

Occupational risk factors for hand dermatitis among professional cleaners in Spain

Maria C. Mirabelli¹, David Vizcaya^{2,3,4}, Anna Martí Margarit^{5,6,7}, Josep Maria Antó^{2,3,4,7}, Lourdes Arjona^{2,3,4}, Esther Barreiro^{7,8,9}, Ramon Orriols^{9,10}, Ana Gimenez-Arnau^{5,6} and Jan-Paul Zock^{2,3,4}

¹Department of Epidemiology and Prevention, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, NC 27157, USA, ²Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain 08003, ³Hospital del Mar Research Institute (IMIM), Barcelona, Spain 08003, ⁴CIBER Epidemiología y Salud Pública (CIBERESP), Spain, ⁵Department of Dermatology, Hospital del Mar, Parc de Salut Mar, Barcelona, Spain 08003, ⁶Unidad Docente Medicina del Trabajo Mateu Orfila, Universitat Autònoma de Barcelona, Barcelona, Spain 08002, ⁷Department of Experimental and Health Sciences, Universitat Pompeu Fabra, Barcelona, Spain 08003, ⁸Pulmonology Department-Muscle and Respiratory System Research Unit (URMAR), IMIM-Hospital del Mar, Barcelona, Spain 08003, ⁹Centro de Investigación en Red de Enfermedades Respiratorias (CIBERES), Instituto de Salud Carlos III (ISCIII), Spain, and ¹⁰Servei de Pneumologia, Hospital Universitari Vall d'Hebron, Barcelona, Spain 08035

doi:10.1111/j.1600-0536.2011.02023.x

Summary

Background. Dermatitis is an important health outcome for workers whose jobs put them in contact with irritants or sensitizing agents.

Objectives. We conducted an analysis of data from the Epidemiological Study on the Risk of Asthma in Cleaning Workers 2 (EPIASLI2) to assess worksites and cleaning products as risk factors for hand dermatitis among professional cleaning workers.

Materials/methods. We distributed 4993 questionnaires to employees of 37 cleaning companies, and used data from 818 (16%) respondents who provided information about skin symptoms and cleaning-related exposures. We assessed associations between the frequencies of worksite and cleaning product exposures and a symptom-based definition of hand dermatitis among current cleaning workers ($n = 693$) and a comparison population ($n = 125$).

Results. Hand dermatitis was reported by 28% of current cleaning workers, versus 18% of the comparison population, and was associated with cleaning outdoor areas and schools, and the use of hydrochloric acid [prevalence ratio (PR) 1.92, 95% confidence interval (CI) 1.22–3.02] and dust mop products (PR 1.75, 95% CI 1.11–2.75).

Conclusions. Professional cleaning workers may not be sufficiently protected from cutaneous disease at work. Future research should further investigate the roles of multiple product exposures and personal protective equipment.

Key words: cleaning; dermatitis; epidemiology; occupational diseases; occupational exposure.

Professional cleaning workers keep homes, hospitals, hotels, office buildings, restaurants, schools, shopping

areas, sidewalks and other public and private spaces clean. The cleaning activities that they perform range from light tasks, such as dusting, sweeping, and vacuuming, to specialized activities that require hazardous cleaning solutions, heavy equipment, and job training (1, 2).

Men and women in the cleaning industry routinely come into contact with a wide range of hazards that are potentially responsible for causing occupational skin diseases. Professional cleaning workers clean and sanitize surfaces that put their skin in contact with biological,

Correspondence: Maria C. Mirabelli, Department of Epidemiology and Prevention, Division of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, NC 27157-1063, USA. Tel: +001-336-716-1112; E-mail: mmirabel@wakehealth.edu

Conflicts of interest: The authors have declared no conflicts of interest.

Accepted for publication 27 November 2011

chemical and physical hazards. The process of cleaning and disinfecting also exposes workers to a range of cleaning products that vary widely, according to the cleaning tasks and locations. Whereas some cleaning agents seem to be simple and relatively safe (e.g. soap and water, and vinegar), many contain preservatives, solvents, fragrances and other compounds with well-known irritating or sensitizing properties (3). In addition, cleaning may involve 'wet work' that may impair the epidermal barrier, allowing for skin irritation and sensitivity (4, 5). To reduce the risk of exposure to both the substances being cleaned and the cleaning products themselves, workers may use gloves or other items of personal protective equipment that protect the skin from hazardous exposures, but that may also exacerbate skin allergies or irritate the skin.

Previous research has provided evidence of an elevated prevalence of hand dermatitis among cleaning workers in hospitals (6, 7) and school buildings (8). We conducted the present study to assess a wide range of worksites, cleaning activities and cleaning products as risk factors for hand dermatitis among men and women employed in the cleaning industry in the province of Barcelona, Spain.

Materials and Methods

Study population and data collection

The Epidemiological Study on the Risk of Asthma in Cleaning Workers 2 (EPIASLI2) was a two-stage epidemiological study conducted to assess associations between cleaning work, including specific worksites and exposures to cleaning products, and dermatological and respiratory health symptoms (9). The study methods have been described previously (9). Summarized briefly, between February and December 2008, 4993 self-administered, paper-and-pencil-style questionnaires were distributed to employees of 37 cleaning companies operating in the province of Barcelona, Spain. Nine hundred and fifty questionnaires were returned by mail; of those, 132 (14%) were excluded because they were incomplete or lacked responses to key questionnaire items, and the remaining 818 respondents constituted our final study population for analyses of the cross-sectional survey data. Following the cross-sectional survey, 95 participants were recruited into a nested case-control study designed to further assess associations between cleaning work and respiratory disease (10). Data for the substudy were collected when participants completed a clinical examination and an interviewer-administered questionnaire. For 70 of the 95 participants (74%), the clinical examination included an in-person skin

health evaluation; therefore, our final study population includes additional data collection for a subset of 70. The study was approved by the ethics committee of the Instituto Municipal de Asistencia Sanitaria, and the analytical plan for this analysis was also approved by the Institutional Review Board of the Wake Forest School of Medicine.

Occupational exposures

Participants were categorized as working as cleaners at the time of their participation with the questions 'have you ever worked as a cleaner?' and 'what position do you currently hold in your company?', and responses to a series of questions about cleaning worksites, activities, and products used at work. As in previous analyses of EPIASLI2 data (9), respondents who indicated that they currently work as cleaners and those with positive responses to any of the questions about cleaning worksites, activities and products in the last month were categorized as 'current' cleaning workers ($n = 693$). Those who indicated that they had worked, but do not currently work, as cleaners were categorized as 'former' cleaning workers ($n = 57$). The remaining respondents were those who had never worked as cleaners ($n = 68$); this population includes office workers and other employees not performing cleaning jobs. In this analysis, former cleaning workers and those who had never worked as cleaners constitute the comparison population.

Respondents with positive answers to the series of questions about worksites (e.g. hospitals, private homes, and schools), activities (e.g. window cleaning) and products (e.g. ammonia, bleach, and glass cleaner) used in the last 12 months were then asked to estimate the frequencies of their work at these sites, performing these activities, or using these products, respectively, during the last month. Glove use was assessed with a single questionnaire item: 'How often did you use rubber gloves during the last 12 months?' Whether the respondent cleaned his or her own home was assessed with the question: 'Do you do cleaning tasks in your home?' Missing responses to these questions were re-assigned as negative responses—that is, not using the specific cleaning product, use of rubber gloves less than once per week, and not cleaning one's own home.

Dermatitis and eczema

Participants reported whether they had a history of eczema or other skin allergy by responding to the following question: 'Have you ever had eczema or other

skin allergies?' The questionnaire also included a series of questions developed by Coenraads et al. (11) and Smit et al. (12) to assess the 12-month prevalence of symptoms of hand dermatitis or eczema (hereafter referred to as 'hand dermatitis'). The symptoms of hand dermatitis included the following: (i) red and swollen hands or fingers; (ii) red hands or fingers and fissures; (iii) vesicles on the hands or between the fingers; (iv) scaling hands or fingers with fissures; and (v) itching hands or fingers with fissures. Symptoms were then classified according to the methods described in Smit et al.; that is, participants were classified as having hand dermatitis if they indicated that they had experienced at least one of the symptoms in the last 12 months and that the symptom(s) lasted for more than 3 weeks or occurred more than once (12).

For 70 participants who completed the in-person clinic examination portion of the study, the questionnaire items included in the survey at the clinical examination were identical to those included in the cross-sectional study described above. The clinical examination also included an in-person assessment by an occupational medicine physician with specialized training in dermatology, and evaluation of anonymized photographs of the hands, wrists and forearms by a dermatologist with expertise in contact dermatitis. The in-person assessment was based upon a visual evaluation of the hands, wrists, and forearms, and conversation with the participant at the time of the examination. Evaluation of anonymized photographs was performed after photographs of the fronts and backs of participants' hands were taken at the time of the examination. Photographs were taken with a Sony Cyber-shot® digital camera (model: DSC-W55), from a distance of 50 cm, and the images were stored digitally and reviewed later. Each of the 70 participants was classified as positive or negative for hand dermatitis independently by the two clinicians. For cases in which the two assessments generated discrepant results, the in-person and photographic assessments were re-evaluated together to obtain a final classification.

Statistical analysis

We estimated associations between each cleaning-related risk factor and hand dermatitis by using Poisson regression models, specified with a log link and robust error variance estimation (13, 14). Cleaning-related risk factors included employment as a current cleaner, worksite, cleaning activities, and products used at work. Results for current cleaning were generated with a single model estimating the prevalence of hand dermatitis among current cleaning workers ($n = 693$) as compared with the prevalence of hand dermatitis among former and

never cleaning workers (i.e. the comparison population, $n = 125$). Results for each worksite were generated with two models. First, we used a model estimating the prevalence of hand dermatitis among current cleaning workers who have and have not cleaned at the specific type of worksite in the last 12 months as compared with the prevalence of hand dermatitis in the comparison population. In order for the estimates generated for the effect of cleaning at the specific worksite within the last 12 months to include the full study population and to retain the ability to directly contrast the estimates across worksites, the population that reported not cleaning the specific type of worksite in the last 12 months is included in each model and the results are presented. Effect estimates presented for the population not cleaning the specific worksite within the last 12 months may be interpreted as the effect of currently cleaning, but not cleaning at the specific worksite; the primary outcome of interest generated with these models is the prevalence of hand dermatitis among current cleaning workers who reported cleaning the specific worksite in the last 12 months relative to the prevalence of hand dermatitis in the comparison population. Second, we used a model estimating the prevalence of hand dermatitis with increasing frequency of work at the specific type of worksite in the population of current cleaning workers who reported such work within the last 12 months as compared with the prevalence of hand dermatitis in the comparison population. Results for analyses of work activities and use of cleaning products were generated with similar models. All models were adjusted for age, country of birth (Spain versus other), sex, history of eczema or other skin allergy, cleaning one's own home, and frequency of glove use at work (<1, 1–3 or 4+ days/week). Associations are presented as prevalence ratios (PRs) with 95% confidence intervals (CIs). All analyses were performed with SAS version 9.1 (SAS Institute Inc., Cary, North Carolina, USA).

In a second set of analyses, we used data collected at the time of the clinical examination ($n = 70$) to compare the classifications of hand dermatitis based on participants' responses to survey items about hand dermatitis with the classification based on the dermatological assessment. We considered the dermatological assessment as the gold standard, and calculated the sensitivity, specificity, positive predictive value and negative predictive value of the questionnaire-based classification of hand dermatitis.

Results

Characteristics of the 818 study participants are shown in Table 1. Overall, the population of current cleaning

Table 1. Demographic characteristics and the prevalence of hand dermatitis among current cleaning workers and members of the comparison population

	Total population	Comparison population		Current cleaning workers	
	No. (%)	No. (%)	No. (%) with hand dermatitis	No. (%)	No. (%) with hand dermatitis
Total	818 (100)	125	22 (18)	693	191 (28)
Demographic characteristics					
Age (years)					
Mean $\pm$ SD	45 $\pm$ 10		42 $\pm$ 11		45 $\pm$ 10
Median	45		40		45
Minimum to maximum	18–65		22–61		18–65
Country of birth					
Spain	608 (74)	107 (86)	19 (18)	501 (72)	151 (30)
Other	210 (26)	18 (14)	3 (7)	192 (28)	40 (21)
Sex					
Female	673 (82)	92 (74)	17 (18)	581 (84)	168 (29)
Male	145 (17)	33 (26)	5 (15)	112 (16)	23 (21)
Cleaning					
Cleans own home					
No	53 (6)	21 (17)	2 (10)	32 (5)	5 (16)
Yes	765 (94)	104 (83)	20 (19)	661 (95)	186 (28)
Rubber glove use in the last 12 months?					
<1 day/week	266 (33)	101 (81)	17 (17)	165 (24)	45 (27)
1–3 days/week	108 (13)	4 (3)	2 (50)	104 (15)	31 (30)
4+ days/week	444 (54)	20 (16)	3 (15)	424 (61)	115 (27)
Health history					
Current asthma symptoms*					
No	736 (90)	116 (93)	19 (16)	620 (89)	160 (26)
Yes	82 (10)	9 (7)	3 (33)	73 (11)	31 (42)
History of eczema or other skin allergy					
No	579 (71)	88 (70)	9 (10)	491 (71)	76 (15)
Yes	239 (29)	37 (30)	13 (35)	202 (29)	115 (57)

SD, standard deviation.

*As defined in Vizcaya et al. (9): positive response 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?'; 'Are you currently taking any medicines including inhalers, aerosols or tablets for asthma?'

workers was slightly older (median age: 45 years) than the comparison population (median age: 40 years), and included larger proportions of women (84% versus 74%) and individuals who clean their own homes (95% versus 83%). The percentage of current cleaning workers with current asthma was slightly higher (11% versus 7%) and the percentages of respondents with a history of eczema or other skin allergy were similar in the two populations (29% versus 30%).

Of the individual skin symptoms included in our questionnaire, the most prevalent symptoms reported were red hands or fingers with fissures (20%) among current cleaning workers, and scaling hands or fingers with fissures (9%) in the comparison population; 36% ($n = 248$) of the current cleaning workers, and 22% ($n = 27$) of the comparison population reported one or more of the symptoms (Table 2). Overall, 28% of current cleaning workers and 18% of the comparison

population (former cleaners, 14%; never cleaners, 21%) met our definition for hand dermatitis, and the prevalence among current cleaning workers was elevated in relation to the comparison population (PR 1.60, 95% CI 1.03–2.47) (Table 3). Like all our estimates, this estimate was generated with a model adjusted for potential confounders selected *a priori*, as well as for cleaning one's own home (PR: 1.14, 95% CI: 0.56–2.32) and the frequency of using rubber gloves at work (1–3 days/week versus <1 day/week, PR 1.12, 95% CI 0.78–1.61; 4–7 days/week versus <1 day/week, PR 0.98, 95% CI 0.74–1.30) (data not shown).

Current cleaning workers cleaning outdoor areas (PR 1.85, 95% CI 1.16–2.96), residential building common areas (PR 1.77, 95% CI 1.11–2.84), and schools (PR 1.84, 95% CI 1.15–2.93), and those who reported cleaning up at a construction or renovation site (PR 1.87, 95% CI 1.18–2.95), each reported significantly higher

Table 2. Skin symptoms in the last 12 months, as reported by current cleaning workers and members of the comparison population, and criteria used to define hand dermatitis

	Total population (n = 818)	Comparison population (n = 125)	Current cleaning workers (n = 693)
	No. (%)	No. (%)	No. (%)
Symptoms			
Red hands or fingers and fissures	146 (18)	10 (8)	136 (20)
Scaling of hands or fingers, with fissures	136 (17)	11 (9)	125 (18)
Red, swollen hands or fingers	124 (15)	10 (8)	114 (16)
Itching hands or fingers, with fissures	102 (12)	8 (6)	94 (14)
Vesicles on hands or between fingers	43 (5)	5 (4)	38 (5)
Criteria			
≥1 symptom	275 (34)	27 (22)	248 (36)
≥1 symptom that lasted >3 weeks or occurred more than once*	213 (26)	22 (18)	191 (28)
≥2 symptoms that lasted >3 weeks or occurred more than once	95 (12)	6 (5)	89 (13)

*Definition of hand dermatitis used in this analysis.

prevalences of hand dermatitis than the comparison group (Table 3). For respondents working in residential building common areas in the last 12 months, we observed a monotonic increase in the prevalence of hand dermatitis from 24% among those who reported cleaning in a residential building common area <1 day/week to 38% among those working 4+ days/week. A similar increase was observed among respondents working in schools in the last 12 months, where the prevalence of hand dermatitis increased from 22% to 43%.

Among current cleaning workers using specific cleaning products, the highest prevalences of hand dermatitis were observed among those who reported moderately frequent (1–3 days/week) use of hydrochloric acid (prevalence 40%, PR 1.73, 95% CI 1.00–2.99) and dust mop products (prevalence 36%, PR 2.12, 95% CI 1.22–3.71) (Table 4). Relative to the comparison group, elevated PRs were also observed among current cleaning workers who reported frequent (4+ days/week) use of products, including ammonia (PR 2.22, 95% CI 1.26–3.91), bleach (PR 2.02, 95% CI 1.20–3.39), multi-use cleaning products (PR 2.24, 95% CI 1.31–3.83), and perfumed products (PR 1.96, 95% CI 1.18–3.26). The use of degreasing agents was associated with hand dermatitis, regardless of how frequently they were used (<1 day/week, PR 1.79, 95% CI 1.04–3.05; 1–3 days/week, PR 1.85, 95% CI 1.08–3.14; 4+ days/week, PR 1.77, 95% CI 1.04–3.02). When we assessed the effect of using multiple products, we found a monotonic increase in the prevalence of hand dermatitis with increasing numbers of different cleaning products (Table 5).

When we compared our survey-based definition of hand dermatitis with classifications based on dermatological assessments in the subsample of 70, we found that, with the questionnaire-based definition, 49% of

the sample was classified as having hand dermatitis, as compared with 24% when the definition was based on a dermatological examination. With the dermatological examination classification as the gold standard, analysis of our questionnaire-based definition generated a sensitivity of 0.82, a specificity of 0.62, a positive predictive value of 0.41, and a negative predictive value of 0.92.

Discussion

From these data, we identified groups of professional cleaning workers at elevated risk of hand dermatitis. Our results extend previous findings from epidemiological research into skin symptoms in cleaning workers (6–8) by showing elevated risk among users of products known to affect the respiratory tract and skin (1, 15, 16), providing evidence of increased risk with increasing frequency of use, and generating increasing adjusted risk estimates for workers performing a variety of tasks or using multiple products.

In addition to occupational risk factors, individual susceptibility factors such as atopy also play a role in the prevalence of hand dermatitis. In our data, hand dermatitis was reported among 39% more respondents with than without a self-reported history of eczema or other skin allergy. Although our data collection was not designed to distinguish allergic from irritant dermatitis, the cleaning-related exposures that we identify here should be considered to be risk factors for both. Indeed, the adjusted PR generated for current cleaning overall was similar to those generated when the data were stratified by self-reported history of eczema or other skin allergy (history, PR 1.61; no history, PR 1.57). These estimates and stratified estimates for particular worksites and cleaning products (not shown) do not provide sufficient evidence of

Table 3. Associations of cleaning worksite and major work activities with hand dermatitis

	No.	No. (%) with hand dermatitis	PR (95% CI)*	No.	No. (%) with hand dermatitis	PR (95% CI)*	No.	No. (%) with hand dermatitis	PR (95% CI)*	No.	No. (%) with hand dermatitis	PR (95% CI)*
Comparison population	125	22 (18)	1.00									
Current cleaning workers	693	191 (28)	1.60 (1.03–2.47)									
Worksite												
In the last 12 months												
No†	515	135 (26)	1.59 (1.03–2.47)	532	146 (27)	1.61 (1.04–2.50)	572	157 (27)	1.61 (1.04–2.49)	525	137 (26)	1.51 (0.97–2.36)
Yes	178	56 (31)	1.62 (1.00–2.62)	161	45 (28)	1.54 (0.94–2.53)	121	34 (28)	1.53 (0.91–2.57)	168	54 (32)	1.85 (1.16–2.96)
Frequency in the last month‡												
<1 day/week	58	15 (26)	1.04 (0.51–2.13)	88	24 (27)	1.33 (0.68–2.61)	54	17 (31)	1.72 (0.85–3.48)	56	20 (36)	1.97 (1.07–3.64)
1–3 days/week	15	6 (40)	1.70 (0.61–4.73)	32	10 (31)	1.29 (0.53–3.11)	15	4 (27)	1.32 (0.40–4.31)	33	15 (45)	2.20 (1.20–4.05)
4+ days/week	105	35 (33)	1.19 (0.63–2.26)	41	11 (27)	1.25 (0.56–2.77)	52	13 (25)	1.26 (0.57–2.78)	79	19 (24)	1.52 (0.80–2.86)
Worksite												
In the last 12 months												
No	612	164 (27)	1.59 (1.03–2.46)	480	130 (27)	1.59 (1.03–2.45)	499	131 (26)	1.53 (0.98–2.37)	537	138 (26)	1.53 (0.98–2.38)
Yes	81	27 (33)	1.64 (0.97–2.78)	213	61 (29)	1.64 (1.01–2.66)	194	60 (31)	1.77 (1.11–2.84)	156	53 (34)	1.84 (1.15–2.93)
Frequency in the last month												
<1 day/week	41	13 (32)	1.60 (0.75–3.40)	79	16 (20)	1.22 (0.62–2.41)	66	16 (24)	1.63 (0.87–3.05)	64	14 (22)	1.28 (0.64–2.56)
1–3 days/week	10	4 (40)	1.66 (0.55–4.97)	78	32 (41)	2.40 (1.30–4.45)	62	19 (31)	1.74 (0.89–3.37)	9	3 (33)	2.48 (0.98–6.29)
+ days/week	30	10 (33)	1.50 (0.72–3.11)	56	13 (23)	1.29 (0.61–2.73)	66	25 (38)	2.08 (1.17–3.67)	83	36 (43)	2.05 (1.14–3.69)
Work activities												
In the last 12 months												
No	533	134 (25)	1.50 (0.96–2.34)	602	166 (28)	1.60 (1.03–2.48)	631	173 (27)	1.62 (1.05–2.50)	440	122 (28)	1.65 (1.06–2.57)
Yes	160	57 (36)	1.87 (1.18–2.95)	91	25 (27)	1.58 (0.91–2.75)	62	18 (29)	1.44 (0.80–2.58)	253	69 (27)	1.50 (0.94–2.40)
Frequency in the last month												
<1 day/week	92	32 (35)	1.54 (0.88–2.69)	50	17 (34)	1.53 (0.73–3.21)	34	9 (26)	1.21 (0.49–2.95)	67	17 (25)	1.50 (0.82–2.75)
1+ days/week	68	25 (37)	1.76 (0.98–3.13)	41	8 (20)	0.86 (0.39–1.89)	28	9 (32)	1.30 (0.53–3.18)	186	52 (28)	1.75 (0.99–3.08)

CI, confidence interval; PR, prevalence ratio.

*Adjusted for age, country of birth, sex, history of eczema or other skin allergy, cleaning one's own home, and frequency of rubber glove use.

†Current cleaning workers who did not work at the worksite or perform the work activity in the last 12 months are included in each model. Effect estimates presented for the population not cleaning the specific worksite within the last 12 months may be interpreted as the effect of currently cleaning, but not cleaning at the specific worksite. The primary outcome of interest generated with these models is the prevalence of hand dermatitis among current cleaning workers who reported cleaning the specific worksite in the last 12 months relative to the prevalence of hand dermatitis in the comparison population.

‡Frequency in the last month among respondents who reported working at the worksite or performing the work activity in the last 12 months.

Table 4. Associations of cleaning product use in the last 12 months and frequency of use in the last month with hand dermatitis

	No.	No. (%) with hand dermatitis	PR (95% CI)*	No.	No. (%) with hand dermatitis	PR (95% CI)*	No.	No. (%) with hand dermatitis	PR (95% CI)*
Comparison population	125	22 (18)	1.00						
Cleaning product Used in the last 12 months			Air fresheners			Ammonia			Bleach
No†	351	98 (28)	1.65 (1.06–2.56)	406	110 (27)	1.62 (1.05–2.51)	160	38 (24)	1.53 (0.97–2.42)
Yes	342	93 (27)	1.52 (0.96–2.41)	287	81 (28)	1.55 (0.97–2.49)	533	153 (29)	1.66 (1.04–2.66)
Frequency of use in the last month‡									Degreasing agents
<1 day/week	68	16 (24)	1.28 (0.68–2.41)	107	23 (21)	1.26 (0.68–2.35)	77	17 (22)	1.51 (0.82–2.78)
1–3 days/week	74	18 (26)	1.28 (0.67–2.46)	64	19 (30)	2.03 (1.09–3.80)	89	25 (28)	1.69 (0.96–2.99)
4+ days/week	200	58 (29)	1.44 (0.84–2.46)	116	39 (34)	2.22 (1.26–3.91)	367	111 (30)	2.02 (1.20–3.39)
Cleaning product Used in the last 12 months			Dust mop products			Glass cleaners			Hydrochloric acid
No	347	86 (25)	1.49 (0.95–2.33)	274	77 (28)	1.68 (1.09–2.61)	389	83 (21)	1.41 (0.90–2.21)
Yes	346	105 (30)	1.75 (1.11–2.75)	419	114 (27)	1.50 (0.94–2.38)	304	108 (36)	1.92 (1.22–3.02)
Frequency of use in the last month									Multi-use products
<1 day/week	73	15 (21)	1.46 (0.78–2.74)	64	16 (25)	1.67 (0.90–3.09)	120	38 (32)	1.59 (0.92–2.75)
1–3 days/week	74	27 (36)	2.12 (1.22–3.71)	107	28 (26)	1.49 (0.83–2.70)	87	35 (40)	1.73 (1.00–2.99)
4+ days/week	199	63 (32)	1.93 (1.16–3.19)	248	70 (28)	1.75 (1.04–2.97)	97	35 (36)	1.54 (0.87–2.73)
Cleaning product Used in the last 12 months			Perfumed products (e.g. pine)			Polishes or waxes			Rug or carpet cleaners
No	310	77 (25)	1.54 (0.98–2.40)	504	137 (27)	1.56 (1.00–2.42)	576	160 (28)	1.61 (1.04–2.50)
Yes	383	114 (30)	1.67 (1.06–2.64)	189	54 (29)	1.71 (1.06–2.75)	117	31 (26)	1.51 (0.90–2.54)
Frequency of use in the last month									Solvents
<1 day/week	58	12 (21)	1.48 (0.77–2.85)	236	53 (22)	1.85 (1.01–3.40)	52	17 (33)	1.52 (0.78–2.97)
1–3 days/week	71	19 (27)	1.60 (0.88–2.92)	37	10 (27)	1.81 (0.83–3.94)	27	3 (11)	0.56 (0.19–1.63)
4+ days/week	254	83 (33)	1.96 (1.18–3.26)	74	21 (28)	1.69 (0.91–3.15)	38	11 (29)	1.06 (0.49–2.31)

CI, confidence interval; PR, prevalence ratio.

*Adjusted for age, country of birth, sex, history of eczema or other skin allergy, cleaning one's own home, and frequency of rubber glove use.

†Current cleaning workers who did not work at the worksite or perform the work activity in the last 12 months are included in each model. Effect estimates presented for the population not cleaning the specific worksite within the last 12 months may be interpreted as the effect of currently cleaning, but not cleaning at the specific worksite. The primary outcome of interest generated with these models is the prevalence of hand dermatitis among current cleaning workers who reported cleaning the specific worksite in the last 12 months relative to the prevalence of hand dermatitis in the comparison population.

‡Frequency in the last month among respondents who reported working at the worksite or performing the work activity in the last 12 months.

Table 5. Associations of the numbers of different types of worksites and different cleaning products used in the last 12 months with hand dermatitis

	No.	No. (%) with hand dermatitis	PR (95% CI)*
Comparison population	125	22 (18)	1.00
Number of worksite types			
0	159	31 (19)	1.38 (0.85–2.25)
1–2	327	97 (30)	1.69 (1.06–2.69)
3+	207	63 (30)	1.80 (1.11–2.93)
Number of different cleaning products			
0	86	20 (23)	1.62 (0.97–2.72)
1–3	95	23 (24)	1.41 (0.81–2.45)
4–6	225	58 (26)	1.50 (0.91–2.48)
7+	287	90 (31)	1.70 (1.04–2.75)

CI, confidence interval; PR, prevalence ratio.

*Adjusted for age, country of birth, sex, history of eczema or other skin allergy, cleaning one's own home, and frequency of rubber glove use.

effect modification by atopic status; improved information about atopy and a larger sample size would have allowed us to more thoroughly explore this potential effect modification. Nonetheless, any interventions aimed at reducing these exposures will probably reduce the burden of hand dermatitis among atopic and non-atopic individuals.

The validity statistics of our symptom-based definition of hand dermatitis as compared with the dermatological evaluation are similar to those published previously (17, 18), and suggest that outcome misclassification may affect our results. In particular, our definition may overestimate the prevalence of current hand dermatitis in this population. This is unsurprising, given that our survey-based definition assessed 12-month prevalence, whereas the in-person dermatological assessment was based on symptoms visible at the time of the examination. Indeed, some participants described improvement of their symptoms at the time of the physical examination. Nevertheless, these data provide strong evidence of the importance of hand dermatitis symptoms among cleaning workers. The fact that over 41% of the respondents who indicated that they had experienced hand dermatitis in the last 12 months had their symptoms observed by our study team suggests a high incidence of hand dermatitis or a long duration of the condition in this population.

Our findings should be interpreted with particular attention to the low survey response rate in EPIASLI2. Limitations of our study design and response rate, as well as a comparison of demographic characteristics of study participants and non-responders in two cleaning

companies, have been described elsewhere (9). If participation in our study was associated with symptom status differently among current and non-current cleaners, then our results may be affected by a response bias. A comparison of demographic characteristics at two cleaning companies by responder status did not reveal major differences between the two populations with respect to the characteristics evaluated (9). Due to regulations in Spain that protect information that would have allowed us to identify, contact, and collect additional information from individuals who did not participate in this study, (19), our study did not include any additional data collection from non-responders, and we are not able to draw further conclusions about differences between responders and non-responders (9). The prevalence of hand dermatitis reported by participants in our study is within the range of those reported among cleaners (5, 8, 20) and general population-based samples (21, 22), suggesting that, despite the low response rate, the external validity of our data is not markedly compromised. In fact, the enrolment of 818 participants in a research study focused on the health of workers in a large and diverse industry in which investigators and other public health personnel have limited workplace access is a noteworthy strength of our study.

Our findings may also be affected by the healthy worker survivor effect. If individuals who are susceptible to hand dermatitis or who have a history of hand dermatitis had left their cleaning jobs, then the workplace-based recruitment in EPIASLI2 may have excluded individuals with cleaning-related dermatitis. If symptomatic individuals reduced the frequency of their use of specific cleaning products, then our analysis may have incorrectly attributed their symptoms to a category of less frequent use. Similarly, if symptomatic individuals moved into administrative jobs, then our analysis would incorrectly attribute their cleaning-related symptoms to the comparison population. If our study were affected in this way by the healthy worker effect, then our results may have underestimated the actual burden of professional cleaning on skin health.

Symptoms of hand dermatitis may have long-term consequences for employment, economics, and quality of life (23–26). Our findings indicate potential opportunities for reducing the frequency of hand dermatitis among professional cleaning workers; namely, the feasibility of performing cleaning work with fewer cleaning products and less hazardous products should be evaluated. Other aspects of cleaning work that may affect the risk of hand dermatitis include cleaning techniques, product mixtures and dilutions, methods used to mix and dilute products, and safety training. Improved information about the types

of gloves used, hours of use and number of glove changes would provide valuable information about the role of gloves in protecting workers during specific activities and from individual products and product mixtures.

In conclusion, our findings support the hypothesis that cleaning work is a risk factor for hand dermatitis and that professional cleaning workers may not be sufficiently protected from dermal hazards at work. Occupational medicine and dermatology specialists, and others who provide healthcare to professional cleaners, should be aware of the health risks of performing cleaning work and handling specific cleaning products, and the possibility that symptoms of cutaneous disease are underreported

and underdiagnosed in this population. These results justify further evaluation of primary prevention methods to reduce cleaning workers' contact with dermal hazards.

Acknowledgements

This research was funded by a Fondo de Investigación Sanitaria grant from the Instituto de Salud Carlos III (Grant Number FIS PI06/1378). The authors also acknowledge partial funding from CIBER Epidemiología y Salud Pública (CIBERESP), Spain. M. Mirabelli received funding from the US National Institutes of Health (Grant Number 1F32ES014142).

References

- 1 Zock J P. World at work: cleaners. *Occup Environ Med* 2005; **62**: 581–584.
- 2 US Department of Labor. *US Department of Labor: Occupational Outlook Handbook, 2010–11, Building Cleaning Workers*: Bureau of Labor Statistics, Washington, D.C.
- 3 Magnano M, Silvani S, Vincenzi C, Nino M, Tosti A. Contact allergens and irritants in household washing and cleaning products. *Contact Dermatitis* 2009; **61**: 337–341.
- 4 Jungbauer F H, van der Harst J J, Schuttelaar M L, Groothoff J W, Coenraads P J. Characteristics of wet work in the cleaning industry. *Contact Dermatitis* 2004; **51**: 131–134.
- 5 Nielsen J. The occurrence and course of skin symptoms on the hands among female cleaners. *Contact Dermatitis* 1996; **34**: 284–291.
- 6 Gawkrödger D J, Lloyd M H, Hunter J A. Occupational skin disease in hospital cleaning and kitchen workers. *Contact Dermatitis* 1986; **15**: 132–135.
- 7 Hansen K S. Occupational dermatoses in hospital cleaning women. *Contact Dermatitis* 1983; **9**: 343–351.
- 8 Lynde C B, Obadia M, Liss G M, Ribeiro M, Holness D L, Tarlo S M. Cutaneous and respiratory symptoms among professional cleaners. *Occup Med (Lond)* 2009; **59**: 249–254.
- 9 Vizcaya D, Mirabelli M C, Antó J M, Orriols R, Burgos F, Arjona L, Zock J P. A workforce-based study on occupational exposures and asthma symptoms in cleaning workers. *Occup Env Med* 2011; **68**: 914–919.
- 10 Vizcaya D, Arjona L, Orriols R et al. Characteristics of asthma in cleaning workers: a case-control study. Annual Congress of the European Respiratory Society Meeting Barcelona, Spain. *Eur Respir J* 2010; **36**: 457s.
- 11 Coenraads P J, Nater J P, van der Lende R. Prevalence of eczema and other dermatoses of the hands and arms in the Netherlands. Association with age and occupation. *Clin Exp Dermatol* 1983; **8**: 495–503.
- 12 Smit H A, Coenraads P J, Lavrijsen A P, Nater J P. Evaluation of a self-administered questionnaire on hand dermatitis. *Contact Dermatitis* 1992; **26**: 11–16.
- 13 Thompson M L, Myers J E, Kriebel D. Prevalence odds ratio or prevalence ratio in the analysis of cross sectional data: what is to be done? *Occup Environ Med* 1998; **55**: 272–277.
- 14 Behrens T, Taeger D, Wellmann J, Keil U. Different methods to calculate effect estimates in cross-sectional studies. A comparison between prevalence odds ratio and prevalence ratio. *Methods Inf Med* 2004; **43**: 505–509.
- 15 Jaakkola J J, Jaakkola M S. Professional cleaning and asthma. *Curr Opin Allergy Clin Immunol* 2006; **6**: 85–90.
- 16 English J S C. Current concepts of irritant contact dermatitis. *Occup Environ Med* 2004; **61**: 722–726.
- 17 Vermeulen R, Kromhout H, Bruynzeel D P, de Boer E M. Ascertainment of hand dermatitis using a symptom-based questionnaire; applicability in an industrial population. *Contact Dermatitis* 2000; **42**: 202–206.
- 18 van Wendel de Joode B, Vermeulen R, Heederik D, van Ginkel K, Kromhout H. Evaluation of two self-administered questionnaires to ascertain dermatitis among metal workers and its relation with exposure to metal working fluids. *Contact Dermatitis* 2007; **57**: 14–20.
- 19 Ley Orgánica 15/1999, de 13 de diciembre, de Protección de Datos de Carácter Personal, 1999.
- 20 Singgih S I, Lantinga H, Nater J P, Woest T E, Kruij-Gaspersz J A. Occupational hand dermatoses in hospital cleaning personnel. *Contact Dermatitis* 1986; **14**: 14–19.
- 21 Thyssen J P, Johansen J D, Linneberg A, Menné T. The epidemiology of hand eczema in the general population – prevalence and main findings. *Contact Dermatitis* 2010; **62**: 75–87.
- 22 Diepgen T L, Coenraads P J. The epidemiology of occupational contact dermatitis. *Int Arch Occup Environ Health* 1999; **72**: 496–506.
- 23 Meding B, Swanbeck G. Consequences of having hand eczema. *Contact Dermatitis* 1990; **23**: 6–14.
- 24 Meding B, Wrangsjö K, Järvholm B. Fifteen-year follow-up of hand eczema: persistence and consequences. *Br J Dermatol* 2005; **152**: 975–980.
- 25 Mäliköinen T, Alanko K, Jolanki R, Luukkonen R, Aalto-Korte K, Lauerma A, Susitaival P. Long-term follow-up study of occupational hand eczema. *Br J Dermatol* 2010; **163**: 999–1006.
- 26 Cvetkovski R S, Zachariae R, Jensen H, Olsen J, Johansen J D, Agner T. Prognosis of occupational hand eczema: a follow-up study. *Arch Dermatol* 2006; **142**: 305–311.