Research Article

The Effects of Major Atmospheric Pollutants on Aeroallergens: Manifestations of Aeroallergens Severity in Pakistan

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Abstract:

Air pollution is harmful. It contains particulate pollution (PM), nitric oxides (NOx), Sulphur oxides, carbon monoxide (CO), and ozone (O3). Allergies are a global health concern.Aeroallergens are biological or non-biological airborne particles that can induce allergic reactions in some persons. Indoor allergies harm millions of people year-round. Dust mites, petdander, cockroach feces, and molds cause it. Allergies are inherited, but annoying reactions can attack anyone. This systematic review aims to identify the major effects of aeroallergens concerning the effects and manifestations caused by increased exposure to these outdoor pollutants. A systematic approach was used using PRISMA guidelines. Google ScholarPubMed and PakMediNet databases were searched to select 20 articles using Specific Keywords. Results show high concentrations of pollutants like CO, NO, SO2, PAH, etc., in various cities of Pakistan, causing various medical conditions and social, economic, and psychological problems. Therefore, there is a dire need for strict pollution control legislation, evidence-based policymaking, political will, and community participation.

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INTRODUCTION:

Air pollution (AP) poses a significant health risk. It is a complex mixture of gases, liquids, andsolid particles such as includes particulate matter (PM), nitric oxides (NOx), sulfur oxides,carbon monoxide (CO), and ozone (O3).[1] According to particle aerodynamic equivalent diameter, inhalable PM is further classified as coarse (2.5-10 m), fine (0.1-2.5 m), and ultrafine (0.1 m), with fine PM capable of reaching the lungs.

Coarse PM cannot reach the lungs,whereas fine PM cans.[2] Transportation and heating systems are typical urban emission sources.The combination of gaseous emissions (including NOx) and non-combustion sources,including road dust, tire wear, and brake wear, contribute to traffic-related AP.[3] These significant emissions generate O3, nitrates, and organic aerosol. Heating systems are asignificant contributor to PM and CO pollution. The industry is a second source of PM.[4,5] Globally, allergic diseases are becoming an increasing public health concern.[6] Asthma is themost prevalent chronic childhood disease, affecting 339 million people globally. Sensitizationto ambient aeroallergens is also prevalent, with prevalence rates ranging from 17% to 50%among 20-44-year-olds in 35 centers in 15 developed countries.[7] Aeroallergens are more irritating to atopic patients.[8] Asthma and respiratory health have been studied extensively in epidemiological research. Because of the need for more green space and the highconcentrations of certain pollutants in the air, it is critical to understand the Interactions between allergens and pollutants in urban areas.[9] A better understanding of how allergen and pollutant co-exposures impact the human body is essential because climate change is expectedto lead to an increase in pollen and spore counts, as well as an increase in the concentration range of many airborne pollutants (e.g., CO, ozone, and extreme dust events). This review article examines and summarizes epidemiological evidence about the types and potential mechanisms of aeroallergens, aeroallergens' interactions with air pollution, and the effect of aeroallergens on body systems.

MATERIALS AND METHODS:

This systematic review was conducted by searching three databases (google scholar, PubMed, and PakMediNet). Articles published between January 2018- to June 2023 were searched. MeSH and Non-mesh keywords, like Aeroallergens, allergy, outdoor pollutants Severity, particulate matter, manifestations, Pakistan, and diseases, were used. Boolean operators AND OR were used.

Articles that were not published in the English language were excluded. Also, the study selection procedure did not include. All clinical trials (RCTS), meta-analyses, perspectives, case reports, case series, and grey literature.

The following inclusion criteria were used for the articles searched from the relevant databases.

- The paper was published in the last five years.
- The Geographic area was defined. Articles addressing Pakistan were included.
- Aeroallergens severity due to outdoor pollutants.
- Systematic reviews, scooping reviews, commentaries, editorials.

- Types of pollutants and mechanism and manifestations of aeroallergens severity in all age groups.

After removing duplicates, the three authors (A.A, K.J, M.N) independently checked the titles and abstracts according to the eligibility criteria. The articles selected were subjected to the next phase, and the Full text was read. The selected three authors the articles independently. In case of confusion, the other authors (S.A, S.R) read the papers to finalize their eligibility.

PRISMA guidelines were used, and a Prisma flow sheet was developed to extract the material. All the relevant data were extracted according to the selection criteria. The summary table contains information on Authors, titles, and publication dates. More specifically, the data about the Major pollutants, sources, manifestations, challenges, and areas affected were included. The table format assisted the authors in completing a detailedover-review of the data selected in the first phase.

The PRISMA flow diagram in Figure 1 shows the authors' article selection procedure whileselecting the articles. The authors searched three databases (Google Scholar. PubMed, and PakMediNet) and identified 1380 articles. From these first records, the authors removed 70 duplicates. Leaving 1300 articles for review. We reduced the total number of articles to 606 after screening titles and abstracts and applying the following exclusion criteria.

- Articles having factors like climate change and allergens in the workplace.
- The effects of COVID-19 on respiratory illnesses.
- Articles mentioning food allergy and genetic causes of allergy are excluded.
- Articles published in languages other than English language were also excluded.

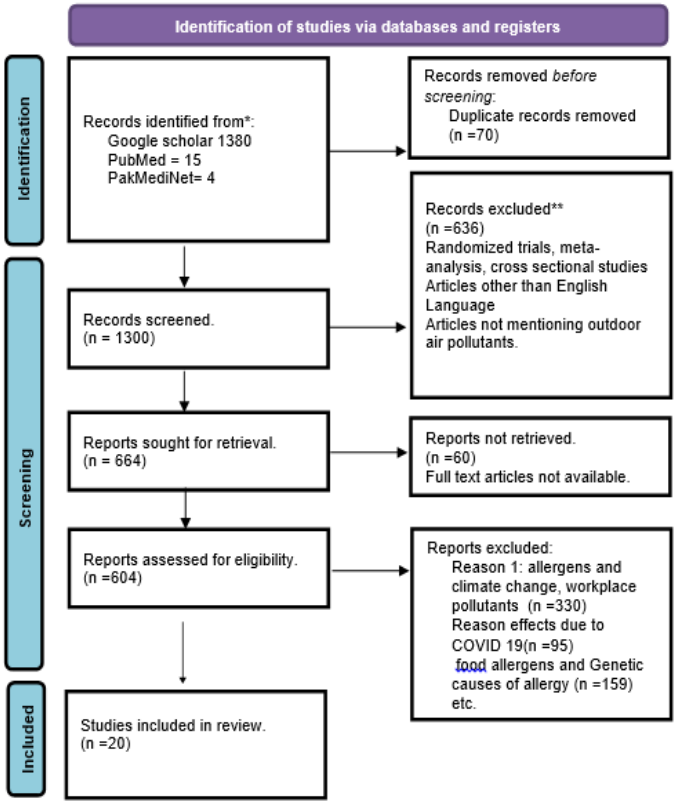

Figure 1: Prisma flow diagram.

The remaining articles were given full reading and the final 20 articles were selected that met the inclusion criteria.

- Types of pollutant, along with mechanism and manifestations of aeroallergens severity in all age groups.
- The Geographic area was defined. Articles addressing Pakistan were included.
- Aeroallergens severity due to outdoor pollutants

Summary of selected 20 studies.

Sr. No	Author year/ reference	Title	Primary cause of pollution	Possible sources	Mechanism	Manifestations of Aeroallergens Severity	Challenges for control	Sites with maximum air pollution
1	Anjum SM., et al.2021 [42]	An Emerged Challenge of Air Pollution and Ever- Increasing Particulate Matter in Pakistan; A Critical Review	CH4,NOx, SO2, CO, PM 2.5,PM10),hydro carbons from	Forecasted oil and industry, agriculture, transport		Clinical: strokes, lung cancer, and chronic respiratory diseases Economic Political	Lack of awareness Lack of policy reforms Use of improper oil No legislation on prohibition of open burning	Lahore, Karachi, Faisalabad, Quetta, Peshawar,&Islamabad / Rawalpindi
2	Malamardi S, et al.2022 [43]	A systematic review of the evidence of outdoor air pollution on asthma hospital visits in children and adolescents in South Asia	TSP, O2, NO, SO2, and CO	Transport emissions Seasonal variability for pollens and increased exposures		ASTHMA Emergency hospital visits and admissions Increasing burden of asthma	Lack of monitoring of environmental factors (dust allergens) Lack of awareness of PPE for children Improper air quality measurement	Lahore
3	Ramli NA, et al.2020 [44]	Chemical and Biological Compositions Associated with Ambient Respirable Particulate Matter: a Review	PM (PM2.5) Bio- aerosols	Solid wastes and sewage transport, wetlands,carbon containing combustion, Changing weather.		Various bacterial viral and fungal diseases. Economic constraints	Lack of proper monitoring equipment's Lack of knowledge and research	Khanaspur
4	Simkovich SM,et al. [45]	The health and social implications of household air pollution and respiratory diseases	HAP	Biomass fuel in low socioeconomic status, and smoking.	biological mechanisms ,HAP cause inflammation	ARIs, tuberculosis, asthma, chronic obstructive pulmonary disease, pneumoconiosis, low birth weight, malnutrition, low	consistent diagnostic criteria exposure monitoring lacking experimental evidence	Pakistan
5	Vasilevskaya N.2022 [46]	Pollution of the Environment and Pollen: A Review	Pollens PMs 2.5 Ozone	Industrial emissions and exhaust gases	PMs can bind with airborne pollen and fungal spores,changing their morphology	Genotoxicity causing cancers. Increased Pollen allergen city	Lack of Monitoring of Pollen Changing morphology of pollens	Quetta
6	Musa LR, 2023 [47	Effects of air pollution on human health: a review	NO2, ozone, arsenic, mercury , PAH	Motor vehicles, solidgfeul burning, industries	Allergic reactions	Respiratory and Cardiovascular diseases, skin diseases, irritation of the eyes. hospital admissions and premature Death.	Increased hospital burden Economic burden OOP increased	Pakistan
7	Fatima M,2022 [48]	Spatial and temporal analysis of acute respiratory infections (ARIs) in Southern Punjab, Pakistan	NO2, SO2, Ozone, Hydrocarbons	Motor vehicles, fossil fuels, industries	lung epithelium can initiate lung inflammation	ARI	set of remedies and policy changes Collaboration of local government and community.	Bahawalpur
8	Niede R, et al.2022 [49]	Integrated review of the nexus between toxic elements in the environment and human health	PTE(As, Cr, Cd,Pb)	Industries	deactivate the intrinsic antioxidant defense mechanism of cells	Renal diseases, hepatic diseases, skin infections, abortions	locating and controlling of these pollution sources monnitoring evaluation control of source and contamination soil	Vehari
9	Aslam R, et al.2022 [50]	Association of human cohorts exposed to blood and urinary biomarkers of PAHs with adult asthma in a South Asian metropolitan city	Semi- volatile organic compounds (SVOCs)	Exposure to dust	biomarkers IgE, resisting	bronchial asthma elevated PAH level in blood and urine	Lack of monitoring by local regulatory agencies	Lahore
10	Khan IA, et al.2020 [51]	Assessment of Asthma-Prone environment in Karachi, Pak using GIS modeling	CO, NO2, NO, SO2, Dust, pollen.	Densely populated Commercial areas, Traffic, wood markets	Lung inflammation	Asthma, tuberculosis, lung diseases Overburdened d medical facilities, low quality of life.	environmental deterioration lack of governance. Loose enforcement of city codes, limited utility services	Pakistan.

11	Ashraf F ,2020 [52]	An analysis of the impact of air pollution on asthma patients in industrial city of Sialkot	dust, and smog	heavy traffic pollution, factory smoke, and air chemicals	Ozone component of smoke irritates and inflames the epithet-lial lining of lungs	Asthma exacerbation	strategic plan for the quality of air lack of safety precautions community-based health policies	Pakistan
12	Zaman H, et al.2022 [53]	Assessment of Bio aerosols and Metal Contaminants in Car cab- in Filters Dust of LHR, Pakistan	CAF dust, Heavy metals	allergic reactions, infections, inflammation,	waste disposable stations	Bacterial viral and fungal infections, and respiratory diseases	Strategies to decrease microbial air pollution. air pollution abatement policy	Lahore
13	Khalid L, et al.2021 [54]	Air Pollution and Boosting Skin and Aero-Allergies	O3, NO2, SO2o	Traffic and modern exercises	hypersensitive illnesses and IgE particles,	asthma, hypersensitive rhinitis, hives and other skin allergies	Lack of advance allergy centers. Monitoring and evaluation, detection of hypersensitivity places.	Islamabad
14	Asif M, et al.2022 [55]	Particulate matter emissi-on sources and their cont-rol technologies	PM2.5,P M10,N O,CO,S O2	Forest fires, power plants. Vehicles,	---------s	Premature deaths, Loss of trees and vegetation,	Monitoring systems, PM pollution and traffic regulation. Choice of fuel,	Pakistan
15	Usman F, Et al.2022 [56]	In-Depth Analysis of Physicochemical Propert-ies of Particulate Matter (PM10, PM2.5 and PM1) and Its Characterization through FTIR, XRD and SEM–EDX Techniques in the Foothills of the Hindu Kush Region of Northern Pakistan	PM2.5,P M,10,P M1.0	Biomass burning, burning, Coal burning, waste material, incineration and Vehicular emissions	--------	silicosis, chronic obstructive pulmonary disorder, tuberculosis, chronic bronchitis and lung cancer	Poor quality of air, Poor drainage, Burning of waste	Swat
16	Bukhari ISS, et al.2020 [57]	Characterization of Bio aerosols and Particulate Matter (PM) in Resident-ial Settings of Asthmatic Patients of Lahore, Pak	PM01, PM2.5, PM10) Bio-aerosols		----------	Asthma	--------	Pakistan
17	Midouhas et al.2019 [58]	The quality of air outside and inside the home: associations with emotional and behavioral problem scores in early childhood	NO2, SO2	Less green space, car emissions, industries		Malnutrition, low birth weight, abortions, respiratory diseases. Emotional problems	Lack of awareness. Personal protection	Pakistan
18	Anwar NM,et al.2021[59]	Emerging challenges of air pollution particulate matter in China, India, Pakistan and mitigating solutions	SO2, NO,CO	Air pollution		COPD, ARI, chronic bronchitis, and emphysema	economic status, local meteorological conditions and industrial interests, public lifestyle, and national literacy rate	Pakistan
19	Yousaf HS, etal.202 1 [60]	A comparative assessment of air pollutants of smog in wagah border and other sites in Lahore, Pakistan	PM 2.2, PM 10,SO2, NO	Smog formation	Lung epithelial irritation	ARI	baseline data on winter smog, monitoring of secondary air pollutants	Wagah border, Pakistan
20	Sarfaraz Z. 2020 [61]	The Social and Economic Burden of Smog in Pak	O3, CO, NO,	Smog formation	Inflammation	smog-related diseases	Evidence based policy	Pakistan

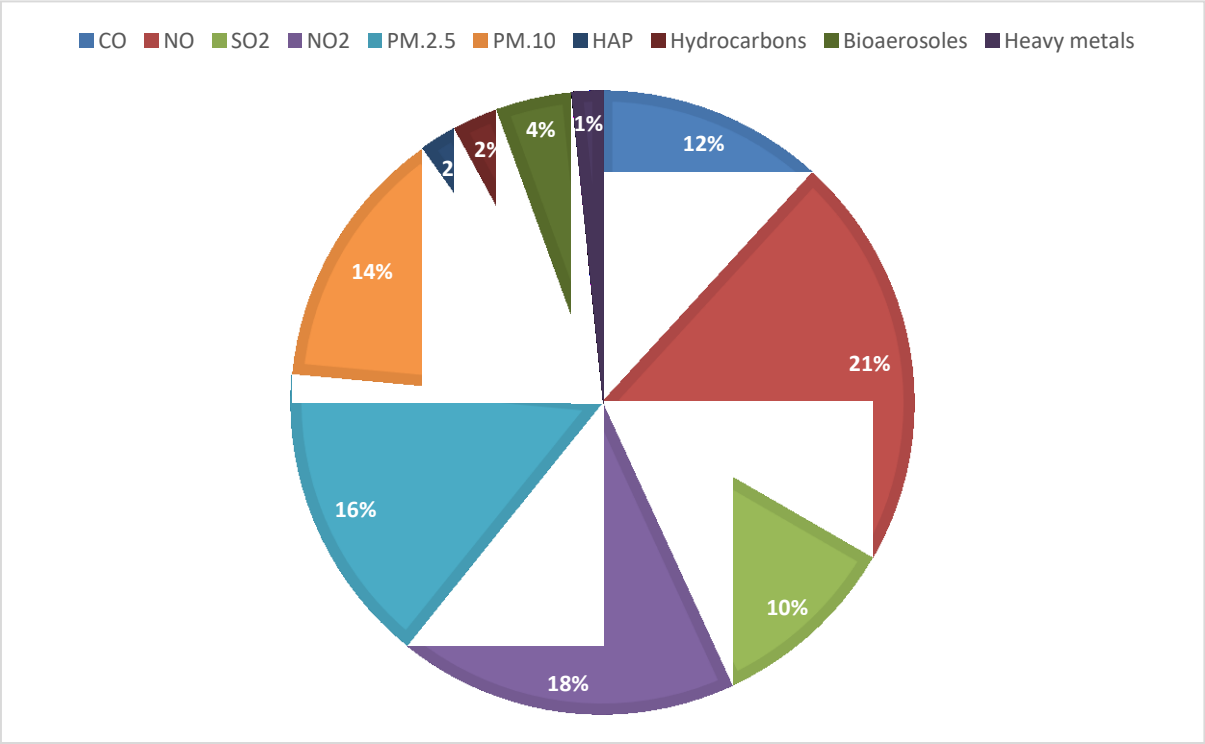

Figure: 2 Types of Pollutants Identified in Pakistan**.**

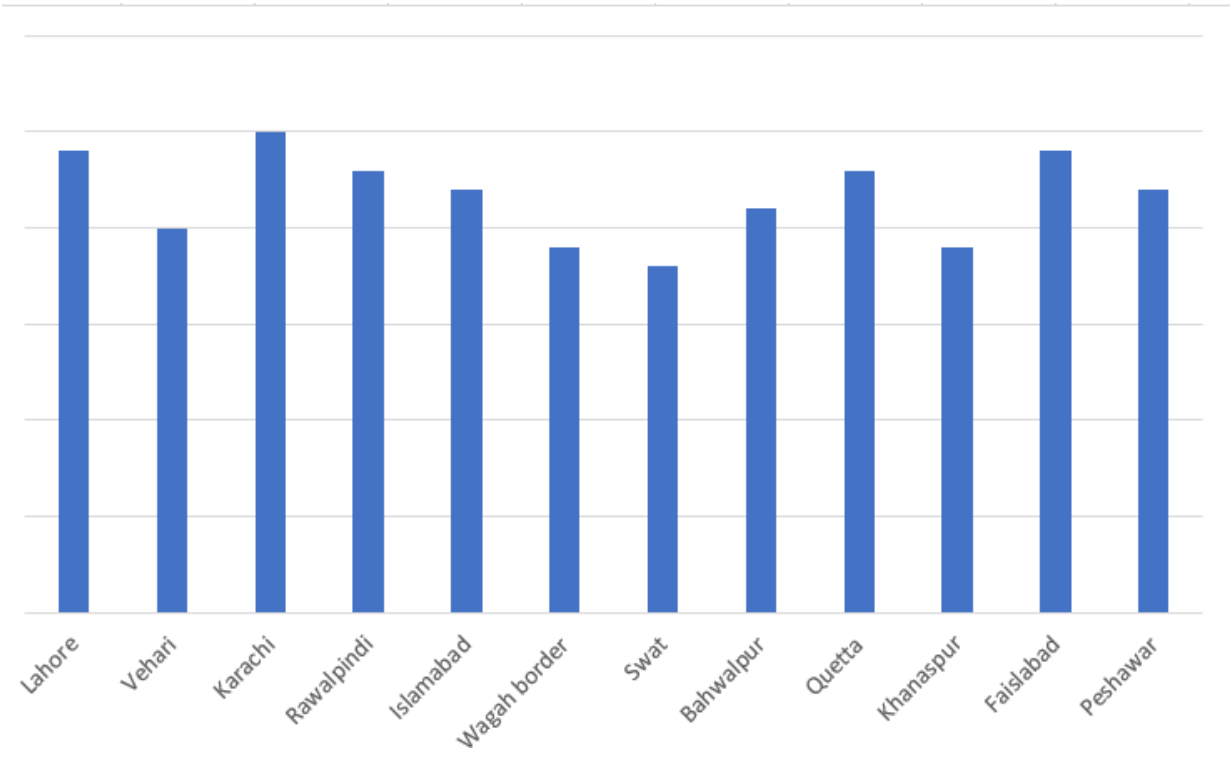

Figure: 3 Areas with high concentration of outdoor pollutants in Pakistan.

Table 2: Challenges identified for the control of outdoor pollution in Pakistan**.**

Sr. No	Categories	Challenges faced
1	Resource related	• Use of Fossil fuels, • Wood and coal burning • Use of improper oil • Vehicles not maintained properly. • Economic constraints • Out of pocket payment increased
2	Organizational related	• Strategies to decrease microbial air pollution, strategic plan for the quality of air. • Collaboration of local government and community.
3	Policy related	• air pollution abatement policy • Lack of policy reforms
4	Legislation related	• No legislation on prohibition ofopen burning • Poor traffic regulation.
5	Governance and leadership	• Poor Governance • industrial interests
6	Monitoring and evaluation	• Monitoring of secondary air pollutants • lack of monitoring equipment's • lack of Air quality monitoringstations • Detection of hypersensitivity places. • Exposure monitoring
7	Evidence based research	• Lack of research regarding etiology, • lacking experimental evidence • Various pollutants and mutations • consistent diagnostic criteria • Changing morphology.
8	Knowledge and awareness	• Regarding using proper PPE • When to avoid outdoor exposures • How to protect children • lack of safety precautions • Open burning of garbage • public lifestyle, and national literacyrate

DISCUSSION:

Pollens, spores, and other biological or non-biological airborne particles can all be consideredaeroallergens because they can trigger allergic reactions in some people. Proteins are releasedas an allergic reaction on the skin and mucous membranes in response to aeroallergens, which can be triggered by inhalation or cutaneous contact.10 Particles in the air can also trigger irritating reactions without eliciting an immune response. Some reactive allergenic compounds and allergens derived from living things can also trigger allergic reactions. The industrial workplace is typically more likely than the average home to have these substances. However, everyday household items may contain immunogenic chemicals (e.g., isocyanates in bathtub refinishing products).[11-14]

Molds found indoors release spores of their spores into the air, which some people can be allergic to. Mold and mildew may flourish almost anywhere there is moisture, but they thrive especially well in damp environments like bathrooms, basements, and other places with water leaks. Indoor plants can be a source, especially those stored in wet wicker baskets. Mold can also thrive in other interior environments, such as on mattresses, old foam rubber pillows, storage closets, and behind furniture.[15,16].

Outside, fungi disperse spores and other byproducts that are sources of allergens. Although thousands of fungi can pollute indoor air, pure allergens have been extracted from only a handful of them, and none have been fully described. There is evidence that allergens in fungal spores have a role in the development of hay fever, asthma, and hypersensitivity pneumonitis and that other fungal products can be irritating or poisonous, potentially exacerbating existing allergic diseases.[17-19].

Triggers for outdoor allergies are found primarily in natural settings. Pollen from grass, trees, and ragweed, as well as mold, are common outdoor allergens. Most people with outdoor allergies do so because of their sensitivity to seasonal allergens and triggers. Pollen and mold spores are the usual culprits for outdoor allergies.[20] Some people may be allergic to tree pollen3, just as they may be to pollen from other plants. While most tree pollen is released in the spring, trees in the south can start releasing pollen as early as January 3.[21]

The allergy that causes hay fever in most people is grass pollen. The climax of the grass pollen season occurs in late spring. If you suffer from outdoor allergies and find that they worsen between April and June, you might have a grass allergy.[22] Ragweed pollen peaks in mid-September and can be seen in some states as early as June 6. Symptoms could be caused by any of 17 species of ragweed found in 49 states across the United States.[23] Mold can be found in many familiar places, including decaying wood, leaves, cereals, and compost piles. Mold spores are released into the air when these surfaces are broken and can be inhaled by nearby humans.[24]

Trees, weeds, and grasses produce pollen grains in the spring, summer, and fall. Pollen is a frequent airborne allergy, especially in the spring and summer when high temperatures and flowers bloom. Many types of grass, including Timothy grass, Kentucky bluegrass, and orchard grass, generate pollen (to name a few). Oak,

elm, and pecan trees are additional potential sources. Pollen is a common allergen that can produce various unpleasant symptoms in the spring.[25,26]

Allergies can only affect those genetically predisposed to them, but irritating reactions can strike anybody. Allergens in the air, indoor or outdoor, can aggravate allergic asthma, although, in industrialized countries, the average person spends more than 90% of their time indoors. Dust mites can cause anthracnose and other respiratory diseases (see the image below) and other animal dander such as cat, dog, and bird droppings.[27]

An allergen is something that triggers an allergic reaction in people. The immune-mediated hypersensitivity that occurs as a result of exposure to an allergen is what is known as an allergy. It can be divided into two stages: sensitization, which involves an immunological deviation toward a T-helper (Th) 2-type response and is aided by allergen-specific Th2 cells that secrete the cytokines interleukin (IL)-4, IL-5, and IL-13. In the second stage, [28] Mast cells loaded with IgE are triggered, resulting in an allergic reaction in the second phase of the process (i.e., histamines, prostaglandins, leukotrienes). As a result, people with respiratory allergies experience many symptoms. The immune system's immunoglobulin E (IgE) antibodies mediate the most frequent allergic reaction.[29]

Additionally, mast cells, which contain histamine and other inflammatory substances, are critical. An individual who develops an allergy is "sensitized" to a particular allergen after the first encounter with that allergen. A person becomes "sensitive" (or "hypersensitive") to additional exposures to an allergen when an IgE antibody specific to that allergen attaches to the surface of the mast cells in their body. Mast cells release histamine and other inflammatory response molecules when a sensitized person is re-exposed to the same allergen. These chemicals cause an allergic reaction and the symptoms we often associate with allergies when interacting with surrounding tissues.16 People with atopy (a genetic allergy tendency) produce much more IgE than the general population. The human body can produce IgE antibodies for years after a person has come into contact with an allergen. A person allergic to penicillin as a child may still be allergic to it as an adult.[30]

Regarding allergies, it's not apparent why some people get them, and others do not. There is little doubt that hereditary factors significantly determine whether an individual suffers from allergies. There is a three-to-one likelihood that a child born to an allergic parent would also have allergies.[18]

Outdoor air pollution modifies the Allergen city of plant pollen and fungal spores, accelerates allergen release, and facilitates allergen transport into the airways. An allergic reaction can be exacerbated if air pollution damages the epithelium, leading to increased oxidative stress and inflammation and a weakened immune system.[30] Biological outcomes have been negatively impacted by allergens and air pollution in numerous human studies. The inflammatory and immunological responses caused by allergens are exacerbated, lung protein expression is altered, and lung function is impaired when they are exposed to air pollution at the same time.[31] Research on allergen-pollutant interactions at the ambient level has yielded conflicting results in epidemiological studies.[17]

Airborne allergens are affected by climate change, which alters allergen and fungus spore allergenicity and the distribution of these allergens. Pollen season trends have been connected to temperature fluctuations in numerous studies over a long period. There has been a study of oak pollen patterns in Ourense, Spain, since 1993.[32] Pollen high content and pollen peak concentration were found to rise 7.9% and 7.5% per year, respectively. In addition to pollen and fungus spores, climate change has considerable effects on dust mites, indoor fungi, and mold (Poole et al., 2019). House dust mites (HDMs), their allergens, and allergy illness are all affected by climate change suggesting that global or regional changes in temperature, humidity, air pollution, or other environmental conditions may alter natural HDM growth, allergen production, and survival.

The components of air pollution can harm human health based on their ability to enter the body, where they deposit, and how they interact once inside. Aeroallergens and air pollutants enter the human body through ingestion and inhalation. Air pollutants most commonly affect the immune, cardiovascular, neurological, and respiratory systems.[33]

People are mostly exposed by breathing in pollen grains and fungal spores. Pollen and fungi proteins enter the body through the respiratory system. Here, allergens cause inflammation. "Skin-prick tests" detect allergies. These tests reveal IgE-mediated Type I hypersensitivity at a "pricked" spot on the skin. Grass and tree pollen are responsible for the majority of seasonal allergic rhinitis. The size determines when aeroallergens affect the respiratory system. Aeroallergens range from 10 to 100 m. Very small (10 m), small (10–25 m), medium (26–50 m), large (51–100 m), and very large (>100 m) Aeroallergen grains larger than 5 m stick to ocular conjunctiva and nasal mucosa. They can cause conjunctivitis or allergic rhinitis and aggravate asthma. Allergens like cat dander can release particles smaller than 5 m. These particles cause asthma. Variable inflammatory responses exist. [21,30]

Aeroallergens induce a chronic immune response mediated by IgE. Interleukin-4 (IL-4) increases regulate IgE-mediated atopic responses. Asthma and allergies have risen in every age group. Asthma is an immune-mediated respiratory disease. Many asthmatic children experience the "atopic march." Age-related allergies cause temporary symptoms. Food (such as egg) and indoor (such as dust mites) allergies come first, followed by outdoor allergens (such as pollen). Prenatal and the first months of life are likely the earliest environmental exposure windows since "atopic march" symptoms may begin in the first year of life. Only exposures before an illness's first symptoms can influence its inception, and antigens and air components can cross the placental barrier.[34]

Environmental exposure is protective if it reduces the risk of a specific condition. Children exposed to dogs or livestock as young as possible are less likely to develop the disease, aeroallergen sensitization, and other allergy-related respiratory disease. Hygiene hypotheses claim that the immune response is shifted toward Th1 predominance when microbial exposures occur. Early and prolonged animal contact protects against aeroallergen sensitization, especially in the first two years of life. Aeroallergen-specific IgE

antibody production is decreased when farm animals are exposed.[35]

Breastfeeding makes it less likely that a child will have eczema or asthma. Even though atopyin the mother could throw off this link, exclusive breastfeeding lowers the risk more than expressed breast milk or breast milk mixed with formula. The risk is cut down the most in children 0–2 years old.[36]

A positive exposure–response relationship must be shown to consider an environmental factora risk factor. Pollen's interactions with the following environmental conditions have been linked to allergic disease. Pollen counts change with the seasons. Ragweed pollen peaks aroundnoon if there are no significant winds or rain. Evening counts can rise or fall in response to temperature, humidity, and wind changes. These aeroallergen productions can be boosted by water in just 24 hours.[37]

Due to the intricacy of precipitation, high counts may not be required for significantaeroallergen exposure due to broken aeroallergen grains. Thunderstorms can trigger asthma exacerbations, resulting in increased emergency (ER) visits and mortality. Thunderstorms carrypollen grains, both intact and fragmented, to the earth, where wind currents disperse them.[38] Climate change is causing an increase in airborne allergens and respiratory illnesses. Anti- climate change mitigation measures are essential in the face of these severe predictions.Tackling climate change will reduce CO2 emission and temperature increase, reducing the effects of global warming on aeroallergens and allergy respiratory illnesses. An important part of mitigating climate change is adapting to it.[39] As climate crisis mitigation and adaptation become more important, health staff are expected to promote them. Alternatives to adaption have been described, but little in-depth investigation of them has been done so far.[40]

Recent research subjects include allergen control, planting techniques, and policy design. Therewas an investigation of the community health impacts of ragweed (A. artemisiifolia) and the impact of a leaf beetle that was accidentally introduced on ragweed sensitivity patients and healthcare expenses.[23] Their findings show that ragweed and other non-native invasive weeds can lower mortality, morbidity, and healthcare costs. An important health marker of climate change is the monitoring of airborne allergens. Calls have been made for an integral approachto air quality monitoring considering the atmosphere's physical, chemical, and biological interactions. Real-time monitoring of pollution exposure, allergies, and weather conditions is possible thanks to smart-phones.[41]

CONCLUSION:

Air pollution (AP) poses a significant health risk. It is a complex mixture of gases, liquids, andsolid particles such as includes particulate matter (PM), nitric oxides (NOx), sulfur oxides, carbon monoxide (CO), and ozone (O3).1 According to particle aerodynamic equivalent diameter, inhalable PM is further classified as coarse (2.5-10 m), fine (0.1-2.5 m), and ultrafine(0.1 m), with fine PM capable of reaching the lungs. Coarse PM cannot reach the lungs, whereas fine PM cans.2 Transportation and heating systems are typical urban emission sources.The combination of gaseous emis-

sions (including NOx) and non-combustion sources, including road dust, tire wear, and brake wear, contribute to traffic-related AP.3 these significant emissions generate O3, nitrates, and organic aerosol. Heating systems are a significant contributor to PM and CO pollution. The industry is a second source of PM.4,5

It is important to note that air pollution directly impacts the production, concentration,seasonality, and dispersion of aeroallergens. Climate change could lengthen the aeroallergen season and increase pollen grains and their Allergenicity. These changes will increase pollen allergens. As will their treatment costs, asthma, and lung allergies are expected to become morecommon. Mold and pollen are common air allergens. Mold and pollen are common air allergens. Aeroallergens cause allergies, especially in genetically predisposed people. Pollen and fungi work together. Aeroallergens can cause or prevent allergies. More exposure to risk factors may worsen symptoms after becoming sensitive and developing symptoms. Symptomsdisappear when a person stops being around risk factors or gets medical help.

Someone allergic to aeroallergens could use an aeroallergen alert system to warn them to limittheir exposure. A model of how aeroallergens are made and spread that considers weather and climate change would help an alert system. This model can predict air quality. Similar pollensreact similarly in humans. It would be easier and cheaper for the public to report total tree, grass, and ragweed pollen, but species counts are still useful for modeling and research. Researchers must conduct longitudinal studies to study long-term patterns, not seasonal and allergy variations. To better understand how pollens and fungi are affected by climate change,we need to conduct research like this. Continued research is needed to fill in the many gaps in our knowledge of this complicated subject, including improving methodological approaches, widening geographical area (toinclude Antarctica), and, as the atmospheric environment's mechanical, biochemical, and biological components come into play, a more coherent and holistic approach is now needed for air quality monitoring and assessment.

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