Agrawal, Sutapa; Pearce, Neil; Millett, Christopher; Subramanian, SV; Ebrahim, Shah; (2014) Occupations with an increased prevalence of self-reported asthma in Indian adults. The Journal of asthma, 51 (8). pp. 814-824. ISSN 0277-0903 DOI: https://doi.org/10.3109/02770903.2014.913619

Downloaded from: http://researchonline.lshtm.ac.uk/id/eprint/1649030/

DOI: https://doi.org/10.3109/02770903.2014.913619
WORK RELATED ASTHMA

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

Sutapa Agrawal, PhD1, Neil Pearce, PhD, DSc, FRSNZ, FMedSci2,3, Christopher Millett, PhD1,4, S.V. Subramanian, PhD5, and Shah Ebrahim, DM, FRCP, FFPHM1,6

1South Asia Network for Chronic Disease, Public Health Foundation of India, New Delhi, India, 2Centre for Global NCDs, London School of Hygiene and Tropical Medicine, London, UK, 3Centre for Public Health Research, Massey University, Wellington, New Zealand, 4School of Public Health, Imperial College, London, UK, 5Department of Society, Human Development and Health, Harvard School of Public Health, Harvard University, Boston, MA, USA, and 6Department of Non-communicable Disease Epidemiology, London School of Hygiene and Tropical Medicine, London, UK

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

Received 16 December 2013
Revised 24 March 2014
Accepted 6 April 2014
Published online 28 May 2014

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
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.iolo.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.

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
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 (refer to codes in Appendix Table A1) were classified as having high-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: 1.85; 95% CI: 1.24–2.76; 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 occupations separately for men and women. Both men and...
Table 4. Adjusted odds ratios for asthma prevalence for major occupational subcategories by gender, India 2005–2006.

| NCO 2004 codes | Occupation subcategories | Total sample N [%] | Current asthma prevalence N [%] | OR [95% CI] \( p \) | Total sample N [%] | Current asthma prevalence N [%] | OR [95% CI] \( p \) |
|-----------------|--------------------------|--------------------|-------------------------------|------------------|--------------------|-------------------------------|------------------|
| 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] | 0.000 | 17 877 [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] |                        |                        | 52 994             | 996 [1.9] |                        |                        |

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

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

| NCO 2004 codes | Occupation categories | Total sample N [%] | Current Asthma Prevalence N [%] | OR [95% CI] \( p \) | Total sample N [%] | Current asthma prevalence N [%] | OR [95% CI] \( p \) |
|-----------------|-----------------------|--------------------|---------------------------------|------------------|--------------------|-------------------------------|------------------|
| 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] | 0.000 | 17 877 [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] |                        |                        | 52 994             | 996 [1.9] |                        |                        |

aAdapted from the Revised Indian National Classification of Occupations (NCO)-2004.

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

DOI: 10.3109/02770903.2014.913619

Occupational Risk factors for asthma in India 817

Odds ratios adjusted for age, 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 studies in specific industries, and only some have been investigated in epidemiological studies of the general population. Second, 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 underestimate 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.

Acknowledgments

We would like to acknowledge the support of Macro International (Calverton, MD, USA) and International Institute for Population Sciences (Mumbai, India) for providing access to the 2005–2006 Indian National Family Health Survey 3 data. An earlier version of this paper is being presented as a poster (P-4-3) at the Population Association of America Annual Meeting, Boston, MA, USA, 1-3 May 2014. Further, valuable comments and suggestions from the two anonymous reviewers are also acknowledged.

Declaration of interest

SA is supported by a Wellcome Trust Strategic Award Grant No Z/041825. CM is funded by the Higher Education Funding Council for England and the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care scheme.

References

1. Christiani DC, Wegman DH. Occupational respiratory disorder. In: Levy B, Wegman DH, eds. Occupational health: recognizing and preventing work-related disease. 3rd ed. Boston: Little, Brown and Company; 1994.
2. Toren K, Jarvholm B, Brismar J, Hagberg S, Hermansson BA, Lilienberg L. Adult-onset asthma and occupational exposures. Scand J Work Environ Health 1999;25:430–435.
3. Jeebhay MF, Quirce S. Occupational asthma in the developing and industrialized world: a review. Int J Tuberc Lung Dis 2007;11:122–133.
4. Messing K, Punnett L, Bond M, Alexanderson K, Pyle J, Zahn S, Wegman D, et al. Be the fairest of them all: challenges and recommendations for the treatment of gender in occupational health research. Am J Ind Med 2003;43:618E29.
5. Messing K. One-eyed science: occupational health and women workers. Philadelphia, PA: Temple University Press; 1998.
6. Eng A, t’ Mannetje A, McLean D, Ellison-Loschmann L, Cheng S, Pearce N. Gender differences in occupational exposure patterns. Occup Environ Med 2011;68:888–894.
7. International Institute for Population Sciences (IIPS) and Macro International. National Family Health Survey (NFHS-3), 2005–2006. India. Mumbai: International Institute for Population Sciences; 2007.
8. National Classification of Occupation (NCO). Directorate General of Employment and Training, Ministry of Labour, Government of India. 2004. [Accessed 24 November 2013] Available at http://dget.nic.in/nco/jobdescription/welcome.html
9. Pearce N. Effect measures in prevalence studies. Environ Health Perspect 2004;112:1047–1050.
10. Eng A, t’ Mannetje A, Douwes J, Cheng S, McLean D, Ellison-Loschmann L, Pearce N. The New Zealand workforce Survey II: occupational risk factors for asthma. Ann Occup Hyg 2010;54:154–164.
11. Eng A, t’ Mannetje A, Cheng S, Douwes J, Ellison-Loschmann L, McLean D, Gander P, et al. The New Zealand workforce survey I: self-reported occupational exposures. Ann Occup Hyg 2010;54:144–153.
12. Kogevinas M, Zock JP, Jarvis D, Kromhout H, Lilienberg L, Planas E, Radon K, et al. Exposure to substances in the workplace and new-onset asthma: an international prospective population-based study (ECRHS-II). Lancet 2007;370:336–341.
13. Arif A, Delcos G, Whitehead L, Tortolero SR, Lee ES. Occupational exposures associated with work-related asthma and work-related wheezing among U.S. workers. Am J Ind Med 2003;44:368–376.
14. Kraut A, Walld R, Mustard C. Prevalence of physician diagnosed asthma by occupational groupings in Manitoba, Canada. Am J Ind Med 1997;32:275–282.
15. Kogevinas M, Anto J, Sunyer J, Tobias A, Kromhout H, Burney P. Occupational asthma in Europe and other industrialised countries: a population-based study. Lancet 1999;353:1750–1754.
16. Fishwick D, Pearce N, D’Souza W, Lewis S, Town I, Armstrong R, Kogevinas M, Crane J. Occupational asthma in New Zealanders: a population based study. Occup Environ Med 1997;54:301–306.
17. LeMoual N, Kennedy S, Kauffmann F. Occupational exposures and asthma in 14,000 adults from the general population. Am J Epidemiol 2004;160:1108–1116.
18. Medina-Ramon M, Zock JP, Kogevinas M, Sunyer J, Torralba Y, Borrell A, Burgos F, Anto JM. Asthma, chronic bronchitis, and exposure to irritant agents in occupational domestic cleaning: a nested case-control study. Occup Environ Med 2005;62:598–606.
19. Eagan T, Gulsvik A, Eide GE, Bakke PS. Occupational airborne exposure and the incidence of respiratory symptoms and asthma. Am J Respir Crit Care Med 2002;166:933–938.
20. Le Van TD, Koh W-P, Lee H-P, Koh D, Yu MC, London SJ. Vapor, dust, and smoke exposure in relation to adult-onset asthma and chronic respiratory symptoms. The Singapore Chinese Health Study. Am J Epidemiol 2006;163:1118–1128.
21. Callister P, Dixon S. New Zealanders’ working time and home work patterns: evidence from the Time Use Survey. Wellington, New Zealand: New Zealand Department of Labour Occasional Paper Series; 2001.
22. Statistics Finland. Finnish quality of work life surveys. Dublin, Ireland: European Foundation for the Improvement of Living and Working Conditions; 2003.
23. Parent-Thirion A, Macias P, Hurley J, Vermeylen G. Fourth European Working Conditions Survey. Dublin, Ireland: European Foundation for the Improvement of Living and Working conditions; 2007.
24. Hodgson J, Jones J, Clarke S, Blackburn AJ, Webster S, Huxtable CS, Wilkinson S. Workplace Health and Safety Survey Programme: 2005 worker survey first findings report. Caerphilly, Wales, UK: Health and Safety Executive; 2005.
25. Hedlund U, Eriksson K, Rönmark E. Socio-economic status is related to incidence of asthma and respiratory symptoms in adults. Eur Respir J 2006;28:303–310.
26. Mannetje A, Slater T, McLean D, Eng A, Briar C, Douwes J. Women’s Occupational Health and Safety in New Zealand. Wellington: National Occupational Health and Safety Advisory Committee Technical report 13; 2009.
27. Jeebhay MF, Baatjies R, Lopata AL, Sander M, Raiff-Heimsoth M, Barnard V, Bateman ED, Robins TG. Occupational allergy and asthma in small bakeries of a supermarket chain store in South Africa. Allergy Clin Immunol Int 2005;18:132.
28. Laraqui CH, Yazidi AA, Rahhali TA, Verger C, Caubet A, Ben Mallem M, Laraqui O. The prevalence of respiratory symptoms and immediate hypersensitivity reactions in a population exposed to flour and cereal dust in five flour mills in Morocco. Int J Tuberc Lung Dis 2003;7:382–389.
29. Ige OM, Onadeko OB. Respiratory symptoms and ventilatory function of the saw millers in Ibadan, Nigeria. Afr J Med Sci 2000; 29:101–104.

30. Mengesha YA, Bekele A. Relative chronic effects of different occupational dusts on respiratory indices and health of workers in three Ethiopian factories. Am J Ind Med 1998;34:373–380.

31. Rongo LM, Besselin A, Douwes J, Barten F, Msamanga GI, Dolmans WM, Demers PA, Heederik D. Respiratory symptoms and dust exposure among male workers in small-scale wood industries in Tanzania. J Occup Environ Med 2002;44:1153–1160.

32. Harindranath N, Prakash O, Subba Rao PV. Prevalence of occupational asthma in silk filatures. Ann Allergy 1985;51:555–115.

33. Al-Neaimi YI, Gomes J, Lloyd OL. Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. Occup Med 2001;51:367–373.

34. Golshan M, Faghihi M, Marandi MM. Indoor women jobs and pulmonary risks in rural areas of Isfahan, Iran. 2000. Respir Med 2002;96:382–388.

35. Huang J, Wang XP, Ueda A, Aoyama K, Chen BM, Matsushita T. Allergologic evaluation for workers exposed to toluene diisocyanate. Ind Health 1991;29:85–92.

36. Wieslander G, Norback D, Wang Z, Zhang Z, Mi Y, Lin R. Buckwheat allergy and reports on asthma and atopic disorders in Taiyuan City, Northern China. Asia Pac J Allergy Immunol 2000;18:147–152.

37. Kim YK, Kim YY. Spider-mite allergy and asthma in fruit growers. Curr Opin Allergy Clin Immunol 2002;2:103–107.

38. Nordernd C, Ohlsn K, Balogh I, Rylander L, Pålsson B. Skerfving S. Fish processing work: the impact of two sex dependent exposure profiles on musculoskeletal health. Occup Environ Med 1999;56:256–64.

39. Hoofman WE, van der Beek AJ, Bongers PM, van Mechemen W. Gender differences in self reported physical and psychosocial exposures in jobs with both female and male workers. J Occup Environ Med 2005;47:244–52.

40. Parasuramanu BG, Huliraj N, Rudraprasad BM, Prashanth Kumar SP, Gangobaiariah, Ramesh Masthi NR. Prevalence of bronchial asthma and its association with smoking habits among adult population in rural area. Indian J Public Health 2010;54:165–168.

41. Gupta PR, Mangal DK. Prevalence and risk factors for bronchial asthma in adults in Jaipur district of Rajasthan (India). Lung India 2006;23:53–58.

42. Jindal SK, Gupta D, Aggarwal AN, Jindal RC, Singh V. Study of the prevalence of asthma in adults in North India using a standardized field questionnaire. J Asthma 2000;37:345–351.

43. Chowgule RV, Shetye VM, Parmar JR, Bhosale AM, Khandagale MR, Phalnitkar SV, Gupta PC. Prevalence of respiratory symptoms, bronchial hyper reactivity, and asthma in a megacity. Results of the European Community Respiratory Health Survey in Mumbai (Bombay). Am J Respir Crit Care Med 1998;158:457–545.

44. Sharma SK, Banga A. Prevalence and risk factors for wheezing in children from rural areas of north India. Allergy Asthma Proc 2007; 28:467–463.

45. Awasthi S, Kalia E, Roy S, Awasthi S. Prevalence and risk factors of asthma and wheeze in school-going children in Lucknow, North India. Indian Pediatr 2004;41:1205–1210.

46. Agrawal S, Pearce N, Ebrahim S. Prevalence and risk factors for self-reported asthma in an adult Indian population: a cross-sectional survey. Int J Tuberc Lung Dis 2013;17:275–282.

47. Guidahtu V, Swathi A, Nair NS. Household and environment factors associated with asthma among Indian women: a multilevel approach. J Asthma 2010;47:407–411.

48. Aggarwal AN, Chaudhry K, Chhabra SK, D’Souza GA, Gupta D, Jindal SK, Katiyar SK, et al. Prevalence and risk factors for bronchial asthma in Indian adults: a multicentre study. Indian J Chest Dis Allied Sci 2006;48:13–22.

49. Pearce N, Beasley R, Burgess C, Crane J. Asthma epidemiology: principles and methods. New York, NY: Oxford University Press; 1998.

50. ISAAC. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema. ISAAC Lancet 1998;351:1225–1232.

51. Subramanian SV, Ackerson LK, Subramanyam MA, Wright RJ. Domestic violence is associated with adult and childhood asthma prevalence in India. Int J Epidemiol 2007;36:569–579.

52. To T, Stanojevic S, Moores G, Gershon AS, Bateman ED, Cruz AA, Boulet LP. Global asthma prevalence in adults: findings from the cross-sectional world health survey. BMC Public Health 2012;12: 204.

53. Hassan MR, Kabir ARML, Mahmud AM, Rahman F, Hossain MA, Bennoor KS, Amin MR, Rahman MM. Self-reported asthma symptoms in children and adults in Bangladesh: findings of the National Asthma Prevalence Study. Int J Epidemiol 2002;31:483–488.

54. Melsom T, Brinch L, Hessen J, Schei MA, Kolstrup N, Jacobsen BK, Svanes C, Pandey MR. Asthma and indoor environment in Nepal. Thorax 2001;56:477–481.

55. Macro ICF. Demographic and Health Survey Interviewer’s Manual. MEASURE DHS Basic Documentation No. 2. Calverton, MD: ICF Macro; 2009.

56. Karjalainen A, Kurppa K, Martikainen R, Klaukka T, Karjalainen J. Work is related to a substantial portion of adult-onset asthma incidence in the Finnish population. Am J Respir Crit Care Med 2001;164:565–568.

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 people 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.
| NCO2004 codes | Occupation categories |
|--------------|----------------------|
| 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 |
| 121          | Directors and managers, financial institutions |
| 1212         | Working proprietors, directors and managers, wholesale and retailers |
| 1213         | Working proprietors, directors and managers in transport & communication |
| 1214         | 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. |
| 2119         | Physical scientists, n.e.c |
| 2129         | Mathematicians, 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 |
| 311          | Physical and engineering science technicians |
| 312          | 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 |
| 3429         | Technical Salesmen and Commercial Travellers, Other |
| 3422         | Business Services Agents and Trade Brokers, n.e.c |
| 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 |
| 51           | Personal and Protective Service Workers |
| 5112         | Transport conductors |
| 5121         | House keepers and related workers |
| 5122         | Cooks, waiters and bartenders |
| 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 |
| 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 |
| 711          | Miners, Shotfitters, 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, Stationary 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 |
|               | 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 |
| 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 |
| 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 = 74369) and women age 15–49 years (n = 124385) by occupational categories.

| Occupational categories                             | Men                        | Women                      |
|-----------------------------------------------------|----------------------------|----------------------------|
|                                                     | Sample Asthma prevalence N [%] | Sample Asthma prevalence N [%] |
| Physical scientists                                 | 17 – 1 –                   | 1 –                         |
| Architects, engineers, technologists and surveyors  | 147 – 20 –                 | 20 –                       |
| Engineering technicians                             | 244 1 [0.4]                | 29 1 [3.4]                 |
| Aircraft and ships officers                         | 5 – 1 –                    | 1 –                        |
| Life scientist/life science technicians             | 13 – 5 –                   | 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                    | 12 –                       |
| Mathematicians, statisticians and related workers   | 19 – 7                     | 7 –                        |
| Economists and related workers                      | 8 – 1 –                    | 1 –                        |
| Accountants, auditors and related workers           | 247 1 [0.4]                | 117 4[3.4]                 |
| Social scientists and related workers               | 56 – 106                   | 106 –                      |
| Jurists                                             | 174 9 [5.2]                | 17 –                       |
| Teachers                                            | 1396 28 [2.0]              | 2346 53 [2.3]              |
| Poets, authors, journalists and related workers     | 41 – 10                    | 10 –                       |
| Sculptors, painters, photographers and related creative art | 176 6 [3.4] | 18 – |
| Composer and performing artists                     | 130 – 19                   | 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] |
Table A2. Continued

| Occupational categories                                                                 | 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                                              | 135    | 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, fellmongers and felt 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, upholsters 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                         | 545    | 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      | –                       |
| Totala                                                                                | 74273  | 1359 [1.8]              | 124289 | 2104 [1.9]              |

*aNumber of men and women varies slightly for individual variables depending on the number of missing values.*