# Air Pollution and Related Morbidity and Mortality in Hungary between 2005 and 2014

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## Abstract

According to a 2015 estimate, 6.2% of the total burden of disease (disability-adjusted life years, DALY) can be attributed to environmental risk factors in Hungary (this is lower than the global average of 11.8%). Air pollution is the most important environmental risk factor being responsible for around 8% of total mortality. Among air pollutants, particulate matter (PM), i.e. small particle pollution is the one with the most significant health effects2014. . About 40% of $PM_{10}$ comes from residential heating. According to the 2011 Hungarian census, about 20% of the households used coal, wood or oil for heating. Particulate matter pollution has shown a decreasing trend in the past 10 years, except for 2011. The population-weighted annual average concentration decreased from 41.5 μg/m$^3$ (2005) to 26.9 μg/m$^3$ by 2015 in Hungary.

The annual average $PM_{10}$ concentrations rarely exceeded the Hungarian limit value (40 μg/m$^3$), but there were very few stations that complied with the 20 μg/m$^3$ annual limit value recommended by the WHO. In most cases the 24-hour average concentrations reached much higher levels than allowed by the relevant legislation. It would be important to sensitize the entire Hungarian population that the proper maintenance of motor vehicles, choosing the proper combustion method, and installing and using all the necessary filters during industrial production are of primary importance. *Air hygiene index* was developed to characterize the short-term health risk of air pollution and to help provide the public with understandable information. In the winter the high $PM_{10}$ concentration plays a dominant role in the air hygiene index, while in the summer ozone pollution is the most important factor. Comparing the heating periods of 2011 and 2015 based on the index, in 2011 at every station in the capital the values of the analysed components were more often above the limit value than in 2015. Several chronic diseases can be related to the exposure to the ambient and indoor air pollution. This pollution plays an important role among the multiple causes of allergic rhinitis, asthma and chronic obstructive pulmonary diseases (COPD). According to the official statistics the incidence of asthma and hay-fever has been decreasing in the latest years, however, this decrease can be attributed to the fact that a considerable proportion of patients did not enter the pulmonary care system. The incidence of COPD did not change in the latest years, but the prevalence showed an increasing tendency. The mortality and morbidity due to cardiovascular diseases decreased in both sexes, however, it is still much higher than the EU average. The mortality due to cancer of the trachea, the bronchi and the lungs declined among men in the latest years, the opposite trend could be observed among females. By improving the ambient air quality these losses could be effectively reduced.

**Key Words:** air pollutants, particulate matter, respiratory diseases, morbidity, mortality, air hygiene index

## INTRODUCTION

Diseases directly related to environmental factors are difficult to identify, since they develop due to combined effects of numerous factors.

The connection between factors of the natural and built environment and human health are known, however, it is often difficult to identify the harmful effects and the cause-effect relationships. The environmental effects are usually low-level/concentration and long-term effects and their health damage is the result of the combination of many effects. The living- and work environment contains many pollutants with different harmful effects which may be claimed to be related to the occurrence of certain diseases. According to a 2004 WHO estimate, environmental factors were responsible for 16% of the total burden of disease in Hungary. According to a 2015 estimate, 6.2% of the total burden of disease (disability-adjusted life years, DALY) could be attributed to environmental risk factors in Hungary (this is lower than the global average of 11.8%, Health Effect Institute). Air pollution is the most important of these (primarily outdoor particulate matter and ozone) and occupational risks are considered a part of it. *Figure 1* shows that outdoor air pollution is responsible for the majority of the environmental burden of disease; the importance of other factors is much less pronounced.

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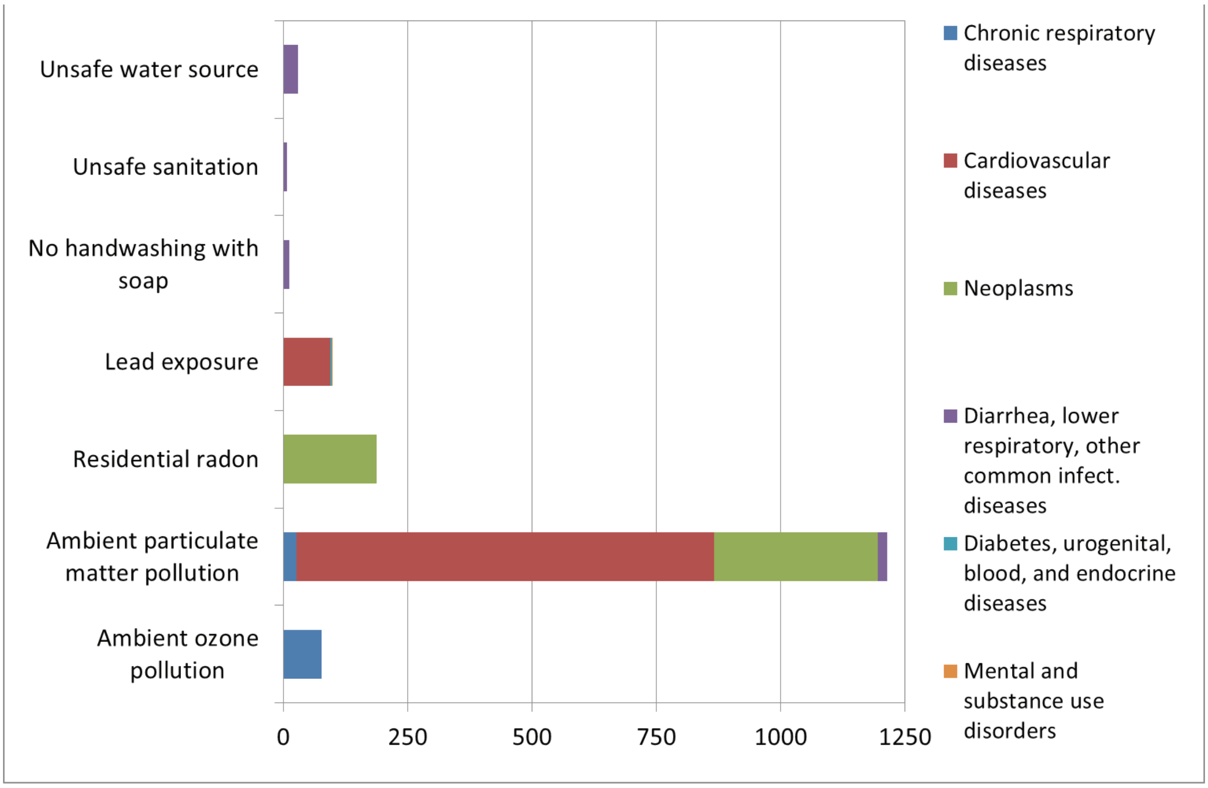



*Figure 1. Disability-adjusted life years per 100,000 population in Hungary, total population, 2015.*

## OUTDOOR AIR QUALITY

### *Air quality in Hungary*

Air quality is one of the most important environmental health risk factors, the reduction of which can significantly mitigate the global burden of respiratory and cardiovascular diseases and lung cancer. At present three of the main pollutants – ground level ozone, nitrogen-oxides, and, mainly, particulate matter ($PM_{10}$) – cause problems.

Analysing $PM_{10}$ emission sources shows that emissions have somewhat reduced during the past years and the largest emission source became residential combustion. About 40% of $PM_{10}$ comes from residential heating *(Figure 2)*. The data from the KSH show that about 20% of Hungarian households use coal, wood, oil or mixed fuels for heating *(Figures 3 and 4)*.

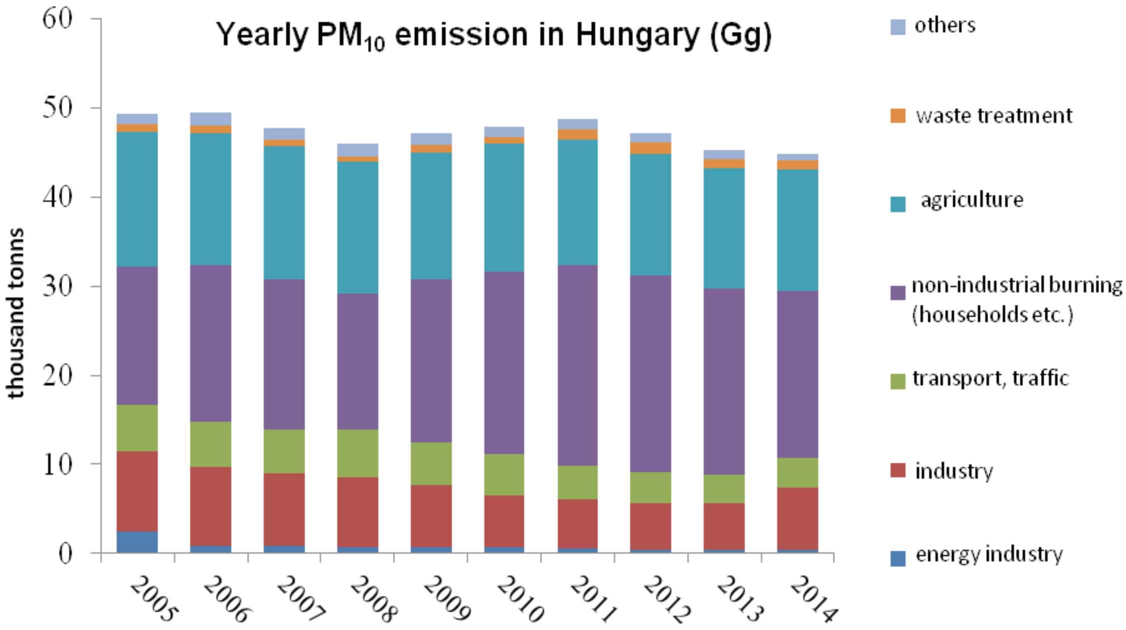



*Figure 2. $PM_{10}$ yearly emissions in Hungary per sector, 2005–2014.*
*(Source: Hungarian Central Statistical Office, KSH)*

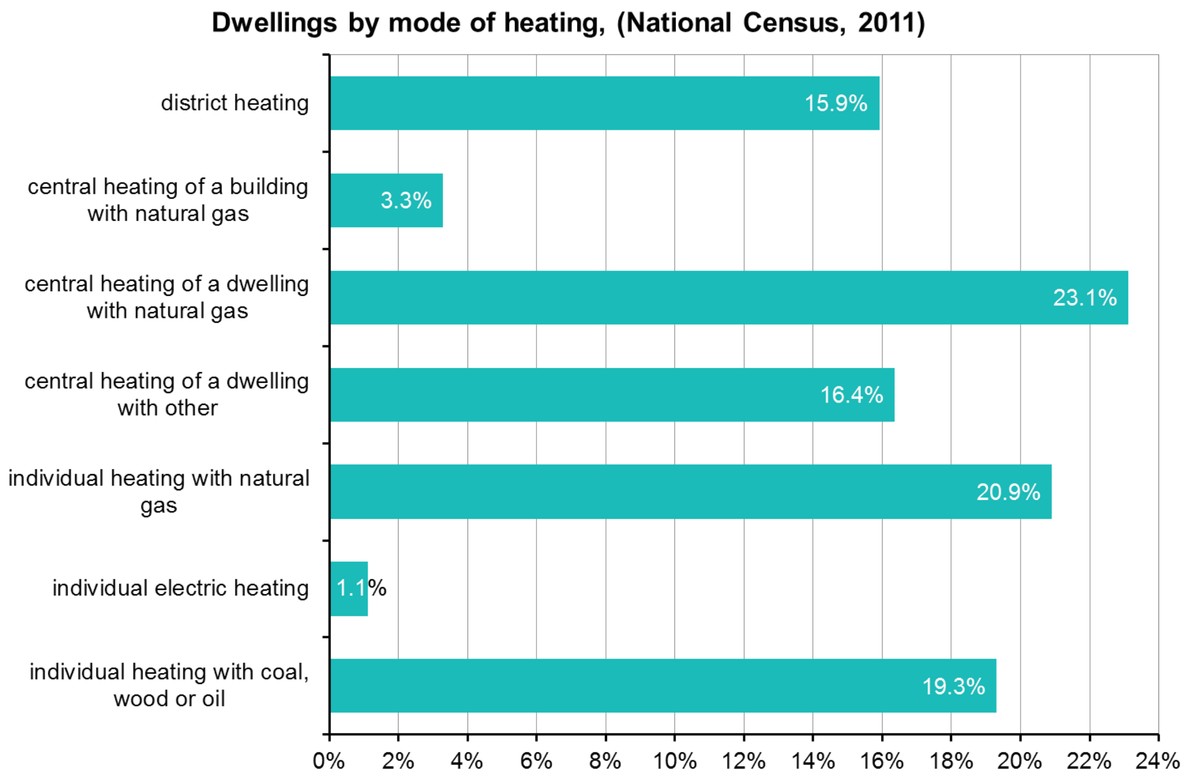



*Figure 3: Distribution of households based on the method of heating in Hungary, 2011.*
*Source: KSH (Census Survey, 2011.)*

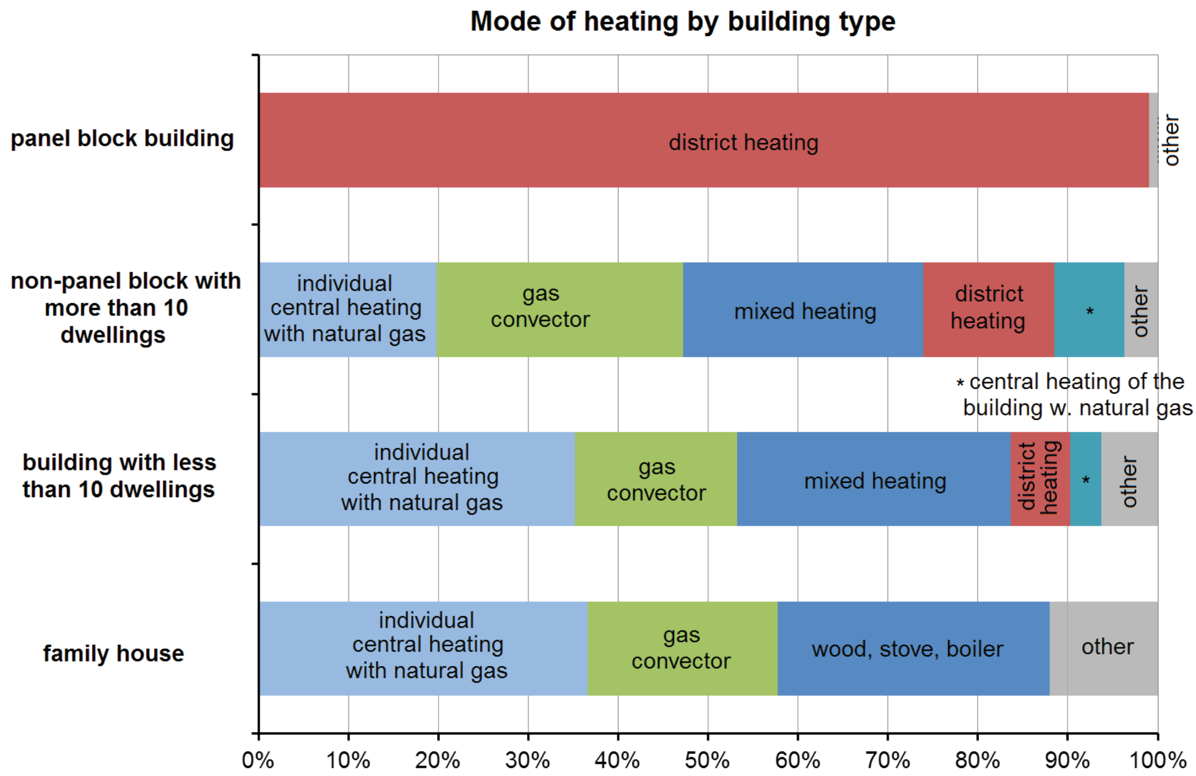



*Figure 4. Distribution of heating methods per building types.*
*Source: National Building Energy Strategy (based on KSH data)*

***Assessing air pollution***

Hungary has had an automatic air pollution monitoring network since 1992 and due to the continuous expansions the number of monitoring stations rose from 21 to 53. The requirements for the placement of the monitoring stations and their revision at least every 5 years is prescribed in the Decree 6/2011 (I. 14.) of the Minister of Rural Development, in accordance with the 2008/50/EC guideline of the European Parliament and Council.

National coverage has improved throughout the years, but the density of the stations is still low in the south-western and south-eastern parts of the country. The stations of the network are placed where the small particles or, in other words, the aerosol fraction with a diameter of less than 10 µm are the problem.

*Aerosols are the mixture of suspended solid and/or liquid particles. Aerosols can be divided into three groups based on their aerodynamic equivalent diameter (AED): the particles bigger than 2.5 µm but smaller than 10 µm are called coarse particles, the particles smaller than 2.5 µm are called fine particles, particles smaller than 0.1 µm are called ultrafine particles.*

According to the latest study results, $PM_{2.5}$ (particles smaller than 2.5 µm AED) concentration poses a greater risk towards the health of the population than $PM_{10}$ concentration, but the amount of reliable $PM_{2.5}$ concentration data is significantly smaller than the data for $PM_{10}$. This is why the most commonly used indicator for the assessment of aerosols is $PM_{10}$ concentration (WHO, 2005).

The indicator capable of measuring the effect of air pollution, population-weighted national annual average concentration of $PM_{10}$, was developed by the WHO and it was adopted by the EU and is also included in the ECHI – European Core Health Indicators. According to the methodological recommendations of the WHO and the ECHI, the indicator has to be calculated from the data of the measuring stations of background urban air pollution by taking population size into account.

The population weighted annual average $PM_{10}$ concentrations (µg/m$^3$) measured by the Hungarian Air Quality Monitoring Network has shown a downward trend in the past 10 years, with the exception of 2011, as it decreased from 42 µg/m$^3$ to 27 µg/m$^3$ *(Figure 5)*.

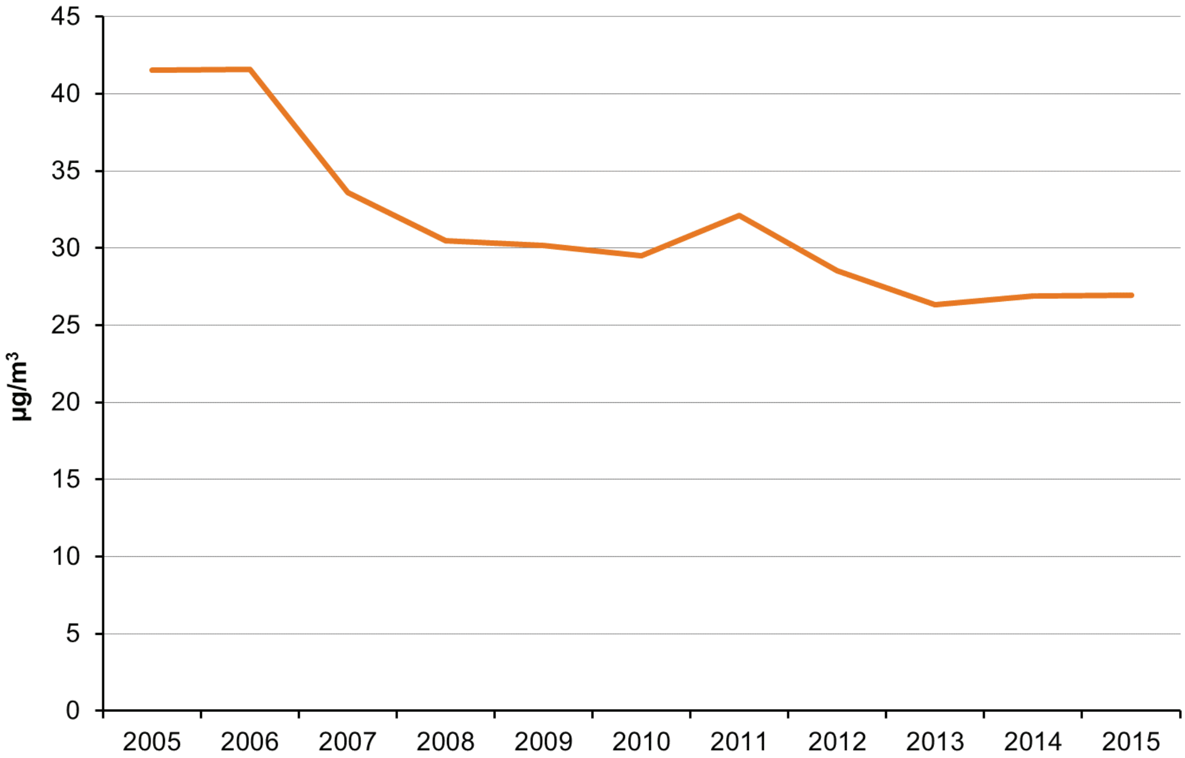



*Figure 5: The population-weighted annual average concentration ambient dust particles (aerosols, $PM_{10}$) in Hungary (2005-2015).*

The very cold weather periods at the beginning and at the end of the year contributed to the relatively high values of the indicator in 2011. However, in order to protect the health of the public, further decreases are necessary to reach the target value determined by the WHO (20 µg/m$^3$).

Hungary belongs to the moderately polluted countries in Europe. The situation is better in Western Europe while Eastern Europe has similar or worse $PM_{10}$ pollution *(Figure 6)*.

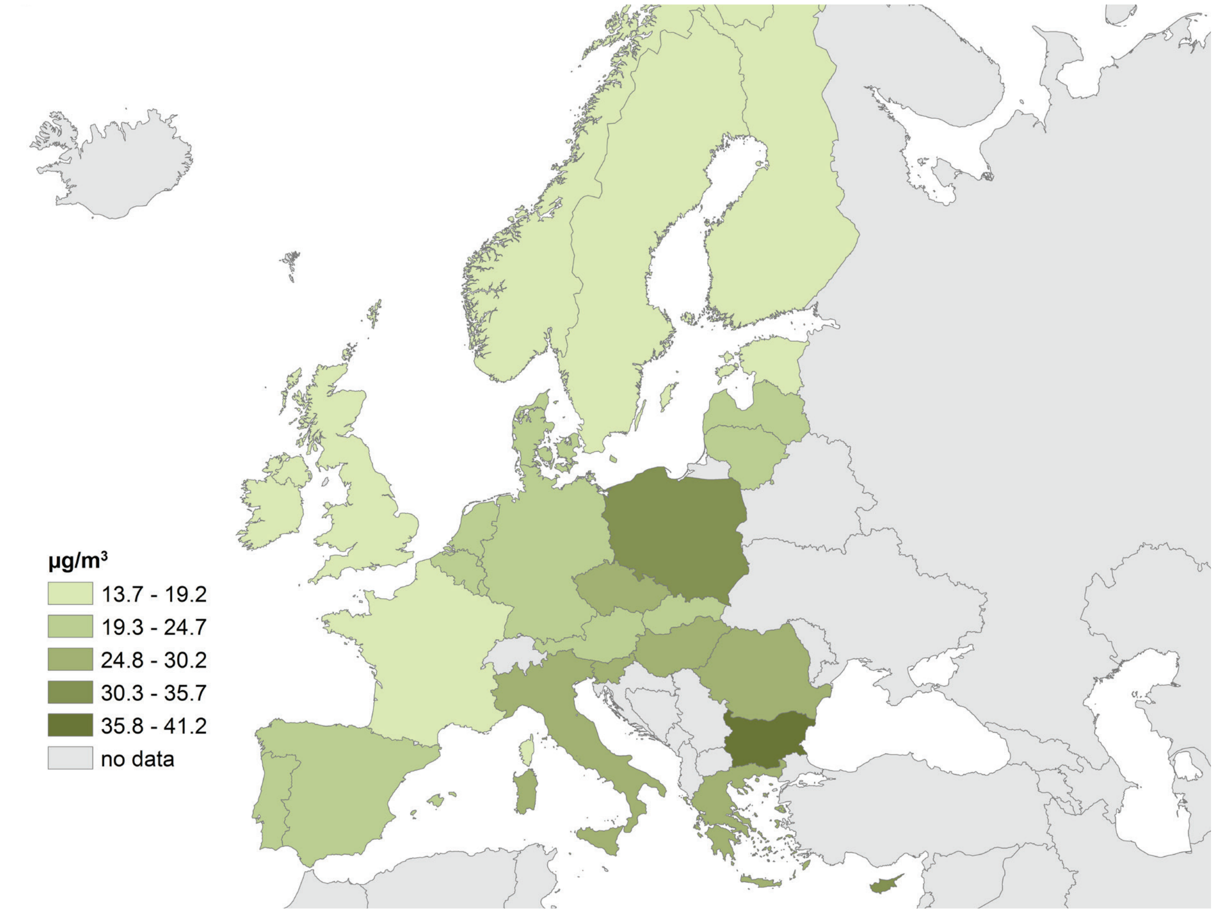



*Figure 6. Population-weighted annual average $PM_{10}$ concentration in Europe, 2014. (Source: Eurostat)*

### *Assessing the geographical differences of $PM_{10}$ exposure*

Below there is a description of the $PM_{10}$ exposure of the Hungarian population between 2007 and 2015.

The assessment took into account the $PM_{10}$ limit values of the 4/2011 (I. 14) Decree of the Minister of Rural Development (*Table I)*.

**Table I.**

**$PM_{10}$ health limit-values (μg/m³)**

| Time | Health limit-value | Comment |
|---|---|---|
| 24-hour | 50 | cannot be exceeded more than 35 times in a year |
| annual | 40 | WHO recommendation*: 20 |

* WHO Air quality guidelines (2005)

The assessment was based on the hourly $PM_{10}$ concentrations measured by the automatic stations of the Hungarian Air Quality Monitoring Network and available on the www.levegominoseg.hu website. The monitoring stations are divided into three groups based on the type of emission source: traffic, industrial pollution, and background stations. In the vicinity of traffic stations the main source of the aerosol burden is the emission from motor vehicles, at the urban background stations the primary source of pollution is residential heating, and for stations close to industrial sites the main source is industrial production. In the capital all the three types can be found. Several cities have two-two different types of measuring points like Győr, Pécs, Százhalombatta, Miskolc, Debrecen and Tatabánya (between 2007-2011). The difference between the station types changed significantly in the past years. Due to the emission limits of industrial production becoming stricter and the technical development of air filter devices, emissions decreased. The development of vehicles also had a positive effect on air quality, but this positive effect was significantly reduced by the increasing average age of the vehicles. In the past years, due to the increasing price of heating fuels, many people choose solid fuels again instead of heating with gas, which significantly increased $PM_{10}$ emissions.

The maps below *(Figures 7 and 8)* show the $PM_{10}$ annual average concentrations of the rather polluted 2011 and the less polluted 2015 years according to the data of the Hungarian automatic monitoring stations (based on confidential data above 90%).

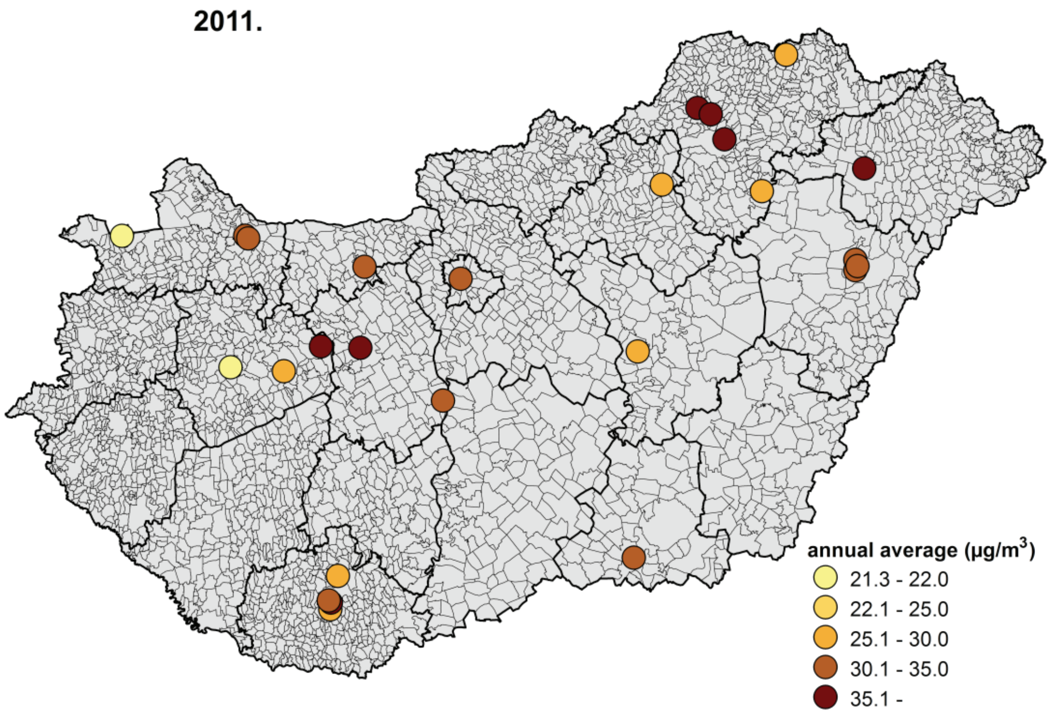



*Figure 7. Annual average $PM_{10}$ concentrations measured by the Hungarian monitoring stations, 2011.*

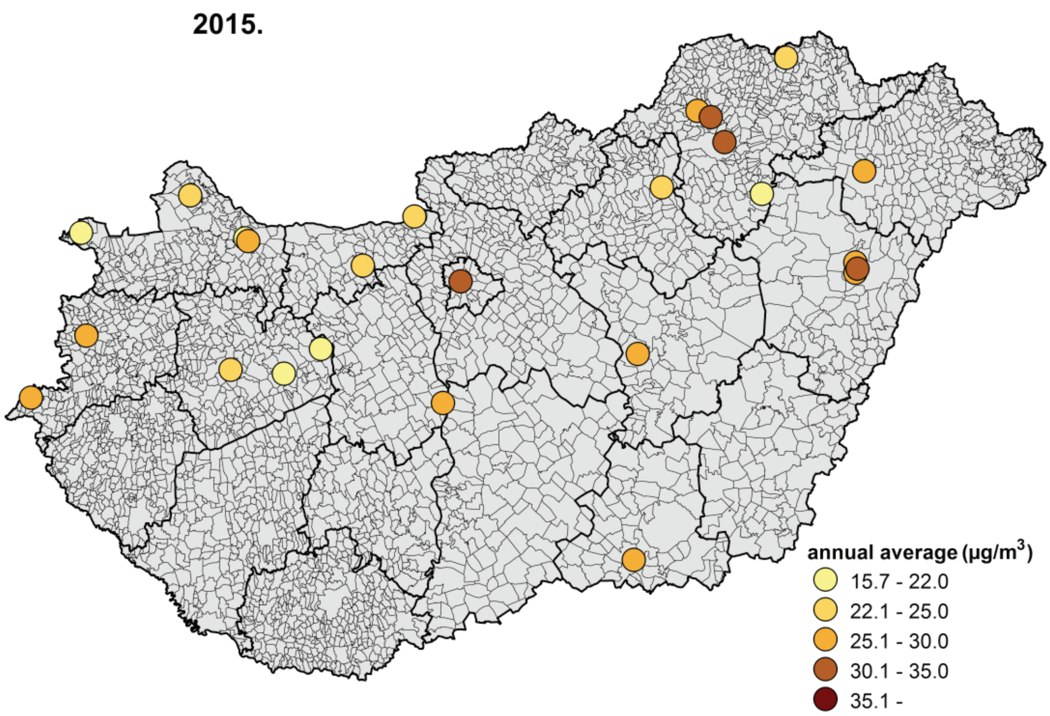



Figure 8. Annual average $PM_{10}$ concentration measured by the Hungarian monitoring stations, 2015.

### *Assessing the health effects of air pollution based on the air hygiene index*

The Department of Air Hygiene of the National Institute of Environmental Health developed a complex index (air hygiene index – AHI) in 2007, which is easy to use, easy to understand, and is scientifically sound.

The AHI consists of three main elements: the concentration data that describe the extent of air pollution, the part describing the health impacts of air pollutants, and the recommendations for reducing the health damaging effects of the air pollution.

Since the index is aimed at conveying the short-term health risk of air pollution, the AHI system is based on the highest one hour concentrations of the basic air pollutants ($SO_2$, $NO_2$, CO), the maximum of the 8-hour moving average of ozone ($O_3$), and the average daily concentration of $PM_{10}$.

The calculation of the index is done using the health limit values described in Decree 4/2011. (I. 14.) of the Minister of Rural Development and taking into account the relevant information and alert thresholds. The AHI system therefore differentiates between four air pollution categories, which are coded by different colours. The first category (1) is acceptable, the second (2) is substandard, the third (3) is unhealthy, and the fourth (4) is dangerous *(Table II).*

**Table II.**

**Definition of the Air Hygiene Index (AHI)**

| AHI | Air hygiene situation | Air pollution level (µg/m³) | | | | |
|---|---|---|---|---|---|---|
| | | 1 hour max $SO_2$ | 1 hour max $NO_2$ | 1 hour max CO | maximum of the 8 hour moving average $O_3$ | 24 hour average $PM_{10}$ |
| 1 | acceptable | 0 - 249 | 0 - 99 | 0 – 9,999 | 0 - 119 | 0 - 49 |
| 2 | substandard | 250 - 399 | 100 - 349 | 10,000 -19,999 | 120 - 179 | 50 - 74 |
| 3 | unhealthy | 400 - 499 | 350 - 399 | 20,000 -29,999 | 180 - 239 | 75 - 99 |
| 4 | dangerous | 500 < | 400 < | 30,000 < | 240 < | 100 < |

*Legend:*
Under the health limit value; Under the information threshold; Under the alert threshold; Over the alert threshold

The four categories mean different health risks for those suffering from lung- and cardiovascular diseases, those suffering from other respiratory illnesses (e.g.: asthma, COPD), for children, for pregnant women, and for the elderly *(Tables III and IV)*. *Table IV* presents the recommendations attached to the individual categories in order to help the population avoid or mitigate exposure.

**Table III.**

**Expected acute health effects according to the air hygiene index categories**

| AHI | Expected acute health effect |
|---|---|
| 1 | Appropriate air quality, acceptable risk. |
| 2 | Mild symptoms can develop in the potentially vulnerable populations (coughing, watery eyes, mild respiratory symptoms). |
| 3 | The potentially vulnerable populations can expect the symptoms getting stronger (shortness of breath, other respiratory difficulties). The symptoms of older people, of those with circulatory and respiratory diseases can worsen. |
| 4 | Increased health damaging effects can be expected for potentially vulnerable populations, but due to the high pollution any person can have symptoms (respiratory symptoms and complaints can occur in the average population, too, with greater possibility). |

**Table IV.**

**Health recommendations for the different categories of air hygiene index**

| AHI | Health recommendations |
|---|---|
| 1 | Nothing needs to be done. |
| 2 | Those suffering from respiratory or circulatory diseases should reduce physical activity and their time spent outdoors. Reduce outdoor activities along busy roads. |
| 3 | Sensitive people and those suffering from respiratory or circulatory diseases may need individual protection (e.g.: using inhaler), staying outdoors and physical activities should be restricted if possible. |
| 4 | Children, the elderly, those suffering from asthma and other respiratory or circulatory diseases should avoid staying outdoors and doing physical activities there. They should follow the doctor’s instructions when taking their medicine. They should immediately seek medical help if they experience any health problems. Even healthy individuals should stay outside as little as possible and avoid doing physical work for long and sport activities. |

Every morning since 2007 the Air Hygiene and Aerobiology Department of the National Public Health Institute (NPHI) assesses the air hygiene situation of settlements with automatic monitoring stations by this index using the data from the automatic monitoring stations of the Hungarian Air Quality Network (http://levegominoseg.hu). The assessments can be found at: http://oki.antsz.hu.

*Assessment of air quality using the air hygiene index*

In the year 2011 $PM_{10}$ pollution was particularly high. In the summer of 2015 high ozone concentrations were measured at some settlements. In the winter it is primarily the high $PM_{10}$

concentration that plays a dominant role in shaping the air hygiene index, while the ozone concentration is the most important factor during the summer among the observed pollutants. *Figure 9* compares the AHI indices of individual stations in Budapest in the heating seasons (January-March and October-December) of 2011 and 2015.

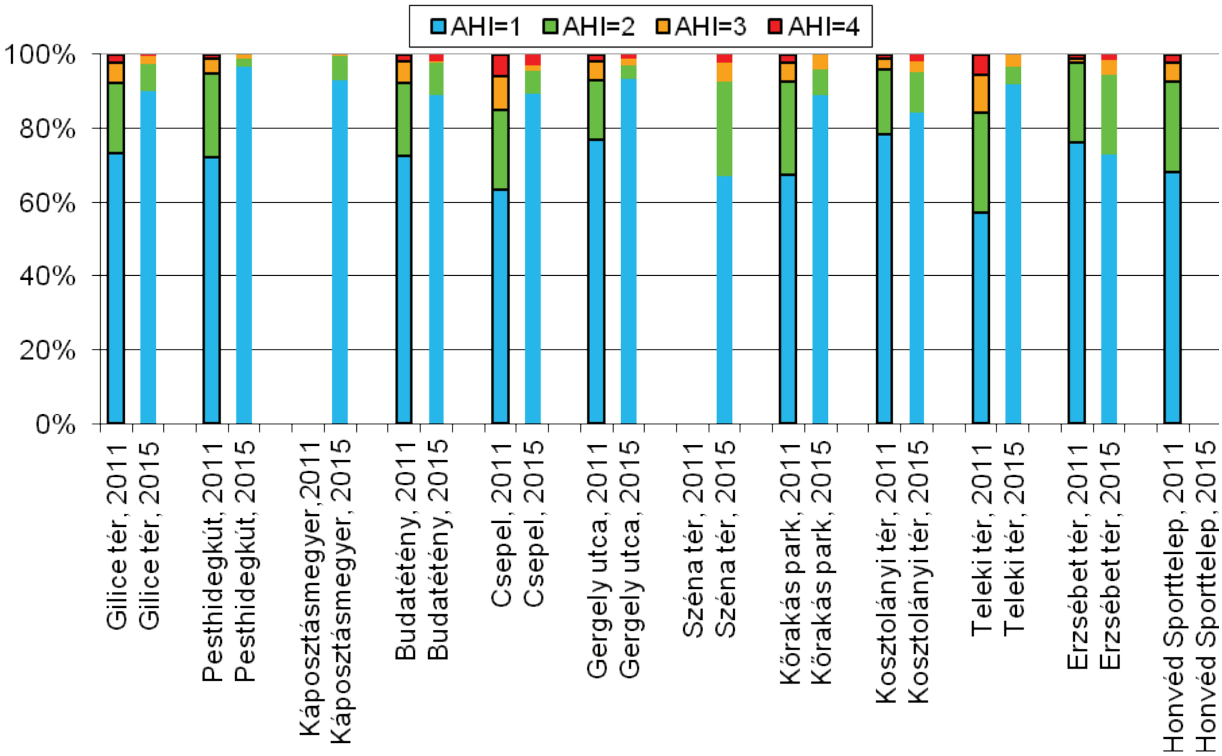



*Figure 9. $PM_{10}$ pollution in the context of AHI, Budapest, heating seasons of 2011 and 2015*

According to the AHI assessment, the values of the analysed components were more often above the limit values at all the stations in the capital in 2011 than in 2015. The AHI in the assessed period was in the acceptable range in 72% of the days in 2011 and 87% of the days in 2015. The difference between the two years is even more conspicuous due to the short-term health damage and in light of the third and fourth categories of the AHI (Figure 10). In 2011 at the Budapest stations the air hygiene index was 101 times in the unhealthy category – due to the $PM_{10}$ concentration –, and 42 days in the dangerous category, due to concentrations above the alert threshold. In 2015 category three occurred 52 times while category four occurred 22 times.

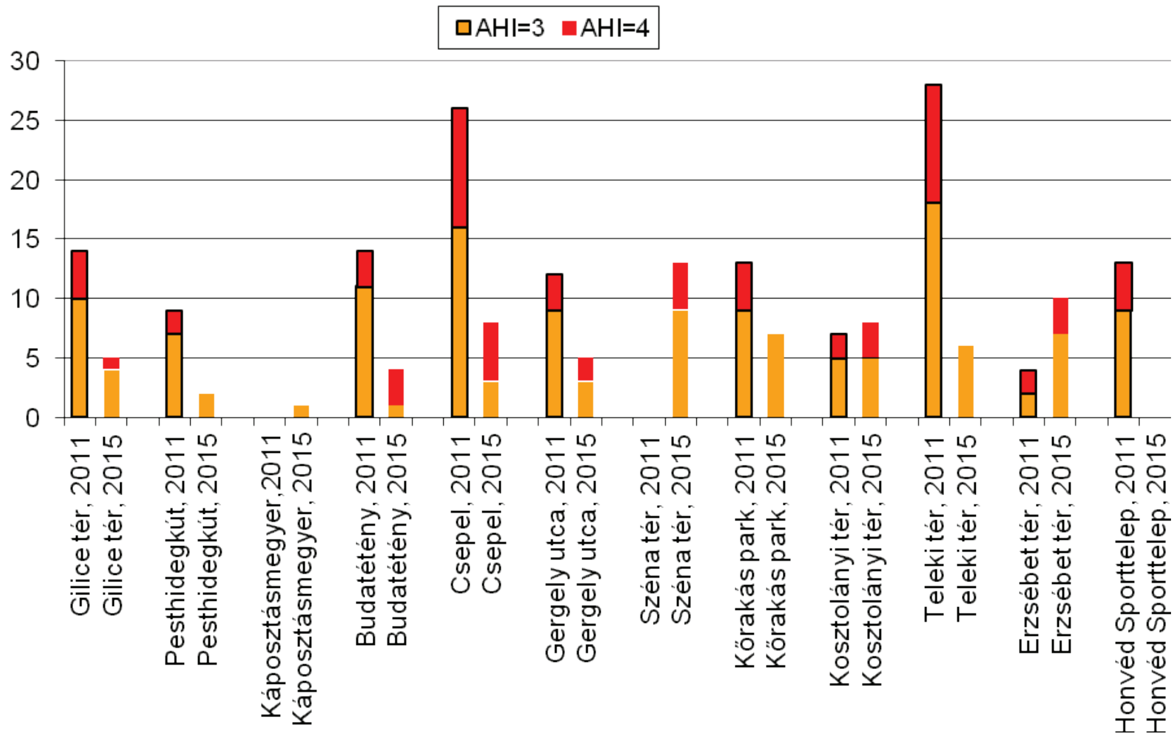



*Figure 10. $PM_{10}$ pollution in the context of AHI, Budapest, heating seasons of 2011. and 2015.*

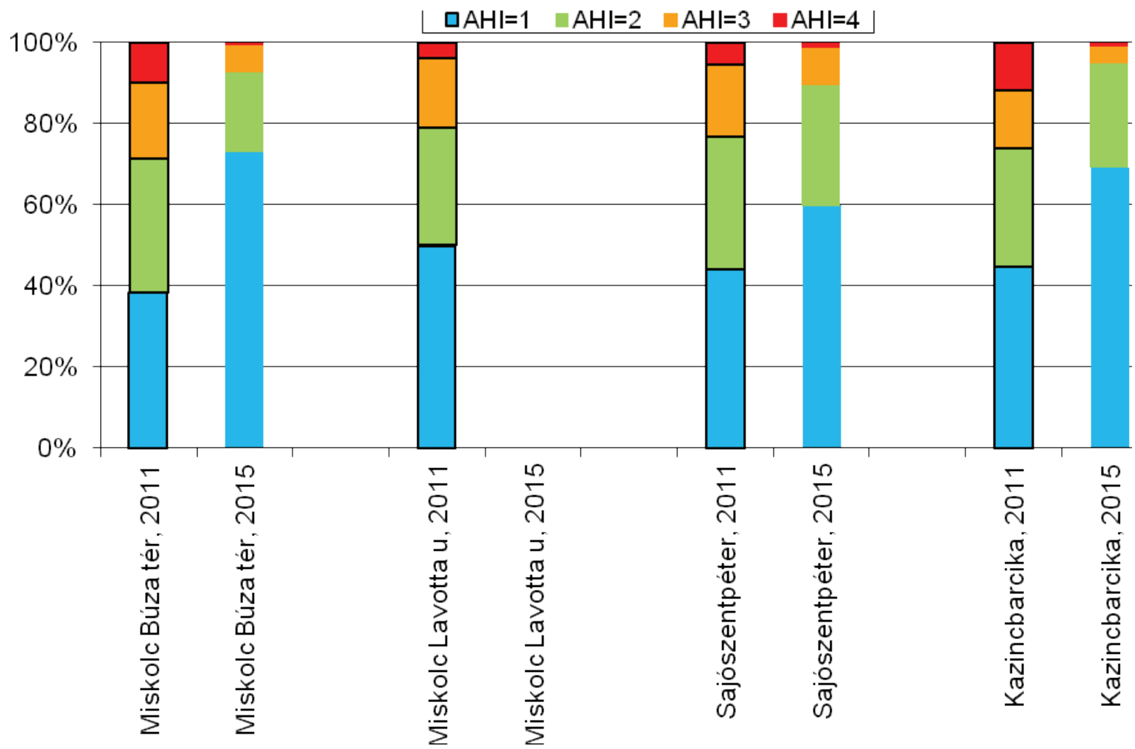



*Figure 11. $PM_{10}$ pollution in the context of AHI, Sajó valley, heating seasons of 2011. and 2015.*

*Figure 11* compares the air quality of the Sajó valley stations in 2011 and 2015.
*Figure 12* shows that there were no cities in 2011 where the proportion of days with acceptable air quality was above 50%,while in 2015 it was 60-73%. It is important to note the number of days categorized as unhealthy and dangerous. In 2015 the air quality was only dangerous on 1-2 days; in 2011 the AHI was in category 4 on 7-21 days. With regard to $PM_{10,}$ those living in the inner city of Miskolc (Búza tér) and the citizens of Kazincbarcika had the largest exposure.

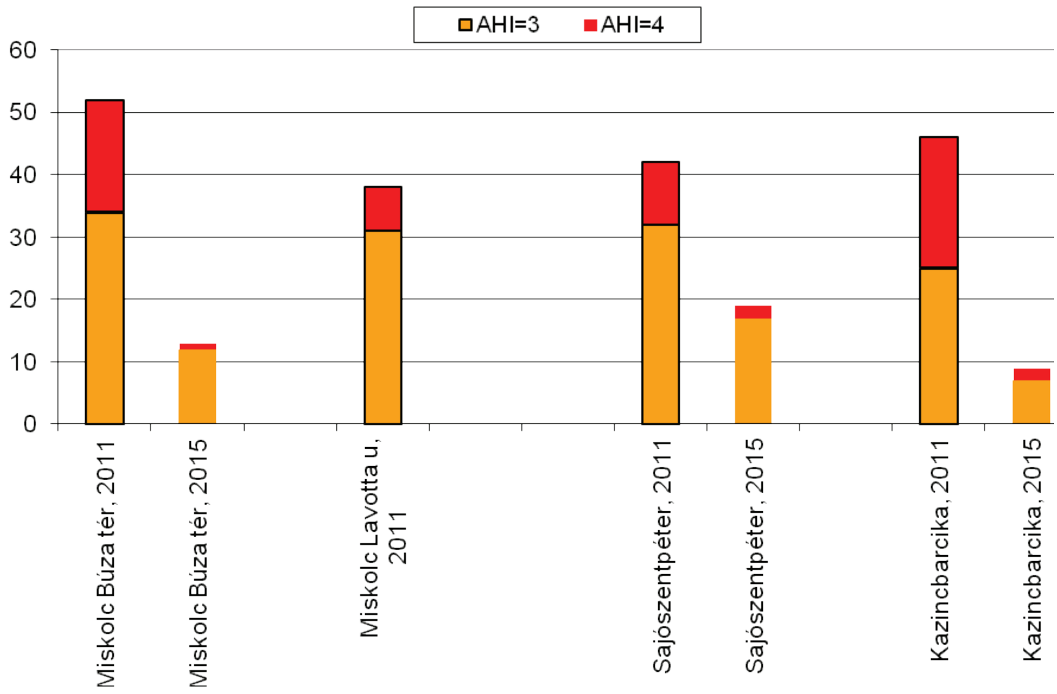



*Figure 12. $PM_{10}$ pollution in the context of AHI, Sajó valley, heating seasons of 2011 and 2015.*

In the non-heating half-year (April-September) the high ozone concentration endangers most frequently the health of the population. Ambient ozone pollution is caused by the sunlight induced photochemical reactions of primary air pollutants (e.g.: nitrogen-monoxide, carbon-monoxide, volatile organic compounds). Therefore, one of the prerequisites of high ozone concentrations is persistent sunlight. This means that high $O_3$ concentrations can be expected during the sunlit summer periods. High ozone concentrations causing more significant health damage occur mainly on summer heat wave days.The comparison of the 2011 and 2015 ozone exposures in the vicinity of the monitoring stations of Budapest can be seen in Figure 13.

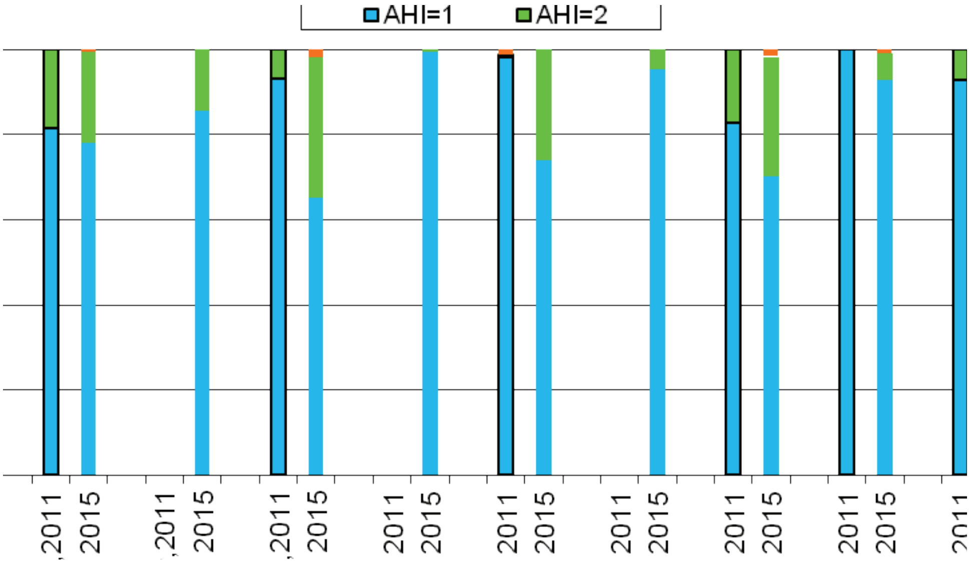



*Figure 13. Ozone ($O_3$) pollution in the context of the AHI, Budapest, non-heating seasons of 2011 and 2015.*

The difference is especially obvious at the background stations. In 2015 at Budatétény the ozone pollution caused substandard air quality (in 34% of the evaluated days). The AHI was in the unhealthy category in the vicinity of Kőrakás park on 3 days, in Budatétény on 2 days, and 1-1 days around Kosztolányi tér and in Pesthidegkút.

In 2011 the air quality around the background stations of Gilice tér, Kőrakás park, and Pesthidegkút was substandard due to higher ozone concentrations (15-19% of the assessed days).

Figure 14 shows the summer ozone exposure of the citizens of Pécs in 2011 and 2015.

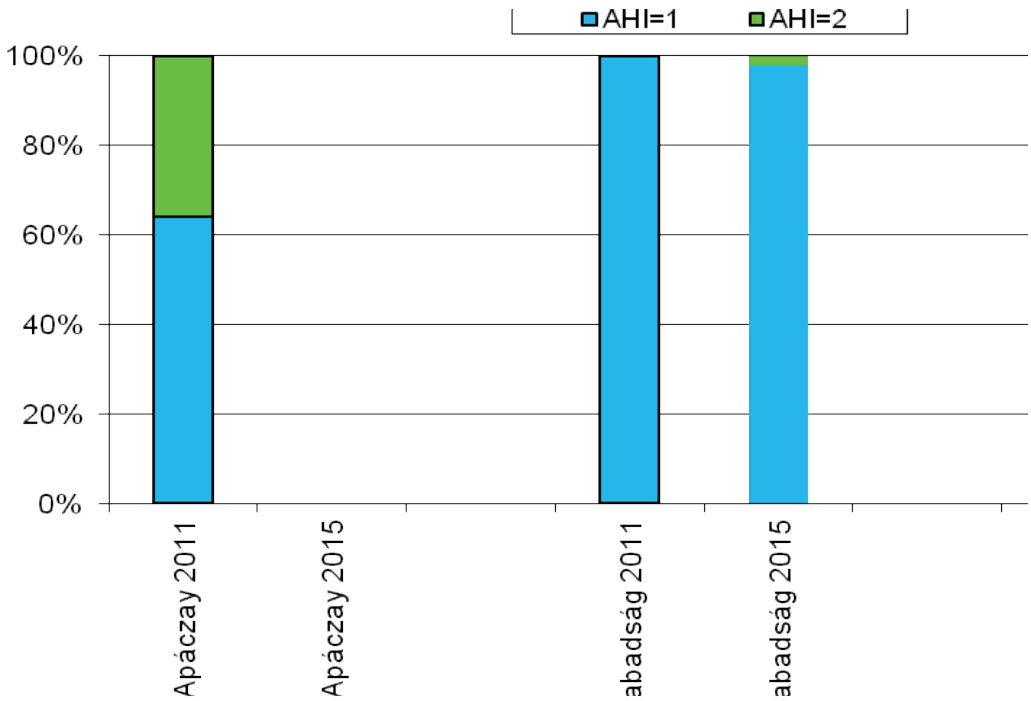



*Figure 14. Ozone ($O_3$) pollution in the context of the AHI, Pécs, non-heating seasons of 2011 and 2015.*

While the ozone pollution was significantly higher in Budapest in 2015 than in 2011, it was the opposite in Pécs, which is south of Budapest. It can be observed here, too, that in the vicinity of traffic stations – Szabadság utca – the ozone pollution rarely (below 10%) exceeds the limit value, compared to the background stations (Boszorkány út, Apáczai Csere János körtér). At Apáczai Csere János körtér in 2011, 36% of the assessed days had *substandard* air quality. In Pécs in the studied years there was no ozone concentration above the information threshold, therefore, the population there had only mild exposure.

***Diseases that correlate most with air pollution***

Air pollution is part of the total burden of disease due to environmental exposures. According to the WHO's estimate, air pollution contributed to 7 million premature deaths in 2012, 600,000 of which happened in the European Region of the WHO. Air pollution is responsible for deaths due to several causes, particularly deaths due to cardiovascular and cerebrovascular diseases: globally about 3.7 million deaths can be attributed to outdoor- and 4.3 million to indoor air pollution (both are responsible for part of the deaths). The average life expectancy in the European Union is 8.6 months shorter due to anthropogenic $PM_{2,5}$ pollution.
Polluted air also affects life quality as it causes asthma and other respiratory diseases. Air pollution also leads to increased absenteeism from school and work, and results in high health care costs. The above exposure especially concerns vulnerable groups: children, asthmatics, and the elderly.
The effect has a broad spectrum, it primarily affects the cardio-respiratory systems and can vary according to age-group and health status. This particular effect intensifies with increasing exposure and there is no evidence that a no-effect threshold exists. The concentration levels causing detectable effects on health do not differ significantly from those generally measured in the air. Epidemiological investigations have proven that particulate matter has both short- and long-term adverse effects.

The number of non-tuberculous lung disease cases has been also constantly increasing in Hungary for years, along with the number of registered asthmatics. This, however, shows significant geographical differences both in terms of new and registered patients. Air pollution also has a role in inducing and maintaining bronchitis: the frequency of adult COPD (chronic obstructive pulmonary disease) is still rising, albeit slowly. The primary role in the development of lung cancer is attributed to smoking, but the carcinogenic air pollutants also play a role. Lung cancer morbidity and mortality has an increasing tendency among women; among men the mortality is decreasing and the incidence is stagnating.

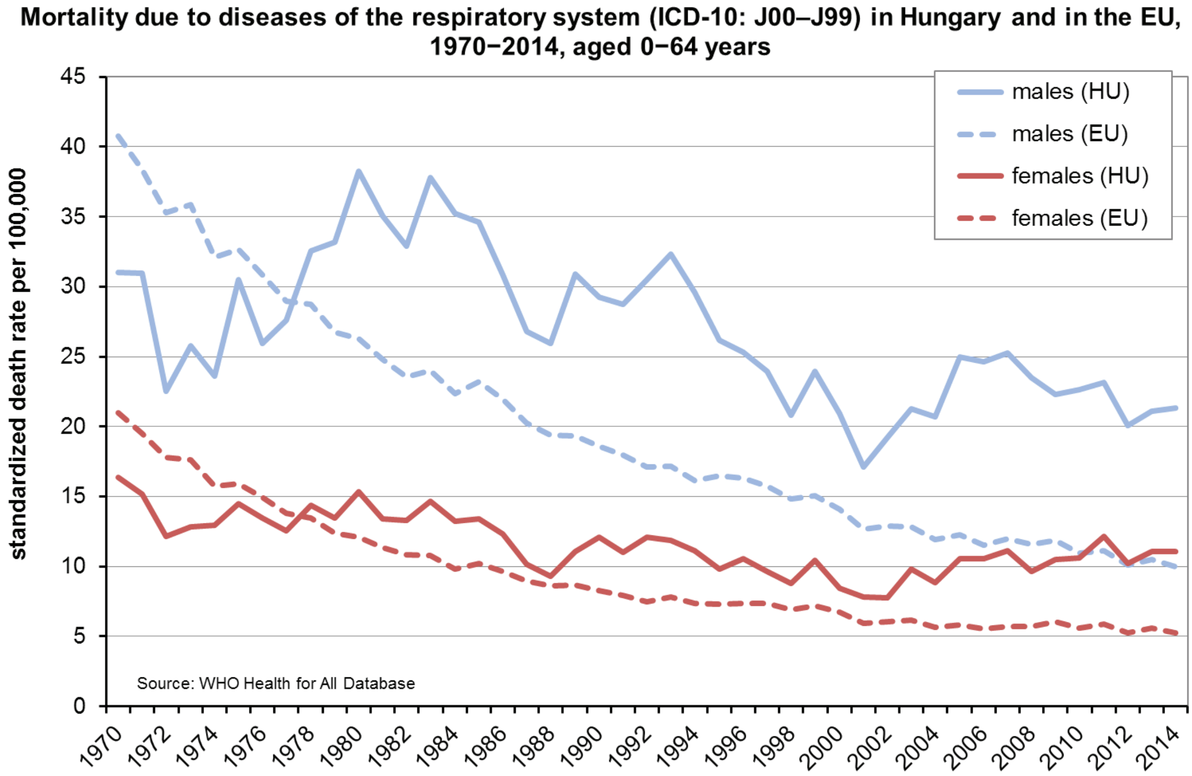
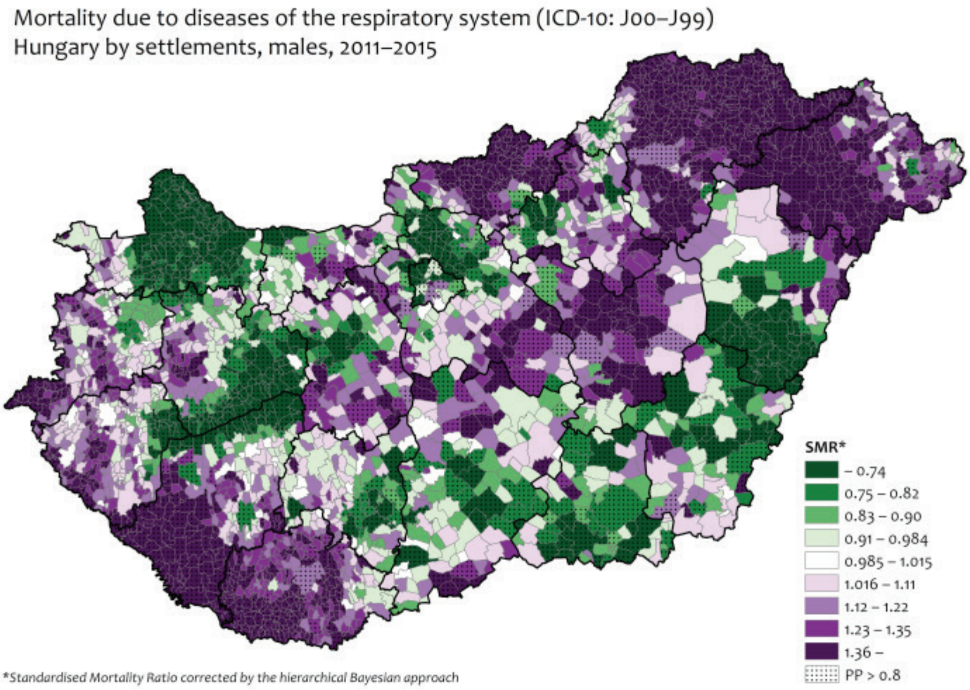



*Figure 15. Mortality due to respiratory diseases in Hungary and the EU in the 0 - 64 year old population, 1970 - 2014. (Source: WHO Health for All Database)*

The rate of premature deaths (0 - 64 years) due to respiratory diseases in Hungary is higher for both sexes than the EU average *(Figure 15)*. It is important to note that while there is a decreasing trend in the EU, there has been an increase since the early 2000'ies in Hungary both among women and men. The geographical distribution of respiratory diseases is typical: for both sexes (although for men on a larger geographical area) the north and north-eastern counties, Hajdú-Bihar and Jász-Nagykun-Szolnok, and the southern Transdanubian counties have a higher mortality than the national average *(Figure 16)*.



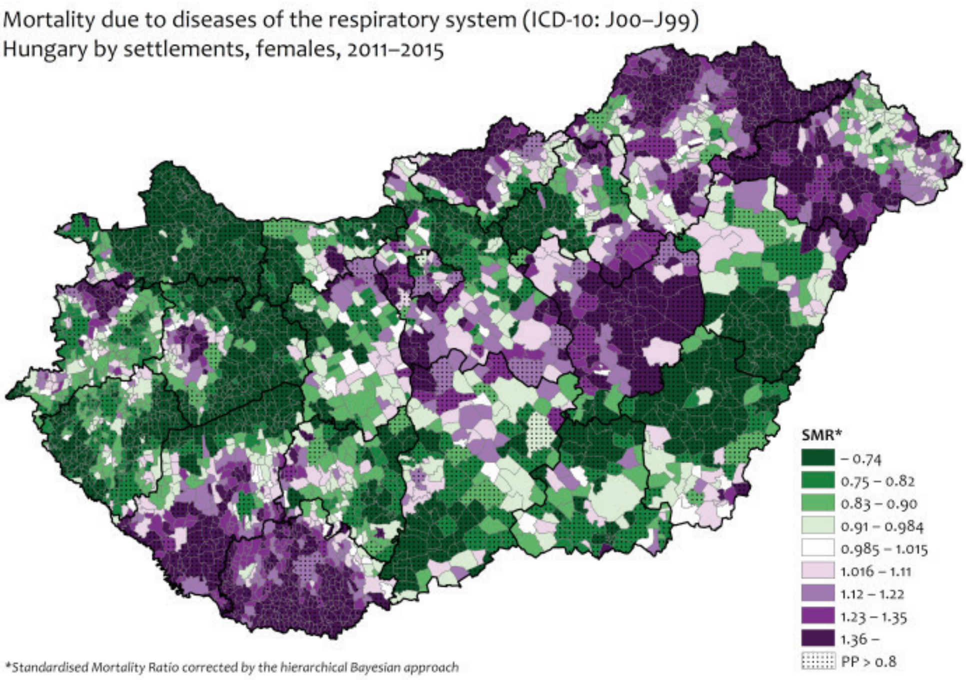




*Figure 16. The geographical differences of mortality due to respiratory diseases (ICD-10: J00–J99) in Hungary, between 2011 and 2015 among 0–100 year old men and women at settlement level.*

Out of the non-tuberculous lung diseases, the most common are allergic rhinitis, asthma, COPD, and primary bronchial cancer.

The incidence of *bronchial asthma* morbidity (*Figure 17*) rose from the annual 35.7/100,000 in 1980 to 167/100,000 in 1999. It has been between 145-192/100,000 since 1999. The total number of bronchial asthma patients has similarly risen in the past decade. 60% of the new asthmatic cases were due to allergy in 2014, which shows that the reduction of outdoor and indoor allergens should receive more attention.

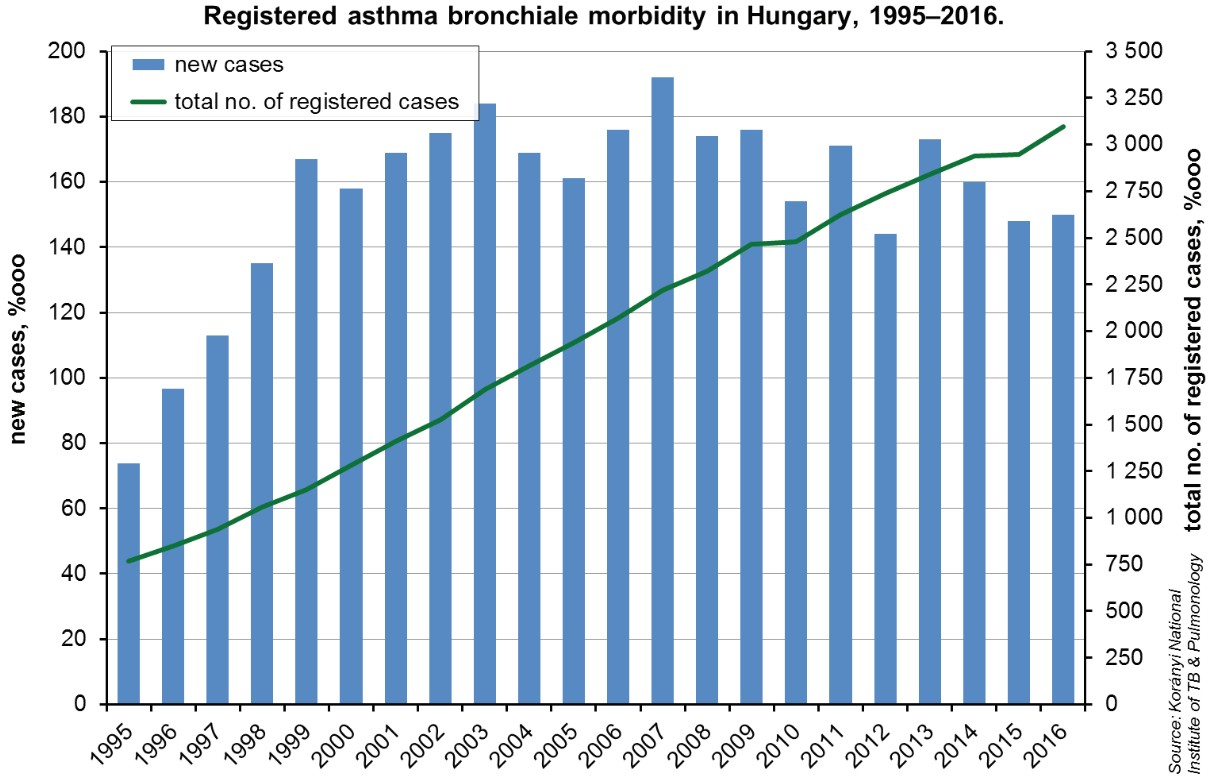



*Figure 17. Registered asthma bronchiale morbidity in Hungary, 1995–2016.*
*(Source:Korányi National Institute of TB and Pulmonology)*

The incidence of *allergic rhinitis* rose from 22/100,000 in 1990 to 281/100,000 in 2000, and then declined slightly until 2008, afterwards the number of new cases decreased (75/100,000 in 2015). The prevalence of registered cases has been practically the same since 2009 (3000-3250/100,000) *(Figure 18)*. The significant reduction of the number of new cases can partly be explained by the fact that a large proportion of the patients did not present themselves at the pulmonary care system.

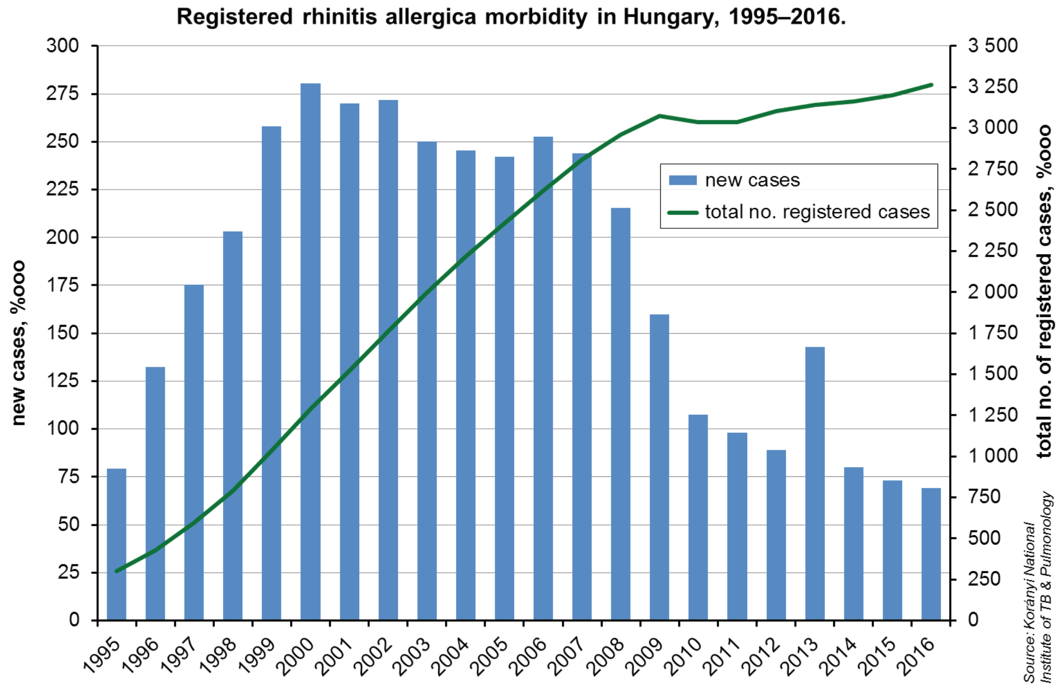



*Figure 18. Registered allergic rhinitis morbidity in Hungary, 1995–2016. (Source:Korányi National Institute of TB and Pulmonology)*

The number of registered new cases of *chronic obstructive pulmonary disease (COPD)* was low in the early 2000s (around 50/100,000), then every year more and more new patients were registered between 2004 and 2009. After 2010 the proportion of new cases declined again. The prevalence of registered patients shows an increasing trend from 2004 on *(Figure 19)*.

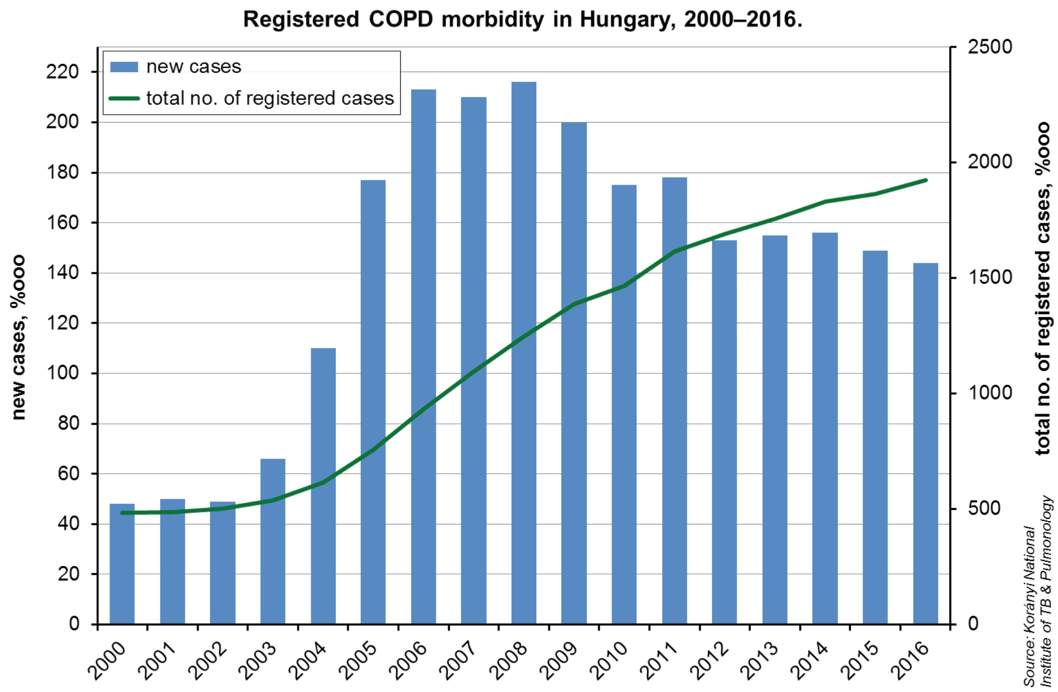
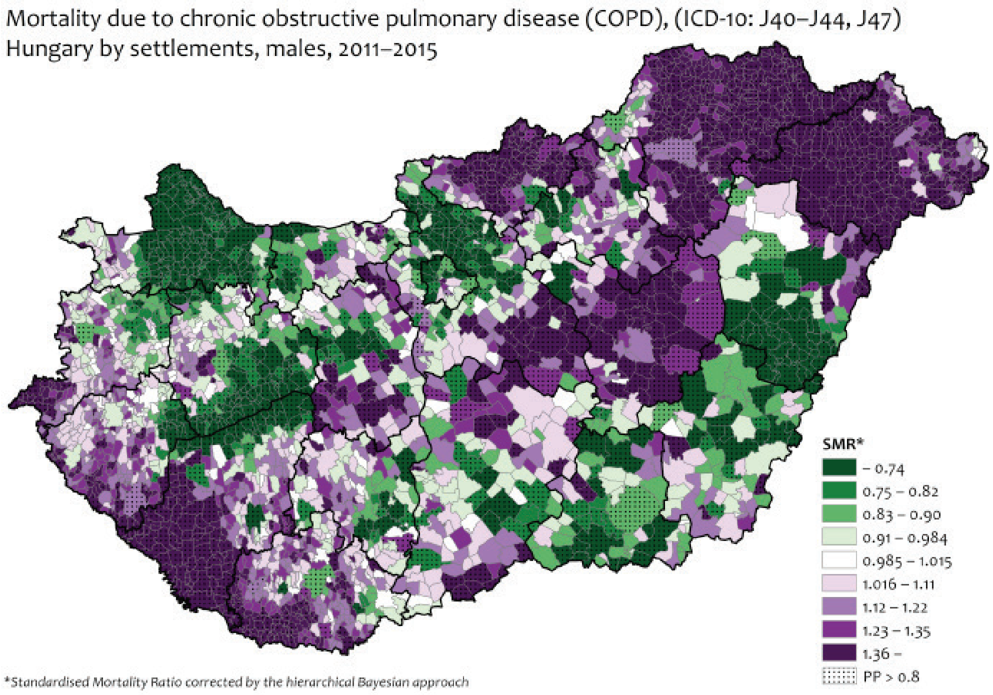



*Figure 19. The registered COPD morbidity, Hungary, 2000–2016. (Source:Korányi National Institute of TB and Pulmonology)*

*Figure 20* shows the geographical differences in mortality due to chronic obstructive pulmonary diseases (COPD). It is important to note that the geographical distribution of mortality due to COPD is very similar to the distribution of total respiratory mortality.



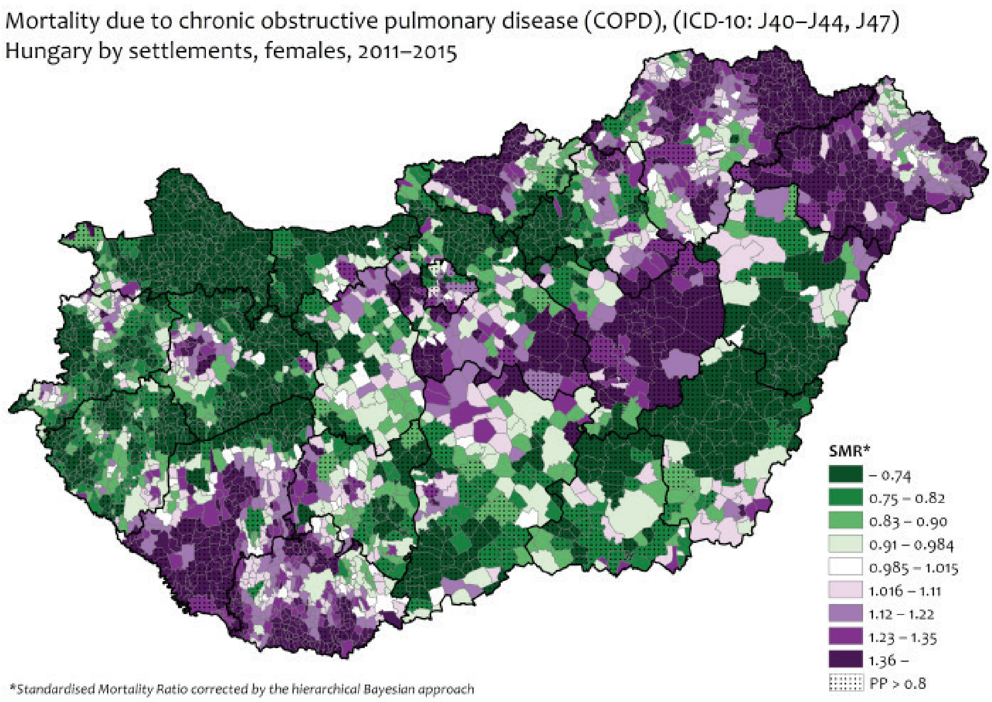




*Figure 20. Geographical differences of mortality due to chronic obstructive pulmonary disease (COPD) (ICD-10: J40–J44, J47), Hungary, 2011–2015 among 0–100 year old men and women at settlement level.*

Both the incidence and the mortality of *primary bronchial cancer* have shown a declining trend among men in the past decade, while they were continuously increasing among women *(Figures 21 and 22)*. Examining the data per county, the 2013 *incidence* was the highest in Békés, Heves, and Jász-Nagykun-Szolnok counties. This spatial accumulation shows a similar picture of *mortality* due to bronchial and lung cancer *(Figure 23)*. The number of patients suffering from primary bronchial cancer starts to rise above the age of 35, it becomes more frequent among the older age groups and it is the most frequent among the 60-69 year olds (172,7/100,000 in 2014).

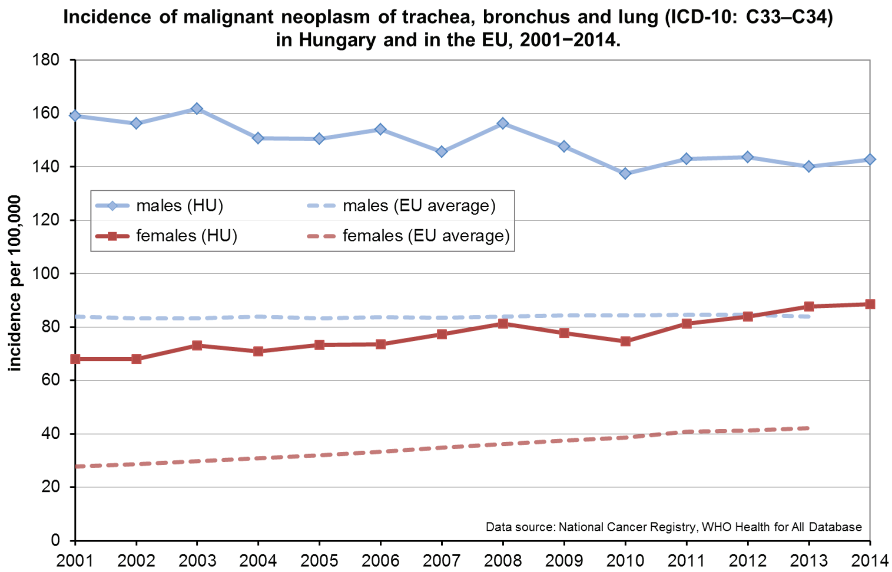



*Figure 21. Incidence of cancer of the trachea, the bronchus and the lung (ICD-10: C33–C34) in Hungary and the EU among 0-100 year olds, 2001–2014. (Source: National Cancer Registry, WHO Health for All Database)*

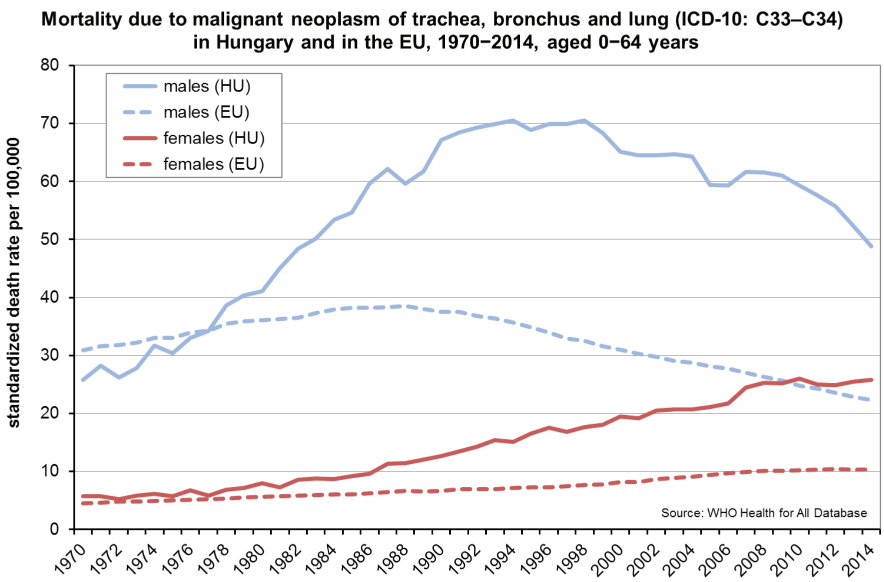
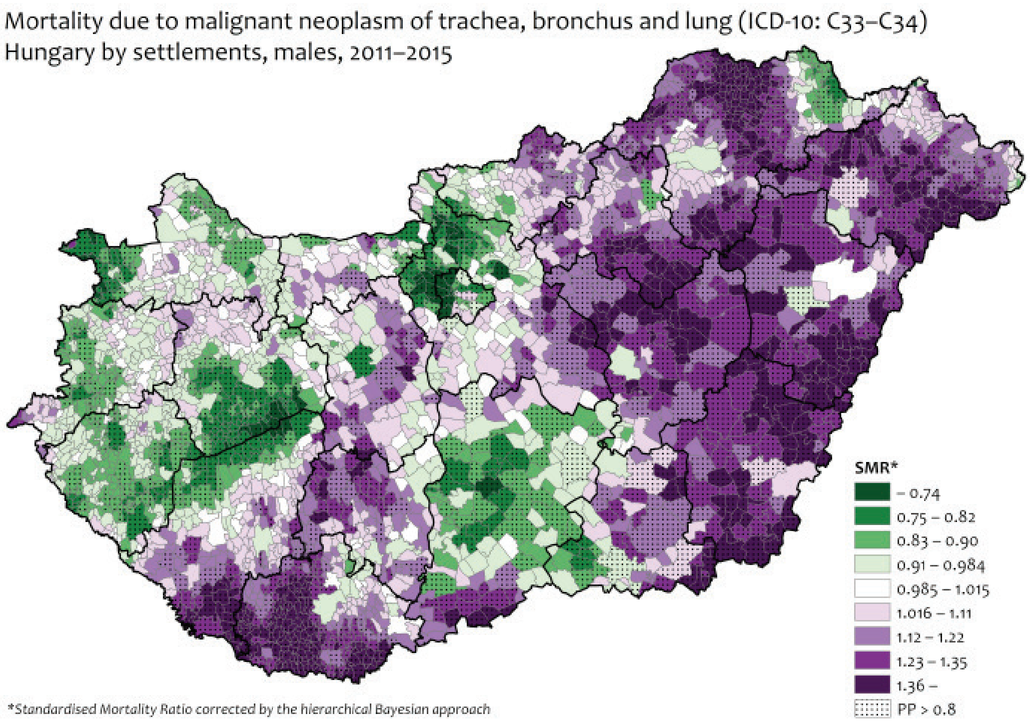



*Figure 22. Mortality due to cancer of the trachea, the bronchus and the lung (ICD-10: C33–C34) in Hungary and the EU among 0-64 year olds, 1970–2014. (Source: WHO Health for All Database)*



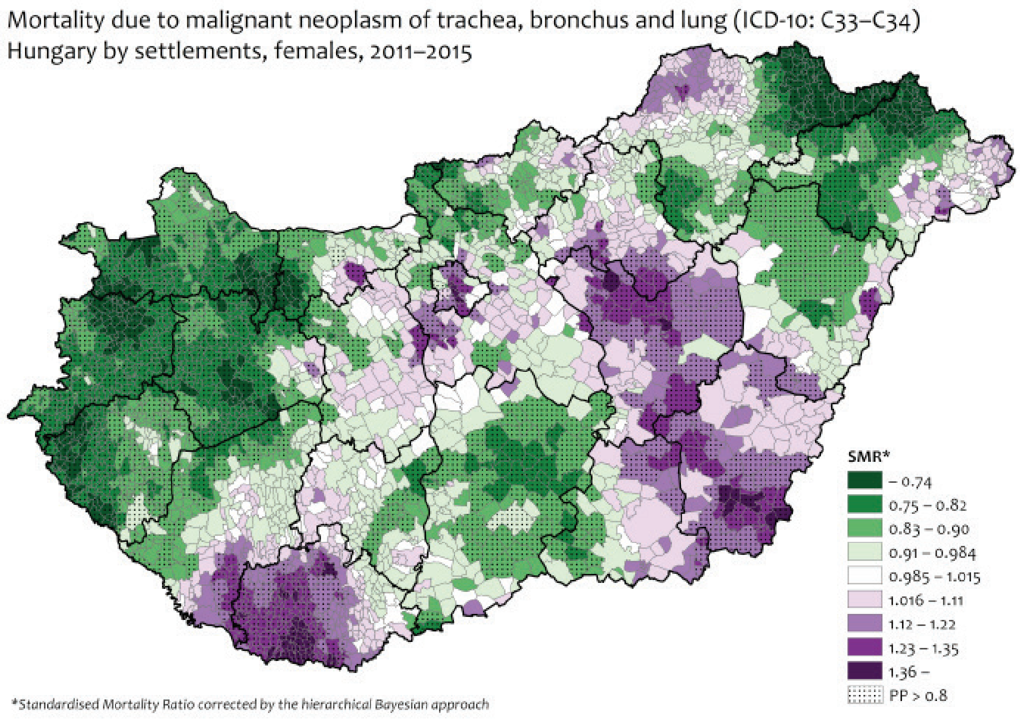
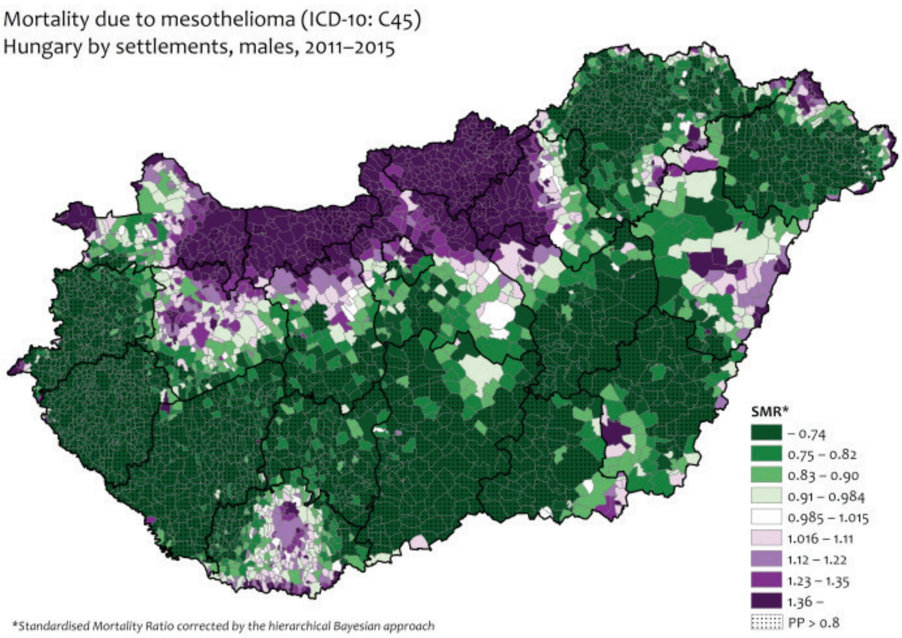




*Figure 23. Geographical distribution of the mortality due to cancer of the trachea, bronchus and lung (ICD-10: C33–C34) in Hungary among 0-64 year old men and women at settlement level, 2011–2015.*

Asbestos pollution poses a special problem. Asbestos fibres can cause pulmonary fibrosis (asbestosis), lung cancer, and mesothelioma. The exposure does not necessarily occur at the workplace, mesothelioma can be caused by residential environment and traffic exposure, but it can develop without asbestos exposure, too. Since the latency of the development of mesothelioma is long, the peak of deaths in connection with asbestos exposure in Hungary – as in other countries – can be expected around 2020-2030. The geographical distribution of mortality is shown in the following maps *(Figure 24)*.



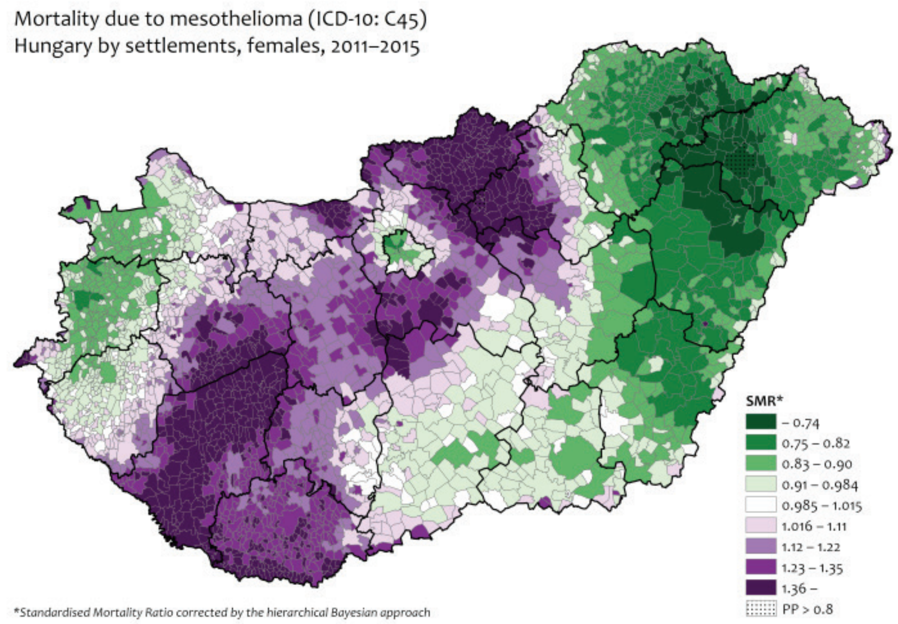




*Figure 24. Mortality due to mesothelioma (ICD-10: C45) in Hungary, 2011–2015, among 0–100 year old men and women at settlement level*

Air pollution, and particularly PM, also plays an important role in the development of circulatory diseases and death, but ozone and nitrogen oxides are risk factors too. Heart failure, the electric conductivity of the heart muscle depends on the $PM_{2.5}$ concentration of the ambient air. Due to the effects of long term exposure of small particulate matter, the early biomarkers of arteriosclerosis can be demonstrated, as thickening of vessel walls, calcification of the heart's coronary arteries.

Mortality due to circulatory diseases is significantly worse in Hungary for both sexes than the EU average, although it shows a significantly declining trend in the past years *(Figure 25)*. *Figure 26* shows the geographical distribution of mortality due to circulatory diseases.

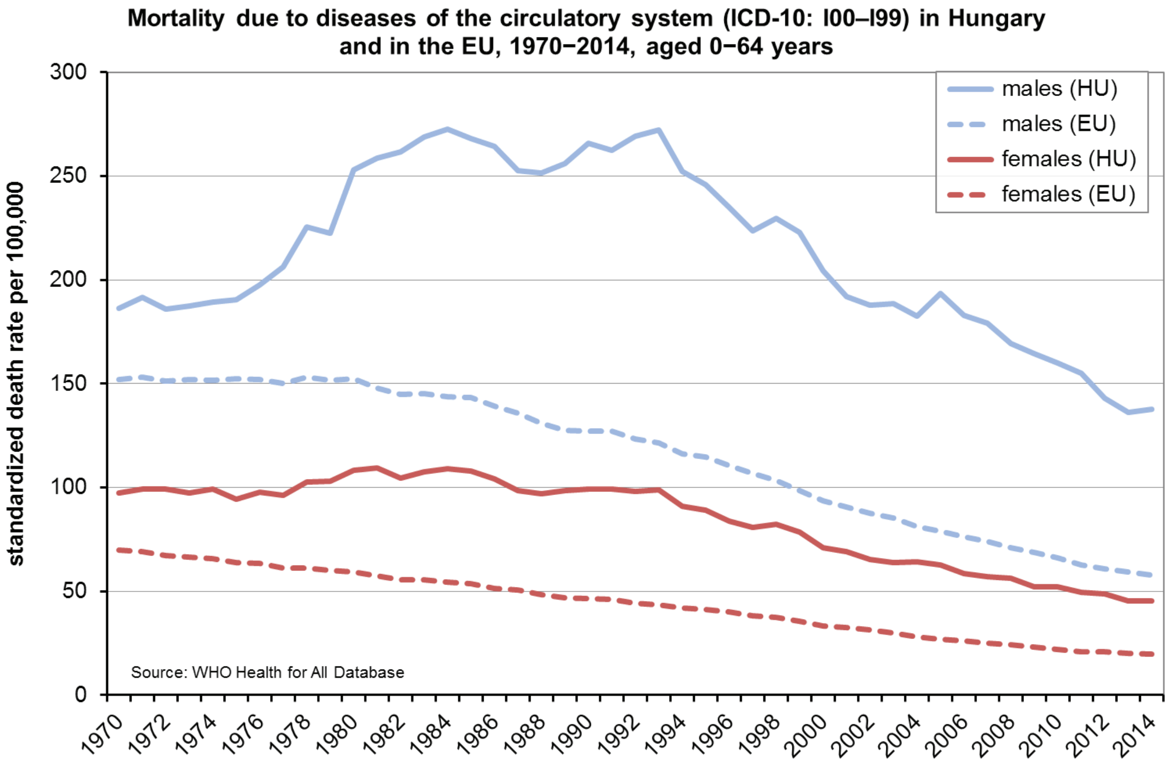
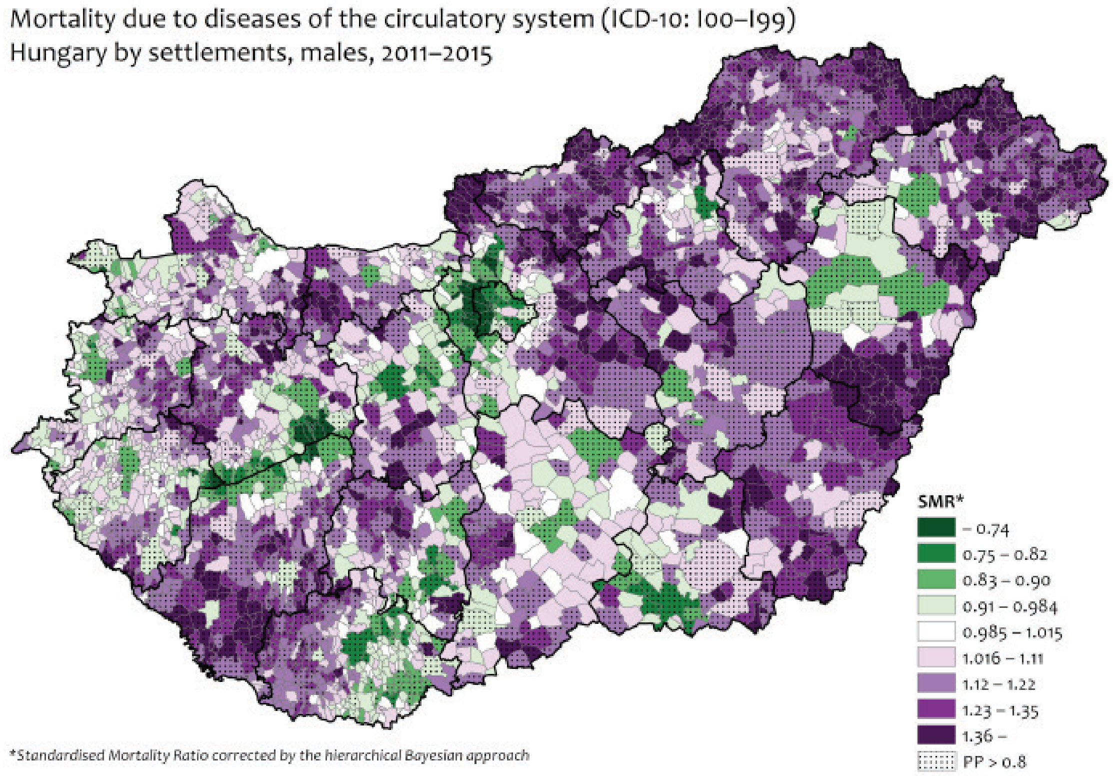



*Figure 25. Mortality due to cardiovascular diseases (ICD-10: I00–I99) in Hungary and the EU, 1970–2014, in the 0–64 age group*



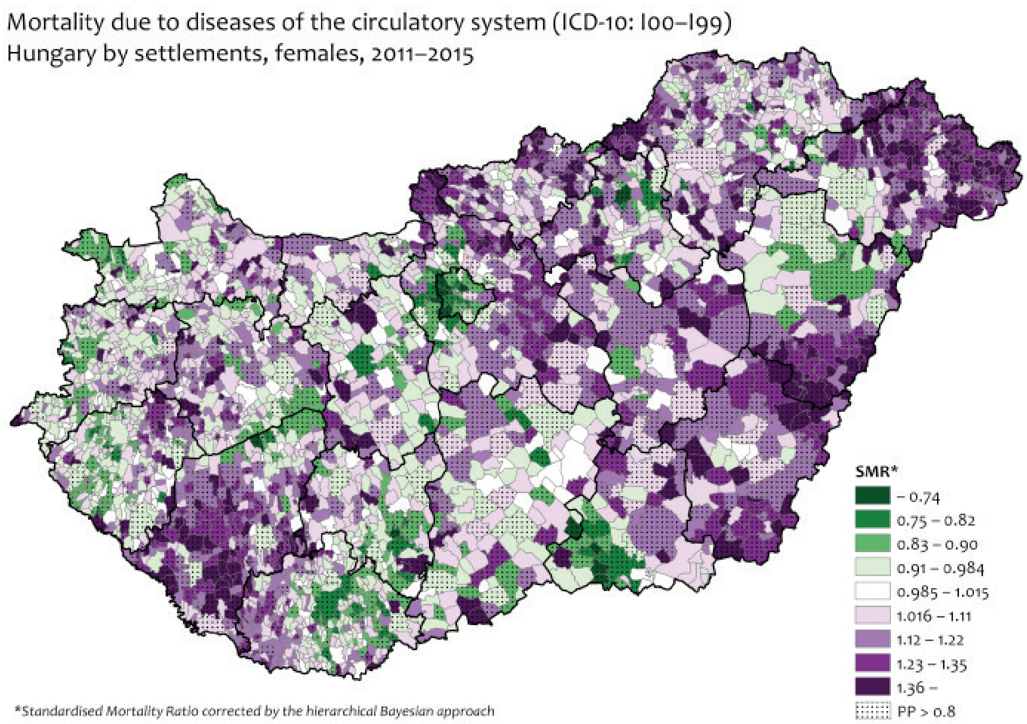




*Figure 26. Geographical distribution of mortality due to circulatory diseases (ICD-10: I00–I99) in Hungary, 2011–2015 among 0–100 year old men and women at settlement level.*

# INDOOR AIR QUALITY

### *Frequency of chronic respiratory symptoms and allergy among 3rd grade elementary school children*

The National Institute of Environmental Health conducted national surveys (National Children's Respiratory Survey, OGYELF-1 and 2) in 2005 and 2010 in order to determine the frequency and most important risk factors of chronic respiratory symptoms (bronchitis or asthma) and allergies of third grade elementary schoolchildren. According to the 67,667 questionnaires completed by the parents in 2010, 18.8% of third grade schoolchildren had *chronic bronchitis symptoms* in the previous fall-winter period. In the 12 months preceding the survey, 20.6% of the children had *asthmatic symptoms* with wheezing of varying severity, while the rate of children receiving *medical care* due to asthma was 6.2%. The studied chronic respiratory symptoms were significantly more frequent among boys than among girls *(Figure 27)*.

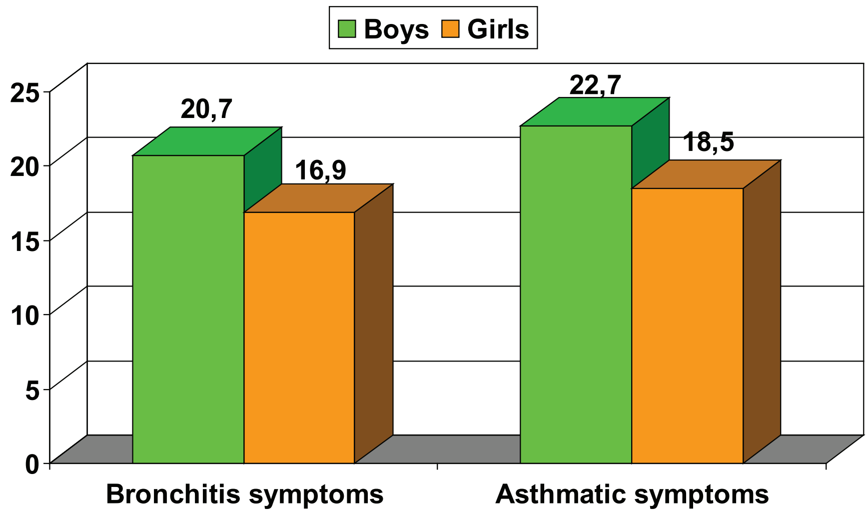



*Figure 27. Frequency of the studied chronic respiratory symptoms among third grade boys and girls (2010).*

The frequency also correlated with the size of the settlement: both the bronchial and allergic symptoms were most frequent in settlements with less than 5,000 inhabitants and they were the least frequent in Budapest *(Figure 28)*. With regard to the regions, the two extremes were represented by the Northern Hungarian and the Central Hungarian (and West-Transdanubian) Regions *(Figure 29)*.

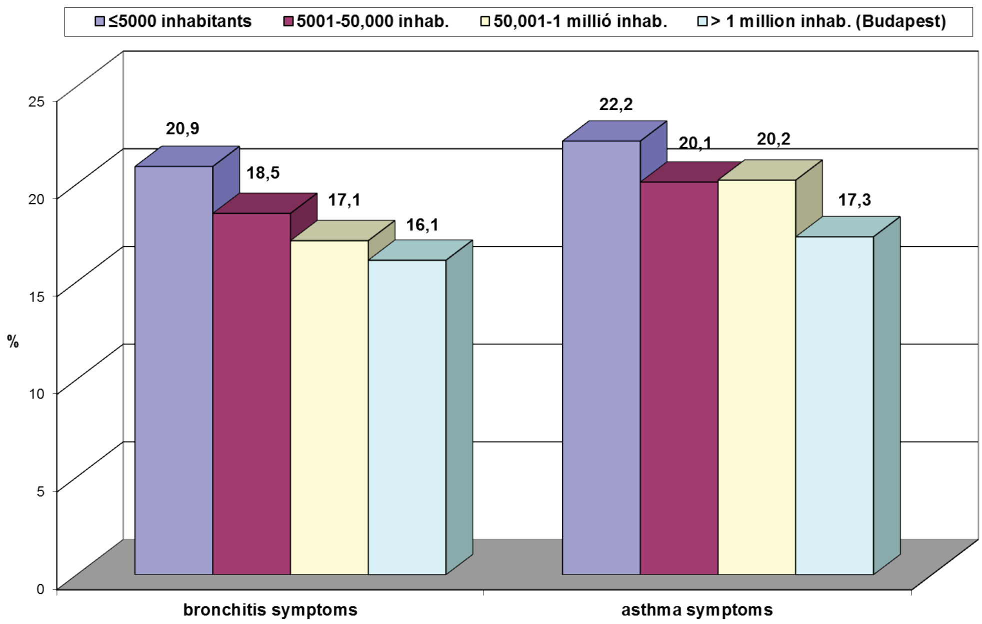



*Figure 28. Prevalence of the chronic respiratory symptoms of 3rd grade schoolchildren according to settlement size (2010).*

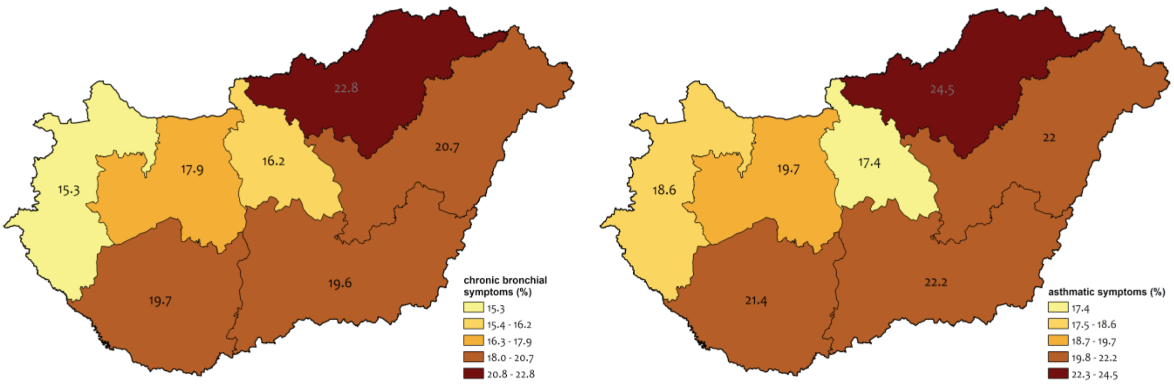



*Figure 29. Prevalence of chronic bronchitis (left) and asthmatic (right) symptoms of 3rd grade schoolchildren according to regions (2010).*

*Figure 30* summarizes the significant indoor risk factors of chronic bronchitis symptoms. Adobe (mud) walls are frequent in small villages. Generally they have a pleasant indoor climate but they easily get mouldy which explains their adverse health effect. Crowding is a well-known risk factor of chronic respiratory diseases. Plastic floor may emit phthalates responsible for respiratory effects. Coal or wood fuelled cookers, mostly occurring in small villages, and frequent use of insecticides were found to have the most serious impact on the prevalence of chronic bronchitis symptoms of 3rd grade schoolchildren.

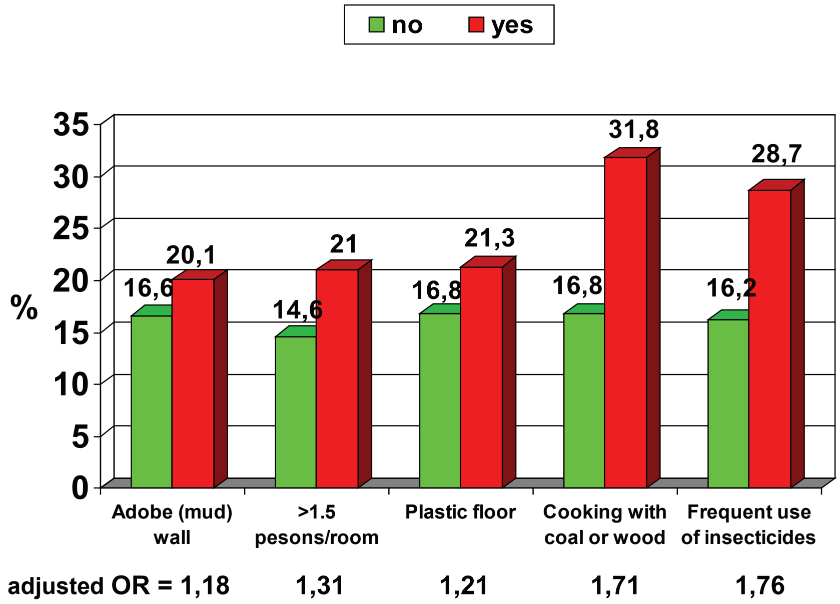



*Figure 30. Significant indoor risk factors of chronic bronchitis symptoms of 3rd grade school-children in Hungary (2010)*

According to the parents' answers to the frequency of *allergic symptoms* in 2010 was 26.2%, the proportion of *diagnosed allergy* was 20.2%. Allergic symptoms and doctor-diagnosed respiratory-, ragweed- and pollen allergy were more frequent among boys than among girls. The frequency of diagnosed food allergies was the same for both sexes *(Figure 31)*.

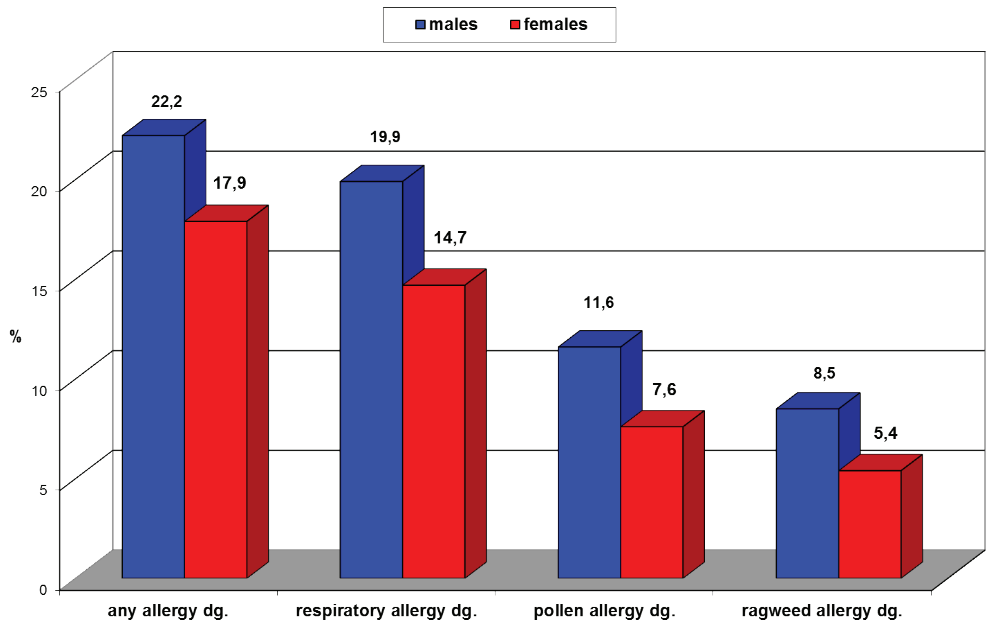



*Figure 31. Frequency of doctor-diagnosed allergy among male and female 3rd grade schoolchildren (2010)*

Taking settlement size into consideration, diagnosed allergy occurred most frequently in big cities. The frequency was the lowest in the settlements that had less than 5 thousand inhabitants and the same trend could be observed with the frequency of the diagnosed pollen allergy (*Figure 32).* This distribution corresponds to international trends, according to which the frequency of allergy is higher in cities than in villages due to the modern lifestyle and the more frequent exposure to the materials used in households.

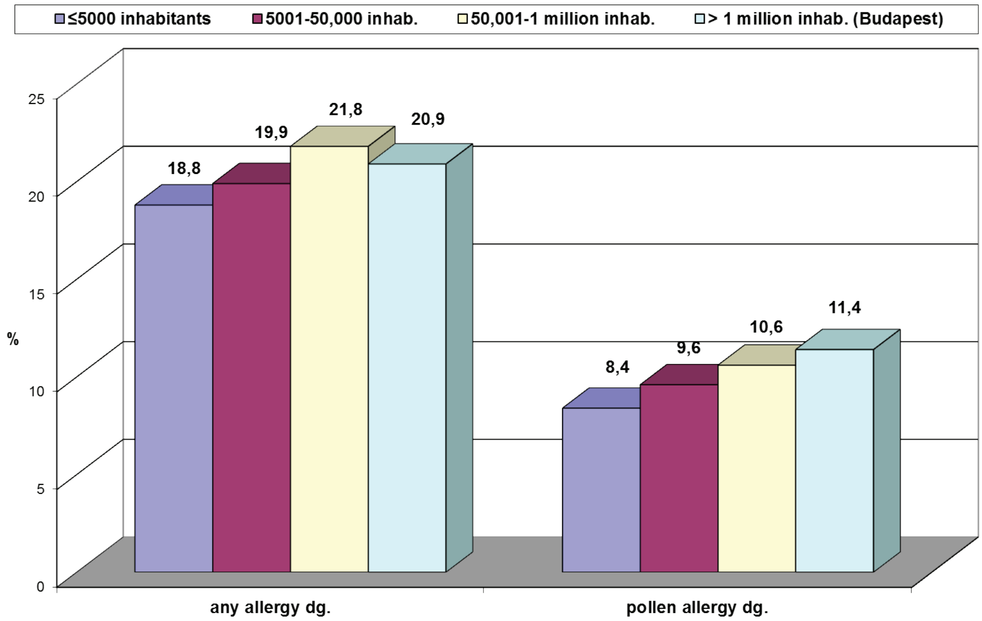



*Figure 32. The frequency of doctor diagnosed allergy among third grade schoolchildren living in settlements of different size*

An analysis of the distribution according to regions showed that the differences between regions were significantly smaller in the frequency of diagnosed allergy, than in the case of chronic respiratory symptoms. The extremes occurred in Central-Transdanubia (21.6%) and in the Northern Great Plain (18%).

## CONCLUSION

Monitoring, identification and reduction of causative factors of diseases related to environmental pollution have always been of great importance. The improvement of living conditions, the reduction of emission has positive effects, however the interaction among lifestyle, socio-economic situation, genetic background and environment have received more and more emphasis.

The environmental situation can be improved by national strategies based on international guidelines and regulations. First of all we have to mention the health strategy framework of the WHO – Health 2020. In formulating the goals of environmental health issues the strategy is partly based upon the Declaration of the Fifth Ministerial Conference on Environment and

Health (Parma, Italy, 2010). The Declaration emphasizes the prevention of diseases by assuring better ambient and indoor air quality. The Sustainable Development Goals of the UN (2015) defines several goals which also contribute to the cleaner and healthier environment like Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all, and Goal 11: Make cities inclusive, safe, resilient and sustainable.

The 7$^{th}$ Environment Action Program of the EU emphasizes the necessity to update regulations related to air quality. The European Commission included the reduction of air pollution in the priority list. The „Clean Air Programme for Europe" formulated a goal to reduce the health impacts (premature mortality due to PM and $O_3$ exposure) of air pollution by 37% till 2025 and by further 44% till 2030.

The Governmental Decision 1330/2011. (X.12.) on the Intersectoral Action Plan to reduce $PM_{10}$ 2012-2020 set up goals to amend air quality. The task of public health authorities is to monitor the health impact of air pollution and give a feedback of the environmental health situation for the government. The above report is a part of this monitoring and reporting process which should be extended by an environmental health impact assessment based on sophisticated methodology elaborated by the WHO.

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