic

5.2.1 Detection and identification of genetically modified organisms

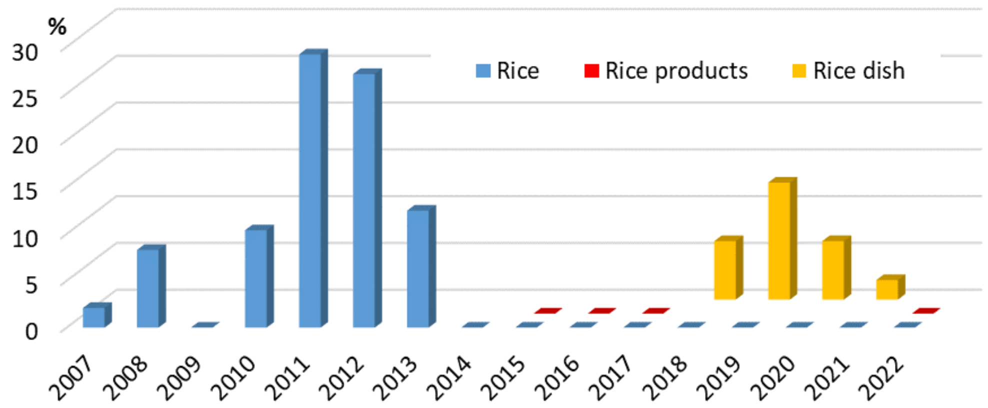
The targeted monitoring of hygiene and health safety of foodstuffs "HYGIMON" was focused on the detection of unauthorised genetically modified organisms (GMOs) in foodstuffs.

The detection and identification of GMOs was again specifically targeted at rice, as genetically modified (GM) rice is not yet authorised for being launched in the EU market, yet regular detections of GM rice continue to occur during border checks. According to the Rapid Alert System for Food and Feed (RASFF), detections are mainly in food products containing rice imported from third countries outside the EU. Under RASFF, 9 cases of GMOs in food were reported in 2022, including 4 cases of unauthorised GM rice. In these cases, it was not specified which genetic modification was involved and no identification of the genetic modification was made [2].

A total of 48 samples of rice (e.g. Basmati rice, Arborio rice, Jasmine rice) and 48 samples of products containing rice (e.g. rice flour, rice groats) were analysed in 2022. The samples were examined by screening polymerase chain reaction (PCR). The presence of screening elements typical for GMOs was not confirmed in the analysed samples of rice products.

The results obtained show that in recent years there have been no detections of unauthorised transgenic rice in rice and rice products in the Czech market network compared to the previous period (Fig. 5.2.1.1).

Fig. 5.2.1.1 Number of positive samples of unauthorized GMOs, 2007 - 2022



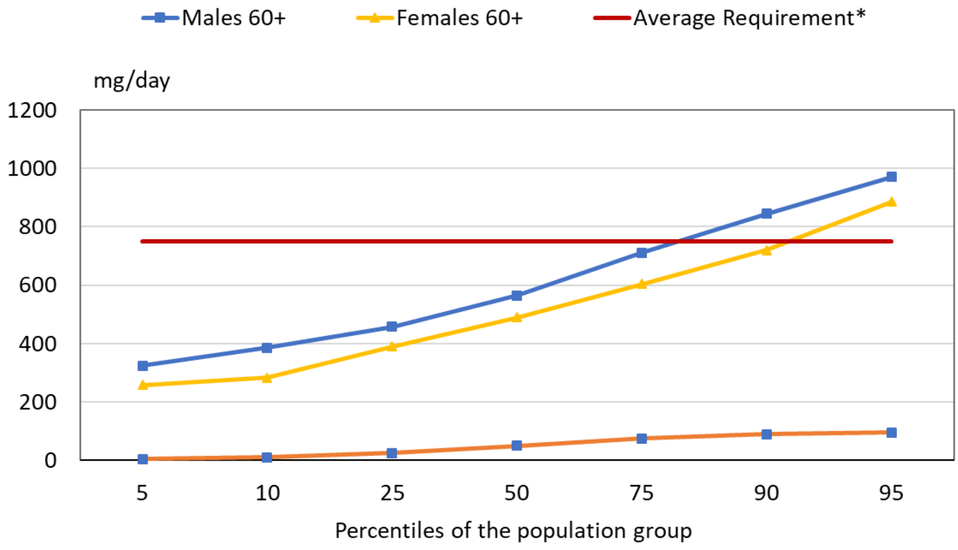
No adverse effect on human or animal health has been observed so far when consuming food based on the GMOs under investigation. The "HYGIMON" study will continue in 2023 with a focus on the presence of unauthorised transgenic rice in rice products and rice.

5.3 Nutrient intake assessment

In 2022, we returned to the data obtained in 2020/2021 and assessed the intake of selected minerals (calcium, magnesium, phosphorus, iron, zinc, sodium, potassium, selenium, iodine, copper, chromium, manganese and molybdenum). The aim was to assess the adequacy of intake for different population groups in the Czech Republic. Food consumption data from the national Study of Individual Food Consumption (SISP04) [3] and the current values of mineral content in food determined within the framework of the Monitoring System – Dietary Exposure project were used for the assessment. Based on the individual daily intake for all persons in the sample, the distribution of usual intake in each population group was determined. The resulting values were then compared with the available daily dietary intakes. In particular, the European recommendations AR, AI, Safe and AI, UL (Average Requirement, Adequate Intake, Safe and Adequate Intake, Tolerable Upper Intake Level; EFSA, 2006–2023) [4], as well as the recommendations used in the USA, i.e. EAR, AI, UL, CDRR (Estimated Average Requirement, Adequate Intake, Tolerable Upper Intake Level, Chronic Disease Risk Reduction Intake; IOM, NASEM, 1997–2019) [5], were used. In two cases, we also used the WHO Recommendation (WHO, 2012) [6, 7]. All of these recommendations are formatted to assess nutritional adequacy in population groups.

In the case of **calcium**, low intakes compared to dietary intakes were observed in all population groups assessed, with the lowest values in the elderly aged 60 years and over (Fig. 5.3.1). When compared with the European AR guideline [4], calcium intake in the elderly was low in 91% of women and 81% of men. When compared with the EAR recommendation [5], intake in this group appeared to be inadequate in 86–96% of men and 97% of women.

Fig. 5.3.1 Comparison of usual calcium intake with the recommendation for men and women aged 60 years and older



* Average Requirement AR EFSA [8]

For **magnesium**, inadequate intake was found across the entire population, with the exception of the 4–6-year age group. The lowest values were observed in the group of adolescent girls aged 15–17 years and older females, where the majority of subjects (92% and 88%, respectively) did not achieve the recommended magnesium intake according to the EAR [5].

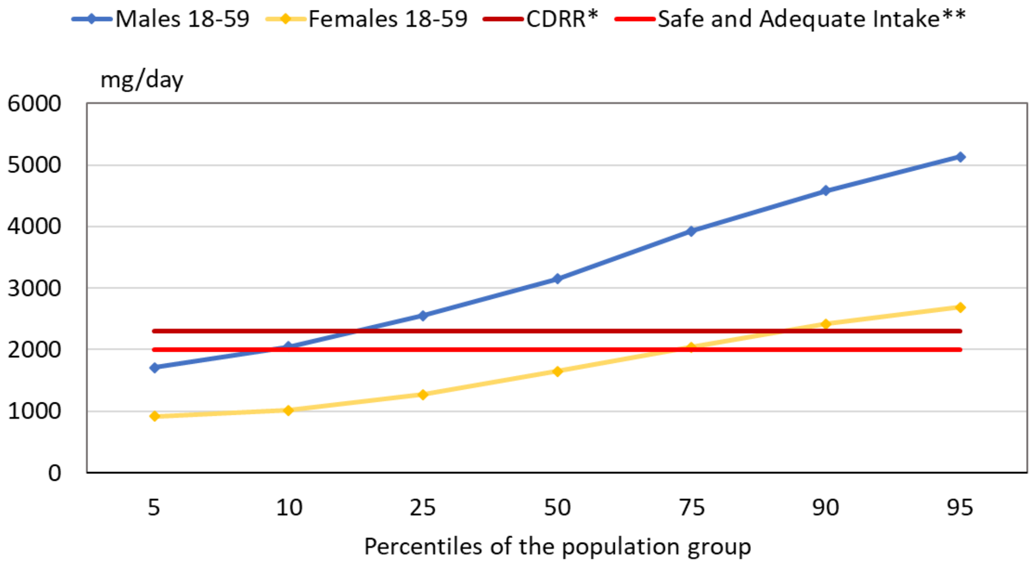
In contrast, for **phosphorus**, the risk of inadequate intake was low in all population groups studied, when compared with the European AI recommendation [4].

For **iron**, lower intake was found especially in women of childbearing age. In the population group of girls aged 15 to 17 years, the proportion of individuals with intakes below the AI recommendation [4] was 58%, and in the group of adult women aged 18–59 years, the range was 44–66%. Also, in the group of children aged 7–10 years, 54% were found to have inadequate intake.

Zinc intake was lower than the recommendations again in females (15 years of age and older) and also in older males (60+), where deficiency was observed in approximately 55% of individuals when assessed according to the EAR recommendations [5]. Using the European AR guideline [4], the situation was least favourable in women aged 15–17 years, where intake was insufficient in as many as 94% of subjects.

Excessive intake was assessed for **sodium**, due to the health risks of this condition. High intake was mainly observed in the male population (Figure 5.3.2). When compared with EFSA values, 91% of males aged 15–59 years were above the guideline value, while the proportion was lower for older males, totalling 79%. The WHO recommendation [6] for sodium is the same as the EFSA recommendation, thus the numbers of people with excessive intake were also the same. The share of individuals with a high intake were somewhat lower when compared with the US CDRR [5], with 83% of men aged 11–59 years or 63% of men aged 60 years or older exceeding this recommendation. In this context, it should be emphasized that the final value does not include salt used for food preparation and salting. The total intake will therefore undoubtedly be even higher than our survey showed.

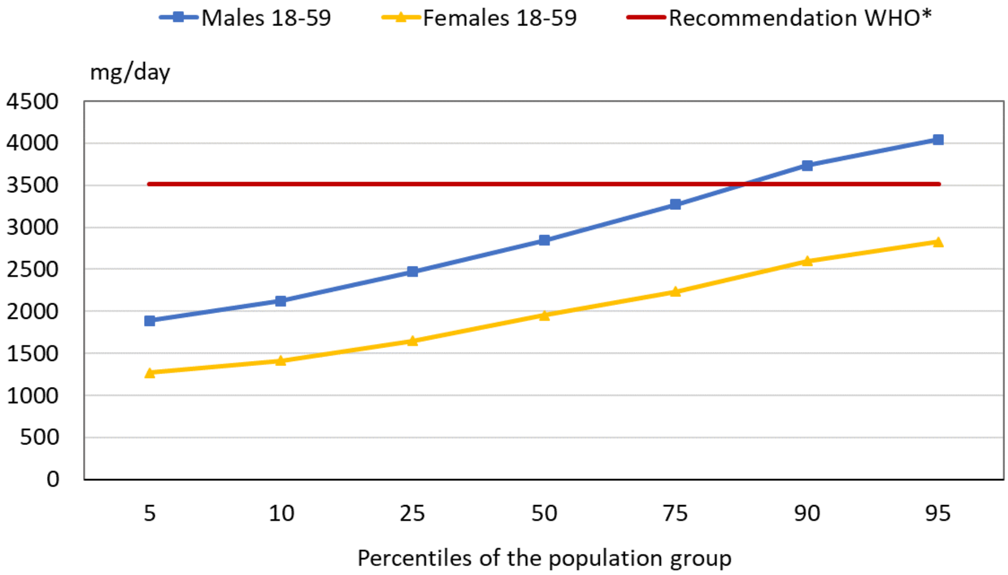
Fig. 5.3.2 Comparison of usual sodium intake with recommendations for men and women aged 18-59 years



* Chronic Disease Risk Reduction (CDRR) Intake, NASEM [9]
** Safe and Adequate Intake, EFSA [10] and WHO [6]

Contrarily, lower intakes of **potassium** were observed compared to recommendations (Fig. 5.3.3), in all population groups except for children aged 4–10 years (when compared to the European recommendation) and boys and girls aged 11–14 years (when compared to the US recommendation). The WHO recommendation [7] of 3 510 mg/person/day was not covered by almost any person in the sample for women aged 15 years and older.

Fig. 5.3.3 Comparison of usual potassium intake with the recommendation for men and women aged 18-59 years



* Recommendation WHO [7]

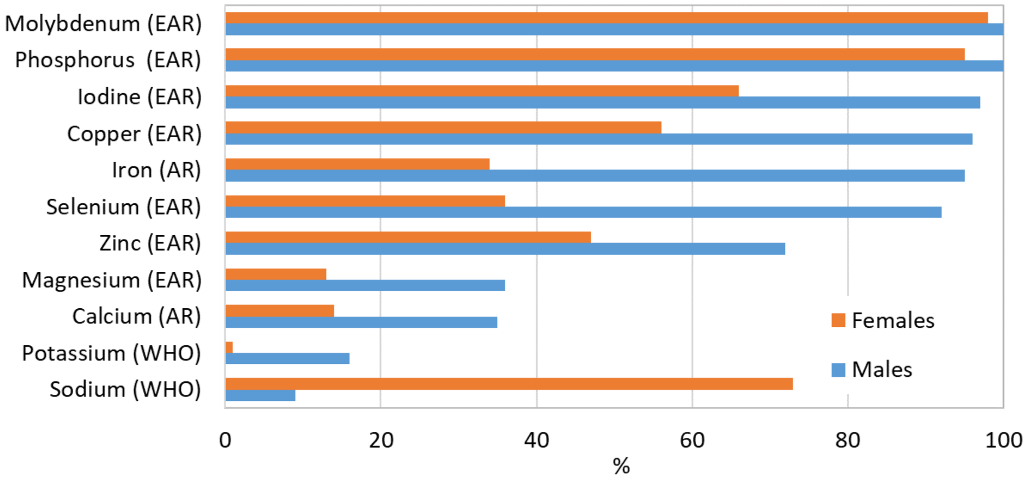
Selenium intake in the population can be assessed as low again especially in women, where 56% of adolescents, 64% of adults and 68% of elderly women do not have sufficient intake according to the EAR recommendation [5]. When **iodine** intake was assessed, a possible deficiency was confirmed in adult women, in 24–34% of individuals [5]. However, this is an assessment that does not take into account the use of iodized salt for food preparation and use of additional salt. It can therefore be assumed that the total iodine intake is higher than the values we report.

In the case of **copper**, sufficient intake was observed in children and men, whereas in women over 15 years of age it was lower in 30–44% of persons. The assessment was made using the American EAR recommendation [5]. For **chromium**, it is possible to compare the observed values with the recommendation in the format of adequate AI intake [5]. Based on this comparison, the intake in all population groups can be considered adequate. **Manganese** intake according to the European AI recommendation [4] was adequate in men. In females aged 15 years and older, mean intake values were below AI levels, where, due to the format of the recommendation, it is not possible to specify the level of risk. When assessed according to the US AI recommendation [5], the risk of inadequate intake was low in all population groups assessed. For **molybdenum**, the European AI recommendation [4] and the US EAR recommendation [5] are available. Molybdenum intake was adequate in all population groups assessed in the Czech Republic. Using the EAR recommendations, the proportion of people with low intake was only 0–2%.

The results of the survey show that, in general, the intake of many minerals is lower than the available recommendations, especially for women in all age groups (15 years and older), and also for older men

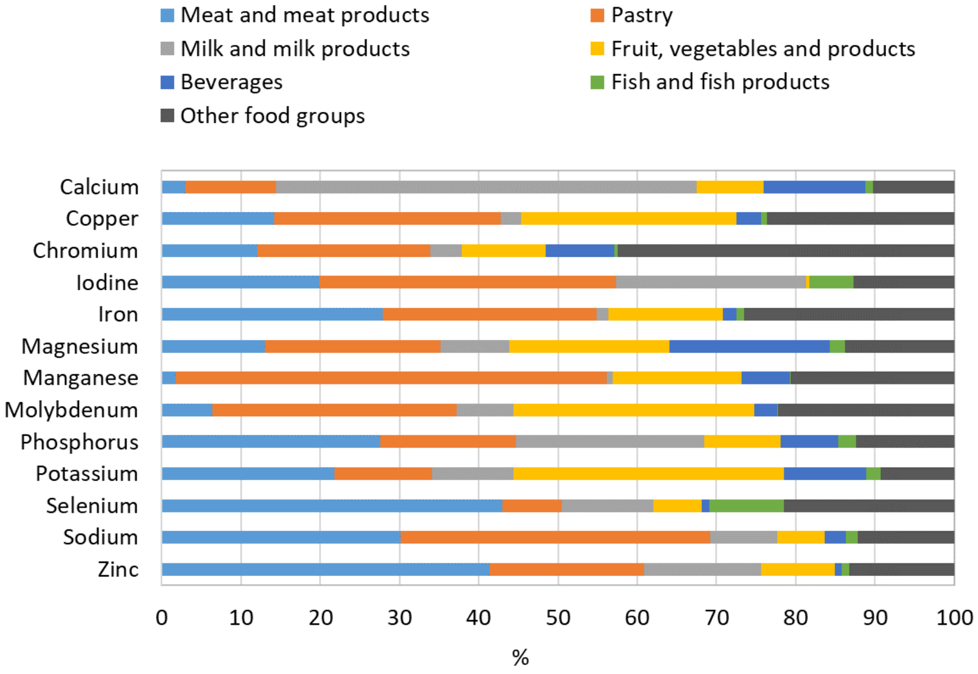
(60 years and older) (see Fig. 5.3.4). On the other hand, excessive intake was observed for sodium in men starting at the age of 11.

Fig. 5.3.4 Proportion of persons aged 18-59 with an adequate intake of minerals according to the EAR*, AR and WHO⁺ nutritional recommended intakes (in %)**



* Estimated Average Requirement, The National Academies of Sciences, Engineering, and Medicine USA
** Average Requirement, EFSA EU
⁺ Guidelines WHO

Fig. 5.3.5 The share of selected food groups in the supply of mineral substances in the population aged 18-59 years



Inadequate intake can have a number of health consequences, but these are usually described for single micronutrients, not for combined malnutrition. The view on the issue of malnutrition predicted by us would be refined in some cases by the results of biological monitoring. In adults aged 18–59 years, meat and baked goods contributed most to the intake of selected minerals, with the exception of calcium and potassium. For calcium, milk and dairy products were the main source, and for potassium, fruit and vegetables (Fig. 5.3.5). It was also found that if the consumption of each food group in the population matched the recommendations of the food pyramid, there would be a substantial improvement in most population groups.

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6. HUMAN BIOMONITORING

Key findings

National Institute of Public Health repeatedly apply data from the human biomonitoring program to determine reference values of toxic chemicals body levels for the Czech adult and child population. The reference value provides information on the level of exposure of the general population/population group to a specific chemical in a given period.

From the previously determined and current reference values, a continuous decrease in the content of monitored toxic metals (lead, cadmium and mercury) in blood and urine of children and adults can be observed.

Reference values were recently established for other monitored toxic chemicals in urine and blood serum, namely for bisphenol A (BPA), the sum of the two main metabolites of di-2-ethylhexyl phthalate (5-oxo-MEHP + 5-OH-MEHP), the sum of three congeners of polychlorinated biphenyls (PCB138 + PCB153 + PCB180), hexachlorobenzene (HCB), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).

6.1 Reference values for the body content of toxic chemicals in the Czech population

Reference values in human biomonitoring provide information on the exposure of the general, non-occupationally exposed population to toxic chemicals over a certain period of time. They are repeatedly revised over the years, given that the environmental burden and thus the magnitude of the population's exposure change over time. Reference values (RV) are then used as a comparison when identifying persons with an increased level of exposure to given substances, or in an international context. The frequency of exceeding the RV is an important evaluation element, e.g. in local studies in places with an old ecological burden or in cases of environmental accidents. However, they do not represent a criterion for health risk assessment.

During the long-term program of human biomonitoring, the National Institute of Public Health (NIPH) has set Reference values for toxic substances for the Czech adult and child population several times, namely for the years 1996 - 1998, 2001 - 2003 and 2005 - 2009 (see Tab. 6.1.1a,b) . Originally, RVs were processed for toxic metals in blood and urine. The newly revised RVs for toxic metals are shown in Tab. 6.1.1 as well. The changes of the Reference values over time indicate the development of real exposures to chemicals in the population.

Comparing the Reference values of blood lead levels for the previous periods with the determined values for 2015 and 2016 (Tab. 6.1.1a and 6.1.1.b) shows a continuous decrease in the burden in men, women and children. The Reference values of cadmium levels in the blood and urine of adults (non-smokers, since in smokers the cadmium body content depends on the number of cigarettes smoked) also decreased. In children, the RV for cadmium levels in urine, which is an indicator of long-term exposure, decreased. On the contrary, the RVs for its content in the blood, which is an indicator of current exposure, in children increased slightly compared to the previous period (0.7 µg/l for 2016 vs. 0.5 µg/l for the period 2005 - 2009).

Reference mercury values decrease over time in the blood and urine of adults and children. In women, the RV for mercury fell significantly especially in urine (12 µg/g creatinine for the period 2001 - 2003 vs. 4.8 µg/g creatinine for 2015), where its content indicates a longer-term burden, especially by inorganic forms and mercury vapours.

Tab. 6.1.1a Reference values of toxic metals in blood since the beginning of the national human biomonitoring program, 1996 - 2016

	Population group	Blood, in µg/l				
		1996–1998	2001–2003	2005–2009	2015	2016
Cadmium	Adults, non-smokers	1.2	1.1	1	0.8	
	Children	0.8		0.5		0.7
Lead	Males	95	80	80	53	
	Females	80	65	50	38	
	Children	65	55	45		26
Mercury	Adults, total		3.5		2.5	
	- Males		3.1	2.6	2.8	
	- Females		4	3	2.3	
	Adults with low fish consumption[1]			2.6	1.4	
	Children, total		1.5	1.4		1
	Children with low fish consumption[1]			1.3		0.9

[1] fish consumption frequency: never or less than 1x monthly

Tab. 6.1.1b Reference values of toxic metals in urine since the beginning of the national human biomonitoring program, 1996 - 2016

	Population group	Urine, in µg/g creatinine (in µg/l)			
		2001–2003	2005–2009	2015	2016
Cadmium	Adults, non-smokers	1.2	0.9 (1.3 µg/l)	0.6 (0.5 µg/l)	
	Children		0.8 (1.0 µg/l)		0.3 (0.4 µg/l)
Mercury	Adults, total	6.8	5.7 (9.0 µg/l)	4.4 (6.3 µg/l)	
	- Males	5.4		4.0 (5.4 µg/l)	
	- Females	12		4.8 (8.9 µg/l)	
	Adults with low fish consumption[1]			4.2 (5.3 µg/l)	
	Children, total	4.2	1.8 (3.0 µg/l)		1.3 (1.2 µg/l)
	Children with low fish consumption[1]				1.0 (1.2 µg/l)

[1] fish consumption frequency: never or less than 1x monthly

A decrease in urine mercury RV is also evident in children (4.2 µg/g creatinine for the period 2001 – 2003 vs. 1.3 µg/g in 2016). Likewise, the RV of blood mercury decreases over time for both adult and child populations. The amount of mercury in the body, especially in the blood, is affected by the consumption of certain types of fish. Therefore, lower reference values are obtained for adults and children with low reported consumption of fish and seafood (frequency never or less than 1x per month) than for these population groups as a whole.

With the gradually expanding spectrum of toxic chemicals in human biomonitoring, it was possible to establish reference values for organic compounds: bisphenol A (BPA) in children, and two main metabolites of di-2-ethylhexyl phthalate: 5-oxo-monoethylhexyl phthalate (5-oxo-MEHP) and 5-hydroxy-monoethylhexyl phthalate (5-OH-MEHP) in children and adults. The Reference values were also established for toxic chemicals in the blood serum of adults: the sum of three congeners of polychlorinated biphenyls: ∑PCBs (138+153+180), hexachlorobenzene (HCB), perfluorooctanoic acid (PFOA) and for perfluorooctane sulfonate (PFOS). These RVs are shown in Tab. 6.1.2 and 6.1.3.

Tab. 6.1.2 Reference values (RVs) of toxic chemicals in blood serum for the period 2015 – 2020

	Population group	Age (years)	Time period	No.of samples	RV (µg/l)
∑PCBs (138+153+180)[1]	Adults	18-64	2015	300	4.9
HCB[2]	Adults	18-64	2015	300	0.4
PFOA[3]	Adults	18-65	2018-2020	637	3.0
PFOS[4]	Adults	18-65		637	12.7

[1] the sum of three congeners of polychlorinated biphenyls

[2] hexachlorbenzene

[3] perfluorooctanoic acid

[4] perfluorooctane sulfonate

Tab. 6.1.3 Reference values (RVs) of toxic chemicals in urine for the Czech population and the periods 2016 and 2018

	Population group	Age (years)	Period	No. of samples	RV (µg/l)	RV (µg/g creat.)
Bisphenol A	Children	*5 - 10*	*2016*	*367*	7.3	6.8
S 5-oxo- + 5-OH-MEHP[2]	Adults	*18-65*	*2018*	*311*	55	50
	Children	*5 - 10*	*2016*	*377*	104	91

6.2 Harmonization of human biomonitoring in Europe – PARC project

Efforts to harmonize human biomonitoring in Europe, initiated by the COPHES/DEMOCOPHES project in the years 2009 - 2012, continue as part of the large-scale project Partnership for the Assessment of Risks from Chemicals 2022-2029 (PARC) supported by the European Commission from the HORIZON Europe program. The studies of the Czech child and adult population, which are planned for the period 2024 to 2026, will be realized with the support of the Ministry of Health.

By participating in this project, we build on the experience with the national program of human biomonitoring. The results will make it possible to compare how burdened the residents of the Czech Republic are compared to other European countries. The collected data will then provide objective information on the current exposure of Europeans and its sources, and on the possible health effects of widespread toxic substances. The outputs of the project should help enforce greater control, or limiting the entry of at least the most dangerous toxic chemicals known to date into the environment.

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7. POPULATION HEALTH SURVEYS

Key findings

Analysis of data from the HELEN and EHES cross-sectional studies has allowed us to track trends in obesity and abdominal obesity in the middle-aged population over the past 20+ years.

Between 1998 and 2019, an increase in the proportion of overweight and obese individuals was observed, and an increase in the proportion of individuals at high cardiovascular risk as determined by waist circumference.

There was an increase in average of waist circumference values across BMI categories.

Based on the specific threshold-values for each BMI category it was found, that the risk of abdominal obesity does not apply to the obese alone.

Abdominal obesity is also a significant risk for normal weight and overweight individuals.

Remark: Limitations of these analyses are the long-term declining response rates to health examinations and the relatively small numbers of respondents in some age categories in the EHES.

7.1 Trends in obesity prevalence in the middle-aged population 1998–2019

Overweight and obesity represent one of the most important health risks of contemporary lifestyle. They cause a range of health problems, such as hypertension, high level of cholesterol, diabetes, cardiovascular diseases, kidney diseases, non-alcoholic fatty liver diseases, chronic respiratory diseases, including sleep apnoea, and 13 types of cancer. They also bring mechanical risks, joint and spinal strain, walking problems, and consequently reduced self-sufficiency in older age. Obese persons are also at increased risk of serious consequences of COVID-19 [1,2].

The prevalence of overweight and obesity in adulthood (as measured by Body Mass Index - BMI) has been increasing over the long term in all populations worldwide. According to a recent WHO report, overweight and obesity affect 60% of the European population, and obesity is responsible for 13% of all deaths in this region [3]. The population of Czechia is not an exception; on the contrary, it is one of the populations most burdened by overweight and obesity in Europe.

The aim of this survey is to assess the evolution of the prevalence of overweight and obesity in Czechia using a combination of two indicators, namely BMI and waist circumference. A number of studies show that the assessment of overweight and obesity using BMI alone is insufficient to estimate and manage the cardio-metabolic risk that increases with abdominal obesity [3]. At the same time, "alternative" waist circumference thresholds based on BMI category will presented that better predict the risk of cardiovascular diseases.

The survey is based on the HELEN and EHES cross-sectional population-based surveys conducted at the National Institute of Public Health. The HELEN study was carried out in an urban population aged 45–54 years in three stages (stage 1: 1998–2002, stage 2: 2004–2005, and stage 3: 2009–2010); more information about the study can be found in previous summary reports or in [4]. EHES was conducted in the population aged 25–64 years, in 2014–2015 and 2019–2020, further information on the design and conduct of the survey can be found in [2,5].

Both studies included a questionnaire survey and a health examination, where anthropometric data were collecting, among others. Health examination data for the age group 45–54 years were using for subsequent comparison. The number of respondents varied in each year, see Tab. 7.1.1. for details. All outcomes needed to be calculated within each stage to avoid bias due to differently sized groups in each one. Thus, using these two data sources allows a comparison of the trends in obesity and abdominal obesity over the last 20 years in the Czech Republic in the middle-aged population, when the risk of health complications due to overweight and obesity is already increasing.

Tab. 7.1.1 Numbers of respondents aged 45–54 in the studies included in the analyses

Title of the study	Time period	No. of men	No. of women	Total no.
HELEN I	1998–2002	1 545	2 048	3 593
HELEN II	2004–2005	762	1065	1827
HELEN III	2009–2010	304	436	740
EHES 2014	2014–2015	106	156	262
EHES 2019	2019–2020	110	170	280

Excess adiposity is most commonly measured by an individual's height and weight and expressed using the body mass index (BMI) value, which is the ratio of weight in kg to height in m^2 (kg/m^2). It is already evident from the calculation that BMI does not directly measure adiposity. Nevertheless, for practical reasons (non-invasiveness, ease of determination, or even knowledge of the anthropometric data by the individuals themselves in the population) it has been used for a long time in clinical and monitoring practice, i.e. at the individual and population level to determine overweight and obesity. The cut-off values for overweight ($BMI \geq 25\ kg/m^2$) and obesity ($BMI \geq 30\ kg/m^2$) in adults are independent of sex, age and often ethnicity. This is one of the main criticisms of BMI, as the same BMI does not mean the same amount of body fat in different individuals. Despite these caveats, BMI is considered adequate for the assessment and monitoring of populations, not least because correlations have been confirmed between BMI and total body fat, as well as between BMI and abdominal adiposity [3].

Abdominal adiposity poses a more significant health risk to individuals than fat stored in other parts of the body (e.g. subcutaneous fat), especially in the case of visceral fat, which is stored in the abdominal cavity and surrounds the organs. BMI cannot distinguish between visceral and subcutaneous fat. Abdominal adipose tissue is determined using the measurement of waist circumference and is strongly related to the amount of visceral fat. Changes in waist circumference represent a separate health risk independent of BMI. The high-risk threshold values for abdominal obesity are gender-specific and lower in women (waist circumference ≥88 cm in women vs ≥102 cm in men). The combination of the two aforementioned indicators is considered a significantly more robust predictor of future health risks than the use of one or the other [3].

Fig. 7.1.1 BMI categories – distribution by sex and stage of the survey, population 45–54 years

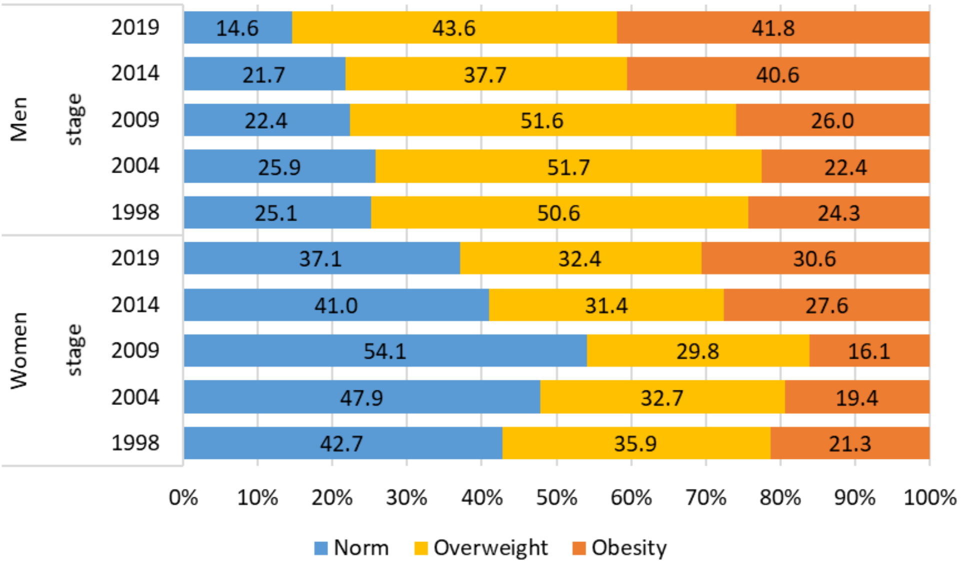
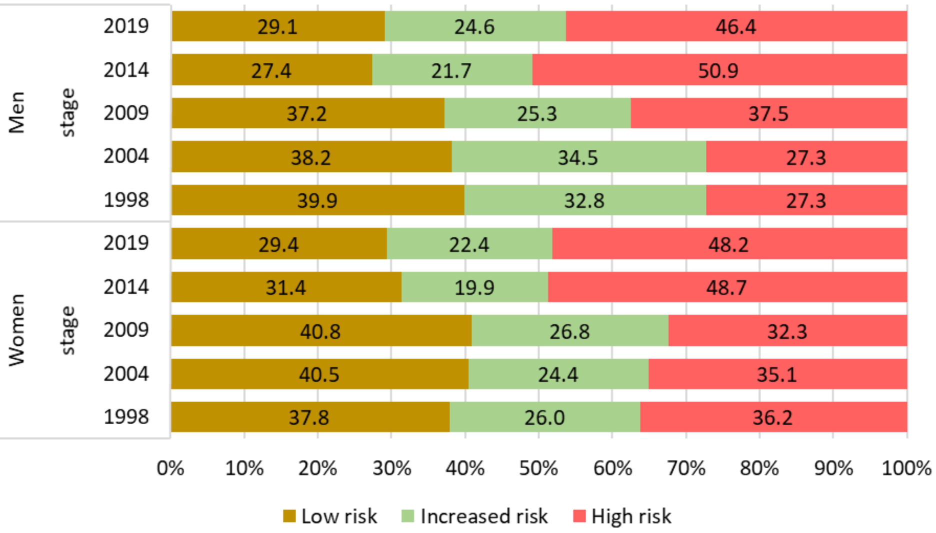


Fig. 7.1.1 shows the distribution of BMI categories by sex at each monitored stage. For both men and women, there was a significant increase in the proportion of overweight and obese individuals, and a significant decrease in those of normal weight. In 2019, normal weight was measured in only 15% of men and 37% of women. Also, for the distribution of categories according to risk determined by waist circumference (Fig. 7.1.2), an increase in the proportion of persons at high risk and a decrease in those at low risk can be observed. In 2019, almost half of the population of both men and women were already in the high-risk range.

Fig. 7.1.2 Risk categories by waist circumference - distribution by sex and stage of survey, population 45–54 years



Despite the strong association between waist circumference and BMI at the population level, a number of studies show that in many populations waist circumference increases more than would be expected given increasing population BMI value [1]. In principle, this can be imagine as an increase in average waist circumference across BMI categories, as confirmed e.g. the Canadian study by Janssen et al. [6] or the international comparison by Albrecht et al. [7]. Thus, the relative increase in waist circumference was to be greater than the relative increase in BMI, which was confirmed in a number of populations.

Based on our data, we did not observe this trend in the whole population, with a 5% increase in both the population BMI and waist circumference values in both men and women between 1998 and 2019 (see Tab. 7.1.2). However, when individual BMI categories are considered, an increase in population values of the waist circumference can be already observed. For example, waist circumference has increased by 1 cm for women in the BMI norm category, 1.2 cm in the overweight category and 4 cm in the obese category (see Figs. 7.1.3 and 7.1.4). The failure of BMI to detect changes in waist circumference and thus the obesity phenotype again points out the limitations of this indicator.

Tab. 7.1.2 Population values of BMI and waist circumference at each stage, men, women, 45–54 years

Time period	BMI, men (kg/m^2)	BMI, women (kg/m^2)	Waist circumference men (cm)	Waist circumference women (cm)
1998–2002	27.7	26.8	96.7	85.0
2004–2005	27.5	26.2	96.5	84.4
2009–2010	27.8	25.6	98.5	84.3
2014–2015	29.7	27.2	102.4	89.0
2019–2020	29.3	27.9	101.0	89.2
Index of change	105.6%	104.4%	104.4%	104.9%

Fig. 7.1.3 Average waist circumference by BMI category and stage of the survey, men 45–54 years

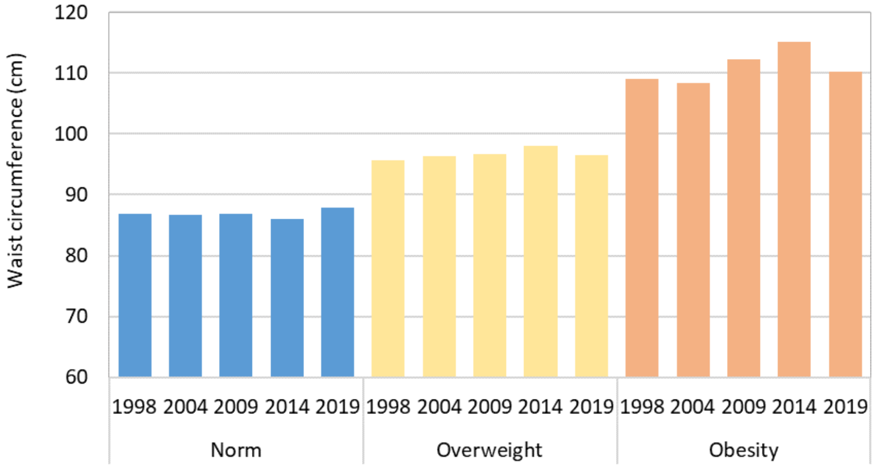
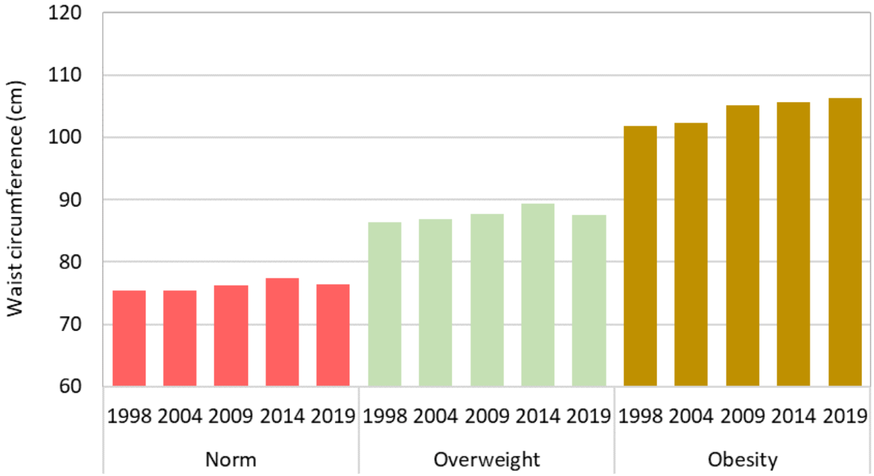


Fig. 7.1.4 Average waist circumference by BMI category and stage of the survey, women 45–54 years



An interesting and hitherto little used approach is to determine abdominal obesity within each BMI category (Tab. 7.1.3). It is common to see the threshold for high cardiovascular risk defined as waist circumference ≥102 cm in men and ≥88 cm in women (or increased risk of 94–101 cm in men and 80–87 cm in women). However, this value is the same regardless of BMI. The definition of these values was based on cross-sectional studies and essentially corresponded to the average waist circumference of persons with BMI=30 kg/m^2, which is the threshold value for this indicator for obesity [1]. Based on our data, over 90% of obese individuals have a waist circumference above 102 or 88 cm, and on the other hand, normal weight individuals rarely fall into the high-risk category of waist circumference. Thus, this approach is actually only an alternative way of determining obesity, and some studies have confirmed that the threshold values thus defined are insufficient to identify risk from abdominal obesity. Ardern et al. [8] have therefore developed waist circumference risk threshold values for different BMI categories (Tab. 7.1.3) and thus refined the estimation of cardiovascular event risk and the estimation of risk of death compared with the traditional threshold values commonly used.

Tab. 7.1.3 Threshold values of waist circumference for determining risk by BMI category

Category of BMI (kg/m^2)	Waist circumference (cm)	
	Men	Women
Norm (18.5–24.9)	≥ 90	≥ 80
Overweight (25.0–29.9)	≥ 100	≥ 90
Obesity I (30.0–34.9)	≥ 110	≥ 105
Obesity II and III (≥35)	≥ 125	≥ 115

Tab. 7.1.4 contains the proportions of people with an above-threshold waist circumference value in each BMI category (obesity categories I–III have been merged). In contrast to the standard definition of threshold values of waist circumference it can be observed that being overweight and obese does not automatically imply a risk of abdominal obesity and, vice versa, normal weight is not protective against abdominal obesity. In 2019, abdominal obesity was diagnosed at one-third of normal-weight women and at one-fifth of normal-weight men. In terms of trends, with the exception of normal-weight men, an increase in the proportion of people with an above-threshold waist circumference value can be observed between 1998 and 2019 in all categories.

Tab. 7.1.4 Proportion of women and men in each BMI category with an above-threshold waist circumference values (in %)

	Category of BMI	Year of the study				
		1998	2004	2009	2014	2019
Women	Norm	24.2	24.7	30.1	29.7	33.3
	Overwieght	31.7	34.2	37.7	51.0	32.7
	Obesity	21.5	22.7	34.3	37.2	28.9
	Total	26.3	27.4	33.0	38.5	31.8
Men	Norm	36.3	35.0	27.9	30.4	18.8
	Overwieght	24.8	30.5	31.9	35.0	33.3
	Obesity	27.7	23.4	48.1	41.9	39.1
	Total	28.4	30.1	35.2	36.8	33.6

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8. OCCUPATIONAL HEALTH RISKS AND THEIR CONSEQUENCES

Key findings

In 2022, there were over half a million employees registered in the high-risk occupation category, with over 13,000 individuals in the highest category (highly risky occupation). Employees are most commonly exposed to risks of excessive physical strain, improper working posture and noise. The highest number of employees in risk occupation categories is traditionally registered in the Moravian-Silesian region (over 100 000 individuals in 2022).

In 2022, a total of 7 439 cases of occupational diseases were diagnosed (5 551 in women and 1 445 in men), with an incidence rate of 158 cases per 100 000 employees in the civil sector. This marked a continued increase from the previous year. The persistent COVID-19 epidemic was the main reason, accounting for over 90% of all cases of occupational diseases (a total of 6 748 cases). However, in most cases, these were diseases that occurred in the years 2020 and 2021.

More than half of the occupational diseases (60%) occurred during work that was not classified as high-risk category.

8.1 Monitoring exposure based on job and workplace categorisation data

The data source for monitoring exposure to work-related risk factors and conditions is the Information System of Job Categorisation (IS KaPr). Within this system, every employer is required to assess the risks and classify the jobs performed at their workplaces into one of the 4 categories, depending on the occurrence and severity of the risk factors.

According to the data from IS KaPr, as of June 15, 2023, a total of 2 368 780 individuals were categorised into all job categories (2, 2R, 3, 4), which is 466 540 fewer than the previous period (as of June 15, 2022). There were 543 597 individuals registered in the high-risk occupation category (categories 2R, 3, 4), which is a decrease of 15 185 individuals. In category 4, which represents highly risky workplaces, there were 13 363 individuals categorised in the Czech Republic, a decrease of 72 employees compared to the previous period.

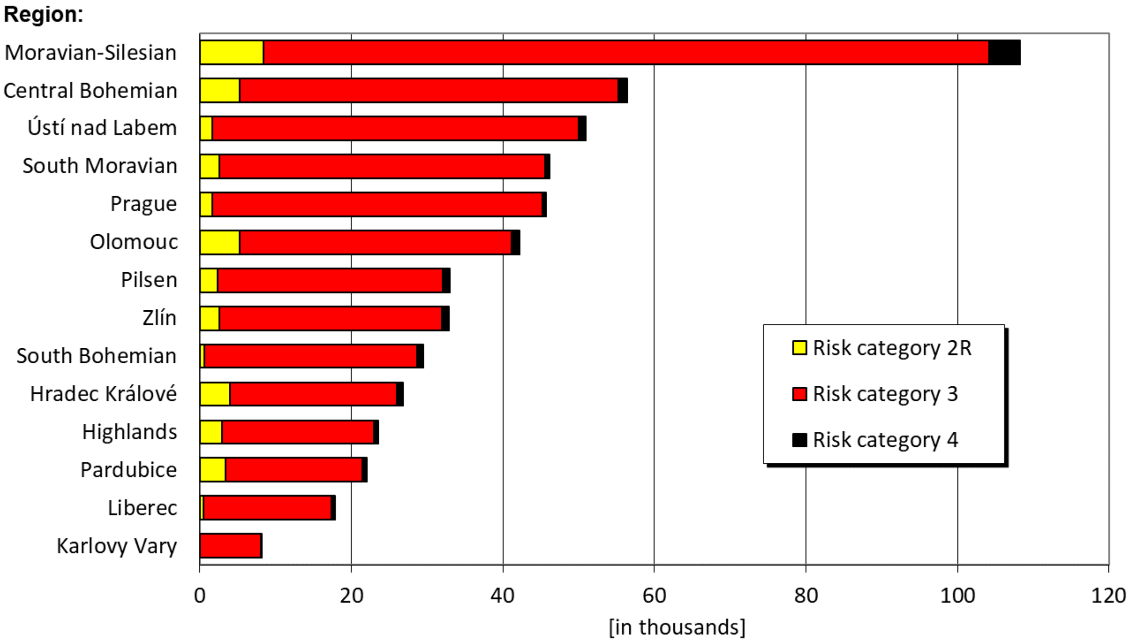
Tab. 8.1.1 Number of exposed employees in job categories by regions as of June 15, 2023

Region	Categories 2+2R+3+4		Category 2		Category 2R		Category 3		Category 4	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Prague	247 977	105 928	202 281	93 006	1 636	570	43 551	12 349	509	3
South Bohemian	130 161	53 811	100 668	42 623	576	401	28 098	10 764	819	23
South Moravian	266 837	109 802	220 636	92 162	2 640	1 645	42 987	15 955	574	40
Karlovy Vary	66 262	29 753	58 067	27 211	57	7	8 038	2 529	100	6
Hradec Králové	125 398	51 378	98 514	42 039	4 044	1 429	21 987	7 825	853	85
Liberec	91 523	39 123	73 663	33 101	511	84	16 838	5 911	511	27
Moravian-Silesian	287 796	110 145	179 562	78 887	8 423	4 070	95 804	26 865	4 007	323
Olomouc	159 248	62 456	117 000	48 677	5 297	2 161	35 916	11 495	1 035	123
Pardubice	118 371	47 328	96 353	41 590	3 449	664	17 987	5 020	582	54
Pilsen	157 717	64 020	124 707	54 529	2 415	1 402	29 627	8 053	968	36
Central Bohemian	276 874	103 590	220 417	85 731	5 242	2 037	50 067	15 773	1 148	49
Ústí nad Labem	186 894	79 179	135 996	60 584	1 676	962	48 348	17 573	874	60
Highlands	122258	47278	98686	41655	2993	895	20045	4716	534	12
Zlín	131 445	53 663	98 614	40 334	2 652	1 148	29 330	12 034	849	147
Not specified	19	0	19	0						

The current number of employees categorised according to individual job categories in the regions is presented in Tab. 8.1.1 and Fig. 8.1.1. The highest number of exposed employees in high-risk occupation categories (2R, 3, 4) is in the Moravian-Silesian region, with over 100 000 individuals, representing a decrease of approximately 9 000 employees compared to the previous period (as of June 15, 2022). Over 50 000 individuals were registered in the Central Bohemian and Ústí nad Labem regions. Approximately 45 000 individuals were registered in Prague and the South Moravian region.

The highest number of employees in all job categories (2, 2R, 3, 4) was recorded in the risk factor category Physical Strain - 1 516 121 individuals (2.4% increase compared to the previous period), Work Position - 1 121 736 individuals (increase of 1.99%), and Noise - 911 262 individuals (0.45% increase).

Fig. 8.1.1 Number of employees registered in the high-risk occupation categories by regions as of June 15, 2023



Source: Information System of Job Categorisation

In the high-risk occupation categories (2R, 3, 4), the most recorded employees are at risk due to the Noise factor - 283 158 individuals (0.38% increase compared to the previous period), Physical Strain - 147 132 individuals (6.8% increase), Vibration - 71 306 individuals (0.29% increase), and Dust - 64 152 individuals (decrease of 1.17%), see Tab. 8.1.2.

These numbers of recorded individuals cannot be considered static. The classification of jobs into risk categories and their records in IS KaPr depend not only on changes in job duties and work technology but also on the ability to quickly respond to these changes. There is also ongoing updating of the legislative framework.

Tab. 8.1.2 Number of recorded employee exposures by factors, as of June 15, 2023

Factor	Categories 2+2R+3+4		Category 2		Category 2R		Category 3		Category 4	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Biological factors	236 663	174 960	203 468	151 499	9 546	6 283	23 585	17 120	64	58
Physical strain	1 516 121	635 909	1 368 889	554 430	8 847	5 179	138 374	76 300	11	0
Noise	911 262	200 583	628 625	159 989	21 746	3 864	259 351	36 700	1 540	30
Chemicals	374 095	174 862	346 796	166 097	8 039	3 697	16 792	4 743	2 468	325
Ionizing radiation	50	25	50	25						
Non-ionizing radiation	43 596	5 698	11 058	1 473	265	13	32 273	4 212		
Work at elevated pressure	284	79	167	55	3	2	113	22	1	0
Working posture	1 217 136	493 409	1 145 298	462 347	1 667	999	70 171	30 063		
Dust	306 518	51 968	242 393	44 502	5 368	1 289	53761	5 739	4 996	438
Psychical strain	923 959	381 777	885 183	368 992	1 786	681	36 990	12 104		
Vibration	279 941	24 344	208 687	20 998	5 906	423	59 204	2 719	6 144	204
Selected works	613	248	599	239	14	9				
Cold strain	290 033	65 249	284 319	64 206	27	2	5 687	1 041		
Heat strain	161 040	40 507	147 646	38 559	683	108	12 608	1 837	103	3
Eye strain	240 250	114774	223744	108 595	123	46	16 383	6 133		
Not specified	16	10	12	10	4	0	0			

8.2. Monitoring health effects of occupational risk factors - National Registry of Occupational Diseases

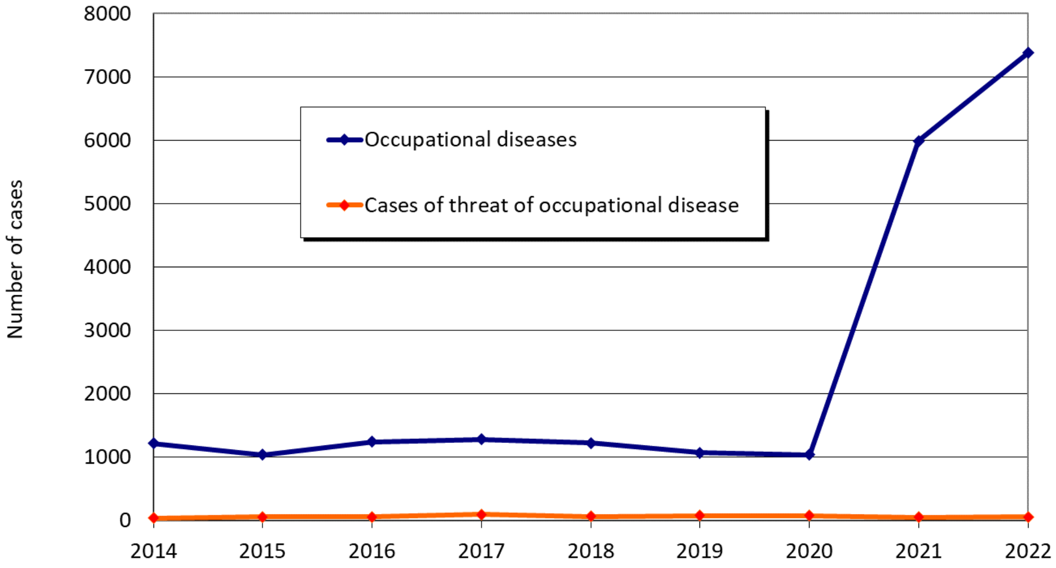
The occurrence of occupational diseases and the risk of occupational diseases is one of the indicators of population health status and working conditions. Occupational disease is defined in government regulation No. 290/1995 Coll., which establishes a list of occupational diseases, as amended (last amendment was made by government regulation No. 506/2021 Coll. and government regulation No. 451/2022 Coll.). Occupational diseases are considered diseases that arise from adverse effects of chemical, physical, biological, or other harmful influences, if they occur under the conditions specified in the list of occupational diseases. Occupational disease also includes acute poisoning caused by adverse effects of chemical substances. According to the Labour Code, the threat of occupational diseases refers to changes in health that have occurred due to the unfavourable conditions under which occupational diseases arise, but do not reach a level of health impairment that can be assessed as an occupational disease, and where further work under the same conditions would lead to the occurrence of an occupational disease.

In the Czech Republic, in 2022, there was an increase in reported occupational diseases mainly caused by the COVID-19 epidemic. A total of 7 439 occupational diseases were diagnosed in 6 996 individuals (5 551 women and 1 445 men), including 7 383 occupational diseases and 56 cases at threat of occupational diseases. The incidence of occupational diseases was 158 cases per 100 000 employees in the civilian sector.

Compared to 2021, the total number of reported occupational diseases increased by 1 396 cases, which represents a 23% increase (Fig. 8.2.1). Consequently, the incidence of occupational diseases increased by 29 cases per 100 000 employees (from 129 cases per 100 000 in 2021). From 2013 to 2020, before the COVID-19 pandemic, the incidence ranged between 23 and 30 cases per 100 000 employees. The development of reported occupational diseases and cases at risk of occupational diseases from 2014 to 2022 is shown in Tab. 8.2.1.

In the course of the year, for 422 individuals, more than one occupational disease, cases at threat of occupational diseases, or their combination were reported. The most common combinations were two diseases - COVID-19 (299 cases) and carpal tunnel syndrome in the right and left hand, occurring from working with overloaded limbs or vibrating tools (75 cases).

Fig. 8.2.1 Development of newly reported cases of occupational diseases in the Czech Republic, 2014 - 2022



Source: National Registry of Occupational Diseases

Tab. 8.2.1 Reported cases of occupational diseases and threat of occupational disease, 2014 - 2022

	2022	2021	2020	2019	2018	2017	2016	2015	2014
Occupational diseases	7 383	5 991	1 035	1067	1 222	1 278	1 242	1 035	1 214
Threat of occupational diseases	56	52	77	78	60	92	55	57	36
Total of occupational diseases	7 439	6 043	1 112	1 145	1 282	1 370	1 297	1 092	1 250
Men	1 445	1 289	438	475	531	566	678	542	598
Women	5 551	4 702	514	476	503	551	619	639	467
Number of patients	6 996	5 890	952	951	1 034	1 117	1 051	911	1 065
Incidence rate per 100 000 employees with sickness insurance	157.6	128.9	23.7	24.2	27.1	29.3	28.4	24.4	28.3

Occupational Diseases

The highest number of occupational diseases was reported in the Olomouc Region (a total of 1 458 cases, 20% of all reported cases). The most common category of occupational diseases in this region was communicable and parasitic diseases (a total of 1 401 cases, of which COVID-19 accounted for 1 395 cases).

Compared to 2021, the number of reported occupational diseases increased in 12 regions, ranging from 3 to 411 cases. The largest increase was observed in the Olomouc Region, while the smallest increase occurred in the Central Bohemian Region. The Moravian-Silesian and Zlín Regions recorded a decrease in reported diseases by 237 and 100 cases, respectively.

The majority of occupational diseases (over 90%) were caused by infectious and parasitic diseases, for details see Tab. 8.2.2.

8.2.2 Occupational diseases and cases of threat of occupational disease according to the chapters of the list of occupational diseases, 2019-2022

		2022		2021		2020		2019	
			%		%		%		%
I.	**Diseases caused by chemicals**	3	0.04	2	0.03	5	0.5	6	0.6
II.	**Diseases caused by physical factors**	429	5.8	400	6.7	480	46.4	527	49.4
III.	**Diseases of the respiratory tract, lungs, pleura and peritoneum**	125	1.7	85	1.4	125	12.1	172	16.1
IV.	**Diseases of the skin**	67	0.9	80	1.3	131	12.7	168	15.7
V.	**Communicable and parasitic diseases**	6 814	91.6	5 473	90.6	294	28.4	193	18.1
VI.	**Diseases caused by other factors and agents**	1	0.01	3	0.05	0	0	1	0.1

Among the individual diagnoses, as in 2021, COVID-19 was the most commonly reported (6 748 cases, which is 91% of all cases), with healthcare and social workers being the most affected. In most cases, COVID-19 manifested as a viral illness with flu-like symptoms or respiratory tract inflammation, with COVID-19 pneumonia occurring in 6% of cases, and seven cases resulting in death due to respiratory or multiorgan failure.

Over 80% of COVID-19 cases reported to the National Register of Occupational Diseases in 2022 originated from March 2020 to December 2021. Cases developed in 2022 have been reported less frequently so far, mainly due to the several-month interval between the onset of COVID-19, its recognition as an occupational disease, and its reporting to the National Register.

The second most frequently reported diagnosis was carpal tunnel syndrome, with a total of 237 cases, followed by joint arthrosis (56 cases), contact allergic dermatitis (56 cases), coal workers pneumoconiosis (55 cases), scabies (41 cases), bronchial asthma (38 cases) and epicondylitis of the humerus due to overuse of the extremities (25 cases).

Asbestos was confirmed as the cause of occupational diseases six times (three cases of pleural mesothelioma, two cases of lung cancer, and one case of asbestosis). Skin cancer (basal cell carcinoma) caused by ionising radiation was reported three times in former uranium mine workers. One case of lung cancer caused by coking plant gases was diagnosed in a worker.

Workers in the section of economic activity Q - Health and social care (a total of 6 753 cases) and in the section "C - Processing industry" (395 cases) were most commonly affected by occupational diseases.

In the economic activity sector Q86 - Healthcare, a total of 5 892 cases were recognised, comprising mainly infectious and parasitic diseases (5 881 cases), including 5 854 cases of COVID-19 and 17 cases of scabies. Other occupational diseases in this sector were less frequently identified.

According to the classification of work determined by the employer, 60% of occupational diseases (a total of 4 361 cases) occurred in workers performing non-hazardous work (categorised as level 1 or 2). A total of 1 265 cases (17%) occurred in workers performing work categorised by the employer as being within the risk categories 2R to 4. In 1 757 cases (24%) the work categorisation by the employer has not as yet been performed, or it involved work that is not categorised.

In jobs categorised by the employer as non-hazardous, the most common types of occupational diseases were infectious and parasitic diseases (4 165 cases), followed by skin diseases (52 cases) and allergic respiratory diseases (a total of 15 cases).

Occupational diseases that occurred due to the influence of physical factors (noise, vibration, and overuse of extremities) in originally non-hazardous jobs categorised by the employer as level 1 or 2 remain a problem. In 2022, there were a total of 122 cases. During investigations by the General Health Insurance Company, it was determined that the conditions for the occurrence of occupational diseases were met in these cases, meaning that the work categorisation by the employer was incorrect.

Threat of occupational disease

In 2022, a total of 56 cases of occupational disease threat were reported, affecting 35 males and 21 females. The majority of occupational disease threats were reported in the Moravian-Silesian Region (27 cases, or 48.2%). The most affected were workers in the motor vehicle manufacturing industry (a total of 12 employees, or 21.4%).

The most commonly diagnosed occupational disease threats were peripheral nerve damage due to prolonged excessive one-sided limb strain (25 cases, or 44.6%) and peripheral nerve damage due to vibration (20 cases, or 35.7%). Light carpal tunnel syndrome was diagnosed in 45 cases within these two categories.

A detailed analysis of occupational diseases reported in 2022 is available in Czech at https://szu.cz/publikace/data/registr-nemoci-z-povolani/nemoci-z-povolani-v-ceske-republice/.
Further information regarding occupational diseases can be obtained upon request at registrnzp@szu.cz.