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IMPACT OF AIR POLLUTION ON RESPIRATORY DISEASE IN HUMAN HEALTH: BRIEF REVIEW

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ABSTRACT

The few cross-sectional studies found that the more polluted locations had higher rates of self-reported chronic bronchitis and emphysema diagnoses, dyspnea and mucus hypersecretion, as well as worse lung function levels. The lone cohort study in adults indicated a faster loss in lung function, while the two cohort studies in children found a slowing of pulmonary function. We examined the effects of the most significant air pollutants on pulmonary diseases, including sulfur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds, ozone, particulate matter, and biomass smoke. We concentrated on respiratory disorders since air pollution amplifies the rise in respiratory diseases and there is mounting evidence that air pollutants are harmful. It is critical to continuously enhance policy actions to improve air quality. According to the study, asthma incidence is the highest among a number of respiratory illnesses, and the majority of those afflicted with such illnesses reside in densely populated, noisy, and environmentally friendly places.

KEYWORDS: Air pollutants, airway disease, asthma, COPD.

1. INTRODUCTION

Worldwide, air pollution is a serious environmental problem that endangers people's health. It is a complicated mixture of several pollutants emitted from manmade and natural sources, such as industrial emissions, vehicle exhaust, and household activities. As a result of these pollutants' harmful effects on the respiratory system, respiratory disorders arise, worsen, and progress.

Lung cancer and other respiratory illnesses including asthma and chronic obstructive pulmonary disease (COPD) significantly affect public health and quality of life. They are distinguished by respiratory symptoms, lung dysfunction, and inflammation.

1.1 Types of air pollution

Air pollution is comprised of a diverse array of pollutants, each with its own sources and characteristics. The following are some of the major types of air pollutants that have significant impacts on respiratory health.

Particulate matter (PM)

The term "particulate matter" (PM) refers to microscopic, inert airborne particles that can range in size from coarse to fine. These particles can come from a variety of sources, such as industrial processes, construction activities, automobile emissions, and natural sources like dust and pollen. Fine particles, or PM2.5 (with a diameter of 2.5 micrometers or less), can enter the bloodstream and go deep into the respiratory system, presenting serious health hazards.

Ozone (O3)

In the presence of sunlight, a chemical interaction between nitrogen oxides (NOx) and volatile organic compounds (VOCs) produces ozone, a secondary pollutant. It is a significant contributor to urban air pollution and is frequently paired with photochemical smog. Ozone can irritate the respiratory tract, causing respiratory symptoms and aggravating respiratory diseases including asthma and COPD.

Nitrogen dioxide (NO2)

Fossil fuel combustion, which occurs in motor vehicles, power plants, and industrial activities, is the main source of nitrogen dioxide emissions. Urban locations with high traffic volumes frequently have high NO2 levels. Long-term NO2 exposure can aggravate respiratory symptoms in people with underlying illnesses, worsen respiratory inflammation, and raise the risk of respiratory infections.

Sulfur dioxide (SO2)

Burning sulfur-containing fossil fuels like coal and oil in power plants and other industrial facilities is the main source of sulfur dioxide production. Additionally, it is

emitted during volcanic eruptions. Sulfur dioxide can aggravate the respiratory system and cause symptoms including coughing, wheezing, and shortness of breath when inhaled. People who have asthma and other respiratory diseases are especially susceptible to its effects.

Carbon monoxide (CO)
A colorless, odorless gas called carbon monoxide is created when carbon-containing fuels like gasoline, coal, and wood burn partially. It is mostly released through vehicle exhaust and can build up in enclosed spaces with insufficient ventilation. Hemoglobin in the blood is bound by carbon monoxide, limiting its capacity to deliver oxygen. Long-term exposure to high CO levels might result in hypoxia and respiratory diseases.

1.2 Sources of air pollution

Both natural and man-made factors can contribute to air pollution. For the purpose of determining the major sources of air pollution and putting in place efficient mitigation strategies, it is imperative to comprehend these sources. Major contributors to air pollution include the following.

Industrial emissions
When burning fossil fuels for energy, manufacturing, or other purposes, industrial activities release pollutants into the atmosphere, which contributes to air pollution. Particulate matter, sulfur dioxide, nitrogen oxides, volatile organic compounds, and heavy metals are just a few of the pollutants that are released by industries like power plants, refineries, chemical plants, and manufacturing facilities.

Vehicle emissions
The transportation industry, particularly the use of motor vehicles, is a significant source of air pollution, particularly in cities. Nitrogen oxides, carbon monoxide, particulate matter, and volatile organic compounds are just a few of the pollutants that are released into the air by vehicles like automobiles, trucks, buses, and motorbikes. The burning of fossil fuels in engine combustion produces these pollutants.

Residential sources
Homes without access to clean energy sources utilize solid fuels (Such as coal and wood) for heating and cooking, which contributes to air pollution. In these environments, indoor air pollution can be a serious problem, causing the emission of harmful pollutants like particulate matter, carbon monoxide, and volatile organic compounds.

Natural Events and Phenomena
Some natural occurrences and phenomena can also cause air pollution. For instance, during volcanic eruptions, significant quantities of sulfur dioxide, ash, and other gases are released into the atmosphere. Particulate matter pollution can also be caused by dust and pollen from natural sources including woods, deserts, and plants. Additionally, smoke and toxins are released into the air by wildfires, both naturally occurring and produced by humans.

Agricultural activities
There are a number of ways that agricultural activities might impact air pollution. Nitrogen oxides and volatile organic compounds may be released during crop cultivation when fertilizers and insecticides are used. Ammonia and methane, which are significant air pollution contributors, are released during livestock production, particularly intensive animal husbandry.

1.3 Mechanism of action on respiratory system

Many different processes allow air contaminants to affect the respiratory system. These pathways involve interactions with the respiratory tissues on a physical and chemical level as well as indirect impacts brought on by oxidative stress, immunological dysregulation, inflammation, and epigenetic changes. Understanding these pathways offers insights into the intricate pathophysiology of respiratory disorders caused by air pollution. The main mechanisms of action are as follows.

Inflammation
The respiratory system may become inflamed as a result of exposure to air pollution. Particulate matter and certain gases, such as ozone and nitrogen dioxide, activate immune cells, such as neutrophils and macrophages, which causes the production of cytokines and chemokines that promote inflammation. This inflammation has the potential to harm lung tissues, impede lung function, and worsen existing respiratory conditions.

Oxidative stress
Reactive oxygen species (ROS), which are produced by air contaminants in the respiratory system, cause oxidative stress. The antioxidant defense systems of the lungs are overpowered by the generation of ROS, which is induced by particulate matter and certain gases, including ozone and nitrogen dioxide. Oxidative stress can result in cellular damage, inflammation, and changes to cellular signaling pathways, which all contribute to the pathophysiology of respiratory illnesses.

Immune dysregulation
Air pollution can impair the respiratory system's immune system's ability to operate normally. Particulate matter and gases have the ability to change immune cell populations, affect immune cell responses, and impede the removal of infections. This immunological dysregulation can intensify allergy reactions, increase vulnerability to respiratory infections, and promote the growth of respiratory illnesses.

Epigenetic modifications
Recent research indicates that air pollution may cause epigenetic changes in the respiratory system. Gene

expression patterns can be affected and regular cellular processes can be upset by epigenetic changes including DNA methylation, histone modifications, and variations in microRNA production. These epigenetic changes might contribute to the onset and progression of respiratory illnesses brought on by air pollution.

It's critical to remember that these methods of action are linked and may interact, enhancing their combined impact on the respiratory system. Furthermore, the degree of activation of these systems and the ensuing respiratory health effects can be influenced by individual sensitivity, hereditary variables, and co-exposure to numerous contaminants.

1.4 Respiratory diseases

Asthma

Chronic airway inflammation caused by asthma causes episodes of wheezing, shortness of breath, chest tightness, and coughing on a regular basis. Exposure to specific pollutants in particular has been found as a substantial risk factor for the onset, aggravation, and deterioration of asthma symptoms. Key elements including asthma and air pollution are as follows.

Prevalence and Risk factors

Asthma is a common respiratory condition that affects people of all ages and is influenced by both genetic and environmental factors. Asthma development has been linked to exposure to air pollutants as particulate matter, nitrogen dioxide, ozone, and volatile organic compounds. People who already have asthma or allergies, children, and people who live in cities with high levels of air pollution are especially at risk.

Exacerbation of asthma symptoms

Asthma attacks and symptom exacerbation are both caused by air pollution. Pollutants, particularly ozone and particulate matter, can irritate the airways, causing swelling and bronchoconstriction. Asthma symptoms may worsen, lung function may decline, and medication consumption may rise as a result. Exacerbations of asthma brought on by air pollution can significantly influence a person's quality of life and overall respiratory health.

Long-term effects on asthma development

Children are more likely to acquire asthma when they are exposed to air pollution for an extended length of time, especially when their lungs are still developing. According to studies, exposure to pollutants such fine particulate matter (PM2.5), nitrogen dioxide (NO2), and air pollution from traffic might cause asthma to develop in vulnerable people. The pathophysiology of asthma is assumed to be influenced by how air pollution affects the immune system, the airways, and lung growth and development.

It is significant to emphasize that there are many relationships between air pollution and asthma, and that each person's vulnerability can differ. In the presence of air pollution, other factors, such as allergens, respiratory infections, and lifestyle choices, can also affect the results of asthma. Additionally, the type of pollutant, its concentration, and the length of exposure all have an impact on the severity and frequency of asthma symptoms.

Chronic obstructive pulmonary disease

A progressive lung condition known as chronic obstructive pulmonary disease (COPD) is characterized by restricted airflow, enduring respiratory symptoms, and heightened susceptibility to respiratory infections. A substantial risk factor for the onset, aggravation, and progression of COPD has been identified as air pollution, particularly exposure to certain contaminants. Key elements involving COPD and air pollution are as follows.

Prevalence and Risk factors

Exposure to air pollution is a substantial risk factor for the development of COPD, a serious concern for world health. An elevated risk of developing COPD has been linked to prolonged exposure to pollutants like fine particulate matter (PM2.5), nitrogen dioxide (NO2), sulfur dioxide (SO2), and biomass smoke. Smokers, people exposed to pollutants at work (such as dust or chemicals), and people who live in heavily polluted locations are especially vulnerable.

Exacerbation of COPD Symptoms

Air pollution can aggravate COPD symptoms and cause sudden exacerbations. When people with COPD are exposed to pollutants including particulate matter, ozone, and nitrogen dioxide, their airways might get inflamed, produce more mucus, and constrict. These exacerbations may lead to a worsening of respiratory symptoms, a decline in lung capacity, more hospitalizations, and a higher mortality rate.

COPD Progression

Progression of COPD can be sped up by prolonged exposure to air pollution, particularly outdoor pollutants. Pollutants, in particular fine particulate matter and gases like ozone and nitrogen dioxide, can cause tissue damage in the respiratory system by causing chronic inflammation and oxidative stress. The deterioration of lung function, airway remodeling, and the progression of COPD are all caused by these mechanisms.

It is significant to remember that COPD is a complex illness affected by a range of genetic, environmental, and lifestyle variables. Air pollution can greatly increase the burden of the disease, especially in non-smokers or people with pre-existing respiratory disorders. Smoking continues to be the main cause of COPD.

Lung cancer

One of the main causes of cancer-related fatalities globally is lung cancer, a malignant tumor that develops

in the lungs. Exposure to air pollution, particularly specific contaminants, has been recognized as a substantial environmental risk factor, even though smoking continues to be the leading risk factor for lung cancer. Key elements relating to lung cancer and air pollution are as follows.

Carcinogenic air pollutants

Several air pollutants have been identified by international health organizations as carcinogens (substances that can cause cancer). These include polycyclic aromatic hydrocarbons (PAHs), benzene, particulate pollution (particularly fine particles), and heavy metals like arsenic, cadmium, and nickel. Numerous sources, including as industrial emissions, vehicle exhaust, and the combustion of fossil fuels, can release these contaminants.

Mechansims of carcinogenesis

There are several ways that air pollution might cause lung cancer. Inhaling harmful compounds from fine particulate matter can cause DNA damage, oxidative stress, and chronic inflammation in the lungs. When absorbed by lung cells, carcinogens like PAHs can activate certain pathways crucial to the growth of cancer. Additionally, air pollution might hinder the immune system's performance, making it less able to identify and get rid of cancer cells.

Lung cancer Risk and Ambient air pollution

Lung cancer is more likely to occur when people are exposed to air pollution over a lengthy period of time, according to epidemiological studies. Even after controlling for other risk factors like smoking, high concentrations of particulate matter and other gaseous pollutants, such as nitrogen dioxide and benzene, have been linked to an increased risk of lung cancer. Populations at risk, such as those who reside in heavily polluted cities or who are exposed at work, may be at greater risk.

Although air pollution is a risk factor for lung cancer, it frequently works in concert with smoking. Lung cancer risk is considerably increased when smoking and exposure to air pollution are combined. Therefore, quitting smoking continues to be the best method for lowering the chance of developing lung cancer.

To lessen the effect of air pollution on lung cancer, it's vital to reduce exposure to pollution, enact stronger limits on industrial and vehicle emissions, support renewable energy sources, and enhance indoor air quality.

CONCLUSION

Pollution has become a serious concern, and every individual must do his bit to overcome its damaging effects on our planet. Increased levels of traffic and the resulting vehicle emissions, as well as an industrial lifestyle, are linked to an increase in the frequency of respiratory infections and asthma flare-ups, particularly in urban as opposed to rural residents, as well as an increase in sensitivity to pollen-induced allergies.

The systematic review and meta-analysis of respiratory disorders and exposure to air pollution (PM2.5, NO2, SO2, CO, O3). Increased concentrations of all atmospheric pollutants, especially aerial particles, have been linked in 70% of studies to cough and phlegm, in 35% to asthma symptoms, in 30% to reduced volumes and respiratory flows, and in 30% to longer hospital stays for respiratory illnesses that have already been diagnosed. Results imply that environmental management may be essential for preventing COPD and other acute and chronic respiratory illnesses.

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