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Original Article

Analysis of the Prevalence of Bronchial Asthma in 6-17 Years Old Urban School Children Belonging to Lower Middle Class and Lower Income Groups

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Abstract

Background: Asthma has become an important public health problem. Asthma is one of the leading causes of hospitalization in children. Childhood asthma is mostly underdiagnosed and also undertreated. Prevalence of bronchial asthma varies from place to place. There is little information about epidemiological trends of asthma in urban India, especially in lower income groups.

Objectives: To determine the prevalence of asthma among school children of age between 6 and 17 years in lower middle class/lower income groups of urban Chennai.

Materials and Methods: All school children between 6 and 17 years belonging to lower middle class/lower income groups in randomly selected urban schools.

Results: Out of 1894 children screened, 85 (4.5%) were asthmatics. Among the 85 asthmatics, 31 belonged to 6-12 age group, and 54 belonged to 13-17 age group. Among the asthmatics, the major symptom was wheezing or whistling in the chest which about 84.7% of asthmatics reported. Only 10.6% of asthmatics reported chest tightness as one of the symptoms of asthma.

Key words: Bronchial asthma, Children, Lower income groups, Prevalence, Urban schools

INTRODUCTION

Asthma is a chronic inflammatory disease of the airways causing episodes of airflow obstruction. This chronic inflammation increases airways hyperresponsiveness to stimulants.[1]

In general, asthma has become an important public health problem. Asthma is not only a leading cause of hospitalization in children but also an important chronic condition causing school absenteeism.[2,3] There is also increase in hospital admissions and emergency department visits to a greater degree worldwide which has lead to changes in medical practice.

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Childhood asthma is mostly underdiagnosed and also undertreated, owing to various factors such as ignorance, misconceptions, and lack of awareness.[4]

Prevalence of bronchial asthma varies from place to place due to changes in environmental factors. The genetic profile and viral infections also predispose to asthma. Increase in exposure to environmental smoke and air pollution has lead to increase in the prevalence of asthma in urban areas.[5] Asthma is generally considered a disease of developed countries and affluent societies in developing countries. There is little information about epidemiological trends of asthma in urban India, especially in lower income groups.[6] To throw more lights on this topic, we planned to accomplish a study on the prevalence of asthma in school children of urban Chennai.

According to global initiative for asthma guidelines, asthma is a heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness, and cough that vary over time

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and in intensity, together with variable expiratory airflow limitation.

Characteristic Symptoms of Asthma

- More than one symptom (wheeze, shortness of breath, cough, and chest tightness).
- Symptoms are often worse at night or in the early morning.
- Symptoms vary over time and in intensity.
- Symptoms are triggered by viral infections (cold), exercise, allergen exposure, changes in weather, laughter, or irritants such as car exhaust fumes, smoke, or strong smells.

These are typical symptoms of asthma and if present increase the probability that the patient has Asthma.

Asthma Qualifiers

The following features are used for diagnosis of asthma in clinical practice:

1. Episodic airflow obstruction more than three
2. Onset after 3 years
3. Afebrile episodes
4. Relief with bronchodilators
5. Trigger induced attacks
6. Nocturnal exacerbations
7. Exercise-induced attacks
8. Seasonal exacerbations
9. Personal H/O of atopy
10. Family H/O asthma, atopy
11. Comorbidities-rhinosinusitis, gastroesophageal reflux disease, and adenotonsillitis.

Asthma Predictive Index (API)

The API as per the 2007 National Heart, Lung and Blood Institute guidelines for the diagnosis and management of asthma. It helps us to determine, that who among children <3 years with four or more episodes in the past year are likely to have persistent asthma after 5 years if they have either.

One major criteria

1. Parental asthma
2. Diagnosis of atopic dermatitis by physician
3. Positive skin test or blood tests to allergens such as grasses, weeds, molds, or dust mites.

Two minor criteria

1. Evidence of food allergies
2. Blood eosinophilia of 4% or more
3. Wheezing apart from colds.

A study conducted by Castro-Rodriguez *et al.* throws light on applicability, validity, and simplicity of this criteria. A child with positive API has a 4-10-fold greater chance of developing asthma.[7]

Patterns of Childhood Asthma[1]

1. Transient nonatopic wheezing:
   - This is common in preschool years.
   - Common viral infections trigger recurrent wheeze/cough.
   - Mostly resolves during early school age with no increased risk of asthma thereafter.
   - Decreased airflow at birth indicates relatively smaller airways.
   - Hyper-responsive airway near birth improves by school age.
2. Atopy-associated persistent asthma:
   - Starts in early preschool age.
   - Related to atopy in early preschool age.
   - Clinical (e.g., atopic dermatitis in infancy, allergic rhinitis, and allergy to food substances).
   - Biologic (e.g., early sensitization of inhalant allergen, elevated.
   - Serum immunoglobulin E and elevated blood eosinophils.
   - More risk for persistence into later childhood and adulthood.
   - Pulmonary function abnormalities.

   Children with onset of wheeze before 3 years of age acquired decreased airflow by school age.

   Children with later onset of wheeze, or with late onset allergen sensitization, are less likely to undergo airflow limitation in childhood.
3. Asthmatics with declining pulmonary function:
   - These include those children with progressively increasing airflow limitation and hyperinflation of lungs in childhood and male gender.

Prevalence of Asthma

It is important to know the prevalence of any condition in the given population or community. This helps us to understand the magnitude of the problem at one point of time and follow trends over a period of time. Information on changes in prevalence rates is important to plan for provision of services and to predict the demand on service providers for treatment. A rising trend in prevalence or mortality from the condition warrants intensification of efforts to control the problem. Clues to etiological factors can be obtained only if trends in the prevalence of the condition are known.

With regard to childhood asthma, all of the above are true. Information from the prevalence studies conducted world over has immensely contributed to the progress in the knowledge of etiological factors and optimal management strategies of childhood asthma.

There are many questionnaires in use to estimate the prevalence of asthma. Easy breathing survey questionnaires based on International Study of Asthma and Allergies in Childhood (ISAAC) is one among them. In children, questionnaire developed by ISAAC is the most widely accepted and used. Our study is based on easy breathing survey and ISAAC questionnaires.

Easy Breathing Survey

It is a study conducted by Hall *et al.* to validate the four simple self-administered questionnaire for the diagnosis of asthma in children and to determine its specificity and sensitivity. A questionnaire exclusively intended to assist primary care providers to make a diagnosis of asthma in children was developed and administered in four different primary care and subspecialty clinics. The questions were validated and then used as part of an asthma management program called easy breathing. Diagnosis of asthma was made based on recommendations from National Asthma Expert Panel Guidelines. The four questions were:

1. In the past 12 months have your child ever had wheezing (or) whistling in the chest?
2. In the past 12 months have your child ever woke up from sleep at night due to cough?
3. Has your child had coughing, wheezing (or) shortness of breath with exercise (or) activity and had to stop because of this symptom at any time in the past 12 months?
4. When your child has a cold, does the cough usually last more than 10 days? Four questions on the survey were shown to be sensitive and specific for asthma. The sensitivity was greater for all levels (mild, moderate, and severe) of persistent asthma than for mild, intermittent asthma. Positive response to any one of the four questions was over 94% sensitive for asthma; a negative response to all four questions was 55% specific for ruling out asthma.

Conclusion of the survey was that the patient responses to four specific respiratory symptom questions can assist primary care providers in diagnosing asthma in children. Primary care providers serving pediatric populations at high risk for asthma should consider asking patients or their parents these four questions regarding asthma symptoms on a regular basis. Hence, we used the four questions for screening asthma in school children[8] and then made the diagnosis of asthma based mainly on detailed history and clinical examination.

ISSAC Questionnaire

The ISAAC was founded for the epidemiological research into asthma and allergic disease by developing standardized methodology. The ISSAC questionnaire for asthma consists of eight questions pertaining to the symptoms of asthma (such as nocturnal cough and exercise induced wheeze), severity and physician diagnosis of asthma.

Jenkins *et al.*[9] reported the results of a study conducted on 361 children in which ISAAC questionnaire was validated against bronchial hyperresponsiveness and physician assessment. Physician assessment was considered the gold standard in this study. For the ISAAC questionnaire positive predictive value was 0.61 (confidence interval [CI] = 0.50-0.71) and negative predictive value was 0.94 (CI = 0.88-0.98). Sensitivity was 0.85 and specificity 0.81. Hence, the authors concluded that ISSAC questionnaire was valid tool for estimating symptoms of asthma in past 12 months.

It has been found that an affirmative answer to the question "Have you had wheezing or whistling in the chest in past 12 months" in the ISSAC written questionnaire corresponds to a diagnosis of asthma.[10] A study on Brazilian school children using ISSAC questionnaire showed that wheezing within the past 12 months and overall asthma score are the best criteria for diagnosis of asthma when ISAAC questionnaire is used.[11]

MATERIALS AND METHODS

Study Center

This study was a cross-sectional observation study conducted in the Government Schools of urban Chennai over a period of 1 year. The sample size of around 1900 was calculated assuming prevalence rate of 5% with precision of 10% and non-response rate of 25%. The sample size was calculated using formula $n = 4\ pq/d^2$ (where n = Number of subjects, p = Prevalence, q = 1−p, and d = Precision). All school children between 6 and 17 years belonging to lower middle class/lower income groups were included and children diagnosed to have tuberculosis, chronic lung diseases such as interstitial lung diseases, bronchiectasis, and congenital heart diseases were excluded.

Sampling

Among the schools who agreed to participate in the study, we randomly chose 3 primary schools, 3 middle schools, and 3 higher secondary schools. Children in the age group 6-17 years studying in 2-12th STD were selected from these schools. All the children were invited to participate. This study was conducted from November 2015 to September 2016.

All eligible students were distributed consent form. These documents were available in English and Tamil. Semi-structured pro forma consisting of sociodemographic

details such as age, gender, number of family members, socioeconomic status, parental education, and occupation were filled by the parents or by children with their parent's and class teacher's help. The completed forms were collected back by the respective class teachers and returned to the researcher. Those children, whose parents signed the consent forms and belonging to the lower middle class and lower income groups as per modified Kuppuswamy classification, were recruited for the study.

On the day of survey, the children belonging to 6-12 years age group were distributed easy breathing survey questionnaires which also have blanks to fill up their name and other identity parameters, translated into local language to be filled by their parents. The parents were asked to come to school on the day of survey. They were explained about the objectives and importance of the study, followed by a brief talk about the four core questionnaires of asthma based on easy breathing survey and ISAAC questionnaires. Then, they were asked to answer the questionnaires (Questionnaire 1) based on easy breathing survey. Similarly, children from 13 to 17 years were explained about the questionnaires and were asked to answer the questionnaires by themselves.

Children from both the groups who answer yes to at least one of the four questions were considered as probable asthmatics. Diagnosis of asthma in those identified as probable asthmatic was done by detailed history and a clinical examination using questionnaire two based on ISSAC questionnaire. Pulmonary function test (spirometry) was done only in doubtful cases.

The doubtful cases were referred to the Department of Pulmonology, Institute of Child Health and Hospital for Children (ICH and HC), Chennai, India, for diagnosing asthma. Diagnosed cases, both old and new were also referred to ICH and HC, Chennai, India, for further management (Chart 1).

The information's obtained was transferred to Excel spreadsheet and entered in SSPS version. Data were checked and cleaned. The frequency analysis was performed to assess the prevalence of asthma and various factors affecting it. Chi-square test was done for certain factors. $P < 0.05$ was considered significant.

RESULTS

This observational cross-sectional study to determine the prevalence of asthma in children 6-17 years of age was done on students of classes 2-12th STD. Out of 1894 children screened, 85 (4.5%) were asthmatics.

Majority of children were in 13-17 years age group (70.75%). This is the age group to which the questionnaires were directly given to the children, and they were asked to answer in the presence of the investigator. Hence, we were able to recruit more children in this age group. Whereas in the age group between 6 and 12 years the questionnaires were given to parents to be filled by them. Only the children whose parents come to school on the day of survey and participate in the study were included and hence the low recruitment rate (Table 1 and Figure 1).

In our study, out of 1894 children, 1020 were males (53.9%), and females were 874 (46.1%). In our study, there is a slight male predominance. Male:female ratio was 1.17:1 (Table 2 and Figure 2).

Out of 1894 students in our study, 156 students answered yes to at least one of the four questions of Questionnaire 1. Positive response to the question wheezing or whistling in the past 12 months was exclusively given only by asthmatics. This difference is statistically significant ($P < 0.001$**).

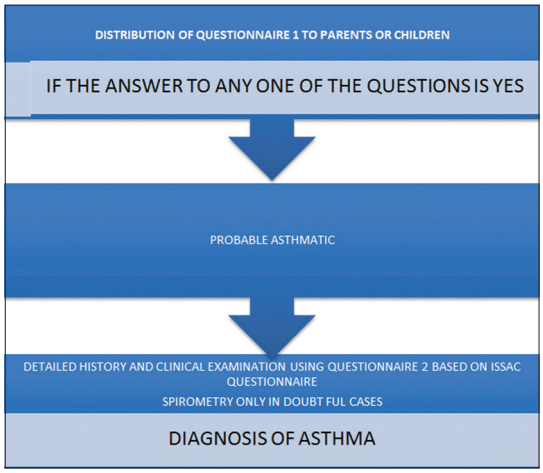

Chart 1: The study manoeuver

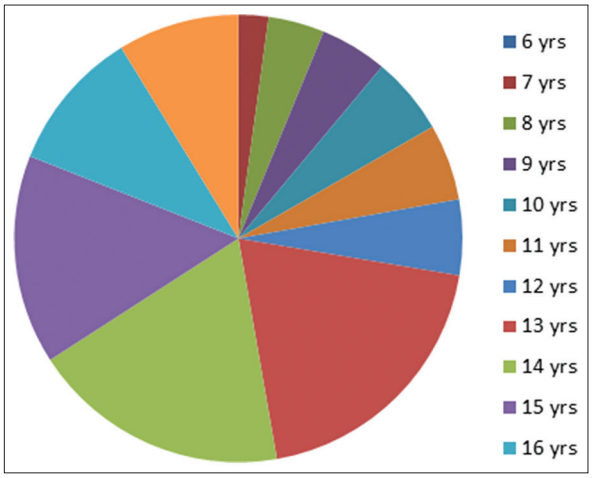

Figure 1: Age distribution of cases

According to our study, the wheezing or whistling in the chest in past 12 months is 100% specific for asthma. In our study, sleep disturbance at night due to a cough in past 12 months is more among asthmatics than non-asthmatics. This difference is statistically significant ($P < 0.001$). This shows the sleep disturbance at night due to cough is more specific for asthma. Our study shows that the exercise-induced symptom is more prevalent among asthmatics than non-asthmatics. This difference is statistically significant with $P < 0.002$. So exercise-induced symptom is more specific for asthma. In our study, the symptom cough during cold lasting for more than 10 days is slightly higher among non-asthmatics, however, this difference is not statistically significant ($P = 0.144$). From this we infer that the above symptom is less specific for asthma than other symptoms previously discussed. With this we can infer that of the four questions used for screening asthmatics, wheezing in chest, sleep disturbance due to cough, and exercise-induced symptoms are more specific in diagnosing asthma (Table 3 and Figure 3).

In our study, after screening 1894 students with four questions, 156 probable asthmatics were selected. On further detailed history using the asthma qualifiers shown in the above table and clinical examination, the diagnosis of asthma was made in 85 students. Among the above qualifiers episodic airflow obstruction >3, relief with bronchodilator and afebrile episodes were seen in all (100%) of the asthmatics. About 5 patients had onset of wheeze before the age of 3 years which corresponds to 6% and are labeled as early onset persistent wheezers (Table 4 and Figure 4).

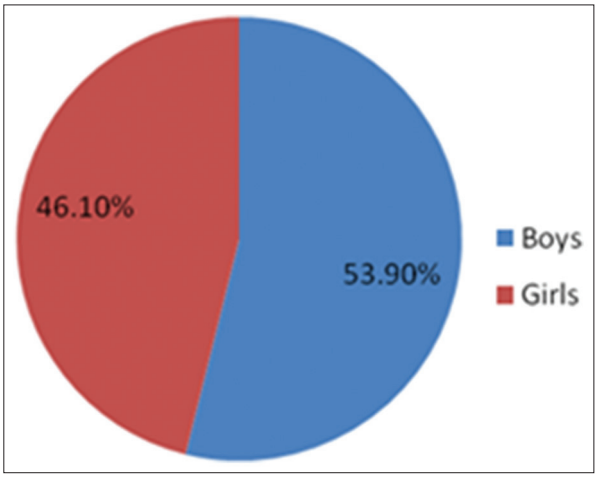

Figure 2: Gender distribution

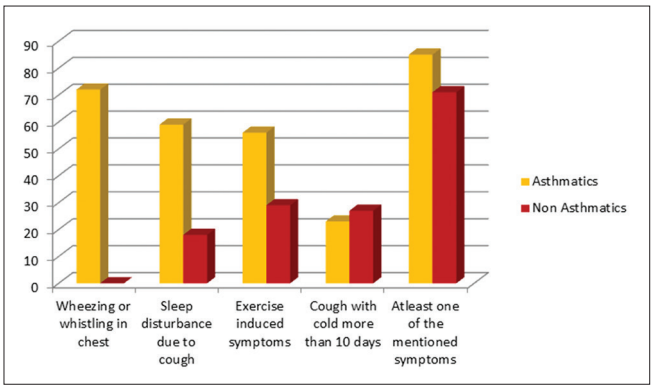

Figure 3: Evaluation of core questionnaires

Table 1: Age-wise distribution of cases

Age (years)	Number of children (%)
6	40 (2.1)
7	42 (2.2)
8	75 (3.95)
9	90 (4.75)
10	104 (5.49)
11	102 (5.38)
12	101 (5.33)
13	363 (19.1)
14	345 (18.21)
15	280 (14.78)
16	190 (10)
17	162 (8.55)
Total	1894 (100)

Table 2: Gender distribution of cases

Sex	*n* (%)
Boys	1020 (53.9)
Girls	874 (46.1)
Total	1894 (100)

Table 3: Evaluation of core questionnaires

Questions	Asthmatics	Non-asthmatics	*P* value
Wheezing or whistling in chest	72	0	<0.001
Sleep disturbance due to cough	59	18	<0.001
Exercise-induced symptoms	56	29	0.002
Cough with cold more than 10 days	23	27	0.144
At least one of the above symptoms	85	71	

Table 4: Asthma qualifiers (*n*=85)

Parameters	*n* (%)
Episodic airflow obstruction >3	85 (100)
Age of onset >3 years	80 (94)
Relief with bronchodilator	85 (100)
Nocturnal exacerbations in past 12 months	80 (94)
Seasonal exacerbations	38 (44.7)
Exercise-induced symptoms	56 (66.9)
Trigger induced attacks	36 (42.35)
Afebrile episodes	85 (100)
Family H/O asthma/atopy	68 (80)
Personal H/O atopy	18 (21.18)
Comorbidity: Obesity	22 (25.9)

Prevalence of asthma was observed slightly higher among children of 6-12 years (5.6%) than children of 13-17 years (4.0%). This difference was not statistically significant ($P = 0.134$) (Table 5 and Figure 5).

In our study, the prevalence of asthma in males (5.29%) is slightly higher than the prevalence of asthma in females (3.54%). This difference is not statistically significant ($P = 0.067$). However, in majority of other studies, there is a male predominance (Table 6 and Figure 6).

Among asthmatics, the major symptom was wheezing or whistling in the chest which about 84.7% of asthmatics reported. Only 10.6% of asthmatics mostly older children above 13 years reported chest tightness as one of the symptoms of asthma. 69.4% ($n = 59$), 65.9% ($n = 56$), and 27.05% ($n = 23$) had sleep disturbance due to cough, exercise-induced symptoms, and cough with cold more than 10 days, respectively (Table 7 and Figure 7).

DISCUSSION

Worldwide Prevalence

Prevalence rates of asthma show a wide variation all over the world. High prevalence rates have been observed in developed countries such as the United Kingdom (UK), Canada, Australia, and New Zealand.[12]

According to ISAAC study, the prevalence of asthma varies from <2% to almost 33%. Prevalence was high in the UK, New Zealand, and Australia which is about 17-30%,

Table 5: Prevalence of asthma - Age distribution

Age	Number of subjects	Asthmatics	Percentage
6-12	554	31	5.6
13-17	1340	54	4.0
Total	1894	85	4.5

Table 6: Prevalence of asthma - Sex distribution

Sex	Number of subjects	Asthmatics	Percentage
Male	1020	54	5.29
Female	874	31	3.54
Total	1894	85	4.5

Table 7: Distribution of symptoms of asthma among asthmatics (*n*=85)

Asthmatic symptoms	*n* (%)
Wheezing or whistling in chest	72 (84.7)
Sleep disturbance due to cough	59 (69.4)
Exercise-induced symptoms	56 (65.9)
Cough with cold more than 10 days	23 (27.05)
Chest tightness	9 (10.6)

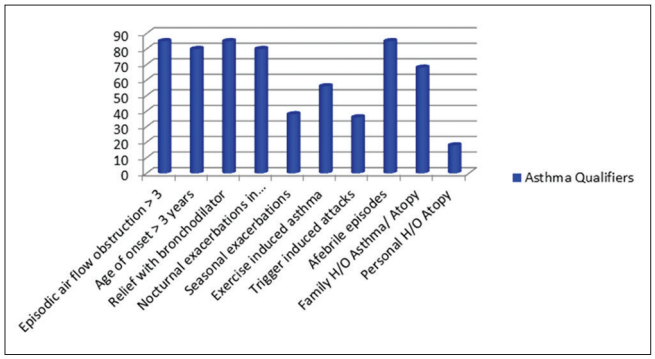

Figure 4: Asthma qualifiers

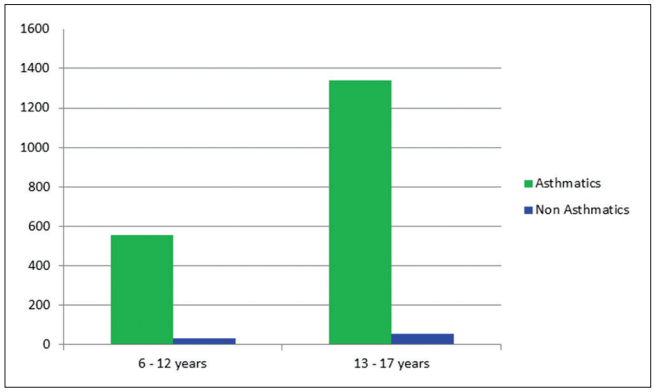

Figure 5: Prevalence of asthma - Age distribution

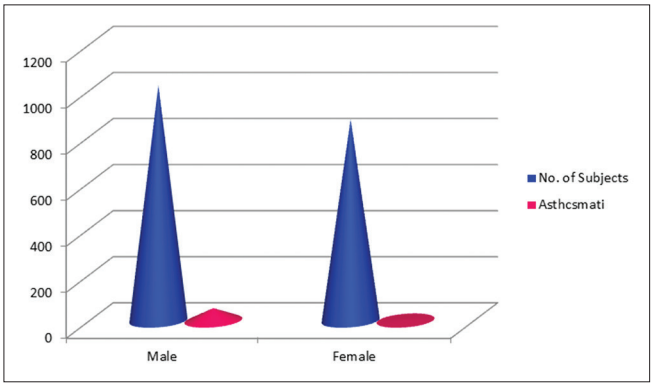

Figure 6: Prevalence of asthma - Sex distribution

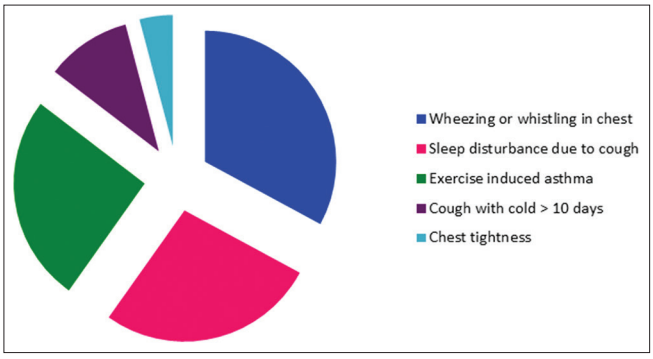

Figure 7: Distribution of symptoms of asthma among asthmatics (*n* = 85)

whereas Eastern Europe, China, and Indonesia were areas of low prevalence about 1-7%. ISAAC Phase I showed that there is a variation in the prevalence of symptoms of asthma between 4.1**%** and 32.1% in the 12-month period. India, Iran, Indonesia, and Malaysia with the lowest rates and Australia, Costa Rica, Brazil, Panama, and New Zealand with the highest rate in the age group of 6-7 years.

For the 13-14 years age group, the study reported that the prevalence of asthma between 2.1**%** and 4.4% in a 12-month period in Albania, Greece, China, Georgia, Romania, Russia, and Indonesia to 29.1-32.2% in New Zealand, Ireland, UK, and Australia.

Prevalence in India

In India, the prevalence of asthma in school children is in an increasing trend in the past decade. In a study conducted in Lucknow,[13] the prevalence of asthma was low (2.3-3.3%), but the prevalence of asthma was 11.6% in a study conducted in urban New Delhi, India.[14] In rural areas of Ludhiana and Punjab, the prevalence of asthma was 2.6% and 1%, respectively.[15] Chakravarthy *et al.*[16] showed that the prevalence of asthma to be 5% in children from 6 to 12 years of urban Chennai. In urban Puducherry Kumar *et al.*[17] reported the prevalence of ever asthmatics to be 5.3% and 4.2% were current asthmatics. Recently, a study conducted by Jain *et al.*[10] showed the prevalence of asthma in 6-15 years children of rural field area in South India to be 10.3%.

Hall *et al.*[8] conducted a study to work out the sensitivity, specificity, and predictive value of a self-administered questionnaire for the diagnosis of asthma in children. Four questions to help primary care providers to make a diagnosis of asthma in children were developed and used in four different primary care and subspecialty clinics. The questions were validated and were used as part of an asthma management program called easy breathing. The four questions on the survey were shown to be sensitive and specific for asthma. The sensitivity was greater for all levels (mild, moderate, and severe) of persistent asthma than for mild, intermittent asthma. A positive response to any one of the four questions was over 94% sensitive for asthma; a negative response to all four questions was 55% specific for ruling out asthma. They concluded that the patient responses to four specific respiratory symptom questions can assist primary care providers in diagnosing asthma in children.

Chakravarthy *et al.*[16] carried out a study to estimate the prevalence of asthma in children under 12 years and to study the possible differences in the prevalence of childhood asthma in urban and rural areas of Tamil Nadu, India. The cross-sectional study was conducted in both urban and rural groups by questioning the parents using the simplified version of ISAAC questionnaires.

The results obtained were the overall prevalence of breathing difficulty was 18% out of which 5% were diagnosed as asthma in children between 6 and 12 years in both urban and rural areas.

Kumar *et al.*[17] conducted a study to assess the prevalence and associated factors of bronchial asthma among 12-16 years aged school children in urban Puducherry. The cross-sectional study conducted in 3 schools of urban field practice area of a Medical Institution in Puducherry. The study was conducted using questionnaires based on ISAAC study which was translated into Tamil and back into English. The children were interviewed based on the questions, and the diagnosis of asthma was made. The study showed that the prevalence of bronchial asthma was 5.3% out of which 4.2% had a current episodes of asthma, 72.7% of current asthmatics had cold or rhinitis, 54.5% of them had itching or rashes and nocturnal cough.

Jain *et al.*[10] carried out a cross-sectional study in South India to determine the prevalence of bronchial asthma between 6 and 15 years children and to analyze the various sociodemographic factors associated with Asthma. This study was conducted in the rural field practice area of the Department of Community Medicine at Kasturba Medical College, Manipal, Karnataka, India, using a questionnaire based on ISAAC questionnaire. These questionnaires were used to interview the parents of 559 randomly selected children between 6 and 15 years.

According to their study, the prevalence of bronchial asthma was 10.3%. Boys had higher prevalence rates (12.1%) than girls (8.4%). There was a significant inverse linear trend with increasing age group. Family H/O asthma had a significant correlation with asthma, but there was no significant association between socioeconomic status and parent's literacy level with asthma.

Behl *et al.*[18] designed and carried out a study to assess the prevalence of bronchial asthma in school children among 6-13 years of age in Shimla city and to determine factors influencing its occurrence. This cross-sectional study conducted in four randomly selected schools in Shimla city using questionnaires based on ISAAC. Various factors influencing the prevalence of asthma were elucidated from the history. They concluded that overall prevalence of asthma was 2.3%. Boys had higher prevalence 3.1% than girls 1.4%. There was significant association between asthma prevalence and family history of asthma and other atopic manifestations.

CONCLUSION

1. The prevalence of asthma is 4.5% in school children of urban Chennai in the age group 6-17 years belonging to lower income group/lower middle class families.
2. Among the four questions used for screening asthmatics, wheezing in the chest, sleep disturbance due to cough, and exercise-induced symptoms are more specific in diagnosing asthma.
3. No statistically significant difference in prevalence of asthma was found between boys and girls in this study though there is a slight male predominance.
4. There is a significant correlation between family H/O asthma and asthma, and also there is a significant correlation between allergic rhinitis and asthma.
5. Obesity is a significant comorbid illness associated with asthma.

RECOMMENDATIONS

1. The prevalence of childhood asthma is increasing the worldwide especially in developing countries like India. Hence, the prevalence studies should be conducted once in 2-3 years to assess the increasing trends.
2. We need to create awareness among general public about the appropriate methods of treatment of various types of asthma.
3. School teachers can be educated about the use of inhaler therapy using rescue drugs in cases of emergencies that arises in school.
4. The questionnaires of easy breathing survey can be used to screen a large population of children for asthma especially in countries like India.

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