Respiratory Diseases Caused by Air Pollution and Interventions

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Abstract. Air pollution become a concerning environmental problem nowadays, and the morbidity of respiratory diseases caused by air pollution increased rapidly in recent years. Interventions for air pollution and respiratory diseases related to air pollution is essential. The essay mainly discussed the background of air pollution and respiratory diseases, the harm to public health, interventions for air pollution and factors related to respiratory diseases. Through the comparison between interventions in China and western countries, it can be seen that most interventions are the same, for example setting standards for emissions, warning people risk factors of respiratory diseases and taking protective measures. The difference between the interventions is that Chinese residents turn to have less knowledge about the diseases and risk factors and they rely on authorities more, while western people's individual efforts and personal willing play important roles in policies and actions, both the government and individuals are important in the control of air pollution and the protection of public health towards air pollution.

Keywords: Public health; air pollution; respiratory disease; policy and intervention.

1. Introduction

Air pollution is consisted of various gases, finely fragmented particles or finely dispersed liquid aerosols, which are released at a rate greater than the capacity of the environment to disperse, dilute or absorb. Person's health, finances and aesthetics are likely to be dramatically impacted by the content of these pollutants in the air. Among all these negative effects, the damage and risks caused by air pollution to human's health will be illustrated in the following paragraph.

Although the world heats up thoroughly and gets crowded, the dirty emissions are still continuedly released from the engines. The overwhelming majority of the world's population cannot get access to the unpolluted air, due to the shortage of clean energy. Among the world population, nine out of ten people breathe the harmful oxygen, and 7 million people die from it every year. The quality of air being used by 99% of the world's human being is in violation of norms by WHO. Air quality is now monitored in more than 6,000 cities in 117 countries, results in people living there are still exposed to harmful levels of nitrogen dioxide and toxic particles. Among those people who are impacted, the ones in low- and middle-income countries are suffering from the hardest hit [1]. Air pollution has a significant negative impact on health. It is responsible for one-third of deaths from cardiovascular disease, pulmonary cancer and apoplexy. The effect of the pollution is comparable to the use of cigarettes and much greater than the effect of excessive salt consumption. No matter how affluent the residence is, air pollution is inevitable. The lungs, heart and brain can be damaged by air pollutants that can escape the body's defenses and penetrate deep into the body's blood system. WHO estimates that the pollutants kill 7 million people each year. Take London as an example, the severe smog in 1952 killed more than 4,000 people within half a year. Ground-level ozone causes muscle contractions in the lungs, making breathing difficult. Exposure to large amounts of ozone may cause severe pulmonary diseases and have negative impact on respiratory system. The symptoms of short-term exposure usually disappear quickly, but long-term exposure is associated with major illnesses and diseases of several body systems. In addition to other groups, people either relatively young or

old, as well as those who feel continuously ill, are at risk of the effects of air pollution. Due to high levels of urban pollution, urban residents are also more at risk.

Air pollution is caused by chemicals or particles in the air that can harm human health. Prolonged exposure of humans to this environment will lead to respiratory and other diseases, as well as serious damage to organs such as the brain, kidneys and liver.

According to WHO statistics, in 2019, the WHO air quality guidelines are not met by practically all of the world's population [2]. Sulfur dioxide, ozone, carbon monoxide, particulate matter and nitrogen oxides are the primary pollutants.

Depending on the source of the pollution, it can be categorized as household air pollution or ambient air pollution. Indoor air pollution often comes from indoor cooking over open fires. Pollutants such as particulate matter and carbon monoxide from incomplete combustion of fuels will have a more serious effect in an enclosed space. In 2020, 3.2 million deaths in 2020 were attributed to household air pollution, including 13.5 percent of children under the age of 5. Of all deaths, 32 percent were from ischemic heart disease, 12 percent from stroke, 21 percent from lower respiratory tract infections, 19 percent from chronic obstructive pulmonary disorder and 6 percent from cancer of the lungs [3].

Outdoor air pollution, mostly from vehicles and industrial facilities, poses health problems in all countries. Nitrogen dioxide, ozone, and particulate matter from industrial and vehicle emissions can irritate the respiratory tract; sulfur dioxide from the burning of fossil fuels makes it difficult to breathe; and carbon monoxide from forest fires can worsen symptoms of heart disease. There are other air toxins, many of which can cause genetic mutations or cefancer. In 2019, 4.2 million premature deaths were attributed to ambient air pollution, with 89% of these fatalities occurring in low- and middle-income nations [4].

This paper aims to discuss the respiratory illnesses brought on by air pollution as well as interventions for these conditions in China and western nations.

2. The Epidemiology of Respiratory Disease

Air pollution may affect the respiratory system and become a threat to people’s health. The respiratory system is an important system in people’s body, the main function of respiratory system is to gain oxygen from the environment and release carbon dioxide. Therefore, respiration is a process in which the body and external environment exchange gas. Respiration has the basic function to maintain metabolism of the body and life activities. The respiratory system consists of respiratory tract and lung.

The respiratory diseases can be divided into three main parts, obstructive lung diseases, restrictive ventilatory disorders and pulmonary vascular diseases. Obstructive lung diseases include asthma, chronic obstructive pulmonary disease (COPD), bronchiectasis, bronchiolitis, etc. Restrictive ventilatory disorders include parenchymal diseases, neuromuscular diseases and pleural diseases. Pulmonary vascular diseases include pulmonary embolism, pulmonary arterial hypertension and pulmonary veno-occlusive disease. The exacerbation of the respiratory diseases may cause severe consequences like respiratory failure and stroke.

The pathogenesis of respiratory diseases includes several aspects. First, microbial infection is a main cause of respiratory diseases. Virus like adenovirus, influenza virus may cause respiratory tract infection, bacteria can lead to diseases like pneumonia and flu. Besides, mycoplasma and chlamydia may also cause respiratory diseases. Secondly, climate change and environmental pollution is another factor that led to the development of respiratory diseases. The inhalation of polluted air, dust, irritant gas and smoke can cause the deposition of toxic substance in lung, causing damage to lung function and result in the development of respiratory diseases [5]. Thirdly, anaphylaxis can also respiratory diseases like bronchitis. The inhalation of allergen induces the happening of anaphylaxis, causing inflammation of respiratory system.

Most people are susceptible to respiratory diseases. Most people contract cold one or two times every year. Generally, people from all age groups, regions and countries are affected by respiratory diseases. Among the susceptible population, children, older people are more likely to get respiratory diseases. People with underlying diseases and has impaired immunity are also having higher risk of getting respiratory diseases [6].

3. Interventions forAir Pollution

3.1. Policy and Personal Interventions in China

Since air pollution affect people's life through various ways, especially causing damage to respiratory system, Chinese government and organizations have taken measures to reduce air pollution and protect public health. In recent years, China reduced its air pollution at an impressive speed, the air concentration of airborne fine particles (PM2.5) decline steadily. The measures are taken through two main aspects, controlling the emissions in the society and protect individuals from the polluted air. In the controlling part, China takes smokestack solutions and energy transition. Since decades age, China have made efforts in reducing the emissions of smokestacks, coal-powered plants have retrofit the smokestacks and other equipment to eliminate sulfur dioxide in the emissions. In 2013, China released air-pollution prevention and control action plan, in which the standards for industrial emissions were tightened, and some power generators and factories were shut down. These measures help reduce the PM2.5 emissions and improve the air quality [7]. In 2022, the ministry of ecological environment has set the target to reduce heavy pollution days by 2025. Apart from smokestack solutions, energy transition policy may play a more important part in controlling the emission. Some parts of rural China still use coal or wood-fired stove as main heat source, which can produce burning waste and cause air pollution. Therefore, it's Chinese government's effort to change the heat source and supply more household with natural gas or electric heating system. Energy transition can eliminate some of the pollution ways to the air can reduce air pollution.

Protect individuals from air pollution can more effectively control the impact of respiratory diseases to the population. Setting air purifier in particular occasion or when it is reported to be heavy polluted. Air purifier can reduce the concentration of the pollutant and clean the air indoor, using air purifier can help people inhale less particulate matter and reduce the morbidity of respiratory diseases. In the outside environment, wearing a mask in heavy pollution days and when having exposure to long-lasting polluted environment can prevent respiratory diseases. Masks isolate most of the pollutants in the air and protect respiratory system, wearing masks can to some extent protect people's health.

3.2. Policy and Personal Interventions in Western Countries

Air pollution is responsible for noticeable chronic diseases and cause acute respiratory system consequences. According to WHO, 92% of the population is excessively exposed to fine particulate matter (PM) [2]. And developing countries are the most severely affected. The control of air pollution in western countries dates back to more than 100 years ago. The earliest strategies for air pollution are the Chicago legislation, smoke abatement in Boston in America and clean air act in the UK. In these legislations, the electric plants in cities are regulated and the spreading of air pollutants are limited. Afterwards, a series of legislations and programs started in both nationwide and at the international level. The Paris Agreement calls the governments to lower the increasing global warming and temperature below 2℃, and prevent harmful impacts of climate change in cities. On the continental level, European Union enacted guidelines for air pollutants and also released agreements to control and reduce emissions for air pollutants [8]. Besides, prohibition of solid fuel use in homes reduce the amount of smoke produced at home and reduce indoor air pollutants. The set of low emission zones regulate the number of diesel vehicles in cities and improve air quality, therefore prevent the happening of respiratory diseases caused by air pollution.

Apart from policy measures, personal interventions also play important roles in preventing respiratory diseases caused by air pollution. The main personal interventions in western countries include avoiding air pollution sources, for example, stay indoors, filter indoor air, reducing physical activities, and using face masks [9].

3.3. Differences in Interventions between China and Western countries

The main personal interventions in western countries are mostly the same as interventions in China. When experiencing bad air quality, people turn to choose to stay indoors, filter indoor air to avoid exposure to air pollutants and wearing masks when going outside. But there's differences between China and western countries. Western countries call on to consider personal interventions when making recommendations or actions to protect public health. They turn to pay more attention on individual's willing on policies and actions, both the government and individuals play important roles in the control of air pollution and the protection of public health towards air pollution.

4. Interventions for Respiratory Diseases (Allergic)

References are cited in the text just by square brackets [1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading *References*, see our example below.

4.1. Interventions for Allergic in China

Allergic reactions can cause a variety of respiratory diseases, such as hypersensitivity pneumonitis. The prevalence of allergic respiratory diseases in China is increasing year by year. The clinical manifestations of respiratory diseases, such as nasal congestion, runny nose, and sneezing, are chronic and recurrent, affecting patients' quality of life. Allergic rhinitis also has many comorbidities such as asthma. In this case, the public knowledge about the disease is relatively lagging behind. Therefore, the popularization of science and education can not only encourage patients to visit hospitals but effectively improve disease prevention, and reduce the role of the social environment in allergic reactions.

For patients who have been diagnosed with allergic respiratory disease, a common method of intervention is to identify the triggers of allergic reactions through allergen testing, and patients try to avoid the allergens in their lives. This method is inexpensive, highly effective, and has no impact on the social or natural environment. However, on occasions when the patient has to come into contact with the allergen, the allergic reaction can be stopped by taking prophylactic medication in advance. Preventing allergic respiratory disease by patients responding in advance so that they can stop allergic reactions from occurring through their own behavior is effective and is currently the most appropriate intervention.

Assuming that the allergen cannot be identified, patients can prevent or alleviate the occurrence of allergic reactions by taking good protective measures, such as wearing masks and carrying medications with them. Patients diagnosed with allergic respiratory diseases can also improve their lung function through breathing exercises and dietary changes. Patients prepare for possible allergic reactions by preparing protective measures at special times or in special environments, strengthening themselves through exercise, and carrying medications with them. These methods may not always be effective, but they can reduce the probability of the patient having an allergic reaction and thus reduce the prevalence of the disease. It is a very effective intervention in conditions where the allergen is not known.

4.2. Interventions for allergic in western countries

Globally, allergic rhinitis and asthma have become major public health problems with more than 300 million people affected by both diseases, and allergens are often the most common asthma

triggers [10]. In the United States, physicians determine whether symptoms are caused by an allergic reaction based on a patient's medical history. Allergens are identified through two common allergy testing methods----skin testing or blood testing. Patients with suspected asthma also undergo additional asthma testing to help the physician make a diagnosis. Once an allergic condition has been diagnosed, the main form of treatment is to stay away from allergens, which can be done by making lifestyle changes to avoid exposure to triggers of allergic reactions. Allergic reactions can also be controlled or relieved by medications such as nasal sprays, epinephrine, and bronchodilators. In addition, there are complementary therapies that can be used in conjunction with medications to relieve allergic reactions, such as acupuncture and saline nasal rinses.

4.3. Differences in Interventions between China and Western countries

All interventions require that the patient has a confirmed diagnosis of allergic disease before they can be implemented. Therefore, when discussing clinical treatments and preventive methods, it is important to first clarify the public perception of allergic diseases. This will directly affect the diagnosis rate. In China, many people still confuse food allergy with picky eating, or allergic rhinitis, which is common in spring, with the flu. These misconceptions prevent patients from being diagnosed and treated as early as possible, which affects their quality of life.

Scientists are currently focusing on environmental and behavioral factors in the prevention of allergic diseases. Through the role of the external environment and personal behavior, intervention in the process of patients exposed to allergens. Genetic factors, which play an important role in allergic reactions, have not yet been able to fully elucidate the principles or mechanisms of action. Direct avoidance of allergens in life is still the most effective and direct treatment, and the gap between China and the United States in the use of drugs is not very obvious. At the same time, it is the public's perception of the disease that has the greatest impact on these interventions. It is only through early diagnosis that we can receive the correct treatment program and implement interventions to effectively manage allergic respiratory disease.

5. Interventions for Respiratory Diseases (Smoking)

5.1. Interventions for Smoking in China

Smoking has been linked to respiratory conditions such chronic obstructive pulmonary disease (COPD) in the past. It is a major contributor to lung cancer, aggravates asthma, and sets off attacks. However, secondhand smoking makes both adults and children more prone to upper respiratory infections and asthma episodes. Smoke inhaled by the smoker and smoke emitted by cigarettes or pipes are considered secondary smoke. It causes more than 7,000 non-smokers to die from pulmonary cancer each year. Also, secondhanded smoke may increase the possibility of getting cardiovascular diseases and respiratory system disorder [11].

Framework Convention on Tobacco Control (FCTC) from WHO, a specialized agency of the UN, has already seen great success with tobacco control strategies. While public health initiatives like higher cigarette taxes, plain packaging, and restrictions on advertising will deter some people from starting to smoke and persuade others to stop. Most of the heavy smokers will not be able to stop using it without help from a healthcare provider.

One of the clinical professionals' most economical therapies is supporting smokers in giving up. Most smokers who are aware of the risks wish to stop. However, there is less knowledge of the risks in nations like China, which consumes one-third of the overall tobacco throughout the world, and many less wealthy individuals who continue to smoke heavily do not yet have any plans to stop. Because tobacco dependency is a chronic, relapsing illness that often starts in childhood or adolescence, nicotine is an addictive substance. Success rates for attempts to quit on one's own are poor. The same concepts that apply to other chronic relapsing illnesses should be used by clinicians when treating tobacco dependency. This entails providing patients with in time screening based on

evidence, aiming to help patients with both physically and mentally support to produce results, the possibility of expecting a return to life, and providing an ongoing support system to stop.

5.2. Interventions for Smoking in Western Countries

A crucial behavior that affects the future effect of smoking on the health of the crop is the process of the onset of smoking. Smoking varies greatly between different parts of the world due to the initial rate. In some of the leading countries, smoking has fallen significantly from the top, but in many low- and low-income communities it continues to increase. Public health initiatives to reduce the negative health impact of tobacco use on Western high-income nations began in the 1960s and have mostly targeted cigarette smoking. The contrasting patterns of cigarette smoking's global dispersion, emphasizing Western high-income nations' early adoption and numerous lower- and middle-income countries' later uptake. The majority of the evidence on strategies to lower smoking initiation comes from high-income countries. The interventions include school curricula, raising prices through increased excise duties, horrible labels on packaging, restrictions of tobacco companies to advertise, media programs, non-smoking policies, and stop smokers from purchasing tobacco products. In Australia and California, global community initiatives with diverse strategies have been shown to be able to significantly reduce smoking rates. The primary goal of this program is to make tobacco use abnormal and unacceptable in the entire community. Australia was the first country to crack down on advertising in the tobacco industry and make transparent cigarette packaging mandatory (i.e., free of tobacco marketing) [12]. Early research on plain packaging found that young Australians were less likely to buy the cigarettes and more likely to put considerable value on the warnings painted on the package. The horrible warning sign painted on the package of tobacco is one of the earliest way to prevent people from smoking. Tobacco companies and smoking-control campaigners throughout the world will closely monitor Australia's large demonstration project regarding the Australian government’s success in defending its new law in 2012.

6. Conclusion

Air pollution has become a serious environmental problem, with the aggravation of air pollution, air pollutants become a big threat to both people’s health and the environment. Air pollutants mainly affect respiratory system and cause various respiratory diseases, factors like allergic and smoking are the main pathogenesis of respiratory diseases related to air pollution. Since the respiratory diseases caused by air pollution account for a large proportion in the death cases, interventions are made to reduce the negative impact of air pollution and respiratory diseases. Policy and personal interventions include setting emission limits, using air purifier and wearing masks. Interventions for allergic mainly rely on identify the triggers of allergic reactions and make protective measures to avoid the allergens. Interventions for smoking including increasing tax rate of cigarettes, using warning tablets on cigarette packages and combating tobacco industry package advertising. In the comparison of interventions in China and western countries, it can be seen that the main interventions in China and western countries are mostly the same, what makes difference is public’s perception of air pollution and related respiratory diseases. Interventions for air pollution and respiratory diseases to some extent improve the situation of pollution and reduce the morbidity of respiratory diseases, but the interventions still have room for improvement in the future. For example, measures can be taken to let public and especially potential patients of respiratory disease learn more about the diseases and the factors related to the diseases, so that they can make personal protection early and have diagnose and treatment timely. Besides, in the future, more environmentally-friendly vehicles and production modes may reduce the emissions and alleviate air pollution.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

References

[1] 99% of the World Breathes Air That Exceeds Recommended Limits." World Economic Forum, www.weforum.org/agenda/2022/04/poorer-nations-lag-behind-higher-income-countries-in-air-quality-standards-who/.

[2] "Household Air Pollution." World Health Organization, www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health.

[3] "Ambient (Outdoor) Air Pollution." World Health Organization, www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

[4] Ayres, J. G., et al. "Climate Change and Respiratory Disease: European Respiratory Society Position Statement." European Respiratory Journal, vol. 34, no. 2, 2009, pp. 295–302, doi:10.1183/09031936.00003409.

[5] Budreviciute, Aida, et al. "Management and Prevention Strategies for Non-Communicable Diseases (NCDS) and Their Risk Factors." Frontiers in Public Health, vol. 8, 2020, doi:10.3389/fpubh.2020.574111.

[6] Lewis, Dyani. "Air Pollution in China Is Falling — but There Is a Long Way to Go." Nature, vol. 617, no. 7960, 2023, pp. 230–231, doi:10.1038/d41586-023-01452-9.

[7] Jonidi Jafari, Ahmad, et al. "Urban Air Pollution Control Policies and Strategies: A Systematic Review." Journal of Environmental Health Science and Engineering, vol. 19, no. 2, 2021, pp. 1911–1940, doi:10.1007/s40201-021-00744-4.

[8] Laumbach, Robert J., and Kevin R. Cromar. "Personal Interventions to Reduce Exposure to Outdoor Air Pollution." Annual Review of Public Health, vol. 43, no. 1, 2022, pp. 293–309, doi:10.1146/annurev-publhealth-052120-103607.

[9] Wikstén, Johanna, et al. "Primary Prevention of Airway Allergy." Current Treatment Options in Allergy, U.S. National Library of Medicine, 2018, www.ncbi.nlm.nih.gov/pmc/articles/PMC6244611/.

[10] "Smoking and Respiratory Diseases." Johns Hopkins Medicine, 19 Nov. 2019, www.hopkinsmedicine.org/health/conditions-and-diseases/smoking-and-respiratory-diseases#:~:text=Nicotine%20nasal%20spray.%20Nicotine%20is%20also%20delivered%20quickly.,It%20helps%20to%20lessen%20the%20discomfort%20of%20quitting.

[11] Van Schayck, O. C. P., et al. "Treating Tobacco Dependence: Guidance for Primary Care on Life-Saving Interventions. Position Statement of the IPCRG." Nature News, Nature Publishing Group, 9 June 2017, www.nature.com/articles/s41533-017-0039-5. Accessed 05 Oct. 2023.

[12] Australian Government Department of Health and Aged Care. "Smoking and Tobacco Laws in Australia." Australian Government Department of Health and Aged Care, 2 May 2023, www.health.gov.au/topics/smoking-and-tobacco/about-smoking-and-tobacco/smoking-and-tobacco-laws-in-australia. Accessed 05 Oct. 2023.