Pulmonary Ventilatory Defects and Occupational Exposures in a Population-based Study in Spain

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We assessed the association between occupational exposures and symptoms of chronic bronchitis and pulmonary ventilatory defects in a general population-based study of five areas in Spain. This study forms part of the European Community Respiratory Health Study (ECRHS). Subjects (n = 1,735; age range, 20–44 yr; 52.4% of those initially selected) completed a respiratory questionnaire on symptoms and occupation and underwent baseline spirometry. Occupation was translated with an *ad hoc* developed job-exposure matrix (JEM) into none, low, and high exposure to biological dust, mineral dust, and gases and fumes. Exposure to high levels of biological dust was associated with cough for more than 3 mo (odds ratio [OR], 1.9; p = 0.07), a reduction in FEF_{25-75} to 478 ml/s (SD 178), and a reduction in FEV_1 to 151 mL (SD 71). These associations remained after excluding subjects with asthma symptoms or bronchial responsiveness. Smokers tended to have a higher risk for respiratory symptoms, but smoking did not modify the association of occupation with pulmonary function. Exposure to mineral dust and gases/fumes was less consistently related to pulmonary function or to respiratory symptoms and this association further decreased after excluding subjects with asthma. In conclusion, exposure to high levels of biological dust in young adults is associated with symptoms of chronic bronchitis and pulmonary ventilatory defects, independently of asthma and smoking. Sunyer J, Kogevinas M, Kromhout H, Antó JM, Roca J, Tobias A, Vermeulen R, Payo F, Maldonado JA, Martinez-Moratalla J, Muniozguren N, and the Spanish Group of the European Community Respiratory Health Survey. Pulmonary ventilatory defects and occupational exposures in a population-based study in Spain. AM J RESPIR CRIT CARE MED 1998;157:512–517.

Occupational exposure to dust, gases, and fumes has been associated with symptoms of chronic bronchitis and lung function changes of obstructive airways disease type in both work force-based studies (1–5) and community-based studies (6–10). The contribution of occupational exposures to the development of chronic airway disease is, however, a subject of controversy (11, 12).

Studies in work force populations are restricted to selected subjects, likely to be less susceptible (13), whereas community studies usually assert a wider spectrum of individuals, but at the price of reducing validity in exposure assessment. Several community studies have used experts to assess occupational exposures. This approach has been claimed to be a more valid method than self-assessment of exposures (14, 15). Another often used method to examine specific occupational exposures based on job titles is the application of job exposure matrices (JEMs) (16, 17). Several studies have examined the advantages and limitations of this approach (18–20).

In a previous study we assessed the occupational risks of asthma in Spain (21). Here, we assess the association of occupational exposures (using job titles and exposure matrices) with symptoms of chronic bronchitis and with pulmonary ventilatory defects in a general population survey of five areas of Spain, controlling for smoking and asthma. The performance of an *ad hoc* general population JEM, a population-specific JEM, and self-reported exposure was also studied.

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METHODS

Subjects

A sample of 16,884 subjects, ages 20 to 44 yr, was randomly selected from the general population of five areas in Spain (Albacete, Barcelona, Galdakao, Huelva, and Oviedo). A short and simple screening respiratory questionnaire was administered by mail and phone to 85% of the subjects. In a second phase, a random subsample of 3,310 persons was selected from the original sample (approximately 20%). From March 1992 to April 1993, subjects were invited to attend a center in each city to complete the European Community Respiratory Health Study (ECRHS) respiratory questionnaire (21, 22), including questions on environmental risk factors and occupation, and to undergo a spirometry and a dose–response methacholine challenge. All the tests were performed during the same visit. Of the 3,310 individuals, 1,735 (52.4%) responded to the ECRHS respiratory questionnaire on symptoms and occupational history and finalized a spirometry. Subjects underwent baseline spirometry (Biomedin, Padua, Italy), performing at least three acceptable repeatable (within 5% or 100 mL) maneuvers to measure forced expiratory capacity (FVC), forced expiratory volume in 1 s (FEV_1), and mean forced expiratory flow during the middle half of the FVC ($FEF_{25–75}$). In 1,324 subjects (76.3%) a methacholine bronchial responsiveness challenge was carried out (22). The study protocol was approved by the Institutional Review Board of the participating centers and patients gave written informed consent.

Occupational Exposure

Subjects were classified on the basis of current occupation or, for subjects reporting a change of occupation due to health problems, their occupation at that time (n = 31). The ECRHS classification was used for coding of reported occupations. This classification includes 350 occupational titles and is constructed on the basis of the 1980 Office of Population Census and Surveys (OPCS) classification of occupations (23). Subjects self-reported their exposure to vapors, gas, dust, or fumes and indicated in which job this had occurred. Two of us (H.K. and R.V.) developed an *ad hoc* job exposure matrix with a job axis consisting of the 350 occupational titles, an exposure axis with biological dust, mineral dust, and gases/fumes, and estimates of exposure (none, low, high) in the matrix cells. The exposure category was assigned using both the prevalences and the intensity of exposure in each occupational title. A second population-specific JEM (18) was created based on the self-reported exposure to vapors, gas, dust, and fumes and individual job histories. Jobs in which less than 10% of the subjects reported exposure were considered nonexposed, jobs in which 10 to 49% of the subjects reported exposure were considered low exposed, and jobs with 50% of the subjects or more were considered high exposed. Thus, the final assigned exposure level is based on the frequency of the reported exposure for each occupational title. Finally, subjects were classified according to their self-reported exposure as recorded in the questionnaire.

Statistical Analysis

The association of respiratory symptoms with occupational exposure was calculated by the odds ratio (OR) using standard methods of logistic regression analysis (21). Subjects without the condition were considered to be the control group. All the analyses were adjusted for age, sex, and area of residence. Area was included because of differences in the participation rate among cities and possible differences of technicians and interviewers between centers. The association between pulmonary function and occupational exposure was calculated using multiple linear regression, adjusting for age, sex, area, and height. The best goodness of fit was obtained after controlling for height squared. Age and height were centered by their mean value to provide a meaningful intercept for each pulmonary function parameter.

The analyses were repeated after excluding subjects with symptoms of asthma (n = 117) and also subjects with bronchial responsiveness (n = 221). Asthma was defined as a positive answer to at least one of the following questions: “Have you been woken by an attack of shortness of breath at any time in the last 12 months?”; “Have you had an attack of asthma in the last 12 months?”; or “Are you currently taking any medicine (including inhalers, aerosols, or tablets) for

TABLE 1

OCCUPATIONAL EXPOSURE BY AREA, SEX, AGE, SMOKING, AND ASTHMA SYMPTOMS AS ASSIGNED BY THE *AD HOC* JOB EXPOSURE MATRIX, SELF-REPORTED EXPOSURE, AND THE POPULATION-BASED JOB EXPOSURE MATRIX

		Percentage Exposed (*low and high*)					
		Ad Hoc JEM					
	n (%)	Biological Dust	Mineral Dust	Gases/Fumes	Any*	Self-report†	Population JEM*
All	1,735	17	28	35	46	40	67
Area							
Albacete	383 (22%)	18	30	34	48	41	63
Barcelona	366 (21%)	13	23‡	29	37‡	34‡	60
Galdakao	442 (25%)	23	33	41‡	55‡	41	76‡
Huelva	301 (17%)	14	27	35	44	38	70
Oviedo	243 (15%)	16	28	33	41	46	68
Sex							
Female	905 (52%)	16	14	25	32	27	61
Male	830 (48%)	18	43‡	46‡	61‡	53‡	74‡
Age (yr)							
20–29	601 (35%)	16	28	36	47	45	71
30–39	751 (43%)	17	27	34	44	36‡	66
40–45	383 (22%)	19	32	35	48	39	65‡
Smoking							
Never	566 (33%)	21	25	31	43	33	64
Ever	1,169 (67%)	16‡	30‡	37‡	47‡	43‡	69‡
Asthma symptoms							
No	1,616 (93%)	16	28	34	45	39	67
Yes	119 (7%)	23	35	48‡	57‡	53‡	74

* Low or high exposure to any type of biological dust, mineral dust, or gases/fumes.
† Self-reported exposure to any type of dust, gases, or fumes.
‡ $p < 0.05$ for differences in exposure for the same variable. Reference categories are Albacete, female, age 20–29, never smoking, and no asthma symptoms.

TABLE 2

FREQUENCY OF THE OCCUPATIONAL EXPOSURES FOR SELECTED JOB CATEGORIES AS ASSIGNED BY THE *AD HOC* JOB EXPOSURE MATRIX

			Biological Dust		Mineral Dust		Gases/Fumes	
Job Category	Occupational Titles	n*	Low (%)	High (%)	Low (%)	High (%)	Low (%)	High (%)
Metal	Metal drowers, moulders, electroplaters, galvanizers, metal making, furnace	119	8	0	66	34	43	53
Cleaner	Cleaners, care takers, window cleaners, chimney and road sweeps	73	89	0	0	89	0	89
Electrical	Electricians, electrical maintenance, radio and TV mechanisms, coil winders	67	0	0	87	0	37	0
Food	Food and drink processing, butchers, fishermen, fish mongers	50	82	18	0	0	18	0
Construction	Bricklayer, plasterer, roofer, handymen, builders, masons, miners	43	7	0	39	61	40	2
Textile	Fibers processing, twister, winder, weaver, knitter, bleacher, dyer, mender, tailor	37	95	5	0	0	5	32
Wood	Carpenter, cabinet and case and box maker, craftsmen, sawyer, wood making	19	16	84	0	0	0	0
Chemical	Chemical, gas, and petroleum process plant, and allied trades laborer, gas works	21	0	0	76	24	76	24
Farmer	Farm workers and managers, horticulturists, gardeners, forestry workers	12	0	100	20	80	33	42
Painter	Painters, decorators, pottery decoration	11	0	0	100	0	18	82
All		1,735	14	3	20	10	24	11

* Number of subjects in each category.

asthma?" Finally, modification of the effect of occupational exposure by smoking was assessed by testing the significance of interactions in the logistic and the linear regression models.

RESULTS

Table 1 gives the prevalence of exposure as assessed by the JEMs and by the subjects themselves. Exposure to gases and fumes was the most common occupational exposure whereas exposure to biological dust was the least frequent exposure. Prevalence of exposure to mineral dust and gases/fumes widely varied by area, from Galdakao to Barcelona. Males were more often exposed to mineral dust and to gases/fumes than females, whereas differences by age were not significant. Smokers were more frequently exposed to mineral dust and to gases/fumes, but were less frequently exposed to biological dusts. Finally, exposure to gases/fumes and self-reported exposure were more prevalent among subjects with asthma symptoms.

Table 2 shows the proportion of subjects either with a high or low exposure for major job categories that have been fre-

TABLE 3

PREVALENCE OF RESPIRATORY SYMPTOMS AND OF RATIO FEV_1/FVC BELOW 70%, BY OCCUPATIONAL EXPOSURE

	Prevalence (%) by Exposure Level			Odds Ratio* (*95% CI*)	
	None	Low	High	Low	High
Biological dust					
Morning cough	18	22	26	1.3 (0.9–2.0)	1.3 (0.6–2.6)
Cough > 3 mo	14	19	27	1.5 (1.0–2.3)†	1.9 (0.9–3.7)‡
Morning phlegm	21	24	33	1.3 (0.8–1.8)	1.5 (0.8–2.8)
Phlegm > 3 mo	16	18	28	1.2 (0.8–1.7)	1.6 (0.8–3.3)
Ratio FEV_1/FVC < 70%	3	4	5	1.6 (0.6–3.9)	1.7 (0.3–8.2)
Mineral dust					
Morning cough	17	18	30	0.9 (0.6–1.4)	1.8 (1.1–3.0)†
Cough > 3 mo	14	17	20	1.2 (0.8–1.9)	1.4 (0.8–2.5)
Morning phlegm	21	24	28	0.9 (0.6–1.2)	1.1 (0.7–1.8)
Phlegm > 3 mo	15	18	23	0.8 (0.5–1.1)	1.0 (0.6–1.7)
Ratio FEV_1/FVC < 70%	2	4	6	1.4 (0.5–3.5)	3.0 (1.0–9.4)‡
Gases/fumes					
Morning cough	17	20	25	1.1 (0.7–1.5)	1.1 (0.6–1.8)
Cough > 3 mo	14	18	17	1.1 (0.8–1.6)	0.9 (0.5–1.5)
Morning phlegm	20	25	27	1.1 (0.8–1.6)	1.2 (0.7–1.9)
Phlegm > 3 mo	14	18	25	1.1 (0.8–1.6)	1.7 (1.0–2.9)†
Ratio FEV_1/FVC < 70%	2	4	4	1.5 (0.6–3.5)	0.8 (0.2–3.0)

* Odds ratio (and 95% confidence interval) adjusted by age, sex, area, smoking, and for the other two exposures, respectively.
† $p < 0.05$.
‡ $p < 0.1$.

TABLE 4

PULMONARY FUNCTION ADJUSTED CHANGE* (AND STANDARD ERROR) IN RELATION TO OCCUPATIONAL EXPOSURE

	FEF_{25-75}	FEV_1	FEV_1/FVC
Intercept	4.453 L/s	3.933 L	83.3%
Biological dust			
Low	−0.020 (0.092)	−0.012 (0.037)	−0.6% (0.4)
High	−0.478 (0.178)†	−0.151 (0.071)†	−1.0% (0.9)
Mineral dust			
Low	−0.143 (0.094)	−0.048 (0.037)	−0.5% (0.5)
High	−0.046 (0.137)	−0.028 (0.054)	−0.4% (0.7)
Gases/fumes			
Low	0.004 (0.083)	0.029 (0.034)	0.0% (0.4)
High	−0.051 (0.129)	−0.025 (0.052)	−0.1% (0.7)

* Adjusted by age, sex, area, smoking, height, and for the other two exposures, respectively.
† $p < 0.05$.

quently associated with respiratory disease, according to the *ad hoc* JEM. High biological dust occurred in farmers and wood processors, whereas low exposure to biological dusts was assigned among textile workers, cleaners, and food processors. A high percentage of cleaners, construction workers, and farmers were assessed as having high exposure to mineral dust, and metal workers, electrical workers, chemical workers, and painters as having low exposure to mineral dusts. In most occupations some percentage of workers was evaluated as exposed to gases and fumes. In particular, cleaners, metal and textile workers, painters, and farmers were assigned a high exposure to gases and fumes.

Symptoms of chronic bronchitis (chronic cough and phlegm) were generally more frequent in subjects exposed to biological and mineral dusts and gases and fumes than in those not exposed. The highest risks were observed in subjects with high exposure to mineral and biological dusts (Table 3). In particular, statistically significant associations were found between cough for more than 3 mo and exposure to biological dust; morning cough with high exposure to mineral dust; and chronic phlegm with high exposure to gases/fumes. An increased risk was found for an FEV_1/FVC ratio lower than 70% and high exposure to biological and mineral dust.

Pulmonary function parameters (Table 4) were significantly lower in subjects highly exposed to biological dust with a decrease of 478 mL/s observed for FEF_{25-75} and of 151 mL for FEV_1. The FEV_1/FVC ratio decreased by 1.0% in those highly exposed to biological dust ($p < 0.1$). Small and statistically not significant pulmonary function decreases were found among those exposed to high levels of mineral dust or to gases/fumes.

Similar findings were obtained for exposure to biological dust, after excluding subjects reporting asthma symptoms (Table 5). High exposure to biological dust was significantly associated with symptoms of chronic bronchitis and pulmonary function parameters. The associations between FEV_1/FVC ratio and mineral dust and between chronic phlegm and gases/fumes observed for all subjects was not found, however, after excluding subjects with asthma. There were no differences in risk between subjects with or without bronchial responsiveness (for example, subjects without bronchial responsiveness and with high exposure to biological dust had a reduction in FEF_{25-75} of 487 mL/s [SE 180] and in FEV_1 of 126 mL [SE 69]).

Smoking was significantly associated with respiratory symptoms (odds ratio for cough and phlegm > 3 mo, 4.2, 2.9–6.2) and with decreased pulmonary function (reduction in FEF_{25-75} of 204 mL/s (SE 53) and in FEV_1 of 93 mL (SE 21). To assess if the association between occupational exposures and symptoms or pulmonary function was modified by smoking, interactions between smoking and occupation were analyzed. The effect of occupational exposures is shown in Table 6, stratifying by smoking status. The association between biological dust and pulmonary function was not modified by smoking. Owing to the small number of nonsmokers with symptoms we were unable to assess whether smoking was a modifier of the association between occupation and respiratory symptoms.

To evaluate the performance of three different methods of occupational exposure assessment (*ad hoc* JEM, population-specific JEM, and self-assessed exposure), exposure to either dusts, gases, or fumes was assigned in three ways. The results of the three exposure assessment approaches were fairly consistent (Table 7). The use of the *ad hoc* job exposure matrix resulted, generally, in stronger associations between exposure to dusts, gases, and fumes and symptoms and pulmonary function than the evaluation of exposure based on the population-specific JEM or based on the self-assessed exposure.

DISCUSSION

In this general population of young adults, we found that occupational exposure to biological dust was associated with symptoms of chronic bronchitis and with decrements of pulmonary function parameters suggestive of chronic obstructive

TABLE 5

RESPIRATORY SYMPTOMS AND PULMONARY FUNCTION AND OCCUPATIONAL EXPOSURES IN SUBJECTS WITHOUT SYMPTOMS OF ASTHMA

	Odds Ratio (*95% CI*)*			Change (*SE*)*	
	Cough > 3 mo	Phlegm > 3 mo	FEV_1/FVC < 0.7	FEF_{25-75} (*L/s*)	FEV_1 (*L*)
Biological dust					
Low	1.6 (1.1–2.3)†	1.1 (0.7–1.5)	1.4 (0.5–3.6)	0.020 (0.089)	−0.012 (0.035)
High	1.9 (1.0–3.7)†	2.0 (1.1–3.8)†	2.9 (0.8–10)	−0.388 (0.175)†	−0.216 (0.066)†
Mineral dust					
Low	1.3 (0.7–1.2)	1.1 (0.6–1.8)	0.8 (0.2–2.1)	−0.096 (0.092)	−0.030 (0.036)
High	1.4 (0.9–2.0)	0.9 (0.6–1.8)	0.8 (0.2–3.1)	−0.068 (0.137)	0.010 (0.053)
Gases/fumes					
Low	1.0 (0.7–1.4)	1.0 (0.7–1.4)	1.4 (0.6–3.3)	−0.006 (0.082)	0.032 (0.033)
High	1.0 (0.6–1.7)	1.5 (0.9–2.5)	1.2 (0.3–4.4)	0.071 (0.129)	−0.033 (0.050)

* Adjusted by age, sex, area, smoking, and for the other two exposures, respectively. FEF_{25-75} and FEV_1 also adjusted for height. Nonexposed subjects without symptoms of asthma constitute the reference group.
† $p < 0.05$.

TABLE 6

MODIFICATION OF THE RELATION BETWEEN LUNG FUNCTION PARAMETERS AND OCCUPATIONAL EXPOSURES, BY SMOKING*

	Change (*SE*)†			
	FEF_{25-75} (*L/s*)		FEV_1 (*L*)	
	Smoking	No-Smoking	Smoking	No-Smoking
Biological dust				
Low	−0.032 (0.107)	0.025 (0.121)	−0.008 (0.042)	0.011 (0.051)
High	−0.406 (0.191)‡	−0.335 (0.298)	−0.194 (0.072)‡	−0.130 (0.118)
Mineral dust				
Low	0.010 (0.102)	−0.219 (0.147)	0.005 (0.039)	−0.115 (0.060)‡
High	−0.004 (0.146)	0.028 (0.229)	0.021 (0.057)	−0.075 (0.085)
Gases/fumes				
Low	−0.068 (0.091)	0.022 (0.129)	0.019 (0.036)	0.104 (0.053)‡
High	−0.106 (0.137)	0.043 (0.212)	−0.068 (0.054)	0.065 (0.081)

* Nonexposed smokers or nonsmokers, in each stratum, respectively, constitute the reference group.
† Adjusted by age, sex, area, height, and for the two other exposures, respectively.
‡ $p < 0.05$.

pulmonary disease (COPD). These associations also occurred after excluding subjects with symptoms of asthma, and were not modified by smoking, although smokers had higher risks of respiratory symptoms than did nonsmokers. Exposure to mineral dust and gas and fumes was associated less consistently with symptoms and pulmonary function, particularly among subjects without asthma. One of the major problems in community-based studies is misclassification of exposure, which occurs both in self-assessed and expert-based assessments, including JEMs. In this study, low-level exposure to any of the occupational exposures was almost not associated with symptoms or pulmonary function. This could be directly related to the difficulties of exposure assessment instruments to distinguish low-level exposures accurately. It is generally considered that general population JEMs are more likely to perform better when exposure assignment is restricted to the high-exposed group (18). The relatively low response rate (54.5%) is the main problem in the present study. However, as discussed by Kogevinas and coworkers (21) in the study of occupational asthma with the same sample, it is unlikely that nonresponse affected the validity of the results in a substantial way. Biased results would be obtained if response of subjects with (or without) disease was conditioned on their exposure status. Although this cannot be totally discharged, it should be noted that primary aims of the study were to investigate exposures other than occupational. It is, therefore, unlikely that subjects with occupational exposures were selectively convinced to participate in the study. Furthermore, occupational respiratory diseases are not frequently discussed diseases in Spain, and general knowledge of their causes can be expected to be low.

The results for symptoms are rather consistent for the three different approaches used to assess occupational exposure, but the results were somewhat less consistent for lung function parameters. Similar to other studies (24), self-reported exposure at the individual level performed rather poorly compared with the *ad hoc* JEM and population-specific JEM in relation to the pulmonary function effects. Even though self-reported exposure appears to be an acceptable method, its degree of measurement error may be larger than that of the *ad hoc* JEM or the population-based JEM, particularly when evaluating symptoms.

Previous community-based studies either combined all exposures (6, 8) or combined all types of dusts, including both biological and mineral (7, 25, 26). This is the first study to assess the specific role of biological dust in the general population. The associations for biological dust observed in this study are stronger than the associations for combined dust exposures observed in previous studies. Biological dust exposure has been related to an increase in bronchitis symptoms and a

TABLE 7

RELATIONS BETWEEN RESPIRATORY SYMPTOMS, LUNG FUNCTION PARAMETERS, AND OCCUPATIONAL EXPOSURE TO EITHER DUST, GASES, OR FUMES ASSESSED BY THREE DIFFERENT METHODS*

	Odds Ratio (*95% CI*)			Change (*SE*)	
	Cough > 3 mo	Phlegm > 3 mo	$FEV_1/FVC < 0.7$	FEF_{25-75} (*L/s*)	FEV_1 (*L*)
Ad hoc JEM					
Low	1.3 (1.0–1.8)‡	1.0 (0.7–1.3)	1.5 (0.7–3.5)	−0.033 (0.066)	0.021 (0.026)
High	2.1 (1.5–3.0)†	1.5 (1.0–2.0)†	1.1 (0.4–2.8)	−0.247 (0.080)†	−0.079 (0.032)†
Population-specific JEM					
Low	1.4 (1.0–1.9)†	0.9 (0.6–1.2)	1.4 (0.6–3.0)	−0.139 (0.069)†	0.001 (0.028)
High	1.5 (1.0–2.2)†	1.4 (1.0–2.0)†	2.4 (1.0–5.4)†	−0.171 (0.087)†	−0.062 (0.034)‡
Self-reported expposure					
Yes	1.5 (1.7–2.0)†	1.5 (1.2–2.0)†	1.4 (0.7–2.7)	−0.152 (0.061)†	−0.019 (0.024)

* Nonexposed subjects constitute the reference group. Adjusted for age, sex, smoking, and area.
† $p < 0.05$.
‡ $p < 0.1$.

decrease in pulmonary function in studies with workers exposed to wood and cotton dust exposures (27, 28).

We did not find a clear association between respiratory symptoms and exposure to mineral dust among workers. In early cross-sectional studies in miners and foundry workers, the prevalence of bronchitis-type symptoms (i.e., chronic mucous hypersecretion, characterized by cough and phlegm) was higher than the frequency attributable to smoking alone, and a decrement in pulmonary function in smokers was beyond the decrement due to smoking (1–3). Pathological evidence of emphysema in coal miners (29) and gold miners (4) and abnormally small airways in mineral dust-exposed workers (30) have been reported. A metaanalysis of epidemiological studies (5) in miners using quantitative measurement of dust showed that 8% of nonsmoking and 7% of smoking coal miners developed a clinically important loss of FEV_1. These figures were three times higher among gold miners. One of the reasons possibly explaining the divergence between our results and that of occupational cohorts is that the number of miners in our population is too small ($n = 8$), or that current exposures are lower than in the past or, perhaps, that our population is too young to express effects associated with mineral dust exposure.

We did not observe an association between exposure to gases and fumes and symptoms and pulmonary function, except for an increase in chronic phlegm. Among the community-based studies that separated gases from dust, Korn and colleagues (7) observed in the six-cities study and increase in COPD prevalence with dust but not gases/fumes. In China, Xu and others (25) found a significant effect of gases/fumes on symptoms of bronchitis, although not on pulmonary function. Interaction between occupational exposures and cigarette smoking in the development of COPD has been suggested by some of the previous community-based studies (25). Although similar to our study, most others did not find such a modification effect (7, 8, 10).

This study on a general population of five areas in Spain suggested that exposure to high levels of biological dust plays a role in the development of pulmonary ventilatory defects, independent of smoking and of asthma. The possible effect of current exposures to mineral dust or gases/fumes was less pronounced, and further decreased after excluding subjects with asthma, suggesting a lower association for these exposures.

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