Prevalence and risk factors of asthma among school going children in urban area of North India

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ABSTRACT

Introduction: Bronchial asthma is a chronic respiratory illness of global importance. Recent reports depict the increasing prevalence of this disorder in urban areas. **Methods:** An observational study was designed with a sample size of 1163 children from grade 4 to grade 12, involving 8 randomly selected schools in 2015-2016. Modified International Study of Asthma and Allergy in Childhood [ISAAC] questionnaire in local language [Hindi version] was used for data collection. The data of assessed risk factors were collected and analysed. **Results:** Prevalence of asthma in the studied population was 2.8%. Multivariate analysis revealed a significant association of risk of asthma with use of firewood kitchener for cooking, keeping pet animals at home, high body mass index (BMI), absence of ventilator measures like chimney and aero-vent. Logistic regression analysis revealed use of firewood kitchener for cooking (odds ratio (OR) = 4.9, 95% confidence interval (CI) = 2.93-11.3), absence of smoke outlet (OR 2.8, 95% CI 1.3-5.8) and keeping pet animals (OR 3.2, CI 1.6-6.8) at home were observed to be significantly associated with asthma. **Conclusion:** Prevalence of asthma in our cohort was significantly lesser than that of developed world. Household smoke was the most conspicuous risk factor contributory to childhood asthma in this part of world.

Keywords: Bronchial Asthma, Patna, school children, Urban

Introduction

Bronchial asthma is a long-term disorder of respiratory tract characterized by airway inflammation and hyperactivity.[1,2] Significant surge in its prevalence is noted in recent time globally.[3,4] As per World Health Organization (WHO) 2005 estimate,[5] 300 million of world's population are suffering from asthma and 255,000 among them die of asthma. Majority of deaths due to asthma occur in poor and resource-limited countries.[6] In India, around 57,000 deaths in a year were attributed to asthma.[5]

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Asthma, the principal culprit for disease and deaths[7] is detected to have further increasing trend in recent studies. National Family Health Survey-3 in India showed that the its prevalence among teenage adolescent of age group 15-19 years is as low as 0.9%,[8] whereas other studies at various age groups showed wide range of prevalence ranging from 1.9% to 16.6%.[9-12] Higher rate of asthma is illustrated in children of school-age in several studies. Urbanization has been associated with an increase in asthma but the exact nature of this relationship is unclear. Patna is a north Indian city in Bihar state of India with the total population of 2950000 and population density of 1823 inhabitants per square kilometres. This city has undergone rapid urbanisation in the recent years. The Patna city has ranked among the top polluted cities of India. Anticipating a high morbidity with childhood

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asthma because of the aforesaid factor, we studied the prevalence and risk factors of asthma in school-age children in this region as there are no published studies in last five decades in order to understand the epidemiology and to develop appropriate preventive strategy.

Methods

This cross-sectional study was carried out during 2015-2016 in eight randomly selected school (4 government and 4 private) among total 18 schools of Patna city. Sampling was done by cluster sampling technique with simple randomization. Children from grade 4 to grade 12 (age range 6 to 16 years) were involved in the study. A pretested and validated bilingual (English and Hindi) questionnaire was designed in competition of the International Study on Allergy and Asthma in childhood (ISAAC) questionnaire.[13] Selection of asthma characteristics were based upon the physician's diagnosis according to global initiative of asthma guidelines (GINA) 2015 and pre-diagnosed children under asthma medications. After obtaining consent, the participants were interviewed as per the questionnaire. Data on risk factors includes family history, smoking among family members, cooking fuel, windows at home, site and windows at kitchen, contact with pet, domestic smoking, and birth order were collected. Permission, consent, and assent (where applicable) were obtained from the authority of every schools, parents and children. The study protocol was approved by Institute Ethics Committee (IEC) and Institute Thesis Committee (IEC/AIIMS/ PAT/112/2016 dated 23.09.2016). The manuscript has been approved by Departmental Review Board.

Sample size

To detect minimum prevalence of 3% childhood asthma with 95% confidence level and precision of ±1%, 1119 children were required and finally 1163 students were interviewed.

Statistical analysis

Statistical analysis was done using R software version 3.41. Results were presented as mean ± SD for continuous outcome and proportion for categorical variable. Odds ratio were analysed with univariate analysis and multivariate logistic regression analysis to analyse the association of risk factors. *P* value was considered significant when $P < 0.05$.

Results

Total 1500 students approached and 1163 students responded with response rate of 77.3%. The mean age of the children was 12.8 (±1.58) years. Among 1163 children 723 (62.2%) were males and 440 (37.8%) were girls with male to female (M: F) ratio of 1.64. In our cohort, children of first or second birth order were 31.6% and 38.4%, respectively. Demographic and risk factors characteristics of the children participated in the study are in **Table 1**. Among all, 33 (2.8%) children were found to have bronchial asthma. Among them, prevalence

Table 1: Baseline characteristic of children in study	
Characteristic	Total (%)
Gender	
Male	723 (62.2)
Female	440 (37.8)
Body mass index (mean±SD)	18.09 (4.45)
Cooking fuel	
Liquified petroleum gas	954 (82)
Firewood kitchener	90 (7.7)
Electricity	119 (10.2)
Family history asthma	
Yes	273 (23.5)
No	890 (76.5)
Windows in sleeping room	
0	18 (1.5)
1	426 (36.6)
2	539 (46.3)
3	173 (14.9)
4	7 (0.6)
Pet animals in house	
Yes	422 (36.3)
No	741 (63.7)
Chimney in kitchen	
Yes	411 (35.3)
No	752 (64.7)
Smoking members in family	
Yes	291 (25)
No	872 (75)
Food allergy	
Yes	336 (28.9)
No	827 (71.1)
Birth order	
1	368 (31.6)
2	447 (38.4)
3	267 (23)
≥4	81 (7.0)
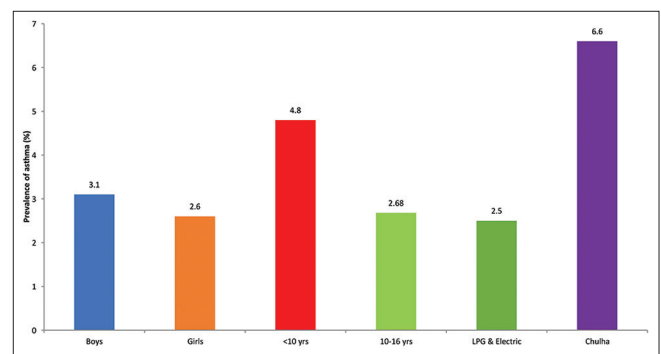
Figure 1: Prevalence of asthma among boys and girls, different age groups and various cooking methods

among boys and girls was 3.1% and 2.6% [Figure 1]. The prevalence of asthma was more common in 7-10 years age group (4.8%). Family history was positive in 273 (23.5%) school going students. Among them, 12 (4.3%) were found to have asthma. One third population (36%) had exposure to at least one pet animals in their house. Smoking family members

were found in 3.8% in asthmatics and 2.5% of non-asthmatics. The difference failed to show statistical significance ($P = 0.32$). Household of more than $4/5^{th}$ (82%) of study subjects of were using liquefied petroleum gas (LPG) or electric heater as the main cooking resource. Only 90 (7.7%) were using firewood kitchener. Univariate analysis revealed 4 times increased risk of having asthma due to the use of firewood kitchener (OR = 3.93, 95% CI = 1.51-10.2, $P = 0.005$) in comparison to use of other type of cooking fuel like LPG and electric heater. The prevalence of asthma among children with use of firewood kitchener in their home was 6.6%. This was significantly higher than that in the children with household with LPG and electric heater as cooking resource [Figure 1]. Absence of chimney in kitchen was found to have 2.5 times more risk of developing asthma (95% CI = 1.19-5.56, $P = 0.0091$). Absence of windows in sleeping room (OR = 1.92, 95% CI = 1.21-3.03) and presence of pet animals (OR = 3.65, 95% CI = 1.75-7.60) were also found to be the other risk factors associated with asthma [**Table 2**]. However, association was not observed between asthma and smoking history in family, food allergy, and birth order of child or family history of asthma. Univariate analysis showed significant association between high body mass index (BMI) (BMI > 85th centile) and incidence of asthma (OR = 2.88, 95% CI = 1.17-6.15, $P = 0.002$).

Associated risk factors were further analysed with multiple logistic regression. The presence of pet animals, absence of smoke outlet in house and use of firewood kitchener for cooking were found to be the significant risk factors associated with asthma. Presence of pet animals increases the risk of asthma by nearly 3 times (adjusted OR = 3.2, 95%CI = 1.53-6.8, $P = 0.004$) and smoky (chimney-less) kitchen increases the risk of asthma by nearly 3 times (adjusted OR = 2.8, 95% = 1.36-5.8, $P = 0.023$) [**Table 3**].

Discussion

Asthma prevalence in urban population is found to be increasing in recent time. Five decades back, asthma prevalence in school going children below nine years was 0.2% in Patna region.[14] Its prevalence in school going children in our study was 2.8%. This signifies that the prevalence has increased by 14-fold.

A systematic review conducted by Pal *et al.* on 15 epidemiological Indian study has documented a mean weighted prevalence of 2.74% in children between 6 and 14 years and our prevalence is in accordance with the previous report.[12] Various studies done in last two decades reported prevalence ranging from 0.9% to 15.7% from different urban areas of India.[9-12] However, a study from Bangalore city of India reported a prevalence of 19.4% which is substantially higher than any other study done in the recent years from different urban territory of our country.[11] A recent study on prevalence of asthma in North-western Indian city was 13.1% in 11–16 years age group school going children. Comparatively lesser prevalence in our study might be attributed to improvement in the environmental state, difference in the way of making ventilated houses and studying only among the school going children.

Carlos *et al.* in a report from Brazil on risk factor assessment in childhood asthma have shown association of prematurity, maternal asthma, exposure to pets during infancy, antibiotics use in first 6 months of life, current rhinitis, sharing bed room in first year of life, history of atopy.[15] In a similar report from South Korea, risk factor analysis related to asthma severity showed significant association of tobacco smoke, exposure to dog dander's and absence of home air purifier in children.[16] Likewise, a Mexican study with 999 children have documented that association of exposure of smoking, common cold in early life, kitchen indoors, exposure to pets and mould were significant risk factors whereas breast feeding more than 3 months, caesarean section and having more than one sibling in the family were found to be protective.[17]

Our prevalence is comparatively lower in comparison to global statistics. The prevalence of childhood asthma was 32.6% in Wellington (New Zealand) and 37.6% in Costa Rica, whereas prevalence in India and Indian subcontinent was low ranging from 5% to 7.5% as reported.[18] These wide variation in prevalence might be attributed to varying levels and types of pollution, exposure to allergen, density of population and difference in industrialization in different places.

The aetiology of childhood asthma is not fully understood. The interplay of various environmental factors, genetic predisposition due to susceptible variants and polymorphisms has been implicated.

Table 2: Results of univariate analysis of association of various risk factors for asthma in children (*n*=1163)				
Risk factors for asthma	Odd ratio	Lower 95% CI	Upper 95% CI	*P*
Cooking fuel as Firewood Kitchener	3.93	1.51	10.20	0.00504
Absence of Windows in sleeping room	1.92	1.21	3.03	0.00531
Pet animals in house	3.65	1.75	7.60	0.00054
Kitchen in sleeping Room	0.59	0.29	1.21	0.1530
Female sex	1.22	0.60	2.46	0.577
Family history of smoking	1.52	0.72	3.17	0.267
Birth order	1.25	0.86	1.80	0.230
Food allergy	1.42	0.69	2.92	0.341
Family history asthma	1.89	0.83	4.10	0.0939
Absence of chimney in kitchen	2.55	1.19	5.56	0.0091
High body mass index	2.68	1.17	6.15	0.00229

Table 3: Results of multivariate analysis of association of various risk factors for asthma in children (*n*=1163)

Risk factors for asthma	Odd ratio	Lower 95% CI	Upper 95% CI	*P*
Cooking fuel as Firewood Kitchener	4.39	1.63	11.8	0.0004
Pet animals in house	3.23	1.53	6.8	0.02
Absence of chimney in kitchen	2.82	1.36	5.8	0.004

In our study, asthma was more commonly noticed in the children of 7–10 years age group. Our finding differs with the findings by Ganesh *et al.* who reported that the prevalence is more in adolescent age group.[9] High BMI was also shown to be associated with asthma in univariate analysis in our cohort. A potential association between childhood asthma and obesity was revealed in the past. Obesity worsens the asthma by mechanical, genetic, immunologic and inflammatory pathways.[19,20] Furthermore, there was an association with obesity and risk of asthma.[21] It is shown that high BMI in different gender also have significantly different rate of developing asthma.[22-24] In a longitudinal study of 3,792 participants, Gilliland *et al.* described a significant association between childhood asthma and overweight (BMI > 85th centile) status.[24] In a meta-analysis of prospective studies in children <18 years of age, the combined risk ratio of obesity and asthma in children was significantly significant.[25] However, other studies failed to show the similar correlation between the two.[26,27]

Among the studied risk factors, exposure to indoor smoke produced by using firewood kitchener was the strongest risk factor observed in our study and this has been substantiated by various studies.[28] The results were not uniform.[29,30] Biomass smoke e.g., dung smoke contains volatile toxic organic molecules and endotoxins.[31] Exposure to biomass fuel combustion produces significant hyper-responsiveness. Further, these pollutants can act as potential triggers resulting in transient air narrowing. Inhalation of these substances establishes inflammation, airway hyperreactivity. Such airway changes and resultant oxidative stress plays pivotal role for etiopathogenesis and exacerbation of asthma.[31,32]

Other observation in our study was association between asthma and the presence of pet animals in house, which is in consonance with available literature. However, this relationship between asthma and pet animals is complex. Some studies stated the protective effect of pet animals whereas others have concluded the detrimental aspect of it. It may depend upon the individual sensitivity to allergens, atopy, age of child, type and level of pet exposure. McHugh *et al.* showed that pets with close, frequent and domestic interaction e.g., cats and dogs significantly contribute for development of atopy, eczema and asthma.[33] Similar results were described from two other studies from India, which illustrated the significant correlation of exposure to pet animals and childhood asthma.[34,35] Alperberg *et al.* performed a systematic review have revealed that exposure to pet animals in first two year of life increases the risk of asthma by 11%.[36] However, pet-keeping has confounding factors related with lifestyle which on themselves

can contribute to asthma. Moreover, temporality of this attribute in human life and inconsistent association makes this observation difficult to be explained in broader sense with significance. Thus, larger scale studies are needed to ascertain the risk of asthma and exposure to pet animals.

Absence of smoke outlet at home and asthma was found to be one of the significant risk factors in our study. This finding is consistent with the study done in northern part of India by Pokharel *et al.*[35] However, in a study among school children of 7th and 8th grade at Bhopal, India, no association was found between asthma and absence of smoke outlet in house.[37] Absence of windows in the sleeping room is the other key risk factor observed in this study and it is consistent with the finding of the study by Pokharel *et al.*[35] Low socioeconomic class, overcrowding, and poor design of the house are the known factors in developing countries which account for inadequate ventilation in the sleeping room.

Adequate sample size, use of standardised tool for assessment is the strength of our study. However, this is a questionnaire-based study targeting only school-age children who are from urban areas. Hence, the results can't be extrapolated to overall paediatric population in the community. A large community-based survey is required to ascertain the exact prevalence in the community. Furthermore, spirometric confirmation of asthma would have strengthened the diagnosis of childhood asthma.

Conclusion

Bronchial asthma is a major public health issue which involves interplay of different genetic and multiple environmental risk factors. the prevalence of asthma in school going children has increased by 14-fold in this region over last five decades but it is lesser than its current prevalence in school children of developed world. Indoor smoke originated from firewood kitchener was the most important contributing risk factor associated with childhood asthma in this region. Environmental risk factors can be modified to introduce an impact on the outcome. Important risk factors significantly associated with asthma in our cohort were presence of the firewood kitchener at home, absence of chimney, poor ventilation and presence of pet animal at home. Family physicians often come across several cases of bronchial asthma in their day to day practice. Counselling regarding avoidance of these risk factors while treating such patients at the outset may change the course and outlook towards disease and reduce the associated morbidity or mortality. This is the only study from North-eastern India in recent times. This information may be of public health importance and for regional administrative and planning purpose.

What is already known on this topic

- Prevalence of bronchial asthma in India is 0.9%. At Patna city, it was 0.2% five decades back.
- Various studies done in last two decades reported prevalence ranging from 0.9% to 15.7% from different urban areas of India.

- A systematic review conducted by Pal *et al.* on 15 epidemiological Indian study has documented a mean weighted prevalence of 2.74% in children between 6 and 14 years.

What this study adds

- For 5 decades, the prevalence was not studied in this region. Our study gives the prevalence of bronchial asthma in this city.
- The prevalence of asthma in school going children in our study was 2.8%. This signifies that the prevalence has increased by 14-fold. This study also identified many risk factors for the bronchial asthma.
- This study gives roadmap for planning and implementing the national health policy in this hugely populated region of South Asia.

Key Points:

1. Prevalence of asthma in school going children in Northern India has increased.
2. Important risk factors significantly associated with asthma in our cohort were presence of the firewood kitchener at home, absence of chimney, poor ventilation and presence of pet animal at home
3. Family physicians may emphasise on counselling regarding avoidance of these risk factors in urban settings which may change the course of disease

Abbreviations: **BMI:** Body mass Index **ISSAC:** International Study of Asthma and Allergy in Childhood [ISAAC] questionnaire **CI:** Confidence interval **OR:** Odds ratio **WHO:** World Health Organization **VOC:** Volatile organic compounds **LPG:** Liquified Petroleum Gas

Consent for publication and consent to participate

Written informed consent for publication of their clinical details and were obtained from the guardians of the participating children. A copy of the consent form is available for review for the Editor of this journal.

Ethical approval

Approval for the study was obtained from the Institute ethics committee of All India Institute of Medical Sciences, Patna, India (IEC/AIIMS/PAT/112/2016 dated 23.09.2016). The manuscript has been approved by Departmental Review Board. Procedures done in the study were as per the institutional, national guidelines and as per Helsinki declaration of 1975, as revised in 1975.

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Conflicts of interest

There are no conflicts of interest.

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