



Validation of a Questionnaire on Hand Hygiene in the Construction Industry

Johan G. Timmerman^{1*}, Hicham Zilaout¹, Dick Heederik¹,
Ton Spee^{1,2} and Lidwien A. M. Smit¹

1.Division Environmental Epidemiology, Institute for Risk Assessment Sciences, Utrecht University, Utrecht 3584 CM, The Netherlands
2.Research and Development, Arbouw, Harderwijk 3847 LG, The Netherlands

*Author to whom correspondence should be addressed. Tel: +31-30-25-32-588; fax: +31-30-25-39-499; e-mail: J.G.Timmerman@uu.nl
Submitted 11 April 2014; revised 23 June 2014; revised version accepted 23 June 2014.

ABSTRACT

Introduction: Construction workers are at risk of developing occupational contact dermatitis. Gloves, when used properly, may protect against chemicals and coarse materials. We investigated the prevalence and determinants of contact dermatitis in a population of Dutch construction workers and aimed at validating questionnaire items on hand hygiene.

Methods: A cross-sectional study was conducted at 13 construction sites, yielding data of 177 subjects (95% response rate). A questionnaire covering questions on hand hygiene and contact dermatitis symptoms was used. Agreement between workplace observations and a number of questionnaire items was assessed by calculating Cohen's kappa. Log-binomial regression analysis was used to assess the association between contact dermatitis and various hand hygiene-related determinants.

Results: The 1-year prevalence of self-reported contact dermatitis in our study sample was 46.9%. Multiple regression analysis showed a positive association with difficulties with hand cleaning (prevalence ratio [PR]: 1.26, 95% confidence interval [CI]: 1.05–1.52), hand contamination at the end of the working day (PR: 2.30, 95% CI: 1.14–4.65), and intensive hand cream use (PR: 2.07, 95% CI: 1.42–3.01). Observations of hand contamination, glove use, and glove types were found to agree well with the self-reported data from the questionnaire (Cohen's kappa's 0.75, 0.97, and 0.88).

Conclusions: Self-reported contact dermatitis prevalence in construction workers was high and related to hand hygiene. A strong agreement was found between workplace observations and self-reported questionnaire data.

KEYWORDS: construction workers; determinants; glove use; hand eczema; hand hygiene in the construction industry; occupational contact dermatitis; personal protective equipment; prevalence; regression analysis; validation

INTRODUCTION

Contact dermatitis is a common inflammatory skin disease that occurs after contact with an external agent (Usatine and Riojas, 2010). Symptoms of contact dermatitis differ in severity, frequency, duration,

and recurrence among individuals and mostly include itching and scaling. Symptoms mainly affect the hands, although other body parts like arms, face, or eyelids may also be involved (Rietschel *et al.*, 2002). Contact dermatitis-inducing substances can be chemicals, and

also physical, mechanical, and environmental factors, such as transpiration and excessive temperature differences (Slodownik *et al.*, 2008).

Occupational contact dermatitis (OCD) is the most common occupational skin disease in many countries, accounting for >95% of all cases of work-related skin disorders (Lushniak, 2000; Anveden *et al.*, 2006; Keegel *et al.*, 2009). Usually the prevalence of hand eczema is used as a proxy for OCD prevalence, resulting in a 1-year prevalence of 6–10% (Belsito, 2005). Studies focusing on the social and economic impact of OCD, reported that it seriously impedes social life of patients (Moberg *et al.*, 2009).

Several population studies have shown that atopic predisposition is the most important endogenous risk factor for hand dermatitis (Yngveson *et al.*, 2000; Mortz *et al.*, 2001; Visser *et al.*, 2014) and also a risk factor for OCD (Coenraads and Diepgen, 1998). A well-known exogenous factor in OCD is 'wet work', work involving exposure to weak irritants, e.g. water and detergents for >2 h a day (Stingeni *et al.*, 1995; Ramsing and Agner, 1996; Held and Jorgensen, 1999). Also environmental factors (such as low humidity) are risk factors for OCD and may enhance the effect of irritants and/or allergens (Nixon, 1996; Douglas *et al.*, 1999).

Construction workers have a substantial risk for developing OCD (Bock *et al.*, 2003; Rycroft and Frosch, 2006). The risk of developing OCD among construction workers is probably related to occupational exposure to chemicals (e.g. epoxides [Spee *et al.*, 2006] and isocyanates [Frick *et al.*, 2003]) and coarse materials, like bricks. Small skin injuries may arise while handling coarse materials and thereby enable irritants and allergens to penetrate the skin, thus facilitating the development of contact dermatitis.

Glove use may protect against dermal exposure to chemicals and coarse materials. A large variety of gloves is available, but only use of adequate gloves greatly reduces harmful exposures and wrong usage can even be a risk factor for dermatitis (Chew and Maibach, 2003; Clark and Zirwas, 2009). However, using gloves may be a risk factor itself as wearing occlusive gloves for >2 h a day is considered wet work (Stingeni *et al.*, 1995; Ramsing and Agner, 1996; Held and Jorgensen, 1999). Chemicals that are trapped inside the glove or permeate through an inappropriate glove may cause a high exposure and a false feeling of safety (Diepgen and Coenraads, 1999; Brown, 2004;

Diepgen and Kanerva, 2006). Existing questionnaires, as being used for construction workers' periodical medical checkup, contain only one question: 'do you use gloves during work: yes or no?' (Timmerman *et al.*, 2014) This is not detailed enough to collect information on the type of gloves construction workers use. Therefore, we have developed a questionnaire that includes more detailed questions on glove use and self-reported hand contamination as a proxy for dermal exposure. The purpose of this questionnaire is to develop a prognostic tool for occupational physicians to use during medical checkups to screen workers for risk of having hand dermatitis. We recently reported a high prevalence of skin symptoms using the routinely collected data of medical checkups in Dutch construction workers (Timmerman *et al.*, 2014). This study aims to further investigate contact dermatitis in the construction industry, by means of workplace observations and an interview-based questionnaire. Specific aims are to (i) determine the 1-year prevalence of contact dermatitis in construction workers, (ii) validate a number of questionnaire items on hand hygiene, and (iii) assess the association between contact dermatitis and various possible risk factors in the construction industry.

STUDY POPULATION AND METHODS

Study population and design

This cross-sectional study was conducted in May and June 2012 and was carried out in a population of Dutch male construction workers. The study involved field work comprising observations, an interview-based questionnaire, and photography of the workers' both hands. In total, 177 out of 186 workers agreed to participate (response 95%). Participants were working in housing and utility construction or civil construction. In total, 15 construction sites were visited. Site visits were facilitated by the Arbouw Foundation, the Dutch foundation established by employers' and employees' organizations in the construction industry to improve working conditions and reduce sick leave in the construction industry. At construction sites where <15 male workers were employed, all male workers were asked to participate. At larger construction sites, a maximum of 15 workers was randomly asked to participate. Subjects were informed about the purpose of the study, and all data were treated anonymously.

Observations

Construction workers were observed at a random moment during a regular working day for 3–5 min. During this observation, glove use, the type of glove they used, and the contamination of their hands was assessed by the observer. After the observation, these questionnaire items were filled in by the observer (H.Z.) to enable their validation (see [Table 1](#)).

Questionnaire

The used questionnaire was filled in during an interview between the observer and the participant following the observation. The questionnaire consists of a selection of questions from the new questionnaire we developed. Three questions were validated in this study, the skin symptom questions were validated before ([Smit *et al.*, 1992](#)) and other questions were simple questions with a minor chance of misinterpretation. The questionnaire covered general aspects such as age and job title; in addition, questions regarding symptoms of contact dermatitis during the last 12 months, use of personal protective equipment, and hand hygiene were included in the questionnaire. Three items from the questionnaire were validated in this study using workplace observations: ‘How dirty are your hands at the end of a working day?’, ‘How often do you wear gloves while working?’, and ‘If you use gloves during work, what type of gloves do you usually use?’. The validated items from the questionnaire are shown in [Table 1](#), the complete questionnaire is given in [supplementary table 2](#) at *Annals of Occupational Hygiene* online.

Presence of contact dermatitis was defined according to the ‘Netherlands Society of Occupational Medicine-guideline: prevention of contact eczema’ ([Jungbauer *et al.*, 2006](#)), which is based on a questionnaire developed by [Smit and colleagues \(1992\)](#). Three questions were used to indicate the presence of contact dermatitis in construction workers: ‘Did you have one of the following symptoms on your hands or fingers in the past 12 months: red and swollen hands or fingers, scaly hands or fingers, itchy hands or fingers, hands or fingers with fissures, vesicles on the hands or between the fingers or red bumps on hands or fingers?’ (question 4 [q4] of our questionnaire), ‘Did one or more of these symptoms last for more than three weeks?’ (q5), and ‘Did one or more of these symptoms occur more than once the past 12 months?’ (q6). The dermatitis

definition is based on a scoring system: one point is being scored by a positive answer to one of the first three symptoms of q4 as well as for a positive answer to q5 or q6. A positive answer to any of the latter three symptoms of q4 yields two points. A total of 11 points can be scored when all questions are answered positively. According to the guidelines, a score of at least three points is being classified as ‘possible dermatitis’, a score of at least five points is being classified as ‘definite dermatitis’. In this study, the health outcome hand dermatitis was defined as a score of at least three points.

Inter-observer reliability

Inter-observer reliability of the classification of hand contamination during the observations was assessed during three working days, on which two observers (H.Z. and J.G.T.) observed the same subjects simultaneously ($n = 40$). The contamination of the hands was rated as not dirty, a bit dirty ($\leq 50\%$ of the hand surface is contaminated), or very dirty ($> 50\%$ of the hand surface is contaminated), equivalent to the corresponding question in the questionnaire (see [Table 1](#)).

Data analysis and statistics

Statistical analyses were performed using SAS Software version 9.2 (SAS System for Windows, SAS Institute, Cary, NC, USA). In order to validate the three questionnaire items and to assess the agreement between the interview-based questionnaire and the observations, Cohen’s kappa was calculated. The question on glove use was validated in a subset of the population: only subjects reporting to use gloves (almost) always or (almost) never were taken into account ($n = 83$) as the observer could only rate ‘yes’ (corresponding to [almost] always) or ‘no’ (corresponding to [almost] never) during the 5-min observation. To calculate agreement between the two observers, Cohen’s kappa was also used.

Crude and adjusted prevalence ratios (PR) and 95% confidence intervals (95% CI) were calculated using log-binomial regression analysis ([Deddens and Petersen, 2008](#)).

RESULTS

Demographic characteristics and visited locations

The study population consisted of 177 male construction workers with a mean age of 39.2 years (range

Table 1. Demographic characteristics of the study population: age, type of construction site, job title, hand dermatitis prevalence, and questions that were validated in this study

	Mean	Standard deviation
Age	39.2	11.7
	<i>N</i>	%
Type of construction site		
Civil construction site	35	19.8
Housing and utility construction site	142	80.2
Job title		
Carpenter	52	29.4
Bricklayer	26	14.7
Electrician	10	5.7
Metal stud wall/modular ceiling assembler	9	5.1
Central heating assembler	7	4.0
Concrete form carpenter	7	4.0
Painter	6	3.4
Scaffolder	6	3.4
Floor layer (screed floor)	6	3.4
Plumber	5	2.8
Roofer (bituminous)	5	2.8
Other (all $n < 5$)	33	18.6
Skin symptoms		
Did you have one of the following symptoms on your hands or fingers in the past 12 months?		
(1pt) Red and swollen hands or fingers	12	6.8
(1pt) Scaly hands or fingers	16	9.0
(1pt) Itchy hands or fingers	28	15.8
(2pts) Hands or fingers with fissures	98	55.4
(2pts) Vesicles on the hands or between the fingers	13	7.3
(2pts) Red bumps on hands or fingers	8	4.5
(1pt) Did one or more of these symptoms last for more than three weeks?	53	29.9
(1pt) Did one or more of these symptoms occur more than once the past 12 months?	69	39.0
Hand dermatitis (score of 3 or more points of the above questions)	83	46.9

Table 1. Continued

	Mean	Standard deviation
Validated questions:		
How dirty are your hands at the end of a working day?		
Not dirty (for example because you carry good protection)	25	14.1
A bit dirty	93	52.5
Very dirty (more than half of your skin surface is dirty)	59	33.3
How often do you wear gloves while working?		
(Almost) always	48	27.1
Mostly	30	17.0
Sometimes	79	44.6
(Almost) never	20	11.3
If you use hand gloves during the work, what type of gloves do you usually use? ^a		
Disposable gloves	0	0.0
Latex housekeeping gloves	7	4.0
Cotton gloves	30	16.9
Semi dipped tricot gloves	115	65
To the cuff dipped tricot gloves	1	0.6
Neoprene gloves	5	2.8
Leather gloves	7	4.0

^aTotal percentage exceeds 100% as some subjects reported to use more than one type of glove.

18–63 years). During field work, activities in 13 cities in the Netherlands, 15 construction sites were visited, including 12 housing and utility construction locations (142 subjects, one construction sites was visited twice), and 3 civil construction locations (35 subjects). The majority of subjects worked as a carpenter (29%), followed by bricklayers (15%) and electricians (6%; Table 1).

Prevalence of hand dermatitis

Table 1 shows the skin symptoms that characterize hand dermatitis. According to the diagnosis based on the questionnaire, ‘hands or fingers with fissures’ was the most common symptom in construction workers ($n = 98$ [55.4%]), whereas only eight persons reported ‘red or swollen hands or fingers’ (4.5%). A total of 114 subjects (64.4%) reported at least one

symptom of q4. A positive response to all the questions q4 (at least one symptom), q5, and q6 was given by 41 (23.2%) out of the 177 subjects. Overall, 83 of the construction workers met the definitions for contact dermatitis, giving a 1-year prevalence of 46.9% among this population.

Answers to questionnaire items that were to be validated are shown in Table 1. Frequency tables for the other questionnaire items can be found in supplementary table 1 at *Annals of Occupational Hygiene* online. Most of the subjects reported that cleaning their hands was easy (73.5%). Hand washing frequencies were low (71.8% reported hand washing <5 times a day), the majority of subjects used irritative substances to clean their hands: 71% used abrasive soap. A small minority reported to never use gloves (11.3%), most subjects reported to use gloves

sometimes (44.6%) or (almost) always (27.1%). The majority of the subjects used semi-dipped cotton gloves (65.0%), waterproof gloves were used by 14.1% of all subjects. Only 12.1% of glove wearing subjects changed gloves at regular moments, 87.9% changed gloves when dirty or torn. Half of the population never used hand cream (49.7), whereas 10.2% used hand cream several times a day.

Validity and inter-observer reliability

Table 2 shows the degree of agreement between direct observations and questionnaire items for hand contamination, glove use, and the type of used glove. Agreement between observations and questionnaire was good for hand contamination (Cohen's kappa 0.75, 95% CI: 0.68–0.83) and very good for the type of glove used (0.88, 95% CI: 0.73–1.00). Agreement was also very good for glove use (0.97, 95% CI: 0.90–1.00) in the subset of subjects reporting to use gloves (almost) always or (almost) never. No subjects reporting to use gloves sometimes or most of the times, however, actually wore gloves during the observation.

Table 2. Validity statistics of the validated questions on hand hygiene

	Cohen's kappa	95% CI
Hand contamination		
Questionnaire versus direct observation	0.75	0.68–0.83
Inter-observer variability (two observers, $n = 40$)	0.86	0.73–0.99
Glove use		
Questionnaire versus direct observation (subset $n = 83$)	0.97	0.90–1.00
Inter-observer variability (two observers, $n = 40$)	0.96	0.91–1.00
Glove type		
Questionnaire versus direct observation	0.88	0.73–1.00
Inter-observer variability (two observers, $n = 40$)	1.00	1.00–1.00

To study reliability of the semi-quantitative exposure assessment during the observations, the inter-observer reliability was assessed. The inter-observer agreement among the two observers using Cohen's kappa for hand contamination (0.86 [0.73–0.99]) and glove use (0.96 [0.91–1.00]) were very good. There was a 100% agreement between the observers regarding glove types used by the constructions workers.

Determinants of hand dermatitis

Univariate and adjusted associations between questionnaire items and hand dermatitis are shown in Table 3. Adjusted PRs were adjusted for age and hand cream use. The use of hand cream (either several times a day or more than once a week) was significantly and positively associated with contact dermatitis. Furthermore, subjects reporting that usually cleaning their hands was 'not easy but not difficult' or 'difficult' had significantly higher dermatitis prevalence. Construction workers whose hands were not clean at the end of the working day reported contact dermatitis significantly more often than construction workers whose hands were not dirty. Also using gloves 'sometimes' was significantly related with higher hand dermatitis prevalence. Hand washing frequencies higher than five times a day were associated with higher dermatitis prevalence but not after adjustment for age and hand cream use.

DISCUSSION

The self-reported 1-year prevalence of contact dermatitis among Dutch construction workers in this study sample was 46.9%. This is high compared with the prevalence found in a study published by Coenraads *et al.* (1984), who reported a hand dermatitis prevalence of 7.8% based on examination of the hands and forearms of a sample of construction workers. This is to be expected as the questionnaire-based prevalence corresponds to 'possible dermatitis', whereas an examination-based prevalence will correspond to 'definite dermatitis'. This is caused by the screening purpose of the questionnaire: a high sensitivity is needed to screen workers for high risk of dermatitis, whereas a physical examination will be more specific. Using the same questionnaire-based method as used in this study, Smit *et al.* (1992) reported a hand dermatitis prevalence of 47.7% among Dutch nurses. Although in a different occupational population, this prevalence is

Table 3. Results of the log-binomial regression analyses of questionnaire items and hand dermatitis

	N	%	Crude PR	95% CI	Adjusted PR ^a	95% CI
Age (per 10 years increase)			1.06	0.93–1.22	0.97	0.87–1.09
Use of hand cream						
Never	88	49.7	Reference		Reference	
Once a week/every other day/once a day	71	40.2	2.05	1.41–2.98	2.71	1.78–4.13
Several times a day	18	10.2	2.63	1.75–3.95	2.07	1.42–3.01
Difficulties with hand cleaning						
Easy	130	73.5	Reference		Reference	
Not easy, but not difficult/difficult	47	26.5	1.49	1.10–2.01	1.26	1.05–1.52
Hand washing frequency						
Less than 5 times a day	127	71.8	Reference		Reference	
At least 5 times a day	50	28.2	1.44	1.06–1.95	1.27	0.94–1.71
Hand washing methods						
Never with irritants ^b	52	29.4	Reference		Reference	
With irritants	125	70.6	1.02	0.72–1.45	0.85	0.62–1.15
Glove changing						
On regular moments	19	12.1	Reference		Reference	
When dirty or torn	138	87.9	1.40	0.76–2.57	1.47	0.82–2.61
Protective glove use						
(Almost) never	20	11.3	Reference		Reference	
Sometimes	79	44.6	2.38	1.09–5.19	1.93	1.00–3.73
Mostly	30	17	2.13	0.93–4.89	1.87	0.95–3.67
(Almost) always	48	27.1	1.25	0.53–2.98	1.18	0.58–2.42
Use of waterproof gloves						
No	152	85.9	Reference		Reference	
Yes	25	14.1	0.74	0.43–1.28	0.74	0.45–1.22
Level of hand contamination						
Not dirty	25	14.1	Reference		Reference	
A bit dirty	93	52.5	2.06	1.00–4.26	1.87	0.91–3.82
Very dirty	59	33.3	2.19	1.05–4.58	2.30	1.14–4.65
Used glove types						
No glove use	20	11.3	Reference		Reference	
Cotton gloves	27	15.3	2.22	0.97–5.10	1.64	0.73–3.70

Table 3. Continued

	N	%	Crude PR	95% CI	Adjusted PR ^a	95% CI
Semi-dipped cotton gloves	115	65	2.12	0.97–4.62	1.81	0.85–3.87
Other glove types	15	8.5	0.53	0.12–2.38	0.48	0.11–2.09

^aAdjusted PR were adjusted for age and hand cream use.

^bSubjects reporting to never use abrasive soap or solvents to clean their hands.

similar to the prevalence in our study. The prevalence found in this study is higher than those previously reported in other high-risk populations, such as rubber workers (38.1%; Kilpikari, 1982), veterinarians (31%; Tauscher and Belsito, 2002), flower industry workers (29.5%; Pereira, 1996), and farmers (9.8%; Susitaival *et al.*, 1995).

In this study, questionnaire items regarding hand contamination, glove use, and used glove type were validated using direct workplace observations. The results suggest a substantial (0.75) to almost perfect (0.97) agreement between observations and these three questionnaire items. Also in other occupational groups, observations and questionnaires provide reliable information on exposure to chemicals inside the protective gloves (Anveden and Meding, 2007).

A strong positive association was found between contact dermatitis and frequent use of hand cream, having dirty hands, and difficulty of hand cleaning. Given the cross-sectional design of this study, the first finding is probably due to reverse causation. Frequent use of hand cream is supposed to protect against skin dryness and roughness (Brown, 2004), but it is likely that subjects start using hand cream when they experience hand dermatitis symptoms. Alternatively, it could be speculated that workers who use hand creams experience softer skin, which makes them more prone to skin injuries. The type of glove used was not found to significantly influence the prevalence of contact dermatitis. Although the use of occlusive gloves, when no cotton under gloves are worn, is a risk factor for OCD (Kezic *et al.*, 2009), in this study, no effect of wearing occlusive gloves for >2 hours a day was found. Washing hands >5 times a day was not related to higher contact dermatitis prevalences in this study, whereas in some studies, high frequencies of hand washing were associated with hand dermatitis (Jungbauer *et al.*, 2004; Visser *et al.*, 2013). However, in the latter studies, high hand

washing frequencies were defined as >8 or >20 times a working day. In our study population, hand washing frequencies were much lower: only 2 subjects reported hand washing frequencies of >10 times a working day. This may explain the absence of a relationship between hand washing frequencies and contact dermatitis in our study.

Subjects reporting to use gloves 'sometimes' reported higher dermatitis prevalences than subjects reporting no glove use, which possibly is also due to reverse causation. In an earlier study, we found a small protective effect of glove use on skin symptom reporting (Timmerman *et al.*, 2014), but in this study, we were able to adjust for a larger number of other variables. The majority of workers (71.8%) reported to wear protective gloves 'because the materials I work with are dirty/coarse'. The most common reason why workers do not use gloves is because they are uncomfortable or do not fit well, and thus hamper precise hand work (Clark and Zirwas, 2009). In this study, 11.3% of workers did not wear any gloves at all, thus increasing exposure to irritating or allergenic substances and increasing the risk of having injuries. Skin that has been previously injured was shown to be more susceptible to irritant contact dermatitis (Slodownik *et al.*, 2008). In our study population, 66.7% used 'semi-dipped tricot gloves', which indeed protect against coarse materials but not against chemicals (Spee *et al.*, 2006). Unfortunately, only 1.1% reported to use gloves because of received information or training on the use of protective gloves. This may indicate lack of management commitment towards protective gloves enforcement.

In this study, 177 construction workers were observed and interviewed. We consider this observation, albeit short and not repeated, to be representative of their working day. As construction workers sometimes work at different parts of the construction yard, it can be complex to get back to them and

observe them more than once, particularly on bigger construction yards. To avoid language problems and translation issues with the questionnaire and during the field work, which might affect the accuracy of our comparisons, only Dutch-speaking subjects were included. In order to reduce the impact of selection bias, the subjects were randomly chosen at construction sites located in various cities in The Netherlands. Since Stichting Arbouw, who facilitated the construction site visits, mainly has contacts with larger construction companies, our study population may be slightly biased to construction workers who work for larger companies. This potential bias will probably be neutralized by the fact that larger companies usually subcontract smaller companies and these workers also participated in the study.

To our knowledge, this is the first validation of a questionnaire on hand contamination and glove use in construction workers by direct workplace observation. Limitations of this study include the short period of time during which the observation took place. As we were only able to perform one short observation per worker, possibly a nonrepresentative moment in time was observed, although most construction workers performed one activity over the day. In addition, the question on hand contamination asks for contamination of the hands at the end of the working day, whereas the observation might be at any moment of the working day. This may have hampered the validation, leading to a lower agreement, although agreement was still considered good.

No detailed quantitative exposure assessment was performed in this study. The main disadvantage of a self-reported exposure assessment question ('how dirty are your hands at the end of the working day?') is that it only considers visible contamination, whereas exposure also can lead to invisible contamination of the skin. There are several ways of performing more detailed dermal exposure assessment like ultraviolet-fluorescence (Cherrie *et al.*, 2000), patching (Soutar *et al.*, 2000), hand washing (Brouwer *et al.*, 2000), and the wet wiping method (Geno *et al.*, 1996). Ultraviolet-fluorescence is impractical at the construction site as fluorescent tracers would have to be added to the building materials. All other methods have in common that analysis of the substance that was retrieved from the skin or patch has to be analyzed using gas chromatography–mass spectrometry or a

likewise method. Given the large number of potentially hazardous exposures at the construction site, this method is not feasible unless specific exposures are studied. Therefore, we used a self-reported exposure assessment, resulting in significant relations between hand contamination and difficulty in hand cleaning and contact dermatitis. Despite of the validation taking place at one moment of time during a working day (and not at the end of the working day), the agreement between the self-reported hand contamination and observed hand contamination was good. We, therefore, suggest these questions are suitable for use as a qualitative exposure assessment in future studies in the construction industry.

CONCLUSIONS

The 1-year prevalence of hand dermatitis was 46.9%, which is high compared with previous studies of hand dermatitis in construction workers as well as the general population. Hand cream use, using gloves sometimes, difficulty of hand cleaning, and dirty hands at the end of the working day were positively associated with having contact dermatitis. There is a strong agreement between direct observations and questionnaire-reported hand contamination, glove use, and used glove type. Therefore, it is reasonable to consider that these questionnaire items are suitable to be used in future epidemiological studies.

SUPPLEMENTARY DATA

Supplementary data can be found at <http://annhyg.oxfordjournals.org/>.

FUNDING

Research and Development Arbouw (11–025).

ACKNOWLEDGEMENTS

We thank the Arbouw Foundation for funding this study and facilitating construction site visits, construction site managers for assistance during field work, and all subjects for their participation in this study. No conflicting interests are declared.

DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

REFERENCES

- Anveden I, Meding B. (2007) Skin exposure in geriatric care - a comparison between observation and self-assessment of exposure. *Contact Dermatitis*; 57: 253-8.
- Anveden I, Wrangsjö K, Järholm B *et al.* (2006) Self-reported skin exposure - a population-based study. *Contact Dermatitis*; 54: 272-7.
- Belsito DV. (2005) Occupational contact dermatitis: etiology, prevalence, and resultant impairment/disability. *J Am Acad Dermatol*; 53: 303-13.
- Bock M, Schmidt A, Bruckner T *et al.* (2003) Occupational skin disease in the construction industry. *Br J Dermatol*; 149: 1165-71.
- Brouwer DH, Boeniger MF, van Hemmen J. (2000) Hand wash and manual skin wipes. *Ann Occup Hyg*; 44: 501-10.
- Brown T. (2004) Strategies for prevention: occupational contact dermatitis. *Occup Med (Lond)*; 54: 450-7.
- Cherrie JW, Brouwer DH, Roff M *et al.* (2000) Use of qualitative and quantitative fluorescence techniques to assess dermal exposure. *Ann Occup Hyg*; 44: 519-22.
- Chew AL, Maibach HI. (2003) Occupational issues of irritant contact dermatitis. *Int Arch Occup Environ Health*; 76: 339-46.
- Clark SC, Zirwas MJ. (2009) Management of occupational dermatitis. *Dermatol Clin*; 27: 365-83, vii-viii.
- Coenraads PJ, Diepgen TL. (1998) Risk for hand eczema in employees with past or present atopic dermatitis. *Int Arch Occup Environ Health*; 71: 7-13.
- Coenraads PJ, Nater JP, Jansen HA *et al.* (1984) Prevalence of eczema and other dermatoses of the hands and forearms in construction workers in the Netherlands. *Clin Exp Dermatol*; 9: 149-58.
- Deddens JA, Petersen MR. (2008) Approaches for estimating prevalence ratios. *Occup Environ Med*; 65: 481, 501-6.
- Diepgen TL, Coenraads PJ. (1999) The epidemiology of occupational contact dermatitis. *Int Arch Occup Environ Health*; 72: 496-506.
- Diepgen TL, Kanerva L. (2006) Occupational skin diseases. *Eur J Dermatol*; 16: 324-30.
- Douglas E, Rushton L, Williams HC. (1999) Is occupational dermatitis being taken seriously by UK industries? *Occup Med (Lond)*; 49: 85-91.
- Frick M, Isaksson M, Björkner B *et al.* (2003) Occupational allergic contact dermatitis in a company manufacturing boards coated with isocyanate lacquer. *Contact Dermatitis*; 48: 255-60.
- Geno PW, Camann DE, Harding HJ *et al.* (1996) Handwipe sampling and analysis procedure for the measurement of dermal contact with pesticides. *Arch Environ Contam Toxicol*; 30: 132-8.
- Held E, Jorgensen LL. (1999) The combined use of moisturizers and occlusive gloves: an experimental study. *Am J Contact Dermat*; 10: 146-52.
- Jungbauer FH, Lensen GJ, Groothoff JW *et al.* (2004) Exposure of the hands to wet work in nurses. *Contact Dermatitis*; 50: 225-9.
- Jungbauer FH, Piebenga WP, ten Berge EE *et al.* (2006) NVABrichtlijn: Preventie Contacteczeem [NVAB guideline: Prevention of Contact Dermatitis]. Utrecht, the Netherlands: Nederlandse Vereniging voor Arbeids- en Bedrijfsgezondheidskunde. pp. 20-23. ISBN-13: 978-90-76721-11-8.
- Keegel T, Moyle M, Dharmage S *et al.* (2009) The epidemiology of occupational contact dermatitis (1990-2007): a systematic review. *Int J Dermatol*; 48: 571-8.
- Kezic S, Visser MJ, Verberk MM. (2009) Individual susceptibility to occupational contact dermatitis. *Ind Health*; 47: 469-78.
- Kilpikari I. (1982) Occupational contact dermatitis among rubber workers. *Contact Dermatitis*; 8: 359-62.
- Lushniak BD. (2000) Occupational skin diseases. *Prim Care*; 27: 895-916.
- Moberg C, Alderling M, Meding B. (2009) Hand eczema and quality of life: a population-based study. *Br J Dermatol*; 161: 397-403.
- Mortz CG, Lauritsen JM, Bindslev-Jensen C *et al.* (2001) Prevalence of atopic dermatitis, asthma, allergic rhinitis, and hand and contact dermatitis in adolescents. The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis. *Br J Dermatol*; 144: 523-32.
- Nixon RL. (1996) Contact dermatitis and occupational skin disease. *Med J Aust*; 165: 47-52.
- Pereira F. (1996) Hand dermatitis in florists. *Contact Dermatitis*; 34: 144-5.
- Ramsing DW, Agner T. (1996) Effect of glove occlusion on human skin. (I). short-term experimental exposure. *Contact Dermatitis*; 34: 1-5.
- Rietschel RL, Mathias CG, Fowler JF Jr *et al.* (2002) Relationship of occupation to contact dermatitis: evaluation in patients tested from 1998 to 2000. *Am J Contact Dermat*; 13: 170-6.
- Rycroft R, Frosch P. (2006) Occupational contact dermatitis. In: Frosch P, Menné T, Lepoittevin J, editors. *Contact dermatitis*. 4th edn. Berlin, Heidelberg/New York: Springer. pp. 717-34.
- Slodownik D, Lee A, Nixon R. (2008) Irritant contact dermatitis: a review. *Australas J Dermatol*; 49: 1-9; quiz 10-1.
- Smit HA, Coenraads PJ, Lavrijsen AP *et al.* (1992) Evaluation of a self-administered questionnaire on hand dermatitis. *Contact Dermatitis*; 26: 11-6.
- Soutar A, Semple S, Aitken RJ *et al.* (2000) Use of patches and whole body sampling for the assessment of dermal exposure. *Ann Occup Hyg*; 44: 511-8.
- Spee T, Van Duivenbooden C, Terwoert J. (2006) Epoxy resins in the construction industry. *Ann N Y Acad Sci*; 1076: 429-38.
- Stingeni L, Lapomarda V, Lisi P. (1995) Occupational hand dermatitis in hospital environments. *Contact Dermatitis*; 33: 172-6.

- Susitaival P, Husman L, Hollmén A *et al.* (1995) Dermatoses determined in a population of farmers in a questionnaire-based clinical study including methodology validation. *Scand J Work Environ Health*; 21: 30–5.
- Tauscher AE, Belsito DV. (2002) Frequency and etiology of hand and forearm dermatoses among veterinarians. *Am J Contact Dermat*; 13: 116–24.
- Timmerman JG, Heederik D, Spee T *et al.* (2014) Skin symptoms in the construction industry: occurrence and determinants. *Am J Ind Med*; 57: 660–8.
- Usatine RP, Riojas M. (2010) Diagnosis and management of contact dermatitis. *Am Fam Physician*; 82: 249–55.
- Visser MJ, Verberk MM, Campbell LE *et al.* (2014) Filaggrin loss-of-function mutations and atopic dermatitis as risk factors for hand eczema in apprentice nurses: part II of a prospective cohort study. *Contact Dermatitis*; 70: 139–50.
- Yngveson M, Svensson A, Johannisson A *et al.* (2000) Hand dermatosis in upper secondary school pupils: 2-year comparison and follow-up. *Br J Dermatol*; 142: 485–9.