

## Impact of air pollution in Poland to the incidence of the lung cancer in adults (2010-2014)

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**Abstract:** Cancer is one of the diseases with highest rates of morbidity in the world and one of the leading causes of death. One of the most dangerous is lung cancer, which in men is first in morbidity and mortality, in women in third place in morbidity (in Poland on second) and in the first in mortality. Among the many factors that contribute to the disease is air pollution.

We have analyzed the databases of the Central Statistical Office, the Chief Inspectorate for Environmental Protection, to determine the air condition in Poland in 2010-2015. We compared these parameters with air quality standards proposed by the WHO and the EU, and also in the light of Polish law. Changes in concentrations of SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>10</sub> over the past six years have compared the number of cases of lung cancer in the same period, obtained from the National Cancer Registry. Unfortunately, the number of lung cancer cases is constantly increasing, with a slight improvement in some of the air quality parameters.

Due to the observed trend, we have been focusing on the issue of screening for lung cancer and their cost-effectiveness. According to the authors, the increase in the number of lung cancer cases is worth considering a screening program in the risk group. This will not, of course, replace education and campaigns aimed at reducing risk factors.

**Keywords:** Lung cancer, PM 2,5, PM10, screening

### 1. Cancer

Cancer is a term for a group of diseases in which diseased cells begin to divide without limitation from the immune control of our body. Cancer can develop almost anywhere, normally cells die due to age and previous damages in order to give space for new cells, which are currently needed in the body. When the disease develops, this regimen stops working. Damaged cells multiply more and

more frequently and they resemble their prototype less. This excess of cells can form solid structures – tumors, but for example blood cancers usually do not form solid structures. Malignant tumors along with their growth obtain the ability to infiltrate neighboring tissues as well as create metastases via the blood or lymphatic system in distant tissues [1].

#### 1.1. Cancer morbidity and mortality

Cancers have one of the highest morbidity rates – about 12 million new cases worldwide in 2012, which means that for every 100,000 people, 182 of them will develop cancer. Unfortunately, this is also one of the main causes of death, approximately 8 million people have died due to cancer in the same period. By showing this in a more graphical way, every 100,000 people 102 of them died during the study year because of the cancer. As for the

mortality rates, subsequent to cancer were the following causes: ischemic heart disease, stroke, pneumonia. It is interesting that the highest incidence of cancer occurs in highly developed countries (North America, Western Europe, Japan, South Korea, Australia, New Zealand), but as many as 60% of all cancers occur in Africa, South and Central America, Asia and results in 70% of fatalities [2].

#### 1.2. Risk factors

Cancer is a multifactorial disease, we can draw here attention to some of the types of cancer (e.g. colorectal, breast cancer) [3, 4], in some viral factors are more important

(cervical cancer, Merkel cell carcinoma) [5÷7]. A wide range of risk factors are the most common in our environment, one can say that for those we can influence the most in our

daily lives. First of all, the environmental pollution should be mentioned – further discussed in more detail on the issue of air pollution in the context of lung cancer. Stress, lifestyle, working conditions (exposure to pollution), diet and alcohol consumption are factors that affect our health and the potential

development of cancer. Active and passive smoking is a significant risk factor and threat to our health, which is important not only in the case of lung cancer but also other cancers, not to mention even other lung and cardiovascular diseases [2, 8].

## 2. Lung cancer

### 2.1. World distribution of lung cancer

According to the World Health Organization report from 2014 (data for 2012), lung cancer is the malignant tumor with the highest morbidity among all cancer types. Gender inequality in cancer distribution is worth noting – among men, lung cancer is in the top place in the world – frequency 34.2/100,000 worldwide, resulting in 16.7% of all cancers. In women the situation is only slightly better, lung cancer occupies third place

(8.7% of all cancers) behind breast cancer (25.2%) and colorectal cancer (9.2%).

Unfortunately, lung cancer is also responsible for the highest mortality of cancers in the world – it accounts for 19.4% of cancer deaths, which gives us almost 1.6 million people in 2012. It is characterized by a very poor prognosis – statistically only in 5.8% patients diagnosed with lung cancer 5-year survival rate is predicted [2].

### 2.2. Distribution of lung cancer in Poland

According to the data available in the National Cancer Registry of Poland we can see that in Poland (data for 2013) the most common malignancy cancer in men was lung cancer 48.1/100.000, resulting in 18.7% of all cancers in Poland. In women, same for the worldwide statistics, lung cancer was in third place – 8.8% of cases (31/100 000).

Unfortunately, in the case of cancer mortality in Poland, lung cancer is at the top place mortality rates of both men and women. The 5-year survival rate was 13.1%, which is better than world-wide statistics. Sadly, however, we must say that in the case of both morbidity and mortality Poland is above the European Union average [9].

### 2.3. Gender differences in lung cancer

Based on the available data [9, 10], we see a growing trend for lung cancer in women over the years, while in men it is on a similar level, in some parts of the world, decreasing. Women are more likely to be diagnosed with adenocarcinoma, which is strongly associated with smoking, but the more commonly diagnosed men in squamous cell carcinoma has

an even stronger correlation. We can see an upward trend in the incidence of adenocarcinoma, which may also suggest other risk factors [10, 11]. Certainly, cultural changes and the increasing popularity of smoking among women are not without reason.

## 3. Tobacco smoking epidemic

Tobacco smoking has a significant negative impact on our body, as it contributes to numerous cardiological, pulmonological and oncological diseases [8, 12÷16]. The World Health Organization estimates that around 6 million people die each year from tobacco-related illnesses. We are pleased to welcome the fact that the number of cigarettes smoked in

developed countries is decreasing. It is difficult to say clearly whether this is due to awareness of the harmfulness of this addiction or legal regulations (high taxes, restrictions on smoking places, anti-smoking campaigns) [2]. Unfortunately, in developing countries, the consumption of tobacco products is constantly increasing.

#### 4. Air pollution

Air purity is recognized as one of the important health parameters and welfare criteria. The World Health Organization has been dealing with air quality since 1987, when the first guidelines for standards and norms for pollutants were issued. Since then many researches and studies have been done on the harmfulness of those substances (most commonly SO<sub>2</sub>, NO<sub>2</sub>, Benzene, Ozone, PM2.5,

PM10), which are largely the result of human kind activities, especially the development of technology and industry. Since the publication of the first guidelines, it has become important for public opinion to take care of the quality of the surrounding environment. This issue is constantly gaining momentum.

##### 4.1. Sulfur dioxide (SO<sub>2</sub>)

Sulfur dioxide is a chemical compound which is being emitted into the atmosphere from both natural and industrial sources. It is not a neutral compound – exposure to its increased concentration in the atmosphere has a negative impact. We can distinguish short-term exposure to elevated concentrations of over 500 µg / m<sup>3</sup> within 10 minutes and long-term exposure of over 20 µg / m<sup>3</sup> per day

[17]. A result of increased exposure may be irritation of the airways, intensification of chronic respiratory diseases, chronic cardiovascular diseases. A measurable index to this correlation lies in the increased frequency of patients reporting intensification of the symptoms to Hospital Emergency Departments during periods of elevated levels of SO<sub>2</sub> in the atmosphere [18÷19].

Tab. 1 Average daily concentrations of SO<sub>2</sub> in Poland in 2010-2014, SO<sub>2</sub> emissions in 2010,2014, Lung cancer incidence ICD-10 C33 + C34 in 2010-2014

	2010	2011	2012	2013	2014
Concentration of SO <sub>2</sub> (µg/m <sup>3</sup> )	6,1	4,6	6,6	2,4	2,1
Emission of SO <sub>2</sub> (in thousands of tons)	970	-	-	-	800
Morbidity of lung cancer cases (ICD-10 C33 + C34) (absolute numbers)	20871	20837	21870	21556	22032

Source: Prepared by the author on the basis of data of the Chief Inspectorate for Environmental Protection, Central Statistical Office– Ochrona Środowiska 2016 oraz Didkowska Joanna, Wojciechowska Urszula. Zachorowania i zgony na nowotwory złośliwe w Polsce. Krajowy Rejestr Nowotworów, Centrum Onkologii – Instytut im. Marii Skłodowskiej-Curie. Available on the website <http://onkologia.org.pl/k/epidemiologia/> dostęp z dnia 13/06/2017

Based on Table 1, we can see that the standards proposed by the World Health Organization are respected in Poland and the SO<sub>2</sub> emission from industrial sources in the

country is decreasing. Despite optimistic data, the incidence of lung cancer still continues to increase.

##### 4.2. Nitrogen dioxide (NO<sub>2</sub>)

Nitrogen oxides mainly represented by nitrogen dioxide are pollutants mainly attributed to road transport. Most of them are formed by NO reaction with ozone. This is another chemical with proven harmful effects, whether in animal studies or humans. Here we also have guidelines prepared by the World Health Organization – the annual norm of 40 µg / m<sup>3</sup> and hourly 200 µg / m<sup>3</sup> [17]. Any

crossing of standards may have a negative effect, it is particularly worth emphasizing in the context of the difference between the WHO guidelines and the Polish and European legislation. The effects of exposure to elevated levels appear in every age group and may occur even in fetus as a low birth weight, low weight in relation to the gestation week or premature birth [20]. This also increases the

risk of children patients in the Emergency Departments due to intensification of symptoms of respiratory diseases [21]. In adult life through long-term exposure to car exhaust

fumes our cardiovascular diseases risk may be increased [22], and we can not forget the increased risk of cancer including lung and breast cancer [23, 24].

Tab. 2 Average annual concentrations of NO<sub>2</sub> in Poland in 2010-2014, NO<sub>2</sub> emissions in 2010, 2014, Incidence of lung cancer ICD-10 C33 + C34 in 2010-2014

	2010	2011	2012	2013	2014
Concentration of NO <sub>2</sub> (µg/m <sup>3</sup> )	19,7	19,7	18,54	18,3	18,09
Emission of NO <sub>2</sub> (in thousands of tons)	874	-	-	-	723
Morbidity of lung cancer cases (ICD-10 C33 + C34) (absolute numbers)	20871	20837	21870	21556	22032

Source: Prepared by the author on the basis of data of the Chief Inspectorate for Environmental Protection, Central Statistical Office – Ochrona Środowiska 2016 oraz Didkowska Joanna, Wojciechowska Urszula. Zachorowania i zgony na nowotwory złośliwe w Polsce. Krajowy Rejestr Nowotworów, Centrum Onkologii – Instytut im. Marii Skłodowskiej-Curie. Available on the website <http://onkologia.org.pl/k/epidemiologia/> dostęp z dnia 13/06/2017

Based on the data in Table 2 we see a decrease in both NO<sub>2</sub> concentration and its emission, analogically to SO<sub>2</sub>. This fact can be explained that the greater risk is the exposure

to the harmful factor itself and the its duration – the greater risk lies in the longer duration and not the intensity [25]

### 4.3. Benzene

The main source of benzene is the processing of crude oil, road transport. It is used in industrial production and we can also find it in tobacco smoke. Under the Polish and European legislation, its annual air quantity is 5 µg/m<sup>3</sup> – the 2005 WHO guidelines do not comment on this. What worries us that it can be also found in food and water. It has toxic

and narcotic effect on the human body [26], which can result in increased mortality, including acute and chronic myeloid leukemia and lung cancer [27]. Negative impact is not limited to cancer proliferation, but also to the damages within reproductive, nervous, immunological, cardiovascular and respiratory systems [28].

Tab. 3 Average annual concentrations of benzene in Poland in 2010-2014, Benzene emissions in 2010,2014, Incidence of lung cancer ICD-10 C33 + C34 in 2010-2014

	2000	2010	2011	2012	2013	2014
Concentration of benzene (µg/m <sup>3</sup> )	2,51	2,25	2,06	2,29	1,88	1,78
Emission of benzene (in thousands of tons)	57	-	-	-	-	-
Morbidity of lung cancer cases (ICD-10 C33 + C34) (absolute numbers)	-	20871	20837	21870	21556	22032

Source: Prepared by the author on the basis of data of the Chief Inspectorate for Environmental Protection, Central Statistical Office – Ochrona Środowiska 2016 oraz Didkowska Joanna, Wojciechowska Urszula. Zachorowania i zgony na nowotwory złośliwe w Polsce. Krajowy Rejestr Nowotworów, Centrum Onkologii – Instytut im. Marii Skłodowskiej-Curie. Available on the website <http://onkologia.org.pl/k/epidemiologia/> dostęp z dnia 13/06/2017

The average concentration in Poland in the case of benzene falls within the limits set by the law. (Tab. 3) But what can cause anxiety is

the increased emissions of this harmful substance, especially given its wide negative impact on the human body.

#### 4.4. Particulate Matter (PM)

Particulate Matter is a mixture of organic and inorganic substances, including toxic substances such as dioxins, furans, or heavy metals suspended in gas. We distinguish two types: PM 10 – that is particles up to 10 microns in diameter – they can reach the airways and lungs. PM 2,5 are particles with a diameter of up to 2.5 micrometers, due to its small size, they can reach not only to the lungs, but also the bloodstream. Major sources of the PM include burning low-quality coal and waste

in old unregulated boilers, chemical, energy and mining industries [26]. Many consequences of exposure to dust can be attributed to circulatory symptoms: arrhythmias, especially ischemic stroke [29÷32] respiratory system: sore throat, cough, intensification of COPD, lung cancer [21, 32, 33]. According to the guidelines proposed by the World Health Organization, the average annual concentration for PM 2,5 should not exceed 10 µg/m<sup>3</sup> and for PM 10-20 µg/m<sup>3</sup>.

Tab. 4 Average annual concentrations of PM2,5 i PM10 in Poland in 2010-2014, PM emissions in 2010,2014, Incidence of lung cancer ICD-10 C33 + C34 in 2010-2014

	2010	2011	2012	2013	2014
Concentration of PM2,5 (µg/m <sup>3</sup> )	34,2	31,7	27,9	26,5	26,3
Concentration of PM10 (µg/m <sup>3</sup> )	37,6	36,7	34	32,1	34,5
Emission of PM (in thousands of tons)	462	-	-	-	383
Morbidity of lung cancer cases (ICD-10 C33 + C34) (absolute numbers)	20871	20837	21870	21556	22032

Source: Prepared by the author on the basis of data of the Chief Inspectorate for Environmental Protection, Central Statistical Office– Ochrona Środowiska 2016 oraz Didkowska Joanna, Wojciechowska Urszula. Zachorowania i zgony na nowotwory złośliwe w Polsce. Krajowy Rejestr Nowotworów, Centrum Onkologii – Instytut im. Marii Skłodowskiej-Curie. Available on the website <http://onkologia.org.pl/k/epidemiologia/> dostęp z dnia 13/06/2017

As can be seen from the information presented in Table 4, the standards for PM 2,5 have been exceeded in many cases over the last few years – and the more liberal EU and Polish norms have been exceedingly disturbed as

well. In the case of PM 10 similar standards were not met, but the scale of their exceedance was lower than in PM 2.5. Optimistic seems to be a downward trend for both concentrations and emissions.

#### 5. Air Quality

Due to the nature and authority of the organization, when writing about air quality, in many places we refer to the standards of the World Health Organization issued in 2005 [17]. Other proposed standards that could be taken into consideration are the guidelines adopted by the European Commission under Directive 2008/50/EC of 2008 and the Regulation of the Minister of the Environment of Poland 2012 (Official Journal of 2012, item 1032). Unfortunately, these values are more liberal than those proposed by WHO. Presumably, the

explanation of this fact may be the economic nature of the European Union and the desire to take care of the Polish economy. Sadly, caring for the surrounding environment is associated with costs and limitations. With the ability to trace and compare the various standards of Tab. 4, we should be more attentive to the numerous media coverage of air purity and compliance. By reading the limit values of the norms in the EU and Poland guidelines it is worth mentioning that the WHO determines each exceedance as harmful to human health [17].

Tab. 4 Comparison of air quality for PM<sub>2,5</sub>;PM<sub>10</sub>;NO<sub>2</sub>;SO<sub>2</sub> between WHO, UE, Poland

	WHO	UE	Poland
Annual concentration PM <sub>2,5</sub> (µg/m <sup>3</sup> )	10	25	25
Annual concentration PM <sub>10</sub> (µg/m <sup>3</sup> )	20	40	40
Daily concentration PM <sub>10</sub> (µg/m <sup>3</sup> )	50	50	50
Number of exceedance days allowed for PM <sub>10</sub>	0	35	35
Daily concentration SO <sub>2</sub> (µg/m <sup>3</sup> )	20	125	125
Number of exceedance days allowed for SO <sub>2</sub>	0	3	3
Annual concentration NO <sub>2</sub> (µg/m <sup>3</sup> )	40	40	40
Hourly concentration NO <sub>2</sub> (µg/m <sup>3</sup> )	200	200	200
Number of hours exceeded for NO <sub>2</sub>	0	18	18

Source: Prepared by the author on the basis of data of the WHO Air Quality Guidelines 2005, Dyrektywa nr 2008/50/EC Komisji Europejskiej, rozporządzenie ministra środowiska Polski z 2012 roku (Dz. U. z 2012 r., poz. 1032)

## 6. Screening of cancer

Early detection and treatment of cancer can reduce the mortality and other complications caused by the disease. This allows to prolong the life expectancy in good health. However, to speak about the legitimacy of conducting such research we have to answer a few questions:

- does the disease included in the research affect the health of individuals or public health and is of the significant importance;
- does its prevalence increases of probability of detection of appropriate (justifying the study) number of cases;
- does the disease has a fairly long pre-clinical (latent) phase in order to detect the disease in the screening test, which precedes the onset of symptoms;
- are there concrete opportunities to implement preventive or curative measures, implementation of which can be cause early prevention, cure the disease or alleviate the course of the disease;
- are there technical capabilities available to carry out such studies in the form of

an organizational structure of appropriately sensitive and specific diagnostic tests and financial means for carrying out the study itself and further care for people with positive screening results [34]?

Responding to these questions in the context of lung cancer, we can say that this disease is so important to the health of individuals due to the long treatment as well as public health – the high cost of advanced disease treatment. As we can see from the statistics, the spread of this disease is constantly increasing. There is a preclinical phase of the disease in which there are no symptoms, and the first symptoms that may disturb us are very unspecific f.ex. cough, hoarseness. There are specific early treatment options – whether in the case of non-small cell lung carcinoma surgery or small-cell carcinoma chemotherapy or immunotherapy. The last question is hard to give an unequivocal answer, because we have research that could be used in this matter – a low-dosage CT or a two-screen X-ray picture. In Poland there is a health care system in which the patient will find care – especially

within the oncological package proposed by the government. But are there adequate financial resources? – in the light

of calculations, should be found, due to the profitability [35÷38].

## 7. Conclusion

Summarizing previous findings and discussions, air quality in Poland requires further attention. Emissions of pollutants tend to be diminishing, but the concentration parameters themselves do not meet the purity standards, which should be cause for concern. We can not judge to what extent the value of measurements is due to pollution produced in Poland and in which the flow of air masses from neighboring areas. Similarly, we can not clearly determine whether the increase in lung cancer incidence is due to exposure to harmful substances in Poland or during migration to foreign countries where concentration is higher. Its necessary to keep an eye on the air quality in the context of different standards, and examine the exact difference between the different standards. In this study, we have highlighted the growing problem of lung cancer, because of the multifactorial etiology

of cancer, we can not blame one factor, whether it is air pollution or tobacco smoking (especially over 30 packs a year). Air pollution can not only increase the risk of disease but also worsen prognosis of existing diseases [39]. In view of the above, it would seem reasonable to consider the appropriateness of screening for lung cancer – which would allow early treatment. Because of the costs of treating lung cancer, nothing will replace the simplest method of raising awareness about risk factors and discouraging smoking [40]. Our study was aimed to identifying the current air quality in Poland based on selected pollutants and assessing their potential impact on lung cancer. In this case we want to point out the necessity of the screening program. We hope that this study will allow you to familiarize yourself with the important issue of the wider audience.

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