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The Positive Effect of Climate on Allergic Rhinitis

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Abstract:

Allergic rhinitis is a growing global health issue, which is one of the most popular chronic diseases. Its prevalence is influenced by both environmental exposures and climatic factors. Therefore, this study aims to give the view of the positive effects of the climate to allergic rhinitis from the past paper, including the characteristics of the disease, relevant climate factors, pollution and geographical factors. The hypersensitivity response to allergens, mediated by immunoglobulin E (IgE), triggers allergic rhinitis, and children have a high prevalence of this condition. The symptoms include nasal symptoms, such as nasal congestion and rhinorrhoea, as well as extra-nasal manifestations such as sinus pressure, eustachian tube dysfunction, and headache. Air pollution can exacerbate allergic responses, and natural allergens are correlated with disease risk. The temperature positively correlates with prevalence. Global warming lifts the factors that directly related to the temperature, humidity and concentration of carbon dioxide, high temperature, humidity and carbon dioxide concentration correlate with increased pollen load and ability to cause allergic inflammatory response through global warming, as well as the higher concentration of spores of fungus and mould in atmosphere. Some extreme weather events that related to global warming, such as wildfire and flood, increase their frequency and intensity as well as the related allergens. The latitude and altitude have a negative correlation with the prevalence of allergic rhinitis in general. The urban resident a higher prevalence, considering the increased air pollution and the natural allergen due to heat islands. The region with different climate type shows diverse main allergens and high-incidence season.

Keywords: Allergic Rhinitis; Climate Change; Pollen; Air Pollution; Epidemiology

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1 Introduction

Allergic rhinitis is one of the most widespread chronic diseases, affecting up to 40% of children and about 10 to 30% of adults. It can lead to some complications, such as asthma, sinusitis, and otitis media as [1]. The condition is triggered by an immunoglobulin E (IgE)-mediated hypersensitivity response to allergens [2]. Allergic rhinitis significantly impacts the quality of life, affecting sleep, daily activities, and work or school performance. The symptoms of allergic rhinitis can be classified into primary nasal symptoms and extra-nasal manifestations. Nasal congestion is the most common symptom, affecting 86.5-94.23% of patients, followed by rhinorrhea in 77.6-90.38%. Extra-nasal manifestations include allergic conjunctivitis [3,4] and systemic effects such as headache, irritability [5], and sleep disturbances [6].

The factors related to this disease include increasing airborne pollution, a higher number of dust mites, inadequate indoor ventilation, and a suboptimal health status, among others [7], while climate conditions play a potential role in the aetiology of allergic rhinitis. A further understanding of this topic can aid in controlling and optimising public health strategies under the influence of climate change. For the aspect of climate, elevated temperatures and frequent heatwaves increase disease prevalence and severity, while heavy rainfall will also contribute to the disease by aiding the growth of mould and impacting indoor air quality [8]. Global warming further exacerbates the condition by rising temperatures, humidity, and carbon dioxide levels, which may enhance pollen production ability to stimulate an allergic inflammatory response, and dispersal [9]. Moreover, the trees exposed to high ozone concentration produce pollen with greater allergenic potential, including elevated levels of the major allergen Bet v 1, which intensifies skin prick reactivity [10].

The geographical factors show a negative correlation between altitude and latitude, and prevalence of allergic rhinitis [11,12]. And the urban residents with a higher prevalence of allergic rhinitis [13].

2 Epidemiological trends, mechanisms, and clinical characteristics

2.1 Epidemiological trends

Allergic rhinitis is a common chronic disease affecting a substantial proportion of the global population. Its prevalence varies internationally from 10 to 40%, with comprehensive reviews estimating rates of 20 to 30% in adults. This disease has a higher prevalence in children, with up to 40% of children worldwide affected by allergic rhinitis [14], and the estimated global prevalence for children specifically is 12.7% for allergic rhinitis [15].

Epidemiological estimates of allergic rhinitis are limited by methodological inconsistencies. A review demonstrates that there are 156 different definitions of rhinitis across 184 studies, with reported prevalence ranging from 1% to 63% and a median of 18.1%. These studies have been varied by the geographical location worldwide [16]. Moreover, prevalence is likely underestimated in low- and middle-income countries due to health system limitations and underdiagnosis [17].

2.2 Aetiology and pathogenesis of allergic rhinitis

Consider the genetic factors, only one nucleotide mutation can make a person highly sensitive to allergic diseases, which is known as single-nucleotide polymorphism (SNP) [18]. As for environmental contributors, including air pollutants, such as diesel exhaust particles (DEP), residual oil fly ash (ROFA), cigarette smoke, and Asian sand dust, which are all able to exacerbate allergic responses [18]. Further, the increasing concentration of ozone (O3), nitric oxides (NOx), respirable particulate (PM10), and volatile organic chemicals (VOCs), the source is the usage of fossil fuel, and these pollutants are correlated to the increasing prevalence of allergic diseases [19]. Moreover, natural allergens, including mites, pollen, and animal hair, further contribute to disease risk [20].

Considering the pathogenesis, allergen exposure induces proliferation of T-helper type 2 (Th2) lymphocytes, which release cytokines that promote IgE synthesis and mast cell activation. Subsequently, IL-4, IL-5, IL-6, and tryptase are expressed in the allergic epithelium as mucosal mast cells proliferate. Inflammatory mediators and cytokines upregulate endothelial adhesion molecules, such as vascular cell adhesion molecule-1, while chemoattractants including eotaxin, RANTES, and IL-5 recruit eosinophils, basophils, mast cells, and Th2 lymphocytes into the nasal mucosa, leading to the late-phase allergic response [21].

1.1 Symptoms of allergic rhinitis

The symptoms of allergic rhinitis can be classified into primary nasal symptoms and extra-nasal manifestations. The most common primary nasal symptoms are nasal congestion (94.23%) and rhinorrhea (90.38%). Patients also experience sinus pressure, ear plugging, muffled sounds and pain, eustachian tube dysfunction, and headache [3,5]. Additional systematic symptoms include feeling discomfort in activities due to allergic rhinitis (71%), irritability (49%), and sleep disorder (46%) [5].

Allergic rhinitis significantly impacts the patients' qual-

ity of life. A study of Unissula Medical Faculty students found a statistically significant correlation between nasal congestion and reduced quality of life (Spearman's r = 0.281, p = 0.048) [22].

Assessments of symptom severity via questionnaires indicate that physical symptoms cause daytime impairment and negatively impact academic or work performance, while frequent sneezing and nasal discharge contribute to social embarrassment [23].

2 How does the climate affect allergic rhinitis

Climate and weather alter allergic rhinitis by changing pollen/fungal production, season length, and pollutant–allergen interactions, with measurable regional prevalence shifts. The warmer temperatures, altered humidity and precipitation will worsen the symptoms with air pollution.

2.1 Climate factors that affect the allergen

The high temperature and precipitation can be a key factor that negatively influences allergic rhinitis. A questionnaire data regarding the allergic rhinitis of childhood shows that the intermittent symptom prevalence is positively correlated with the country-level mean monthly temperature. Persistent symptom prevalence was positively associated with regional climatic measures [24]. Questionnaire-based research in Finland shows a positive correlation between precipitation and prevalence of allergic rhinitis [25].

2.2 Climate and allergens

Global warming stimulates the prevalence of allergic rhinitis via allergens. According to the studies, higher temperature has a significant correlation with the increasing seasonal pollen load. Global warming leads to longer frost-free days throughout the year, and this is associated with both higher pollen load and longer pollen season duration [26]. Moreover, the increased temperature, humidity and concentration of carbon dioxide is correlated to the pollen larger in size, the wider range of pollen spreading and enhanced ability to stimulate an allergic inflammatory response [20].

The global warming led to several extreme weather that correlate to stimulated allergens. The rising sea level may lead to higher intensity and frequency of floods. The concentration of mould and fungal spores in atmosphere increase after the severe floods, which linked to prevalence of allergic disease [27]. And increased desertification linked to the prediction of more sandstorms, this is correlate to the allergic disease due to the sand particles are able to bring other allergens including spores, pollen, air pollutants and dust mites [28]. Moreover, the frequency of wildfire shows an increasing trend in respond to global warming [29], which the smoke produced by wildfire contains the air pollutants such as particular matter, ozone and organic compounds [30].

2.3 Pollution and rhinitis

The pollutants can interact with the environment and lead to more severe allergic reactions. Except for the high carbon dioxide associated with more intensive pollen. The pollen-associated lipid mediators (PALMs), which activate Th2 cells to promote IgE synthesis, are in greater quantity in the pollen from the road with busy traffic [31]; and the birch trees with the condition of higher concentrations of ozone will produce the pollen with higher amounts, higher content of PALMs and more severe allergies [9].

The air pollutants are contributed to prevalence of allergic rhinitis. The odds ratio of increasing pollutants per 10 μg/m^3 for particulate matter 10, particulate matter 7, nitrogen oxide and sulfur dioxide are all grater than one, which means a positive association between the air pollutants above and the prevalence of allergic rhinitis [32].

3 Effects of geographical factors

The latitude and altitude influence allergen ecology and measured AR prevalence. Multinational research shows a general trend that the prevalence of allergic rhinitis decreases as the latitude increases, but exceptions exist frequently [11]. And a research based on a Turkish pediatric sample illustrates that a lower altitude correlates to an increasing allergic disease [12].

Moreover, urban residence is a strong factor that affects the prevalence of allergic rhinitis through research in southwest Iran, which is based on the data that people born and raised in urban areas has a higher prevalence. considering the increased air pollution and sensitising chemicals in urban areas [13]. Certain allergic plants, like ragweed, expand due to the urban heat islands and land-use change, then lead to further exposure to populations [33].

The climate type influences the allergens. Research at Thailand, which is a nation with tropical monsoon climate. It shows that the allergens from plants including Bermuda grass, para grass, and Johnson grass that highly related to the allergic sensitization. And the molecule with similar function exhibit IgE cross-reactivity considering the conserved structure, this could happen in both close related species and diverse spices. This drives persistent AR in many tropical populations [34]. For temperate continental climate, research at the northern China shows a high prevalence of allergic rhinitis relate to the pollen

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season and changed dominant pollen, and shows marked seasonal allergic rhinitis [35]. For tropical desert climate, research at Katar shows the fungal spores have important contribution to allergic rhinitis, the peaks of fungal air-spora usually presents during February and August. The count of spores positively correlates to wind speed and precipitation [36].

4 Conclusion

The allergic rhinitis is triggered by an immunoglobulin E (IgE)-mediated hypersensitivity response to allergens. Gene mutation can lead to high sensitivity to allergic disease. Children have a high prevalence of allergic rhinitis. The common nasal symptoms include nasal congestion and rhinorrhoea, and the extra-nasal manifestations include sinus pressure, ear plugging, muffled sounds and pain, eustachian tube dysfunction, and headache. The symptoms highly impact the life quality fro the patients and the academic and work performance.

The air pollution is able to exacerbate allergic responses, and natural allergens contribute to disease risk. The temperature positively correlates with prevalence. Global warming lifts the factors that directly related to the temperature, humidity and concentration of carbon dioxide, high temperature, humidity and carbon dioxide concentration correlate with increased pollen load and ability to cause allergic inflammatory response through global warming, as well as the higher concentration of spores of fungus and mould in atmosphere. Some extreme weather events that related to global warming, such as wildfire and flood, increase their frequency and intensity as well as the related allergens. The latitude and altitude have a negative correlation with the prevalence of allergic rhinitis in general. The urban resident with higher prevalence, considering the increased air pollution and the natural allergen due to heat islands. The region with different climate type shows diverse main allergens and high-incidence season.

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