

GREEN ECONOMY, POLLUTION INCREASE AND ITS IMPACT ON HEALTH CARE FINANCING MANAGEMENT

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Abstract

In the strategy of Green economy from WHO, one of the five sectors is health care facilities. Its report finds that many forms of asthma and allergies, as well heart disease and stroke related to increasingly intense pollution.. The aim of our research were to analyze the impact of air pollution on increased death on people under 30 year old and health care economy. Material and method: we have used statistic data from Institute of Public Health, and Statistic institute. Results: In the period 2013-2023 years, the percentage of health care costs of Gross Domestic Income was min. 6.6% (2015) to max. 8.2% (2021). As an indicator of pollution, the percentage of the population that died under the age of 30 as a result of pollution in 2018-2019 was 1.8%. It has believed that pollution was the cause of 17.3 % of the total mortality for that year. Pollution mainly occurs in: household heating, dilapidated central heating systems, lignin electricity production, outdated vehicle fleet, traffic and inadequate waste management. Public health spending increased from 49.12% (2013y) to 64.6% (2023y). Discussion: as a medium-developed country on our territory are harmful energy sources. On the one hand pollutants and their elimination are associated with investments in green energy, and on the other hand, reducing the costs of treating the sick as a result of pollution and repurposing funds for preventive health care. Conclusion: Investments in green energy and a green economy will directly affect the reduction of the consumption of health money taken from the fund and their repurposing into direct investments in health services.

Keywords: green economy, pollution, health system

JEL classification: I18, Q52, Q01

1. GLOBAL AIR QUALITY AND CLIMATE CHANGE

Air pollution is the contamination of the indoor or outdoor environment caused by any chemical, physical or biological agent that alters the natural characteristics of the atmosphere. Solid fuel heating appliances in households, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of concern to public health include: particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulphur dioxide. Outdoor and indoor air pollution causes respiratory and other diseases that are a important sources of morbidity and mortality.[1] WHO data show that globally almost the entire population (99%) breathes air that exceeds WHO guideline limits and contains high levels of pollutants, with low- and middle-income countries suffering the highest exposure.[2][3] Air quality is closely linked to the climate and ecosystems of planet Earth at a global level. Many of the drivers of air pollution (i.e., the burning of fossil fuels) are also sources of greenhouse gas emissions. Therefore, policies to reduce air pollution offer successful climate and health strategies to reduce the burden of diseases caused by air pollution. These strategies certainly contribute to the mitigation of climate change in the near and long term. [4] From the smog that hangs over cities to the smoke in homes, air pollution poses a major threat to health and the climate.

1.1. AIR POLLUTION AND DISEASE

Ambient (outdoor) air pollution, both in cities and rural areas, results in fine particulate matter that causes strokes, heart disease, lung cancer, and acute and chronic respiratory diseases.[5][6][7][8] In addition, an estimated 2.4 billion people are exposed to hazardous levels of household air pollution because they use polluting open fires or stoves for heating/cooking that burn biomass (wood and waste) and coal. The combined effects of ambient air pollution and household air pollution are associated with 7 million premature deaths annually.[9][10] Sources of air pollution are multiple and environment-specific. The main sources of outdoor pollution include: residential energy for cooking and heating, vehicles, electricity generation, agriculture/waste incineration, and industry. Policies and investments that support sustainable land use, cleaner energy and household transportation, energy-efficient housing, electricity generation, industry, and better municipal waste management can effectively reduce key sources of ambient air pollution.

The aim of our research was to analyze the impact of air pollution on increased death of people under 30 year old and the health care economy.

1.2. RESEARCH METHODOLOGY

To achieve the set goal, we conducted a retrospective analysis of published data on air pollution in our country from research published by the Institute of Public Health of the Republic of Macedonia: Report on the Health of the Population in the Republic of North Macedonia for 2020 and 2021 [11][12], PHI Institute of Public Health of the Republic of North Macedonia (2025): Trend of Health Indicators "Health for All" in the Republic of North Macedonia in the period 2013-2023 [13], Air Pollution Surveys and Related Health Consequences in Novaci, North Macedonia from 2021 [14], Bulletin on the Movement of Acute Infectious Diseases in the Republic of North Macedonia in January 2025, by the Institute of Public Health of the Republic of Macedonia.[15] Data from the UNICEF website in Macedonia [16]. These data were analyzed in terms of the most prevalent air pollutants, PM particle size, the most polluted regions and cities, as well as the most prevalent diseases associated with polluted air. As well as the needs for treatment of the population as a result of the increased morbidity for certain diseases related to pollution. They are presented in this order in the results.

2. RESULTS

2.1. MOST COMMON AMBIENT AIR POLLUTANTS IN THE REPUBLIC OF NORTH MACEDONIA

People in the Republic of Macedonia, and in general people in the Balkans and Eastern Europe, breathe more toxic air polluted with suspended particles than their neighbors in Western Europe. In fact, the Balkan region is home to many coal and lignite units as well as 7 of the 10 most polluting coal-fired power plants in Europe [17]. World Health Organization (WHO) data shows that air pollution kills around seven million people worldwide each year. Nine out of ten people breathe air that exceeds WHO guidelines for high levels of pollutants, with low- and middle-income countries suffering the highest exposure.[18] The WHO claims that 56% of cities in high-income countries do not meet air quality guidelines. [19] Numerous sources of ambient air pollution have been identified in the Republic of Macedonia, such as: inefficient combustion in household furnaces, dilapidated central heating systems, electricity generation in old thermal power plants using lignite, traffic and outdated vehicle fleet, inadequate waste management, etc. Although overall, air pollution in the country has been decreasing during the period 2006-2016, which is seen in the decreasing trend especially of SO₂ and even PM particles (suspended particles) in ambient air, which is mainly due to the reduced use of fossil fuels for electricity generation and the gasification of heating plants, the entire population in the country is still exposed to concentrations of PM₁₀ particles that exceed the annual limit values of the EU₆ and especially those of the World Health Organization.[20][21]

2.2. THE MOST COMMON DISEASES AND THEIR MORBIDITY TREND DUE TO POLLUTED AIR

For estimates of the impacts of polluted air on the health of the population during long-term exposures, we applied the WHO methodology. In doing so, the input data for the analysis was: the average annual PM_{2.5} concentrations measured at the monitoring stations of the state monitoring network in the Republic of Macedonia (average for two years). The calculations of the impacts on health (Health Impact Assessment-HIA) refer to the effects of long-term exposure to polluted air on mortality (mortality) from all causes (excluding external causes of death) as a selected health outcome, and do not include morbidity (number of patients) due to the same cause/risk factor. Data on mortality from all causes except external (natural mortality) from the last available year (2018) were obtained from the State Statistical Office (SSO). The estimates are based on concentration-response coefficients (CRFs), which in turn are based on certain assumptions established in numerous epidemiological studies. In particular, the CRFs functions used in the WHO software are based on a systematic review of all available studies and their meta-analyses. The burden of disease (Burden of Disease) due to ambient air pollution is estimated by combining exposure to air pollution and its distribution in the population using integrated exposure-response estimates (IERS) from the Global Burden of Disease (GBD) Study 2015/2016 at each exposure level.[22]

The average annual concentration for the period 2017–2018 was 30.04 (µg/ m³). The all-cause mortality rate (age group 30 years and older) was 1483.6 per 100,000 population at risk. The mortality rate under 30 years of age represents 1.8% of the total mortality in the country. It has been estimated that 3408 deaths are lost annually in the Republic of North Macedonia that can be attributed to exposure to current concentrations of PM 2.5 particles. This amounts to 17.3% of the total mortality in the country, and expressed as a rate, current levels of air pollution are attributed to 257 deaths per 100,000 population. Exceeding the WHO limit value of 10 µg/m³ which can be attributed to 2650 15 deaths (13.5% of the total mortality), while exceeding the EU Directive limit value is attributed to about 1600 deaths (8.1% of the total mortality).[11]

2.3. ECONOMIC ASPECTS OF ABSENTEEISM, TREATMENT AND MORTALITY DUE TO AIR POLLUTION

The health impacts and disease burden due to ambient air pollution in the Republic of Macedonia, including the economic losses and costs associated with premature mortality due to air pollution, are significant. We estimated that 3,408 lives are lost annually in our country due to exposure to current ambient air quality (calculations refer to the period 2017-2018), which represents 17.4% of total mortality. Exceeding the limit values of the EU Ambient Air Quality Directive is attributed to 8% of total mortality, while exceeding the limit values of the WHO Guidelines (the previous value of 10 µg/m³) is attributed to 13.5% of total mortality. The burden of disease, as expected, increases significantly among the age group of the population 65 years and older in terms of mortality from ischemic heart disease and stroke, but also in terms of mortality (natural) from all causes. Estimated economic losses and costs, according to the World Bank, amount to 5.2% to 8.5% of gross national product in 2016.[11][12]

Tab.1 Total health care costs as % of gross domestic product (GDP) in the Republic of North Macedonia in the period 2013-2023 [Source 13]

Indicators	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total health expenditure as % of gross domestic product (GDP)	6.92	7.02	6.7	7.57	7.09	7.16	7.3	7.7	8.2	7.4	7.5

The sum of the percentage of the Fund's and the Ministry of Health's funds is increased by 35% as an additional payment from the citizens' personal budget (private treatment, over-the-counter medicines, co-payments, etc.).

Air pollution was estimated to cause 13.7% of all deaths in 2019, a share 3.5 times higher than in the EU. Air pollution also likely contributes to a high prevalence of respiratory conditions, including among children. The country has made a commitment to address air pollution [23], including by transitioning to renewable energy sources and, in 2022, providing subsidies for home insulation [24] However, a more strategic and comprehensive approach is needed to address air pollution from cars and household heating with conventional energy sources such as crude oil or wood.

3. DISCUSSION

Global data show that the level of ambient air pollution is due not only to industry but also to traffic and the use of fossil fuels in households. Staying in a room where cigarettes are consumed is also cited as a cause of air pollution. Many countries, including China, want to reduce pollution through investments in green energy.[25] Such attempts to build renewable energy sources are expensive, which is why countries use loans from the World Bank. Global experts from various fields such as epidemiology, medicine, economics, and climatologists are analyzing the political and economic aspects of reducing air pollution as a cause of climate change, which negatively affects the health of people, animals, and plants.[26] It is thought that the economic costs of climate change and projected that, without intervention, these losses will consume 5% or more of global economic output.

According to some analysts, a global plan of action is needed, since neither the air nor the sky can be divided, and therefore pollution has no borders. Here are primarily several documents: 1. World Health Organization [27][28][29], and Pure Earth [30][31]. 2. Develop robust new estimates of the economic costs of pollution-related disease and death. 3. Elucidate the interconnections between pollution, poverty, and injustice and advance the argument that pollution is a violation of human rights. 4. Examine prospects and pathways for control of pollution and prevention of pollution-related diseases. The Commission found that all forms of pollution were responsible in 2015 for an estimated 9 million premature deaths—16% of all deaths worldwide—as well as for 268 million disability-adjusted life-years (DALYs). Pollution is thus the world's largest environmental cause of disease and premature death. [32] Figure 1 shows the prevalence of diseases at a global level according to data from 2015, which shows that air pollution is represented as a cause of disease in middle-developed countries and more as a cause of mortality than non-communicable causes of death in low-developed countries.

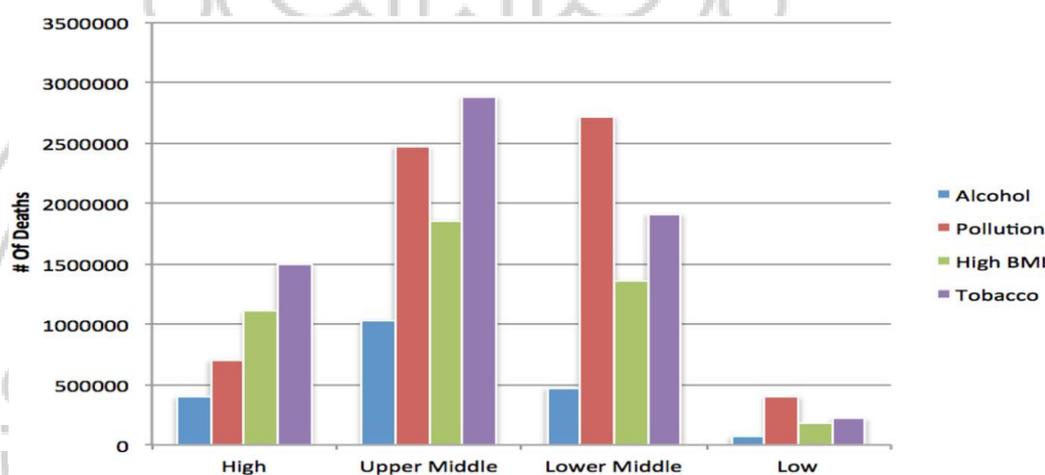


Figure 1. Global noncommunicable disease (NCD) deaths by risk factor and income group, 2015. Note: Adapted from Fuller et al. 2018. [33] Permission for reproduction granted by Lancet Planetary Health.

Although cigarette smoking is the number one risk factor, air pollution is also listed as a significant risk factor by the American Lung Association. Lung cancer mortality increases with exposure to air pollution, and worldwide, according to a study conducted in the mid-1990s, it was 62,000 cases. According to the same study, 60% of these cases are recorded in developing countries, in urban areas. The annual treatment of lung cancer is about \$ 6,000 per patient for radiotherapy, new methods require even greater costs. This does not include the costs of care and improving the quality of life. [34] It is particularly important to note that since 2021, the World Health Organization has classified air pollution as carcinogenic.

The available evidence on the effects of ambient air pollution on cardiovascular diseases (CVDs) has increased substantially. The current epidemiological evidence from systematic reviews and meta-analyses linking ambient air pollution and CVDs, with a focus on geographical differences and vulnerable subpopulations are showing great relation between air pollution and stroke incidence. [35]

The cost of stroke studies were retrieved, the average cost per patient, where specified, or estimated it using a top-down approach. Resulting costs depending of analyze per patient per year and per patient lifetime. Per patient per year costs are larger in high income countries and in studies conducted from the payer perspective.

The highest average per patient per year cost by country was reported in the United States (\$59 900), followed by Sweden (\$52 725) and Spain (\$41950).

According to the latest data from the Ministry of Health from October 2025, there are 5,000 cases of stroke in our country annually. We do not have a specific estimate of how much the treatment costs.

Air pollution is associated with increased risk of certain common neurological disorders. More specific studies are needed to investigate the impact of seasonal haze on neurological conditions. [36]

Its impact on neurological diseases remains underrecognized. The mechanisms by which various components of air pollutants contribute to neurological disorders are not yet fully understood. Air pollutants, including particulate matter (PM_{2.5} and PM₁₀), nitrogen dioxide (NO₂), ozone (O₃), carbon monoxide (CO), and diesel exhaust particles (DEPs). The key findings suggested on the effects of air pollution on neurological disorders, including autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), Alzheimer's disease (AD), and Parkinson's disease (PD). [37]

Parkinson's disease (PD) is the second most common neurodegenerative disorder, with an increasing prevalence worldwide. PD prevalence of 928 per 100,000 individuals aged 50 years and older in 2016, higher in men (1032 per 100,000) than in women (831 per 100,000). The total mean cost of care for PD was estimated at €22,673 per patient per year in 2016, with the highest costs being associated with long-term care (69%). [38]

The new WHO guidelines for healthcare workers and the healthcare system provide guidance on taking care of ambient air, starting with each of us individually, but also by implementing preventive measures first and foremost as an example for society in healthcare institutions. [39]

Indirect costs, including transportation, accommodation and missed work, further impede access to health care services, particularly for rural and disadvantaged populations. In the WHO study, nearly half of rural respondents identified indirect costs as serious barriers, compared to a quarter of urban respondents.

Overall, evidence on the quality of health services in North Macedonia remains limited. Key indicators on the quality of care that are available for many EU countries are lacking. These include avoidable hospital admissions for chronic conditions, in-hospital mortality rates and cancer survival rates. Patient satisfaction has not been much in focus and there are no regularly conducted surveys to monitor what patients think and need in terms of specific and integrated care [40] (WHO Regional Office for Europe, 2019b).

CONCLUSIONS

Polluted air has an effect of increasing the costs for treating the sick, the mortality rate, and thus weakens the health system and the economy in the country as a whole.

Polluted air cannot be isolated, People should be directed towards green energy, starting from households to industry, but the production of healthy food should also be a priority and the prevention of diseases.

However, our primary role as individuals is to put pressure on the authorities to do their job correctly in changing the laws and standards that will reduce and control air pollution.

If industries and individuals are obliged to respect these standards, we will all be one step closer to a cleaner, less polluted, calmer, healthier and greener world. The action must start from medical health center: building-related energy efficiencies, on-site energy generation and storage, intensified development and use of low-energy medical devices, appropriate use of natural (mixed-mode) ventilation and natural day lighting, on-site rainwater capture and treatment, as appropriate, waste/sewage treatment as appropriate, siting of facilities to improve access to health care by mass transport and active transport, materials procurement and waste reduction/management strategies, expanded use of telehealth and other home-care strategies, reduction, recapture/reuse of inhaled anaesthetics.

Finally, there is a need for more systematic measuring and benchmarking of health sector energy consumption and emissions, as well as of overall environmental performance in the context of "greener" facility designs and use of renewable energy sources. Systematic assessment of the actual health impacts and economic impacts of energy-saving technologies, designs and devices is needed to identify the most cost-effective and practical strategies, particularly for low-resource settings.

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