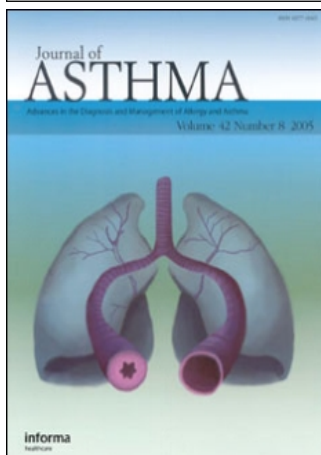


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Smita Pakhale ^a, Kate Wooldrage ^a, Jure Manfreda ^a, Nick Anthonisen ^a

^a Department of Respiriology, Health Sciences Center, Winnipeg, Manitoba, Canada

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ORIGINAL ARTICLE

Prevalence of Asthma Symptoms in 7th- and 8th-Grade School Children in a Rural Region in India

SMITA PAKHALE, KATE WOOLDRAGE, JURE MANFREDA, AND NICK ANTHONISEN

Department of Respiriology, Health Sciences Center, Winnipeg, Manitoba, Canada

We estimated the prevalence of asthma related symptoms in grade 7 and 8 students in a rural region in India. *Method.* An International Study of Asthma and Allergies in Childhood (ISAAC), questionnaire with added questions related to environmental and familial exposures, was administered to 3668 students from 48 rural schools near Malegaon, India. *Results.* A history of asthma was present in 10.7% students and 7.3% wheezed in the past 12 months, with about one-third having at least four attacks. Boys had the higher prevalence of all asthma-related symptoms than girls did, and symptom frequency was generally above the median reported for urban Indian ISAAC centers. Asthma and wheeze were associated with a family history of asthma, smoking, and frequent chest colds. Significant environmental factors included parental occupation and smoking and poor water sources. Increased odds of asthma occurred in students working for wages, exposed to animals, or eating in the kitchen. Relationships were similar for wheezing. Both asthma and wheeze were higher in the Scheduled Tribe (ST) group. Most markers of socioeconomic status and environmental exposure were not significant in multivariate analysis. *Conclusion.* The prevalence of asthma and wheeze in a rural region in India was similar to that found in the urban ISAAC study; it was higher in students from lower socioeconomic groups with poorer environmental conditions.

Keywords asthma epidemiology, Indian caste system, socioeconomic status, asthma school, rural asthma, rural India

INTRODUCTION

Asthma is a complex disease with a multifactorial etiology. There are limited data regarding the prevalence of asthma in children in rural India (1, 2). The ISAAC phase I project in India estimated the prevalence of asthma in 14 urban sites (1). According to the 2001 census (3), out of a total population of 1027 million in India, 72.2% live in rural areas. In western countries, the prevalence of asthma is higher in urban inner-city populations than in rural areas (4–6), but similar comparative data are not available for India. Further, rural Indians are subject to a variety of exposures that have not been assessed in relation to asthma (7, 8).

The objective of our study was to assess the prevalence of asthma-related symptoms in Indian schoolchildren in grades 7 and 8 in a rural region and to evaluate their association with personal, family, and environmental risk factors pertinent to rural regions.

METHODS

Setting

The study was conducted in November and December 2004 in the district of Washim in the state of Maharashtra, west central India. Maharashtra has a population of 96,878,627 (80% Hindu, 10% Muslim, 6% Buddhist, and 1% Christian) (3) and is divided into 35 districts. The District of Washim has a total population of 1,020,216, of which 83% reside in rural areas. This area is predominantly agricultural with little industrial and commercial activity.

Subjects

We identified 75 schools in the nearest small villages outside the town of Malegaon. We studied students in grades 7 and 8 to obtain a sample of 13–14 year olds, for comparison with the ISAAC study. We conducted the survey in 48 schools taught in the Marathi language. We excluded 4 Urdu schools, 3 others because of poor attendance on the day of the visit, and another 20 because they were not open at the time of our visit due to bazaar day or a local holiday.

Conduct of the Survey

The University of Manitoba Research Ethics Board approved the project. In India, permissions were obtained from local district health and education officers. Information about the survey was sent to all schools via the office of district education officer. Six volunteers were hired locally to implement the survey. They were trained to understand the objective of the survey and administer the questionnaire. A vehicle was rented for traveling to the villages.

On the day of the visit to the school, verbal permission for conducting the survey was obtained from the school principal. Parents were informed of the study/survey, and then, on the day of survey, students were asked verbally about their willingness for participation. None of the students disagreed. The questionnaire was introduced as a “health survey,” and words such as “asthma” and “breathing problems” were not used. The questionnaire was self-completed by most of the students. Volunteers administered it verbally to 6–7% of the students who had difficulty in reading it. Height and weight were measured and recorded at the time of collection of the questionnaire.

Corresponding author: Smita Pakhale, RECRU, Montreal Chest Institute, 3650 St-Urbain Street, Montreal, Quebec, H2X 2P4 Canada; E-mail: spakhale@yahoo.com

Questionnaire

Questions related to asthma symptoms were obtained from the Marathi version of the ISAAC questionnaire (1). We added questions regarding family and environmental characteristics. These were translated from English to Marathi, and an independent translator, who was familiar with asthma terminology, did the successful back translation. Students were asked to note their caste affiliation, defining their socioeconomic position. The government of India has categorized all castes and subcastes into six groups. They are, in order of descending socioeconomic status: Others, OBC (other backward class), SC (Scheduled Caste), ST (Scheduled Tribe), VJ (Vimukta Jati), and NT (Nomadic Tribe). The "Others" category includes "upper-caste" Hindus, while the OBC consists mainly of artisans and farmers who own their land. The categories of SC, ST, VJ, and NT are the lowest socioeconomic classes. The SC group contains the untouchables.

Symptoms

Students with ever asthma were those who answered "yes" to the question "Have you ever had asthma?" They did not need to answer positively to any other question. Identification of students with asthma-related symptoms was the same as in ISAAC (1) to compare our results with those from ISAAC (1). Students were asked if they had wheezing or whistling in the chest at any time in the past. For the period of the last 12 months, they were asked if they had wheezing or whistling in the chest; if their chest sounded wheezy during or after exercise; and if they had dry cough at night, apart from cough associated with a cold or chest infection. Additional questions, also with respect to the last 12 months, concerned the number of attacks of wheezing (none, 1–3, 4–12, >12), the frequency of sleep disturbance due to wheezing (never, <1 night/week, ≥1 night/week), and whether wheezing ever limited speech to only one or two words at a time between breaths.

Statistical Analysis

All questionnaires were reviewed for completion and consistency. Overall, each question was answered by at least 90% of students. Minimal editing was carried out. If there was a positive answer to wheezing attacks, sleep disturbances, or speech limitation due to wheezing in the last 12 months and a negative answer to wheezing in the past 12 months, the latter was recorded as positive. If a student gave a positive answer to wheeze in the past 12 months but a negative answer to "ever" wheezing, the latter was recoded as positive. Ques-

tionnaires with a missing answer to ever wheezing ($n = 134$) and gender ($n = 50$) were not analyzed further.

The percent prevalence (with 95% confidence interval [CI]) of symptoms was estimated for the total group as well as for boys and girls separately. In addition, this analysis was repeated for the subset aged 13 and 14 years in order to compare our estimates with those from the ISAAC (1) sites in India. We performed univariate logistic regression analysis to identify variables associated with increased or decreased odds of symptoms. Although we did this for all symptoms, we present results of this analysis only for ever asthma and wheezing in the last 12 months. Other symptoms were similarly associated with these variables. In order to identify variables independently associated with these symptoms, a multivariable logistic analysis was carried out, using the backwards elimination procedure, after all significant variables had been fit into the model. The results were considered statistically significant if $p < 0.05$. All analyses were carried out using SAS (SAS Institute, Inc., Cary, NC, USA).

RESULTS

Between November 2004 and January 2005, 3668 students from 48 schools completed the questionnaire. The final analysis was performed with 3484 students, 1539 (44.2%) being females. There were 2627 (75.4%) students of age 13 and 14 years, as in the ISAAC study, while 456 (13.1%) students were less than 13, and 185 (5.3%) were 15 or 16. The mean height of the girls was 142.3 (± 8.1 standard deviation [SD]) cm and of the boys was 142.7 (± 8.7 SD) cm. The mean weight of the girls was 31.5 (± 5.8 SD) kg and of the boys was 30.6 (± 5.9 SD) ($p < 0.0001$).

Table 1 shows that all symptoms were significantly more common in boys. More than 10% of the students reported having had wheezing or asthma in the past, while about 7% had wheezed in the previous year. Dry night cough and wheeze with exercise were very common, the former occurring in about one-third of the students, and the latter in nearly one-fifth. Severe wheezing symptoms (four or more attacks, those associated with sleep disturbance or speech limitation) were less common and were concentrated in children who were thought to have current asthma, that is, those with wheezing in the last 12 months. Thus, 33% of those who wheezed in the last 12 months had more than four wheezing attacks per week, 45% had disturbed sleep due to wheezing, and 49% had had dyspnea severe enough to limit speech. Also shown in Table 1 are data from our 13–14-year-old students compared

TABLE 1.—Prevalence of symptoms.

Symptom		Males % (95%CI)	Females % (95%CI)	Total	
				All % (95%CI)	13–14 years % (rank)
Ever	Asthma	12.6 (11.2–14.2)	8.3 (7.0–9.9)	10.7 (9.7–11.8)	11.2 (14)
	Wheeze	12.5 (11.1–14.1)	10.2 (8.7–11.8)	11.5 (10.5–12.6)	11.0
12 months	Wheeze	8.6 (7.4–10.0)	5.7 (4.6–6.9)	7.3 (6.5–8.3)	7.3 (10)
	>4 attacks	2.1 (1.5–2.8)	0.5 (0.2–1.0)	1.4 (1.0–1.8)	1.1 (6)
	Disturbed sleep	1.9 (1.3–2.6)	0.8 (0.4–1.4)	1.4 (1.0–1.8)	1.4 (10)
	Limiting speech	2.8 (2.1–3.6)	1.8 (1.2–2.6)	2.4 (1.9–2.9)	2.4 (7)
	Exercise wheeze	19.9 (18.1–21.8)	17.7 (15.8–19.8)	19.0 (17.7–20.3)	18.2 (13)
	Night cough	35.6 (33.5–37.8)	30.7 (28.3–33.1)	33.5 (31.9–35.1)	33.8 (15)

Data are presented as the % and 95% CI (confidence interval) of subjects with symptom. The rank represents the position of our data when the prevalence from our and 14 ISAAC (1) centers are ranked in ascending order. Ever wheeze is not reported in ISAAC (1).

TABLE 2.—The relationship of personal characteristics to ever asthma and wheezing in last 12 months.

Variable		Ever asthma			Wheeze in 12 months		
		N	%	OR (95% CI)	N	%	OR (95% CI)
Total		3390	10.7		3484	7.32	
Sex	Females	1498	8.3	1.00	1539	5.65	1.00
	Males	1892	12.6	1.59 (1.26–1.99)	1945	8.64	1.58 (1.21–2.06)
Age ^a	1 year	3390		1.08 (0.94–1.25)	3484		1.14 (0.96–1.34)
	Others	793	10.6	1.00	819	6.84	1.00
Castes	OBC	1169	8.5	0.78 (0.58–1.06)	1187	6.91	1.01 (0.71–1.44)
	SC	791	11.8	1.12 (0.82–1.54)	818	6.97	1.02 (0.70–1.50)
	VJ	180	13.9	1.36 (0.84–2.20)	189	7.41	1.09 (0.59–2.00)
	NT	204	11.3	1.07 (0.66–1.75)	206	7.28	1.07 (0.59–1.93)
	ST	167	18.0	1.85 (1.17–2.91)	172	12.79	2.00 (1.18–3.37)
	1 cm	3390		0.99 (0.98–1.00)	3484		0.98 (0.97–1.00)
	1 kg	3390		0.99 (0.97–1.01)	3484		0.98 (0.96–1.01)
Smoking	Yes vs.no	29	31.0	3.82 (1.72–8.45)	31	12.9	1.91 (0.66–5.51)
Chest colds	None	2020	7.3	1.00	2055	5.45	1.00
	1 to 3	795	17.5	2.70 (2.11–3.46)	816	10.91	2.12 (1.59–2.84)
	4 to 12	99	25.3	4.30 (2.65–6.98)	100	18.00	3.81 (2.21–6.56)
	>12	62	25.8	4.43 (2.45–8.02)	65	21.54	4.76 (2.56–8.86)

Data are presented as the number of subjects (N), % with symptom, and OR (odds ratio) with 95% CIs (confidence intervals).

^aOR for one unit increase in the variable.

to the 14 Indian ISAAC sites. Except for the prevalence of four or more wheezing attacks and speech limitation, our estimates are above the median for the 14 urban sites. Exercise wheeze, dry cough, and ever asthma were relatively common in our study.

Of the students who reported a diagnosis of asthma, 29.4% attributed the diagnosis to a doctor, while 66.8% did not know who had made the diagnosis. About half of these children reported missing at least one day of school in the previous year due to asthma, one-third had seen a physician for asthma in the past year, 9.6% were on continuous asthma medication while 29.9% were on intermittent therapy, and 10.7% had been hospitalized for asthma.

Table 2 shows the relationship between personal characteristics, asthma, and wheezing in the last 12 months. Students in the ST caste group had significantly more symptoms than the "Others," (i.e., the reference group). Less than 1% of the students smoked, and these students reported relatively high

levels of asthma and wheeze. Both symptoms were also significantly related to a history of chest colds.

Table 3 enumerates the relationship between family characteristics and asthma and wheeze in the past 12 months. Neither was related to parental education, and both were related to a history of asthma in a first-degree relative and to smoking on the part of the father. Maternal smoking (only 9.7% of mothers smoked) was related to asthma but not wheeze, as were parental occupations. Asthma but not wheeze was increased if either parent worked for wages or had his or her own business, as compared to children of farmers.

Table 4 shows relationships between environmental factors, asthma, and wheeze in the last 12 months. There were no consistent relationships between symptoms and the number of siblings. However, prevalence of ever asthma decreased with increasing numbers of occupants and rooms in the house. Use of coal or electricity as cooking fuel was associated with an increased prevalence of asthma but not wheeze in the past

TABLE 3.—The relationship of family characteristics to ever asthma and wheezing in last 12 months.

Variable	Ever asthma			Wheeze in 12 months		
	N	%	OR (95% CI)	N	%	OR (95% CI)
Mother's education						
None	1275	11.0	1.00	1299	7.3	1.00
Primary	1333	9.8	0.88 (0.69–1.14)	1364	6.9	0.94 (0.70–1.26)
Secondary	602	11.5	1.05 (0.77–1.43)	616	8.1	1.12 (0.78–1.60)
Father's education						
None	571	11.9	1.00	587	7.8	1.00
Primary	1208	10.6	0.88 (0.64–1.20)	1241	7.4	0.94 (0.65–1.36)
Secondary	1413	10.0	0.82 (0.60–1.11)	1440	7.2	0.91 (0.63–1.30)
Mother's occupation						
Own farm	1617	9.4	1.00	1653	7.7	1.00
For wages	677	12.7	1.40 (1.06–1.86)	690	6.7	0.86 (0.61–1.22)
Government	70	8.6	0.90 (0.38–2.12)	72	5.6	0.71 (0.25–1.97)
Housewife	629	10.7	1.15 (0.85–1.56)	645	6.4	0.82 (0.57–1.17)
Own business	206	14.1	1.58 (1.03–2.42)	210	8.6	1.13 (0.67–1.89)
Father's occupation						
Own farm	1873	9.0	1.00	1910	7.3	1.00
For wages	601	14.3	1.68 (1.28–2.22)	615	6.7	0.91 (0.63–1.31)
Government	302	11.6	1.32 (0.90–1.94)	307	8.1	1.13 (0.72–1.77)
Own business	319	12.9	1.49 (1.03–2.14)	324	8.6	1.21 (0.79–1.84)
Mother smoked vs. not	269	19.3	2.15 (1.55–2.98)	277	8.7	1.25 (0.80–1.94)
Father smoked vs. not	1090	14.0	1.65 (1.31–2.08)	1111	8.3	1.32 (1.00–1.75)
Family asthma vs. not	550	14.6	2.72 (2.05–3.63)	563	22.0	3.17 (2.48–4.05)

Data are presented as the number of subjects (N), % with symptom, and OR (odds ratio) with 95% confidence intervals (CIs).

TABLE 4.—The relationship of environmental characteristics to ever asthma and wheezing in last 12 months.

Variable	Ever asthma			Wheeze in 12 months		
	N	%	OR (95% CI)	N	%	OR (95%CI)
People live in house						
1- to 3	113	17.7	1.00	115	9.6	1.00
4	448	13.0	0.70 (0.40–1.21)	459	7.0	0.71 (0.35–1.45)
5	932	9.4	0.48 (0.29–0.82)	951	6.7	0.68 (0.35–1.33)
6	570	9.3	0.48 (0.27–0.83)	591	5.9	0.60 (0.29–1.21)
7	530	12.5	0.66 (0.38–1.14)	540	9.1	0.94 (0.47–1.88)
>7	658	9.1	0.47 (0.27–0.81)	673	7.0	0.71 (0.36–1.41)
Siblings						
0- to 1	495	11.5	1.00	504	9.3	1.00
2	1130	9.7	0.83 (0.59–1.16)	1162	6.9	0.72 (0.49–1.05)
3	881	10.8	0.93 (0.66–1.32)	902	7.2	0.76 (0.51–1.12)
>3	775	11.0	0.95 (0.66–1.35)	798	6.8	0.71 (0.47–1.06)
Rooms in house						
1	371	12.9	1.00 (0.63–1.28)	378	7.9	1.00 (0.63–1.48)
2	1177	11.8	0.90 (0.63–1.28)	1209	7.7	0.97 (0.63–1.48)
3	742	10.4	0.78 (0.53–1.14)	762	5.5	0.68 (0.42–1.10)
4	474	9.5	0.71 (0.46–1.09)	485	7.4	0.93 (0.56–1.54)
>4	432	8.1	0.59 (0.37–0.94)	439	7.3	0.91 (0.54–1.53)
Cooking fuel						
Wood	2742	11.2	1.31 (0.97–1.76)	2801	7.3	0.95 (0.69–1.30)
Cow dung	1377	11.0	1.05 (0.85–1.31)	1401	6.9	0.91 (0.70–1.18)
Coal	348	14.1	1.42 (1.03–1.96)	356	8.2	1.14 (0.76–1.70)
Kerosene	821	12.6	1.27 (0.99–1.62)	834	6.8	0.91 (0.67–1.23)
LPG	626	10.4	0.96 (0.72–1.27)	639	8.0	1.12 (0.82–1.55)
Electricity	501	13.4	1.35 (1.01–1.79)	513	6.8	0.92 (0.63–1.33)
Work for wages	1437	13.4	1.72 (1.37–2.18)	1468	9.2	1.77 (1.34–2.34)
Help in cooking	2327	10.7	0.94 (0.74–1.21)	2377	7.3	0.97 (0.73–1.30)
Eat in kitchen	2619	11.4	1.53 (1.11–2.10)	2683	7.7	1.28 (0.90–1.83)
Livestock						
Cat	622	13.2	1.34 (1.03–1.74)	635	9.1	1.35 (1.00–1.84)
Buffalo	962	10.4	0.95 (0.75–1.21)	978	7.8	1.10 (0.83–1.45)
Cow	1544	10.7	0.99 (0.80–1.23)	1573	8.0	1.18 (0.92–1.53)
Ox	1724	10.7	0.99 (0.79–1.23)	1760	7.5	1.06 (0.82–1.36)
Dog	753	12.1	1.19 (0.92–1.53)	766	8.6	1.26 (0.94–1.69)
Goat	755	14.0	1.50 (1.18–1.91)	772	8.9	1.33 (1.00–1.78)
Chicken	258	14.3	1.44 (1.00–2.07)	264	8.0	1.10 (0.69–1.76)
Drinking water source						
Municipal tap	1003	8.7	1.00	1220	6.6	1.00
Community well	1343	11.8	1.42 (1.09–1.84)	1375	7.5	1.15 (0.85–1.56)
Own well	550	11.8	1.42 (1.02–1.97)	562	7.8	1.21 (0.83–1.77)
River	80	17.5	2.24 (1.22–4.13)	81	13.6	2.24 (1.14–4.40)
Variable water source	1356	12.4	1.30 (1.04–1.63)	1383	8.6	1.33 (1.02–1.73)

Data are presented as the number of subjects (N), % with symptom, and OR (odds ratio) with 95% confidence intervals (CIs).

12 months. Students that worked for wages reported increased odds of asthma and wheeze in the past 12 months. This was largely due to students who did farm work. Having a cat or goat was associated with both asthma and wheeze, while other domestic animals were not, except perhaps chickens. A nonmunicipal source of drinking water was also a risk factor. Obtaining water from a river was associated with relatively high risks for asthma and wheeze, as was seasonal variations in water sources.

Table 5 shows the results of the multivariable analysis (N = 2454). Male gender, history of familial asthma, chest colds, and working for wages increased the odds of both ever asthma and wheezing in the last 12 months. The likelihood of wheezing in last 12 months increased with age and decreased with height. The likelihood of ever asthma, on the other hand, was higher in those who ate in the kitchen, whose fathers worked for wages or owned a business, and whose mothers smoked.

DISCUSSION

The present study has several strengths. We included only rural, as opposed to the urban children in the ISAAC study. It is worth noting that the majority of Indian people live in villages. Questions related to personal and family characteristics and environmental risk factors pertinent to rural regions were included. We think that although the data was acquired from

68% of selected schools, our study sample was representative of schoolchildren in the surveyed region, because there was no evidence that participating and nonparticipating schools differed in any relevant aspect (i.e., type and size of schools,

TABLE 5.—Multivariable analysis showing variables significantly associated with ever asthma or wheezing in the last 12 months.

	Ever asthma OR (95% CI)	Wheeze in 12 months OR (95% CI)
Gender		
M vs. F	1.40 (1.05–1.86)	1.52 (1.08–2.15)
Age		
1 year		1.28 (1.04–1.57)
Height		
1 cm		0.96 (0.94–0.98)
Familial asthma	2.14 (1.58–2.90)	2.16 (1.52–3.05)
Chest colds		
None	1.00	1.00
1 to 3	2.80 (2.16–3.87)	2.10 (1.49–2.97)
4 to 12	3.55 (2.04–6.20)	3.35 (1.83–6.13)
>12	2.95 (1.41–6.19)	3.40 (1.58–7.34)
Mother smoking	1.65 (1.09–2.50)	
Work for wages	1.42 (1.05–1.91)	1.52 (1.10–2.11)
Eat in kitchen	1.86 (1.22–2.82)	
Father's occupation		
Own farm	1.00	
Wages	1.57 (1.11–2.23)	
Government	1.49 (0.93–2.38)	
Own business	1.88 (1.21–2.92)	

Data are presented as the OR (odds ratio) with 95% CIs (confidence intervals).

type of village, and distance from Malegaon). We obtained usable questionnaires from 95% of students; each question was answered by at least 90% of students attending; there were absent students who did not participate. Nonattendance at participating schools might have biased our results.

A weakness of the study is obviously the dependence on self-reported symptoms, particularly for "ever" asthma. We could not validate answers to this question. However, "ever asthma" and wheezing in the last 12 months showed a similar relationship to personal and environmental factors, and about one-third of those reporting asthma saw a physician for asthma in the last year. It should not be too surprising that only 29.4% of grade 7 and 8 students reporting ever asthma knew who had made the diagnosis.

Our editing and recoding had a minimal effect on the results of the study. The prevalence of "ever" wheezing increased by 0.3% and that of wheezing in the last 12 months by 0.5%. This should not have affected the comparison with other ISAAC sites in India (1).

There is a wide range of prevalence of different asthma-related symptoms among Indian urban sites in the ISAAC study (1). It is possible that a similar variation would be found among rural areas in India if several had been surveyed. In our study, the prevalence of wheezing in the last 12 months and ever asthma was higher than the median for ISAAC sites. Others have found lower prevalence in rural than in urban India (9, 10). In Tamil Nadu, Chakravarthy et al. (9) found a history of wheeze in 22.1% of urban and 9% of rural children. In rural Andhra Pradesh, Sudhir et al. (10) found wheeze in 12.5% of urban and 5.5% of rural schoolchildren aged 7–15. The prevalence of wheezing in our study was similar to that of Tamil Nadu and higher than that of Andhra Pradesh. Our estimate of asthma prevalence (10.7%; Table 1) was higher than that in rural Karnataka (5.7%) (11) and that of the ISAAC site in Akola (2.6%), a major town in the area we studied.

In addition to ever asthma, the prevalence of exercise-related wheezing and dry night cough were higher in our study than the median of ISAAC studies in India, while severe wheezing (>4 attacks in the last 12 months) was lower (Table 1). The prevalence of dry cough at night was 33.5% in our study as compared to 14.1% the median figure for ISAAC, though in Kottayam the prevalence was 32.2%. Chakravarthy et al. (9) also found a high prevalence of dry cough (18.7%) in rural children 6–12 years old. Increased prevalence of dry cough at night, unrelated to cold or chest infections, could be due to the very dry and dusty environment in our study area. The use of coal as a cooking fuel was associated with increased prevalence of dry cough at night (data not shown). This might be related to the practice of letting the coal stove burn at night for heating purposes, as opposed to turning off wood, electric, and natural gas stoves after cooking for safety and economy.

In our study, smoking among students (<1%) was much less common than the lowest rate observed in other studies of Indian children (12–15). The absence of bidi making in the study area and the practice of not giving regular pocket money to children could explain the lower prevalence of smoking. It is unlikely that the people conducting the study introduced bias with respect to reporting smoking.

In addition to smoking (personal and secondhand), both asthma and wheezing were associated with a family history

of asthma and frequent chest colds, similar to many other studies (16).

Several socioeconomic and environmental variables were associated with ever asthma and wheezing in the last 12 months (Tables 2, 3, and 4). Although, in most instances, in the same direction, the associations of these variables appear to be stronger (more significant) for ever asthma than for wheezing in the last 12 months. Several variables indicative of lower socioeconomic status were associated with increased odds of ever asthma and wheezing in the last 12 months: students working for wages, exposure to goats or chickens, use of non-municipal drinking water, variable water source, and ST caste.

On the other hand, ever asthma (but not wheezing) was increased in students whose parents were working for wages or owned a business. Odds of ever asthma were associated with neither parental educational level nor the number of siblings, but decreased with the number of people living in the house and the number of rooms in the house (Table 4). Thus, in some respects, our study is consistent with other studies carried out in India (17, 18).

In the multivariable model, the number of significant variables was reduced, suggesting confounding and significant correlation of some variables. In addition to male sex, family history of asthma, and chest colds, only students' work exposure was identified as an independent predictor of both asthma and wheezing in the last 12 months. It is possible that working for wages increased students' exposure to factors triggering asthma. It is possible that association is due to some other factors associated with the low social status of which students' work for wages is a marker. In lower social castes (i.e., combined NT, SC, ST, and VJ), in comparison with combined OBC and Others, it was more common for students to work (59.3% vs. 38.9%), to have a goat (31.6% vs. 15.7%), and to use nonmunicipal (66.0% vs. 59.6%) and variable drinking water sources (50.0% vs. 38.0%).

Kitchen exposures (i.e., eating in kitchen), maternal smoking, and father's occupation (i.e., working for wages and owning a business) were associated with ever asthma even after an adjustment for the effect of other variables, suggesting an additional role for environmental factors.

CONCLUSION

In conclusion, the prevalence of asthma in our rural area was higher than the median in urban India in contrast to findings in Europe and America (19–21). Our study confirms the known risk factors of asthma (i.e., sex, history of smoking, chest colds, and asthma in first-degree relatives). In multivariable analysis, there was evidence favoring the importance of environmental exposures, such as working for wages, associated with lower socioeconomic status groups.

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