

ASTHMA AND THE ENVIRONMENT

Household and Environment Factors Associated With Asthma Among Indian Women: A Multilevel Approach

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Background. Asthma is a prevalent disease among adults in India. This study aims to find prevalence and risk factors for asthma among Indian women aged 15 to 49 based on Indian National Family Health Survey–3. **Methods.** Prevalence of asthma was reported per 1000 women among individual- and household-level variables. Chi-square test was used as test of association. Odds ratio with 95% confidence interval was used to find risk factors. Multilevel logistic regression was used to find risk factors adjusting for the confounding effect. Attributable risk percentage and population-attributable risk percentage were computed and interpreted. **Results.** The overall prevalence of asthma was 17 per 1000 women. Overweight, obesity, exposure to alcohol, smoking, use of biomass for cooking, and low education are proven to be risk factors for asthma. The odds ratio ranges from 1.2 to 3. Not cooking under chimney and exposure to biomass fuels were observed to have high population-attributable risk percentage (19%, 18.6%). Controlling for these variables may reduce major burden of asthma. **Conclusion.** Modification of household-level variables such as cooking fuel and cooking condition coupled with abstinence in consumption of alcohol and smoking may reduce the prevalence of asthma among women.

Keywords asthma; multilevel model; odds ratio; population-attributable risk percentage

INTRODUCTION

Prevalence of asthma among adults in various countries have been reported as 1.2% to 6.3% (1–9). In Indian and developing countries' social context, women are more exposed to household and environmental risk factors of asthma. The prevalence of asthma in India varies from 1.2% to 3.5% (10–18). Asthma was more prevalent among children (7% to 10%) (11–13) as compared to adults. Among males the prevalence of asthma varies from 1.42% to 3.36% (10, 18) and among females it varies from 1.5% to 3% (10, 18). Exposure to environmental tobacco smoke in childhood and adulthood was important in increasing morbidity for asthma (11, 15, 17). Exposure to biomass fuels, domestic violence, obesity, household-type are risk factors for asthma (17, 18). In the present study, we examined the risk factors for asthma among women aged 15 to 49. The study is based on secondary data obtained from Indian National Family Health Survey (INFHS) (19). We have used multilevel modeling (20) to find various risk factors. Because NFHS has adopted two-stage and three-stage samplings in selecting the subjects, we had used this approach to get precise estimates of the risk.

MATERIALS AND METHODS

Selection and Description of Study Sample

The data for this analysis comes from national family health survey of India (2005–2006). The total number of women aged 15 to 49 in the survey was 1,24,395 across 29 states in India. The 2005–2006 National Family Health Survey (NFHS-3) was designed to provide estimates of important indicators on family welfare, maternal and child

health, and nutrition. Furthermore, unlike the earlier surveys in which only ever-married women aged 15 to 49 were eligible for individual interviews, NFHS-3 interviewed all women aged 15 to 49. NFHS-3 covered 29 states in India, which comprise more than 99% of India's population. The household head or a knowledgeable adult in the household available at that time reported for every household member. Each respondent was surveyed through face-to-face interview in 1 of 18 Indian languages in respondent's own home, providing information on range of health, demographic, and socioeconomic factors. All individual and households were geo-coded to the primary sampling unit (PSU), district and state to which they belonged.

Sampling Technique

A two-stage sampling design was adopted in rural areas. The first stage involved in selection of PSU, namely villages, using probability proportional to population size (PPS) sampling scheme. The second stage involved in selection of household using systematic sampling. Three-stage sampling scheme was adopted in urban areas. First stage involved in selection of wards using PPS sampling scheme. In second stage census enumeration blocks (CEBs) are selected by PPS sampling within each ward and in third stage households are selected within each CEB using systematic random sampling.

Outcome

The prevalence of asthma was ascertained based on a single question: Does anyone listed as a usual resident of the household suffer from asthma. The response for this question was classified as "yes" or "no."

Exposure Variables

In the multilevel modeling context, we had classified exposure variables as individual-level and household-level

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variables. Age, body mass index (BMI), education level, smoking habits including cigar, beedi, and pipe, and alcohol drinking were individual-level variables. Age was classified as 15–24, 25–34, and 35–49 years. BMI is classified as underweight (<18), normal (18–24.99), overweight (25–25.99), and obese (≥ 30). Type of house, type of cooking fuel, cooking done under chimney or not, place of residence, standard of living index, and wealth index were among the household-level variables. Further houses were classified as kachha, semi-pucca, and pucca. Houses made from mud, thatch, or other low-quality material are kachha houses (19), houses that were partly low quality and partly high quality were called semi-pucca houses (19), and houses that are made with high quality throughout, including floor roof and walls, are called pucca houses (19). In the survey, wealth index was based on 33 assets of the household. Each asset was given a score and the total of the scores was classified as poor, middle and rich. Cooking fuel was classified as biomass fuel (kerosene, wood, and agricultural products) or low-polluting fuel (LPG; electricity and biogas). Type of family was classified as nuclear or not. Place of residence was classified as city, town, and country side.

Statistical Analysis

Prevalence of asthma was reported per 1000 women across all individual-level variables. For household-level estimate, we assessed whether at least one woman living in that household was having asthma. Based on this classification, we have reported prevalence of asthma across all household-level variables. Chi-square test was carried out to find univariate association. Odds ratio and its 95% confidence interval was reported as measure of strength of association. Multilevel logistic regression (20) was carried out to find risk factors adjusting for the effect of other variables. Variables having p value less than .20 in univariate analysis were included in logistic regression analysis (21). Attributable risk percent and population-attributable risk percent were used to

find risk of each factor associated with asthma in the population. The analysis was performed using MLwin 2.11 (22) and SPSS 15. A p value of less than .05 was considered to be statistically significant.

RESULTS

This analysis is based on 1,24,395 women in age group 15–45 years. There were 2131 women reported to have asthma, which gave a prevalence of 17 per 1000 women. Table 1 presents the prevalence of asthma according to various individual-level variables and their strength of association. The prevalence of asthma among individual-level variables ranges from 14.34 to 38.14 per 1000 women. Asthma prevalence was higher among overweight, obese, underweight, lower education level women compared to their respective counterparts. Women with exposure to smoking and alcohol were at higher risk of having asthma (odds ratio [OR]_{smoking} = 2.31, 95% confidence interval [CI]: 1.97–2.82; OR_{alcohol} = 2.13, 95% CI: 1.75–2.5). Women who were overweight and obese were more at risk of having asthma than normal. The corresponding odds ratio for overweight and obese were 1.71 (95% CI: 1.50–1.96) and 1.98 (95% CI: 1.61–2.02). Women with less education were at more risk to have asthma than their counterpart. The corresponding odds ratio was (OR_{noeducation} = 1.37, 95% CI: 1.16–1.6; OR_{primaryeducation} = 1.44, 95% CI: 1.15–1.72). Risk of asthma increases as age increases.

Table 2 presents the prevalence of asthma among household-level variables. The overall prevalence of asthma among household is 17 per 1000 households. The prevalence of asthma ranges from 14.99 to 24.35 per 1000 households among various household-level variables. Women who were from nuclear family, standard of living index is poor or middle, and staying in kachha or semi-pucca houses had higher risk of asthma compared to their counterpart. The odds ratio for women staying in kachha and semi-pucca houses were 1.16 (95% CI: 1.04–1.3) and 1.2 (95% CI: 1.01–1.42).

TABLE 1.—Prevalence of asthma among 15- to 49-year-old women across individual-level variables ($N = 124,395$).

Exposure variables (individual level)	Population	Asthma present	Prevalence (per 1000 woman)	Odds ratio	95% confidence Interval for odds ratio
BMI group					
Under weight	34597	568	16.42	1.06	1.05–1.07
Normal	66164	1020	15.42	1.00	Ref
Overweight	13861	362	26.12	1.71	1.50–1.96
Obese	4126	124	30.05	1.98	1.62–2.34
Smoking					
Yes	3461	132	38.14	2.35	1.97–2.82
No	120801	1997	16.53	1	Ref
Alcohol					
Yes	3506	122	34.80	2.13	1.77–2.57
No	120819	2009	16.63	1.00	Ref
Literacy					
No education	39752	780	19.62	1.36	1.16–1.6
Primary	17754	365	20.55	1.42	1.17–1.72
Secondary	53864	800	14.85	1.02	0.87–1.20
Higher	12776	186	14.55	1.00	Ref
Age group (years)					
15–24	46745	449	10	1	Ref
25–34	38503	615	16	1.67	1.48–1.89
35–49	39095	1067	27	2.89	2.58–3.23
Place of residence					
City	34361	585	17.03	0.98	0.88–1.08
Town	20098	327	16.27	0.90	0.81–1.04
Rural	62897	1133	18.01	1.00	Ref

TABLE 2.—Prevalence of asthma among women aged 15 to 49 across household-level variables.

Exposure variable (household-level)	No. of households	Asthma present	Prevalence (per 1000 women)	Odds ratio	95% confidence interval for odds ratio
Wealth index					
Poor	24185	440	18.19	0.96	0.83–1.1
Middle	16569	270	16.03	0.94	0.89–1.2
Rich	45961	709	15.43	1.00	Ref
Standard of living index					
Low	16785	299	18.14	1.17	1.01–1.34
Medium	26518	610	23.00	1.57	1.35–1.7
High	40483	618	15.26	1.00	Ref
Household structure					
Nuclear	50634	839	16.57	1.06	1.03–1.19
Non-nuclear	35103	552	15.72	1	Ref
Type of house					
Kacha	8742	157	17.96	1.20	1.01–1.42
Semi-pucca	31764	552	17.38	1.16	1.04–1.30
Pucca	44620	669	14.99	1.00	Ref
Cooking fuel					
Low-polluting fuel	34870	551	15.8	1	Ref
Biomass fuel	50829	839	16.5	1.045	0.94–1.16
Other	1274	29	22.76		
Cooking under chimney					
Absent	65415	1181	18	1.27	1.06–1.56
Present	8322	118	14	1.00	Ref

TABLE 3.—Multilevel logistic regression for risk factors of asthma among women aged 15 to 49.

Exposure variables	Odds ratio	95% confidence interval	Attributable risk (%)	Population-attributable risk (%)	p value
Age group (years)					
15–24	1	Ref			
25–34	1.5	1.37–2.04	33.3	13.3	<.001
35–49	2.3	1.88–2.80	56.5	29.01	<.001
Education level					
No education	1.45	0.91–2.32	31	12.5	.12
Primary	1.58	1.26–1.99	36	7.6	<.001
Secondary	1.12	0.69–1.84	10.7	4.9	.51
Higher	1	Ref			
Cooking under chimney					
Yes	1	Ref			
No	1.28	1.05–1.57	21.85	19	.01
Standard of living index					
Low	1.10	0.87–1.14	9.1	1.96	.17
Medium	1.01	0.84–1.21	1	0.31	.91
High	1.00	Ref			
Household structure					
Nuclear	1.00	Ref	4	1.67	
Non-nuclear	0.96	0.86–1.08			.48
Alcohol					
Yes	1.51	1.18–1.93	33.7	1.4	<.001
No	1.00	Ref			
Smoking					
Yes	1.81	1.47–2.25	44.75	2.2	<.001
No	1.00	Ref			
BMI group					
Under weight	1.16	1.02–1.31	13.7	4.45	.01
Normal	1.00	Ref			
Overweight	1.68	1.39–2.04	40.47	7.35	<.001
Obese	1.75	1.21–2.54	42.8	2.53	<.001
Cooking fuel					
Low-polluting fuel	1.00	Ref			
Biomass fuel	1.41	1.05–1.90	29.07	18.6	.01
Other					
Wealth index					
Poor	1.01	0.78–1.31	1	0.27	.94
Middle	1.10	0.91–1.34	9	1.9	.33
Rich	1.00	Ref			
Place of residence					
City	1.23	1.21–1.25	18.6	5.9	<.001
Town	0.88	0.72–1.08	12		.21
Countryside	1.00	Ref			

Further the risk for women who were from non-nuclear family, standard of living index (SSLI) is poor or middle are, respectively, $OR_{nuclear} = 1.06$ (95% CI: 1.03–1.19), $OR_{SSLI:poor} = 1.17$ (95% CI: 1.01–1.34), $OR_{SSLI:middle} = 1.57$ (95% CI: 1.35–1.7). The houses with no chimney in the kitchen also experienced higher risk $OR_{chimney:absent} = 1.27$ (95% CI: 1.06–1.56).

Table 3 present results of multilevel logistic regression. Here we estimated the odds ratio of each variable (individual and household) after adjusting for the effect of others. Women living in city are at higher risk of having asthma when compared to those living in the countryside ($OR = 1.23$, 95% CI: 1.21–1.25). The risk of asthma was more among women who use biomass fuels, do not cook food under chimney, education level is less, obese or overweight, and age is 25 to 49. The corresponding adjusted odds ratios were given in Table 3.

Because the data were obtained from proper methodological and sampling framework that relatively represent the entire country, we looked at the attributable risk (AR) percent and population-attributable risk (PAR) percent. Not cooking under chimney, cooking using biomass fuels, and higher age group (35–49) has higher population-attributable risk percent. The corresponding PAR were $PAR_{notcookingunderchimney} = 19\%$, $PAR_{biomassfuel} = 18.6\%$, $PAR_{age35-49} = 29.01\%$. These findings were also depicted in Table 3.

DISCUSSION

The overall prevalence of asthma among Indian women in the age group 15–49 years was found to be 17 among 1000 women. Aggarwal et al. (23) reported asthma prevalence trial ranges from 12.3 to 37.7 per 1000 women. Subramanian et al. (18) reported asthma prevalence from NFHS-2 study as 2.3%. Considering the methodological involvement in gathering data for this national project, this may be a very reliable estimate.

In the univariate analysis smoking, alcohol consumption, BMI, older age, and less education were found to be significant individual-level factors. Low standard of living index, biomass as cooking fuel, and cooking without chimney were significant variables among household-level variables.

This was in agreement with results from Subramanian et al. (18), Jindal (14? 2007), Salvi (24), Mishra (16), Gupta et al. (10), and Mathew et al. (25). Multivariate analysis had also found same variables to be associated with asthma. Further multilevel analysis had added place of residence as one of the risk factors for asthma. Women who live in city are at more risk of having asthma than who live in villages. Because the study has adopted multistage sampling, multilevel logistic regression will provide accurate estimate of the risk factors than any other methods (26). Interestingly, cooking fuel, which was not significant in the univariate analysis, changed to be a significant correlate during multilevel analysis. The masking effect of the other covariate might have played a role. The odds ratio obtained from multilevel logistic regression was used for computing population-attributable risk percentage, which has demonstrated interesting results. Use of biomass fuels for cooking had a PAR of 18.6% and not cooking under chimney had a PAR of 19%. Modifying these two variables may help in considerable reduction of asthma among women.

The limitation of this study was the prevalence of asthma was measured based on single question. The results can be underreported because the prevalence of asthma based on a question may not be as accurate as clinical diagnosis. Also, information on parental history of asthma is not available which can confound the results.

CONCLUSION

In summary, we had found a significant association between asthma and exposure to cooking environment, biomass fuel, illiteracy, BMI, age group, and place of residence as the risk factors for asthma. Because the survey covered almost all states in India, the risk estimate can be considered as reliable. Furthermore, cooking under chimney and use of low-polluting fuels will help in reducing the risk of asthma in a significant level.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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