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Environmental Factors Influencing Pollen Allergy in Urban and Rural Areas.

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A B S T R A C T

Pollen allergy, also known as seasonal allergic rhinitis or hay fever, is an allergic reaction triggered by pollen from trees, grasses, and weeds. The symptoms can range from mild issues like itchy eyes and sneezing to severe, potentially fatal anaphylaxis. Identifying plants that cause allergies can be difficult, and the unchecked proliferation of weeds and trees worsened by air pollution creates a setting that promotes allergies. Urban heat islands, air pollution, and climate change are significant factors that exacerbate pollen allergy. The urban heat island effect raises temperatures in cities, while air pollutants can alter the allergenic potential of pollen. Climate change intensifies extreme weather occurrences, posing risks to honey bee populations and plant-pollinator relationships.

Keywords: Pollen allergy, Type of pollen, Amaranthaceae allergens, asthma.

Introduction

Pollen allergy, referred to as seasonal allergic rhinitis or hay fever, is an allergic response initiated by pollen from trees, grasses, and weeds. When breathed in, pollen may prompt an immune system overreaction in susceptible people, resulting in a range of symptoms.

In people with a tendency towards allergies, coming into contact with airborne allergens frequently stimulates the creation of allergen-specific IgE antibodies (Moneret-Vautrin *et al*, 1997; Moneret-Vautrin and Kanny, 2007). These IgE antibodies identify intricate structures, such as motifs or conformational epitopes, found on the surface of allergenic proteins. Because of the elaborate characteristics of these structures, it is difficult to identify exact linear peptide sequences that are responsible for IgE binding (Adachi *et al*. , 1993). When sensitized individuals are exposed to the allergen again, the attached IgE antibodies trigger an immediate allergic reaction, resulting in symptoms that can vary from mild issues like itchy eyes, sneezing, and skin rashes to severe, potentially fatal anaphylaxis. (1)

The connection between pollen allegies and environmental surroundings is significant, with both urban and rural locales presenting distinct challenges. Allergenic flora thrive in various environments, impacting people in diverse settings. While urban regions generally report fewer pollen counts, pollutants and other stressors can exacerbate allergy symptoms. On the other hand, rural areas frequently have elevated pollen counts because of more vegetation. The differences in allergenic plant and pollen species between urban and rural areas highlight the necessity of recognizing these variations to create focused strategies for managing pollen allergies. (10)

Grass pollen allergy :-

Gramineae :- Globally, grass pollen is the main factor responsible for pollinosis, with different prevalence rates in various regions. In Europe, grass-related pollinosis is the most common type of pollen allergy. Importantly, a substantial majority of individuals allergic to grass pollen – as much as 95% - produce IgE antibodies that are specific to group 1 allergens, while approximately 80% respond to group 5 allergens, which are the two primary allergenic elements found in grass pollen.

The grass family (Gramineae) is extensive, including more than 600 genera and 10,000 species. In Europe, there are over 400 herbaceous grasses that rely on wind for pollination. Most of the airborne grass pollen is derived from tall meadow grasses, including timothy, orchard grass, and meadow foxtail. Cultivated rye serves as another major source of allergens, generating particularly large quantities of pollen. Although there are many grass species, their pollen shows an extraordinarily high level of cross-reactivity, with only a few exceptions.

In northern, central, and eastern Europe, the main period for grass flowering usually stretches from early May to late July. Conversely, the Mediterranean area has a somewhat earlier flowering period, generally finishing by the end of June. Moreover, pollination takes place earlier at sea level, usually 2-3 weeks in advance of mountainous areas. Although the pollen season changes each year due to climate variations, the greatest grass pollen

concentrations in the atmosphere typically happen 1-2 months after the primary flowering season begins. In general, June represents the peak month for grass flowering throughout Europe. (11)

Tree pollen allergy :-

In different areas, certain trees are well-known for generating very allergenic pollen. For example, in northern, central, and eastern Europe, birch trees (Betula) serve as a main offender. On the other hand, the Mediterranean area suffers from the allergenic pollen of olive trees (Olea europaea) and cypress trees (Cupressus).

Fagales:- In Central and Northern Europe, allergies to tree pollen are mainly triggered by birch pollen and pollen from related species in the Fagales order, such as hazel, beech, alder, oak, hornbeam, and chestnut. These kinds of pollen impact around 25% of those who have allergies. The key allergen implicated is Bet v 1, a significant birch pollen allergen that cross-reacts with similar allergens from associated trees, prompting sensitization. Remarkably, 95% of those allergic to birch pollen respond to Bet v 1, with 60% showing exclusive sensitization. In addition to Bet v 1, five other allergens have been recognized within birch pollen. Moreover, pollen from these trees can lead to complications beyond respiratory issues, as some allergens correspond to those in edible plants, resulting in pollen-food-syndrome (PFS), formerly referred to as oral allergy syndrome (OAS).

Pollen production reaches its highest point 1-3 weeks after the season starts and continues for anywhere from 2 to 8 weeks, depending on the temperature. Interestingly, certain European regions have shorter or longer pollen production durations, characterized by alternating low and high pollen levels. In Europe, Corylaceae trees such as hazel and alder are the first to emit pollen into the atmosphere, generally from December to April.

This early release of pollen, alongside allergenic cross-reactivity, implies that hazel and alder can sensiti+ze people to Betulaceae pollen allergens, worsening symptoms during the birch pollen season. Likewise, the oak pollen season can extend the birch season in western, central, and eastern Europe. Sweet chestnut pollen generally appears in June and July in western and central Europe. (11)

Cupressaceae:- The Cupressus genus is commonly found throughout the Mediterranean area, with prevalent species being C. sempervirens, C. arizonica, C. macrocarpa, and C. lusitanica. Cypress trees release large quantities of pollen carried by the wind, significantly adding to the yearly airborne pollen levels in numerous Mediterranean regions. In southern Spain, for example, Cupressaceae pollen represents at least 30% of the overall pollen count in winter, whereas in Italy and Albania, it makes up 20-40% of the yearly pollen precipitation. In recent years, Cupressaceae pollen has become an increasingly significant trigger of pollinosis in Mediterranean nations like France, Israel, Spain, and Italy. Importantly, it is also linked to winter pollinosis, which arises during a time when other allergenic plants are inactive.

Recent clinical studies have shown notable improvements in the effectiveness of immunotherapy for cypress allergy, making use of standardized extracts. Both subcutaneous and sublingual methods of administration have indicated encouraging outcomes. However, additional research is necessary to completely utilize the possible advantages of specific immunotherapy for cypress allergy. (11)

Weed pollen allergy

Urticaceae Allergens:- Parietaria, a genus belonging to the Urticaceae (nettle) family, is the main source of allergens. The two most important species, Parietaria judaica and Parietaria officinalis, generate significant allergens that are small glycoproteins with molecular weights ranging from 10-14 kDa, showing considerable cross-reactivity. Recent findings have shown that P. judaica pollen includes an aminopeptidase enzyme that has the ability to penetrate the epithelial barrier, aiding in the transfer of allergenic proteins to dendritic cells and possibly worsening the allergic reaction.

Parietaria judaica and *Parietaria officinalis* are two species that have different geographical distributions. *P. judaica flourishes* in the Mediterranean area, encompassing Spain, France, Italy, Greece, and some regions of Asia and Africa. In contrast, P. officinalis is located in northern Italy, central France, and central and eastern Europe, particularly in Croatia. Although both species are predominantly found in the Mediterranean, they have also been recorded in temperate European areas, California, and Australia.

The pollination period of Parietaria Is significantly lengthy, affected by climatic conditions. Typically, it starts in early spring, continues through the spring and summer months, and has a shorter secondary phase from late August to October. In Sicily and southern Italy, pollen is available from February to December, with peak levels (up to 1000 grains/m3) occurring during May and June. Patients usually suffer from chronic symptoms in the spring (75. 12%), although many show multiseasonal patterns (18. 55%).

Parietaria-induced pollinosis is fairly uncommon in children who are younger than 10 years old. Nevertheless, its prevalence rises notably among individuals aged 10 to 30 years, especially in coastal areas in comparison to rural, non-coastal regions. In both Europe and the United States, there is a greater occurrence of reactivity to Parietaria. The extended presence of Parietaria pollen in the Mediterranean air results in symptoms lasting through several seasons. In certain areas, such as southern Italy, some patients report symptoms throughout the entire year. A retrospective cohort study indicated that sensitization to Parietaria judaica significantly increases the likelihood of developing asthma, while no notable correlations were observed with sensitization to house dust mites or other types of pollen. Importantly, 52% of patients who were monosensitized to Parietaria in central and southern Italy experienced bronchial asthma or similar symptoms, including severe cough together with rhinoconjunctivitis, with peak percentages reaching 60% in Naples and Rome. (2)

Urban environment and pollen allergy

Urban heat islands effect :- A remarkable occurrence takes place in numerous large metropolitan areas, where the temperature in the central or urban core is reliably warmer than in adjacent suburban regions.

This occurrence is referred to as the Urban Heat Island (UHI) effect. Essentially, cities generally display elevated temperatures at their centers when contrasted with the neighboring rural zones, resulting in a clear temperature gradient between urban and rural settings. Multiple elements lead to the Urban Heat Island (UHI) phenomenon, such as heat produced by humans, characteristics of surfaces, weather conditions, and air pollution. Study by Oke (1982) indicates that in appropriate circumstances, the UHI may cause temperature elevations of as much as 10-15°C. The microclimate established by the UHI carries substantial consequences, including an increase in energy requirements for cooling structures.

Air pollutants from industrial operations, power generation, vehicle emissions, and heat produced by humans further amplify the UHI phenomenon, as observed by Taha (1997). Moreover, Akbari et al. (2001) discovered that electricity consumption rises by 2-4% for each 1°C increase in temperature. In urban settings, the dominance of dark surfaces and sparse vegetation leads to a temperature disparity of up to 2. 5°C compared to neighboring rural areas on hot summer days, causing a further 5-10% rise in peak electricity demand for municipalities. Although the UHI effect has beneficial influences during winter by supplying warmer air, it poses harmful consequences for human health and energy usage during summer. (7)

The UHI phenomenon undermines comfort and elevates energy consumption at all hours, emphasizing the necessity for sustainable urban development and mitigation approaches. The urban heat island effect is a phenomenon in which cities experience considerably higher temperatures compared to their neighboring rural regions. Research conducted by Nakayama and Fujita (2010), Stone *et al.* (2010), Synnefa *et al.* (2011), and Santamouris (2013b, 2015a) has repeatedly demonstrated that urban locations are generally warmer than their rural equivalents. Initial studies by the World Meteorological Organisation (1984) and Oke (1987), referenced in Gorsevski *et al.* (1998), suggested that the urban heat island effect can lead to air temperature increases of 2-8°C in urban settings. Nevertheless, more recent studies indicate that the actual temperature disparity is probably between 5-15°C (Santamouris 2013a).The urban heat island effect mainly arises from alterations in urban landscapes, such as diminished vegetation and evapotranspiration, greater presence of dark surfaces with low reflectivity, and elevated levels of anthropogenic heat generation (Stone et al. 2010). These elements play a role in the heightened temperature variations between urban and rural regions. (5)

Causes of urban heat islands effect

The Urban Heat Island (UHI) phenomenon is linked to various factors, including:

1.Low Albedo Materials: Urban surfaces characterized by low albedo (reflectivity) capture more solar energy, which raises temperatures.

2.Human Activity: A high population density in urban centers results in increased CO2 emissions, which trap heat and worsen the UHI effect.

3.Air Conditioning: The extensive use of air conditioning units emits heat into the atmosphere, further elevating the temperature of the urban setting.

4.Deforestation: The removal of trees and green areas diminishes the urban environment's capacity to control temperature through evapotranspiration and shading.

5.Urban Canopy: The existence of multilayered buildings retains heat, establishing an "urban canopy" effect that amplifies the UHI.

6.Wind Blocking: Closely packed buildings lessen wind speed, reducing the cooling impact of convection.

7.Air Pollution: The accumulation of air pollutants in urban regions, especially in city centers, captures solar radiation and adds to the UHI effect (3)

Air pollution :- Air pollution denotes the deterioration of air quality caused by the emission of harmful chemical or biological agents, either from natural sources or human actions. These contaminants consist of particulate matter (PM), classified into three categoriesCoarse particles (PM10): diameter, Vehicle emissions (traffic), Burning of carbon-based fuels (gas, diesel, etc.) (9)

It is important to note that secondary emissions from diesel engines are the leading cause of particulate matter in urban air pollution. The possible health hazards linked to PM exposure are influenced by several factors:

Size of particles: smaller particles can infiltrate further into the airways Characteristics of the surface, Composition of chemicals. Upon inhalation, PM can inflict direct harm to the airways and alveoli through irritation and oxidative stress. This stress activates various cellular signaling pathways and triggers transcription factors, resulting in potential health problems.

Air pollutants have been demonstrated to change the allergenic potential of specific types of pollen. In particular, they can decompose pollen allergens into smaller, more easily airborne particles. For example, exposure to ozone has been shown to structurally modify the outer layers of pollen grains, resulting in alterations in their interactions with plants and human cells, ultimately increasing their allergenic characteristics. Research conducted by Kim *et al*. indicates that ozone exposure is strongly associated with heightened sensitization to outdoor allergens, shedding light on the growing incidence of allergic rhinitis. Likewise, investigations have revealed that simultaneous exposure to diesel emissions and airborne allergens can enhance allergen-specific immune responses (IgE), worsen asthma severity, and elevate airway inflammation and hyperreactivit

Urban vegetables : Urban green spaces have traditionally fulfilled various roles, offering a multitude of advantages to city inhabitants. These roles consist of Visual attractiveness and leisure activities, Environmental regulation (temperature, humidity, noise, pollution, and runoff management), Economic and ecological improvement of urban regions.

As society, technology, and sustainability issues have progressed, the function of urban vegetation has broadened beyond its conventional applications. New advantages and values have surfaced, including Food production, illustrated by the idea of "edible cities", Biomass production, Improvement of water quality via tree-based systems for sewage treatment, stormwater management, and groundwater recharge. In recent years, studies have increasingly concentrated on the link between green spaces, health, and well-being. Research has shown that urban green areas enhance physical and mental health throughout life, underscoring their significance within the larger environmental framework. This research is represented by case studies such as Shanghai, which highlight the importance of urban green spaces in densely populated areas. (12)

Rural Environment and pollen allergy

In recent years, there has been a notable increase in the prevalence of allergic diseases. Research indicates that being exposed to a wide variety of environmental microorganisms is vital in preventing allergic diseases by affecting immune system development during early childhood. Studies have repeatedly demonstrated that children who grow up on traditional farms in Europe or within Amish communities exhibit a reduced risk of developing asthma. Likewise, our earlier research conducted in South China (Guangzhou) revealed that rural children had significantly lower asthma rates (3. 4%) when compared to their urban peers (6. 9%). This protective Influence of living in rural areas has also been seen in North China (Beijing), underscoring the significance of environmental factors in influencing immune responses and the risk of allergies.

China's swift urban development has resulted in a transition towards a more Western-style way of living, marked by a greater focus on indoor Hygiene adoption of Western-style diets alterations in the gut microbial community, giving rise to a more Westernized microbiota. Studies indicate that an imbalance in the gut microbiome, referred to as dysbiosis, is associated with the emergence of allergic conditions. Recent research suggests that environmental factors encountered in early life are vital in determining the gut microbiota and affecting the likelihood of developing asthma and allergic disorders. A significant study revealed that contact with environmental microorganisms can alter the gut microbiome in mice, leading to better mental health outcomes. This underscores the potential significance of environmental microbial interactions in influencing both physical and psychological well-being. (13)

Natural vegatable : Natural vegetation refers to a plant community that has evolved over time without human involvement, allowing its member species to completely adjust to the local climate and soil condition.

India showcases an astounding variety of natural vegetation, differing significantly across various areas. The Himalayas sustain temperate plant life, while the Western Ghats and Andaman Nicobar Islands are filled with dense tropical rainforests. The delta regions include tropical forests and mangrove habitats, and the dry and semi-dry regions of Rajasthan are marked by cacti, shrubs, and spiny vegetation.

Weather patterns :

Climate change is intensifying extreme weather occurrences, presenting major risks to honey bee populations. A study by Schweiger et al. demonstrates the dire effects of heatwaves on pollinators and their environments, emphasizing the sensitivity of bees to climate-driven pressures. Furthermore, Stabentheiner et al. shed light on the complex connections between climate change, habitat loss, and disturbances to plant-pollinator relationships, emphasizing the extensive and ripple effects of ecological disturbances on honey bee communities.

Climate change is an intricate issue, influenced by a mix of natural and humaninduced elements. The main human-caused contributors to climate change are the release of greenhouse gases (GHGs), such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). These gases capture heat in the Earth's atmosphere, resulting in the greenhouse effect. The combustion of fossil fuels, including coal, oil, and natural gas, plays a major role in CO2 emissions. As noted in the 2018 Intergovernmental Panel on Climate Change (IPCC) special report, human activities – mainly the combustion of fossil fuels – have significantly raised atmospheric CO2 levels since the pre-industrial period, fueling global warming. (14)

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