



Impact of air pollution on respiratory health: A case study in Mumbai, India

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Abstract

Introduction: Recent studies highlight the concerning connection between air pollution and respiratory health in two major Indian cities: Mumbai and Delhi. The rising prevalence of asthma, worsened by deteriorating air quality, poses significant challenges to public well-being. Urgent action is needed to protect millions of lives.

Looking Ahead: Despite these challenges, there's an opportunity for positive change. By focusing on air quality management, stricter emission standards, sustainable transportation options, and green infrastructure, we can reduce the impact of pollution on respiratory health. Public awareness campaigns and community involvement are essential for fostering environmental responsibility and empowering individuals to safeguard their health.

A Call to Action: The future of respiratory health in Mumbai and Delhi depends on collective efforts. Policymakers, industry leaders, healthcare professionals, and citizens must collaborate to address pollution's root causes. Together, we can create a cleaner, healthier environment for generations to come.

Conclusion: The link between asthma, air pollution, and the future of respiratory health in these cities is undeniable. Taking decisive action now is crucial to protect public health, preserve our environment, and ensure a brighter future for all.

Keywords: Air pollution, asthma, asthma due air pollution in Mumbai

Introduction

Air pollution is a serious environmental and health issue that affects millions of people around the world. According to the latest State of Global Air report, India is the third most polluted country in the world in terms of PM_{2.5} levels, after China and Bangladesh. PM_{2.5} are fine particles that can penetrate deep into the lungs and cause various respiratory and cardiovascular diseases.

Among the Indian cities, New Delhi, Kolkata, and Mumbai are among the top 20 most polluted cities in the world in terms of PM_{2.5} levels^[3]. New Delhi and Kolkata rank first and second, respectively, while Mumbai stands 14th on the list^[3]. Mumbai has also become the second most polluted city in the world in terms of the global Air Quality Index (AQI), according to Switzerland-based air quality monitoring tech company IqAir^[1, 2]. The AQI is a measure of how clean or polluted the air is, based on various pollutants such as ozone, nitrogen dioxide, sulfur dioxide, and particulate matter.

The main sources of air pollution in Mumbai are road or construction dust, vehicle emissions, industrial and power units, airports, and garbage dumps^[5]. These factors, combined with low wind speed and high humidity, create a smoggy and unhealthy atmosphere for the residents of the city^[2]. Air pollution in Mumbai has been linked to increased mortality, morbidity, and economic losses^[5]. According to a global study by Greenpeace Southeast Asia and the Centre for Research on Energy and Clean Air, Mumbai ranks fifth in annual deaths due to air pollution, with an estimated 25,000 deaths and a total cost of \$3.6 billion in 2020^[4, 5].

To improve the air quality in Mumbai, some of the possible solutions are:

- Implementing stricter emission standards and regulations for vehicles, industries, and power plants.

- Promoting public transportation, cycling, and walking as alternatives to private vehicles.
- Enhancing green cover and urban forestry to reduce dust and absorb pollutants.
- Increasing public awareness and participation in air quality monitoring and management.
- Adopting cleaner and renewable sources of energy such as solar, wind, and biogas.

Epidemiology of Asthma due to Air Pollution

The prevalence of childhood Asthma significantly contributes to the global disease burden. In India, this condition has become increasingly common due to rising Air Pollution. Let's delve into the specifics:

1. India's Asthma Scenario

- **Prevalence:** According to the World Health Organization (WHO), 235 million people worldwide are affected by asthma, with 15–20 million of them residing in India^[8, 3].
- **Self-Reported Asthma:** Among Indian women aged 15–49 years, the prevalence of self-reported asthma is 2.00%, while it is 1.00% among young women aged 15–19 years and men aged 15–49 years^[8, 3].
- **Global Burden:** The recent Global Burden of Disease (GBD) estimates that India bears a total asthma burden of 34.3 million cases, accounting for 13.09% of the global burden. Additionally, there were 13.2 per thousand deaths attributed to asthma in India^[9, 4].

2. Air Pollution and Asthma

- **India's Air Quality:** Over the last two decades, air pollution has escalated in India. Notably, particulate matter (PM_{2.5}) plays a significant role in asthma exacerbation^[10, 5].

- **Delhi vs. South India:** A study by the Lung Care Foundation revealed that 29.4% of Delhi children compared to 22.6% in cities in South India suffer from asthma, primarily due to higher PM2.5 levels [7, 2].
- **Greenspaces and Air Pollution:** Recent research examined the associations among greenspaces, air pollution, and asthma prevalence in Indian children and adolescents. It found that:
 - Greenspace (NDVI) was associated with asthma prevalence, especially in areas with high PM2.5 levels.
 - High levels of gaseous air pollutants (SO₂ and NO₂) were positively associated with asthma prevalence.
 - Interestingly, high O₃ levels had a strong negative association with asthma prevalence [6, 1].

3. Mumbai City

- While specific data for Mumbai City was not mentioned in the provided results, it's essential to recognize that Mumbai, like many other Indian cities, faces air pollution challenges. Factors such as vehicular emissions, industrial activities, and construction contribute to the deteriorating air quality [6, 7].

In summary, asthma due to air pollution is a pressing issue in India, affecting millions of people. Efforts to improve air quality, promote greenspaces, and raise awareness about asthma management are crucial for public health.

Pathophysiology and Pathogenesis of Asthma in the context of Air Pollution

Asthma is a chronic inflammatory disorder of the airways. This inflammation has significant implications for the diagnosis, management, and potential prevention of the disease. Let's delve into the pathophysiology and pathogenesis of asthma in the context of air pollution caused by PM2.5 [16, 17, 4, 5].

1. Inflammatory Cell Infiltration [15, 16, 3, 4]

- **Neutrophils:** Especially prominent in sudden-onset, fatal asthma exacerbations, occupational asthma, and patients who smoke.
- **Eosinophils.**
- **Lymphocytes.**
- **Mast cell activation.**
- **Epithelial cell injury.**

2. Airway Inflammation

- Contributes to airway hyperresponsiveness, airflow limitation, respiratory symptoms, and disease chronicity.
- Persistent changes in airway structure may occur, including sub-basement fibrosis, mucus hypersecretion, epithelial cell injury, smooth muscle hypertrophy, and angiogenesis.

3. Gene-Environment Interactions

- Atopy (genetic predisposition for IgE-mediated response to common aeroallergens) is a strong predisposing factor for developing asthma.
- Viral respiratory infections play a crucial role in both asthma exacerbation and development.

4. Phenotypic Differences

- Evidence suggests variability in the pattern of inflammation, indicating phenotypic differences that may influence treatment responses.

5. Natural History of Asthma

- Asthma often begins early in life, with risk factors including atopic disease, recurrent wheezing, and a parental history of asthma.
- Current anti-inflammatory therapy does not appear to prevent progression of underlying disease severity.

Remember that air pollution, especially PM2.5, can exacerbate asthma symptoms due to inflammation and irritation of the airways. Toxic substances in air pollution further contribute to respiratory distress [13, 14].

In summary, understanding the intricate interplay between inflammation, genetic factors, and environmental triggers is crucial for managing asthma effectively.

Overview of Asthma its causes, symptoms and impact of Air Pollution in Mumbai and Delhi.

Let's explore into asthma, its causes, symptoms, and the impact of recent air pollution in Mumbai and Delhi, India.

Asthma Overview [26]

Asthma is a chronic condition characterized by inflammation in the lungs. It leads to narrowing of the airways, making breathing difficult. Here are some key points about asthma:

Causes [25]

- **Inflammation:** Asthma results from inflammation in the lungs due to an overactive immune system. This inflammation includes tightening of muscles around the airways, swelling of tissues within the airways, and the release of mucus that can obstruct airflow [18].
- **Triggers:** Various factors can trigger asthma attacks, including
 - **Allergens:** Pollen, pet dander, and other allergens.
 - **Irritants:** Cigarette smoke, perfume, paint, cleaning products, and air pollution.
 - **Respiratory Infections:** Infections can exacerbate asthma symptoms.
 - **Exercise:** Physical activity may lead to asthma symptoms.
 - **Genetic Factors:** A family history of asthma increases the risk [23].

Symptoms [24]

Symptoms vary from person to person but commonly include:

- Tightness in the Chest
- Shortness of Breath
- Wheezing
- Coughing
- Coughing at Night

Severe symptoms may involve

- Gasping for Breath
- Difficulty Speaking Due to Shortness of Breath
- Chest Muscle Strain
- Worsening Symptoms When Lying on the Back
- Severe Sweating
- An at-home peak flow meter can help monitor lung function. A reading below 80% of your personal best peak flow may indicate an asthma attack ^[18].

Asthma Attacks ^[21]

- An asthma attack (also called an asthma exacerbation or flare-up) occurs when symptoms suddenly worsen. During an attack:
- Airways swell and narrow, making breathing significantly harder ^[19].
- People with severe asthma are more prone to attacks.
- An asthma action plan guides individuals on managing attacks, including when to seek emergency care ^[18].

Air Pollution in Mumbai and Delhi ^[22, 23]**Delhi Pollution**

- Hazardous levels of air pollution in Delhi have led to healthy children developing asthma-like symptoms. Doctors recommend inhalers for upper respiratory tract infections caused by pollution exposure ^[20].

Mumbai

- Air pollution in Mumbai, similar to Delhi, can exacerbate asthma symptoms due to pollutants such as dust, pollens, cigarette smoke, and other unknown agents ^[25].

Remember, timely medical attention is crucial for managing asthma effectively. If you experience worsening symptoms, seek professional help promptly.

Case Study

63 years old female patient staying in Mumbai Suburban comes with history of cough and breathing problem more than one month, mostly in the night and early morning, no major illness in the past, no past history of cough or asthma in general and in family, on physical education examination general condition was normal but on auscultation bilateral rhonchi, mostly during expiration. Treatment was given, she follows up after 15 days with her son, who is 31 years old with the same problem Cough chest tightness and breathing problem with no major illness in past and no history of cough or asthma in past.

When I asked, she got a relief after treatment for 10 days and last 2 days again she had Cough which is mild, and they have given me the building construction work is going around the building where they are staying. Heavy dust and fogs is around the building. Which has caused this cough and most of the neighbors are suffering from Cough and respiratory problems.

Discussion

This case study highlights a scenario where both a 63-year-old female patient and her 31-year-old son present with persistent cough, chest tightness, and breathing difficulties. Despite no prior history of asthma or significant illnesses, both individuals exhibit bilateral rhonchi on auscultation, indicative of bronchial constriction. The fact that they

experienced relief with treatment initially, only to relapse after exposure to heavy dust and fumes from nearby construction work, suggests an environmental trigger for their respiratory symptoms.

The presence of similar complaints among neighbors further supports the likelihood of environmental factors playing a role in exacerbating respiratory issues. Construction-related dust and pollutants can irritate the airways, leading to symptoms such as coughing and chest tightness, particularly in individuals with underlying susceptibility.

Management of such cases requires a comprehensive approach, including both pharmacological interventions to alleviate symptoms and addressing environmental factors to minimize exposure to triggers. This may involve advising patients to avoid outdoor activities during periods of heavy pollution, using air purifiers indoors, and wearing masks when exposed to irritants. Additionally, educating patients and the community about the potential health impacts of environmental pollutants and advocating for measures to mitigate exposure can contribute to long-term respiratory health and well-being.

Conclusion

In conclusion, this case study underscores the significant impact of environmental factors, particularly urban construction-related pollutants, on respiratory health. The presentation of persistent cough, chest tightness, and breathing difficulties in both the 63-year-old female patient and her 31-year-old son, along with their temporary relief followed by symptom recurrence after exposure to construction dust, highlights the crucial role of environmental triggers in exacerbating respiratory symptoms. Recognition of such environmental influences is essential in managing respiratory conditions effectively, necessitating a multifaceted approach that combines pharmacological interventions with strategies to mitigate exposure to airborne pollutants. By addressing these environmental factors and advocating for measures to reduce pollution levels, healthcare providers can contribute to improved respiratory outcomes and overall public health.

Summary

In summary, this case study illustrates the impact of environmental factors, particularly construction-related pollutants, on respiratory health. Both a 63-year-old female patient and her 31-year-old son presented with persistent respiratory symptoms, which were alleviated temporarily by treatment but recurred after exposure to construction dust. This highlights the importance of recognizing environmental triggers in managing respiratory conditions. A comprehensive approach that combines pharmacological interventions with strategies to mitigate exposure to pollutants is essential for effective management. By addressing environmental factors and advocating for measures to reduce pollution levels, healthcare providers can contribute to improved respiratory outcomes and public health overall.

Message**Social Message**

This case emphasizes the critical intersection between urban development and public health. The impact of construction-related pollutants on respiratory health highlights the need for greater awareness and action to mitigate environmental

triggers. By advocating for cleaner construction practices and policies that prioritize respiratory health, we can create healthier communities for all.

Clinical Message

Healthcare providers should consider environmental factors, such as exposure to construction dust, when evaluating and managing respiratory symptoms. A comprehensive approach that includes pharmacological treatment and measures to reduce exposure to pollutants is essential for effective management of respiratory conditions in urban settings.

Prospective Message

This case serves as a reminder of the importance of proactive measures to address environmental health concerns in urban areas. By investing in sustainable development practices and implementing policies that prioritize air quality, we can prevent respiratory illnesses and promote better health outcomes for future generations. Let's work together to create healthier and more sustainable communities for everyone.

Way Forward

Recent studies have shed light on the alarming intersection of air pollution and respiratory health in two major Indian cities, Mumbai and Delhi. The prevalence of asthma, exacerbated by deteriorating air quality, poses significant challenges to public health and calls for urgent action to safeguard the well-being of millions.

Looking to the Future

However, amidst these challenges lies an opportunity for change. By prioritizing air quality management, implementing stricter emission standards, promoting sustainable transportation alternatives, and investing in green infrastructure, we can mitigate the impact of air pollution on respiratory health. Public awareness campaigns and community engagement initiatives are crucial in fostering a culture of environmental stewardship and empowering individuals to take proactive measures to protect their health.

A Call to Action

The future of respiratory health in Mumbai and Delhi hinges on our collective efforts to address the root causes of air pollution and prioritize the well-being of our communities. From policymakers and industry leaders to healthcare professionals and citizens, we must work together to create a cleaner, healthier environment for generations to come.

In conclusion, the link between asthma, air pollution, and the future of respiratory health in Mumbai and Delhi is undeniable. It is imperative that we take decisive action now to safeguard public health, preserve the environment, and ensure a brighter future for all.

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