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Respiratory Symptoms and Occupational Dust Exposure In US Veterans

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Abstract

PROBLEM—Occupational exposure to organic and inorganic dusts may result in symptoms of chronic respiratory disease.

METHOD—To investigate the utility of obtaining a history of occupational exposure to dust in US veterans, a respiratory health survey was conducted between 1988 and 1992. They were asked for history of cough, phlegm, and wheeze, and occupational dust exposures. Information on cigarette use and other possible confounders was also obtained.

RESULTS—In 2,617 white males, after adjusting for cigarette smoking, age, distance to the nearest major roadway, and chronic respiratory disease, there was an overall 2-fold increased risk of all three respiratory symptoms attributable to occupational dust exposure. The odds ratio (OR) increased based on exposure intensity.

CONCLUSIONS—After considering possible confounders, dust exposure was associated with respiratory symptoms, with the greatest risk attributable to heavy intensity exposure.

Keywords

occupational dust exposure; respiratory symptoms; US Veterans

Introduction

Although cigarette smoking results in chronic cough, phlegm, and wheeze, these symptoms can also occur due to occupational dust exposure. Specifically, exposure to inorganic dusts such as those found in the coal (1–4), gold (5,6), and hard rock (7) mining industries, or to organic dusts such as found in cotton processing (8–11) or associated with various farm related and agricultural jobs (12–17) may result in an excess of these symptoms. General population surveys conducted in six US cities (18), Europe (8,19–24), and China (25) found elevated risks of respiratory symptoms attributable to occupational dust exposure. In veterans treated at US

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Department of Veterans Affairs (DVA) Medical Centers, potentially significant occupational exposures have been noted (26,27), but the relationship between occupational exposures and respiratory health has not been assessed in this population. In this report, we describe the results of an assessment of occupational dust exposure as a risk factor for respiratory symptoms in a cohort of US veterans from southeastern Massachusetts taking into account the effects of cigarette smoking and other possible confounders.

Methods

Population

A two-page health questionnaire was mailed to 5,654 male veterans between 1988–1992 who lived in southeastern Massachusetts, who were eligible for medical care and living in the community, but had not been treated in a DVA medical center in the year preceding the mailing. The purpose of the survey was to obtain information regarding the prevalence and potential risk factors for respiratory symptoms and chronic illnesses in veterans eligible for healthcare benefits. Addresses were obtained from the DVA, and efforts were made to include veterans residing in proximity to the Brockton Massachusetts Veterans Affairs Hospital, the VA Medical Center in southeastern Massachusetts. Addresses were selected based on ZIP codes. Subjects were invited by letter to participate in a respiratory health survey. After two mailings, 2,985 completed questionnaires were received, representing an overall response rate of 58.4% once incorrect addresses and deceased subjects were omitted. Additional details have been described previously (28). Analysis was limited to 2,617 white males with information available regarding smoking status (current/former/never) and dust exposure (yes/no). There were too few subjects of other races or genders to draw meaningful conclusions. Approval was obtained from the VA Boston Healthcare System and Brigham and Women's Hospital Institutional Review Boards.

Questionnaire and Dust Exposure

The assessment of occupational exposure to dust was based on questions adapted from the American Thoracic Society (ATS) DLD-78 adult respiratory questionnaire (29), and included the question: "Have you ever worked in a dusty job (yes/no)?" Subjects were asked to write the year exposures started and stopped, the type of dust exposure, and indicate the intensity of exposure (mild, moderate, or heavy). The response to type of dust exposure was reviewed and categorized as organic dusts, metals, other inorganic dusts, ill-defined and non-specific dusts and dirt, and if fumes were noted instead of dust. If more than one dust type was listed, the category was based on the first type listed by the respondent. Smoking history and cough, phlegm, and wheeze history were also based on the ATS respiratory questionnaire (29). Subjects were asked whether they had doctor-diagnosed asthma, emphysema, chronic bronchitis, heart attack, angina, and other heart disorders. Questions were also included to obtain information on years of education, usual job, and employment status.

Traffic Exposure, Urban Residence, Occupation, and Socioeconomic Status

Using ArcGIS (ESRI, Redlands, CA), geographic information system (GIS) methodology was used to link each respondent's home address to the nearest major roadway, to 1990 Census socioeconomic status indicators, and urban or rural designation (30) for 2,600 members (99.4%) of the cohort. Analyses specific to the assessment of exposure to motor vehicle exhaust has been described in detail elsewhere (28), and was based on residential distance from a major roadway and average daily traffic (ADT) values. Socioeconomic status was estimated using variables for block level median housing value, median monthly rent, median yearly household income, per capita yearly income, number of persons in poverty, and percent in poverty. Usual job was coded based on the 1980 Occupational Classification System of 3-digit job classifications (31) and grouped by occupational category. Current employment status was

grouped as unemployed, employed, or retired, and educational status was grouped as less than high school, completion of high school, and greater than high school.

Statistical Analysis

Multiple logistic regression models were used to examine the association of dust exposure with each respiratory symptom. Exposure to occupational dust was modeled using indicator variables for dust (ever/never exposed), intensity of exposure, type of exposures, duration of exposure (in years), and years since last exposure. The relationship between categories of dust intensity (mild, moderate, or heavy) and each respiratory symptom was assessed by a test for trend. “Chronic cough” was defined as cough on most days for 3 consecutive months or more during the year; “chronic phlegm”, as phlegm on most days for 3 consecutive months or more during the year; and “persistent wheeze”, as wheezing with a cold and occasionally apart from colds, or on most days or nights. Age was calculated based on the year of questionnaire return minus the year of birth and modeled as a continuous variable. A smoker was defined as smoking 20 or more packs of cigarettes in a lifetime or more than 1 cigarette per day for 1 year. A current smoker had smoked cigarettes within one month of questionnaire completion. Indicator variables for “current smoker”, “former smoker”, and continuous variables for current number of cigarettes per day and years since quit smoking were considered.

Regression models were examined for potential confounding by age, smoking, job category, employment, education, proximity to and ADT of the nearest major roadway, urban residence, chronic respiratory or heart disease, and socioeconomic status. We also assessed effect modification, i.e., whether the effects of dust exposure on the occurrence of respiratory symptoms might vary based on respiratory and cardiac disease, educational status, employment status, age, and cigarette smoking history. Heart disease was defined as having had doctor diagnosed angina, myocardial infarction, or other heart disorders. Chronic obstructive pulmonary disease (COPD) was defined as either having had doctor diagnosed emphysema or chronic bronchitis, and chronic respiratory disease was defined as either doctor diagnosed asthma and/or COPD. In separate regression models, block level median housing value, median monthly rent, median yearly household income, per capita yearly income, number of persons in poverty, and percent in poverty were considered as both continuous and dichotomous variables for values above and below the median. Indicator variables were used for adjustment of missing values in regression models.

Results

Cohort Description

The mean age of the population was 60.3 ± 12.7 years, and the prevalence of smoking, medical conditions, educational status, usual job category, census variables, and residential distance from a major road are provided in Table 1 categorized based on dust exposure. Most respondents lived in urban areas (Table 1), were retired, and only 21.7% reported that their usual job was professional or managerial. Not unexpectedly, the two groups varied by job classification and those with dust exposure were less likely to continue their education after high school. The exposed were also slightly more likely to be current smokers and the prevalence of chronic diseases was greater in this group. A description of dust exposure in the cohort is presented in Table 2. The mean duration of dust exposure for exposed subjects was 15.9 ± 13.1 years ($n=1,009$). Subjects with mild, moderate, and heavy intensity exposure had similar mean years of exposure (16.7, 16.3, 13.9 yrs, respectively).

Occupational Dust Exposure

In models unadjusted for other covariates, occupational dust exposure (yes/no; Table 3) was a significant predictor of persistent wheeze, chronic cough, and chronic phlegm. The OR of each

respiratory symptom increased with increasing exposure intensity, and the tests for trend were statistically significant. The ORs for each symptom were also elevated regardless of the type of dust reported with slight variation among dust types. There was no evidence of increased risk of each respiratory symptom with increasing years of occupational dust exposure, including models assessing years of exposure for categories of mild, moderate, and heavy exposure intensity. Subjects with current exposure had similar risks compared to those without current exposure (details not shown). Years since dust exposure ended was also not a predictor of each symptom. After adjusting for age, smoking (current, former, never), distance from a major roadway, and chronic respiratory disease, the ORs for persistent wheeze, chronic cough, and chronic phlegm attributable to occupational dust exposure were only modestly reduced and remained significantly elevated (Table 4). The odds ratios also remained significantly elevated with exposure based on dust intensity and dust types. The other covariates, such as indicators of socioeconomic status presented in Table 1, were not confounders when included in these models. Additional regression models that included number of cigarettes smoked daily and years quit smoking also yielded similar results.

Of 2,123 subjects with complete respiratory symptom information available, 881 subjects (42%) reported at least one symptom and 292 (14%) reported all 3 symptoms. There were 207 subjects with persistent wheeze in the absence of chronic cough and chronic phlegm, and of 489 subjects with chronic cough and chronic phlegm, 112 (23%) had chronic cough without chronic phlegm. The relative odds of experiencing all three symptoms due to dust exposure, adjusting for age, smoking, distance from a major roadway, and chronic respiratory disease was 2.03 (95% CI=1.52–2.71). The risk of reporting all three symptoms based on intensity was 1.48 (95% CI=0.96–2.31), 1.74 (95% CI=1.19–2.57), 2.83 (95% CI=1.84–4.35) for mild, moderate, and heavy exposure intensity, respectively.

Effect Modification

We evaluated effect modification by smoking status, chronic respiratory and heart disease, education, age, and employment status. The effect of dust exposure for each symptom was statistically significant in both age groups, however it was slightly stronger in those 60 years old and above (Table 5). Similar results were obtained based on employment status where the effect of dust exposure on respiratory symptoms was slightly greater in workers not currently employed (results not shown). The effect of dust exposure was statistically significant among the former and current smokers, but not the never smokers (Table 5). However, the ORs and upper confidence limits for chronic cough and chronic phlegm were comparable in all three groups as indicated by a nonsignificant interaction term between dust exposure and ever smokers (former and current). The ever smoking and dust interaction term for persistent wheeze was statistically significant ($p=0.01$). Subjects with chronic respiratory disease had a lower risk of symptoms than those without the disease, but for persistent wheeze there was considerable overlap in the confidence intervals. Subjects with and without heart disease had similar risks of all symptoms. The effect of dust exposure was most evident in subjects with a high school education or less.

DISCUSSION

In this study we report a significant relationship between occupational dust exposures and persistent wheeze, chronic cough, and chronic phlegm in a community based group of US veterans eligible for healthcare benefits. The risk remained elevated after adjustment for age, cigarette smoking, distance from a major roadway, and chronic respiratory disease, and there was no evidence of confounding by other factors. The trend between increasing exposure intensity and risk of each respiratory symptom was significant.

Studies conducted in other community-based groups have also noted an association between occupational dust exposure and respiratory symptoms (8,18–23,25,32). Unlike the present study, only a few studies had sufficient information to address the question of an exposure-response relationship and one other study compared current to past exposures. In 1,735 subjects in Spain, exposures to dusts and fumes were assigned using job title-exposure matrices based on both expert assessment and self-report (24). There were slightly greater risks of respiratory symptoms in subjects categorized with greater exposures. Korn and coworkers obtained an exposure history by interview in 8,515 adults in 6 US cities (18). The OR of chronic cough, chronic phlegm, and persistent wheeze increased based on years of dust exposure. Dust exposure history was also reassessed 3 and 6 years later, and subjects with current or past exposure had higher rates of symptoms compared to unexposed subjects. Those with current exposure still had the greatest rates. In 3,606 adults in Beijing (25), subjects were asked to categorize dust exposure as low, moderate, or high based on dust noted on one's clothes or in the air. Subjects were categorized with high cumulative exposures if they reported moderate or high intensity exposure over 10 or more years, and these subjects had the greatest risk of bronchitis and wheeze. In 1,195 men in Arizona (32) increasing rates of symptoms were also observed based on an exposure index related to self-report of dust intensity and duration.

In the current study, exposure duration and time since last exposure did not influence risk. A possible reason for this finding is that in contrast to previous studies, this study included a high percentage of individuals whose exposures had occurred mainly in the past. Subjects also had relatively long exposure duration, even in younger subjects and those currently employed. Therefore, there would be limited power to assess the effects of exposure duration, or possibly there is a threshold effect. However, subjects who were older and who were not currently employed had greater overall effects of exposure. This suggests that occupational exposures occurring in the past may have been more significant than more recent exposures, and that the effects of years of exposure to a variety of occupational dusts persist after exposure ends.

The current study also suggests that current and former smokers with occupational dust exposure have a greater risk of respiratory symptoms compared to never smokers. Effect modification by smoking category has not been a consistent finding in past studies. In some studies no effect modification was reported (8,19), while other studies have reported a small increase in the risk of symptoms in never smokers (18), or in current smokers (25).

An advantage to studying the effects of occupational exposures of a community based cohort such as this, rather in a group of currently employed workers or in subjects who have already presented for healthcare, is that individuals can be studied without the potential for exclusion or change in exposure status based on health. Thus, it might be easier to detect a true effect of exposure. However, an association with dust exposure might be overestimated if subjects were selected for study based on respiratory symptoms or illness. Therefore, a potential limitation of this study is that information is not available regarding the health status of the non-responders. Rates of cigarette smoking, a known risk factor for respiratory symptoms and illness, reported in this study are similar to national rates. This suggests that response to the survey was not based on symptoms, illness, or on risk factors for disease.

Since the study results should be internally consistent, bias would be created only if responders with respiratory symptoms differentially reported dust exposure, overestimating the association. Results in studies with occupational histories assessed prior to the ascertainment of respiratory symptoms or obtained by a review of job histories (18,21,22,24) are not subject to this bias. These studies have similar results compared to studies where measures of self-report were used to assess exposure as in the current study (19,20,23,25). In addition, in studies where pulmonary function measurements are available (19,20,23,25), abnormalities consistent with airflow obstruction are observed based on self-reported occupational exposures.

Furthermore, in the current study, subjects with chronic respiratory disease and heart disease did not have a greater risk of chronic cough, chronic phlegm, or persistent wheeze due to dust exposure. These observations provide validation for the use of self-reported exposure measures and suggest the effect of dust exposure has not been over-reported based on illness.

Alternatively, it is possible that the true effects of occupational dust exposure are underestimated in this study. Self-report of dust exposure was based on simple categories. Many large cohort studies have used a more detailed questionnaire or structured interview to obtain job and exposure history (18,20,22,25) together with an expert assessment (21,24). The method used in the current study could potentially lead to an underreporting of exposure. When self-report and expert assessment are compared, the specificity of the self-assessment of exposure is high (approximately 0.90), but the sensitivity is lower (less than 0.24 to 0.85) (33–36). In a recent study, 53% of men indicated exposure to dusts, gases, or fumes based on self-report whereas 74% were classified as exposed after expert assessment (24). This is consistent with our findings in a subset of the cohort when a more detailed dust exposure history was obtained in a follow-up clinic visit in 116 subjects who were mailed the 1988 survey (37). Therefore, the prevalence of occupational dust exposure is possibly underreported in this mail survey. It is likely that our efforts to categorize exposure into predominant dust types (Table 2) is an over simplification of actual exposure. Exclusion of subjects who were regular VA users may also contribute to a weaker association since it is also possible that subjects with the most respiratory symptoms were excluded from study,

In previous general population-based studies, the relative risk of respiratory symptoms attributable to occupational dust exposure was approximately 1.2 to 2.0. Reports of the association of occupational dust exposure with chronic cough, chronic phlegm, and persistent wheeze this study are greater in subjects with the highest exposure intensity. We used a simple self-report of exposure intensity and found an association with an increased risk of symptoms with increasing intensity. Similar questions regarding dust exposure intensity were originally included on the 1978 ATS adult respiratory questionnaire (grades of mild, moderate, or severe suggested), but are not often used for exposure assessment. Based on our results, these questions, or similar questions regarding exposure intensity may be useful to clinicians and epidemiologists seeking to assess the significance of the self-report of dust exposure. Intensity of occupational exposure to dust should be considered in evaluation of risk for chronic cough, chronic phlegm, and persistent wheeze, particularly in blue-collar white US males (i.e. similar to US veterans) who present for health care.

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Abbreviations

ADT	Average daily traffic
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
GIS	Geographic information system
OR	Odds ratio
DVA	Department of Veterans Affairs

Table 1

Selected characteristics by occupational dust exposure among 2,617 US Veterans.

Characteristic	Reported Occupational Dust Exposure?			
	No (N=1,333)		Yes (N=1,284)	
	N	%	N	%
Mean Age ($\pm$ SD)	1,333	61.6 $\pm$ 12.4	1,284	58.9 $\pm$ 13.0
Smoking				
Current	284	21.3	399	31.1
Former	731	54.8	665	51.8
Never	318	23.9	220	17.1
Chronic diseases *				
Asthma	54	4.1	93	7.2
COPD **	124	9.3	225	17.5
Asthma or COPD	150	11.3	261	20.3
Heart attack or angina	232	17.4	247	19.2
Other heart disorders	149	11.2	171	13.3
Residential Designation				
Urban	1,113	83.5	1,047	81.5
Rural	220	16.5	236	18.4
Education				
< 12 th Grade	311	23.3	362	28.2
12 th Grade	496	37.2	528	41.1
> 12 th Grade	505	37.9	372	29.0
Missing	21	1.6	22	1.7
Employment Status				
Employed	488	36.6	526	41.0
Unemployed	78	5.9	72	5.6
Retired	756	56.7	678	52.8
Missing	11	0.8	8	0.6
Usual Job Classification				
Managerial and Professional	383	28.7	186	14.5
Technical, Sales, Administrative Support	348	26.1	245	19.1
Service Occupation	143	10.7	153	11.9
Agriculture, Crafts, Machine Operators, and	301	22.6	577	44.9
Transportation workers				
Missing	158	11.9	123	9.6
Census Variables				
Median home value $\geq$ \$143,000	702	52.7	633	49.3
Median rent $\geq$ \$604/month	672	50.4	662	51.6
Median household income $\geq$ \$41,439/year	505	37.9	509	39.6
Median per capita income $\geq$ \$15,553/year	613	46.0	538	41.9
Distance to Major Road (in meters)				
$\leq$ 50	329	24.7	338	26.3
50–400	666	50.0	602	46.9
Missing Distance Information	8	0.6	9	0.7

* Self-report of doctor confirmed disorders;

** Self-report of doctor confirmed chronic bronchitis or emphysema.

Table 2

Distribution of Various Indices of Self-Reported Dust Exposure Among Cohort Members With Dust Exposure

Exposure Categories	N	%
Dust Intensity		
Mild	374	29.1
Moderate	509	39.6
Heavy	261	20.3
Intensity Missing	140	10.9
Dust Duration (years)		
>0–9	417	32.5
10–19	230	17.9
20–29	170	13.2
30+	192	15.0
Duration Missing	275	21.4
Timing of last dust exposure		
Current	166	12.9
Within last 5yrs	142	11.1
More than 5yrs prior	646	50.3
Missing	330	25.7
Dust Type		
Non-specific/ill-defined	177	13.8
Fumes	88	6.9
Other inorganic	236	18.4
Metals	45	3.5
Organic	217	16.9
Type of dust missing	521	40.6

Table 3

Odds ratios (OR) and 95% confidence intervals (CI) for the association of dust exposure and respiratory symptoms, in selected logistic regression models unadjusted for other covariates

Dust Variable	Persistent Wheeze (# of subjects: 2,439; # of cases: 763)			Chronic Cough (# of subjects: 2,398; # of cases: 550)			Chronic Phlegm (# of subjects: 2,351; # of cases: 638)		
	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)
Dust exposure									
No	1,256	280	1.00	1,231	202	1.00	1,201	236	1.00
Yes	1,183	483	2.41 (2.02–2.87)	1,167	348	2.17 (1.78–2.63)	1,150	402	2.20 (1.82–2.65)
Dust intensity									
None	943	208	1.00	919	147	1.00	898	167	1.00
Mild	347	108	1.60 (1.21–2.10)	346	84	1.68 (1.24–2.28)	341	103	1.89 (1.42–2.52)
Moderate	461	191	2.50 (1.97–3.18)	459	136	2.21 (1.69–2.89)	459	154	2.21 (1.71–2.86)
Heavy	250	130	3.83 (2.86–5.13)	241	86	2.91 (2.12–4.00)	241	112	3.80 (2.81–5.15)
Missing	438	126	1.43 (1.10–1.85)	433	97	1.52 (1.14–2.02)	412	102	1.44 (1.09–1.91)
Test for trend ¹			P=<0.0001			P=<0.0001			P=<0.0001
Dust type									
None	1,256	280	1.00	1,231	202	1.00	1,201	236	1.00
Non-specific/ ill-defined	166	63	2.13 (1.52–3.00)	165	47	2.03 (1.40–2.94)	165	62	2.46 (1.74–3.48)
Organic	198	76	2.17 (1.58–2.98)	199	50	1.71 (1.20–2.44)	194	60	1.83 (1.31–2.56)
Other inorganic	221	92	2.49 (1.84–3.35)	216	69	2.39 (1.73–3.30)	218	70	1.93 (1.41–2.66)
Metals	43	19	2.76 (1.49–5.11)	37	13	2.76 (1.38–5.51)	35	13	2.42 (1.20–4.87)
Fumes	80	37	3.00 (1.90–4.75)	74	29	3.28 (2.01–5.36)	80	37	3.52 (2.22–5.58)
Type missing	475	196	2.45 (1.95–3.07)	476	140	2.12 (1.66–2.72)	458	160	2.20 (1.73–2.79)

¹ Test for trend modeled nominal variable (1=mild, 2=moderate, 3=heavy) on subset with complete information on dust intensity

Table 4

Odds ratios (OR) and 95% confidence intervals (CI) for the association of dust exposure and respiratory symptoms, in selected logistic regression models adjusted for smoking, distance from a major roadway, age, and chronic respiratory disease.

Dust Variable	Persistent Wheeze (# of subjects: 2,439; # of cases: 763)			Chronic Cough (# of subjects: 2,398; # of cases: 550)			Chronic Phlegm (# of subjects: 2,351; # of cases: 638)		
	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)
Dust Exposure									
No	1,256	280	1.00	1,231	202	1.00	1,201	236	1.00
Yes	1,183	483	1.91 (1.57-2.32)	1,167	348	1.70 (1.38-2.11)	1,150	402	1.79 (1.46-2.19)
Dust intensity									
None	943	208	1.00	919	147	1.00	898	167	1.00
Mild	347	108	1.31 (0.97-1.78)	346	84	1.38 (0.99-1.91)	341	103	1.64 (1.21-2.23)
Moderate	461	191	1.93 (1.47-2.53)	459	136	1.68 (1.25-2.24)	459	154	1.77 (1.34-2.34)
Heavy	250	130	2.70 (1.95-3.75)	241	86	1.98 (1.39-2.81)	241	112	2.82 (2.03-3.93)
Missing	438	126	1.20 (0.90-1.60)	433	97	1.20 (0.88-1.64)	412	102	1.21 (0.89-1.63)
Test for trend ¹			P=<0.0001			P=<0.0001			P=<0.0001
Dust type									
None	1,256	280	1.00	1,231	202	1.00	1,201	236	1.00
Non-specific/ ill-defined	166	63	1.60 (1.09-2.35)	165	47	1.55 (1.04-2.33)	165	62	2.06 (1.41-3.00)
Organic	198	76	2.09 (1.48-2.97)	199	50	1.53 (1.04-2.24)	194	60	1.65 (1.15-2.36)
Other inorganic	221	92	1.99 (1.43-2.79)	216	69	2.02 (1.42-2.87)	218	70	1.61 (1.14-2.27)
Metals	43	19	2.35 (1.18-4.70)	37	13	2.53 (1.18-5.41)	35	13	2.18 (1.02-4.66)
Fumes	80	37	2.14 (1.28-3.59)	74	29	2.33 (1.36-4.01)	80	37	2.61 (1.58-4.29)
Type missing	475	196	1.84 (1.43-2.37)	476	140	1.56 (1.19-2.05)	458	160	1.70 (1.31-2.21)

¹ Test for trend modeled nominal variable (1=mild, 2=moderate, 3=heavy) on subset with complete information on dust intensity

Table 5

Odds ratios (OR) and 95% confidence intervals (CI) for the association of occupational dust exposure and respiratory symptoms, in selected logistic regression models.

Model	Persistent Wheeze (# of subjects: 2,439; # of cases: 763)			Chronic Cough (# of subjects: 2,398; # of cases: 550)			Chronic Phlegm (# of subjects: 2,351; # of cases: 638)		
	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)	No subjects	No cases	OR (95% CI)
Dust exposure stratified by age ^a									
<60 yrs	968	346	1.76 (1.30–2.38)	974	262	1.42 (1.03–1.95)	954	277	1.79 (1.31–2.44)
≥60 yrs	1,471	417	2.04 (1.57–2.64)	1,424	288	2.04 (1.52–2.72)	1,397	361	1.84 (1.41–2.41)
Dust exposure stratified by smoking status ^b									
Never	508	88	1.09 (0.64–1.86)	487	51	1.52 (0.83–2.80)	472	64	1.15 (0.66–2.02)
Former	1,301	347	2.26 (1.72–2.98)	1,271	205	2.06 (1.49–2.86)	1,254	278	2.15 (1.61–2.87)
Current	630	328	1.93 (1.37–2.70)	640	294	1.45 (1.05–2.02)	625	296	1.62 (1.16–2.26)
Dust exposure stratified by chronic respiratory disease ^c									
Yes	392	266	1.49 (0.95–2.32)	370	161	0.87 (0.56–1.36)	377	196	1.15 (0.74–1.78)
No	2,047	497	2.13 (1.71–2.65)	2,028	389	2.12 (1.66–2.71)	1,974	442	2.07 (1.64–2.60)
Dust exposure stratified by heart disease ^d									
Yes	565	199	2.31 (1.54–3.45)	562	134	1.75 (1.12–2.75)	547	162	1.76 (1.16–2.66)
No	1,874	564	1.80 (1.44–2.26)	1,836	416	1.71 (1.34–2.19)	1,804	476	1.82 (1.44–2.30)
Dust exposure stratified by educational status ^d									
<High School	611	193	2.51 (1.67–3.79)	597	147	1.83 (1.20–2.77)	571	166	2.26 (1.49–3.43)
High School	954	298	2.40 (1.73–3.33)	941	218	1.83 (1.29–2.60)	930	257	2.02 (1.45–2.81)
>High School	839	257	1.25 (0.89–1.75)	822	177	1.52 (1.04–2.21)	816	206	1.31 (0.93–1.86)

^a adjusted for age, smoking, chronic respiratory disease, and distance to a major road

^b adjusted for age, chronic respiratory disease, and distance to a major road

^c adjusted for smoking, distance to a major road, and age

^d adjusted for smoking, distance to a major road, chronic respiratory disease, and age