The Prevalence and Exacerbation of Pulmonary Diseases as a Consequence of Smog

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INTRODUCTION

Air pollution in which visibility is reduced is known as smog (Swinn & Fuentes, 2023). The term *smog* has been derived from two words - *smoke* and *fog*. It is a kind of fog that holds smoke, and primarily began from the burning of coal in industrial areas during the 1900s (Swinn & Fuentes, 2023). Today, most of the smog we see is known as *photochemical smog*, which is a pollutant formed from the photochemical reactions (reactions occurring in the presence of sunlight) between oxides of nitrogen (NO, NO_2) and volatile organic compounds in the atmosphere. When sunlight hits these chemicals, they form airborne particles and ground-level ozone - or smog (Swinn & Fuentes, 2023). Major contributing factors of smog include emissions from the transportation sector, crop burning, industrialization and urbanization, and deforestation (*Air Pollution*, n.d.).

The escalating severity of smog is leading to a surge in various health issues. According to the World Health Organization, nearly 99 percent of the world's population is exposed to air that surpasses the WHO's recommended limits and is filled with high levels of pollutants, with low and middle-income countries bearing the brunt of the impact (*Air Pollution*, n.d.). Major public health concerns arise from pollutants such as particulate matter, carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). Both outdoor and indoor air pollution contribute to respiratory and other diseases, playing a significant role in morbidity and mortality rates. The World Bank highlighted that air pollution cost the globe approximately $8.1 trillion in annual global health costs in 2019, equivalent to 6.1 percent of the global GDP (*Pollution*, n.d.).

Particulate Matter (PM), which is composed of solid particles in liquid droplets in the air, is a major component of smog (*What Is Particulate Matter?*, n.d.). It is of various sizes, however, PM 2.5 is a component in smog which has proven to be the most serious hazard to human health. (Ashraf MF et al., 2022) Due to its small size (smaller than or equal to 2.5μm in diameter), it can easily enter into the lung alveoli, hindering gaseous exchange and causing many pulmonary pathologies.

The aim of this study is to understand how smog poses a threat to human health, especially with regards to the respiratory system. This article explores the pulmonary diseases caused by smog, including their symptoms, treatment(s), and effects on the human body.

GENERAL OVERVIEW OF THE IMPACTS OF SMOG ON THE RESPIRATORY SYSTEM

Smog may lead to the development and aggravation of major respiratory health issues including asthma, lung tissue damage, allergies, and bronchitis, among other conditions (Riaz, 2018). Exposure to ambient air pollutants can have damaging effects on various organs and systems within the human body, with the respiratory tract being the most vulnerable due to its direct interaction with the surrounding environment (Cui, 2020).

There are protective mechanisms present in the bronchopulmonary tract, such as ciliated epithelial cells and goblet cells. Ciliated epithelial cells form a physical barrier by pushing big particles away from the lungs with their rhythmic movement. Goblet cells produce a sticky, gelatinous fluid called mucus, which traps dust, particles, and harmful bacteria in the area (Dunleavy & Chu, 2022). The cilia, with their rhythmic movement push away the mucus from the lungs towards the mouth. Despite these protective mechanisms, harmful air pollutants can still build up in or penetrate lung tissues based on their size and chemical composition (Kim D et al., 2018). PM 2.5 and other ultrafine particles pose a significant risk, contributing to the onset of respiratory ailments like asthma, chronic obstructive pulmonary disease (COPD), and lung cancer (Kim D et al., 2018). Such particles are able to do this because the lower respiratory system (trachea, bronchi, bronchioles, alveoli) has fewer protective features than the upper respiratory system (nose or nostrils, nasal cavity, mouth, throat, larynx). Within the lower respiratory system, the protective features keep diminishing. An example of this is the mucociliary escalator, where the number of goblet cells and cilia decreases from the bronchi to the respiratory bronchioles. This allows ultrafine particles to penetrate through easily.

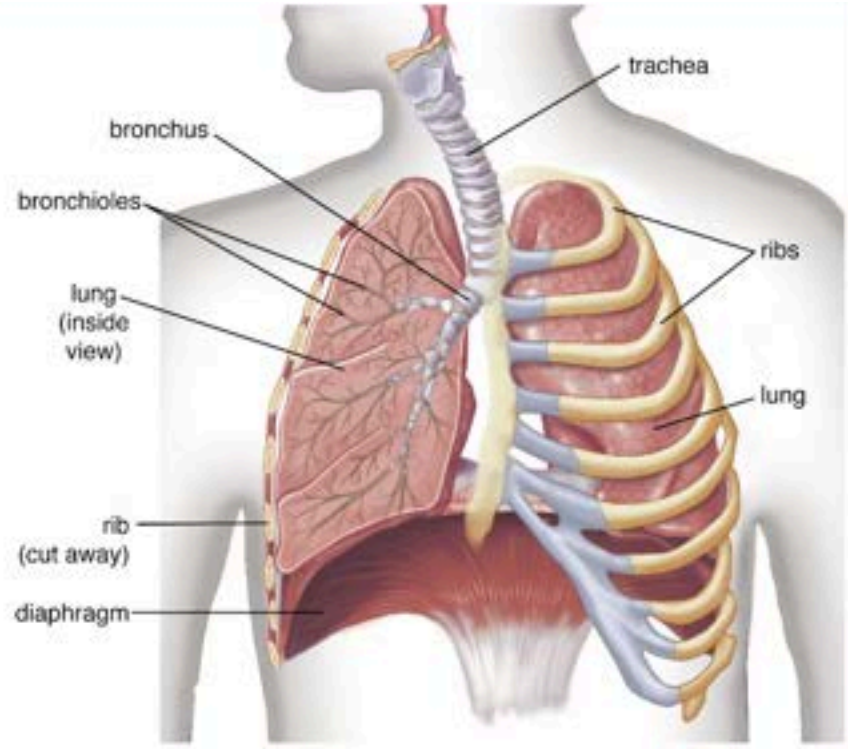

Figure 1. The Respiratory System. *Extracted from Encyclopedia Britannica (https://www.britannica.com/science/human-respiratory-system)*

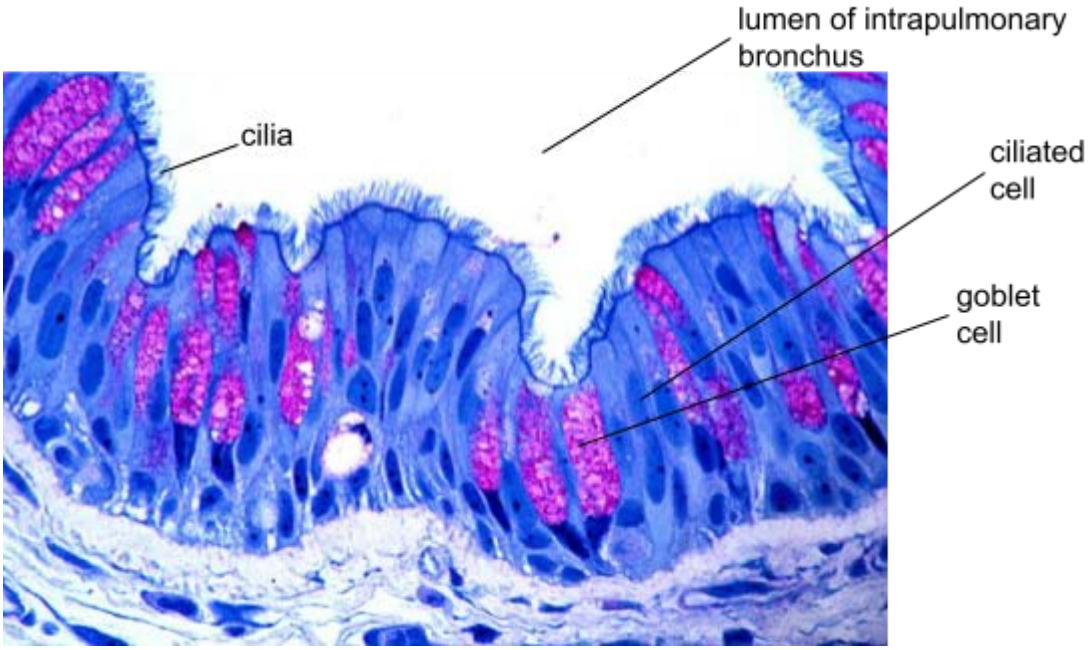

Figure 2. Microscopic Slide of Cilia and Goblet Cells, stained with PAS/Pb hematoxylin. Cilia are the tiny, hair-like projections extending from cells (ciliated cells). Goblet cells, which take the shape of a goblet, produce mucus. *Extracted from Boston University (https://www.bu.edu/phpbin/medlib/histology/p/13902ooa.htm)*

Sulfur and nitrogen oxides, along with fine particulate matter, exacerbate symptoms in individuals with asthma, COPD, and other lung disorders (*Air Pollution Effects on Your Lungs, Including Lung Cancer*, 2023). The presence of fine particulate matter in smog leads to coughing and sneezing, eye, throat, and lung irritation, as well as worsening breathing difficulties in those affected by asthma, COPD, and other lung conditions. Sulfur and nitrogen oxides can cause breathlessness and irritation in the upper respiratory tract, which includes the nose or nostrils, nasal cavity, mouth, throat (pharynx), and voice box (larynx) (Canadian Lung Association, n.d.).

REVIEW OF THE MAJOR DISEASES EVOLVING FROM SMOG

For the purpose of this study, three of the major diseases caused by smog will be explored - asthma, chronic obstructive pulmonary disease (COPD), and pneumoconiosis. The first two diseases mentioned are categorized under *obstructive lung diseases*, in which there is an obstruction or narrowing of the airways, making it difficult for air to flow into and out of the lungs properly (Respiratory Sleep Disorder Centre, 2023). Pneumoconiosis, on the other hand, comes under a different category of lung diseases called *restrictive lung disease*, which is characterized by the stiffening or damage of lung tissue, which hinders the lungs' ability to expand, resulting in a decrease in lung volume and impairing the ability to inhale effectively (Respiratory Sleep Disorder Centre, 2023). A major difference between the two categories of lung disease to highlight is that obstructive lung diseases are characterized by difficulty in exhaling (pushing air out) but ease in inhaling (bringing air in), whilst restrictive lung diseases involve difficulty in inhaling and reduced lung volume (Respiratory Sleep Disorder Centre, 2023).

A general overview of the two obstructive lung diseases in this study is given in table 1 below.

Table 1. Summary of Obstructive Lung Diseases

Disease	Causes	Symptoms	Reversible Disease	Effects
Asthma	inflammation and muscle tightening around the airways, outdoor and indoor air pollution, especially the outdoor pollutants O_3, NO_2, SO_2, CO, and PM (Tiotiu AI et al., 2020)	wheezing, chest tightness, cough, breathlessness – all of which are episodic and may vary in intensity	yes	sleep disturbance, tiredness during the day, poor concentration, emergency health care and hospitalization for treatment and monitoring, death in the most severe cases (World Health Organization (WHO), 2024)
Chronic Obstructive Pulmonary Disease	tobacco smoking and exposure to fumes from burning fuel, organic and inorganic dusts, indoor and outdoor pollution, PM 2.5, and ozone are significant contributors	difficulty breathing, wheezing, chest tightness, cough, mucus (sputum) production, lack of energy, frequent respiratory infections	no; keeps progressing overtime	bronchial tubes and air sacs lose their natural elasticity and over-expand leaving some air trapped in your lungs when you exhale (Mayo Clinic, 2020). people with COPD are more likely to catch respiratory infections e.g. colds, flu, and pneumonia heart problems, including the chances of a heart attack lung cancer high blood pressure in lung arteries

Asthma

Asthma is a major non communicable disease that affects both children and adults (World Health Organization (WHO), 2024). It is the result of inflammation and muscle tightening around the small airways in the lungs (bronchioles), causing difficulty in breathing. It usually begins in youth, but can become clinically apparent at any age. Although mostly genetic, asthma also

occurs in people who have other allergic conditions e.g. eczema and rhinitis (World Health Organization (WHO), 2024).

Increasing evidence indicates that both outdoor and indoor air pollution contributes to asthma development. The exposure to outdoor pollutants (O_3, NO_2, SO_2, CO, PM) could induce asthma symptoms, exacerbations and hospitalizations (Tiotiu AI et al., 2020). A study was conducted by Liu et al. amongst 4,454 individuals in Hubei province, China, who died from asthma between 2013 and 2018. The authors obtained daily mean concentrations of PM2.5, PM10, SO2, NO2, O3, and CO. For each asthma death, they estimated air pollutant exposure using inverse distance weighting at all monitoring stations within 50 km of each corresponding home address. The authors found that short-term exposures to PM 2.5, NO2, and O3 were strongly associated with asthma mortality. With every interquartile range increase of PM 2.5, NO2, and O3, the odds of asthma mortality increased by 7%, 11%, and 9% respectively (Liu et al., 2019).

Being exposed to these pollutants during childhood increases the risk of developing asthma, since children breathe faster and consequently take in more polluted air (*Air Pollution Effects on Your Lungs, Including Lung Cancer*, 2023). During childhood, lungs are still growing, hence early exposure to environmental pollutants can more easily disrupt lung development and lung function (Esposito et al., 2014). Traffic-related air pollution (TRAP) plays an extremely harmful effect on the function of the respiratory system. It is a complex mixture rich in particulate matter, and has resulted in 13% of global incidence of asthma in children (Tiotiu et al., 2020).

Although smog can be a direct cause of asthma morbidity, it is more often that atmospheric pollutants amplify asthma symptoms in asthmatic patients. Aggravations in intrinsic asthma (nonallergic asthma) are primarily attributed to irritants, leading to a notable association between ozone and sulfur dioxide exposure and exacerbations. Studies have also shown that smog can impact exacerbations in allergic asthma as well (Grzywa-Celińska A et al., 2020).

People with under-treated asthma can suffer sleep disturbance, tiredness during the day, and poor concentration (World Health Organization (WHO), 2024), because asthmatic patients are at higher risk of developing sleep apnea (Allergy & Asthma Network, n.d.). Recent studies have proven a link between asthma and obstructive sleep apnea (OSA), where each disorder adversely influences the other (Teodorescu M et al., 2010). If symptoms are severe, people with asthma may need to receive emergency health care and they may be admitted to hospital for treatment and monitoring. In the most severe cases, asthma can lead to death (World Health Organization (WHO), 2024). It is pertinent to note that asthma may be fully reversible, although a notable proportion of patients demonstrate incomplete reversibility of the disease (Boulet, 2009).

Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory lung disease that causes obstructed airflow from the lungs (Mayo Clinic, 2020). Tobacco smoking, as well as exposure to fumes from burning fuel, organic dusts (e.g. molds, pollen, bacteria, pesticides) and inorganic dusts (e.g. dusts from silica, coal, asbestos, natural stone, tungsten) are the leading contributors to this disease's development. Accounting for 6% of all deaths worldwide, COPD is the third leading cause of death (Lozano et al., 2012).

Cross-sectional analyses have shown an association between ambient levels of particulate matter (PM 2.5/10) and COPD prevalence (*Global Initiative for Chronic Obstructive Lung Disease Global Initiative for Chronic Obstructive Lung Disease*, 2020). The increased concentration of various air pollutants such as ozone, nitrogen dioxide, sulfur dioxide, and PM 2.5 can increase the risk of mortality in patients with COPD (Cui, 2020). PM 2.5, household air pollution and ozone together account for 40% of deaths from COPD (State of Global Air, 2023). Indoor air pollutants aggravate inflammation in the lung tissue of COPD patients, causing an exacerbation of symptoms and a decline in lung function. Particulate matter can have more severe effects on the health of patients living with chronic lung disease (*COPD and Particulate Matter*, 2023).

COPD includes chronic bronchitis (inflammation of the lining of bronchial tubes (*Chronic Bronchitis*, n.d.)) and emphysema (destruction of the alveoli and lung parenchyma due to exposure to cigarettes, irritating gasses and particulate matter (*Emphysema*, n.d.)). It causes bronchial tubes and air sacs to lose their natural elasticity and over-expand, which leaves some air trapped in your lungs when you exhale (*COPD - Symptoms and Causes*, 2020). Air trapping causes overinflation of the lungs, making a person feel short of breath (Villalobos & Whitworth, 2023). In the long term, this may lead to damage of the lung tissue, heart damage, and insufficient amount of oxygen circulating in your body (*Hyperinflated Lungs: Causes, Symptoms & Treatment*, 2023). The most common symptoms of this disease include difficulty breathing, chronic cough, tiredness, wheezing, and frequent respiratory infections. People with COPD are at higher risk for other health problems, including lung infections (flu, pneumonia etc.), lung cancer, heart problems, weak muscles and brittle bones, as well as depression and anxiety (*Chronic Obstructive Pulmonary Disease (COPD)*, 2023). These symptoms develop mid-life onwards, and as they progress, it becomes increasingly difficult for people to carry out their regular daily activities, mostly due to breathlessness.

Treatments of Asthma and COPD

Both asthma and COPD have no cure, however, they can be treated with bronchodilators - a type of medication that makes breathing easier by relaxing the muscles in the lungs and widening the airways (bronchi) (*Overview - Bronchodilators*, n.d.). Asthmatic and COPD patients require inhalers, which are devices that allow you to breathe in medicine (e.g. albuterol). Tablets and other relevant treatments may be required in severe cases. Rescue inhalers, also known as quick-relief inhalers, are often used to ease asthma and COPD symptoms. They include short-acting beta-agonists (which include albuterol, epinephrine, and levalbuterol), anticholinergics, and oral corticosteroids (Pichardo, 2022). Preventative long-term medications include inhaled corticosteroids and inhaled long-acting beta-agonists (Pichardo, 2022).

Acute Treatment

Acute treatment is defined as health system components or care delivery platforms being used to treat sudden, often unexpected, urgent or emergent episodes of injury and illness that could potentially result in death or disability without rapid intervention (Hirshon et al., 2013). The medications for asthma and COPD under this category include short-acting beta-agonists, corticosteroids, and anticholinergics.

Beta-agonists are primarily used to treat lung conditions (*Beta-Agonist: Types, Dosing, Benefits & Side Effects*, 2023). They can be short-acting and long-acting. Short-acting beta agonists (SABAs) are crucial for saving lives (especially in emergency asthma attack symptoms), but their regular use is discouraged due to safety concerns including worsening asthma symptoms, heart palpitations, and muscle attacks (Olopaade & Hoffman, 2022). Patients treated with SABA alone are at greater risk for asthma related death and urgent asthma-related healthcare. A study among 365,324 asthmatic patients aged 12-45 years in Sweden was conducted to observe the association between SABA overuse and poor asthma control (Nwaru et al., 2020). Overall, the mortality rate increased with an increasing number of SABA canisters being used (Nwaru et al., 2020).

An example of a beta-agonist are beta-2 agonists, which are further classified into short-acting as well as long-acting and ultra-long-acting drugs, hence they are used in both acute and chronic treatment (*Beta-Agonist: Types, Dosing, Benefits & Side Effects*, 2023). They work by triggering receptors in the muscles that line the airways called beta-2 receptors, causing the muscles to relax and the airways to widen (*Overview - Bronchodilators*, n.d.). Side effects of beta-2 agonists (e.g. salbutamol) include heart palpitations, trembling, nervous tension, headaches, and muscle cramps (*Bronchodilators - Side Effects*, n.d.). Examples of short-acting beta-2 agonists include albuterol and levalbuterol (*Beta-Agonist: Types, Dosing, Benefits & Side Effects*, 2023), and they are prescribed for COPD, bronchial asthma, and emphysema treatment (Abosamak & Shahin, 2023).

Corticosteroids are a type of medication that reduces inflammation in the body, making air flow easier in the lungs (Ngo, 2024). Inhaled corticosteroids for asthmatic patients include Fluticasone (Flovent HFA, Arnuity Ellipta, others), Budesonide (Pulmicort Flexhaler), Mometasone (Asmanex Twisthaler), Beclomethasone (Qvar RediHaler), and Ciclesonide (Alvesco) (*Asthma Medications: Know Your Options*, n.d.). Doctors most often prescribe the corticosteroids Fluticasone (Flovent), Budesonide (Pulmicort), and Prednisolone to COPD patients (Ngo, 2024). However, in spite of their effectiveness, corticosteroids have multiple side effects. They increase chances of developing fungal infections (Sellers, 2022). Inhaled corticosteroids in particular may include coughing, difficulty speaking, and oral thrush (Sellers, 2022). Higher doses of corticosteroids are associated with a higher frequency of adverse effects. 90% patients who have taken corticosteroids for over sixty days have experienced the negative effects of the medication (Hodgens & Sharman, 2023).

Anticholinergics stimulate the widening of the airways by blocking cholinergic nerves, which release chemicals that can cause the tightening of the muscles lining the airways (*Overview - Bronchodilators*, n.d.). Ipratropium and other anticholinergics may cause coughing, nausea, dry mouth, and constipation (*Bronchodilators - Side Effects*, n.d.).

Chronic Treatment

Medical treatment administered over a long period of time is known as chronic treatment (Fina et al., n.d.). For asthma and COPD, this includes long-acting beta-agonists.

Long-acting beta-agonists (LABAs), while effective in controlling symptoms, pose safety risks and should only be used by patients who have not responded to first-line controller medications

such as inhaled corticosteroids (Donohue, 2008). Furthermore, the use of LABAs on their own poses significant risk. In 2010, the United States Food and Drug Administration (FDA) found that the use of LABAs resulted in an increased risk of severe asthma exacerbations in patients compared to those who did not use them (Olopaade, 2021). In 2017, however, the FDA found that there was no significant rise in the risk of severe asthma outcomes in people using a combination of inhaled corticosteroids and LABAs (*No Significant Increase in Serious Asthma Outcomes With ICS/LABA*, 2017).

Long-acting beta-2 agonists include formoterol, salmeterol, and indacaterol (*Beta-Agonist: Types, Dosing, Benefits & Side Effects*, 2023). They are prescribed for COPD, chronic bronchitis, and emphysema treatment (Abosamak & Shahin, 2023).

People with COPD and asthma must refrain from smoking as it exacerbates the disease. Moreover, patients must be vaccinated against the flu viruses, because they are immunocompromised. Pulmonary rehabilitation, oxygen therapy, and non-invasive ventilation are highly encouraged for effective treatment (*What Are the Treatments for COPD?*, 2022).

Asthma-COPD Overlap Syndrome

Despite being two different lung diseases, asthma and COPD share many similarities. Both being chronic inflammatory diseases that involve the small airways in the lungs and cause airflow limitation (American College of Allergy Asthma and Immunology, n.d.). There may be a comorbidity of asthma and COPD symptoms in a person. When this happens, they are diagnosed with Asthma-COPD overlap syndrome (ACOS) (American College of Allergy Asthma and Immunology, n.d.). ACOS is not a separate disease - rather it is a way for doctors to recognize the overlapping of symptoms and select a treatment plan appropriate for both diseases. ACOS patients tend to have more severe attacks and symptoms than people with either asthma or COPD (*Asthma-COPD Overlap Syndrome (ACOS)*, 2023).

ACOS patients may use the following medicines in order to improve symptoms (*Asthma-COPD Overlap Syndrome (ACOS)*, 2023):

- Low-dose inhaled corticosteroid
- Long-acting bronchodilator
- Long-acting muscarinic antagonist

Treatment may also involve supplemental oxygen and lung rehabilitation. Avoiding smoking is necessary for patients (*Asthma-COPD Overlap Syndrome (ACOS)*, 2023).

Pneumoconiosis

Any lung disease resulting from the inhalation of organic or inorganic airborne dust or fibers is termed pneumoconiosis (DeLight & Sachs, 2023). These fine inhaled particles (e.g. silica) are difficult for the lungs to get rid off, hence they cause a chronic inflammatory response in the lungs, leading to an irreversible lung disease (*Pneumoconiosis*, n.d.).

Industrial, blue-collar, and construction workers are commonly exposed to these inhalants in their occupational settings, leading to their categorization as occupational diseases. Occupations including coal mining, construction, and shipbuilding, which involve crushing, cutting, manufacturing, or grinding, resulting in the release of mineral dusts are the highest at risk (*Pneumoconiosis Occupational Pulmonary Fibrosis | Pulmonary Fibrosis Foundation*, n.d.). Pneumoconiosis develops over time after prolonged exposure to fine mineral or chemical dust, such as silica, coal dust, or asbestos. When these particles are inhaled, the body's immune response is triggered, causing inflammation in the lung tissue and the formation of scar tissue. This scarring reduces the elasticity of the lungs, making it more difficult for affected individuals to breathe normally (Svoboda, 2022).

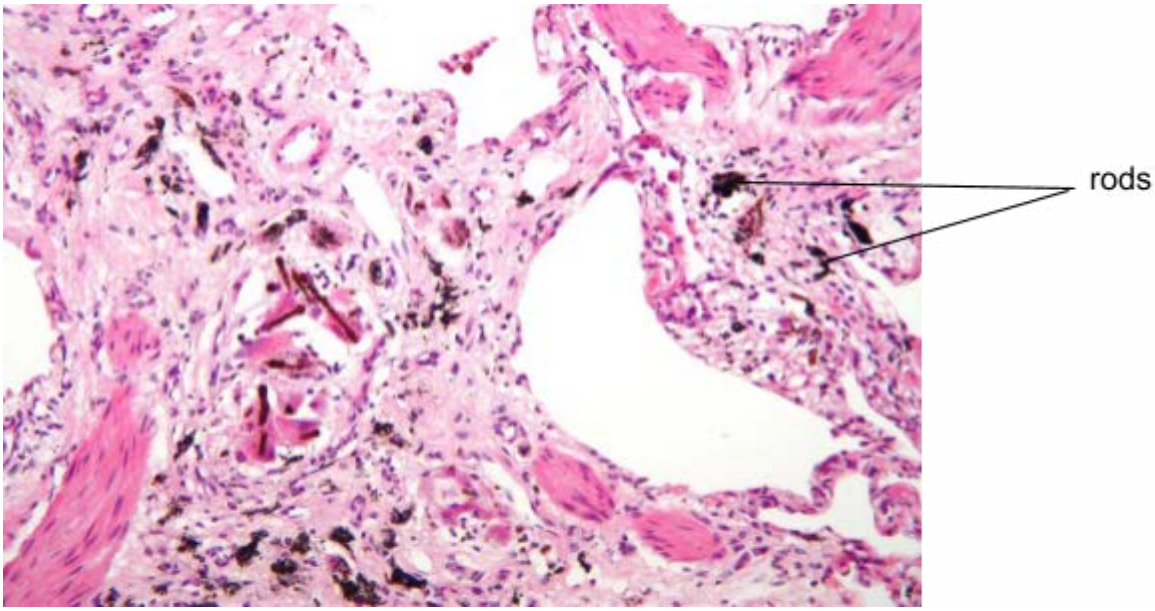

Figure 3. A micrograph of asbestosis showing ferruginous bodies (rust-coloured rods). *Extracted from Encyclopedia Britannica (https://www.britannica.com/science/pneumoconiosis#/media/1/465474/154204)*

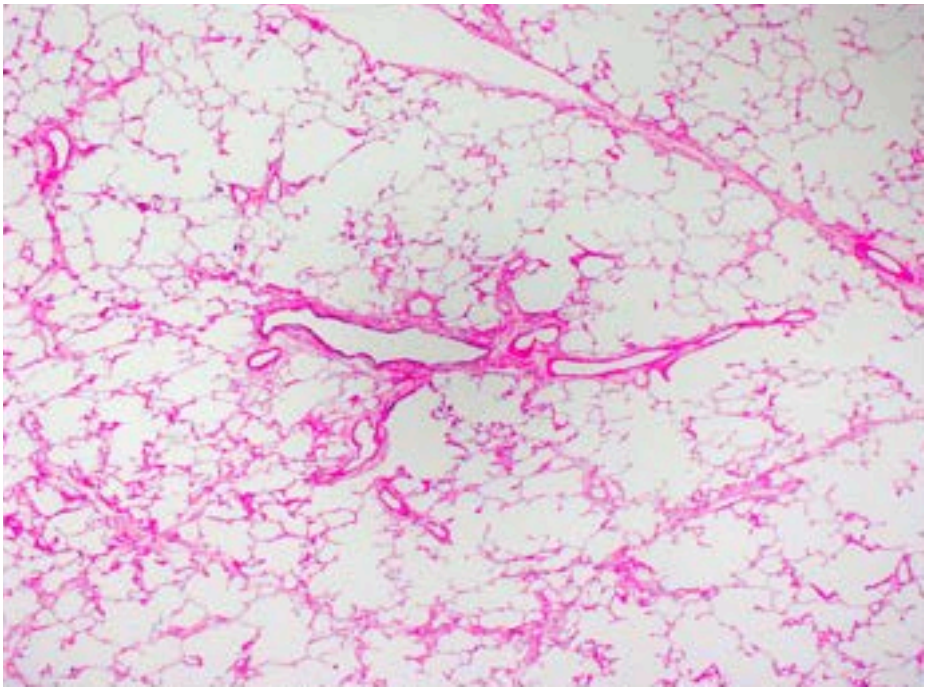

Figure 4. Healthy Lung Cells. *Contributed by Hirotsugu Hashimoto, M.D., Ph.D. Extracted from Pathology Outlines*

Pneumoconiosis may be simple or complicated. A small amount of scar tissue is caused by simple pneumoconiosis, whereas a lot of scarring in the lungs is brought about by complicated pneumoconiosis - also known as progressive massive fibrosis (PMF) (*Pneumoconiosis*, n.d.).

Pneumoconiosis may appear in different forms, depending on the type of dust inhaled. Some of these have been summarized in Table 2:

Table 2. Types of Pneumoconiosis

Type of Pneumoconiosis	**Causative Agent**
Black Lung Disease / Miner's Lung	Coal dust
Silicosis	Silica dust
Asbestosis	Asbestos dust

Symptoms of pneumoconiosis include long-term coughing, coughing up large quantities of mucus, and shortness of breath. Other symptoms are possible depending on the type of pneumoconiosis (*Pneumoconiosis Occupational Pulmonary Fibrosis | Pulmonary Fibrosis Foundation*, n.d.). It is important for patients to strictly avoid smoking. Doctors prescribe patients with inhaled medication such as bronchodilators or corticosteroids. Supplemental oxygen therapy is given to those who have low oxygen levels in their blood (Svoboda, 2022).

PAKISTAN - A CASE STUDY

Pakistan is recognized as the most urbanized country in South Asia (Riaz, 2018), with Lahore, its second-largest city, being the most polluted city in the nation (Dawn News, 2021). Faisalabad and Gujranwala are also grappling with the escalating problem of smog, which intensifies every winter. This is because cold air is denser and has less space between gas molecules, which is why it sinks, whereas warm air being less dense rises. Pollutants are unable to escape and disperse as freely in dense cold air, which is why smog is trapped near the ground during winters (Qadri, 2020).

In November 2021, certain areas of Lahore recorded Air Quality Index (AQI) levels exceeding 400 μg/m³, far above the safe threshold of 50 μg/m³ (Dawn News, 2021). Data from IQAir reports indicate that Faisalabad, Lahore, and Gujranwala had air quality levels of 297.2 μg/m³, 271.8 μg/m³, and 201.6 μg/m³ respectively during this period (Ashraf MF et al., 2022). Faisalabad and Lahore are industrial centers of Pakistan, with Lahore being plagued by uncontrolled urbanization. The lack of proactive measures from the government and the failure of relevant authorities to acknowledge the urgency of the situation are contributing to the worsening conditions of smog in Pakistan (Ashraf MF et al., 2022).

Both COPD and asthma are major respiratory problems in Pakistan accounting for one-fourth of patients at primary healthcare facilities (Khan, 2022). Asthma and COPD are prevalent in 4.3% and 2.1% of Pakistan's total population of 235.8 million (as of 2022) respectively (Yusuf, n.d.). It is recognized that there is a dearth of data available on the prevalence of asthma and COPD in the rural setting due to the demographics of Pakistan's healthcare system, resulting in many cases of asthma and COPD unreported and hence creating doubt in statistics.

15 million children and 7.5 million adults are suffering from asthma in Pakistan (Khan, 2022), proving that the disease can be presented by anyone regardless of age. The fact that there are twice as many children than adults suffering from asthma further proves that children are more prone to the disease due to their developing lungs. The Global Asthma Report 2022 notes that seasonal asthma is very important in some selected parts of the country, with most of it being triggered by various indoor and outdoor airborne allergens.

A cross-sectional study conducted among 400 coal miners of Cherat, District Nowshera, KPK showed that 49.50% of the coal miners showed prevalence of pneumoconiosis on chest X-rays (CXR) and pulmonary function tests (PFTs) (Ishtiaq et al., 2014). The overall occupational safety and health considerations of Cherat's coal miners is completely overlooked (Ishtiaq et al., 2014), with the majority of the miners unaware of occupational safety at coal mines (Ishtiaq et al., 2013). Coal is the major energy source being used in the domestic and commercial sectors of Pakistan, including power plants, cement, railway, and fertilizers (Ishtiaq et al., 2013). From a total of 185 billion tons of coal reserves in the country, the province of KPK contributes to 90 million tons (from Hangu/Orakzai and Cherat/Nowshera) (Ishtiaq et al., 2013). Heavy physical work and severe working conditions, coupled with occupational dust exposure are the leading causes of occupational morbidity and mortality in Cherat (Ishtiaq et al., 2013).

There are numerous obstacles hindering the treatment of COPD in Pakistan, including economic, social, and cultural factors. The economic burden is particularly significant, as chronic illnesses place immense pressure on families. Treatment quality is often determined by the family's socioeconomic status, leading middle-class and poor families to seek reduced-cost

treatment at public hospitals (Sakina et al., 2022). Additionally, the elderly rely on their families for support, creating both financial and mental strain. Social challenges arise from overwhelming patients with family discussions (Sakina et al., 2022), while cultural factors include patients' struggles to accept their illness.

A significant number of patients and caregivers lack essential knowledge about asthma, causing delays in receiving appropriate diagnosis and treatment, ultimately leading to higher rates of morbidity and mortality (Hazir et al., 2002). The underprivileged face additional challenges in accessing diagnosis and treatment due to financial constraints and limited resources. The scarcity of trained respiratory specialists in rural hospitals further hinders effective care, with most professionals working in urban settings. Furthermore, the stigma associated with asthma being contagious adds another layer of complexity to the issue (*Why Increasing Asthma Cases in Pakistan Demand Action and Awareness*, 2024).

Many individuals in Pakistan are not fully informed about the serious health risks associated with indoor air pollution (*Why Increasing Asthma Cases in Pakistan Demand Action and Awareness*, 2024). The continuous use of wood and animal dung for fuel is a major factor contributing to the high levels of smog. (*Why Increasing Asthma Cases in Pakistan Demand Action and Awareness*, 2024).

These barriers to proper COPD and asthma treatment must be resolved by careful policy making, with the help of respiratory specialists. The Government of Pakistan must improve access to treatment by investing in better, high quality treatment facilities and creating incentives for asthma and COPD medication research. Regulations need to be placed on factories and other sources of smog production (e.g. fuel cars and deforestation). Also, more and better training programs in respiratory diseases must be established for physicians, and policies must be made for specialized physicians to work in rural areas.

Working conditions must be improved for laborers in coal mines and other industries where they are prone to pneumoconiosis. They must be informed about the hazards of working in coal mines. Regular medical checkups, along with training programs and workshops to educate and train coal mine workers must be arranged by the government and the private sector (Ishtiaq et al., 2014).

DISCUSSION

From the evidences provided in this study, it can be concluded that smog is a strong driving factor in the prevalence and exacerbation of multiple respiratory diseases. Inorganic chemicals in smog, including sulfur dioxide and nitrogen dioxide cause upper airway irritation. Particulate matter of diameter 2.5μm or less are small enough to travel deeply through the respiratory tract and enter the lungs, triggering various pulmonary diseases and inhibiting gaseous exchange. Asthma and COPD are widely prevalent as a result of smog, and both have similar effects in that they are chronic inflammatory diseases. Workers are largely prone to pneumoconiosis in their occupational settings and are therefore at the risk of developing an irreversible lung disease.

Treatments to asthma and COPD must be made affordable and available throughout the globe. Workers in occupational settings who are prone to pneumoconiosis e.g. coal mines, construction sites etc. must be provided with safety materials and be made aware of risks associated with their work. More importantly, however, is to tackle the issue of smog by shifting towards renewable and clean energy resources. Developed economies must aid developing economies in doing this by the provision of financial aid. Furthermore, research needs to be done on supplying protective gear to workers in Pakistan, such as filters and other devices to workplaces to decrease aerosolizing particles.

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