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Early View

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Association of respiratory symptoms and lung function with occupation in the multinational Burden of Obstructive Lung Disease (BOLD) study

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Abstract

Chronic obstructive pulmonary disease has been associated with exposures in the workplace. We aimed to assess the association of respiratory symptoms and lung function with occupation in the Burden of Obstructive Lung Disease study.

We analysed cross-sectional data from 28,823 adults (≥40years) in 34 countries. Eleven occupations were considered and grouped by likelihood of exposure to organic dusts, inorganic dusts and fumes. The association of chronic cough, chronic phlegm, wheeze, dyspnoea, FEV1/FVC and FVC with occupation was assessed, per study site, using multivariable regression. These estimates were then meta-analysed. Sensitivity analyses explored differences between sexes and gross national income (GNI).

Overall, working in settings with potentially high exposure to dusts or fumes was associated with respiratory symptoms but not lung function differences. The most common occupation was farming. Compared to people not working in any of the 11 considered occupations, those who were farmers for ≥20years were more likely to have chronic cough (OR=1.52, 95%CI 1.19-1.94), wheeze (OR=1.37, 95%CI 1.16-1.63), and dyspnoea (OR=1.83, 95%CI 1.53-2.20), but not lower FVC (β=0.02L, 95%CI -0.02L to 0.06L) or lower FEV_1/FVC (β=0.04%, 95%CI -0.49% to 0.58%). Some findings differed by sex and GNI.

In summary, at a population level, the occupational exposures considered in this study do not appear to be major determinants of differences in lung function, although they associate with more respiratory symptoms. As not all work settings were included in this study, respiratory surveillance should still be encouraged among high-risk dusty and fume job workers, especially in low- and middle-income countries.

Introduction

Irreversible airflow obstruction often accompanied by dyspnoea, persistent cough and phlegm production are characteristic of chronic obstructive pulmonary disease (COPD). It has been estimated that workplace exposures may account for 10% to 18% of COPD cases in the population.(1) However, these estimates are based on studies whose designs, definitions of disease and exposure assessments are not easily comparable. In addition, most of the studies were undertaken in high-income countries (HICs),(2) with a relative lack of knowledge concerning low- and middle-income countries (LMICs), where farming and manufacturing under weak health and safety regulations remain common.

In this analysis, we assessed the association of respiratory symptoms (i.e. chronic cough, chronic phlegm, dyspnoea and wheeze) and lung function parameters (i.e. FEV_1/FVC and FVC) with occupational exposures in the large, multinational, population-based Burden of Obstructive Lung Disease (BOLD) study, which collected data across several regions of the world in a standardised manner.

Materials and methods

Study participants

The BOLD study design and rationale have been described elsewhere.(3) Representative samples of at least 600 non-institutionalised adults, aged 40 years or older, were recruited from 41 sites in 34 countries.(4) (table 1) Classified by their gross national income per capita,(5) 14 sites were in HICs and 27 sites in LMICs. Information on respiratory symptoms and exposure to potential risk factors, including occupation, was collected through face-to-face interviews conducted by trained and certified staff in the participant's native language. This report is based on data from 28,823 participants who completed the core and occupational questionnaires and provided acceptable and repeatable post-bronchodilator spirometry measurements. All sites received approval from their local ethics committee, and participants provided informed consent.

Occupational exposure

Participants were asked if they had ever worked, for at least three months, in at least one of 11 work settings likely to be associated with significant exposures to particulates or fumes and loss of lung function. These were: 1) farming; 2) flour, feed or grain milling; 3) cotton or jute processing; 4) hard-rock mining; 5) coal mining; 6) sandblasting; 7) working with asbestos; 8) chemical or plastics manufacturing; 9) foundry or steel milling; 10) welding; and 11) firefighting. In addition, they were asked about their longest-held job, which was coded using the International Standard Classification of Occupations (ISCO-88).(6) (table S1) Based on expert opinion, these self-reported occupational data were used to group occupations into three categories according to likely exposure to organic dusts, inorganic dusts, and fumes. For each occupation and category of exposure, we calculated the total number of cumulative years of exposure based on the self-reported number of years worked in each setting.

Respiratory symptoms and lung function

Chronic cough was defined as a frequent cough, without having a cold, on most days for at least three months each year. Chronic phlegm was defined as a frequent production of phlegm, without a cold, on most days for at least three months each year. Wheeze was defined by having had any whistling in the chest at any time in the last 12 months. Dyspnoea was assessed using the modified Medical Research Council (mMRC) dyspnoea scale as breathlessness at least when walking more slowly than people of the same age or sufficient to have to stop walking. (7)

Lung function testing was undertaken using an EasyOne™ spirometer (ndd Medizintechnik AG) and each participant performed between three and eight manoeuvres. Forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were measured before and after the delivery of 200µg of salbutamol through a metered-dose inhaler, via a spacer. At the coordinating centre, all lung function measurements were individually evaluated and to be considered usable for analysis they had to fulfil the following criteria, based on the ATS criteria at the time the study began (8): 1) no hesitation, i.e. back-extrapolated volume less than 150 mL and peak expiratory flow time less than 120 ms; 2) complete blow, i.e. lasting at least 6 s or evidence of clear plateau (end-of-time volume less than 40 mL; 3) no artefact affecting the FEV1 or FVC (e.g. cough; zero flow error); and 4) the two best blows within 200 mL of each other. We used FEV_1/FVC as a marker of airflow obstruction, and FVC as a proxy for lung volumes.

Statistical analysis

Participants with no exposure to any of the considered work settings were used as the reference group for all analyses. We used regression analysis to assess the association of respiratory symptoms (logistic) and lung function (linear) with occupation and occupational exposure category. All regression models were adjusted for sex, age (years) and smoking status (never smoker; <20 pack-years; and ≥20 pack-years). Models with FVC as the outcome were further adjusted for height (cm), and those with wheeze or dyspnoea as outcomes were also adjusted for body mass index (BMI). (9) Exposure-response trends were evaluated using both continuous and categorical exposure variables, with the median of years of exposure used as cut-off value for examining cumulative exposures. The effect size for each association was estimated for each site, and the estimates from all sites were combined through random effects meta-analysis. The level of between-site heterogeneity was summarised by the I^2 statistic. (10)

In sensitivity analyses, we examined the associations of lung function with each of the three occupational categories among never-smokers only. In addition, we re-ran analyses by sex and by gross national income groups (HICs and LMICs). Stata 15 (Stata Corp., College Station, TX, USA) was used to perform all data analyses. Weights were used to account for sampling strategy. All results were considered statistically significant at $p<0.05$.

Results

Table 1 summarises the characteristics of the study participants from the 41 BOLD sites included in this report. The mean age across sites ranged from 46.7 to 63.3 years; 47.4% of participants were male. The mean FEV_1/FVC varied from 74.3% in Austria (Salzburg) to 82.6% in Saudi Arabia (Riyadh); and the mean FVC from 2.3L in Sri Lanka to 4.0L in Austria (Salzburg), Iceland (Reykjavik), the Netherlands (Maastricht) and Sweden (Uppsala). The highest proportion of people likely exposed to organic dusts in the workplace was in a rural site in India (Pune, 87.9%), while workers likely exposed to inorganic dust were more common in Poland (Krakow, 26.4%) and those likely exposed to fumes were in the USA (Lexington, KY; 27.6%). The proportion of participants who did not work in any occupation with exposure to dusts or fumes varied across sites from 8.8% in India (Pune) to 98.2% in India (Mumbai). Further details on the distributions among the 11 occupations in each site can be seen in table 2.

Respiratory symptoms and occupational factors

Figures 1 and 2 show the relationships between respiratory symptoms and occupational exposures. Overall, chronic cough, chronic phlegm, wheeze and dyspnoea were associated with most high-risk occupations. Farming, the most common occupation among participants, was associated with chronic cough (≥20 years; OR=1.52, 95%CI 1.19 to 1.94), chronic phlegm (<20 years; OR=1.36, 95%CI 1.15 to 1.61), wheeze (<20 years; OR=1.53, 95%CI 1.29 to 1.83 and ≥20 years; OR=1.37, 95%CI 1.16 to 1.63) and dyspnoea (≥20 years; OR=1.83, 95%CI 1.53 to 2.20). Flour, feed or grain milling regardless of duration of exposure was associated with all respiratory symptoms studied. Working with asbestos at least 7 years was clearly associated with chronic cough (OR=4.15, 95%CI 2.29 to 7.53). Hard-rock mining at least 3 years was associated with chronic phlegm (OR=3.91, 95%CI 1.79 to 8.58). Coal mining was associated with wheeze (<13years; OR=4.15, 95%CI 2.40 to 7.19). Sandblasting was highly associated with dyspnoea (<3 years; OR=4.87, 95%CI 2.02 to 11.76 and ≥3 years; OR=6.87, 95%CI 2.63 to 17.95).

Lung function and occupational factors

We found no significant associations between post-bronchodilator FEV_1/FVC ratio or FVC and work in any of the high-risk occupations. FEV_1/FVC was low in coal miners, sandblasters, chemical or plastic processors and steel millers with long durations of exposure, but these associations were not statistically significant. Moreover, there was no evidence of exposure-response associations of either post-bronchodilator lung function measures with any of the specific occupations. (table S2)

Sensitivity analyses of lung function among men in HICs indicated that working in a job with organic dust exposure for at least 20 years was associated with a significantly decreased FEV_1/FVC (β=-0.34%, 95%CI -0.42% to -0.27%) (table S3) and FVC (β=-0.18 L, 95%CI -0.32 L to -0.04 L) (table S4). In LMICs, we found that men working in an organic dust job for a longer duration had a lower FEV_1/FVC than in HICs; however, this finding was not statistically significant (β=-1.01%, 95%CI -2.77% to 0.75%) and there was high heterogeneity across the LMIC sites (I^2=92.2%, p<0.001). There were no significant associations, in sensitivity analyses, between work with inorganic dusts and FEV_1/FVC. (table S5). Among never-smoking women in HICs, workplace exposure to inorganic dusts for at least six years was associated with greater FVC (β=0.60 L, 95%CI 0.53 L to 0.66 L). (table S6) Among men exposed to fumes at work for at least 11 years in LMICs, a sensitivity analysis showed a significant association with a lower FEV_1/FVC (β=-0.29%, 95%CI -0.39% to -0.17%) (table S7). In contrast, there was no such association in HICs. There was no significant association between workplace exposure to fumes with FVC. (table S8)

Discussion

In this large, international, population-based study we found that respiratory symptoms are associated with working in settings where exposure to dusts and fumes is likely to be high. Overall, these findings agree with two recent reviews reporting significant relationships of chronic bronchitis and breathlessness with occupational exposures to organic dusts, inorganic (mineral) dusts or fumes. (1, 2) In contrast, we found no consistent associations between occupational exposures and measures of lung function. Lung function was lower in miners and chemical or plastic processors with long durations of exposure, but these differences were not statistically significant. One explanation for the association of chronic respiratory symptoms without significant lung function differences may be irritation of the airways leading to chronic bronchitis without obstruction. These findings are similar to those we found previously in the BOLD study, where chronic phlegm but not chronic airflow obstruction was more likely to occur among users than among never users of solid fuels.(11) The “English Hypothesis” of a strong link between bronchitis and obstruction was largely discredited by the study of Fletcher,(12) and the lack of a strong association in this study should not be entirely unexpected. Another explanation could be the occurrence of occupational asthma, presenting with wheeze and breathlessness without affecting post-bronchodilator lung function. This can be induced by substances in workplaces such as animal dusts, flour, chemicals and metals.(13) In addition, non-differential misclassification of exposure might have hampered the ability to detect a statistically significant association.

Stratified analyses by sex, gross national income and smoking status among male participants in HICs showed that working in an organic dust job for at least 20 years is associated with slightly lower FEV_1/FVC and FVC. In a combined analysis of the European

Community Respiratory Health Survey (ECRHS) and the Swiss Cohort Study on Air Pollution and Lung and

Heart Diseases in Adults (SAPALDIA), a decline in FEV1/FVC was associated with exposure to organic dust. However, this association was not evident among never smokers suggesting that this relationship may be due to residual confounding by smoking.(14) A population-based study in Denmark reported an increased prevalence of COPD, defined by the lower limit normal (LLN) of FEV_1/FVC, among workers exposed to high levels (at least 15 years) of organic dust. (15) In LMICs, we found that men working in an organic dust job for at least 20 years had a greater, but insignificant, decrement in FEV_1/FVC. However, this finding was highly heterogeneous across the LMIC sites. A potential explanation for these results is that farming is the most prevalent industry sector involving exposures to organic dusts in both HICs and LMICs. While HICs have similar commercial agriculture systems, LMICs are characterised by diverse and less intense agricultural practices, which might cause the significant heterogeneity in our LMIC analyses. (16)

No significant association was observed in overall or sensitivity analyses of the relationships between each lung function measure and inorganic dust exposure among men. Adjustment for passive smoking and education made no material difference to our findings. In the recent ECRHS and SAPALDIA report, FEV1/FVC decline was associated with mineral dust but again only if ever smokers were included in the analysis.(14) The ECRHS had already reported no significant association of incident COPD, defined as $FEV_1/FVC < LLN$, with inorganic (mineral) dust exposures. (17) For FVC, the only significant association we found was among never-smoking women exposed to inorganic dust for at least six years in HICs, whose FVC was on average 0.6 L greater than their unexposed counterparts. However, the women exposed in HICs were few (n=5) and diverse: two from the USA had worked with asbestos for 19 years and in hard-rock mining for eight years respectively; one from Estonia had worked with asbestos for 24 years; one from Germany had worked in sandblasting for 11 years and the other from Norway had worked with asbestos for 10 years. Therefore, the greater FVC in this group might have occurred by chance or might reflect a healthy worker effect. (18)

The ECRHS study, which was conducted in 12 high-income European countries, reported an increased risk of COPD based on LLN of FEV_1/FVC among workers with occupational gas and fume exposures. (17) However, the association between FEV1/FVC decline and gases and fumes was not significant in the combined analysis of ECRHS and SAPALDIA.(14) In the current analysis of the BOLD study, we found no association between fumes and FEV_1/FVC among men exposed to fumes for at least 11 years in HICs. This result is consistent with the recent findings of the UK Biobank, a large population-based study on lifetime job-histories and spirometry-defined COPD that found no increased risk for fume-related jobs including chemical processing, metal processing and firefighting. (19) In contrast, there was a significant small effect on FEV_1/FVC (decreased by 0.29%) among men in LMICs. An explanation for our study's contradictory findings might be related to different standards of industrial control between HICs and LMICs, where working conditions remain poor. (20)

This study has several strengths. To the best of our knowledge, it is the first large population-based study covering both HICs and LMICs. We used a rigorous standardised protocol for data collection and lung function testing across all 41 sites. This is an advantage over published meta-analyses, which pooled findings from a mixture of study designs (cross-sectional surveys, case-control, longitudinal) with varying outcome definitions (either measured or based on self-report), as it reduces the heterogeneity across sites.(1, 2) Data collection was undertaken by certified technicians and trained interviewers. We tried to control for a potential recall bias by asking participants about their jobs (coded using the standard ISCO-88 classification) instead of their exposures at work. Furthermore, we undertook post-bronchodilator spirometry with centralised quality control for precision of spirometric measurements. In BOLD, about 96% of the manoeuvres met the ATS/ERS 2005 goals for acceptability and 90% for repeatability.(21)

We also recognise limitations. This study is cross-sectional, which makes it difficult to infer temporality and to distinguish causal relationships. Self-reported respiratory symptoms may be influenced by recall bias. Measurement error might have occurred due to misclassification of occupational histories and poor precision on durations of exposure particularly in LMIC sites. For example, participants who worked on subsistence farms might not consider and report themselves as farmers. The inclusion of participants with an exposure greater than three months but less than one year in the least exposed category may partly explain the lack of association among this category. However, this group of participants was relatively small (2% of those exposed to organic dust, 15% of those exposed to inorganic dust, and 6% of those exposed to fumes) and the contrast between the highest exposure category and the non-exposed category should have been enough to detect a true association, if one exists. In addition, the questionnaire did not collect information on the intensity of each occupational exposure, which might limit analyses of the exposure-response relationship. Although the overall prevalence of occupational exposure to organic dust, inorganic dust and fumes was like that of other studies (37% vs

36-42%),(14) we are aware that the prevalence of exposure to inorganic dust is much lower than reported in those same studies. Regarding sensitivity analyses of lung function, we restricted these to just three main groups of dust and fume exposures rather than the 11 specified occupations as for some of these there were too few participants, particularly among women. Moreover, it is also noted that industrial workplaces are generally exposed to combinations of respiratory hazards, which affects grouping of dusty and fume jobs so that we were not able to adjust our models for co-exposure to multiple occupational exposures. We are also conscious that our analysis is based on lung function measured using spirometry, not lung diffusion capacity or blood gases, which have been previously linked to occupational exposure to pesticides.(22) Finally, although the study is large, it does not necessarily imply representativeness of the population in each country.

We suggest a further longitudinal study on the association of occupational exposure with respiratory outcomes, which would more easily distinguish causal from non-causal relationships. In addition, to evaluate high-quality occupational exposure assessment, comprehensive data on exposure magnitude (e.g., dose, frequency and intensity) is suggested. Therefore, personal monitoring for a larger global prospective cohort and application of a job-exposure matrix are recommended.(23, 24) We also found clear evidence that occupational dusty jobs were related to chronic respiratory symptoms with, in some cases, effects on lung function. Further laboratory studies to understand the mechanism of how workplace exposures to dusts and fumes affect lung function are also suggested.

In conclusion, we found that exposure to selected work settings, which are thought to be associated with substantial exposures to particulates or fumes and loss of lung function, may increase the risk of chronic respiratory symptoms, without significant changes in spirometric measures of lung function. This does not mean that unlimited occupational exposure is acceptable or cannot have an effect on the lungs. It just suggests that, in this study, occupational exposures do not appear to be major determinants of low spirometric values, compared with other exposures. As we are aware that many work settings were not included in the BOLD study and individual risk might be higher in certain settings, interventions to avoid or reduce occupational exposures are advised. Industrial hygiene is still important and respiratory surveillance should be encouraged among high-risk dusty and fume job workers, especially those living in LMICs.

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Conflict of interest

JR, AFSA, SDM, HL, KM, DOO, IH, MD, EFMW, CJ, AG, HHC, FM, MPA, AE, RA, WT, LCL, AR, MS, AAN, TS, AAS, MAG, JZ, SJ, SS, RJ, TG, ASB, PC, and PB have no conflict of interest to disclose. RN reports grants from AstraZeneca, Boehringer Ingelheim, Chiesi, GlaxoSmithKline and Novartis, and receipt of equipment/material/services from ResMed Norway. RN is President of the Norwegian Respiratory Society. DM reports royalties from Up to Date, personal fees from GlaxoSmithKline, AstraZeneca, and Schlesinger Law Firm, honoraria from American Association of Respiratory Care, and stock in GlaxoSmithKline. DM is the Medical Director of the COPD Foundation.

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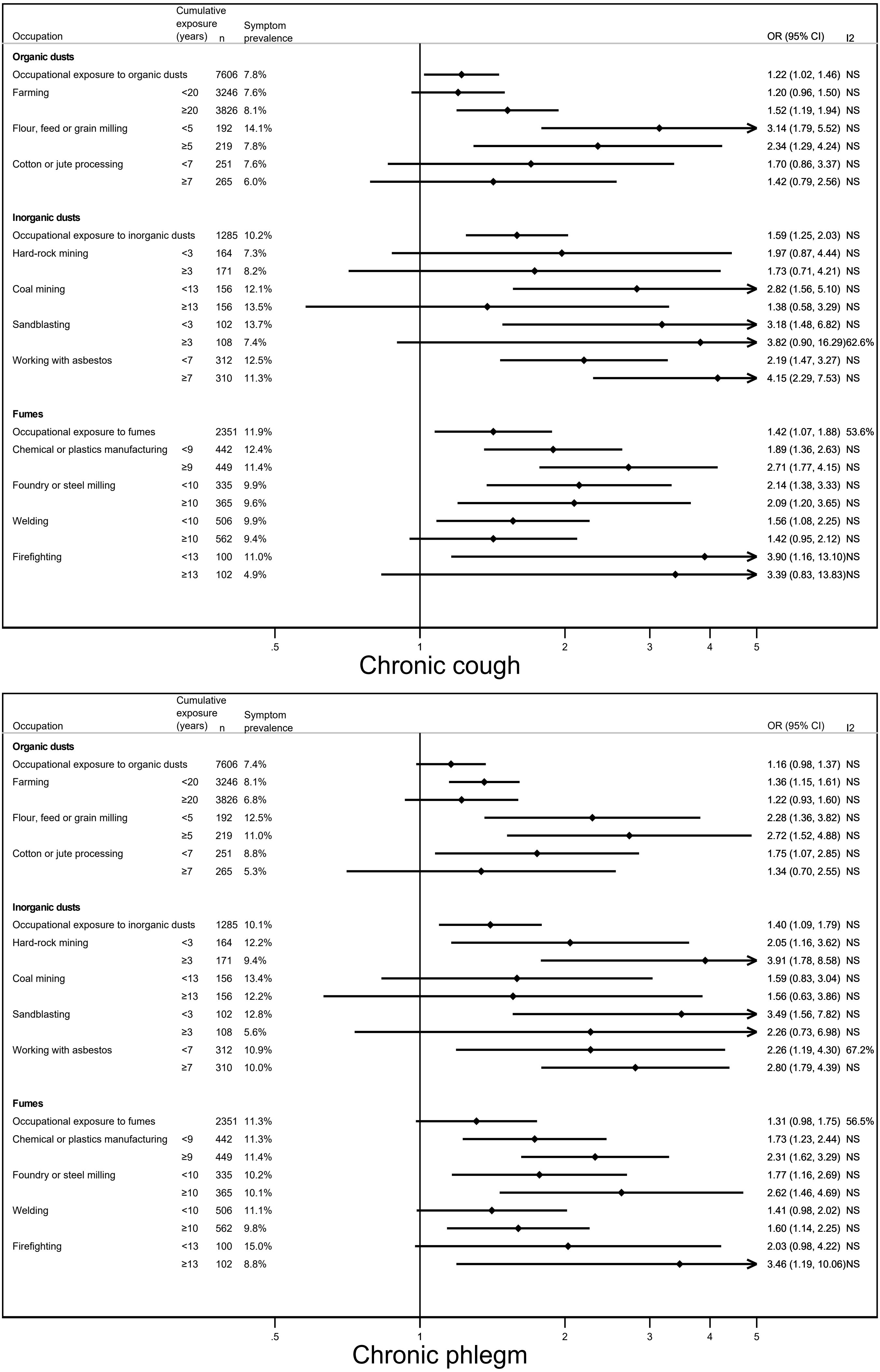

Figure 1. Association of chronic cough and chronic phlegm with high-risk occupations.

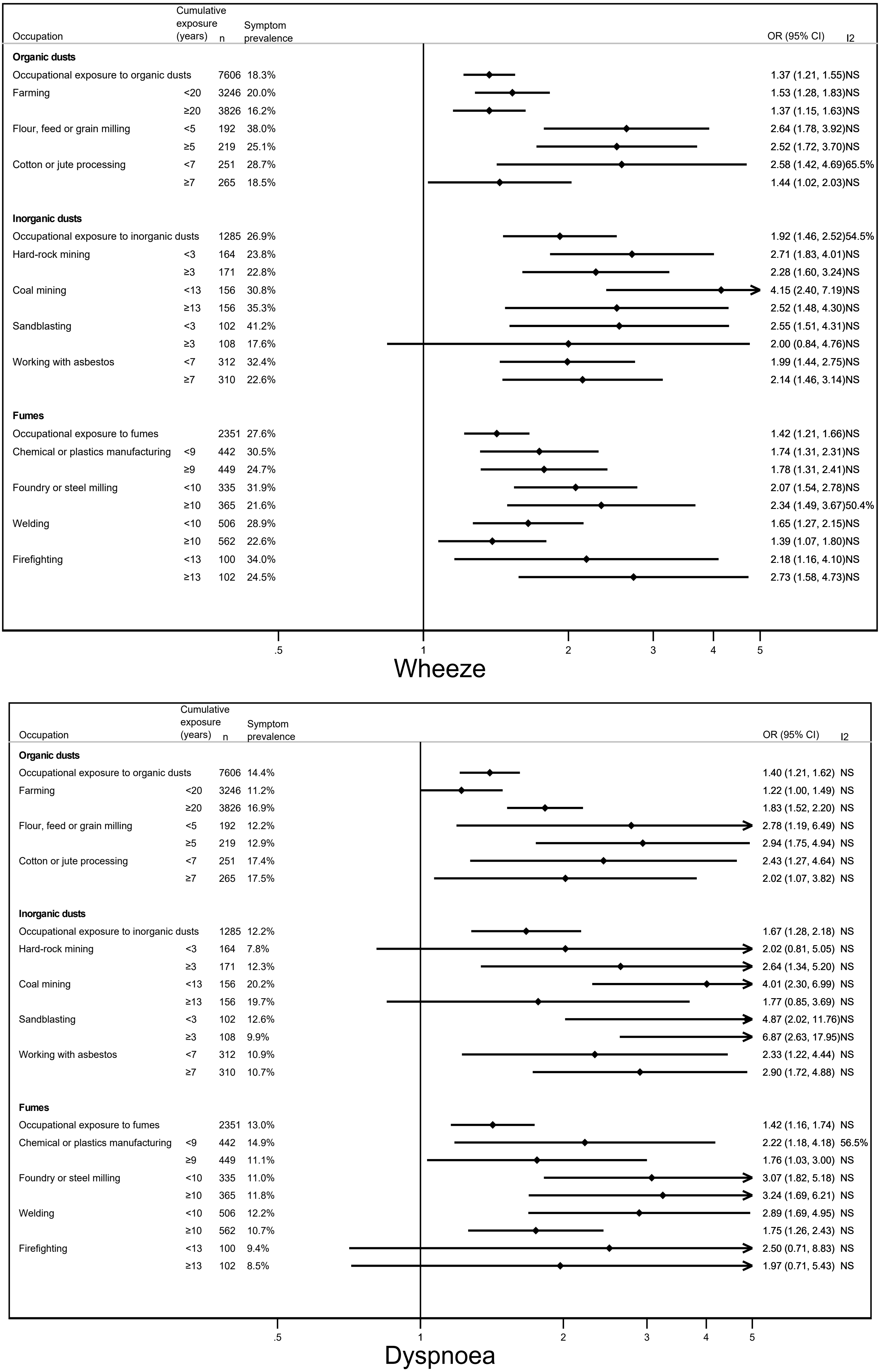

Figure 2. Association of wheeze and dyspnoea with high-risk occupations.

Table 1. Characteristics of participants from 41 sites of the BOLD Study with acceptable and repeatable post-bronchodilator spirometry and occupational exposure data.

BOLD site	Albania (Tirana)	Algeria (Annaba)	Australia (Sydney)	Austria (Salzburg)	Benin (Sèmè-Kpodji)	Cameroon (Limbe)	China (Guangzhou)	Canada (Vancouver)	England (London)	Estonia (Tartu)	Germany (Hannover)	Iceland (Reykjavik)	India (Kashmir)	India (Mumbai)
n	939	890	541	1,253	698	331	461	827	675	613	680	757	760	439
Age (year), mean (SD)	54.6 (10.8)	52.5 (9.9)	58.9 (12.4)	57.7 (11.4)	51.5 (9.8)	51.3 (9.9)	54.0 (10.6)	56.0 (11.8)	58.2 (11.5)	60.9 (12.0)	58.1 (11.0)	56.4 (11.7)	51.4 (10.4)	51.1 (8.9)
Height (cm), mean (SD)	164.2 (8.8)	164.6 (9.7)	165.3 (9.6)	170.1 (8.9)	164.9 (8.0)	165.8 (8.0)	160.0 (8.4)	167.2 (10.1)	168.1 (9.7)	169.2 (9.8)	169.1 (9.6)	173.1 (9.4)	160.5 (8.8)	160.8 (8.4)
BMI (kg/m^2), mean (SD)	28.0 (4.7)	28.3 (5.7)	28.0 (5.2)	26.4 (4.2)	26.4 (5.6)	26.6 (5.4)	23.3 (3.3)	26.7 (5.2)	27.1 (5.0)	28.5 (5.3)	27.3 (4.6)	27.9 (4.9)	22.4 (3.6)	23.8 (4.0)
Sex (male), %	49.7	49.7	49	54.5	43.3	59.5	49.7	41.6	47.6	50.2	51	53.2	54.7	62.6
Never-smokers, %	62.9	61.7	46	44.8	98	77.6	56.4	43.2	35.9	52.4	38.1	33.7	45.1	90.2
<20 pack-years, %	10.2	15.7	31.1	28.6	1.9	16.6	18.7	33.9	32.9	30.2	30.2	41	7.4	7.7
≥20 pack-years, %	26.8	22.6	22.9	26.7	0.1	5.7	25	23	31.3	31.8	31.8	25.4	47.5	2.1
Chronic cough, %	8.8	3.2	7	5.3	2.4	0.9	5.6	11.3	12.2	7	8.4	11.5	5.7	2.1
Chronic phlegm, %	1.8	2.6	5.7	7.9	2.2	1.2	6.9	10.6	11.7	9.4	8.2	9.3	5.7	2.3
Wheeze, %	3.7	14.5	25.4	13.2	2.8	4.5	1.5	26	34.2	22.8	18.7	24.2	3	3.2
Dyspnoea, %	8	11.8	7	6.6	1.4	5.8	3.8	6.9	12.1	14	4	8.4	4.9	9.9
FEV_1/FVC (%), mean (SD)	78.4 (9.0)	78.6 (7.3)	76.4 (8.9)	74.3 (8.6)	79.3 (7.1)	80.4 (6.9)	78.1 (7.3)	76.0 (8.8)	75.0 (9.2)	77.2 (7.8)	76.2 (7.9)	76.1 (8.5)	76.4 (10.6)	79.1 (7.5)
FVC (L), mean (SD)	3.6 (0.9)	3.4 (0.9)	3.6 (1.0)	4.0 (1.0)	2.8 (0.7)	3.0 (0.8)	3.1 (0.8)	3.9 (1.1)	3.7 (1.0)	3.8 (1.1)	3.9 (1.0)	4.0 (1.0)	3.3 (0.9)	2.8 (0.7)
FEV_1 (L), mean (SD)	2.8 (0.8)	2.7 (0.8)	2.8 (0.9)	3.0 (0.8)	2.2 (0.6)	2.4 (0.7)	2.4 (0.7)	3.0 (0.9)	2.7 (0.8)	3.0 (0.9)	3.0 (0.9)	3.1 (0.9)	2.5 (0.8)	2.3 (0.6)

Table 1. Characteristics of participants from 41 sites of the BOLD Study with acceptable and repeatable post-bronchodilator spirometry and occupational exposure data (continued).

BOLD site	India (Mysore)	India (Pune)	Jamaica	Kyrgyzstan (Chui)	Kyrgyzstan (Naryn)	Malawi (Blantyre)	Malawi (Chikwawa)	Malaysia (Penang)	Morocco (Fes)	Netherlands (Maastricht)	Nigeria (Ife)	Norway (Bergen)	Pakistan (Karachi)	Philippines (Manila)
n	604	845	578	891	859	403	448	663	768	590	884	658	610	892
Age (year), mean (SD)	46.7 (7.3)	52.4 (9.9)	55.9 (11.6)	52.4 (9.1)	52.7 (10.2)	52.2 (10.0)	53.7 (10.5)	54.5 (9.5)	55.1 (10.3)	57.5 (10.7)	55.3 (12.0)	59.8 (12.6)	51.6 (9.6)	52.4 (10.2)
Height (cm), mean (SD)	158.6 (6.6)	158.8 (8.9)	165.7 (8.8)	161.1 (8.8)	160.1 (8.7)	161.2 (8.2)	161.6 (9.1)	158.8 (8.2)	161.7 (9.1)	169.9 (9.6)	162.7 (7.7)	170.9 (9.5)	159.5 (9.6)	156.4 (8.6)
BMI (kg/m^2), mean (SD)	24.7 (3.8)	22.1 (3.8)	27.5 (6.6)	28.4 (5.7)	27.0 (5.0)	25.0 (5.4)	21.8 (3.9)	26.1 (4.5)	27.9 (5.3)	27.4 (4.5)	25.3 (5.4)	26.5 (4.3)	26.5 (5.5)	24.9 (4.7)
Sex (male), %	42.7	59.4	42	31.4	38.2	40	51.3	51.3	46.1	50.9	39.1	49.2	44.1	42.4
Never-smokers, %	89.7	87.5	62.3	70.4	75.4	86.3	69.7	74.5	72.1	32.9	88.6	35.7	74.1	46.6
<20 pack-years, %	8.4	11.7	19.4	14.5	14.9	12.7	27.8	12.4	13.4	34.8	10.4	38.6	13.3	35.4
≥20 pack-years, %	1.8	0.8	18.3	15.2	9.7	1	2.6	13.1	14.5	32.4	1	25.7	12.5	17.9
Chronic cough, %	1.7	1.9	4.2	10.2	10.7	2.2	1.4	4.5	9.8	5.3	0.5	7.9	11.4	4.5
Chronic phlegm, %	1.7	1.4	4.3	7	7.8	0.3	0.5	4.2	7.9	3.2	0.3	10	10.1	11.4
Wheeze, %	0.8	4.7	16.4	14.5	13.4	8	3	6.6	12.1	16.7	2.2	23.7	11.5	15.5
Dyspnoea, %	0	6.6	12.9	14.2	21.1	2	1.3	9.2	14.5	9.5	3.5	5.4	30.7	21.8
FEV_1/FVC (%), mean (SD)	79.5 (7.4)	79.7 (8.1)	78.4 (9.2)	77.4 (8.1)	78.0 (7.2)	78.2 (7.8)	76.3 (9.2)	81.0 (6.8)	78.1 (8.3)	74.6 (10.0)	78.5 (8.4)	74.9 (8.8)	80.1 (9.7)	79.0 (8.9)
FVC (L), mean (SD)	2.6 (0.7)	2.7 (0.7)	2.9 (0.8)	3.4 (0.9)	3.5 (0.9)	3.0 (0.7)	3.1 (0.7)	2.7 (0.7)	3.3 (0.9)	4.0 (1.1)	2.7 (0.7)	3.9 (1.1)	2.5 (0.8)	2.6 (0.7)
FEV_1 (L), mean (SD)	2.1 (0.6)	2.2 (0.6)	2.3 (0.7)	2.6 (0.7)	2.7 (0.7)	2.3 (0.6)	2.4 (0.6)	2.2 (0.6)	2.6 (0.7)	2.9 (0.9)	2.1 (0.6)	2.9 (0.9)	2.0 (0.6)	2.1 (0.6)

Table 1. Characteristics of participants from 41 sites of the BOLD Study with acceptable and repeatable post-bronchodilator spirometry and occupational exposure data (continued).

BOLD site	Philippines (Nampicuan & Talugtug)	Poland (Krakow)	Portugal (Lisbon)	Saudi Arabia (Riyadh)	South Africa (Uitsig & Ravensmead)	Sri Lanka	Sudan (Gezira)	Sudan (Khartoum)	Sweden (Uppsala)	Trinidad & Tobago	Tunisia (Sousse)	Turkey (Adana)	USA (Lexington, KY)
n	722	526	711	700	846	1,035	590	517	547	1,097	661	806	508
Age (year), mean (SD)	54.1 (10.5)	55.7 (11.5)	63.3 (11.3)	50.3 (7.7)	54.2 (10.5)	53.7 (9.5)	53.7 (10.2)	54.0 (10.4)	58.4 (10.9)	54.1 (10.8)	53.0 (9.1)	53.6 (10.4)	56.6 (9.9)
Height (cm), mean (SD)	158.7 (8.6)	167.0 (8.5)	160.7 (9.4)	162.5 (8.9)	161.6 (8.9)	156.4 (8.8)	163.0 (10.8)	165.5 (9.5)	171.0 (9.7)	165.1 (11.3)	163.2 (9.4)	160.7 (9.3)	167.1 (9.9)
BMI (kg/m^2), mean (SD)	21.5 (3.9)	27.7 (4.7)	28.2 (4.6)	31.2 (6.0)	27.9 (7.5)	24.2 (4.6)	27.3 (17.1)	26.5 (6.4)	27.0 (4.4)	29.1 (10.0)	29.2 (5.6)	29.6 (5.3)	30.8 (6.8)
Sex (male), %	49.3	50.6	46.6	53.6	37.2	44.9	51.5	59.4	51.7	39.8	46.8	48.3	40.6
Never-smokers, %	46.8	38.2	59.5	73.1	32.3	78.1	74.3	76	39.1	72.4	57.8	45.2	35.8
<20 pack-years, %	26.2	28.5	16.6	11.7	48.1	17.5	19.9	17	38.8	14.2	12.3	23.3	21.3
≥20 pack-years, %	27	33.3	23.9	15.1	19.6	4.4	5.8	7	22.1	13.4	30	31.5	42.9
Chronic cough, %	7.1	8.2	10.6	12.1	11.5	6.6	2.6	4.1	7.9	7.5	11.4	7.8	19.5
Chronic phlegm, %	9.6	7.8	13.1	12.9	13.7	10.9	3.8	4.6	11.5	3.7	15.4	8.7	16.3
Wheeze, %	28	26.3	27.9	40.7	27.7	30.2	19.9	8.5	25.4	11.8	25	35	44.1
Dyspnoea, %	25.5	23.7	14.6	22	29.2	26.8	8	6.7	5.1	8.7	16.4	23.3	20
FEV_1/FVC (%), mean (SD)	77.0 (10.6)	75.1 (9.2)	75.8 (9.0)	82.6 (6.0)	75.6 (11.1)	79.7 (8.7)	80.1 (7.2)	77.9 (8.4)	76.3 (8.0)	79.6 (7.6)	80.0 (7.5)	75.8 (8.7)	76.2 (9.4)
FVC (L), mean (SD)	2.7 (0.8)	3.8 (1.0)	3.2 (0.9)	3.0 (0.8)	2.9 (0.8)	2.3 (0.6)	3.0 (0.8)	2.9 (0.8)	4.0 (1.1)	2.7 (0.8)	3.4 (0.9)	3.4 (0.9)	3.4 (1.0)
FEV_1 (L), mean (SD)	2.1 (0.7)	2.9 (0.9)	2.4 (0.8)	2.5 (0.7)	2.2 (0.7)	1.9 (0.5)	2.4 (0.7)	2.3 (0.6)	3.0 (0.9)	2.2 (0.7)	2.7 (0.8)	2.6 (0.7)	2.6 (0.9)

Table 2. Participants from 41 sites of the BOLD Study across 11 work settings likely linked to significant exposure to particulates or fumes and loss of lung function.

BOLD site	Albania (Tirana)	Algeria (Annaba)	Australia (Sydney)	Austria (Salzburg)	Benin (Sèmè-Kpodji)	Cameroon (Limbe)	Canada (Vancouver)	China (Guangzhou)	England (London)	Estonia (Tartu)	Germany (Hannover)	Iceland (Reykjavik)	India (Kashmir)	India (Mumbai)
n	939	890	541	1,253	698	331	827	461	675	613	680	757	760	439
Unexposed to any high-risk occupation, n (%)	486 (51.8)	356 (40.0)	442 (81.7)	831 (66.3)	650 (93.1)	108 (32.6)	678 (82.0)	396 (85.9)	596 (88.3)	439 (71.6)	491 (72.2)	306 (40.4)	495 (65.1)	431 (98.2)
Occupational exposure to organic dusts, n (%)	352 (37.5)	33 (3.7)	40 (7.4)	307 (24.5)	9 (1.3)	194 (58.6)	80 (9.7)	20 (4.3)	36 (5.3)	99 (16.2)	71 (10.4)	369 (48.8)	259 (34.1)	7 (1.6)
Farming, n (%)	334 (35.6)	24 (2.7)	31 (5.7)	288 (23.0)	8 (1.2)	194 (58.6)	66 (8.0)	1 (0.2)	27 (4.0)	91 (14.9)	51 (7.5)	350 (46.2)	259 (34.1)	0 (0.0)
Flour, feed or grain milling, n (%)	7 (0.8)	9 (1.0)	7 (1.3)	37 (3.0)	1 (0.1)	0 (0.0)	21 (2.5)	3 (0.7)	5 (0.7)	13 (2.1)	16 (2.4)	43 (5.7)	0 (0.0)	0 (0.0)
Cotton or jute processing, n (%)	15 (1.6)	0 (0.0)	6 (1.1)	19 (1.5)	0 (0.0)	0 (0.0)	4 (0.5)	16 (3.5)	7 (1.0)	4 (0.7)	13 (1.9)	18 (2.4)	0 (0.0)	7 (1.6)
Occupational exposure to inorganic dusts, n (%)	68 (7.2)	24 (2.7)	30 (5.6)	59 (4.7)	17 (2.4)	8 (2.4)	44 (5.3)	8 (1.7)	18 (2.7)	24 (3.9)	58 (8.5)	62 (8.2)	4 (0.5)	0 (0.0)
Hard-rock mining, n (%)	20 (2.1)	3 (0.3)	4 (0.7)	16 (1.3)	3 (0.4)	2 (0.6)	14 (1.7)	3 (0.7)	3 (0.4)	5 (0.8)	6 (0.9)	27 (3.6)	0 (0.0)	0 (0.0)
Coal mining, n (%)	16 (1.7)	1 (0.1)	3 (0.6)	6 (0.5)	3 (0.4)	0 (0.0)	2 (0.2)	2 (0.4)	1 (0.2)	1 (0.2)	11 (1.6)	1 (0.1)	0 (0.0)	0 (0.0)
Sandblasting, n (%)	10 (1.1)	7 (0.8)	1 (0.2)	15 (1.2)	0 (0.0)	1 (0.3)	8 (1.0)	0 (0.0)	5 (0.7)	4 (0.7)	14 (2.1)	13 (1.7)	4 (0.5)	0 (0.0)
Working with asbestos, n (%)	34 (3.6)	15 (1.7)	26 (4.8)	30 (2.4)	14 (2.0)	5 (1.5)	26 (3.1)	3 (0.7)	12 (1.8)	19 (3.1)	36 (5.3)	29 (3.8)	0 (0.0)	0 (0.0)
Occupational exposure to fumes, n (%)	57 (6.1)	194 (21.8)	64 (11.8)	162 (12.9)	10 (1.4)	4 (1.2)	59 (7.3)	42 (9.1)	41 (6.1)	88 (14.4)	115 (16.9)	177 (23.4)	3 (0.4)	1 (0.2)
Chemical/plastics manufacturing, n (%)	22 (2.3)	14 (1.6)	28 (5.2)	44 (3.5)	0 (0.0)	0 (0.0)	25 (3.0)	11 (2.4)	24 (3.6)	45 (7.3)	50 (7.4)	78 (10.3)	1 (0.1)	0 (0.0)
Foundry or steel milling, n (%)	11 (1.2)	156 (17.5)	11 (2.1)	22 (4.1)	0 (0.0)	0 (0.0)	20 (2.4)	18 (3.9)	8 (1.2)	17 (1.4)	16 (2.6)	30 (4.4)	1 (0.1)	0 (0.0)
Welding, n (%)	24 (2.6)	50 (5.6)	28 (5.2)	77 (6.2)	10 (1.4)	4 (1.2)	19 (2.3)	16 (3.5)	14 (2.1)	34 (5.6)	62 (9.1)	95 (12.6)	0 (0.0)	1 (0.2)
Firefighting, n (%)	3 (0.3)	7 (0.8)	6 (1.2)	52 (4.2)	0 (0.0)	0 (0.0)	6 (0.7)	1 (0.2)	2 (0.3)	10 (1.6)	8 (1.2)	11 (1.5)	1 (0.1)	0 (0.0)

Table 2. Participants from 41 sites of the BOLD Study across 11 work settings likely linked to significant exposure to particulates or fumes and loss of lung function (continued).

BOLD site	India (Mysore)	India (Pune)	Jamaica	Kyrgyzstan (Chui)	Kyrgyzstan (Naryn)	Malawi (Blantyre)	Malawi (Chikwawa)	Malaysia (Penang)	Morocco (Fes)	Netherlands (Maastricht)	Nigeria (Ife)	Norway (Bergen)	Pakistan (Karachi)	Philippines (Manila)
n	604	845	578	891	859	403	448	663	768	590	884	658	610	892
Unexposed to any high-risk occupation, n (%)	506 (83.8)	74 (8.8)	353 (61.1)	535 (60.0)	240 (27.9)	204 (50.6)	396 (88.4)	557 (84.0)	514 (66.9)	444 (75.3)	417 (47.2)	419 (63.7)	556 (91.2)	674 (75.6)
Occupational exposure to organic dusts, n (%)	91 (15.1)	743 (87.9)	172 (29.8)	317 (35.6)	617 (71.8)	189 (46.9)	28 (6.3)	69 (10.4)	209 (27.2)	55 (9.3)	424 (49.1)	95 (14.4)	24 (3.9)	159 (17.8)
Farming, n (%)	91 (15.1)	739 (87.5)	163 (28.2)	307 (34.5)	617 (71.8)	182 (45.2)	21 (4.7)	52 (7.8)	184 (24.0)	38 (6.4)	416 (47.1)	64 (9.7)	21 (3.44)	128 (14.4)
Flour, feed or grain milling, n (%)	0 (0.0)	12 (1.4)	1 (0.2)	8 (0.9)	1 (0.1)	4 (1.0)	0 (0.0)	3 (0.5)	17 (2.2)	14 (2.4)	24 (2.7)	21 (3.2)	0 (0.0)	11 (1.2)
Cotton or jute processing, n (%)	98 (16.2)	5 (0.6)	8 (1.4)	17 (1.9)	0 (0.0)	9 (2.2)	8 (1.8)	16 (2.4)	18 (2.3)	7 (1.2)	16 (1.8)	24 (3.7)	3 (0.5)	29 (3.3)
Occupational exposure to inorganic dusts, n (%)	1 (0.2)	60 (7.1)	26 (4.5)	24 (2.7)	0 (0.0)	13 (3.2)	14 (3.1)	9 (1.4)	19 (2.5)	49 (8.3)	46 (5.2)	87 (13.2)	10 (1.6)	13 (1.5)
Hard-rock mining, n (%)	0 (0.0)	48 (5.7)	0 (0.0)	6 (0.7)	0 (0.0)	7 (1.7)	7 (1.6)	4 (0.6)	8 (1.0)	4 (0.7)	15 (1.7)	9 (1.4)	0 (0.0)	4 (0.5)
Coal mining, n (%)	0 (0.0)	2 (0.2)	0 (0.0)	14 (1.6)	0 (0.0)	2 (0.5)	1 (0.2)	3 (0.5)	2 (0.3)	7 (1.2)	3 (0.3)	4 (0.6)	0 (0.0)	0 (0.0)
Sandblasting, n (%)	0 (0.0)	7 (0.8)	1 (0.2)	3 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.6)	3 (0.4)	2 (0.3)	12 (1.4)	20 (3.0)	0 (0.0)	5 (0.6)
Working with asbestos, n (%)	1 (0.2)	5 (0.6)	25 (4.3)	2 (0.2)	0 (0.0)	6 (1.5)	6 (1.3)	1 (0.2)	10 (1.3)	39 (6.6)	24 (2.7)	73 (11.1)	10 (1.6)	6 (0.7)
Occupational exposure to fumes, n (%)	3 (0.5)	61 (7.2)	44 (7.6)	42 (4.7)	3 (0.4)	10 (2.5)	5 (1.1)	33 (5.0)	48 (6.3)	84 (14.2)	36 (4.1)	156 (23.7)	13 (2.1)	59 (6.6)
Chemical/plastics manufacturing, n (%)	0 (0.0)	18 (2.1)	13 (2.3)	18 (2.0)	0 (0.0)	2 (0.5)	1 (0.2)	20 (3.0)	15 (2.0)	43 (7.3)	8 (0.9)	102 (15.5)	4 (0.7)	19 (2.1)
Foundry or steel milling, n (%)	2 (0.3)	43 (5.1)	0 (0.0)	13 (1.5)	0 (0.0)	1 (0.3)	1 (0.2)	8 (1.2)	12 (1.6)	92 (12.2)	13 (1.5)	26 (4.4)	2 (0.3)	6 (0.7)
Welding, n (%)	1 (0.2)	4 (0.5)	29 (5.0)	12 (1.4)	3 (0.4)	3 (0.7)	3 (0.7)	7 (1.1)	25 (3.3)	35 (5.9)	22 (2.5)	64 (9.7)	8 (1.3)	33 (3.7)
Firefighting, n (%)	0 (0.0)	0 (0.0)	3 (0.5)	0 (0.0)	0 (0.0)	4 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.7)	2 (0.2)	6 (0.9)	0 (0.0)	6 (0.7)

Table 2. Participants from 41 sites of the BOLD Study across 11 work settings likely linked to significant exposure to particulates or fumes and loss of lung function (continued).

BOLD site	Philippines (Nampicuan & Talugtug)	Poland (Krakow)	Portugal (Lisbon)	Saudi Arabia (Riyadh)	South Africa (Uitsig & Ravensmead)	Sri Lanka	Sudan (Gezira)	Sudan (Khartoum)	Sweden (Uppsala)	Trinidad & Tobago	Tunisia (Sousse)	Turkey (Adana)	USA (Lexington, KY)
n	722	526	711	700	846	1,035	590	517	547	1,097	661	806	508
Unexposed to any high-risk occupation, n (%)	145 (20.1)	193 (36.7)	544 (76.5)	617 (88.1)	641 (75.8)	715 (69.1)	265 (44.9)	322 (62.3)	381 (69.7)	909 (82.9)	613 (92.7)	339 (42.1)	206 (40.6)
Occupational exposure to organic dusts, n (%)	574 (79.5)	176 (33.5)	132 (18.6)	60 (8.6)	92 (10.9)	228 (22.0)	291 (49.3)	124 (24.0)	91 (16.6)	96 (8.8)	23 (3.5)	436 (54.1)	211 (41.5)
Farming, n (%)	559 (77.4)	164 (31.2)	120 (16.9)	60 (8.6)	21 (2.5)	218 (21.1)	284 (48.1)	116 (22.4)	86 (15.7)	92 (8.4)	13 (2.0)	394 (48.9)	204 (40.2)
Flour, feed or grain milling, n (%)	8 (1.1)	18 (3.4)	2 (0.3)	0 (0.0)	16 (1.9)	3 (0.3)	13 (2.2)	8 (1.2)	25 (4.6)	4 (0.4)	2 (0.3)	15 (1.9)	19 (3.7)
Cotton or jute processing, n (%)	34 (4.7)	3 (0.6)	12 (1.7)	0 (0.0)	62 (7.3)	10 (1.0)	14 (2.4)	14 (2.7)	5 (1.0)	1 (0.1)	8 (1.2)	73 (9.1)	11 (2.2)
Occupational exposure to inorganic dusts, n (%)	17 (2.4)	139 (26.4)	10 (1.4)	3 (0.4)	44 (5.2)	21 (2.0)	31 (5.3)	11 (2.1)	49 (9.0)	27 (2.5)	6 (0.9)	18 (2.2)	116 (22.8)
Hard-rock mining, n (%)	4 (0.6)	27 (5.1)	2 (0.3)	0 (0.0)	8 (1.0)	9 (0.9)	26 (4.4)	4 (0.8)	8 (1.5)	2 (0.2)	5 (0.8)	7 (0.9)	15 (3.0)
Coal mining, n (%)	14 (1.9)	117 (22.2)	2 (0.3)	0 (0.0)	3 (0.4)	3 (0.3)	5 (0.9)	0 (0.0)	1 (0.2)	0 (0.0)	1 (0.2)	4 (0.5)	78 (15.4)
Sandblasting, n (%)	0 (0.0)	6 (1.1)	1 (0.1)	3 (0.4)	14 (1.7)	1 (0.1)	0 (0.0)	0 (0.0)	11 (2.0)	6 (0.6)	1 (0.2)	9 (1.1)	19 (3.7)
Working with asbestos, n (%)	1 (0.1)	13 (2.5)	5 (0.7)	0 (0.0)	30 (3.6)	10 (1.0)	2 (0.3)	7 (1.4)	36 (6.6)	21 (1.9)	0 (0.0)	0 (0.0)	41 (8.1)
Occupational exposure to fumes, n (%)	23 (3.2)	103 (19.6)	38 (5.3)	24 (3.4)	102 (12.0)	17 (1.6)	35 (5.9)	26 (5.0)	87 (15.9)	74 (6.8)	19 (2.9)	50 (6.2)	140 (27.6)
Chemical/plastics manufacturing, n (%)	7 (1.0)	29 (5.5)	35 (3.5)	8 (1.1)	54 (6.4)	5 (0.5)	12 (2.0)	11 (2.1)	37 (6.8)	20 (1.8)	4 (0.6)	15 (1.9)	60 (11.8)
Foundry or steel milling, n (%)	4 (0.6)	19 (3.6)	59 (9.0)	0 (0.0)	16 (1.9)	0 (0.0)	2 (0.3)	2 (0.4)	21 (3.8)	5 (0.5)	2 (0.3)	16 (2.0)	33 (6.5)
Welding, n (%)	13 (1.8)	46 (8.8)	9 (1.3)	14 (2.0)	47 (5.6)	12 (1.2)	23 (3.9)	14 (2.7)	42 (7.7)	52 (4.7)	14 (2.1)	28 (3.5)	71 (14.0)
Firefighting, n (%)	0 (0.0)	20 (3.8)	2 0.3)	2 (0.3)	1 (0.1)	0 (0.0)	2 (0.3)	3 (0.6)	9 (1.7)	2 (0.2)	1 (0.2)	4 (0.5)	24 (4.7)

Table S1. Categorisation of occupations collected by the BOLD Study.

High-risk occupations*	Longest held occupations (ISCO-88)**	
Organic dust		
Farming	6111	Field crop & vegetable growers
	6112	Gardeners, horticultural & nursery growers
	6121	Dairy & livestock producers
	6122	Poultry producers
	6129	Animal producers & related workers
	6130	Crop & animal producers
	6141	Forestry workers & logger
	6142	Charcoal burners & related workers
	8331	Motorised farm & forestry plant operators
	9211	Farm hands & labourers
	9212	Forestry labourers
Flour, feed or grain milling	8273	Grain & spice milling machine operators
	8274	Baked goods & cereal products machine operators
Cotton or jute processing	8261	Fibre preparing, spinning & winding machine operators
	8262	Weaving and knitting machine operators
	8263	Sewing machine operators
	8264	Bleaching, dyeing & cleaning machine operators
	8265	Fur & leather preparing machine operators†
	8269	Textile, fur & leather products machine operators†
Inorganic dust		
Hardrock mining	7111	Miners & quarry workers
	7113	Stone splitters, cutters & carvers
	9311	Mining & quarrying labourers
Coal mining	8111	Mining plant operators
	8112	Mineral ore & stone processing plant operators
	9311	Mining & quarrying labourers
Sandblasting	7143	Building structure cleaners
Working with asbestos	7124	Carpenters & joiners
	7131	Roofers
	7136	Plumbers & pipe fitters
	7137	Building & related electricians

Table S1. Categorisation of occupations collected by the BOLD Study (continued).

High-risk occupations*	Longest held occupations (ISCO-88)**	
Fumes		
Chemical or plastics manufacturing	8151	Crushing, grinding & chemical mixing machinery operators
	8152	Chemical heat-treating plant operators
	8153	Chemical filtering & separating equipment operators
	8154	Chemical still & reactor operators
	8155	Petroleum & natural gas refining plant operators
	8159	Chemical processing plant operators
	8221	Pharmaceutical & toiletry products machine operators
	8223	Metal finishing, plating & coating machine operators
	8224	Photographic products machine operators
	8229	Chemical products machine operators
	8231	Rubber products machine operators
	8232	Plastic products machine operators
	8284	Metal, rubber & plastic products assemblers
Foundry or steel milling	7211	Metal moulders & coremakers
	7221	Blacksmiths, hammer smiths & forging press workers
	8121	Ore & metal furnace operators
	8122	Metal melters, casters & rolling mill operators
	8123	Metal heat-treating plant operators
	8124	Metal drawers & extruders
Welding	7211	Metal moulders & coremakers
	7212	Welders & flame cutters
	7213	Sheetmetal workers
	7214	Structural metal preparers & erectors
	7215	Riggers & cable splicers
	7231	Motor vehicle mechanics & fitters
	7232	Aircraft engine mechanics & fitters
	7233	Agricultural or industrial machinery mechanics & fitters
Firefighting	5161	Firefighters

*High-risk occupations classified by US Department of Labour Dictionary of Occupational Titles (4th Ed., Rev. 1991)
**Longest held jobs classified by the International Standard Classification of Occupations (ISCO-88)
†This study included only participants responding to these codes and specifying work in cotton or jute processing industries

Table S2. Association of post-bronchodilator spirometric parameters with occupational variables.

			FEV_1/FVC (%)†				FVC (%)††			
		n	Mean (SE)	β (95% CI)	I^2(%)	p-trend	Mean (SE)	β (95% CI)	I^2(%)	p-trend
Unexposed to any high-risk occupation		18,484	79.28 (0.19)	reference			3.09 (0.02)	reference		
Occupational exposure to organic dusts		7,612	77.32 (0.32)	-0.16 (-0.44 to 0.13)	NS		3.37 (0.03)	0.01 (-0.01 to 0.03)	NS	
Farming	<20 years	3,250	77.80 (0.51)	0.14 (-0.24 to 0.52)	NS	0.95	3.47 (0.03)	0.04 (-0.01 to 0.09)	77.9%	0.80
	≥20 years	3,828	76.37 (0.39)	0.04 (-0.49 to 0.58)	50.0%		3.25 (0.04)	0.02 (-0.02 to 0.06)	53.2%	
Flour, feed or grain milling	<5 years	192	77.27 (2.10)	-0.84 (-3.96 to 2.29	97.0%	0.84	3.92 (0.22)	-0.01 (-0.22 to 0.21)	96.1%	0.93
	≥5 years	219	74.64 (1.99)	-0.27 (-2.07 to 1.53)	93.3%		3.70 (0.22)	0.02 (-0.06 to 0.11)	86.9%	
Cotton or jute processing	<7 years	251	80.19 (0.90)	1.02 (-0.03 to 2.07)	66.7%	0.82	3.44 (0.31)	-0.12 (-0.24 to 0.00)	88.7%	0.88
	≥7 years	265	76.57 (0.97)	0.32 (-0.90 to 1.54)	87.1%		3.02 (0.08)	0.02 (-0.08 to 0.11)	85.3%	
Occupational exposure to inorganic dusts		1,287	76.58 (0.79)	-0.19 (-0.76 to 0.38)	NS		3.92 (0.08)	0.02 (-0.04 to 0.08)	64.1%	
Hard-rock mining	<3 years	164	74.58 (4.18)	-0.68 (-2.25 to 0.89)	78.4%	0.79	3.79 (0.09)	0.03 (-0.21 to 0.28)	96.9%	0.95
	≥3 years	171	71.61 (3.30)	-0.39 (-2.63 to 1.85)	94.1%		3.64 (0.22)	0.01 (-0.17 to 0.20)	94.0%	
Coal mining	<13 years	157	74.63 (0.53)	0.13 (-2.53 to 2.79)	97.0%	<0.05	3.79 (0.07)	-0.07 (-0.21 to 0.08)	90.7%	0.78
	≥13 years	156	74.05 (1.97)	-0.48 (-3.36 to 2.41)	94.3%		3.99 (0.12)	0.05 (-0.22 to 0.32)	97.1%	
Sandblasting	<3 years	102	73.20 (3.50)	0.15 (-3.39 to 3.69)	94.8%	0.27	3.86 (0.15)	-0.03 (-0.22 to 0.15)	92.7%	0.98
	≥3 years	108	70.83 (0.63)	-0.93 (-6.09 to 4.22)	99.4%		3.60 (0.05)	-0.03(-0.15 to 0.08)	89.9%	
Working with asbestos	<7 years	313	75.71 (0.65)	-1.80 (-4.60 to 1.01)	93.6%	0.72	4.17 (0.07)	-0.07 (-0.28 to 0.14)	95.0%	0.21
	≥7 years	310	78.10 (1.13)	0.19 (-1.25 to 1.63)	74.6%		3.96 (0.10)	-0.05 (-0.20 to 0.10)	90.8%	
Occupational exposure to fumes		2,352	76.42 (0.61)	0.13 (-0.65 to 0.92)	78.8%		3.78 (0.05)	0.00 (-0.03 to 0.04)	NS	
Chemical or plastics manufacturing	<9 years	443	76.29 (1.50)	0.13 (-0.84 to 1.10)	74.3%	0.28	3.68 (0.07)	0.01 (-0.06 to 0.08)	61.7%	0.86
	≥9 years	449	76.27 (1.31)	-0.65 (-1.84 to 0.54)	70.6%		3.59 (0.10)	-0.02 (-0.15 to 0.11)	89.7%	
Foundry or steel milling	<10 years	335	76.69 (0.96)	-0.68 (-2.14 to 0.79)	79.1%	0.16	3.90 (0.17)	0.04 (-0.10 to 0.18)	88.2%	0.06
	≥10 years	365	76.34 (2.68)	-1.70 (-4.73 to 1.33)	95.1%		3.84 (0.22)	-0.17* (-0.33 to -0.01)	87.9%	
Welding	<10 years	506	77.45 (0.71)	-0.25 (-1.79 to 1.28)	87.3%	0.07	4.03 (0.06)	0.04 (-0.27 to 0.35)	98.3%	0.32
	≥10 years	562	75.61 (1.59)	0.93 (-0.13 to 1.99)	76.4%		3.85 (0.07)	-0.04 (-0.12 to 0.04)	79.2%	
Firefighting	<13 years	100	77.20 (1.24)	1.73* (0.30 to 3.16)	86.8%	0.38	3.91 (0.10)	0.06 (-0.11 to 0.23)	94.0%	0.39
	≥13 years	102	76.38 (1.29)	-0.51 (-2.89 to 1.87)	96.9%		4.20 (0.11)	-0.05 (-0.18 to 0.08)	92.4%	

Means (SE) were from all 41-site participants together. †The coefficients (β) were adjusted for sex, age (years) and smoking status (never, <20 pack-years, ≥20 pack-years). ††The coefficients (β) were adjusted for sex, age (years), height (cm) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S3. Association of FEV_1/FVC (%) with groups of organic dust jobs stratified by sex and sites' country economy.

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**
Organic dusts (all)											
Overall	unexposed to any	7,443	78.48 (0.28)	reference			11,041	79.99 (0.17)	reference		
	<20 years	2,005	77.48 (0.73)	0.13 (-0.46 to 0.71)	NS	0.65	1,626	78.90 (0.60)	0.07 (-0.40 to 0.55)	NS	0.80
	≥20 years	2,282	75.18 (0.45)	-0.95* (-1.48 to -0.42)	88.9%		1,699	78.53 (0.59)	0.75 (-0.26 to 1.77)	86.6%	
HICs	unexposed to any	3,023	78.15 (0.26)	reference			4,280	78.98 (0.17)	reference		
	<20 years	773	77.39 (0.77)	0.43 (-0.38 to 1.23)	NS	0.76	547	77.22 (0.44)	-0.29 (-0.96 to 0.38)	NS	0.83
	≥20 years	232	75.53 (0.87)	**-0.34* (-0.42** to **-0.27)**	**NS**		190	76.11 (1.19)	1.38 (-1.67 to 4.42)	90.1%	
LMICs	unexposed to any	4,420	78.56 (0.33)	reference			6,761	80.29 (0.21)	reference		
	<20 years	1,232	77.50 (0.86)	-0.05 (-0.83 to 0.74)	50.5%	0.56	1,079	79.45 (0.80)	0.23 (-0.40 to 0.85)	NS	0.85
	≥20 years	2,050	75.14 (0.48)	-1.01 (-2.77 to 0.75)	92.2%		1,509	78.96 (0.63)	0.41 (-0.57 to 1.39)	83.4%	
Organic dusts (never-smokers)											
Overall	unexposed to any	3,144	79.78 (0.27)	reference			8,437	80.27 (0.18)	reference		
	<20 years	819	76.81 (2.58)	0.16 (-0.65 to 0.97)	57.4%	0.53	1,227	79.34 (0.68)	0.07 (-0.39 to 0.54)	NS	0.50
	≥20 years	987	76.42 (0.60)	-0.36 (-1.37 to 0.65)	71.6%		1,471	79.20 (0.57)	0.44 (-0.63 to 1.51)	90.3%	
HICs	unexposed to any	1,126	79.94 (0.33)	reference			2,551	80.20 (0.16)	reference		
	<20 years	248	78.34 (0.65)	0.04 (-1.02 to 1.09)	NS	0.88	298	78.25 (0.50)	-0.35 (-1.13 to 0.43)	NS	<0.05
	≥20 years	82	79.02 (1.48)	-0.69 (-3.09 to 1.72)	80.8%		136	76.65 (1.48)	0.17 (-2.45 to 2.80)	89.0%	
LMICs	unexposed to any	2,018	79.75 (0.32)	reference			5,886	80.29 (0.21)	reference		
	<20 years	571	76.57 (2.95)	0.16 (-0.98 to 1.30)	65.3%	0.40	929	79.60 (0.85)	0.23 (-0.39 to 0.85)	NS	0.85
	≥20 years	905	76.24 (0.63)	-0.20 (-1.23 to 0.84)	62.6%		1,335	79.57 (0.59)	0.56 (-0.61 to 1.73)	90.7%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S4. Association of FVC (L) with groups of organic dust jobs stratified by sex and sites' country economy

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**
Organic dusts (all)											
Overall	unexposed to any	7,443	3.60 (0.03)	reference			11,041	2.64 (0.04)	reference		
	<20 years	2,005	3.74 (0.07)	0.02 (-0.02 to 0.07)	NS	0.87	1,626	2.89 (0.05)	0.04 (0.00 to 0.08)	63.1%	<0.05
	≥20 years	2,282	3.57 (0.05)	-0.02 (-0.07 to 0.03)	52.0%		1,699	2.63 (0.05)	0.03 (-0.05 to 0.11)	88.3%	
HICs	unexposed to any	3,023	4.00 (0.04)	reference			4,280	2.84 (0.02)	reference		
	<20 years	773	4.06 (0.06)	0.01 (-0.05 to 0.06)	NS	<0.05	547	2.89 (0.05)	0.01 (-0.04 to 0.06)	NS	0.05
	≥20 years	232	3.73 (0.07)	**-0.18* (-0.32** to **-0.04)**	**NS**		190	2.72 (0.08)	0.02 (-0.17 to 0.21)	90.7%	
LMICs	unexposed to any	4,420	3.51 (0.05)	reference			6,761	2.58 (0.06)	reference		
	<20 years	1,232	3.67 (0.07)	0.03 (-0.04 to 0.09)	51.5%	0.14	1,079	2.89 (0.07)	0.05 (-0.01 to 0.11)	72.9%	0.15
	≥20 years	2,050	3.55 (0.05)	0.02 (-0.03 to 0.07)	NS		1,509	2.61 (0.06)	0.04 (-0.04 to 0.13)	86.6%	
Organic dusts (never-smokers)											
Overall	unexposed to any	3,144	3.53 (0.04)	reference			8,437	2.60 (0.04)	reference		
	<20 years	819	3.50 (0.20)	-0.06 (-0.16 to 0.03)	78.4%	0.69	1,227	2.87 (0.06)	0.04 (0.00 to 0.09)	62.4%	<0.05
	≥20 years	987	3.46 (0.05)	0.01 (-0.09 to 0.12)	81.5%		1,471	2.61 (0.04)	0.05 (-0.04 to 0.14)	92.0%	
HICs	unexposed to any	1,126	3.95 (0.07)	reference			2,551	2.69 (0.02)	reference		
	<20 years	248	4.00 (0.08)	0.00 (-0.10 to 0.10)	NS	<0.05	298	2.79 (0.06)	0.03 (-0.03 to 0.09)	NS	0.13
	≥20 years	82	3.66 (0.12)	-0.24* (-0.47 to -0.02)	67.2%		136	2.73 (0.10)	0.09 (-0.12 to 0.30)	91.4%	
LMICs	unexposed to any	2,018	3.45 (0.04)	reference			5,886	2.58 (0.06)	reference		
	<20 years	571	3.42 (0.22)	-0.08 (-0.21 to 0.05)	84.9%	0.59	929	2.89 (0.07)	0.05 (-0.01 to 0.12)	73.9%	0.17
	≥20 years	905	3.44 (0.06)	0.10 (-0.01 to 0.20)	80.5%		1,335	2.59 (0.05)	0.04 (-0.06 to 0.13)	92.5%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years), height (cm) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S5. Association of FEV_1/FVC (%) with groups of inorganic dust jobs stratified by sex and sites' country economy

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**
Inorganic dusts (all)											
Overall	unexposed to any	7,443	78.48 (0.28)	reference			11,041	79.99 (0.17)	reference		
	<6 years	550	76.48 (1.73)	0.19 (-0.91 to 1.30)	72.8%	0.73	77	75.10 (1.68)	0.09 (-2.43 to 2.61)	97.4%	0.56
	≥6 years	606	76.68 (1.26)	-0.04 (-0.78 to 0.71)	NS		54	77.50 (0.43)	0.73* (0.02 to 1.44)	98.4%	
HICs	unexposed to any	3,023	78.15 (0.26)	reference			4,280	78.98 (0.17)	reference		
	<6 years	344	75.47 (0.65)	0.54 (-1.12 to 2.21)	77.9%	0.13	43	74.85 (1.47)	-0.61 (-6.56 to 5.34)	97.3%	0.99
	≥6 years	235	75.75 (0.67)	0.91 (-0.33 to 2.14)	NS		14	77.59 (0.99)	-0.32 (-3.29 to 2.66)	96.1%	
LMICs	unexposed to any	4,420	78.56 (0.33)	reference			6,761	80.29 (0.21)	reference		
	<6 years	206	77.66 (3.63)	-0.15 (-1.72 to 1.42)	69.8%	0.08	34	75.96 (5.56)	0.82 (-0.92 to 2.57)	90.1%	0.42
	≥6 years	371	76.97 (1.66)	-0.59 (-1.31 to 0.13)	NS		40	77.42 (0.07)	1.53 (-1.13 to 4.20)	98.9%	
Inorganic dusts (never-smokers)											
Overall	unexposed to any	3,144	79.78 (0.27)	reference			8,437	80.27 (0.18)	reference		
	<6 years	154	79.96 (1.41)	1.12 (-0.48 to 2.72)	86.0%	0.11	43	76.82 (0.41)	-0.28 (-4.27 to 3.70)	99.4%	<0.01
	≥6 years	191	82.11 (1.38)	0.97 (-1.00 to 2.93)	93.8%		33	77.16 (0.60)	0.62 (-2.19 to 3.44)	98.3%	
HICs	unexposed to any	1,126	79.94 (0.33)	reference			2,551	80.20 (0.16)	reference		
	<6 years	83	77.57 (1.06)	0.63 (-1.92 to 3.18)	85.7%	0.79	18	78.23 (0.56)	0.86 (-4.94 to 6.66)	99.1%	0.25
	≥6 years	52	78.88 (0.80)	0.21 (-2.91 to 3.33)	94.3%		5	81.71 (2.26)	0.04 (-6.42 to 6.50)	98.5%	
LMICs	unexposed to any	2,018	79.75 (0.32)	reference			5,886	80.29 (0.21)	reference		
	<6 years	71	81.39 (1.73)	1.47 (-0.75 to 3.69)	87.1%	0.14	25	72.98 (0.14)	-1.44 (-6.94 to 4.05)	99.5%	<0.001
	≥6 years	139	82.69 (1.60)	1.42 (-1.33 to 4.17)	93.7%		28	75.61 (0.09)	0.84 (-2.41 to 4.09)	98.2%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S6. Association of FVC (L) with groups of inorganic dust jobs stratified by sex and sites' country economy.

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**
Inorganic dusts (all)											
Overall	unexposed to any	7,443	3.60 (0.03)	reference			11,041	2.64 (0.04)	reference		
	<6 years	550	4.05 (0.05)	-0.02 (-0.14 to 0.10)	88.4%	0.18	77	2.87 (0.08)	0.04 (-0.19 to 0.27)	98.6%	0.09
	≥6 years	606	3.95 (0.11)	0.05 (-0.03 to 0.12)	66.4%		54	2.80 (0.08)	0.01 (-0.15 to 0.16)	95.7%	
HICs	unexposed to any	3,023	4.00 (0.04)	reference			4,280	2.84 (0.02)	reference		
	<6 years	344	4.38 (0.07)	-0.04 (-0.19 to 0.10)	80.5%	0.34	43	3.03 (0.06)	0.01 (-0.38 to 0.41)	98.3%	0.06
	≥6 years	235	4.18 (0.07)	0.05 (-0.06 to 0.15)	NS		14	3.17 (0.15)	0.23 (-0.11 to 0.57)	97.5%	
LMICs	unexposed to any	4,420	3.51 (0.05)	reference			6,761	2.58 (0.06)	reference		
	<6 years	206	3.65 (0.10)	-0.01 (-0.19 to 0.16)	91.1%	0.33	34	2.29 (0.26)	0.07 (-0.18 to 0.33)	98.2%	<0.001
	≥6 years	371	3.88 (0.14)	0.05 (-0.05 to 0.14)	73.5%		40	2.52 (0.09)	-0.13* (-0.26 to 0.00)	88.8%	
Inorganic dusts (never-smokers)											
Overall	unexposed to any	3,144	3.53 (0.04)	reference			8,437	2.60 (0.04)	reference		
	<6 years	154	3.90 (0.06)	-0.03 (-0.19 to 0.13)	90.4%	0.22	43	2.83 (0.01)	0.04 (-0.25 to 0.33)	99.2%	<0.05
	≥6 years	191	3.91 (0.17)	0.06 (-0.02 to 0.14)	71.3%		33	2.64 (0.02)	0.03 (-0.17 to 0.24)	96.6%	
HICs	unexposed to any	1,126	3.95 (0.07)	reference			2,551	2.69 (0.02)	reference		
	<6 years	83	4.49 (0.10)	0.01 (-0.20 to 0.21)	78.6%	<0.05	18	2.97 (0.02)	0.02 (-0.61 to 0.64)	99.4%	0.17
	≥6 years	52	4.11 (0.12)	0.11 (-0.01 to 0.23)	56.8%		5	3.50 (0.03)	**0.60* (0.53** to **0.66)**	**NS**	
LMICs	unexposed to any	2,018	3.45 (0.04)	reference			5,886	2.58 (0.06)	reference		
	<6 years	71	3.55 (0.15)	-0.05 (-0.29 to 0.18)	93.5%	0.75	25	2.45 (0.03)	0.08 (-0.21 to 0.38)	98.6%	<0.001
	≥6 years	139	3.87 (0.20)	0.03 (-0.07 to 0.13)	76.8%		28	2.35 (0.03)	-0.15* (-0.29 to 0.00)	87.4%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years), height (cm) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S7. Association of FEV_1/FVC (%) with groups of fume jobs stratified by sex and sites' country economy.

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	I^2**(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	I^2**(%)**	**p-trend**
Fumes (all)											
Overall	unexposed to any	7,443	78.48 (0.28)	reference			11,041	79.99 (0.17)	reference		
	<11 years	951	77.62 (0.69)	0.22 (-0.74 to 1.18)	74.4%	0.45	229	77.57 (1.10)	-0.51 (-1.63 to 0.60)	82.4%	<0.05
	≥11 years	1,002	75.23 (1.02)	**-0.28* (-0.39** to **-0.17)**	**NS**		170	78.82 (1.87)	-0.79 (-2.12 to 0.54)	94.8%	
HICs	unexposed to any	3,023	78.15 (0.26)	reference			4,280	78.98 (0.17)	reference		
	<11 years	595	75.44 (0.71)	-0.43 (-1.13 to 0.28)	NS	0.73	159	76.69 (1.03)	-0.21 (-1.70 to 1.29)	76.6%	0.18
	≥11 years	479	76.32 (0.65)	0.08 (-0.70 to 0.86)	NS		76	77.59 (1.49)	-0.78 (-2.91 to 1.35)	87.8%	
LMICs	unexposed to any	4,420	78.56 (0.33)	reference			6,761	80.29 (0.21)	reference		
	<11 years	356	79.21 (1.09)	0.69 (-0.63 to 2.01)	75.4%	0.37	70	78.99 (2.52)	-0.82 (-2.18 to 0.53)	61.0%	0.10
	≥11 years	523	74.88 (1.31)	**-0.29* (-0.41** to **-0.16)**	**NS**		94	79.43 (2.58)	-0.78 (-2.75 to 1.20)	96.3%	
Fumes (never-smokers)											
Overall	unexposed to any	3,144	79.78 (0.27)	reference			8,437	80.27 (0.18)	reference		
	<11 years	266	79.80 (0.76)	0.48 (-0.65 to 1.61)	77.9%	0.55	104	78.62 (1.68)	-1.01 (-2.76 to 0.74)	95.8%	0.50
	≥11 years	311	79.66 (1.29)	0.16 (-1.22 to 1.54)	85.0%		114	79.48 (1.94)	0.09 (-1.99 to 2.17)	97.0%	
HICs	unexposed to any	1,126	79.94 (0.33)	reference			2,551	80.20 (0.16)	reference		
	<11 years	163	79.05 (0.68)	0.69 (-0.52 to 1.89)	NS	0.58	56	78.03 (1.06)	-1.47 (-5.19 to 2.25)	98.1%	0.95
	≥11 years	133	79.30 (0.87)	-0.54 (-1.91 to 0.83)	NS		41	80.21 (1.17)	0.43 (-2.54 to 3.41)	97.2%	
LMICs	unexposed to any	2,018	79.75 (0.32)	reference			5,886	80.29 (0.21)	reference		
	<11 years	103	80.25 (1.19)	0.34 (-1.38 to 2.07)	85.1%	0.32	48	79.00 (2.70)	-0.45 (-1.79 to 0.89)	72.3%	0.47
	≥11 years	178	79.78 (1.70)	0.76 (-1.06 to 2.58)	88.9%		73	79.24 (2.60)	-0.31 (-3.69 to 3.07)	97.0%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.

Table S8. Association of FVC (L) with groups of fume jobs stratified by sex and sites' country economy.

		Men					Women				
		n	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**	***n***	**Mean (SE)**	**β (95% CI)**	**I^2(%)**	**p-trend**
Fumes (all)											
Overall	unexposed to any	7,443	3.60 (0.03)	reference			11,041	2.64 (0.04)	reference		
	<11 years	951	3.97 (0.06)	-0.02 (-0.08 to 0.05)	57.6%	0.77	229	3.15 (0.06)	0.11 (-0.01 to 0.23)	89.7%	<0.05
	≥11 years	1,002	3.86 (0.08)	0.00 (-0.06 to 0.06)	54.6%		170	2.97 (0.11)	-0.01 (-0.14 to 0.11)	95.2%	
HICs	unexposed to any	3,023	4.00 (0.04)	reference			4,280	2.84 (0.02)	reference		
	<11 years	595	4.37 (0.05)	-0.04 (-0.14 to 0.05)	56.8%	0.84	159	3.17 (0.05)	0.10 (-0.06 to 0.25)	85.5%	0.82
	≥11 years	479	4.05 (0.05)	0.00 (-0.07 to 0.08)	NS		76	2.96 (0.09)	0.03 (-0.08 to 0.15)	80.5%	
LMICs	unexposed to any	4,420	3.51 (0.05)	reference			6,761	2.58 (0.06)	reference		
	<11 years	356	3.67 (0.09)	0.01 (-0.09 to 0.10)	57.1%	0.98	70	3.13 (0.15)	0.12 (-0.06 to 0.30)	91.5%	<0.05
	≥11 years	523	3.80 (0.10)	-0.01 (-0.09 to 0.07)	63.2%		94	2.98 (0.16)	-0.05 (-0.25 to 0.15)	96.4%	
Fumes (never-smokers)											
Overall	unexposed to any	3,144	3.53 (0.04)	reference			8,437	2.60 (0.04)	reference		
	<11 years	266	3.77 (0.07)	-0.05 (-0.27 to 0.18)	96.0%	0.63	104	3.12 (0.11)	0.11 (-0.03 to 0.24)	92.8%	<0.01
	≥11 years	311	3.70 (0.12)	-0.01 (-0.10 to 0.08)	75.8%		114	2.98 (0.13)	0.03 (-0.11 to 0.18)	95.9%	
HICs	unexposed to any	1,126	3.95 (0.07)	reference			2,551	2.69 (0.02)	reference		
	<11 years	163	4.31 (0.11)	-0.07 (-0.21 to 0.08)	63.1%	0.45	56	3.02 (0.10)	0.08 (-0.11 to 0.28)	92.5%	<0.05
	≥11 years	133	4.11 (0.07)	0.06 (-0.11 to 0.22)	55.5%		41	2.97 (0.12)	0.13* (0.01 to 0.26)	85.0%	
LMICs	unexposed to any	2,018	3.45 (0.04)	reference			5,886	2.58 (0.06)	reference		
	<11 years	103	3.46 (0.08)	-0.04 (-0.39 to 0.30)	97.5%	0.96	48	3.18 (0.15)	0.13 (-0.06 to 0.31)	90.9%	<0.01
	≥11 years	178	3.56 (0.16)	-0.03 (-0.14 to 0.07)	80.6%		73	2.99 (0.17)	-0.08 (-0.27 to 0.11)	95.6%	

HICs: high-income countries; LMICs low- and middle-income countries classified by the World Bank; never-smokers stratification included only participants reporting 'never-smoking'. All Means (SE) were from all 41-site participants; HIC Means (SE) were from 14 high-income site participants; LMIC Means (SE) were from 27 low- and middle-income site participants. The coefficients (β) were adjusted for age (years), height (cm) and smoking status (never, <20 pack-years, ≥20 pack-years). *p<0.05; NS non-statistically significant (p≥0.05) heterogeneity (I^2); both p<0.05 and I^2=NS in bold.