Prevalence of bronchial asthma and its associated risk factors in school-going adolescents in Tier-III North Indian City

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ABSTRACT

Background: Asthma is one of the most common chronic diseases of childhood and a major health problem not only in India but globally. Despite multifold increase in prevalence, there is paucity of data on bronchial asthma from non-metro cities. The objectives were to find prevalence of bronchial asthma and various risk factors that are associated in this age group and determine the extent of under diagnosis. **Materials and Methods:** A cross-sectional study involving 927 students from four government and three private schools was conducted using International Study of Asthma and Allergies in Childhood questionnaire. **Results:** Prevalence of bronchial asthma in adolescents was 13.1% (n = 121) of which 10.3% had episodes in the past 1 year. Prevalence was higher among males (8.77%) compared to females (4.33%). About 77.7% of total asthmatics were newly diagnosed cases. Prevalence was significantly higher among those having pets at home (P < 0.001), belonging to higher socioeconomic status (P = 0.021), using smoke-producing fuel at home (firewood/cow dung/kerosene; P = 0.032), and with history of smoking among family members (P = 0.035). Among current asthmatics, 72.3% reported cold/rhinitis (54.6% in March–May duration), 63.6% nocturnal dry cough, 50.5% sleep disturbances, and 38.9% speech disturbances in the past 1 year. **Conclusion:** The study shows higher prevalence of bronchial asthma in school-going population (11–16 years) compared to other parts of Northern India possibly attributable to rapid industrialization and post harvesting season when the study was carried out. Preventive interventions need to be taken to reduce disease burden at community level.

Keywords: Asthma, seasonal variation, underdeveloping areas

Introduction

Asthma is one of the most common chronic diseases of childhood and a major health problem not only in India but globally. A multifold increase in incidence of bronchial asthma has been reported in the past decade.[1] This increase is attributed mainly by increasing environmental smoke and air pollution due to rapid industrialization of cities.[2,3] Most children develop asthma in early age.[4] Many previous studies on asthma in India reported an estimated prevalence rate of 2% up to as high as 23%.[1,5-9] Such huge variation is not only due to difference in methodology of studies but also wide geographical and environmental variations in India. Contribution of various risk factors associated with incidence of asthma may vary with geographical locations, local traditions customs, and environmental factors. In addition to, this childhood asthma is often underdiagnosed and undertreated that may lead to disturbances in (quality) life of children.[10,11] Understanding of associated risk factors such as family history, exposure to smoke (indoor/outdoor), allergen, and others may help taking suitable and timely preventive measures.

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In sharp contrast to the earlier belief of bronchial asthma to be considered a disease of metro cities, a study reported higher prevalence in rural areas compared with urban areas.[12] Prevalence pattern is now changing and more and more cases of childhood asthma are now being diagnosed in developing areas where earlier prevalence was lower. In our tertiary care referral hospital in Tier-III city (also Z class city as latest Government classification – all cities other than Class X and Y); more children were presenting with respiratory difficulties in winter months and crop harvesting months in summers, but this trend was not analyzed further.

The current model of study using International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire has been used extensively worldwide with proven efficacy in epidemiological studies on childhood asthma.[2,13] ISAAC questionnaire includes all aspects to be studied not only asthma but also allergic conditions such as rhinitis and eczema. Environmental questionnaire – a part of ISAAC questionnaires – covers almost all the risk factors associated with bronchial asthma in children. Not only the epidemiological studies are possible using this questionnaire but also symptom severity when child has most suffered from conditions such as rhinitis. Video questionnaire part is added on for more accuracy of responses. This ISAAC questionnaire for 13-/14-year children can be filled by students themselves, thus time-efficient and easy to operate in groups (as all student of a class can be surveyed in one single setting). Thus, ISSAC questionnaire model is sensitive, quick, effective, convenient, and time-efficient to perform.

Despite many studies, there has largely been paucity of data from lower tier cities in India. There may be undiagnosed childhood asthma cases in this region as well, thus this study becomes important.

The study aims to find the prevalence of bronchial asthma among 11- to 16-year school-going children of a Tier-III city, to find association with various risk factors and determine the extent of underdiagnosis.

Materials and Method

This was a cross-sectional, self-administered questionnaire-based study followed by detailed history and clinical examination of suspected individuals selected on the basis of response to questionnaire. The study was conducted in the months of April–May 2017 in a total of seven schools: three private sector and four government sector schools selected randomly from all parts of the city based on operational feasibility of study and in an attempt of covering almost all socioeconomic strata of the community uniformly. School-going children of 11–16 years age group of seven schools were study subjects considering they would be able to answer the questionnaire on their own, thus making study convenient, accurate, and time-efficient compared to younger children. All students of particular class of targeted age group (class VII to XI standard) selected randomly present

on time of visit were asked to take part in the study. Where student strength was higher classes/sections were selected randomly. Student's selection from one school was kept limited so as to include all variability. Minimum sample size assuming a prevalence rate of 10% in the region and maximum allowable error of 20% was calculated to be 900.

Prior approval from Institute Ethical Committee on human subjects was obtained before commencing the work. After selecting schools for study concerned, school principals were approached and a written permission was obtained after briefing them about study objectives, procedures, and safety. Students asked to participate in study were briefed about the study and a written "Parent Information Sheet" describing the disease and study procedure for parents along with "Written Consent Sheet for participation in study to be signed by parents/guardians" was distributed among the participating student. Parent information sheet and informed consent form were made available in local and English languages. Students were included in the study only after receiving consent form fully filled and signed by parents. Exclusion criteria included age <11 years and >16 years and any other comorbid respiratory or systemic illness. Participants were briefed about exclusion criteria which were further scrutinized while taking detailed history taking of selected subjects.

Study tools

ISSAC questionnaires are effective tools for epidemiological studies on childhood asthma and allergic respiratory conditions as proved by a number of studies.[2,13] The questionnaires were made available in English and Hindi languages. ISAAC questionnaire for 13-/14-year age about symptoms of asthma, rhinitis, and eczema and ISAAC Environmental questionnaire comprising questions on demography, environmental, and risk factors associated with asthma were used to access the students. After completing written questionnaire, a video prepared by Wellington School of Medicine and Health Sciences, University of Otago, showing five different symptoms of asthma such as wheezing/whistling sound from chest in resting conditions, after exercise/running/physical activity, nocturnal dry cough disturbing sleep, and respiratory difficulty disturbing sleep was shown. Based on the video, study subjects were asked to fill a Video Questionnaire prepared by ISAAC.

Diagnosis

Subjects giving positive response to any question of ISAAC questionnaire asthma/rhinitis/skin allergies were labeled as suspected asthmatics and were selected for *detailed history taking and clinical examination*. Detailed history of total 285 subjects was taken and examined clinically on this basis for active wheeze/whistling and confirm the diagnosis. Clinical examination not only confirmed previously diagnosed cases but also strengthened diagnosis as in a study by Brozek *et al*.[14] Asthma cases were followed up in outpatient department of hospital and asked to start treatment which patients complied with. Their parents were also informed about the condition.

Symptom severity of asthma based on the number of attacks of wheezing/whistling in the past 1 year, nocturnal dry cough, sleep, and speech disturbances was also recorded.

Statistical analysis

Data were recorded in Microsoft Office Excel 2013. Statistical analysis was performed using Statistical Package for Social Sciences v20. Pearson's Chi-square and odd's ratio were calculated for associated risk factors. Statistical significance was checked by P value (two-tailed) considering value <0.05 as significant.

Results

A total of 927 subjects in age group of 11–16 years were analyzed. Prevalence of bronchial asthma was found to be 13.1% (121/927); 10.2% (95/927) had asthma episode/(s) in the past 1 year labeled as current asthmatics. The study found that younger age group (66.9%; 81/121) and male subjects (69.4%; 84/121) were more affected. Prevalence was significantly higher among those with history of smoking among family members, having pet at home, using smoke-producing fuel at home, elder in birth order, and experiencing two or more episodes of fever ($P < 0.05$) [Table 1].

In the past 1 year, 50.5% of current asthmatics (48/95) had sleep disturbances, 38.9% (37/95) had speech disturbances, 63.6% (77/121) had nocturnal dry cough, and 72.7% (88/121) had cold/rhinitis. Only 22.3% (27/121) of total asthmatics were previously diagnosed [Table 2].

More subjects reported rhinitis episodes in November–January period (winters period; 47.1% (57/121) and March–May (crop harvesting/post harvesting season; 33.9% (41/121) [Figure 1].

Discussion

Asthma is being increasingly diagnosed nowadays indicating increasing prevalence, but reasons for the same are still poorly understood. A study by Taylor *et al.* depicts burden of childhood asthma on US society in terms of 2.7 million children affected annually comprising 7.3 million days of restriction to bed, 10.1 million days of absence from school, 12.9 million contacts with doctors, and 2 lakh hospitalization resulting in 1.9 million days of hospital admissions.[15] International difference in prevalence of asthma is now decreasing as more cases are diagnosed from areas where previous prevalence rates were lower as suggested by Lai *et al.* in their study.[2]

In our study, bronchial asthma prevalence among 11–16 years urban-school going adolescents in lower tier city was calculated to be 13.1%. This is in contrast to national pool prevalence in adults and many recent studies on childhood asthma in different cities that have shown lesser prevalence rates.[1,6,7] Higher prevalence can be explained by difference in geographical, climate differences, agriculture dominant region, and post harvesting season when the study was carried out. As shown by some
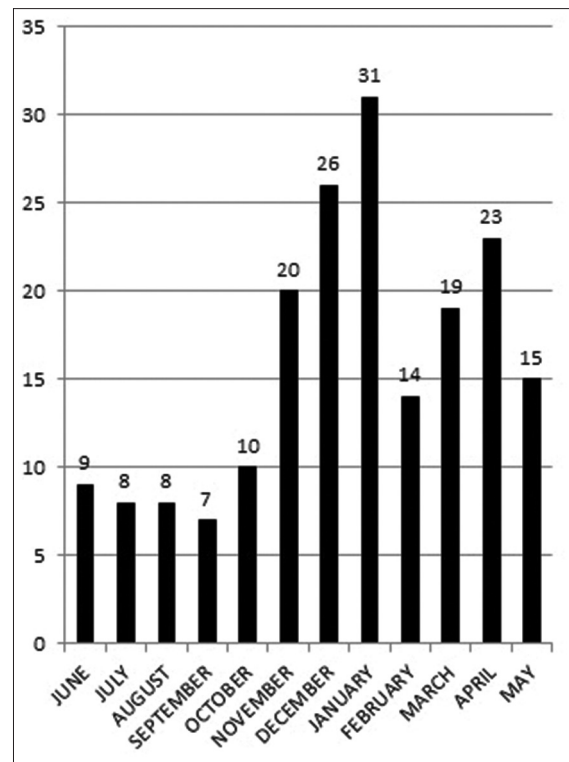
Figure 1: Month wise number of students with rhinitis in past one year

domestic and international studies, there is seasonal variation in symptom severity of asthma; it is relevantly observed in our study as well (highest number of episodes of rhinitis observed in months of December–January in winter season and April–May when crop harvesting season is going on/partially completed in this agricultural dominant region).

Prevalence was higher in male gender compared with female with M:F of 2.27:1. This finding is in accordance with a study carried out by Pal *et al.*[1]

Pet presence at home proved to be a significant risk factor for bronchial asthma in our study as 55.37% asthmatics reported pet presence in the past 1 year. Statistical analysis proves it a significant risk factor ($P < 0.05$). This is in contrast to some previous studies.[4,11] History of smoking among family members was present in 6.7% (51% of total asthmatics). This is in accordance with earlier study by Taylor and Newacheck and Jindal.[15,16]

Indoor air pollution in terms of smoke produced due to fuel used at home for cooking/water heating emerged as an important risk factor. Prevalence was higher among those using smoke-producing fuel at home. Similar observations were made by Jindal *et al.*[7]

Socioeconomic status as reflected indirectly by school where private sector represents upper socioeconomic and government school representing lower socioeconomic status. Children belonging to upper socioeconomic status are at more risk of

Table 1: Various risk factors associated with Bronchial asthma in children population					
Associated factors	Total number of subjects (*n*=927)	Number of subjects having asthma (%)	Chi square	*P*	OR
Age (years)			1.89	0.17	1.37
11-13	568	81 (14.26%)			
14-16	359	40 (11.14%)			
Sex			26.37	<0.001*	2.84
Male	442	84 (19%)			
Female	485	37 (7.63%)			
Fuel used			4.61	0.032*	1.52
Smoke producing (cowdung/firewoord/kerosene)	362	58 (16.02%)			
Smokeless (gas/electricity)	565	63 (11.15%)			
Smoking among family members			4.46	0.035*	1.51
Yes	390	62 (15.75%			
No	537	59 (11.08%)			
Number of episodes of fever					
0-1/year	250	65 (26%)	27.32	<0.001*	0.37
≥2/year	560	56 (9.89%)			
Birth order					
Elder	282	55 (19.50%)	4.98	0.026*	1.50
Younger	524	66 (12.60%)			
Vigorous Physical Activity					
Never-once/week	712	101 (14.19%)	2.31	0.12	1.49
≥3 times/week	94	20 (21.28%)			
Presence of pet					
Yes	182	67 (36.81%)	112.65	<0.001*	7.46
No	745	54 (7.25%)			
Dietary habits					
Nonvegetarian	266	43 (16.17%)	3.18	0.074	1.44
Vegetarian	661	78 (11.80%)			
Vehicle movements near home					
Never-seldom	564	71 (12.16%)	1.12	0.29	0.81
Frequently-all day	343	50 (14.58%)			
School (reflecting socioeconomic status)					
Private (upper)	492	76 (15.45%)	5.30	0.021*	1.58
Government (lower)	435	45 (10.34%)			
Residence					
Urban	808	106 (13.12%)	0.24	0.877	1.05
Rural	119	15 (12.615%)			

OR: Odds ratio. *P<0.05 significant

developing asthma as 62.80% of asthmatics belong to private schools. Similar observations were made by Amir *et al.* in their study.[17]

Being younger in birth order was found to be a significant risk factor in this study. About 55.54% of asthmatics were younger in birth order with *P* value calculated as 0.026. Although a few of the previous studies did not show such correlation. Subjects experiencing two or more episodes of fever were at higher risk of developing bronchial asthma as significance proved by *P* value <0.05. This finding is consistent with a study by Mutius *et al.*[18]

However, in our study no significant correlation of bronchial asthma could be established with younger age as was observed by Arora *et al.* in their study.[4] This could be explained on the basis of a study by Martin *et al.* suggesting a prevalence of asthma

decreased by up to three-fourth with age.[19] The study by Amir *et al.* observed higher prevalence of asthma in those having nonvegetarian dietary habit compared with vegetarian diet.[17] But no such statistically significant correlation was found in this study. This could be possibly explained by a more number of subjects with vegetarian dietary habits. Also, vehicle movement near home and vigorous physical activity in terms of vigorous physical activity twice or more times per week and rural versus urban residence were not found to be statistically significant risk factors.

Of 121 asthma cases, only 27 (22.30%) were previously labeled cases, and the remaining 94 (77.70%) were diagnosed for the first time, showing high degree of underdiagnosis in the region – for every diagnosed child with asthma, there are 2.9 undiagnosed as well. Several studies have shown some degree of underdiagnosis of bronchial asthma among children in India and abroad with

Table 2: Symptom severity in past one year	
Symptom in past year (*n*=95)	Number (%)
Number of attacks of wheezing	
1-3	81 (85.2%)
4-12	10 (10.5%)
>12	4 (7.3%)
Sleep disturbances	
Never	47 (49.5%)
<Once a night per week	98 (40%)
>Once a night per week	10 (10.5%)
Speech disturbances	
Yes	37 (38.9%)
No	58 (61.1%)
Wheezing on exercise (*n*=121)	
Yes	52 (42.9%)
No	61 (57.1%)
Nocturnal dry cough (*n*=121)	
Yes	77 (63.6%)
No	44 (36.4%)
Cold/rhinitis (*n*=121)	
Present	88 (72.7%)
Absent	33 (27.3%)
Itching/rashes (*n*=121)	
Present	34 (28.1%)
Absent	87 (71.9%)
Previously diagnosed (*n*=121)	
Yes	27 (22.3%)
No	94 (77.7%)

range varying from 36.9% in the study by Sharma BS *et al.*, 55.4% in the study by Sharma *et al.*, and 82.2% in a study by Kaur *et al.* and Brozek *et al.*[5,11,12,14] Hence, this finding is consistent with previous studies as well. Certain risk factors as observed by Kaur *et al.* in their study such as female sex, lower socioeconomic status, and younger age may be responsible for underdiagnosis.[11]

Noticeable observation in symptom severity is monthwise number of subjects with problem of rhinitis, among others. The highest number of subjects reported rhinitis in the month of January (31/121) when winters are on peak in Northern India [Figure 1]. Multiple months were selected by many subjects indicating problem in more than 1 month. Cumulated two peaks were observed one in November–December–January (57 subjects) and the other peak in March–April–May (41 subjects), which is crop harvesting/post harvesting season in this particular region. Similar seasonal variation in incidence of asthma in children was observed in a study by Paramesh that shows seasonal variation as episodes of asthma increased in summer.[3] In Canada and the United States as well Dales *et al.* and Wisniewski *et al.* observed higher incidence in autumn and fall seasons, respectively.[20,21] Difference in timing of peak may be due to different climate of different regions. Seasonal variation in episodes of rhinitis especially in March–May in harvesting/post harvesting could possibly be explained by an increase in atmospheric pollution by increased dust from crop harvesting and fly ashes after burning barren fields post crop harvesting in this region.

Few limitations of this study include shorter duration of study, unable to establish confirmatory relationship with seasonal variation, not using laboratory test such as pulmonary function test, or spirometry that could have further strengthened the diagnosis.

Avoiding smoking by family members and pet in case of susceptible subjects and shifting to clean nonsmoke-producing fuel may help reducing asthma prevalence. Keeping all risk factors in mind, suitable timely measures must be taken by government authorities for prevention, early diagnosis, and prompt treatment.

Conclusion

Prevalence of bronchial asthma among 11- to 16-year urban school-going children in this region is 13.1%, higher that what most other recent studies from other North Indian cities. In this study, after statistical analysis incidence of bronchial asthma could be significantly associated with risk factors such as gender (male at higher risk than females), type of fuel used at home for cooking and water heating, presence of pet (cat/dog) in the home, history of smoking among family members, and socioeconomic status (more in upper socioeconomic status). Bronchial asthma in this age group is largely underdiagnosed in the region (77% new cases); only 23% were previously diagnosed by physician. Public awareness about asthma needs to be done so that disease may be diagnosed earlier and some timely preventable measures may be taken.

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Conflicts of interest

There are no conflicts of interest.

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