

The Impact of Air Pollution on the Incidence of Asthma: A Comparative Analysis of Regional Factors

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Abstract. Air quality is closely related to human health and has attracted the attention of governments and people around the world. This paper aims to study whether there is a concrete link between the development of asthma and air pollution. By adopting comparative analysis, it examines three regions (Seoul, Sydney, and San Joaquin Valley) in terms of how different sources of air pollution affect the incidence of asthma. The results indicate that agricultural and industrial pollution cause asthma outbreaks worst in certain areas. The implication of this paper is that the local governments should develop programs to train public health professionals through public health networks. These health networks provide practical training in epidemiology and strategic planning, and help achieve effectively Communication with other health professionals and the public through public speaking, academic reports and scientific investigations, while advocating for other community managers for improved community health. In the meanwhile, it is crucial to improve local air quality through reasonable environmental regulation.

1 Introduction

The term "air pollution" refers to any chemical, physical, or biological component in the indoor or outdoor environment that modifies the natural characteristics of the atmosphere. Some of the primary pollutants that are bad for people's health are particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide. Both indoor and outdoor sources of air pollution are major contributors to respiratory and other ailments, as well as a substantial cause of morbidity and death. According to World Health Organization (WHO) data, low and middle income countries have the highest exposures, with 99% of the world's population breathing air with high levels of pollutants and exceeding WHO recommended limits. Asthma is the most prevalent chronic disease in children and a serious non-communicable disease (NCD) that affects both children and adults.

Asthma is predicted to have impacted 262 million people in 2019, killing 455,000 people. The majority of deaths from asthma occur in low- and lower-middle-income countries, where underdiagnosis and undertreatment are problems. This current research paper is concentrating on the impacts of air contamination on regional asthma rates and confirms that air pollution is directly proportional to the incidence of asthma, and the proportion of young children and the elderly is higher. Asthma results in acute and major health concerns, lost time from work and school, and higher healthcare costs. Even while asthma is often under control, it is nevertheless a dangerous illness that can lead to several issues. Consequently, Asthma is a common condition but should be taken seriously.

Although many previous researches have been on asthma treatments, the direct or indirect effects of specific factors (such as contamination) on asthma incidence have not been well studied. Quantitative research methods will be used in this research paper. First, study the causes of asthma, and then use air quality health risk inventory (AQHI) to explore air quality reports and measures to reduce pollution risks. In this way, this study can look at the relationship between the fluctuation of AQHI value and the outpatient utilization rate of asthma services, and then see whether these data can confirm the hypothesis that air pollution and asthma incidence are positively proportional. The following step is to examine the effect of poor air quality on the prevalence of asthma in various locations using the available data (comparing air quality and asthma incidence in different regions). Besides region, the second variable is age. According to the information on the data website and the comparison with the asthma incidence rate of people of other age groups, it is proved that groups such as the elderly and children have a stronger response to air pollution and a higher proportion of asthma.

2 Literature review

This study is aimed at confirming whether air pollution is directly proportional to occurrences of asthma and whether the proportion of young children and the elderly is higher in comparison with other people of age. Numerous scholars have conducted extensive studies on the onset of asthma, demonstrating that asthma prevalence has peaked in past decades. The prevalence

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of asthma increased from 4.1% to 6.6% between 1990 and 2010 in a series of cross-sectional studies conducted in Italy using the same screening tool. The age- and sex-standardized prevalence of asthma increased by 55% in Ontario, Canada, from 8.5% in 1996 to 13.3% in 2005. The prevalence of paediatric asthma also rose by 30% at the same time [1]. According to American Lung Association, from 2010 to recent years, in 2018, 41.9 million Americans (13.0%) were diagnosed with asthma by a health professional. This is a 43% increase from 1999 (9.1%). In addition, 24.8 million Americans (7.7%) reported having asthma in 2018 despite receiving a medical professional's diagnosis. Anandan et al. methodically reviewed epidemiological literature to determine the asthma prevalence trend. Studies that satisfied the inclusion criteria were found in the review by the team of academics, which also included cohort studies, replicated cross-sectional studies, and healthcare data sets. Overall, they concluded that the prevalence is still rising in many parts of the world and shows no signs of decreasing [1].

Under certain wealthy nations, the incidence rate increased significantly in the second part of the 20th century. Based on this revelation, a number of epidemiological studies were carried out in several countries in the 1990s to ascertain the incidence of asthma worldwide and its causes. Research into the epidemiology of asthma has exploded over the past 20 years. Many scholars have researched the etiology of asthma. These studies found that asthma is caused by a variety of factors, mainly including categories such as environment, emotion, gene, and socioeconomic. Among them, environmental factors refer to outdoor air pollution, and emotional factors include strong emotions such as fear and anger. In addition, there is a genetic component; if one parent has asthma, there is a 25 percent chance that their children will also develop asthma. A final factor has to do with socioeconomic, according to some studies, poorer socioeconomic groups often have greater asthma prevalence and incidence, and more precisely, higher mean asthma scores.

Moreover, an overwhelming majority of research suggests that the environment is a major trigger, especially air pollution. The San Joaquin Valley (SJV) in California has some of the worst air quality in the country. It has the greatest incidence of hospitalizations and asthma symptoms as well because of asthma in California. Using information from the California Health Interview Survey, a researcher looked at the connection between local asthma prevalence and air pollution. The researchers found that, after adjusting for gender, age, race, income level, and insurance status, exposure to PM10, PM2.5, and ozone was linked to a greater likelihood of having daily or weekly asthma symptoms. The researcher also discovered that ozone doubled the likelihood of hospitalizations or ER visits due to asthma, while PM10 raised the likelihood by 29% [2]. This previous research has established that there is a direct link between severe regional environmental pollution and an increase in the incidence of asthma. Other studies have also shown that adult-onset asthma is linked to exposure to contaminated air over time,

especially from sources that burn fossil fuels, such cars, even at levels below current regulations. Past research examined the relationship between prolonged exposure to nitrogen dioxide (NO₂), black carbon (BC), and particulate matter (PM2.5) and the prevalence of adult asthma in Effects of Low-Level Air Pollution: A European Study (ELAPSE), a multicenter investigation. Among 98,326 individuals, with an average follow-up of 16.6 years, 1,965 people developed asthma. The hazard ratios for PM2.5, NO₂, and BC in the fully adjusted model were 1.22, 1.17, and 1.15, respectively. Among subsets of the cohort with exposure levels below EU and US limits and maybe below WHO standards for PM2.5 and nitrogen dioxide, hazard ratios were higher [3]. This study has found that generally lower levels of air contamination can also cause the onset of asthma morbidity. As there is a link between air pollution and the beginning of asthma, whether mild or severe, can have an influence, it is inferred from all the data previously presented that air pollution is directly proportionate to the incidence of asthma.

To examine how these pollutants impact the infection of asthma, researchers have used diverse methods to collect data. Most of the methods are quantitative, but qualitative measurements are also adopted. Some researchers accepted interviews and surveys as methods to conduct their studies. A subgroup of people who were eligible for the 2001 California Health Interview Survey reported having asthma that had been diagnosed by a doctor (14.6%). Therefore, the antecedent research took into account two findings that might indicate uncontrolled asthma [2]. Apart from this, questionnaires can often contain both quantitative and qualitative questions. In a study that looked at how long-term exposure to low levels of pollution affected asthma, 713 kids between the ages of 8 and 12 were observed in two regions close to incinerators and in a control area that didn't have any incinerators that burned sludge. 626 youngsters. Along with data comparisons, they looked at the histamine inhalation test for airway hyperresponsiveness (AHR) and a questionnaire for respiratory disease from the prior year [3]. Nevertheless, this study will adopt a systematic review research method that is different from the above research strategies and make a comparative analysis of different regional and age factors.

3 Methodology

3.1 Data collection

This paper collects information and data based on some journal papers, official websites, and databases, and then compare and analyze the original data from three divergent regions with dissimilar degree of contamination. The study mainly obtained information about the incidence rate of asthma from the official website of the American Lung Association. In addition, this paper also collected the PM2.5 index and air quality reports of the three regions that need to be compared and analyzed in the paper on the IQ Air Website. These three regions are Seoul, South Korea, San Joaquin Valley,

California, USA, and Sydney, Australia. To figure out divergent pollution sources that have the most serious impact on asthma incidence in Seoul, San Joaquin Valley, and Sydney, this paper analyzes the different characteristics of asthma incidence in these three regions and explores the local ecological environment, especially the air quality status, and provides targeted improvement strategies.

3.2 Three areas in comparative perspectives

Considering the similarity of Seoul, San Joaquin Valley, and Sydney, it is without a shadow of a doubt that the asthma rate in all three areas was affected by environmental pollution. There is a relevant study conducted by Park Sung-soo and other researchers from Hanyang University in South Korea. The research made note of the fact that in Seoul, an important risk factor for the onset and acute exacerbation of asthma is outdoor air pollution. At the same time, these scholars also explained that some epidemiological studies other than theirs also showed that higher air pollution levels were associated with acute exacerbations of asthma [4]. According to the official release on the Asthma Australia website, the organization will announce the inclusion of air pollution management activities in the Australian government's ten-year national preventive health policy. At the same time, it is worth noting that for 2.07 million people with asthma, the 10-year national preventive health initiative of the Australian government now recognizes that air pollution can directly affect people's health, such as raising the chance of cancer or asthma [5]. Rull et al. investigated the outdoor air pollution and uncontrolled asthma in California's San Joaquin Valley, according to the ResearchGate website. This research believed that patients with asthma who live in the San Joaquin Valley region, which is more prone to have frequent asthma symptoms because to its greater levels of ozone and particle pollution, as well as to require hospitalization and ER visits for asthma-related reasons [6]. All the evidence mentioned above has directly demonstrated that asthma rates in all three divergent regions are affected by environmental pollution.

Furthermore, this section would concentrate on the disparity between the data of Sydney, San Joaquin Valley, and Seoul. Sydney has a very high incidence of asthma, one of the highest in the world; just under 2.7 million people (10.7% of the population) will suffer from asthma in 2020-21. The San Joaquin Valley of California has the highest prevalence of asthma in the whole state, with one in six children there suffering from the condition. Asthma prevalence rates in the valley is as high as 20% among school-age children. Compared with Sydney and the San Joaquin Valley, the incidence of asthma in Seoul is lower at 3.9%, but the severity of the disease is often underestimated by doctors and patients. In addition to the incidence of asthma, the air pollution index, which is related to the onset of asthma, varies from region to region. The author of this paper gathered air pollution index reports for California's San Joaquin Valley region on the website of the American Lung Association. The table on the website shows that

the index in the San Joaquin Valley area is 51.5, which is nearly twice higher than other areas with relatively serious air pollution. On the IQ Air website, this paper cites Seoul's air quality index (AQI) and PM_{2.5}-related data. Statistics reveals that Seoul has a much lower PM_{2.5} concentration and an air quality score of 39 than the San Joaquin Valley region [7]. This paper also gathered data on Sydney, Australia's PM_{2.5} concentration and air quality index (AQI) on the same website (IQ Air). According to the statistics, the PM_{2.5} air pollution concentration in the Sydney region is 2, while the region's air quality index is 3 [8].

Finally, the sources of air pollutants affecting asthma incidence also varied within the three regions. The air pollution in Sydney, Australia, is primarily caused by bushfires. In Australia, bushfires are a very dangerous issue. More than 8,000 direct casualties were caused by big forest fires in Australia between 1967 and 2013, according to statistics, 433 direct fatalities, and a loss of roughly 4.7 billion Australian dollars. PM₁₀ and PM_{2.5} are the most well-documented toxic substances in forest fire smoke. In most areas of Sydney, the 24-hour average PM_{2.5} concentration in December 2020 was over 100 g/m³ (and might have reached 500 g/m³) due to bushfires, exceeding the WHO recommended threshold of 25 g/m³ by 4 times [9]. Some researchers also found a link between exposure to wildfire smoke and an increased risk of hospitalization and ER visits for respiratory conditions including asthma and respiratory infections. In addition to this, the combustion of fossil fuels and vehicle emissions are the two main sources of air pollution in South Korea. 20 studies have directly assessed the impact of NO₂ and found that a small increase in NO₂ exposure led to a 5% increase in the risk of developing asthma. So, the major source of environmental pollutants in Seoul is related to traffic pollution. Nevertheless, Thanks to the city of Seoul's measures, the incidence of asthma in Seoul has been declining in recent years. Since 2007, Seoul City has been implementing emission reduction policies across the metropolitan region in an effort to enhance air quality and reduce the harmful impacts of air pollution on health. Consequently, Seoul's air quality has increased. In a scientific paper published online at the ScienceDirect website, researchers including Hyomi Kim uncover proof of a relationship between emission reductions and lower ambient concentrations [10]. Since the introduction of these rules, hospital admissions for asthma in Seoul have decreased after previously increasing. The primary cause of air pollution in the San Joaquin Valley of California is farm and agricultural emissions, which are also to blame for the high prevalence of asthma among inhabitants in the area.

3.3 Analysis

Based on all the evidence analyzed above, the incidence of asthma in these three regions (Seoul, San Joaquin Valley, and Sydney) is more or less affected by environmental contamination. In addition, the air pollution index of each region affects the high or low incidence of asthma.

In the Seoul region, vehicle exhaust emissions are the leading cause of air pollution. The pollution emissions generated by industry and residents' lives have not become the main source of air pollution in Seoul. The air pollution in this location is not as bad as it is in Sydney or the San Joaquin Valley. The concentration of PM_{2.5} in Seoul is much lower than in the other two regions, and correspondingly, the incidence of asthma is also much lower.

In the San Joaquin Valley in California, the environmental pollution brought on by business and agriculture is quite severe. As one of the more developed agricultural regions in the United States, its pollution emissions are also worth paying attention to. According to the air quality assessment for this region, there are also high PM_{2.5} concentrations that can cause asthma and other respiratory diseases, which also lead to the area's Asthma incidence was the highest among the three regions. As a long-standing environmental issue, the resolution of these pollution problems requires the joint efforts of the government and agricultural production enterprises.

In Sydney, the main source of environmental pollution is wildfires. According to the information gathered above, Sydney has one of the highest rates of asthma in the world, and the asthma epidemic from 2020 to 2021 will be extremely serious. During that time, local forest fires were also severe. One good news is that in recent years, the Sydney government has increased its governance efforts. The local government's effective management and diversified service has, however, resulted in a drop in Sydney's PM_{2.5} concentration in recent years.

4 Conclusion

Asthma's prevalence is supported by numerous studies from environmental engineering, medicine, and lung science research fields. By examining the impact of diverse air pollution sources on the prevalence of asthma in three different locations, the current study contributes to this body of information. The result demonstrates that agriculture, natural disasters, and urban living cause divergent rates of incidence, with agriculture being the main culprit. The use of secondary literature sources rather than primary sources and the limited quantity of the data obtained, which prevents a thorough analysis, are the study's principal drawbacks.

According to this study, the government in the Seoul region can redirect traffic by widening roads, which will lower the density of pollutants and lower the concentration of pollutants with regard to the environmental pollution brought on by car exhaust emissions in the Seoul region. In addition, Seoul's high population density is also a major issue that urgently needs to be addressed

For the Sydney area, although the wildfire is a natural disaster, its occurrence is actually caused by some man-made activities. In Australia, more bushfires are started by intentional ignition than by lightning or other natural causes. Therefore, these wildfires are more caused by human factors. This constitutes the elements

of a bushfire-related offense which includes making bushfire arson a serious criminal offence. This study argues that local governments can prevent and treat criminals by figuring out why these people start forest fires, and then take targeted governance measures. Only in this way can the local government minimize the air pollution caused by human factors to the greatest extent possible.

For the industrial and agricultural pollution that caused the extremely high incidence of asthma in California's San Joaquin Valley, people can reduce agricultural pollution through the rational use of pesticides and chemical fertilizers, and degradable and less toxic pesticides. More ecological pesticides and organic fertilizers should be used. In addition, the local government should establish strict industrial and agricultural pollutant discharge standards. For industrial pollution sources especially air pollutants, relevant enterprises and the general public should develop the habit of treating pollutants to purify them before discharge.

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