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Original Research Article

Urbanization, Biodiversity Loss, and Allergy Epidemics: A One-Year Observational Study from an Urban Allergy Clinic in Eastern India

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Abstract:

Background: Rapid urbanization and biodiversity loss are increasingly recognized as major contributors to the global epidemic of allergic diseases. Reduced environmental microbial exposure, increased air pollution, and altered lifestyle patterns associated with urban living are believed to dysregulate immune tolerance and promote allergic sensitization.

Objectives: To evaluate the clinical pattern of allergic diseases in an urban population and assess the association between urban exposure indicators and allergy burden.

Methods: A one-year observational study was conducted among 100 patients attending an urban allergy clinic. Demographic characteristics, clinical diagnosis, and urban exposure indicators were recorded and analyzed.

Results: Allergic rhinitis was the most prevalent condition (42%), followed by asthma (25%). Higher allergy burden was observed among patients with high urban exposure. Age-wise distribution, allergy pattern, and urban exposure associations are presented in tables and figures.

Conclusion: Urbanization and biodiversity loss appear to significantly influence the rising burden of allergic diseases. Integrating biodiversity conservation and urban green planning may be essential strategies to reduce allergy epidemics.

Keywords: Urbanization, biodiversity loss, allergy epidemic, allergic rhinitis, asthma, environmental health.

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Introduction

The last century has witnessed unprecedented urban expansion, fundamentally transforming human interaction with natural ecosystems. More than half of the global population now resides in urban areas, with projections suggesting this figure will exceed 68% by 2050. Parallel to this demographic shift is a dramatic rise in allergic diseases, including asthma, allergic rhinitis, and atopic dermatitis, particularly in low- and middle-income countries undergoing rapid urbanization. The temporal association between urban growth and allergy prevalence strongly suggests an environmental contribution to immune dysregulation. [1,2]

The classical "hygiene hypothesis" proposed that reduced childhood exposure to infections skews immune responses toward allergic phenotypes. [3] This concept has since evolved into the "biodiversity hypothesis," which emphasizes the importance of continuous contact with diverse natural environments and environmental microbiota in maintaining immune tolerance. [4,5] Declining biodiversity, deforestation, urban sprawl, and reduced green spaces limit microbial exposure, impairing regulatory immune pathways and predisposing individuals to allergic sensitization. [6,7]

Urban ecosystems are also characterized by elevated air pollution, vehicular emissions, indoor allergen exposure, dietary transitions, and sedentary lifestyles, all of which independently and synergistically promote allergic airway inflammation. [8-10] Numerous epidemiological studies have documented higher prevalence of asthma and allergic rhinitis in urban compared with rural populations. [11-13] Experimental evidence further demonstrates that exposure to farm environments, natural vegetation, and diverse microbial ecosystems protects against allergic disease development. [14-16]

India represents a critical setting to explore these associations. Rapid industrialization, loss of peri-urban green belts, and escalating pollution have coincided with a steady rise in allergy clinic attendance and asthma-related hospitalizations. [17,18] However, data linking urban exposure

patterns and allergy burden in eastern India remain limited.

This study was therefore undertaken to evaluate the clinical spectrum of allergic diseases in an urban outpatient population and to assess the relationship between urban exposure indicators and allergy burden at a tertiary-level urban allergy clinic.

Materials and Methods

Study Design and Setting: This observational cross-sectional study was conducted at Modi Allergy Clinic, Rajendranagar, Patna, Bihar, over a one-year period from January 2024 to January 2025.

Study Population: A total of 100 consecutive patients clinically diagnosed with allergic disorders were included. Diagnoses were based on clinical evaluation, history of atopy, and relevant investigations such as spirometry, serum IgE, and skin prick testing where applicable.

Inclusion Criteria

- Patients aged ≥10 years
- Clinical diagnosis of allergic rhinitis, asthma, urticaria, or atopic dermatitis
- Willingness to participate

Exclusion Criteria

- Autoimmune disorders
- Chronic infectious diseases
- Immunodeficiency states

Data Collection: Demographic details, residential history, duration of urban stay, proximity to traffic or industrial areas, availability of green spaces, and indoor environmental factors were recorded. Patients were categorized into high, moderate, or low urban exposure groups based on residential density, green cover, and pollution proximity.

Statistical Analysis: Data were analyzed descriptively. Results are expressed as frequencies and percentages.

Results

A total of 100 patients were analyzed. The majority belonged to the economically productive age group, with a slight male predominance.

Age Distribution: The highest proportion of patients was observed in the 21–40year age group (60%). Age-wise distribution is detailed in Table 1 and illustrated in Figure 1.

Table 1: Age-wise distribution of patients

Age group (years)	Number of patients	Percentage
<20	10	10%
21–30	28	28%
31–40	32	32%
41–50	20	20%
>50	10	10%

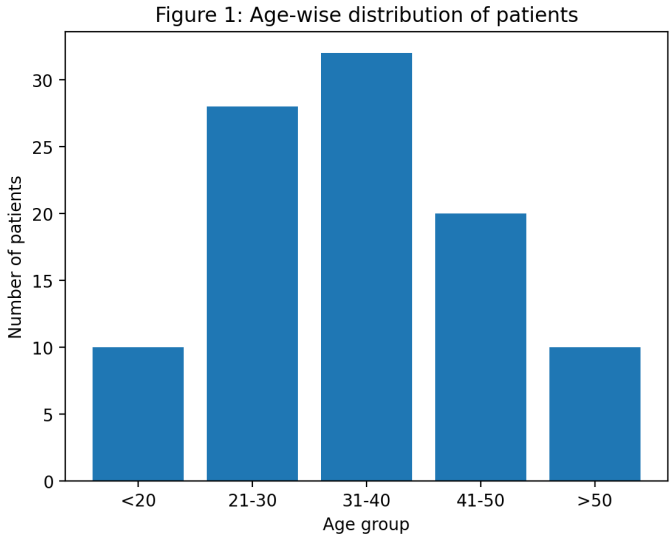

Figure 1: Bar graph showing age-wise distribution of patients attending the allergy clinic.

Pattern of allergic diseases: Allergic rhinitis was the most common diagnosis (42%), followed by asthma (25%). The distribution of allergic conditions is summarized in Table 2 and depicted in Figure 2.

Table 2: Distribution of allergic diseases

Allergic condition	Number of patients	Percentage
Allergic rhinitis	42	42%
Bronchial asthma	25	25%
Atopic dermatitis	15	15%
Chronic urticaria	10	10%
Mixed allergic disorders	8	8%

Figure 2: Distribution of allergy types

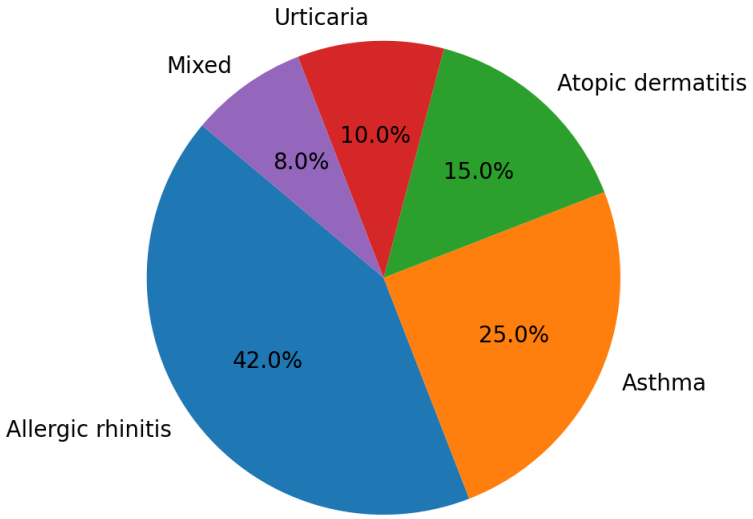

Figure 2: Pie chart showing percentage distribution of various allergic diseases.

Urban exposure and allergy burden: High urban exposure was observed in nearly half of the study population (48%), followed by moderate exposure (34%). Patients with high urban exposure showed greater prevalence of persistent rhinitis and asthma symptoms. Urban exposure categories are shown in Table 3, and their association with allergy burden is illustrated in Figure 3.

Table 3: Urban exposure categories

Urban exposure level	Number of patients	Percentage
High exposure	48	48%
Moderate exposure	34	34%
Low exposure	18	18%

Discussion

This study demonstrates a high prevalence of allergic disorders among urban residents, with allergic rhinitis and asthma constituting the major clinical burden. The predominance of disease in young and middle-aged adults reflects increasing urban occupational exposure and lifestyle transitions. These findings are consistent with global epidemiological trends showing higher allergy prevalence in urban compared with rural populations. [11,12]

The observed association between high urban exposure and increased allergy burden supports the biodiversity hypothesis. Reduced contact with diverse natural environments may impair the development of immune tolerance, leading to exaggerated Th2-mediated responses. [4,6] Experimental studies have shown that exposure to farm environments and natural vegetation increases microbial diversity on human skin and airways, thereby enhancing regulatory immune mechanisms. [14,15]

Air pollution is a major co-factor in urban allergy epidemics. Diesel exhaust particles and particulate matter enhance allergenicity, disrupt epithelial barriers, and amplify inflammatory responses. [8,19] In Patna, one of India's most polluted cities, vehicular emissions and construction-related dust may significantly contribute to allergic airway disease.

The dominance of allergic rhinitis observed in this study mirrors national and international reports.

[17,20] Allergic rhinitis often precedes asthma, underscoring the importance of early intervention and environmental control. The co-existence of multiple allergic conditions in a subset of patients further supports the concept of "atopic march." [21]

Urban biodiversity loss is not merely an ecological concern but a public health issue. Fragmentation of green spaces, declining tree cover, and altered soil microbiomes collectively reduce human–nature interactions critical for immune education. [22,23] Restoration of urban green spaces, promotion of nature-based interventions, and sustainable urban planning may therefore represent viable preventive strategies. [24,25]

The main limitation of this study is its single-center design and descriptive analysis. However, it provides valuable region-specific evidence supporting environmental determinants of allergy epidemics.

Conclusion

This study highlights a substantial burden of allergic diseases in an urban population and demonstrates a clear association between higher urban exposure and increased allergy prevalence. Urbanization and biodiversity loss likely play significant roles in shaping contemporary allergy epidemics. Public health strategies integrating biodiversity conservation, pollution control, and urban green planning may be crucial in mitigating the rising allergy burden.

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