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## Asthma risk, cleaning activities and use of specific cleaning products among Spanish indoor cleaners

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**Objectives** Recent studies have shown an excess risk of asthma for cleaners, but it is not clear which cleaning-related exposures induce or aggravate asthma.

**Methods** Risk factors for asthma were studied among indoor cleaners participating in the Spanish part of the European Community Respiratory Health Survey in 1992. In 1998, 78 of the 91 subjects reporting cleaning-related jobs in 1992 were identified. Of these, 67 indoor cleaners were interviewed by telephone about their cleaning activities and their use of cleaning products in 1992. These data were related to asthma prevalence in 1992, and the cleaners were compared with a reference group of office workers.

**Results** Asthma prevalence was 1.7 times higher [95% confidence interval (95% CI) 1.1—2.6] among the cleaners than among the referents, being highest among private home cleaners (3.3, 95% CI 1.9—5.8). The prevalence of housedust mite sensitization amounted to 28% for the home cleaners and was significantly ( $P < 0.01$ ) higher than for other indoor cleaners (3%), but similar to the corresponding prevalence of office workers (22%). More than half of the cleaners reported work-related respiratory symptoms. The asthma risk of the home cleaners was mainly associated with kitchen cleaning and furniture polishing, with the use of oven sprays and polishes.

**Conclusions** The asthma risk of Spanish cleaners is primarily related to the cleaning of private homes. This relationship may be explained by the use of sprays and other products in kitchen cleaning and furniture polishing.

**Key terms** irritants, occupation, respiratory diseases, sprays

Occupational asthma is the most common occupational respiratory disease in industrialized countries (1, 2). From both work-force-based and community-based studies, several occupations at risk have been identified, for example, spray painters, bakers, welders, agricultural workers, laboratory animal technicians, hairdressers, and nurses (1—3). Cleaning was not generally

indicated as a high-risk occupation until the analysis of data of the European Community Respiratory Health Survey, showing an elevated risk for asthma among cleaners (4). This excess risk was consistent across different countries, with Spain among the those with the highest. No data were available about specific exposures related to the cleaning jobs.

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Some chemicals in cleaning products have been suggested to cause work-related asthma, for example, chlorine and ammonia (3), quaternary ammonium compounds (5, 6), and (ethanol)amines (7). However, so far, no epidemiologic study on asthma among cleaning workers has been performed. The present survey was done to determine which specific cleaning activities and cleaning products are associated with asthma among Spanish indoor cleaners.

## Subjects and methods

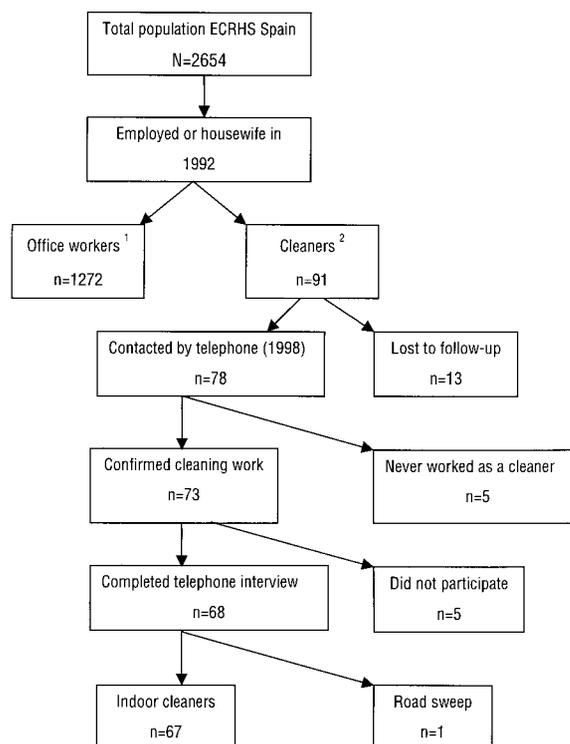
### Study population

The subjects were derived from the Spanish population of the European Community Respiratory Health Survey. The aims and methods of this multicenter study have been described earlier (8). Briefly, a random sample of the population aged 20 to 44 years and living in 5 areas in Spain was contacted in 1992 and asked to complete a short screening questionnaire on respiratory symptoms. Subsequently, a 20% random subsample of the study population and an additional subsample including all subjects reporting respiratory symptoms in the screening questionnaire were asked to take part in the main survey. The final population comprised 2654 subjects who completed a questionnaire on respiratory symptoms, medication, environmental and life-style factors, and smoking habits. In addition, the majority provided blood samples for serum immunoglobulin (Ig) E analyses and underwent baseline spirometry, a methacholine bronchial responsiveness test, and skin prick tests to common allergens. The institutional review board of the participating centers approved the study protocol, and the subjects gave their written informed consent.

The selection of the subjects is summarized in figure 1. Ninety-one subjects reported cleaning-related jobs in 1992. In the summer of 1998 they were contacted by telephone for an interview. Five of the 78 subjects that could be contacted said that they had never worked as a cleaner. Five confirmed that they had been working as a cleaner in 1992 but did not further participate in the detailed telephone interview. Of the 68 participants, 67 were indoor cleaners. One subject worked as a street cleaner and was excluded from the analyses because his worktasks were entirely different.

### Telephone interview

Detailed information about the cleaning job in 1992 was requested during the telephone interview, which lasted approximately 15 minutes. The subjects were asked whether they were still cleaners, how many years they had been working as a cleaner, the main location of the cleaning work, the frequency (times per week or hours



**Figure 1.** Flow chart showing the selection of subjects [<sup>1</sup> = professionals, clerical and administrative workers; <sup>2</sup> = occupational code (European Community Socioeconomic Status Group Classification) 158 = cleaners, window cleaners, and chimney and road sweeps; ECRHS = European Community Respiratory Health Survey]

per week) of all cleaning activities, and the use of different cleaning products. The following four specific types of cleaning products were distinguished: soaps and detergents, disinfectants, solvents, and polishes. It was also asked whether the cleaning products were perfumed and whether they were in spray form. A question on the mixing of cleaning products was included because it is known that mixing may lead to unforeseen high exposures to irritants (9, 10). The interview included questions on the following 4 work-related symptoms: breathing effects, eye irritation, skin irritation, and rhinitis or nasal effects.

### Health outcome

"Asthma symptoms or medication" was defined as an affirmative answer to at least 1 of the following questions in the European Community Respiratory Health Survey of 1992: "Have you ever 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?", "Are you currently taking any medicine (including inhalers, aerosols or tablets) for asthma?" This definition complies with that used in previous studies (4, 11) and will hereafter be referred to as

**Table 1.** Risk of asthma for cleaners relative to that of the reference group of office workers (N=1272 and 798 for the 2 asthma definitions, respectively). Prevalence ratio (PR) and 95% confidence interval (95% CI) adjusted for gender, age category, smoking, and area of residence. (ECRHS = European Community Respiratory Health Survey, BR = bronchial responsiveness)

Occupational group	Asthma symptoms or medication <sup>a</sup>			Asthma symptoms or medication <sup>a</sup> + BR		
	Number of persons	PR	95% CI	Number of persons	PR	95% CI
Cleaners according to ECRHS-I <sup>b</sup>	91	1.7	1.1–2.5	45	2.3	1.1– 5.1
→ Cleaners confirmed by telephone	73	1.7	1.1–2.6	37	2.8	1.3– 6.2
→ Indoor cleaners with telephone interview	67	1.7	1.1–2.7	37	2.8	1.3– 6.2
Private home cleaners	21	3.3	1.9–5.8	12	5.0	1.9–13.2
Other cleaners	46	1.0	0.5–2.0	25	1.7	0.5– 5.5

<sup>a</sup> For a definition see the text.<sup>b</sup> Occupational code (European Community Socio-economic Status Group Classification) 158: cleaners, window cleaners, chimney and road sweeps.**Table 2.** General and respiratory health characteristics of the indoor cleaners. (Ig = immunoglobulin)

Characteristic	Private home cleaners (N=21)		Other cleaners (N=46)	
	N	%	N	%
Female gender	21	100	43	93
Age group				
20–29 years	4	19	10	22
30–39 years	8	38	24	52
40–44 years	9	43	12	26
Smoker				
Current	8	38	20	43
Ex	2	10	4	9
Never	11	52	22	48
Work-related symptoms				
Breathing effects	13	62	23	50
Eye irritation	9	43	27	59
Skin irritation	4	19	19	41
Rhinitis or nasal effects	13	62	19	41
Allergic status				
Atopy <sup>a</sup>	6	33	8	20
Housedust mite sensitization <sup>a</sup>	5	28 <sup>b</sup>	1	3
Sensitization to detergent enzymes <sup>c</sup>	–	0	–	0

<sup>a</sup> Either by specific serum IgE test or by skin prick test (N=18+40).<sup>b</sup> Higher than other cleaners (Fisher's exact test 2-tailed P<0.01).<sup>c</sup> Specific IgE to protease or amylase (N=11+23).

“asthma”. Bronchial responsiveness was defined as a 20% decrease in forced expiratory volume in 1 second (FEV<sub>1.0</sub>) in association with a methacholine dose of ≤8 µmol. Specific IgE to the detergent enzymes protease and amylase was measured in available serum samples collected in 1992 from 34 of the indoor cleaners. Binding of ≥2% in a radioallergosorbent test (RAST) was regarded as positive.

### Analyses

The prevalence of asthma among the cleaners was compared with that of a reference group comprising professionals and clerical and administrative workers. This procedure is similar to that used earlier in other

analyses of the European Community Respiratory Health Survey (4, 11) and in the SWORD (Surveillance of Work-related and Occupational Respiratory Disease) project (3). The prevalence ratio (PR) was used as the risk estimate. In cross-sectional studies with a high prevalence of asthma, the PR has been suggested to provide a more interpretable measure of the relative risk than the odds ratio (12). PR values and 95% confidence intervals adjusted for potential confounders were calculated using the Cox proportional hazards model (13), as modified by Breslow (14), with the PHREG procedure of SAS (15). Data on the frequency of cleaning tasks and the use of cleaning products, as obtained in the telephone interview, were dichotomized (never; ever) for the statistical analyses.

### Results

The prevalence ratio for asthma in the 73 “confirmed” cleaners ranged from 1.7 (asthma defined according to the questionnaire only) to 2.8 when asthma was defined using both the questionnaire and the results of a methacholine challenge test (table 1). Asthma risk was higher for the cleaners of private homes, the prevalence being 3.3 to 5.0 depending on the asthma definition. The “other cleaners” mainly cleaned schools, shops, hospitals, and offices. The prevalence of asthma in this group was similar to that of the reference group.

Since asthma prevalence was apparently higher for the home cleaners than for the other cleaners, subsequent analyses were performed separately for these 2 groups. The prevalence of housedust mite sensitization was 10-fold higher for the home cleaners (table 2), but comparable with the prevalence of office workers, which amounted to 22%. Many cleaners in both groups indicated work-related symptoms. Among the 36 cleaners with work-related breathing effects, 42% reported that the effects were related to the mixing of products, and 22% associated them with the use of ammonia (results not shown).

sprays more frequently. In order for the activities and products associated with the excess risk among the home cleaners to be evaluated, the latter group was subdivided according to each activity or product, and the asthma risks were compared (table 4).

Asthma risk was higher for the exposed cleaners for most of the activities and products under study. The highest risks were found for the cleaners who cleaned kitchens or polished furniture, and for cleaners using oven sprays or polishes. Home cleaners who vacuumed or swept or cleaned furniture or sanitary facilities had an almost 3-fold higher risk. Neither the limited numbers of subjects nor the concomitant exposure to various risk factors permitted multiple regression analyses.

## Discussion

In this study a previously observed excess risk for asthma among cleaners was confirmed using specific information on the cleaning job and questions on work-related respiratory symptoms. In addition, we investigated determinants of asthma among indoor cleaners. The excess risk of asthma was predominantly attributable to private home cleaning. Kitchen and sanitary cleaning, polishing furniture, and the use of oven sprays and polishes seemed to be the main work-related risk factors for asthma in home cleaners.

The potential limitations of this study included the small and selected population and the possible influence of recall bias. The group of home cleaners comprised 21 subjects, but, nevertheless, we were able to demonstrate statistically significant risks for subgroups containing down to 6 subjects with a certain activity or use of a certain product. We asked for characteristics of the cleaning job of 6 years earlier. Therefore, the occurrence of recall bias cannot be excluded. Most cleaners, however, could easily recall the brand names of the cleaning products they used, and probably recall bias was of marginal importance. The findings cannot directly be generalized to other populations since cleaning products and cleaning tasks may be different in other countries. In order to investigate this possibility, an inquiry on work activities among cleaners in several countries will be part of the ongoing follow-up of the European Community Respiratory Health Survey.

The elevated asthma risk for cleaners was dominated by private home cleaning. Several explanations can be hypothesized from our results. First, asthma was associated with kitchen cleaning. This finding seems consistent with an elevated asthma risk for home cleaners using ammonia and oven cleaning sprays. The active compound of oven sprays is caustic soda. Some cutaneous burns due to oven sprays have been reported also

The cleaners used a variety of different cleaning agents (table 3). Apart from some typical household activities, home cleaners also used perfumed products and

**Table 3.** Exposure characteristics of the cleaning job.

Exposure	Private home cleaners (N=21)		Other cleaners (N=46)	
	N	%	N	%
Vacuuming or sweeping	17	81	37	80
Mopping floor	18	86	38	83
Polishing floor	7	33	7	15
Cleaning furniture	17	48 <sup>a</sup>	9	20
Cleaning carpets and rugs	10	48	16	35
Cleaning sanitary	17	81	37	80
Cleaning kitchens	16	76 <sup>b</sup>	8	7
Cleaning windows inside	18	86 <sup>b</sup>	22	48
Ironing	12	38 <sup>b</sup>	2	4
Washing clothes by hand	8	38	2	4
Washing clothes by machine	10	48 <sup>b</sup>	5	11
Using cleaning products				
Soaps and detergents	21	100	44	96
Disinfectants	20	95	46	100
Bleach	20	95	45	98
Ammonia	19	90	33	72
Solvents	6	29	19	41
Polishes	11	52	18	39
Perfumed products	19	90 <sup>a</sup>	31	67
Products in spray-form	19	90 <sup>a</sup>	31	67
Glass cleaning sprays	14	67	20	43
Furniture sprays	9	43	17	37
Oven sprays	6	29 <sup>b</sup>	2	4
Mixing products	10	48	19	41

<sup>a</sup> Fisher's exact test 2-tailed (P<0.05).

<sup>b</sup> Fisher's exact test 2-tailed (P<0.01).

**Table 4.** Exposure characteristics of home cleaning and the risk of asthma relative to that of the reference group of office workers (N=1272). Prevalence ratio (PR) and 95% confidence interval (95% CI) adjusted for gender, age category, smoking, and area of residence.

Exposure	Ever exposed		Never exposed	
	PR	95% CI	PR	95% CI
Vacuuming or sweeping	3.8	2.1—6.8	1.3	0.2—9.1
Mopping floor	3.6	2.0—6.4	1.7	0.2—12.5
Polishing floor	2.9	1.1—7.9	3.5	1.8—6.8
Cleaning furniture	3.8	2.1—6.8	1.3	0.2—9.2
Polishing furniture	4.0	1.9—8.8	2.8	1.3—6.1
Cleaning carpets and rugs	3.6	1.8—7.5	3.0	1.3—6.8
Cleaning sanitary facilities	3.8	2.1—6.8	1.3	0.2—9.2
Cleaning kitchens	3.9	2.2—7.0	1.1	0.2—8.1
Cleaning windows inside	3.5	2.0—6.3	1.7	0.2—12.5
Ironing	3.5	1.8—7.0	3.0	1.2—7.4
Washing clothes by hand	3.5	1.5—8.1	3.2	1.5—6.5
Washing clothes by machine	3.4	1.6—7.3	3.2	1.5—7.0
Using cleaning products				
Ammonia	3.4	1.9—5.9	2.4	0.3—17.4
Solvents	3.7	1.3—10.3	3.2	1.7—6.1
Polishes	4.3	2.2—8.7	2.3	0.9—5.8
Perfumed products	3.2	1.8—5.9	3.7	0.9—15.3
Products in spray form	3.5	2.0—6.2	0.0	—
Glass cleaning sprays	3.8	2.0—7.1	2.2	0.7—6.9
Furniture sprays	3.7	1.8—7.7	2.8	1.2—6.4
Oven sprays	4.1	1.6—10.0	2.9	1.5—5.8
Mixing products	3.2	1.5—7.0	3.4	1.6—7.3

(16). The use of cleaning products in spray form facilitates inhalatory exposures during use. Irritative effects after the inhalation of caustic-soda-containing aerosols can be expected, possibly similar to that for ammonia (17). Second, polishing furniture and the use of polishes and furniture sprays were related to asthma. These products contain a variety of chemical compounds, which may act as irritants in the airways. Moreover, some of them are perfumed with pine scent containing (mono)terpenes, which have sensitizing properties (18). Many other types of cleaning products are also perfumed, typically with pine or lemon scent. The latter also contains potential sensitizers (19).

Finally, home cleaners had more housedust mite allergy than other cleaners. This finding may partially explain the difference in risk between the home cleaners and other cleaners. It can not, however, explain the excess risk for home cleaners since the prevalence of housedust mite sensitization was not essentially different from that of the reference group. The finding that "dusty" cleaning activities like vacuuming and sweeping were related to asthma nevertheless suggests that housedust mite allergen exposure may play a role in the onset or aggravation of the asthma of home cleaners.

Our results do not allow a single hypothesis for the mechanism of work-related asthma in cleaners. A plausible mechanism is work-aggravated asthma; work-related exacerbations of a preexisting asthmatic condition (2). Irritants from cleaning sprays can cause these exacerbations, principally in subjects with nonspecific bronchial responsiveness. However, it is possible that some cleaners have new-onset asthma due to the cleaning job. Cases of "classical" occupational asthma with allergic sensitization cannot be excluded (20). Apart from the scents already mentioned, cleaning products contain other potentially sensitizing additives, like isothiazolinones (preservatives) (5, 21), quaternary ammonium compounds (biocides) (6), and ethanolamines (corrosion inhibitors) (7, 22). The use of natural rubber gloves might also introduce the risk of sensitization and asthma due to latex allergens.

Irritants may also induce asthma in cleaners. A possibility is the reactive airways dysfunction syndrome (RADS), due to onetime, high-level irritant exposure at work (23). This disorder may occur when cleaning products are being mixed and exposure to chlorine or monochloramine gas results (10). A final mechanism is low-dose RADS, due to repeated exposures to moderate levels of irritants, with a not-so-sudden onset of asthma (24, 25).

In conclusion, asthma risk among Spanish indoor cleaners is related to the cleaning of private homes. This finding may be explained by the use of sprays and other products for kitchen cleaning and furniture polishing. These findings should be confirmed in additional

studies in different countries. The identification of specific types and brands of cleaning products associated with asthma risk in combination with clinical evaluations will allow a better understanding of the underlying mechanisms and responsible agents.

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