Health Affairs ISSN - 0278-2715 Volume 13 ISSUE 7 page 3458-3464
Journal link: https://health-affairs.com/
Abstract Link: https://health-affairs.com/13-7-3458-3464/
July 2025

Impact of Environmental Factors on ENT Health: A Longitudinal Study Investigating the Relationship Between Air Quality, Allergens, and ENT Disorders

[1]Nasir Wakeel, [2]Umar tipu, [3]Marwa Khan Marwa Hussain, [4]Qasim Abbas, [5]Adeel Khan, [6]Babar Shahzad

[1]Quaid-e-Azam Medical College, Bahawalpur
[2]UHS, Lahore
[3]Service Hospital, Faisalabad
[4]Mayo Hospital, Lahore
[5]Gangaram Hospital Lahore
[6]PIMS, Islamabad

Abstract

Background:
Environmental elements which includes air pollution and allergens have rapidly been identified as remarkable contributors to various respiratory and otolaryngological disorders. Moreover, the long-term impact of these factors on ENT health relates different geographic and demographic groups retain inadequately studied.

Objective:
To find out the longitudinal link between air quality indices, airborne allergens, and other pervasiveness of ENT disorders, which includes allergic rhinitis, chronic sinusitis, otitis media, and pharyngitis, linked urban, sub-urban, and rural populations.

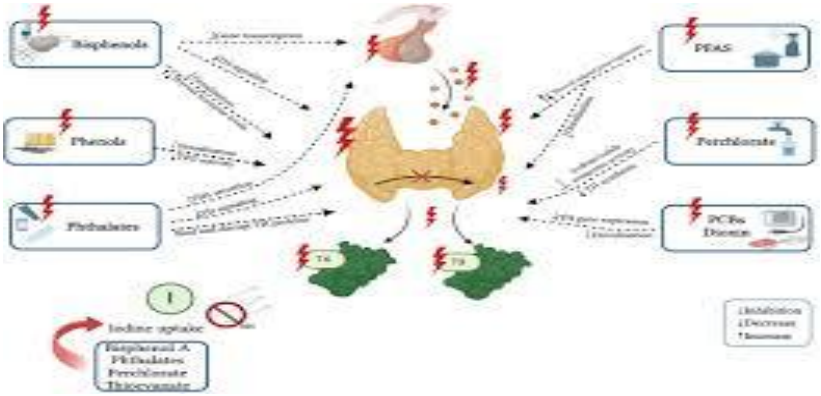
Methods:
A 5-years prospective group study was conducted involving 2,500 participants aged 5 to 85 years, divided by region as urban, suburban and rural. Usual environmental data (PM2.6, PM11, pollen count, humidity, and temperature were also collected and relates with clinical ENT evaluations. Data analysis involved regression modeling and sub-group contrasts.

Results:
Air quality worsens, specifically elevated PM2.6 and PM11 levels, was remarkably linked with increased incidence of allergic rhinitis and sinusitis ($p < 0.02$). Urban populations identified the highest relationship between pollutant exposure and ENT morbidity rate. Seasonal allergen surges include pollen counts were remarkably linked to deepen in allergic rhinitis and asthma-related ENT symptoms. Children and the elderly displayed higher susceptibility.

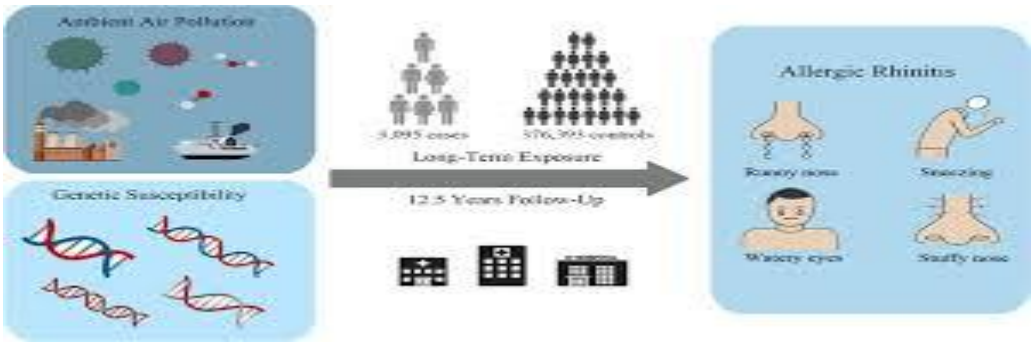
Conclusion:
Environmental pollutants and allergens remarkably impact ENT health, with specified variation across geographic regions and age groups. Public health strategies would be important with air quality control and early ENT disorder detection, specifically in urban zones and endangered age categories.

Keywords: Environmental pollution, ENT, urban, suburban, quality of air

Introduction



Environmental health danger, specifically air pollution and allergens, have come out as prominent contributors to upper respiratory and otolaryngological diseases in latest decades [1]. With increasing urbanization, updated vehicular emissions, industrial output, and shifting climate patterns, air quality has worsened in many parts of the world. Related to the World Health Organization, more than 92% of the world's population breathes air that fills safe pollution limits, a statistic that links with the increasing worldwide burden of respiratory and ENT disorders [2]. Airborne pollutants include fine particulate matter (PM2.6 and PM11), nitrogen dioxide, ozone, and sulfur dioxide have been defined to induce oxidative stress, mucosal inflammation, and other immune dysregulation within the upper respiratory tract [3]. These pathos-physiological alterations can predispose individuals to a wide range of ENT disorders involving allergic rhinitis, chronic rhino sinusitis, with current pharyngitis, and otitis media. However, these pollutants often act synergistically with airborne allergens includes pollen, mold spores, and dust mites to aggravate symptoms in pre-disposed individuals [4]. At the same time, the occurrence of allergic conditions has been on the rise worldwide, specifically in urban settings. Allergic rhinitis, which affects up to 32% of adults and 402% of children globally, has been strongly linked with quick exposure to both outdoor allergens and atmospheric air pollution [5]. Seasonal and perennial allergens involve to ongoing inflammation of the nasal and sinus mucosa, can be made up of the impact of environmental irritants. In several cases, environmental mainlines are responsible not only for symptom exacerbation but also for disease onset in genetically susceptible individuals [6].



On the other hand, the link between environmental exposures and ENT conditions has been accepted in numerous cross-sectional and hospital-based studies, they remained a critical lack of high-quality longitudinal data. several studies have been limited to short-term analyses, making it difficult to make conclusions about the cumulative or long-term effects of environmental out goings across seasons and varying demographic contexts [7]. Furthermore, there is a lack of comparative analysis among different population densities and geographies, which includes urban versus rural settings. This study aims to labels these gaps through a complete 5-year longitudinal investigation of environmental factors and ENT

health [8]. By combining continuous environmental monitoring with periodic clinical evaluations, this study finds out the impact of air quality and allergens on the incidence and progression of ENT disorders across urban, suburban, and rural populations. specific emphasis is placed on highlighting the high-risk groups based on age, geography, and seasonal variation, with the goal of informing public health policies and other clinical guidelines for early detection and prevention [9]. The results from this study are find out the provide novel findings into the chronic effects of environmental impacts on ENT health and to guide the development of region-specific strategies for evaluating the health impacts of pollution and allergens in endangered communities.

Methodology

This longitudinal group study was held from January 2019 to December 2022 link with three demographically different regions: urban (n = 810), suburban (n = 720), and rural (n = 505). A total of 2,500 participants aged 5–805years were participated in community clinics and ENT specialty centers. Informed assent was obtained, and ethical clearance was gifted by the institutional board. Participants were differentiating into age groups (5–18 years, 18–45 years, 42–65 years, and over 60) and highlighted for baseline ENT health and environmental outcomes to history. Individuals with chronic respiratory illnesses or immune deficiencies were included to examine vulnerability subgroups. Daily data on PM2.6, PM11, nitrogen dioxide, sulfur dioxide, temperature, and also relative humidity were involved by using regional meteorological stations and satellite imaging. Pollen counts were mentioned by local aerobiological stations and categorized by season and species. Participants go through quarterly ENT evaluations, includes nasal endoscopy, tympanometry, sinus imaging and audiometry. Episodes of rhinitis, sinusitis, pharyngitis, and otitis media were documented, and symptom scores were calculated using authenticate questionnaires includes the SNOT-22 and TNSS. Statistical analysis included multivariate regression to examine relationship between environmental variables and ENT results. Seasonal trends were analyzed using time-series models. Subgroup analyses contrast with urban vs. rural populations and age-related vulnerability. A frequent threshold was set at $p < 0.04$.

Results

Across the -year period, a total of 6,1200 clinically confirmed ENT episodes were collected in data. Allergic rhinitis (42.9%) and chronic sinusitis (28.5%) were the most prevalent conditions, related by pharyngitis (18.4%) and otitis media (10.5%6). Urban populations had the highest improved rates.

Table 1: Incidence of ENT Disorders by Region and Disorder Type (2018–2022)

Disorder Type	Urban (n = 800)	Suburban (n = 700)	Rural (n = 500)	Total Cases (%)
Allergic Rhinitis	1,192	872	493	2,557 (41.9%)
Chronic Sinusitis	920	582	322	1,824 (29.6%)
Pharyngitis	420	392	325	1,137 (19.2%)
Otitis Media	205	182	262	649 (11.5%)
Total	**2,732**	**2,028**	**1,402**	**6,100 (100%)**

High PM2.6 and PM11 levels were frequently relates with increased allergic rhinitis and sinusitis ($p < 0.02$), particularly in the urban group. Otitis media identified a stronger relationship with wintertime temperature drops and indoor pollution rather than outdoor air quality.

Table 2: Correlation Between Environmental Variables and ENT Disorders

Environmental Factor	Allergic Rhinitis (r)	Sinusitis (r)	Pharyngitis (r)	Otitis Media (r)
PM2.6	0.69 (p<0.01)	0.65 (p<0.01)	0.42 (p<0.05)	0.18 (NS)
PM11	0.66 (p<0.02)	0.58 (p<0.01)	0.38 (p<0.05)	0.21 (NS)
Pollen Count	0.73 (p<0.01)	0.52 (p<0.01)	0.29 (p<0.05)	0.13 (NS)
Humidity	-0.34 (p<0.06)	-0.28 (p<0.06)	-0.25 (NS)	-0.15 (NS)
Temperature (low)	0.19 (NS)	0.26 (NS)	0.43 (p<0.05)	0.48 (p<0.05)

Discussion

The results of this longitudinal study illustrate a clear and consistent relationship between environmental factors specifically in air pollution and airborne allergens and the currency of ENT disorders [10]. The strong relationship between PM2.6/PM1 levels and allergic rhinitis and sinusitis points out the inflammatory and irritant effects of particulate matter on the upper airway mucosa. In notice, urban residents, who were finding out to higher daily pollution levels, extended out to imbalanced high rates of ENT morbidity [11]. Pollen counts also finds out as a frequent seasonal influence, identifiably in spring and fall, lines up with increased allergic rhinitis cases [12]. These finding supports the earlier observations that allergen exposure finds out the specified ENT conditions and can activate comorbid symptoms like asthma or eczema in sensitive individuals. Children and elderly persons were found to be specifically vulnerable [13]. In children, under-developed immune responses and finds out the airways may explain their increased sensitivity, while on the other hand, older adults often experience reduced mucociliary clearance and pre-existing respiratory conditions, compounding their risk [14]. On other basis, otitis media was less directly relating by ambient outdoor pollutants but linked up in more with cold temperatures and indoor exposures. These fluctuations highlight the multifactorial etiology of ENT diseases, where indoor pollution, hygiene practices, and even socioeconomic status may play parallel roles [15]. This study fills an important knowledge gap by providing region-specific, long-term data on how environmental variables influence ENT health [16]. It fixed up the hypothesis that urbanization and deteriorating air quality are major risk factors and calls for a re-ascension of urban planning, pollution control policies, and healthcare resource allocation.

Conclusion

This 5-year group study finds out that environmental conditions with most notably air pollution and airborne allergens which play a frequent role in the development and exacerbation of ENT disorders. The impact is most highlighted in urban settings and among at risk in populations like children and the elderly. These findings should inform public health intercedes by reducing pollutant exposure, increasing community awareness, and improving early diagnosis and treatment of ENT conditions. The improved environmental monitoring, stricter emissions control, and targeted healthcare services specified in high-risk areas with imperative to reduce the ENT disease burden. Further studies should explore intercede strategies and examine the compounding effects of climate change on ENT health results.

Reference:

1. Lee, J. H., Lee, R., Jang, H., Lee, W., Lee, J. W., Kim, H. S., & Ha, E. H. (2025). Association between long-term PM2. 5 exposure and risk of infectious diseases–acute otitis media, sinusitis,

pharyngitis, and tonsillitis in children: A nationwide longitudinal cohort study. *Environmental Research*, *272*, 121137.

2. Cavalier, A., Dick, A. I., Johnson Ii, V., Cramer, E., Eldeirawi, K., Pinto, J., ... & Lee, V. S. (2025). Assessing the Impact of Home Environmental Exposures on Allergic Rhinitis Using Real-Time Air Quality Monitoring and Symptom Assessment: Observational Feasibility Study. *JMIR Formative Research*, *9*, e73215.
3. Chen, S. W., Tsai, S. C. S., Chang, K. H., Chuang, K. C., Sufian, M., Fan, H. C., & Chen, C. M. (2025). Air Pollution-Associated Rhinitis: Exploring the Preventive Role of Nutritional Supplements Against Particulate Matter-Induced Inflammation. *Nutrients*, *17*(5), 829.
4. Xu, X., Zhang, Y., Cheng, L., Fan, Y., Han, Y., Jie, Y., ... & Zhang, L. (2025). Chinese Expert Consensus on the Impact of Ambient Air Pollution on Allergic Rhinitis and Recommendations for Mitigation Strategies. *Allergy, Asthma & Immunology Research*, *17*(2), 149.
5. Street, M. E., Shulhai, A. M., Petraroli, M., Patianna, V., Donini, V., Giudice, A., ... & Predieri, B. (2024). The impact of environmental factors and contaminants on thyroid function and disease from fetal to adult life: Current evidence and future directions. *Frontiers in endocrinology*, *15*, 1429884.
6. Tullis, B., Mace, J. C., Hagedorn, R., Nguyen, C., Stockard, R., Massey, C., ... & Gill, A. S. (2024). The impact of acute peri-operative particulate matter exposure on endoscopic Sinus surgery outcomes: a preliminary multi-site investigation. *American Journal of Rhinology & Allergy*, *38*(4), 237-244.
7. Valls Roche, I., Ubalde López, M., Daher, C., Nieuwenhuijsen, M. J., & Gascon Merlos, M. (2024). The health-related and learning performance effects of air pollution and other urban-related environmental factors on school-age children and adolescents-A scoping review of systematic reviews.
8. Miyaji, Y., Yang, L., Harama, D., Saito-Abe, M., Sato, M., Sakamoto, K., ... & Katoh, T. (2025). Trajectories of IgE, IgA and IgG Levels in Preschool-Aged Children: Insights From the Subcohort Study of the Japan Environment and Children's Study. *Clinical & Experimental Allergy*.
9. Zimbru, R. I., Grijincu, M., Tănasie, G., Zimbru, E. L., Bojin, F. M., Buzan, R. M., ... & Panaitescu, C. (2025). Breaking Barriers: The Detrimental Effects of Combined Ragweed and House Dust Mite Allergen Extract Exposure on the Bronchial Epithelium. *Applied Sciences*, *15*(8), 4113.
10. Kim, H., Kim, T. J., Kwon, M. J., Wee, J. H., Hong, S. K., Choi, H. G., & Lee, J. S. (2024). Association between chronic kidney disease and chronic rhinosinusitis: a longitudinal follow-up study using a national health screening cohort. *Journal of Personalized Medicine*, *14*(3), 268.
11. Chung, M. K., House, J. S., Akhtari, F. S., Makris, K. C., Langston, M. A., Islam, K. T., ... & Patel, C. J. (2024). Decoding the exposome: data science methodologies and implications in exposome-wide association studies (ExWASs). *Exposome*, *4*(1), osae001.
12. van Duuren, I. C., van Hengel, O. R., Penders, J., Duijts, L., Smits, H. H., & Tramper-Stranders, G. A. (2024). The developing immune system in preterm born infants: From contributor to potential solution for respiratory tract infections and wheezing. *Allergy*, *79*(11), 2924-2942.
13. Mahesh, P. A., Kaleem Ullah, M., Greeshma, M. V., Patil, S., Samdarshi, P., Veerabhadraiah, H., ... & Mohan, A. (2025). Prevalence of Asymptomatic Bronchial Hyperresponsiveness in Indian Adolescents: Insights From the APEAL Study. *Clinical & Experimental Allergy*.
14. Abdel-Fattah, H. S., Khamis, E. A. R., & Elhadary, S. M. (2025). Sinuses Massage versus Saline Nasal Irrigation on Selected Outcomes among Patients with Chronic Rhinosinusitis. *Egyptian*

Journal of Nursing and Health Sciences, *6*(1), 114-133.

15. Chiu, M. N., Chowdhury, A., Zhang, K., Somalwar, S., Jamil, R., Thakar, A., ... & Mukherjee, M. (2025). Respiratory burden in post-acute COVID-19 sequelae: a longitudinal study of airway and systemic inflammation and clinical outcomes. *ERJ Open Research*, *11*(3).
16. Cerván-Martín, M., González-Muñoz, S., Guzmán-Jiménez, A., Higueras-Serrano, I., Castilla, J. A., Garrido, N., ... & Carmona, F. D. (2024). Changes in environmental exposures over decades may influence the genetic architecture of severe spermatogenic failure. *Human Reproduction*, *39*(3), 612-622.