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Occupations with an increased prevalence of self-reported asthma in Indian adults

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Abstract

Objectives: Occupational asthma remains relatively under-recognized in India with little or no information regarding preventable causes. We studied occupations with an increased prevalence of self-reported asthma among adult men and women in India. *Methods*: Analysis is based on 64 725 men aged 15–54 years and 52 994 women aged 15–49 years who participated in India's third National Family Health Survey, 2005–2006, and reported their current occupation. Prevalence odds ratios (ORs) for specific occupations and asthma were estimated using multivariate logistic regression, separately for men and women, adjusting for age, education, household wealth index, current tobacco smoking, cooking fuel use, rural/urban residence and access to healthcare. *Results*: The prevalence of asthma among the working population was 1.9%. The highest odds ratios for asthma were found among men in the plant and machine operators and assemblers major occupation category (OR: 1.67; 95% CI: 1.14–2.45; $p = 0.009$). Men working in occupation subcategories of machine operators and assemblers (OR: 1.85; 95% CI: 1.24–2.76; $p = 0.002$) and mining, construction, manufacturing and transport (OR: 1.33; 95% CI: 1.00–1.77; $p = 0.051$) were at the highest risk of asthma. Reduced odds of asthma prevalence in men was observed among extraction and building trades workers (OR: 0.72; 95% CI: 0.53–0.97; $p = 0.029$). Among women none of the occupation categories or subcategories was found significant for asthma risk. Men and women employed in high-risk occupations were not at a higher risk of asthma when compared with those in low-risk occupations. *Conclusions*: This large population-based, nationally representative cross-sectional study has confirmed findings from high income countries showing high prevalence of asthma in men in a number of occupational categories and subcategories; however, with no evidence of increased risks for women in the same occupations.

Keywords

Epidemiology, occupational asthma, men, women, india, NFHS-3

History

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Introduction

Asthma is among the most common chronic diseases in working-aged populations. Among the general adult population in high income countries, it has been estimated that 2–5% of patients with asthma have occupational asthma [1,2]; some studies from the United States and Japan have estimated the risk to be as high as 15% [3]. Among populations at risk due to their exposure to known sensitizing agents, the risk of developing occupational asthma can be as high as 5–10% per year [1].

Recent studies of the global burden of disease over the last two decades indicate that occupational lung diseases such as chronic obstructive pulmonary disease (COPD), asthma and pneumoconioses caused by exposure to airborne particulates are major contributors to mortality and disability, particularly in low-and-middle income countries [3] with much of this burden falling on working age groups. However, occupational asthma remains under-studied and under-recognized in low- and middle-income countries where diagnosis and management are considered to be poor [3]. There have been no previous studies reporting occupational risk factors for asthma in India in a nationally representative population. Also, there is a particular lack of information on occupational risk factors for women workers [4]. Women's work has traditionally been considered safe and less hazardous to health in comparison with men's work [5]. This has resulted in a lack of information on occupational hazards for women workers [4], and our knowledge of occupational health has mainly been based on studies of men. Differences in occupational morbidity have also been observed for men and women with the same job

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title, suggesting that even in the same occupation, men and women are not equally exposed to particular risk factors for disease [6]. Very few studies in India have investigated the prevalence of occupational risk factors in women workers, or compared the distribution of risk factors between women and men. We therefore studied associations between occupation and self-reported asthma among adult men and women in India.

Methods

Study design and participants

India's third National Family Health Survey (NFHS-3, 2005–2006) was designed on the lines of the Demographic and Health Surveys (available at www.measuredhs.com) that have been conducted in many low- and middle-income countries since the 1980s. The NFHS has been conducted in India for three successive rounds, each at an interval of 5 years. NFHS-3 collected demographic, socioeconomic and health information from a nationally representative probability sample of 124 385 women aged 15–49 years and 74 369 men aged 15–54 years residing in 109 041 households. The sample is a multistage cluster sample with an overall response rate of 98%. All states of India are represented in the sample (except the small Union Territories), covering more than 99% of the country's population. Full details of the survey have been published elsewhere [7]. The analysis presented here focuses on 64 725 men aged 15–54 years and 52 994 women aged 15–49 years who reported their current occupation.

Outcome measure

The survey included several questions relating to the current health status of the respondents during the personal interview, including the question, ''*Do you currently have asthma?*''. The response options were ''yes'', ''no'' and ''don't know''. The survey was conducted using an interviewer-administered questionnaire in the native language of the respondent using a local, commonly understood term for asthma. A total of 18 languages were used with back translation to English to ensure accuracy and comparability. However, no physician diagnosis of asthma was obtained and it was not feasible to clinically test for the disease.

Occupational categories

In NFHS-3, information on respondent's current occupation was obtained through self-reports at the time of personal interview. Altogether, there were 98 categories of occupations reported. These occupations were then coded using the Revised Indian National Classification of Occupations [8]. NCO 2004 is based on and is compatible with ILO's (International Labour Organization) International Standard Classification of Occupations 1988 (ISCO-1988; available at www.ilo.org) which serves as a model for development of national standards for classification of occupations for individual nations. The NCO of an occupation describes the duties, skills, competencies and aptitudes required for an occupation in the Indian labour market. NCO 2004 has been prepared by the Director General of Employment & Training (DGET) under the Ministry of Labour and Employment, Government of India, after extensive consultation with Governments, industries and academicians. A detailed survey of about 28 000 establishments all over India was conducted for job descriptions and job analyses before finalizing the NCO 2004. It is extensively used for economic planning by the Government and by economists and statisticians for research.

Table 1. Example of the Revised Indian National Classification of Occupations 5-level classifications.

Division (one-digit code)	2	Professionals
SubDivision (two-digit code)	22	Life Science and Health Professionals
Group (three-digit code)	222	Health Professionals (except nursing)
Family (four-digit code)	2222	Physicians and Surgeons, Ayurvedic
Occupations (six-digit code)	2222.10	Physicians, Ayurvedic

The NCO is a hierarchical skills-based classification of occupation which consists of 10 divisions (one-digit code); 30 sub-divisions (two-digit code); 116 groups (three-digit code); 439 families (four-digit code) and 2945 occupations (six-digit code). Table 1 shows an example of different levels of classifications in NCO. The choice of the most applicable six-digit occupation code was based on the self-reported job title as well as the respondent's description of tasks. A broad list of occupational categories provided in the NFHS-3 data is provided in the Appendix with corresponding NCO codes.

Covariates

The socio-demographic factors considered in the present analysis included current smoking status (not smoking, smoking – data on former smoking is not available in the data); household cooking fuel use (clean fuel which include kerosene, liquefied petroleum gas/natural gas, biogas or electricity; solid fuel-less clean which include coal/lignite or charcoal; biomass fuel-not clean which include wood, straw/shrubs/grass, agricultural crop waste, dung cakes, others); age (15–19, 20–34, 35–49 and 50–54 years); education (no education, primary, secondary and higher); wealth index (measured by an index based on household ownership of assets and graded as lowest, second, middle, fourth and highest) was computed using previously described methods [7]; place of residence (urban and rural); and access to health care (public medical sector, NGO or trust hospital/clinic, private medical sector and other sources). For a definition of variables, refer Table 2.

Statistical analyses

The analysis was conducted separately for women and men, because they may have different occupational exposures (even in the same job category), as well as different non-occupational exposures [6]. From the analysis, we removed occupation category such as ''workers not classified by occupations'' (NCO 2004 Code 10; men $n = 9549$; 12.8% and women $n = 71\,343$; 57.4%), since this include new workers seeking employment and currently not working. We first examined asthma prevalence by various occupational categories in bivariate analysis stratified by gender. Prevalence odds ratios (Ors) [9] and 95% confidence intervals (CIs) were

Table 2. Characteristics of the study participants (men and women reporting their current occupation).

Characteristics	Men age 15–54 years $n = 64\,725$ (37.4%) N	%	Women age 15–49 years $n = 52\,994$ (62.6%) N	%
Currently Smoking				
No	40 737	62.9	51 770	97.7
Yes	23 988	37.1	1202	2.3
Household cooking fuel use				
Clean	28 065	43.4	18 506	41.2
Solid-less clean	1351	2.1	949	2.1
Biomass-not clean	35 285	54.5	25 435	56.7
Age				
15–19	6381	9.9	8228	15.5
20–34	30 154	46.6	25 264	47.7
35–49	23 756	36.7	19 480	36.8
50–54	4434	6.9	–	–
Mean	32.8		30.5	
SD	±10.2		±9.4	
Education				
No education	13 542	20.9	28 666	54.1
Primary	12 252	18.9	8120	15.3
Secondary	31 432	48.6	13 202	24.5
Higher	7482	11.6	3184	6.0
Wealth index				
Lowest	10 991	17.0	13 576	25.5
Second	12 251	18.9	12 811	24.2
Middle	13 415	20.7	11 791	22.3
Fourth	14 159	21.9	8673	16.4
Highest	13 909	21.5	6182	11.7
Residence				
Urban	22 810	35.2	11 837	22.3
Rural	41 915	64.8	41 135	77.7
Access to health care				
Public medical sector	27 511	42.5	17 692	39.4
NGO or trust hospital/clinic	309	0.5	184	0.4
Private medical sector	36 570	56.5	26 796	59.7
Other sources	317	0.5	219	0.5
Current Asthma				
No	63 478	98.1	51 955	98.1
Yes	1238	1.9	997	1.9

estimated using multivariate logistic regression, adjusting for age, education, household wealth index, current tobacco smoking, household fuel use, rural/urban residence and access to healthcare. The selection of the high-risk groups was based on those groups that had consistently shown increased risks in previous studies in high income countries [10–12]. Selections of occupations were generally based on findings from population-based studies rather than studies of specific subgroups. Participants who reported currently working exclusively in professional, clerical or administrative jobs (referNCO codes in Appendix Table A1) were classified as having low-risk occupations and were considered the reference group in this study. Table A2 in Appendix gives the full sample distribution and asthma prevalence in respective single occupational categories stratified by gender. As certain states and certain categories of respondents were oversampled, in all analyses sample weights were used to restore the representativeness of the sample [7].

Before carrying out the multivariate model, we assessed the possibility of multicollinearity between the covariates. In the correlation matrix of covariates, all pair-wise Pearson correlation coefficients were <0.5, suggesting that multicollinearity is not a problem. All analyses including the logistic regression models were conducted using the SPSS statistical software package Version 19 (IBM SPSS Statistics, Chicago, IL).

Ethics approval

The NFHS-3 survey received ethical approval from the International Institute for Population Science's Ethical Review Board and the Indian government. Participation in the survey was totally voluntary. Prior informed written consent was obtained from each respondent. The analysis presented in this study is based on secondary analysis of existing survey data with all identifying information removed.

Results

Characteristics of the study participants

Table 2 shows the characteristics of the study participants. The prevalence of current asthma was 1.9% both among men and women. Three-fifths men (62.9%) were currently smoking while only 2.3% women were current smokers. More than half of the respondent's (both men and women) were residing in households using biomass – not a clean fuel for cooking. Two out of five respondents were in age group 20–34 years and 1 in 5 men and 1 in 10 women belonged to households with highest wealth. A majority of the respondents lived in rural areas. More than half the women were not educated while almost half of men were with secondary education. A majority of the respondents have access to private medical sector health services.

Asthma prevalence for major occupation categories by gender (adjusted odds ratios)

Table 3 shows the prevalence odds ratios of asthma in major occupational categories separately for men and women. Of the 10 major NCO-2004 occupational categories, statistically significant elevated asthma risks in men was observed only among plant and machine operators and assemblers (OR: 1.67; 95% CI: 1.14–2.45; $p = 0.009$). In women, the odds of self-reported asthma were not significantly higher in any major occupational category.

Asthma prevalence for major occupation subcategories by gender (adjusted odds ratios)

Table 4 shows the prevalence odds ratios of asthma in various occupational subcategories separately for men and women. Of the major NCO-2004 occupation subcategories, statistically significant elevated odds of asthma in men were observed among machine operators and assemblers (OR: 1.85; 95% CI: 1.24–2.76; $p = 0.009$), and among labourers in mining, construction, manufacturing and transport (OR: 1.33; 95% CI: 1.00–1.77; $p = 0.051$). Reduced odds of asthma in men was observed among extraction and building trades workers (OR: 0.72; 95% CI: 0.53–0.97; $p = 0.029$). In women, no occupation was found significant for asthma risk.

Asthma prevalence for high-risk occupations by gender (adjusted odds ratios)

Table 5 shows the prevalence odds ratios of asthma for high-risk occupation separately for men and women. Both men and

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Table 3. Odds ratios for asthma prevalence for major occupational categories by gender, India 2005–2006.

NCO 2004 codes[a]	Occupation categories	Men				Women			
		Total sample *N* [%]	Current Asthma Prevalence N[%]	OR[95% CI][b]	*p*	Total sample *N* [%]	Current asthma prevalence N[%]	OR[95% CI][b]	*p*
1,2,4	Legislators, managers, administrators, clerks and reminder professionals	11 526 [17.8]	180 [1.6]	1.00 [ref]		5255 [9.9]	122 [2.3]	1.00 [ref]	
3	Technicians and Associate professionals	1102 [1.7]	19 [1.7]	1.23 [0.76–1.97]	0.399	236 [0.4]	2 [0.9]	0.49 [0.13–1.83]	0.290
5	Service workers and shop and market sales workers	6119 [9.5]	95 [1.6]	0.89 [0.69–1.16]	0.379	3795 [7.2]	91 [2.4]	1.02 [0.71–1.43]	0.899
6	Skilled agricultural and fishery workers	11 931 [18.4]	251 [2.1]	0.96 [0.77–1.19]	0.694	13 176 [24.9]	212 [1.6]	0.77 [0.56–1.08]	0.131
7	Crafts and Related Trade Workers	11 322 [17.5]	174 [1.5]	0.90 [0.72–1.12]	0.344	5405 [10.2]	113 [2.1]	0.98 [0.70–1.39]	0.925
8	Plant and Machine Operators and Assemblers	1095 [1.7]	34 [3.1]	1.67 [1.14–2.45]	0.009	1787 [3.4]	35 [2.0]	1.00 [0.61–1.65]	0.997
9	Elementary Occupations	21 631 [33.4]	486 [2.2]	1.06 [0.86–1.29]	0.626	23 318 [44.4]	423 [1.8]	0.92 [0.66–1.27]	0.595
	Total	64 725	1239 [1.9]			52994	996 [1.9]		

[a]Adapted from the Revised Indian National Classification of Occupations (NCO)-2004.
[b]Odds ratios adjusted for age, education, household wealth index, current smoking, household cooking fuel use, urban/rural residence and access to health care.

Table 4. Adjusted odds ratios for asthma prevalence for major occupational subcategories by gender, India 2005–2006.

NCO 2004 codes	Occupation subcategories	Men				Women			
		Total sample *N* [%]	Current asthma prevalence *N* [%]	OR [95% CI][a]	*p*	Total sample *N* [%]	Current asthma prevalence *N* [%]	OR [95% CI][a]	*p*
11,12,21,22,23, 24,41,42	Legislators, managers, administrators, clerks and reminder professionals	11 526 [17.8]	180 [1.6]	1 [ref]		5255 [4.2]	122 [2.3]	1 [ref]	
31	Physical and Engineering Science Associate Professionals	65 [0.1]	2 [3.1]	1.93 [0.42–8.80]	0.398	3 [0.0]	0 [0.0]	–	
32	Life Science and Health Associate Professionals	13 [0.0]	0 [0.0]	–	–	3 [0.0]	0 [0.0]	–	
34	Other Associate Professionals	1024 [1.6]	18 [1.8]	1.20 [0.73–1.97]	0.474	229 [0.4]	2 [0.9]	0.50 [0.14–1.86]	0.303
51	Personal and protective service workers	2946 [4.6]	51 [1.7]	1.00 [0.73–1.37]	0.984	2920 [5.5]	65 [2.2]	0.95 [0.67–1.35]	0.766
52	Models, sales persons and demonstrators	3172 [4.9]	44 [1.4]	0.78 [0.55–1.10]	0.150	875 [1.7]	27 [3.1]	1.27 [0.79–2.03]	0.327
61	Market Oriented Skilled Agricultural and Fishery Workers	11 931 [18.4]	251 [2.1]	0.94 [0.75–1.17]	0.569	13 176 [24.9]	212 [1.6]	0.78 [0.59–1.03]	0.076
71	Extraction and Building Trades Workers	5004 [7.7]	66 [1.3]	0.72 [0.53–0.97]	0.029	747 [1.4]	11 [1.5]	0.81 [0.43–1.54]	0.473
72	Metal, Machinery and Related Trades Workers	3103 [4.8]	53 [1.7]	1.06 [0.77–1.45]	0.736	265 [0.5]	7 [2.6]	1.52 [0.68–3.39]	0.307
73	Precision, Handicraft, Printing and Related Trades Workers	774 [1.2]	8 [1.0]	0.68 [0.33–1.40]	0.294	189 [0.4]	2 [1.1]	0.70 [0.19–2.65]	0.603
74	Other Craft and Related Trades Workers	2441 [3.8]	47 [1.9]	1.11 [0.79–1.55]	0.556	4203 [7.9]	93 [2.2]	1.01 [0.73–1.40]	0.971
81	Stationary Plant and Related Operators	191 [0.3]	3 [1.6]	0.82 [0.27–2.45]	0.721	60 [0.0]	0 [0.0]	–	
82	Machine Operators and Assemblers	904 [1.4]	31 [3.4]	1.85 [1.24–2.76]	0.002	1727 [3.3]	35 [2.0]	1.04 [0.66–1.64]	0.876
91	Sales and Services Elementary Occupations	8361 [12.9]	151 [1.8]	0.85 [0.66–1.09]	0.195	5200 [9.8]	87 [1.7]	0.80 [0.59–1.08]	0.137
92	Agricultural, Fishery and Related Labourers	10 186 [15.7]	259 [2.5]	1.08 [0.86–1.36]	0.488	18 105 [34.2]	336 [1.9]	0.91 [0.71–1.15]	0.414
93	Labourers in Mining, Construction, Manufacturing and Transport	3084 [4.1]	76 [2.5]	1.33 [1.00–1.77]	0.051	13 [0.0]	0 [0.0]	–	
	Total	64 725	1240 [1.9]			52 994	996 [1.9]		

[a]Odds ratios adjusted for age, current smoking, household cooking fuel use, urban/rural residence, and access to health care.

Table 5. Adjusted odds ratios for asthma prevalence for high-risk occupations subcategories by gender, India 2005–2006.

	Men				Women			
Occupational categories	Total sample *N* [%]	Current asthma prevalence *N* [%]	OR [95% CI][a]	*p* Values	Total sample *N* [%]	Current asthma prevalence *N* [%]	OR [95% CI][a]	*p* Values
Reference group (Low-risk occupation)	11 526 [17.8]	180 [1.6]	1 [ref]		5255 [9.9]	120 [2.3]		
High-risk occupation	53 198 [82.2]	1058 [2.0]	0.99 [0.82–1.19]	0.910	47 718 [90.1]	876 [1.8]	0.91 [0.68–1.22]	0.527

[a]Odds ratios adjusted for age, education, household wealth index, current smoking, household cooking fuel use, urban/rural residence and access to health care.

women working in high risk occupations were not at significantly higher risk of self-reported asthma when compared with low-risk occupations (men: OR: 0.99; 95% CI: 0.82–1.19; $p = 0.910$; women: OR: 0.91; 95% CI: 0.68–1.22; $p = 0.527$).

Discussion

Main findings

This study examined the prevalence of asthma in a range of occupational categories, subcategories and high-risk occupations as reported by the current working population in India. This population-based survey has shown increased risks of asthma among men in a number of occupation categories, such as plant and machine operators and assemblers, and subcategories, such as mining, construction, manufacturing and transport, machine operators and assemblers, but has found no risk for women in the same occupations. Both men and women working in high risk occupations were not at significantly higher risk of self-reported asthma when compared with low-risk occupations. Our study adds to the currently sparse evidence on occupations with an increased prevalence of self-reported asthma in Indian adults.

Our study has confirmed findings from previous studies in high-income countries showing elevated risks in a number of occupation categories and subcategories [13,14] among men. The European Community Respiratory Health Survey (ECRHS) consistently found elevated risks of current asthma symptoms for farmers across the 12 participating countries with an overall risk of OR: 1.73 (95% CI: 1.00–3.01) [15]. The New Zealand component of the ECRHS reported an excess risk of asthma symptoms of OR: 1.95 (95% CI: 0.74–5.11) compared to the professional, administrative, clerical and service group [16]. There is limited evidence on the risk of asthma symptoms in sales workers around the globe. Examining the industry in addition to the occupation may provide some insight into the excess risks observed in this group. Although the evidence is sparse, other population based surveys have also identified excess asthma risks in the protective services industry [13] and in stock clerks [17]. The potential causative agents in the high risk occupational categories may be respiratory allergens and irritants [18] including sterilizers and disinfectants such as glutaraldehyde or bleach [12] in the case of nurses and health professionals; exposure to dust and oils and solvents in case of trade workers [6]; exposure to pesticides and acids or alkalis in the case of agriculture and fishery workers [6]; exposure to smoke/fume/gas [19,20], working night shift and working irregular hours [21] in the case of plant and machine operators and assemblers [6,22]; lifting [23], exposure to loud noise [24], and the use of personal protective equipment in case of manual occupational groups [6,25].

Gender differences in occupational distribution, i.e. men and women working in different jobs and therefore being exposed to different risk factors, play an important role in many of these differential outcomes [26]. In the present analyses, we found no effect of occupation on asthma among women in India. This might be because, our analyses only assessed asthma prevalence in the current occupation and did not take into account duration or intensity of exposure (not available in the survey), which may also impact on gender differences in exposure and ultimately gender differences in occupational health. For example, female workers are more often employed part time and, therefore, more likely to experience shorter exposure duration [6].

Some differences compared with previous studies

Although many epidemiological studies in high risk workplaces have been conducted in high-income countries, studies in low- and middle-income countries are few with the exception in Africa where studies in occupational exposure of asthma have been conducted in South Africa [27], Morocco [28], Nigeria [29], Ethiopia [30] and Tanzania [31]. However, very few studies have been reported in other low- and middle-income countries. Two earlier studies in India reported of occupational asthma prevalence in specific occupations. An earlier study of two silk filatures (processing natural silk) in India reported a 17% prevalence of asthma due to silkworm allergens [32]. Another study which examined the long-term effects of metal dusts on the broncho-pulmonary system among 104 polishers and 90 unexposed controls reported that a prevalence of 4.8% of occupational asthma and 6.7% of chronic bronchitis, confined only to polishers. Workers in a cement factory in the United Arab Emirates had a two-fold higher prevalence of asthma compared to an unexposed group (6% versus 3%) [33]. Women performing indoor jobs in Iran had an 11% prevalence of asthma, which was more prevalent among those involved with bread baking, carpet weaving and poultry feeding activities [34]. A few small-scale studies among Chinese workers have reported a high prevalence (27%) of work-related wheeze and lung function impairment among workers at the furniture factory [35], food harvesting and processing industry [36] and fruit farms in Korea [37]. Certain occupational groups are known to be at particular high risk of occupational asthma, including laboratory workers, healthcare workers, construction workers, bakers, woodworkers handling western red cedar and chemical

workers exposed to isocyanates [10]. However, many of these findings are from studies in specific industries, and only some have been investigated in epidemiological studies of the general population.

Strengths and weaknesses of the study

This study has several important strengths. Our study includes a large nationally representative study sample, which allows comparisons to be made between men and women and the ability to examine occupational asthma risk. The men and women covered by this survey were representative of the total working population, as opposed to similar studies that were limited to selected occupation or industry groups [38,39]. We could also quantify gender differences in asthma prevalence in occupational categories and subcategories at the population level and among men and women working in the same occupation. This is the first study that not only quantified the gender differences in occupational asthma at the population level, but also investigated whether any gender differences in occupational exposure exist for men and women working in the same occupation. However, it was not possible to investigate whether the observed gender differences in occupational asthma were entirely due to (a) the segregation of men and women into different occupations or could also be due to (b) men and women with the same occupation carrying out different tasks [6].

This study has other limitations. First, we found that the prevalence of self-reported asthma (both in general population and currently employed population) in this large, nationally representative survey was low compared to other Indian studies carried out clinically or in specific geographical locations [40–43] where the prevalence ranged from 1% to over 3%. Although several studies have been conducted in India on asthma prevalence in children and adolescents [44,45] but very few studies have been conducted in adults [46–48]. Due to the general challenges of measuring asthma in population-based studies [49], the measurement of asthma in the NFHS also has apparent limitations. The NFHS assessment of asthma prevalence was based on a single question, in contrast to a hierarchy of asthma/wheeze outcomes based on responses to standardized respiratory questionnaires. No effort was made in NFHS-3 to clinically test for asthma or to inquire whether the response was based on a physician's diagnosis. Given the marked variation in recognition and presentation to a physician by an individual with recurrent wheezing or asthma episodes, considerable differences in diagnostic labelling and treatment by doctors between populations [50] and suboptimal levels of access to health care, physician-diagnosed asthma prevalence or use of asthma medication is equally problematic in the Indian context [51]. Furthermore, neither asthma severity nor the frequency of asthma attacks was ascertained in NFHS-3. Overall, the NFHS data appear to under estimate asthma prevalence compared with other studies in India [42,43], including those from the International Study of Asthma and Allergies in Childhood (ISAAC) [52], although prevalence is similar to those of other countries in the subcontinent, such as Bangladesh and Nepal [53,54].

Other possible sources of bias should be considered when interpreting the findings of this study. First, asthma prevalence was based on self-reports of asthma itself rather than asthma symptoms, and respondents may have been more likely to report some disease conditions such as chronic bronchitis or chronic obstructive pulmonary disease with similar symptoms to asthma due to their lack of awareness, low educational status and hesitation to disclose diseases. However, rigorous efforts were employed in NFHS-3 to obtain reliable self-reported data [55]. The survey used local terminology and commonly understood terms to describe the disease, rigorously trained interviewers, supervisors and standard quality checks such as cross checks and back checks (refer Appendix for detail). It is also important to recognise here that self-report of asthma is not as accurate as clinical measures of asthma and there is a risk of under-reporting of mild asthma in self-reporting as well. Further, a higher proportion of healthcare workers in the female reference population may explain why the association between occupation category and asthma was not significant in women.

We studied a large number of occupational groups and subgroups and it is therefore possible that some of our results may have been due to chance. Nevertheless, we obtained more significantly positive findings in some occupations than would have been expected by chance alone. Also, several of the occupational groups identified in our analyses have been consistently reported by other studies to be at high-risk of asthma, and the consistency of excess risks in certain occupations in this study independent of the disease definition (current asthma) used suggests that the findings are relatively robust. We also adjusted for other high-risk occupations in the analyses and this only had a small effect on the results. Furthermore, there are several potential problems with selecting a single reference group which includes: (i) weak statistical power to detect associations due to small numbers; (ii) issues of bias arising from comparing to an ''unexposed'' group who are likely to differ on a number of factors other than the one under study; and (iii) previous studies have acknowledged that the assumption of lack of exposure in the reference group is not entirely plausible [56].

Conclusions

This population-based nationally representative large scale cross-sectional study has confirmed the findings of high-income countries showing high prevalence of asthma in a number of occupational categories and subcategories with no evidence of increased risks for women in the same occupations. Our study adds to sparse evidence on occupations with an increased prevalence of self-reported asthma in adult working population in India and also illustrates that the influence of gender should not be overlooked in occupational health research. Occupational asthma is also widely under-recognized by employers, employees and healthcare professionals. Raising awareness among working population that this is an almost entirely a preventable disease would be a major step in reducing its incidence especially in low- and middle-income countries.

What is the key question: Occupational asthma remains relatively under-recognized in India with little or no information regarding preventable causes.

What is the bottom line: No previous studies reported occupations with increased prevalence for asthma in India in a nationally representative population, more specifically among women workers.

Why read on: This large population-based nationally representative study has confirmed findings from high income countries showing high prevalence of asthma in men in a number of occupation categories and subcategories; however, with no evidence of increased risks for women in the same occupations.

Our study adds to the currently sparse evidence on occupations with an increased odd of asthma in adults in India, but did not identify higher odds of asthma among persons working in high-risk occupations.

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Appendix

Cross checks and back checks as a part of standard quality check

Standard quality checks such as cross-checks and back-checks are normally employed in a cross-sectional survey to obtain reliable self-reported data during the time of personal interview. Cross check is the method applied during personal interview to check if the respondent has answered a given question correctly and that she/he has not forgotten anything. For example, during this interview, the investigator cross-check to see if the interval between brothers and sisters is not very long (5 years and above). If there is a long interval between births, it is ensure that the respondent has not forgotten to mention a brother or sister. Therefore, he/she has to probe more the right answer.

If an interview is not completed on the first visit, further attempts were made with the sampled household or respondent, up to three times and over three different days, before classifying the case as non-response. This is known as back-check. It is important to make callbacks to reach those people who are not at home, since they may be different from people who are at home. The subsequent contacts are scheduled at times when the respondent is more likely to be at home. For example, it may be that women who have no children are more likely to be working away from the house, and if we do not call back to interview them, we may bias the fertility estimates.

Table A1. List of occupational categories given in the NFHS-3 data; coded with corresponding NCO codes.

NCO2004 codes	Occupation categories
1.	*Legislators, senior officials and managers*
111	Elected and legislative officials
112	Administrative and executive officials government and local
1129	Administrative, executive and managerial workers, n.e.c
113	Village officials
1212	Directors and managers, financial institutions
1213	Working proprietors, directors and managers mining construct
1214	Working proprietors, directors and managers, wholesale and retailers
1215	Working proprietors, directors managers and related executives in transport & communication
1219	Working proprietors, directors and managers, other services, n.e.c
1224	Production and Operations Department Managers in Wholesale and Retail Trade
1239	Other Department Managers, n.e.c.
2.	*Professionals*
2119	Physical scientists, n.e.c
2129	Mathematecians, Statisticians, and related professionals, n.e.c
2132	Programmer, Engineering and Scientific
214	Architects, engineers, technologists and surveyors
2143	Engineering technicians
222	Health professionals-except nursing (physicians and surgeons)
2229	Health professionals (except nursing), n.e.c
223	Nursing and other medical and health technicians
23	Teaching professionals
24	Other Professionals
2411	Accountants, auditors and related works
2422	Jurist
2441	Economist and related workers
244	Social science and related professionals
2451	Authors, journalist and other writers
2452	Sculptors, painters and related artists
2453	Composers, musicians and singers
3.	*Technicians and associate professionals*
311	Physical and engineering science technicians
3132	Broadcasting and Telecommunication Equipment Operators
314	Ship and aircraft controllers and technicians
32	Life Science and Health associate Professionals
3411	Securities and finance dealers and brokers, Insurance Representatives, Estate agents, business services agents and trade brokers, n.e.c
3415	Technical Salesmen and Commercial Travellers, Other
3429	-Business Services Agents and Trade Brokers, n.e.c
4.	*Clerks*
4111	Stenographers and key board-operating clerks
4114	Calculating Machine operators
4121	Accounting and book keeping clerks
4133	Transport and communication supervisors
4142	Mail Carriers and Sorting Clerks
4190	Office clerks-others
41	Office clerks
4214	Pawnbrokers and Money Lenders
4222	Telephone Switch Board operators
5.	*Service workers and shop and market sales worker*
51	Personal and Protective Service Workers
5112	Transport conductors
5121	House keepers and related workers
5122	Cooks, waiters and bartenders
512	Housekeeping and restaurant services workers
5139	Personal care and related workers, n.e.c
5141	Hair dresser, barbers, beauticians and related workers
516	Protective service workers
5220	Shop salesperson and Demonstrators
6.	*Skilled agricultural and fishery workers*
61	Market Oriented Skilled Agricultural and Fishery Workers
6111	Cultivator, Crop
6121	Farmer, Livestock
6121.50	Dairy Farm Workers, Other
615	Fishery Workers, Hunters and Trappers
7.	*Craft and related trades worker*
711	Miners, Shotfirers, Stone Cutters and Carvers
7113	Stone Splitters, Cutters and Carvers
7124	Carpenters and Joiners

(*continued*)

Table A1. Continued

NCO2004 codes	Occupation categories
7136	Plumbers and Pipe Fitters, Other
7141	Painters and Related Workers, Other
721	Metal moulders, Welders, Sheet Metal Workers, Structural Metal Prepares and Related Trades Workers
722	Blacksmiths, Toolmakers and Related Trades Workers
723	Machinery Mechanics and Fitters
7233	Mechanic, Stationery Steam Engine
724	Electrical and Electronic Equipment Mechanics and Fitters
7313	Jewellery and Precision Metal Workers
7322	Glass Makers, Cutters, Grinders and Finishers
7432	Weavers, Knitters & Related Workers, Other
7433	Tailors, Dress Makers and Hatters
7441	Pelt Dressers, Tanners and Fell Mongers, Other
7442	Shoemakers and Related Workers
8.	*Plant and machine operators and assemblers*
814	Wood Processing and Paper Making Plant Operators
815	Chemical-Processing-Plant Operators
823	Rubber and Plastic Products Machine Operators
8258	Printing, Binding and Paper Products Machine Operators, Other
827	Food and Related Products Machine Operators
8279	Tobacco Preparers and Tobacco Product Makers, Others
9.	*Elementary occupations*
9133	Hand Launderers and Pressers
9141	Building Caretakers
9162	Sweepers and Related Labourers, Other
9201	Labourer, Agriculture
9202	Forestry Labourer
9202.10	Labourer, Plantation
9331	Transport Equipment Operators and Drivers, Other
10.	*Workers not classified by occupation*
X0	New workers seeking employment
X9	Workers without occupations, Other

n.e.c – not elsewhere classified.

Table A2. Asthma prevalence in the full sample; among men age 15–54 years ($n = 74\,369$) and women age 15–49 years ($n = 124\,385$) by occupational categories.

	Men		Women	
Occupational categories	Sample	Asthma prevalence N [%]	Sample	Asthma prevalence N [%]
Physical scientists	17	–	1	–
Architects, engineers, technologists and surveyors	147	–	20	–
Engineering technicians	244	1 [0.4]	29	1 [3.4]
Aircraft and ships officers	5	–	1	–
Life scientist/life science technicians	13	–	5	–
Physicians and surgeons	155	1 [0.6]	67	–
Nursing and other medical and health technicians	280	–	372	12 [3.2]
Scientific, medical and technical persons, others	51	–	12	–
Mathematicians, statisticians and related workers	19	–	7	–
Economists and related workers	8	–	1	–
Accountants, auditors and related workers	247	1 [0.4]	117	4[3.4]
Social scientists and related workers	56	–	106	–
Jurists	174	9 [5.2]	17	–
Teachers	1396	28 [2.0]	2346	53 [2.3]
Poets, authors, journalists and related workers	41	–	10	–
Sculptors, painters, photographers and related creative art	176	6 [3.4]	18	–
Composer and performing artists	130	–	19	–
Professional workers, not elsewhere classified	317	7 [2.2]	81	4 [4.9]
Elected and legislative officials	39	3 [7.7]	21	-
Administrative and executive officials government and local	274	3 [1.1]	70	2 [2.9]
Working proprietors, directors and managers, wholesale and retailers	55	2 [3.6]	7	–
Directors and managers, financial institutions	128	3 [2.3]	18	–
Working proprietors, directors and managers mining construct	136	–	22	–
Working proprietors, directors managers and related executives	74	–	6	–
Working proprietors, directors and managers, other services	103	3 [2.9]	19	1 [5.3]

(*continued*)

Table A2. Continued

Occupational categories	Men		Women	
	Sample	Asthma prevalence N [%]	Sample	Asthma prevalence N [%]
Administrative, executive and managerial workers, not elsewhere classified	136	–	44	2 [4.5]
Clerical and other supervisors	472	3 [0.6]	83	2 [2.4]
Village officials	63	–	128	7 [5.5]
Stenographers, typist and card and tape punching operators	73	–	44	–
Book keepers, cashiers and related workers	155	2 [1.3]	42	2 [4.8]
Computing machine operators	251	2 [0.8]	136	–
Clerical and related workers	1135	19 [1.7]	424	10 [2.4]
Transport and communication supervisors	131	–	12	–
Transport conductors and guards	181	3 [1.7]	2	–
Mail distributors and related workers	110	4 [3.6]	21	1 [4.8]
Telephone and telegraph operators	95	6 [6.3]	65	1 [1.5]
Merchants and shopkeepers, wholesale and retail trade	4443	76 [1.7]	798	16 [2.0]
Manufacturers, agents	221	4 [1.8]	40	–
Technical salesmen and commercial travellers	74	–	6	–
Salesmen, shop assistants and related workers	3173	44 [1.4]	873	27 [3.1]
Insurance, real estate, securities and business service	730	14 [1.9]	182	2 [1.1]
Money lenders and pawn brokers	59	–	10	–
Sales workers, not elsewhere classified	140	1 [0.7]	82	2 [2.4]
Hotel and restaurant keepers	282	2 [0.7]	111	2 [1.8]
House keepers, matron and stewards (domestic and institutional)	33	–	47	2 [4.3]
Cooks, waiters, bartenders and related workers (domestic and international)	424	7 [1.7]	560	6 [1.1]
Maids and related housekeeping service workers, not elsewhere classified	103	–	1652	43 [2.6]
Building caretakers, sweepers, cleaners and related workers	382	13 [3.4]	455	4 [0.9]
Launderers, dry-cleaners and pressers, not elsewhere classified	237	3 [1.3]	250	1 [0.4]
Hair dresser, barbers, beauticians and related workers	394	10 [2.5]	203	3 [1.5]
Protective service workers	884	21 [2.4]	60	2 [3.3]
Service workers	642	8 [1.2]	286	7 [2.4]
Farm plantation, dairy and other managers and supervisors	160	–	50	1 [2.0]
Cultivators	7902	185 [2.3]	7594	112 [1.5]
Farmers, other than cultivators	3154	61 [1.9]	5198	91 [1.8]
Agricultural labourer	9854	246 [2.5]	17242	312 [1.8]
Plantation labourers and related workers	141	9 [6.4]	678	20 [2.9]
Other farm workers	311	2 [0.6]	211	4 [1.9]
Forestry workers	192	5 [2.6]	169	4 [2.4]
Hunters and related workers	–	–	1	–
Fishermen and related workers	403	3 [0.7]	122	4 [3.3]
Miners, quarrymen, well drillers and related workers	290	11 [3.8]	66	2 [3.0]
Metal processors	147	2 [1.4]	43	–
Wood preparation workers and paper makers	127	2 [1.6]	55	–
Chemical processors and related workers	63	1 [1.6]	5	–
Spinners, weavers, knitters, dyers and related workers	714	10 [1.4]	909	24 [2.6]
Tanners, fell mongers and pelt dressers	16	–	7	–
Food and beverage processors	438	14 [3.2]	210	6 [2.9]
Tobacco preparers and tobacco product makers	103	9 [8.7]	1393	23 [1.7]
Tailors, dress makers, sewers, upholsterers and related worker	1415	25 [1.8]	3203	69 [2.2]
Shoemakers and leather goods makers	297	13 [4.4]	85	–
Carpenters, cabinet and related wood workers	929	17 [1.8]	26	2 [7.7]
Stone cutters and carvers	181	–	74	–
Blacksmiths, tool makers and machine tools operators	383	3 [0.8]	32	–
Machinery fitters, machine assemblers and precession instruments	1161	17 [1.5]	9	1 [11.1]
Electrical fitters and related electrical and electronic workers	1055	25 [2.4]	32	3 [9.4]
Broadcasting station and sound equipment operators and cinema	60	2 [3.3]	2	–
Plumbers, welders, sheet metal and structural metal preparers	543	7 [1.3]	10	–
Jewellery and precious metal workers and metal engravers	645	8 [1.2]	108	2 [1.9]
Glass formers, potters and related workers	129	–	81	–
Rubber and plastic product makers workers	81	–	32	–
Paper and paper board products makers/printing and related works	283	8 [2.8]	91	6 [6.6]
Painters/production and related workers, bricklayers and others, not elsewhere classified	3057	30 [1.0]	570	7 [1.2]
Stationery engines and related equipment operators, oilers	356	5 [1.4]	147	2 [1.4]
Transport equipment operators	3083	76 [2.5]	13	–
Labourers, not elsewhere classified	7739	134 [1.7]	4494	81 [1.8]
Others (new workers seeking employment, workers reporting occupation	87	–	85	1 [1.2]
None (workers not reporting any occupation, including housewives	9462	116 [1.2]	71231	1108 [1.6]
Do not know	4	–	3	–
Total[a]	74 273	1359 [1.8]	124 289	2104 [1.9]

[a]Number of men and women varies slightly for individual variables depending on the number of missing values.