Skin Symptoms in the Construction Industry: Occurrence and Determinants

Johan G. Timmerman, MSc,[1]* Dick Heederik, PhD,[1] Ton Spee, PhD,[1,2] and Lidwien A.M. Smit, PhD[1]

Background *In the construction industry, a relatively high hand eczema prevalence can be expected due to exposure to irritating and allergenic agents.*
Methods *As part of a regular program of voluntary medical examinations, a questionnaire including items on health symptoms and working circumstances is administered to construction industry personnel. We studied 152,200 male workers (response rate 52%). Associations between possible risk factors and self-reported skin symptoms and skin hypersensitivity were assessed using log-binomial regression analysis.*
Results *Prevalence of skin symptoms on the hands was 25.4% among construction workers, 14.6% among office personnel. Nuisance due to dust exposure was the most important work-related determinant for skin symptoms [Prevalence Ratio (PR) 1.59, 95% confidence interval (CI): 1.55–1.63]. Cross-sectional findings were supported by longitudinal analyses in a study population subset.*
Conclusions *Skin symptoms are common among construction workers. Nuisance due to dust exposure was associated with higher prevalences of skin symptoms.* Am. J. Ind. Med. 57:660–668, 2014. *© 2014 Wiley Periodicals, Inc.*

KEY WORDS: construction workers; eczema; prevalence; occupational exposure; skin symptoms

INTRODUCTION

Occupational contact dermatitis (OCD) is one of the most prevalent occupational diseases in many countries and accounts for more than 95% of all occupational skin diseases [Diepgen and Coenraads, 1999; English, 2004b; Lushniak, 2004]. It can be described as an inflammatory skin condition caused by skin contact with one or more exogenous agents in the workplace setting, with or without a concurrent exposure to a contributory physical agent (e.g., ultraviolet light) [Lushniak, 2004]. Two main types of contact dermatitis can be distinguished: irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD). ICD is an inflammation of the skin resulting from a direct cytotoxic effect of a chemical or physical agent, whereas ACD is a type IV delayed immune response induced by an allergen [Lushniak, 2004].

Data on incidence and prevalence of OCD are rare, often hand eczema is used as a proxy variable for OCD [Diepgen and Coenraads, 1999]. A literature review of studies on hand eczema in the general population in Western countries showed an average point prevalence of 4.2%. One year prevalence is higher (almost 10%) with considerable difference between men (5%) and women (11%). Incidence in males was found to be 4.0 cases in 1,000 person years [Thyssen et al., 2010]. Of subjects suffering from hand eczema, more than two-thirds report visiting a doctor and 44% reports visiting a dermatologist because of their hand eczema. Sick leave (21%) and job change (8%) are also

[1]Division Environmental Epidemiology, Institute for Risk Assessment Sciences, Utrecht University, Utrecht, The Netherlands
[2]Research and Development Arbouw, Harderwijk, The Netherlands
Contract grant sponsor: Research and Development Arbouw; Contract grant number: 11-025.
Disclosure Statement: The authors report no conflicts of interests.
*Correspondence to: Johan G. Timmerman, Division Environmental Epidemiology, Institute for Risk Assessment Sciences, PO Box 80178, 3508 TD Utrecht, The Netherlands. E-mail: j.g.timmerman@uu.nl

Accepted 6 February 2014
DOI 10.1002/ajim.22314. Published online 11 March 2014 in Wiley Online Library (wileyonlinelibrary.com).

frequently reported [Meding and Swanbeck, 1990; Hald et al., 2008]. Prognosis of hand eczema is generally poor. In a Swedish study with 15-year follow-up, 66% of almost 1,000 subjects with hand eczema reported to have had symptoms during follow-up and 44% percent of subjects with eczema reported to have had symptoms in the 12 months preceding the interview at the end of the follow-up period [Meding et al., 2005]. Not much is known about the social impact of OCD [Diepgen and Coenraads, 1999] but hand eczema seriously hampers social life of people suffering from it [Moberg et al., 2009]. Some studies also estimated the economic impact of occupational skin disease. In the Netherlands, the direct costs of occupational skin diseases in 1995 were estimated to be 45 million euro [Diepgen and Coenraads, 1999]. In the UK, yearly costs were estimated to be 200 million pound per year due to 4 million lost working days [English, 2004b].

Construction workers have a considerable risk of developing OCD as they are often exposed to substances with allergenic and/or irritant properties such as (wet) cement, epoxy resins, solvents, and abrasive materials [Diepgen and Coenraads, 1999; Winder and Carmody, 2002; Bock et al., 2003; Uter et al., 2004; Geraut et al., 2009; Ronmark et al., 2012]. In 1984, in a sample of about 1,700 Dutch construction workers, 7.8% showed a form of hand eczema [Coenraads et al., 1984], whereas in the general population, prevalence among men was 4.6% [Lantinga et al., 1984]. In the construction industry, ACD is generally more often reported than ICD, in particular in certain occupations such as bricklayers and cement workers. In other occupations such as wood processors and painters, ICD is more prevalent [Bock et al., 2003]. Although a few studies indicated an increased risk of OCD among various occupations within the construction industry [Koch, 2001; Halioua et al., 2012], there is an almost complete lack of studies reporting the prevalence and risk factors of hand eczema in the construction industry as a whole.

In the present epidemiological study, we analysed questionnaire data on skin symptoms and occupational risk factors from a large sample of Dutch construction workers. We aim to determine prevalence of skin symptoms in the construction industry and to assess possible risk factors and determinants.

METHODS

Study Population and Design

Dutch construction workers (including office workers) are invited for a voluntary periodical medical checkup at an occupational health service every 2–4 years, depending on their age. Data from the examinations are registered by Arbouw, the Dutch foundation that was established by employers' and employees' organizations in the construction industry to improve workers' health and reduce sick leave. An anonymized dataset was obtained from Arbouw. According to Dutch legislation, medical ethical approval was not required for this study. A cross-sectional study was performed among all construction workers who had a medical checkup between January 2005 and December 2011. Since 2005, questions on skin symptoms were included in the questionnaire. In this period, from a total of 530,412 invitations, 277,710 checkups were performed, giving a response rate of 52.4% (personal communication Arbouw, 2013). Data from 115,379 male construction workers were used. An additional population of 36,821 male office personnel employed in the construction industry (including office workers, supervisors, and canteen personnel) was treated as a separate group and only used in analyses that explored differences in risk between job titles. Data from 8,744 subjects were not used in data analyses because we excluded subjects with an inconsistent date of birth at their second visit, subjects aged <16 or >65 years, and female workers. The female population working on the construction yard is relatively small and not usable for meaningful analyses. For 58,772 construction workers and 15,890 office workers, data on at least two checkups were available. Workers were invited all year round. We explored whether seasonal variation existed in reported dermal symptoms and whether the month in which the checkup took place could be a confounder of relations between nuisance due to occupational exposures and reported dermal symptoms.

Data Collection

As part of the checkup, construction workers are asked to fill in a questionnaire with a large number of questions on personal characteristics, health aspects, and work-related aspects. This questionnaire has been used for years as a tool to help the occupational physician detect possible health problems in construction industry employees. Six questions on skin symptoms were included. Workers were asked whether they experienced much nuisance from dust, smoke, vapors/gases, or chemicals during their work. In addition, questions on personal protective equipment and sanitary facilities at the work place, skin type, smoking habits, and respiratory symptoms were asked. All analyzed questionnaire items are available in Table I. In the present study, two skin outcomes were studied: "skin symptoms" and "skin hypersensitivity." Skin symptoms was defined as one or more positive answers on the questions "Did you in the last 12 months suffer from: red and swollen hands or fingers? (question1); red hands or fingers with fissures? (q2); vesicles on the hands or between the fingers? (q3); raw or scaling hands with fissures? (q4); itching hands or fingers with fissures? (q5)." Occupational skin hypersensitivity was

TABLE I. Questionnaire Items on Skin Symptoms and Potential Determinants That Were Used in Data Analysis

Question	Answering options
Did you in the last 12 months suffer from: *(multiple answers possible)*	1. Red and swollen hands or fingers?
	2. Red hands or fingers with fissures?
	3. Vesicles on the hands or between the fingers?
	4. Raw or scaling hands with fissures?
	5. Itching hands or fingers with fissures?
6. Is your skin hypersensitive for one or more substances you are exposed to at your work?	Yes/no
7. During your work, do you experience much nuisance from: (*multiple answers possible*)	Dust?
	Smoke?
	Vapor or gas?
	Chemicals?
7. Do you wear gloves during work?	Yes/no
9. Are there proper washing and dressing facilities available on the construction site?	Yes/no
10. How would you describe your skin type?	Normal/dry/oily
11. Do you have an allergic airway disease?	Yes/no
12. Do you regularly have respiratory symptoms (coughing, wheezing, shortness of breath)?	Yes/no
13. What is applicable to you?	I never smoked
	I smoked in the past
	I currently smoke

defined as a positive answer to the question "Is your skin hypersensitive for one or more substances you are exposed to at your work? (question 6)."

Data Analysis

All statistical analyses were performed using SAS Software version 9.2 (SAS System for Windows, SAS Institute, Cary, NC). Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (95% CI) were calculated using log-binomial regression analysis according to Deddens and Petersen [2008].

In the longitudinal analyses, only the first two checkups were used in analyses on subjects with two or more checkups. For job title risk analyses, only subjects who had the same job title during the two checkups were included (total N = 60,694). Longitudinal analyses were conducted using log-binomial regression analysis. Subjects reporting symptoms at both checkups were considered to have persistent symptoms, subjects with symptoms at the second but not the first checkup were considered to have incident symptoms and subjects with symptoms at the first but not the second checkup were considered to have remittent symptoms. Subjects with no symptoms at both checkups were used as the reference category. Variation of independent variables like reported nuisance due to exposures and glove use over the two checkups was also taken into account by creating dummy variables for exposure status at both time points. PR were calculated similarly as in the cross-sectional analysis described above.

RESULTS

Table II shows personal characteristics, nuisance due to occupational exposures, and prevalence of skin symptoms according to the main job titles. Among the 115,379 construction workers, nuisance resulting from dust exposure was reported by more than half of the workers (57.4%), whereas nuisance due to chemicals (8.9%), vapors or gases (6.8%), or smoke (5.0%) were reported less often.

One out of four workers (25.4%) reported at least one skin symptom. The most frequently reported skin symptom was "raw or scaling hands with fissures" (15.9%). Office workers reported lower prevalences (14.6% skin symptoms, 2.9% skin hypersensitivity).

Seasonal Variation in Skin Symptom Prevalence

We observed a clear seasonal pattern in reported skin symptoms (Fig. 1). During winter (December–February; 26.6%) and spring (March–May; 27.9%) reported prevalence was higher than during summer (June–August; 23.6%) and autumn (September–November; 23.0%). There was no such effect in reporting skin hypersensitivity (Fig. 1). In subsequent regression analyses we adjusted results for season.

Determinants

In Table III, univariate and adjusted PR are given for associations between personal characteristics, nuisance due

TABLE II. Characteristics of the Study Population

			Construction workers (per job title)					
	Office workers	**Construction workers**	**Carpenters**	**Painters**	**Bricklayers**	**Drivers**	**Plasterers**	**Other**
N	36,821	115,379	49,001	14,276	10,567	4,880	2,843	33812
1 checkup	56.85%	49.06%	22797	7600	4713	2145	1742	17610
2 or more checkups	43.15%	50.94%	26204	6676	5854	2735	1101	16202
Age (mean, Q1–Q3)	42.96 (35–52)	40.74 (31–52)	39.55 (28–51)	42.85 (35–52)	42.07 (32–52)	43.45 (36–53)	37.46 (24–48)	41.05 (32–50)
Smoking status:								
Never smoked	47.3%	33.9%	39.2%	30.9%	33.3%	31.0%	27.9%	28.6%
Quited smoking	29.8%	27.4%	26.9%	29.2%	30.7%	31.1%	25.3%	25.9%
Current smoking	22.9%	38.7%	33.9%	39.9%	35.9%	38.0%	40.9%	45.5%
Nuisance due to occupational exposure to:								
Dust	11.7%	57.4%	59.4%	69.9%	57.8%	31.3%	76.5%	51.2%
Smoke	1.6%	5.0%	2.8%	4.0%	2.2%	9.4%	2.3%	9.0%
Vapors/gas	2.1%	6.8%	2.5%	15.4%	1.9%	10.3%	3.1%	10.8%
Chemicals	1.9%	8.9%	4.1%	34.3%	3.2%	3.0%	7.0%	7.9%
Glove use	85.1%	37.3%	41.5%	34.9%	42.5%	30.9%	72.5%	28.4%
No suitable washing and dressing facilities available	18.0%	38.4%	36.1%	36.9%	40.3%	45.4%	40.5%	40.5%
Skin type:								
Normal	75.4%	76.8%	76.9%	75.5%	76.1%	79.3%	74.5%	77.1%
Dry	15.7%	16.2%	15.9%	17.5%	16.7%	13.3%	20.7%	16.2%
Oily	4.7%	3.7%	3.3%	4.3%	3.0%	4.2%	3.4%	4.0%
Respiratory symptoms	8.7%	12.4%	10.7%	16.0%	11.3%	9.5%	15.5%	13.9%
Respiratory allergy	8.2%	7.0%	7.0%	7.9%	6.5%	5.4%	9.0%	7.0%
Red hands or fingers with fissures	3.6%	6.2%	6.2%	6.1%	7.9%	3.8%	8.9%	6.0%
Vesicles on the hands or between the fingers	4.1%	4.2%	3.6%	6.1%	4.0%	3.7%	3.8%	4.3%
Raw or scaling hands with fissures	7.8%	15.9%	16.5%	12.7%	20.2%	9.2%	24.3%	15.2%
Itching hands or fingers with fissures	4.7%	6.7%	6.0%	8.3%	7.4%	4.9%	8.6%	7.0%
Skin symptoms	14.6%	25.4%	25.2%	24.7%	30.5%	16.2%	36.1%	24.8%
Work-related skin hypersensitivity	2.9%	9.5%	11.1%	10.9%	9.0%	3.6%	9.1%	7.6%

The total construction worker population is divided into six job titles (right half of table).

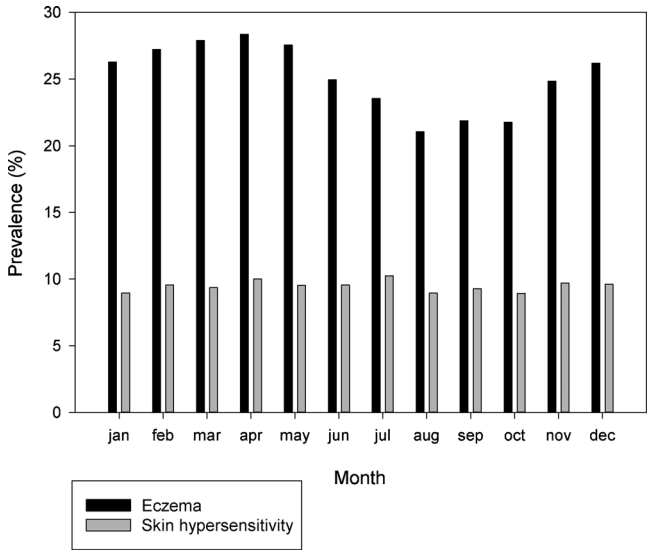

FIGURE 1. Seasonal variation in reported crude prevalences of eczema and skin hypersensitivity among construction workers.

to occupational exposures and skin outcomes. Nuisance due to occupational dust and chemicals exposure was significantly associated with both skin symptoms and skin hypersensitivity. After adjusting, nuisance due to exposure to vapors or gases or nuisance due to exposure to smoke were not significantly related to either hand skin symptoms or skin hypersensitivity. Construction workers reported slightly more often skin symptoms and skin hypersensitivity when suitable washing and dressing facilities at the workplace were absent. Use of gloves was negatively associated with skin hypersensitivity (adjusted PR 0.61). A dry skin type was associated with a twofold increase of both skin symptoms and skin hypersensitivity compared with a normal skin type. To a lesser extent, also an oily skin type was associated with both skin symptoms and skin hypersensitivity. Respiratory symptoms were positively related to both hand skin symptoms and skin hypersensitivity. These effects were strongest for skin hypersensitivity (adjusted PR 1.36). The observed change in PR after adjusting was mainly caused by adjusting for nuisance due to the occupational exposures. PR that were mutually adjusted for nuisance due to occupational exposures, did not change meaningfully after adding all other variables in Table III.

TABLE III. Associations of Skin Symptoms and Skin Hypersensitivity With Potential Determinants in 115,379 Male Construction Workers

	Skin symptoms		Skin hypersensitivity	
	Crude PR (95% CIs)	**Adjusted PR (95% CIs)**	**Crude PR (95% CIs)**	**Adjusted PR (95% CIs)**
Age (per 10 years increase)	1.04 (1.03–1.05)	1.03 (1.02–1.04)	1.06 (1.05–1.08)	1.06 (1.05–1.08)
Smoking status				
Never smoked	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Quited smoking	1.28 (1.25–1.31)	1.15 (1.12–1.19)	1.23 (1.18–1.29)	1.06 (1.01–1.11)
Current smoking	1.27 (1.24–1.30)	1.11 (1.08–1.14)	1.19 (1.14–1.24)	0.98 (0.94–1.03)
Nuisance due to occupational exposure to				
Dust	1.90 (1.87–1.94)	1.59 (1.55–1.63)	2.76 (2.65–2.86)	1.78 (1.71–1.86)
Smoke	1.40 (1.35–1.45)	1.03 (0.98–1.08)	1.66 (1.55–1.78)	0.99 (0.92–1.07)
Vapors/gases	1.44 (1.39–1.48)	1.04 (0.99–1.08)	1.87 (1.77–1.98)	0.98 (0.92–1.04)
Chemicals	1.50 (1.45–1.54)	1.09 (1.06–1.14)	2.49 (2.38–2.61)	1.55 (1.48–1.63)
Glove use	0.76 (0.74–0.77)	0.98 (0.95–1.00)	0.39 (0.38–0.41)	0.61 (0.58–0.63)
No suitable washing and dressing facilities	1.21 (1.19–1.23)	1.06 (1.04–1.09)	1.30 (1.25–1.34)	1.06 (1.02–1.10)
Skin type:				
Normal	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Dry	2.16 (2.12–2.20)	2.01 (1.96–2.06)	2.74 (2.64–2.84)	2.28 (2.19–2.36)
Oily	1.20 (1.15–1.26)	1.16 (1.09–1.23)	1.41 (1.30–1.54)	1.35 (1.23–1.47)
Respiratory allergy	1.29 (1.25–1.33)	1.09 (1.05–1.14)	2.08 (1.98–2.18)	1.49 (1.41–1.57)
Respiratory symptoms	1.47 (1.44–1.51)	1.20 (1.16–1.24)	2.08 (2.00–2.17)	1.36 (1.29–1.42)
Season:				
Autumn	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Winter	1.16 (1.13–1.19)	1.13 (1.10–1.17)	1.01 (0.96–1.06)	0.97 (0.92–1.02)
Spring	1.22 (1.18–1.25)	1.16 (1.12–1.19)	1.03 (0.98–1.08)	0.96 (0.92–1.01)
Summer	1.03 (1.00–1.06)	1.00 (0.97–1.04)	1.03 (0.97–1.08)	1.00 (0.95–1.06)

PR were adjusted for all other determinants shown in the table.

TABLE IV. Associations Between Job Titles and Skin Symptoms and Skin Hypersensitivity

	Skin symptoms at first checkup	Crude PR (95% CI)	Adjusted PR (95% CI)	Skin hypersensitivity at first checkup	Crude PR (95% CI)	Adjusted PR (95% CI)
Drivers	16.2%	1 (reference)	1 (reference)	3.6%	1 (reference)	1 (reference)
Carpenters	25.2%	1.56 (1.46–1.66)	1.54 (1.44–1.65)	11.1%	3.10 (2.67–3.60)	2.98 (2.57–3.46)
Bricklayers	30.5%	1.88 (1.76–2.02)	1.80 (1.68–1.93)	9.0%	2.50 (2.13–2.93)	2.37 (2.02–2.77)
Painters	24.7%	1.53 (1.42–1.64)	1.43 (1.33–1.53)	10.9%	3.02 (2.59–3.53)	2.70 (2.32–3.15)
Plasterers	36.1%	2.23 (2.05–2.41)	1.98 (1.83–2.14)	9.1%	2.53 (2.09–3.05)	2.25 (1.86–2.71)
Other construction workers	24.8%	1.53 (1.43–1.63)	1.47 (1.37–1.57)	7.6%	2.11 (1.81–2.46)	1.99 (1.71–2.31)
Office workers	14.6%	0.90 (0.84–0.96)	0.90 (0.84–0.96)	2.9%	0.81 (0.69–0.96)	0.78 (0.66–0.91)

PR were adjusted for age, smoking, skin type, respiratory symptoms, respiratory allergy, available sanitary facilities, and season.

Relations between job titles and skin symptoms are shown in Table IV. In this analysis, office workers were also included. Drivers (both on the road and off-road) were used as a reference as they work on the construction site but usually have much lower dermal exposures compared to other job titles. The job group with highest PR for hand skin symptoms were plasterers and bricklayers (PR >1.8) whereas office workers had a significantly lower prevalence than drivers (PR 0.90). For skin hypersensitivity, highest PR were found in carpenters and painters (PR >2.7), whereas office workers again had a significantly lower prevalence than drivers (PR 0.78).

Longitudinal Analysis

Among subjects with at least two checkups, 23.7% reported skin symptoms at their first visit and 23.4% reported skin symptoms at their second visit. Skin symptoms at both visits were reported by 11.8%, incident skin symptoms by 11.6% and remittent skin symptoms by 11.8% of subjects. Results of the regression analysis are shown in Table V. Reporting nuisance due to occupational dust exposure at both checkups was strongly related to both skin symptoms and skin hypersensitivity (PR > 1.50), regardless if the symptoms were reported at only the first, only the second or both checkups. In addition, a pattern was observed that suggested a temporal relation between nuisance due to exposure and symptoms: associations of reported nuisance at the second but not the first checkup were strongest with incident skin symptoms and skin hypersensitivity, whereas associations of nuisance due to exposure reported at the first but not the second checkup were strongest with remittent skin symptoms and skin hypersensitivity. A similar temporal pattern was seen for associations between nuisance due to chemical exposures and reporting skin hypersensitivity, whereas associations of nuisance due to chemical exposures with skin symptoms were much weaker.

As in the cross-sectional analysis, longitudinal analyses showed only weak associations with PR close to unity for nuisance due to occupational exposure to smoke, or vapors or gases (data not shown).

Reporting glove use at both check-ups was strongly negatively associated with skin hypersensitivity, regardless if symptoms were reported at only the first, only the second or both checkups (PR: 0.43–0.56). Interestingly, glove use at the second but not the first checkup was positively associated with remittent skin hypersensitivity, and glove use at the first but not the second checkup was positively associated with incident skin hypersensitivity, again suggesting a temporal relation. All construction yard job titles shown in Table V except painters had a statistically significantly increased prevalence of incident, remittent, and persistent skin symptoms compared with drivers. Carpenters and bricklayers had significantly higher prevalences of incident, remittent, and persistent skin hypersensitivity than drivers. Painters had higher prevalences of remittent skin hypersensitivity, plasterers had higher prevalences of persistent skin hypersensitivity and other construction workers had higher prevalences for both remittent as well as persistent skin hypersensitivity. Office job titles had a statistically significantly lower risk of incident skin hypersensitivity.

DISCUSSION

In this large-scale questionnaire survey, self-reported prevalence and determinants of skin symptoms and skin hypersensitivity among 152,200 Dutch construction workers were analyzed. Among male construction workers, 1 year prevalences of skin symptoms and occupational skin hypersensitivity were 25.4% and 9.5%, respectively. Nuisance due to exposure to dust was the main work-related determinant.

To our knowledge, this is the first time since 1984 that skin symptom prevalence was studied across the construction industry as a whole, thus giving a unique insight in this large occupational group. We had a wealth of data available, with self-reported routine data from no less than 152,200 subjects which provided ample statistical power. The response rate

TABLE V. Associations of Incident, Remittent, and Persistent Skin Symptoms and Skin Hypersensitivity in the Subpopulation of Construction Workers With at Least Two Checkups

	Skin symptoms			Skin hypersensitiviy		
	Incident	**Remittent**	**Persistent**	**Incident**	**Remittent**	**Persistent**
Nuisance due to occupational dust exposure						
No/no	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
No/yes	1.70 (1.59–1.82)	1.15 (1.06–1.25)	1.49 (1.37–1.62)	2.07 (1.82–2.36)	1.51 (1.31–1.75)	1.87 (1.61–2.17)
Yes/no	1.13 (1.04–1.22)	1.67 (1.56–1.78)	1.56 (1.44–1.69)	1.35 (1.17–1.57)	2.06 (1.82–2.34)	1.88 (1.62–2.19)
Yes/yes	1.51 (1.43–1.60)	1.57 (1.48–1.66)	2.30 (2.16–2.45)	2.12 (1.90–2.37)	2.22 (1.99–2.47)	2.72 (2.41–3.06)
Nuisance due to occupational chemicals exposure						
No/no	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
No/yes	1.18 (1.07–1.30)	0.92 (0.82–1.03)	1.08 (0.98–1.18)	1.81 (1.58–2.08)	1.13 (0.95–1.35)	1.59 (1.37–1.84)
Yes/no	0.94 (0.84–1.05)	1.17 (1.07–1.28)	1.04 (0.96–1.14)	1.18 (1.00–1.41)	1.69 (1.48–1.93)	1.59 (1.38–1.84)
Yes/yes	0.99 (0.88–1.12)	1.10 (0.99–1.23)	1.16 (1.07–1.26)	1.50 (1.27–1.77)	1.34 (1.13–1.59)	1.95 (1.73–2.20)
Glove use						
No/no	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
No/yes	1.04 (0.97–1.12)	1.10 (1.03–1.17)	0.92 (0.86–0.99)	0.68 (0.59–0.79)	1.40 (1.27–1.55)	0.61 (0.53–0.70)
Yes/no	1.12 (1.05–1.19)	1.11 (1.05–1.18)	0.99 (0.93–1.05)	1.41 (1.28–1.54)	0.70 (0.62–0.79)	0.65 (0.57–0.73)
Yes/yes	0.97 (0.91–1.02)	0.94 (0.88–0.99)	0.89 (0.85–0.94)	0.54 (0.48–0.61)	0.56 (0.50–0.62)	0.43 (0.38–0.49)
Job title						
Drivers	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Carpenters	1.48 (1.30–1.68)	1.39 (1.22–1.58)	1.55 (1.31–1.85)	1.83 (1.43–2.35)	2.56 (1.91–3.43)	2.82 (2.05–3.89)
Bricklayers	1.70 ((1.48–1.96)	1.63 (1.42–1.88)	1.94 (1.61–2.33)	1.45 (1.10–1.91)	2.01 (1.47–2.74)	2.44 (1.74–3.41)
Painters	1.15 (0.99–1.32)	1.20 (1.04–1.38)	1.12 (0.93–1.35)	1.20 (0.92–1.58)	1.73 (1.27–2.36)	1.38 (0.98–1.93)
Plasterers	1.56 (1.29–1.90)	1.60 (1.33–1.93)	1.84 (1.48–2.29)	1.01 (0.68–1.51)	1.50 (0.99–2.27)	2.29 (1.54–3.40)
Other construction workers	1.30 (1.14–1.48)	1.32 (1.16–1.51)	1.36 (1.14–1.62)	1.20 (0.93–1.55)	1.67 (1.24–2.25)	1.50 (1.08–2.08)
Office workers	0.94 (0.82–1.08)	1.07 (0.94–1.23)	0.97 (0.81–1.17)	0.62 (0.47–0.82)	1.06 (0.77–1.44)	0.98 (0.69–1.38)

PR were adjusted for age, smoking status, skin type, respiratory symptoms, season and all other determinants in the table except for job title. Job title associations were adjusted for age, smoking, skin type, respiratory symptoms, allergic airway diseases, available sanitary facilities, and season.

was 52.4%, which is lower than in a study among Swedish construction workers in an equivalent setting, where a response rate of at least 80% was achieved [Toren et al., 2011]. A non-response survey was performed to evaluate the reasons why invited workers did not visit the checkup. Already undergoing medical treatment (19.6%) was the most frequently mentioned reason for non-response, followed by lack of interest (14.3%) and not being able to visit the checkup (11.1%) (personal communication Arbouw, 2013). Prevalence estimates in our study may be somewhat influenced by selection bias. Underreporting might happen because some workers with skin symptoms may not have visited the checkup as they were already receiving medical treatment for these symptoms. Conversely, overreporting might happen because subjects who feel healthy are also likely to be underrepresented. In general however, we assume that the presence of skin symptoms during the past year may not have had a large influence on the decision to attend the checkup.

Self-reported assessment of nuisance due to occupational exposures was used as a proxy for exposure. Nuisance due to dust is probably strongly correlated with actual exposure levels, but misclassification of exposure status among exposed workers who do not experience much nuisance is also likely to have occurred. Although subjects with symptoms may tend to report more nuisance, the impact of reporting bias on the risk estimates for skin symptoms is probably low, as the questions on nuisance are not skin-specific. Exposure to dust can, for example, also lead to respiratory symptoms. We do not expect subjects with hand skin symptoms to overreport nuisance due to dust compared with workers with similar exposures but no skin symptoms on the hands. Moreover, job title analysis also showed more symptoms in workers with dusty jobs. In our study sample, a 1 year skin symptoms prevalence of 25.4% was found. These skin symptoms are an indication of hand eczema but also of other skin diseases like psoriasis. In Dutch construction workers, a hand eczema prevalence of 7.8% was found by Coenraads et al. The lack of a standard definition for hand eczema makes it difficult to compare the observed skin symptom prevalence with other studies. Within our study, every subject completed the same questionnaire. For internal

comparisions, for example, between job titles, the lack of a standard definition is less important. The questions we used in the present study to determine skin symptom prevalence, were developed to give an indication of hand eczema prevalence. They should be used together with two additional questions which were not included in our routine survey questionnaire data. A positive answer to one of these additional questions, "Did one or more of these symptoms last for more than 2 weeks?" and "Did one or more of these symptoms occur more than once?," is needed for a reliable indication of hand eczema, as was validated in a population of nurses [Smit et al., 1992]. Due to the high sensitivity (100%) and moderate specificity (64%) of this symptom-based diagnosis, Smit et al. recommended to subsequently perform a dermatological examination in the positively scoring subjects. Vermeulen et al. [2000] found that the specificity and sensitivity of this method was different in an industrial population and they recommended the symptom-based questionnaire to be validated in other populations. Therefore, we plan to validate the questionnaire in a population of construction workers during ongoing research. In this study, also a more detailed exposure assessment will be performed.

Weather conditions have been reported to influence the prevalence of hand eczema [Weiland et al., 2004; Suarez-Varela et al., 2008; Silverberg et al., 2013]. Although the questionnaire asked for the occurrence of symptoms in the last 12 months, we investigated whether there was a seasonal effect of symptom reporting, as subjects people might tend to report symptoms more frequently when they experienced the symptoms shortly before. It appeared there was a seasonal variation, with almost 5% more skin symptoms reported in spring than in autumn, indicating that subjects tend to report symptoms that occurred shortly before filling in the questionnaire as was earlier suggested by Diepgen and Coenraads [1999]. This finding indicates that year-prevalence obtained by questionnaire on symptoms in the last 12 months should be interpreted carefully, as the data could have a tendency towards a point prevalence rather than a 1 year prevalence and thus underestimate the 1 year prevalence.

In our study, survivor bias may have influenced prevalences and risk estimates as subjects with severe skin symptoms on the hands may leave jobs [Diepgen and Coenraads, 1999]. Although we subdivided the construction workers population into six job title groups, a lot of variation between the job titles in the "other job titles" group remains. For example, floor layers very commonly report nuisance due to exposures to dust (86.2%) and chemicals (62.1%) whereas steel fixers (dust: 35.6%) and road pavers (chemicals: 1.8%) much less often report nuisance due to these exposures. In addition, there is a lot of variation within the job titles. Carpenters, for instance, all have the same job title but may perform different tasks and consequently have different exposure patterns.

It is well known that dust may contain eczema causing components, for instance allergenic wood species dust and gypsum drywall dust that dehydrates the skin. This might explain the high prevalence of skin hypersensitivity in carpenters (11.1%) and the high percentage of plasterers reporting a dry skin (20.7%) or skin symptoms (36.1%). The effect on skin conditions of both exposure to wood dust and gypsum may be exacerbated by the use of abrasive materials. Although not asked for in the questionnaire, many construction workers handle abrasive materials that damage the skin, creating a port of entry for small particles to enter the skin and underlying tissues, provoking a skin inflammation.

We only had access to a limited number of determinants; in our questionnaire, no questions on wet work were included. Wet work is a major risk factor for OCD [Visser et al., 2013] and construction workers may also be exposed to wet work either by direct contact with water or wet materials such as cement, wearing occlusive gloves, or high hand washing frequencies. In our job title analysis, bricklayers showed a high prevalence of skin symptoms. This might be due to wet characteristics of cement but also due to allergenic components of cement or due to abrasive characteristics of bricks. Another important risk factor for hand eczema is a history of atopy or childhood eczema [Diepgen and Coenraads, 1999; Thyssen et al., 2010]. As a proxy for atopy, we corrected for respiratory allergy in our analysis but this hardly influenced the risk estimates.

In our study, we had the strength of longitudinal data which made it possible to analyze the change in symptom prevalence in association with a change in nuisance due to exposure. The longitudinal data support the hypothetic temporal relation between nuisance due to dust exposure and skin symptoms, as incident skin symptoms are most strongly associated with reported nuisance due to exposure at the second but not the first checkup, and remitting skin symptoms are most strongly associated with nuisance due to exposure at the first but not the second checkup. In the longitudinal analysis, also a temporal relationship between glove use and skin symptoms was suggested as incident skin symptoms were most strongly associated with glove use at the first but not the second checkup and remittent skin symptoms were strongest associated with glove use at the second but not the first checkup. Glove use at both checkups was also negatively associated with skin symptoms at both checkups. To prevent OCD in construction workers, preventing the skin from contact with the inducing agent is essential [Diepgen and Coenraads, 1999]. The first approach in prevention is to eliminate the harmful substance [Diepgen and Coenraads, 1999; English, 2004a]. Wearing appropriate gloves to protect the skin from OCD causing agents and contributory factors is recommended as an alternative measure [Koch, 2001; Agner and Held, 2002]. It is remarkable that in our data, painters report high nuisance due to chemicals exposure (34.3%) but glove use is low amongst painters (34.9%). This might stress

the need of gloves that are both protective and suitable for the working tasks of the construction workers. At the moment, many workers might not use gloves as they bother them in doing their work.

In conclusion, in Dutch male construction workers, a high prevalence of skin symptoms and skin hypersensitivity was observed compared to the general population, which might be an indication for high eczema prevalence. Main occupational determinants were nuisance due to dust and chemical exposures. These findings need to be confirmed by using a complete set of validated eczema questions supplemented by a dermatologist's diagnosis. Moreover, in-depth analysis of high-risk job titles will give more insight into the determinants of OCD, and will help to develop a prevention policy.

ACKNOWLEDGMENTS

We thank Frans Meijer from Arbouw for providing the dataset. The funder had no role in study design, data analysis, or decision to publish.

REFERENCES

Agner T, Held E. 2002. Skin protection programmes. Contact Dermatitis 47:253–256.

Bock M, Schmidt A, Bruckner T, Diepgen TL. 2003. Occupational skin disease in the construction industry. Br J Dermatol 149:1165–1171.

Coenraads PJ, Nater JP, Jansen HA, Lantinga H. 1984. Prevalence of eczema and other dermatoses of the hands and forearms in construction workers in the Netherlands. Clin Exp Dermatol 9:149–158.

Deddens JA, Petersen MR. 2008. Approaches for estimating prevalence ratios. Occup Environ Med 65(481):501–506.

Diepgen TL, Coenraads PJ. 1999. The epidemiology of occupational contact dermatitis. Int Arch Occup Environ Health 72:496–506.

English JS. 2004a. Current concepts of irritant contact dermatitis. Occup Environ Med 61(722–726):674.

English JS. 2004b. Occupational dermatoses: Overview. Occup Med (Lond) 54:439–440.

Geraut C, Tripodi D, Brunet-Courtois B, Leray F, Geraut L. 2009. Occupational dermatitis to epoxydic and phenolic resins. Eur J Dermatol 19:205–213.

Hald M, Berg ND, Elberling J, Johansen JD. 2008. Medical consultations in relation to severity of hand eczema in the general population. Br J Dermatol 158:773–777.

Halioua B, Bensefa-Colas L, Bouquiaux B, Crepy MN, Assier H, Billon S, Chosidow O. 2012. Occupational contact dermatitis in 10,582 French patients reported between 2004 and 2007: A descriptive study. Dermatology 225:354–363.

Koch P. 2001. Occupational contact dermatitis. Recognition and management. Am J Clin Dermatol 2:353–365.

Lantinga H, Nater JP, Coenraads PJ. 1984. Prevalence, incidence and course of eczema on the hands and forearms in a sample of the general population. Contact Dermatitis 10:135–139.

Lushniak BD. 2004. Occupational contact dermatitis. Dermatol Ther 17:272–277.

Meding B, Swanbeck G. 1990. Consequences of having hand eczema. Contact Dermatitis 23:6–14.

Meding B, Wrangsjo K, Jarvholm B. 2005. Fifteen-year follow-up of hand eczema: Persistence and consequences. Br J Dermatol 152:975–980.

Moberg C, Alderling M, Meding B. 2009. Hand eczema and quality of life: A population-based study. Br J Dermatol 161:397–403.

Ronmark EP, Ekerljung L, Lotvall J, Wennergren G, Ronmark E, Toren K, Lundback B. 2012. Eczema among adults: Prevalence, risk factors and relation to airway diseases. Results from a large-scale population survey in Sweden. Br J Dermatol 166:1301–1308.

Silverberg JI, Hanifin J, Simpson EL. 2013. Climatic factors are associated with childhood eczema prevalence in the United States. J Invest Dermatol 133:1752–1759.

Smit HA, Coenraads PJ, Lavrijsen AP, Nater JP. 1992. Evaluation of a self-administered questionnaire on hand dermatitis. Contact Dermatitis 26:11–16.

Suarez-Varela MM, Garcia-Marcos Alvarez L, Kogan MD, Gonzalez AL, Gimeno AM, Aguinaga Ontoso I, Diaz CG, Pena AA, Aurrecoechea BD, Monge RM, Quiros AB, Garrido JB, Canflanca IM, Varela AL. 2008. Climate and prevalence of atopic eczema in 6- to 7-year-old school children in Spain. ISAAC phase III. Int J Biometeorol 52:833–840.

Thyssen JP, Johansen JD, Linneberg A, Menne T. 2010. The epidemiology of hand eczema in the general population--prevalence and main findings. Contact Dermatitis 62:75–87.

Toren K, Qvarfordt I, Bergdahl IA, Jarvholm B. 2011. Increased mortality from infectious pneumonia after occupational exposure to inorganic dust, metal fumes and chemicals. Thorax 66:992–996.

Uter W, Ruhl R, Pfahlberg A, Geier J, Schnuch A, Gefeller O. 2004. Contact allergy in construction workers: Results of a multifactorial analysis. Ann Occup Hyg 48:21–27.

Vermeulen R, Kromhout H, Bruynzeel DP, de Boer EM. 2000. Ascertainment of hand dermatitis using a symptom-based questionnaire; applicability in an industrial population. Contact Dermatitis 42:202–206.

Visser MJ, Verberk MM, van Dijk FJ, Bakker JG, Bos JD, Kezic S. 2013. Wet work and hand eczema in apprentice nurses; part I of a prospective cohort study. Contact Dermatitis 70:44–55.

Weiland SK, Husing A, Strachan DP, Rzehak P, Pearce N, ISAAC Phase One Study Group. 2004. Climate and the prevalence of symptoms of asthma, allergic rhinitis, and atopic eczema in children. Occup Environ Med 61:609–615.

Winder C, Carmody M. 2002. The dermal toxicity of cement. Toxicol Ind Health 18:321–331.