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Original Article

Asthma in School Children: Assessment of Prevalence And Risk Factors Among Rural and Urban Settings from the Western Part of India

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Abstract

Background: Asthma in children remains a significant global public health challenge, contributing extensively to paediatric hospitalizations, increased healthcare utilization, missed school days, and reduced caregiver productivity, apart from the problem of underdiagnosis and undertreatment of asthma. This study aimed to assess the prevalence of asthma in school children aged 5 to 15 years in urban and rural areas of the western part of India.

Methods: The study was conducted to assess the prevalence and associated risk factors of asthma among school-going children aged 5 to 15 years in urban and rural regions. The cross-sectional survey included 6,959 children, with 4,553 from urban schools and 2,416 from rural schools. Data collection was based on a modified version of a standardized and validated questionnaire developed by the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh.

Results: Among urban children, 645 (14.2%) were found to have different allergic disorders, with a higher prevalence among females (15.9%) compared to males (11.3%). The rural population showed a lower overall prevalence of allergic disorders (5.1%), again with female predominance (6.1 vs. 4.2% in males). In urban children, asthma was present in 26% of those with allergies compared to just 0.8% among non-allergic peers. 44.7% of rural children with allergic conditions had asthma, compared to 1.2% among those without allergic conditions. In urban areas, asthma was diagnosed in 8.7% of children with environmental tobacco smoke exposure compared to 5.9% in rural children. 278 (6.1%) urban children reported biomass fuel exposure, with an asthma prevalence of 4.3% (n = 8). 48.7% (n=1177) of rural children were exposed to biomass fuel, with an asthma prevalence of 6.03% in the exposed group.

Conclusion: The prevalence of allergic disorders was significantly higher in urban children compared to their rural counterparts. The overall prevalence of asthma was markedly higher among children with allergic conditions. Exposure to environmental tobacco smoke was found to be a significant risk factor for asthma in both urban and rural populations. Biomass smoke exposure was significantly associated with increased asthma prevalence among rural female children.

Keywords: School children, allergic conditions, environmental tobacco smoke, biomass fuel, prevalence of asthma..

Introduction

Asthma is a serious global health problem, affecting approximately 300 million people around the world, and causing around 1,000 deaths per day. Most of these deaths occur in low- and middle-income countries, and most of them are preventable. Asthma interferes with people's work, education, and family life, especially when children have asthma.[1]

As per the 2019 Global Burden of Disease report, India's total asthma burden is 34.3 million, which accounts for 13.09% of the global burden.[2] However, India reports three times higher mortality and more than two times higher

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disabilityadjusted life years (DALYs) than the global proportion of asthma burden.[2] This is alarming and could be attributed to late reporting, underdiagnoses, delayed treatment, undertreatment, or no treatment.

Recent studies show that asthma prevalence in children is generally higher in urban areas compared to rural areas. In India, a study found asthma prevalence at 7.9%, with urban children having a higher rate than rural ones. A cross-sectional survey of 3321 school-going children (5-15years) using the modified ISAAC questionnaire in Jaipur city showed 7.59% children to have asthma (in the last 12 months) and 8.4 wheezing in the last 12 months. Only 5.3 % children had "physician-diagnosed asthma ever," suggesting underdiagnosis.[3] The problem of underdiagnosis and undertreatment of asthma has also been noted in other studies.[4] Up to 82% of subjects with current wheeze and up to 70% of subjects with symptoms of severe asthma remain undiagnosed.

A larger study across six African countries reported a similar trend, linking urbanization and pollution to higher asthma symptoms, but with many cases undiagnosed. These trends suggest that urban environments, with more pollution and allergens, contribute to increased asthma rates.[5]

The prevalence of asthma varies worldwide, most likely due to different genetic backgrounds as well as different exposure to various risk factors such as respiratory infection, indoor/outdoor pollution, and diet.

The ISAAC study noted a significant variation in asthma prevalence across different parts of India, with a range of 0.5-18%. In India, the prevalence surveys have been carried out in Tamil Nadu, Bangalore, Delhi, Mumbai, Kanpur, Chandigarh, Lucknow, and Ludhiana.[6]

Unfortunately, there are very few studies with a standard validated questionnaire to analyse the prevalence of asthma in the western part of the country. Thus, the present study was planned to assess the prevalence of bronchial asthma in school children aged 5 to 15 years in urban and rural areas of the western part of India, using the standard and validated questionnaire developed at the Post Graduate Institute, Chandigarh.[7]

Material And Methods

The present cross-sectional study was conducted among school-going children aged 5 to 15 years in both rural and urban areas of the western part of India. Schools were first listed and then randomly selected for inclusion. In urban areas, selection was performed to ensure equal representation of boys' and girls' schools while also capturing children across different socioeconomic backgrounds. A total of 6,959 students were included in the study sample, comprising 3,034 boys and 3,925 girls.

Children were excluded from the study if they had a history suggestive of bronchiolitis (defined as a short prodrome of fever, upper respiratory, or gastrointestinal symptoms), recent hospitalization for causes other than asthma, known cardiac diseases, pulmonary tuberculosis, diagnosed diabetes mellitus, or structural/skeletal disorders involving the spine, intercostal muscles, or diaphragm.

Data collection was based on a modified version of a standardized and validated questionnaire developed by the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh. For ease of comprehension, especially among younger children and their families, the questionnaire was translated into Hindi. The methodology in urban areas involved a structured three-meeting approach with school authorities and participants. The first meeting involved sensitization of school principals and teachers about bronchial asthma. The second meeting, held during the school's Parent-Teacher (PT) Day, included an educational program with audiovisual aids, during which the questionnaire was explained to students and their parents. In the third meeting, the questionnaires were distributed and subsequently filled. Children aged 10 years and above generally completed the questionnaire independently, while those younger than 10 received assistance from their parents.

In rural areas, data collection was coordinated through scheduled school-based visits. On designated days, intern doctors and class teachers administered the questionnaire by directly collecting responses from children and/or their parents. In all cases, clinical examination was conducted, and peak expiratory flow rate (PEFR) measurements were taken for each child. Additional demographic and environmental data, including height, weight, exposure to environmental triggers such as biomass fuel or tobacco smoke, presence of allergens, atopic history, and socioeconomic background, etc., were also recorded.

Based on the responses and clinical evaluation, students were included in the study who gave positive responses to asthma-specific questions, had asthma specific symptoms, had PEFR values in the red zone (<30% of the expected standard), and demonstrated wheezing on physical examination, had family history of asthma, or were suspected of having allergen exposure.

This methodology allowed for a comprehensive and layered approach to asthma detection, combining symptom-based screening, objective measurement, and clinical assessment.

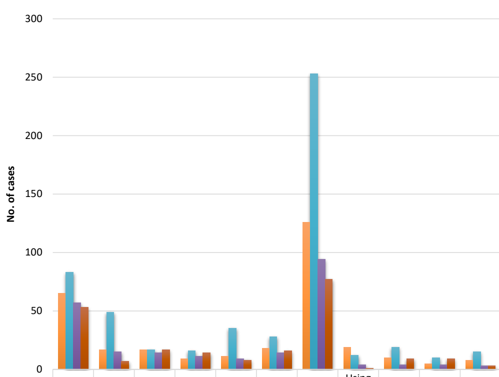
Results

In the present study, a total of 4,974 school-going children were approached in the urban region of the western part of India, comprising 1,910 males and 3,064 females. Among these, 1,785 males (94%) and 2,758 females (90%) responded by either completing or returning the questionnaire, yielding an overall response rate of 91.15% in the urban cohort. In comparison, 2,909 children were approached in rural areas (1,486 males and 1,423 females), with 1,249 males (84%) and 1,167 females (82%) providing valid responses, resulting in an overall rural response rate of 83%. Thus, the response rate was higher in the urban group.

Figure 1 presents a comparative overview of asthma-related symptoms, functional limitations, and family history among urban and rural children, stratified by gender. Wheezing was more frequently reported among urban females (n = 83) and males (n = 65) compared to rural males (n = 57) and females (n = 53). Shortness of breath was particularly prominent in urban females (n = 49) in contrast to rural females (n = 7). Nighttime awakenings and cough were also more frequent in urban females, recorded in 16 and 35 cases, respectively. School absenteeism due to respiratory complaints was reported by 28 urban females and 18 urban males, whereas 14 rural males and 16 rural females missed school. Urban children also demonstrated a higher prevalence of reduced peak expiratory flow rate (PEFR), especially females (n = 253) and males (n = 126), when compared to rural males (n = 94) and females (n = 77). Asthma medication use was greatest in urban males (n = 19), while it was minimal among rural children, with only one rural female reportedly on treatment. A family history of asthma was also more frequently documented among urban children, with urban females reporting paternal, maternal, and sibling history in 19, 10, and 15 cases, respectively, compared to rural males, where these figures were 4, 4, and 3. These findings reflect a higher burden of respiratory symptoms, airflow limitation, and familial predisposition among urban children, particularly among females.

Figure 2 illustrates the prevalence of allergic conditions among study participants. In the urban cohort, females (n = 2758) showed the highest overall prevalence of allergic disorders at 15.9%, while urban males (n = 1795) had a prevalence of 11.3%. The most common conditions were allergic rhinitis (6.7% in females, 5.0% in males) and allergic conjunctivitis (5.9% in females, 4.5% in males). Eczema was reported in 3.1% of urban females and 1.6% of males, whereas food-related and other allergies were less than 0.5% across both sexes. Among rural children, allergic conditions were notably less prevalent. Rural females (n = 1167) had a total allergy prevalence of 6.1%, while rural males (n = 1249) showed a prevalence of 4.2%. Allergic rhinitis was the leading condition in rural groups (4.5% in females and 2.48% in males), and no food-related allergies were reported. Overall, urban children had a significantly higher burden of allergic diseases (14.2%) than rural children (5.1%), with urban females being the most affected group across all categories.

The association between allergic disorders and asthma is depicted in Figure 3. In the urban population, asthma was observed in 26.0% (168 out of 645) of children with allergic disorders, whereas the prevalence was only 0.8% (34 out of 3908) in those without allergies. Similarly, in the rural cohort, 44.7% (55 out of 123) of allergic children had asthma, compared to just 1.2% (28 out of 2293) among non-allergic children. This association was statistically significant

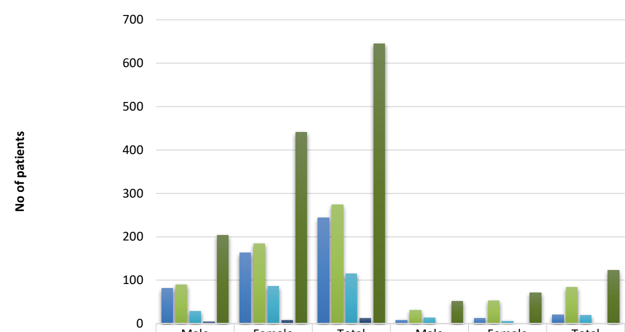


	Wheezing	SOB	Chest Tightness	Night Awakening	Cough	Missing School Days	Decreased PEFR	Using Asthma Medication	Father	Mother	Sibling
Urban	65	17	17	9	11	18	126	19	10	5	8
Urban	83	49	17	16	35	28	253	12	19	10	15
Rural	57	15	14	11	9	14	94	4	4	4	3
Rural	53	7	17	14	8	16	77	1	9	9	3

Parameters

Urban Urban Rural Rural

Figure 1: Bar diagram depicting clinical profile of children (5 To 15 Years) from schools in urban and rural areas



	Urban Male	Urban Female	Urban Total	Rural Male	Rural Female	Rural Total
Allergic conjunctivitis	81	163	244	8	12	20
Allergic Rhinitis	90	184	274	31	53	84
Eczema	29	86	115	13	6	19
Food & other items	4	8	12	0	0	0
Total allergic reaction	204	441	645	52	71	123

Categories

Allergic conjunctivitis Allergic Rhinitis Eczema Food & other items Total allergic reaction

Figure 2: Bar diagram depicting different allergic conditions in children from schools of urban and rural areas

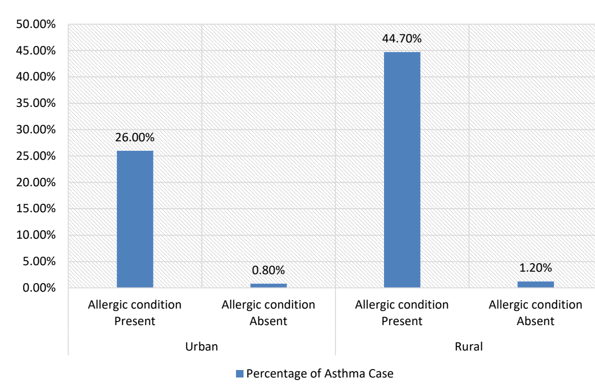


Figure 3: Bar diagram depicting comparison between prevalence rate of asthma in children having allergic condition and in children having no allergic condition in urban and rural areas

($p < 0.001$), indicating a strong correlation between the presence of allergic manifestations and the development of asthma in both urban and rural children.

Figure 4 explores the impact of environmental tobacco smoke exposure on asthma prevalence. Among urban children exposed to passive smoking (n = 1642), asthma was identified in 143 cases (8.7%), while among the unexposed (n = 2911), only 59 children (2.02%) had asthma. A similar trend was noted in the rural cohort, where 5.9% (55 out of 932) of tobacco-exposed children had asthma, compared to 1.8% (28 out of 1484) in the non-exposed group. This association was statistically significant ($p < 0.05$), demonstrating that passive tobacco exposure is a significant risk factor for childhood asthma in both urban and rural populations. These findings highlight the adverse impact of environmental tobacco exposure and the need for preventive strategies to mitigate exposure in households.

Figure 5 assesses the relationship between biomass fuel exposure and asthma prevalence. In urban settings, 278 children were exposed to biomass fuels, among whom 8 (4.3%) had asthma, while 196 (4.5%) of the 4274 unexposed children were diagnosed with asthma, indicating no significant difference ($p > 0.05$). However, in rural areas, asthma prevalence was significantly higher among biomass-exposed children, that is 71 out of 1177 (6.03%), as compared to only 9 out of 1239 (0.72%) in the non-exposed group. This difference was statistically significant ($p < 0.01$), underscoring the role of biomass fuel exposure as a significant risk factor for asthma in rural children, possibly due to prolonged exposure to indoor smoke and poor ventilation conditions.

Discussion

Asthma in children remains a significant global public health challenge, contributing extensively to paediatric hospitalizations, increased healthcare utilization, missed school days, and reduced caregiver productivity. Several well-established factors account for the rising burden of paediatric asthma, including under-treatment, poor adherence to recommended pharmacological regimens, inadequate use of anti-inflammatory medications, exposure to environmental and indoor allergens, limited awareness among caregivers, and diagnostic challenges, especially in younger children.[8-10]

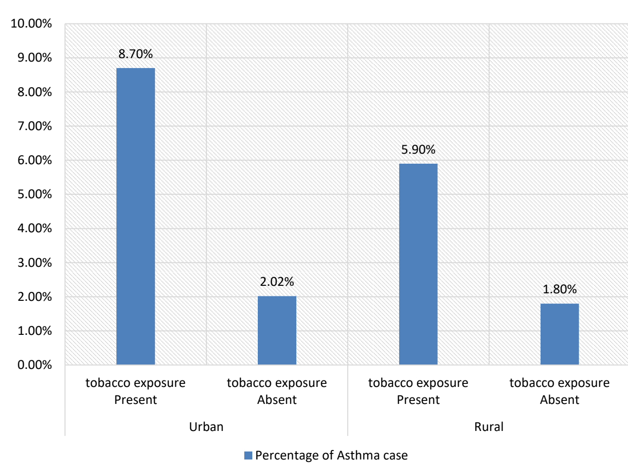


Figure 4: Bar diagram depicting comparison between prevalence of asthma in children exposed/not exposed to tobacco smoke in urban and rural areas

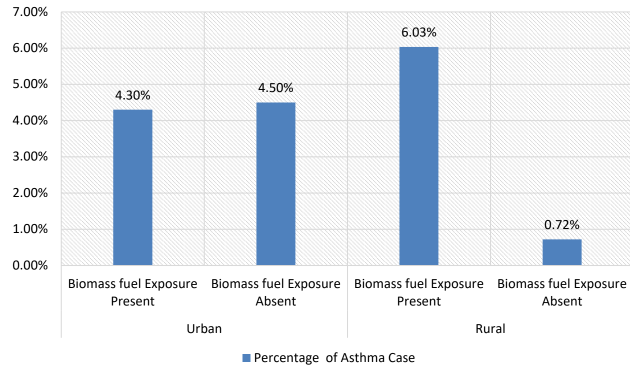


Figure 5: Bar diagram depicting comparison between prevalence of asthma in children exposed/not exposed to biomass fuel exposure in urban and rural areasasthma in children exposed/not exposed to tobacco smoke in urban and rural areas

The present study was conducted to assess the prevalence and associated risk factors of asthma among school-going children aged 5 to 15 years in urban and rural regions of the western part of India. The cross-sectional survey included 6,959 children, with 4,553 from urban schools and 2,416 from rural schools, representing a diverse socioeconomic spectrum. Among urban children, 645 (14.2%) were found to have one or more allergic disorders, with a higher prevalence among females (15.9%) compared to males (11.3%). The most common conditions observed were allergic rhinitis (6.7% in females; 5.0% in males), allergic conjunctivitis (5.9% in females; 4.5% in males), and eczema (3.1% in females; 1.6% in males). Food and miscellaneous allergies were rare (<0.5%). In contrast, the rural population showed a lower overall prevalence of allergic disorders (5.1%), again with female predominance (6.1% vs. 4.2% in males). Notably, allergic rhinitis was significantly less common in rural children than in their urban counterparts. These findings align with studies by Skoner DP *et al.*[11] and Chen MH *et al.*[12] that show allergic rhinitis is one of the most common allergic disorders and one of the most common non-communicable diseases worldwide, which can coincide with other diseases like asthma. Another study by Blaiss MS *et al.*[13] states that allergic rhinitis mostly develops during the paediatric years and it is the most common chronic allergic disorder seen in children. There are numerous complications that can lead to significant problems both physically and mentally in the child who suffers from allergic rhinitis. Under physical complications, otitis media with effusion, recurrent and/or chronic sinusitis, asthma, and snoring impact children.

A strong association between allergic conditions and asthma was evident. In urban children, asthma was present in 26% of those with allergies compared to just 0.8% among non-allergic peers. Among allergic urban asthmatics, 27% of males and 25% of females had coexisting allergies. A similar trend was observed in rural areas, where 44.7% of children with allergic conditions had asthma, compared to 1.2% among those without. Specifically, asthma prevalence among allergic rural females reached 47.8%, and 40.3% among allergic rural males, indicating a robust correlation. These findings match those reported by Gupta *et al.*[14] from Jaipur, who found that 56.4% of asthmatic children had concomitant allergic rhinitis, 30.2% had recurrent skin itching, and 40.3% suffered from allergic conjunctivitis (p <0.01). Jain *et al.*[15] similarly noted a 10.3% asthma prevalence with male predominance (12.1%), and an inverse association with age. Significant associations with passive smoking, family history of atopy, inadequate ventilation, and prematurity were also reported. In a study by Kumar GS *et al.*[16] in Puducherry, 72.7% of current asthmatics had coexisting rhinitis, slightly higher than our study (66.6%), while 54.5% reported cutaneous allergy manifestations. Vyankatesh AA *et al.*[17] further reinforced the role of both genetic predisposition and environmental exposures such as family history, coexisting allergies, and isolated cough without cold in asthma pathogenesis.

In urban areas, 278 children (6.1%) reported biomass fuel exposure, with an asthma prevalence of 4.3% (n = 8). No significant sex difference was observed in this group. The relatively low burden may be attributed to greater liquefied petroleum gas (LPG) adoption in urban households. However, in rural areas, where 48.7% of children (n = 1177) were exposed to biomass fuel, the asthma prevalence in the exposed group was substantially higher (6.03%) compared to unexposed children (0.72%). Among rural girls exposed to biomass, asthma prevalence was 7.9% versus 1.4% in boys possibly due to higher indoor exposure during cooking activities. The rural association was statistically significant ($p < 0.01$), while urban findings were not up to that extent ($p > 0.05$). These observations are supported by a Nigerian study that also reported a significant link between biomass fuel exposure and respiratory morbidity[18].

Passive tobacco smoke exposure was widespread, affecting 36.1% of urban and 38% of rural children. In urban areas, asthma was diagnosed in 12.9% of exposed males and 5.7% of exposed females, compared to just 2.02% among unexposed children. Similarly, in rural settings, asthma prevalence was 7.03% in exposed males and 4.5% in females, while only 1.8% of unexposed children were affected. The association was statistically significant ($p < 0.05$), confirming environmental tobacco smoke as a strong risk factor in both settings. Comparable findings were reported by Boskabady *et al.*,[19] who observed significantly increased severity and persistence of respiratory symptoms in children with smoking parents over a three-year period ($p < 0.05$–<0.001). Singhs *et al.*[20] also documented a strong association between asthma prevalence and exposure to tobacco smoke and traffic-related air pollution among Jaipur school children

Findings of this study suggest the need for broader public health strategies addressing environmental exposures and allergic sensitization in paediatric populations. Further large-scale, longitudinal studies are warranted to evaluate the influence of additional risk factors such as family history, genetic predisposition, socioeconomic conditions, early childhood infections, and other determinants contributing to the rising burden of asthma among children.

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