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CONTACT DERMATITIS

Evaluation of two self-administered questionnaires to ascertain dermatitis among metal workers and its relation with exposure to metal working fluids

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We performed an exploratory study to evaluate 2 self-administered questionnaires assessing hand dermatitis and to investigate a possible exposure-response relation between dermal exposure to semi-synthetic metal working fluids (SMWF) and dermatitis. In a cross-sectional survey on dermatitis, a symptom-based questionnaire and a picture-based skin-screening list were applied in 80 SMWF-exposed workers and 67 referents. To evaluate accuracy of the questionnaires, 47 subjects were examined by a dermatologist. Dermal exposure levels to SMWF were assessed on the hands, forearms, and face with an observational method that was validated with a fluorescent-tracer method. The symptom-based questionnaire had a relatively high sensitivity (0.86) but moderate specificity (0.64), the skin-screening list had a low sensitivity (0.36) and a relatively high specificity (0.84). The skin-screening list seemed to represent the more severe cases of dermatitis and showed a significant relation to exposure, for dermatitis on hands, forearms, or face. In epidemiological surveys where workers are not seen by a dermatologist, the skin-screening list seems to be more appropriate to detect cases of dermatitis, as its higher specificity results in less false positives. Alternatively, it would be preferable to apply the symptom-based questionnaire; workers with symptoms should be seen by a dermatologist to identify false positives.

Key words: allergic contact dermatitis; cutting fluids; dermal exposure; epidemiology; irritant contact dermatitis; machine operators; occupational; skin complaints; validation.

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Surveillance systems on occupational skin diseases show that workers exposed to metal working fluids (MWF) account for 8% of all reported work-related skin diseases, with an incidence rate of about 10 per 10 000 metal workers per year (1–3). MWFs are normally categorized as straight oil, soluble oil, semi-synthetic, and synthetic metal working fluids of which the last 3 groups are designed to be diluted with water (4). Exposure to water-based MWF can cause irritant contact dermatitis because of wetting of the skin (wet work), or allergic contact dermatitis because of contact with biocides and emulsifiers present in water-based MWF (1, 5).

The use of water-based MWF increased in the mid 1980s, and was followed by an increase in the incidence of eczematous dermatitis in metal workers (6). This was usually an endemic, chronic, irritant contact dermatitis, but thorough patch testing also showed allergic contact dermatitis in some of the cases (6). A relation between occupational exposure to water-based MWFs and both irritant and allergic contact dermatitis was also found in other studies (5–10). However, only the study by Sprince et al. (10) attempted to estimate dermal exposure quantitatively.

Epidemiological studies of skin diseases are hampered by the lack of cost-effective methods

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for the identification of dermatitis, as dermatological examinations of the total study population are often not feasible for large study populations (11). As a result, only a few methodological sound epidemiological studies of occupational contact dermatitis have been carried out (1). To reduce costs, self-administered questionnaires can be applied; however, validity of the questionnaires should be investigated, especially because the accuracy of the same questionnaires may differ between occupational populations, among others, because of differences in appreciation of skin complaints (11, 12).

We performed an exploratory study in order to (i) evaluate 2 self-administered questionnaires for assessment of contact dermatitis, (ii) investigate whether workers with high dermal exposure levels to SMWF had an increased prevalence of dermatitis, as compared to workers with low, and no dermal exposure to SMWF.

Methods

Study design

A cross-sectional survey on dermatitis was conducted in 80 (62% response rate) metal workers exposed to synthetic MWF, and 67 (66% response rate) unexposed assembly workers, of a truck manufacturing plant.

Questionnaires on dermatitis

We applied 2 self-administered questionnaires: a symptom-based questionnaire for assessment of hand dermatitis (11), directly followed by a recently developed skin-screening list with pictures of increasing severity of dermatitis on hands, forearms, and face (ISTI and Centre for Skin and Work, Arnhem, the Netherlands). In addition, information was obtained on personal factors possibly related to dermatitis such as hand washing at work (2–4 times a day versus 5–0 times a day), glove use at work (yes/no), and leisure activities ($\geq$1 hr weekly). To determine atopic dermatitis, we asked subjects 'Have you ever suffered from infantile eczema', with the answers 'yes', 'no', 'do not know'.

For the symptom-based questionnaire, the period prevalence of hand dermatitis was defined by using the standard definition (11), defined as 1 or more reported symptoms in the past 12 months (a, red swollen hands or fingers; b, red hands or fingers with fissures; c, vesicles on the hands or at the sides of the fingers; d, scaling hands or fingers with fissures; e, itching hands or fingers with fissures) that were recurrent or lasted for more than 3 weeks (criterion I). In addition, dermatitis was defined by using more lenient criteria, 1 or more reported symptoms (criterion II); and more stringent criteria, 2 or more reported symptoms that were recurrent or lasted for more than 3 weeks (criterion III).

For the skin-screening list, period prevalence of dermatitis on hands, forearms, or face was defined by using the standard criteria that consist of a positive answer to the question: 'did you have a skin disorder in the past 12 months that is similar to one or both pictures'. For hands, in total 18 pictures were shown, while for both forearms and face 6 pictures were shown. The pictures show skin disorders of increasing severity, defined as dermatitis of degree 1, 2, or 3, with an equal number of pictures for each degree.

In order to evaluate the accuracy of the questionnaires, the hands of a subset of the workers ($n = 47$) were examined by 1 of the 2 dermatologists who collaborated in our study. Note that in order to estimate sensitivity and specificity with more precision, this subset was not a random sample of the studied population, but an enriched sample. This sample included all subjects with a positive score on the symptom-based questionnaire ($n = 28$) and/or the picture list ($n = 12$) who worked in the day shift on the day of examination. From the subjects with a negative score, a random sample was taken. Consequently, the proportion of subjects with dermatitis according to the symptom-based questionnaire or the skin-screening list was larger in the subset than in the studied population; 60% (28 out of 47) versus 25% (36 out of 147) for the symptom-based questionnaire and 26% (12 out of 47) versus 13% (19 out of 147) for the skin-screening list.

Dermatological examinations were performed within 2–6 weeks (3 weeks on average) after workers filled in the questionnaires. The dermatologists did not know the workers' answers to the dermatological questionnaires, but were aware of the exposure status of subjects. Both dermatologists examined the same proportion of exposed and referent workers. Examined workers were grouped into 5 categories of skin disorders in the past 12 months: (i) no skin complaints, (ii) minor dermatitis, (iii) major dermatitis, (iv) traumata, and (v) other skin complaints.

Dermal exposure assessment

Dermal exposure levels to SMWF were assessed in the hands, forearms and face, in 36 out of the 80 metal workers. Dermal exposure was estimated semiquantitatively with an observational method called DeRmal Exposure Assessment Method (DREAM) (13–15), and in addition, in order to

validate the DREAM estimates, measured quantitatively with the fluorescent-tracer method Visual Imaging Technique for Assessment of dermal Exposure (VITAE) (16–18). Workers were grouped in exposure categories by applying a determinant-based grouping strategy that resulted in workers with 'low' and 'high' attributed dermal exposure to SMWF. DREAM and VITAE resulted in the same grouping of workers. The exposure assessment is described in detail elsewhere (19).

Data analysis

Statistical analyses were performed in SAS version 8.2 (SAS Institute, Cary, NC, USA). The prevalence of dermatitis was assessed in the 12 months before the study was performed.

In order to evaluate the accuracy of the questionnaires, the sensitivity (proportion of subjects with hand dermatitis according to the dermatologist who were identified by the questionnaire) and specificity (proportion of subjects without hand dermatitis according to the dermatologist who scored also negative on the questionnaire) were calculated. 95% confidence intervals (CI) were estimated by assuming validity statistics as a proportion (ρ) drawn from a normal distribution ($\rho \pm 1.96\sqrt{(\rho\ (1-\rho)/n)}$).

In order to determine possible relations between personal and exposure-related factors and dermatitis, prevalence ratios (PR) were estimated by log-binomial regression analysis (20) with dermatitis (yes = 1, no = 0) as dependent variable. Subsequently, log-binomial analysis was used to correct for possible confounding factors. Risk factors with $P < 0.20$ in the univariate analysis were included in the multivariate log-binomial regression model comprising dermatitis as dependent variable and exposure group (exposed workers versus referents; and low exposure and high exposure to SMWF versus referents) as independent variable.

Results

Exposed workers and referents had comparable age, were comparable with regard to smoking habits and educational background (Table 1). Exposed workers had slightly more working years at the plant than referents [mean 12 (SD = 11) versus 10 (SD = 9)]. Exposed workers reported less frequent hand washing, more frequent glove use, and less frequent car repairing in spare time than referents (Table 1).

The prevalence of dermatitis assessed by the symptom-based questionnaires was a factor 1.4 (exposed) and 2.7 (referents) higher than the prevalence assessed by the picture-based skin-screening list (Table 2). The symptom-based questionnaire showed a somewhat lower prevalence for exposed (21.3%) as compared with referents (28.4%). No differences were seen between the standard definition of hand dermatitis (criterion 1), and the more lenient (criterion 2), or stringent (criterion 3) definitions of hand dermatitis. The skin-screening list showed a somewhat higher prevalence of hand dermatitis for exposed (15.0%) as compared with referents (10.5%). Exposed workers had higher prevalence of dermatitis on forearms and face according to the skin-screening list.

In Table 3, the comparison of the results for hand dermatitis by the symptom-based questionnaire, the picture-based skin-screening list, and the dermatological examination ($n = 47$) are presented, whereas in Table 4 the validity statistics of the 2 questionnaires are presented ($n = 47$). All cases of dermatitis diagnosed by the dermatologists were identified as minor dermatitis ($n = 21$). In addition, 1 subject was diagnosed as having 'traumata'. The symptom-based questionnaire showed a relatively high sensitivity (0.86) and a

Table 1. Demographics of study population and personal factors possibly related to dermatitis

	Metal workers (exposed, $n = 80$)	Assembly workers (referents, $n = 67$)
Factor	*n* (%)	*n* (%)
Smokers	28 (35)	21 (32)
Educational background		
Lower vocational education	44 (55)	37 (56)
Lower general secondary education	27 (34)	25 (37)
Polytechnic education or university	9 (11)	5 (7)
Hand washing at work		
2–4 times a day	20 (63)	34 (51)
5–10 times a day	30 (37)	33 (49)
Glove use at work	67 (83)	10 (15)
Leisure activities (≥1 hr weekly)		
Car repairing	13 (17)	24 (36)
Gardening	43 (53)	35 (52)
Doing odd jobs about the house	49 (61)	44 (65)
Welding	2 (3)	5 (8)
Hay fever		
Yes	18 (22)	17 (25)
Do not know	3 (4)	1 (1)
No	59 (74)	49 (73)
Infantile eczema		
Yes	0 (0)	3 (5)
Do not know	7 (9)	3 (5)
No	73 (91)	61 (90)
	Mean (SD)	Mean (SD)
Age	37 (10)	36 (11)
Working years at plant	12 (11)	10 (9)

Table 2. Prevalence of dermatitis during the last 12 months by a symptom-based questionnaire and a picture-based skin-screening list for workers exposed to SMWF and a referent group of assembly workers

	Metal workers (exposed, $n = 80$)		Assembly workers (referents, $n = 67$)	
	n (%)	95% CI	*n* (%)	95% CI
Symptom-based questionnaire[a]				
Hands				
Criterion I 1 or more symptoms and recurrent or lasted more than 3 weeks	17 (21.3)	12.3–30.2	19 (28.4)	17.6–39.2
Criterion II 1 or more symptoms	18 (22.5)	13.3–31.6	20 (29.4)	18.5–40.3
Criterion III 2 or more symptoms and recurrent or lasted more than 3 weeks	17 (21.3)	12.3–30.2	19 (28.4)	17.6–39.2
Skin-screening list (pictures) (Degree 1, 2, or 3)				
Hands	12 (15.0)	7.2–22.8	7 (10.5)	3.1–17.7
Forearms	5 (6.3)	0.9–11.6	2 (3.0)	0.0–7.1
Face	5 (6.3)	0.9–11.6	1 (1.5)	0.0–4.4
Any degree	19 (23.8)	14.4–33.1	7 (10.4)	3.1–17.8

[a]Symptoms: Red swollen hands or fingers; red hands or fingers with cracks; vesicles on hands or between fingers; coarse or flaky hands with cracks; itchy hands or fingers with cracks.
SMWF, synthetic metal working fluids.

moderate specificity (0.64) for the prevalence of hand dermatitis (Table 4). The skin-screening list had a low sensitivity (0.36) but a relatively high specificity (0.84) (Table 4). The symptom-based questionnaire and the skin-screening list showed similar sensitivity and specificity for exposed workers and referents (Table 4). Considering all subjects ($n = 167$), the questionnaires showed moderate agreement among each other (Cohen's Kappa-value for subjects = 0.45, 95% CI: 0.28–0.68) (data not presented). All, except for 1, workers who were positive on the picture-based list also indicated to have skin problems in the symptom-based questionnaire.

Table 3. Comparison of results for hand dermatitis by the symptom-based questionnaire, the picture-based skin-screening list, and the dermatological examination

	Dermatologist ($n = 47$)	
	Yes	No
Overall ($n = 47$)		
Symptom-based questionnaire (criterion I)		
Yes	19	9
No	3	16
Skin-screening list (pictures)		
Yes	8	4
No	14	21
Exposed ($n = 26$)		
Symptom-based questionnaire (criterion I)		
Yes	8	6
No	1	11
Skin-screening list (pictures)		
Yes	4	4
No	5	13
Referents ($n = 21$)		
Symptom-based questionnaire (criterion I)		
Yes	11	3
No	2	5
Skin-screening list (pictures)		
Yes	4	0
No	9	8

In Table 5, crude and adjusted PR are presented for exposed ($n = 80$) versus referents ($n = 67$). In addition, workers with 'low' ($n = 33$) and 'high' dermal exposure levels to SMWF ($n = 47$) are compared with referents ($n = 67$). Crude and adjusted PR showed similar results. Exposure to SMWF was not associated with hand dermatitis measured with the symptom-based questionnaire, nor with the skin-screening list. However, dermatitis on hands, forearms, and face measured with the skin-screening list occurred more frequently in exposed workers. The risk slightly increased with a higher level of dermal exposure to SMWF; low-exposed workers had a PR of 2.0 and high-exposed workers a PR of 2.4. Workers with higher levels of dermal exposure to SMWF on hands and forearms, in general, also had more often

Table 4. Validity statistics of hand dermatitis by the symptom-based questionnaire (criterion I) and the skin-screening list (hand dermatitis of degree 1, 2, or 3), as compared to the examination of hand dermatitis by 2 dermatologists ('golden' standard) in 47 subjects

	Symptom-based questionnaire	Skin-screening list (pictures)
Overall ($n = 47$)		
Sensitivity	0.86 (0.77–0.96)	0.36 (0.23–0.50)
Specificity	0.64 (0.50–0.78)	0.84 (0.74–0.94)
Exposed ($n = 26$)		
Sensitivity	0.89 (0.80–0.98)	0.44 (0.30–0.59)
Specificity	0.65 (0.51–0.78)	0.76 (0.64–0.89)
Referents ($n = 21$)		
Sensitivity	0.85 (0.74–0.95)	0.31 (0.18–0.44)
Specificity	0.63 (0.49–0.76)	>0.89 (0.80–0.98)[a]

[a]In Table 3, it is shown that all referents without hand dermatitis according to the dermatologist also scored negatively on the skin-screening list ($n = 8$). To be able to calculate the specificity it was supposed that 1 additional subject without hand dermatitis according to the dermatologist scored positively on the questionnaire, resulting in a specificity of more than 0.89 (8/9).

Table 5. Crude and adjusted PR for dermatitis according to the symptom-based questionnaire (criterion I) and the skin-screening list (hand dermatitis of degree 1, 2, or 3) with 95% CI (in parenthesis), for exposed as compared to referent workers (models 1a and 2a), and for workers with high and low dermal exposure to SMWF as compared to referents (models 1b and 2b). Bold PRs have $P < 0.05$

	Symptom-based	Skin-screening list	
Dermatitis during last 12 months	Hands	Hands	Hands, forearms or face
Crude PR			
Model 1a			
Exposed ($n = 80$)	0.7 (0.4–1.3)	1.4 (0.6–3.4)	**2.3 (1.0–5.1)**
Model 1b			
Low dermal exposure to SMWF ($n = 33$)	0.7 (0.3–1.6)	2.0 (0.8–5.3)	2.0 (0.8–5.3)
High dermal exposure to SMWF ($n = 47$)	0.8 (0.4–1.5)	1.0 (0.3–3.0)	**2.4 (1.0–5.7)**
Adjusted PR[a]			
Model 2a			
Exposed ($n = 80$)	0.9 (0.5–1.6)	1.6 (0.7–3.8)	**2.3 (1.0–5.1)**
Hand washing[b]	0.7 (0.4–1.2)	0.9 (0.4–2.0)	1.0 (0.5–1.9)
Car repairing[c]	1.7 (0.9–3.1)	1.3 (0.5–3.2)	0.9 (0.4–2.1)
Gardening[c]	1.5 (0.9–2.7)	1.5 (0.6–3.5)	1.5 (0.7–3.2)
≥7 company working years[d]	0.6 (0.3–1.0)	0.5 (0.2–1.1)	0.7 (0.3–1.4)
Model 2b			
Low dermal exposure to SMWF ($n = 33$)	1.0 (0.5–2.4)	2.6 (0.9–7.2)	2.0 (0.7–5.1)
High dermal exposure to SMWF ($n = 47$)	0.8 (0.4–1.6)	1.1 (0.4–3.2)	**2.4 (1.0–5.8)**
Hand washing[b]	0.7 (0.4–1.2)	0.9 (0.4–2.1)	1.0 (0.5–1.9)
Car repairing[c]	1.8 (1.0–3.3)	1.4 (0.6–3.7)	0.9 (0.4–2.1)
Gardening[c]	1.5 (0.9–2.7)	1.4 (0.6–3.3)	1.5 (0.7–3.2)
≥7 company working years	0.6 (0.3–1.0)	0.4 (0.2–1.0)	0.7 (0.4–1.5)

[a]Adjusted for hand washing and car repairing.
[b]2–4 times a day = 0; 5–10 times a day = 1.
[c]<1 hr weekly = 0; >1 hr weekly = 1.
[d]Cut-off point is 75th percentile.
PR, prevalence ratios; SMWF, synthetic metal working fluids; CI, confidence intervals.

detectable dermal exposure levels on the face; 68% (21 out of 31) of the DREAM estimates was larger than zero for high-exposed workers versus 41% (7 out of 17) for low-exposed workers (19).

Car repairing and, to a lesser extent, gardening showed an association with hand dermatitis measured with the symptom-based questionnaire. In addition, the prevalence of hand dermatitis was decreased in workers who had worked 7 years, or more, at the plant, for both the symptom-based questionnaire and the skin-screening list. Other factors were not related to dermatitis.

Discussion

The 2 questionnaires showed different results for the assessment of hand dermatitis compared to the diagnosis by the dermatologists. The symptom-based questionnaire had a relatively high sensitivity (0.86) but only moderate specificity (0.64), whereas the skin-screening list had a low sensitivity (0.36) and a relatively high specificity (0.84). The questionnaires appeared to measure different degrees of hand dermatitis, which was expressed by the only moderate agreement (Cohen's kappa 0.45, 95% CI: 0.28–0.68). The pictures of the skin-screening list seemed to represent the more severe cases of dermatitis, whereas the symptom-based questionnaire seemed to include very mild dermatitis as well. The results of the skin-screening list indicated a possible exposure-effect relation between dermal exposure level to SMWF and the occurrence of dermatitis on hands, forearms, and face.

Compared to previous validation studies of the symptom-based questionnaire, our results showed a similar sensitivity and specificity (0.86 and 0.64, respectively) as compared to a study in nurses by Smit et al. (11) (1.00 and 0.64, respectively) and a somewhat higher sensitivity and lower specificity as compared to workers of the rubber manufacturing industry by Vermeulen et al. (12) (0.71 and 0.76, respectively).

In this study, the prevalence of hand dermatitis as diagnosed by a dermatologist lay between 15% and 20% for both exposed and referents, as the prevalence was overestimated by the symptom-based questionnaire and underestimated by the skin-screening list. Both referents and exposed workers had a higher prevalence of dermatitis than the general male population (5–10%) (10, 21). Metal workers in our study had a lower prevalence of dermatitis than those reported in other studies on the basis of clinical evaluations that reported a prevalence of 27–56% (5, 6, 8), except for the study by Sprince et al. (10) who reported 13% definite and 15% possible dermatitis.

The validation of the questionnaires in this study had several limitations. First, it could only be realized in a subset of the studied population. The sensitivity and specificity, however, may be extrapolated to the entire studied population because sensitivity and specificity are independent of disease prevalence, and because the enriched subset was selected independently of exposure status. Secondly, it focussed on hand dermatitis, not at other body parts, whereas the skin-screening list included dermatitis on face and forearms as well. The sensitivity and specificity may have been different for these body parts and should be considered as a future validation study. Thirdly, skin examinations were performed by 2 dermatologists, and inter-expert variability may have affected the sensitivity and specificity found. However, stratified analysis yielded comparable sensitivity and specificity for both dermatologists (results not presented), although the dermatologists might identify different cases and non-cases. Sensitivity and specificity were similar for exposed and referents, indicating that dermatologists were most likely not biased by the exposure status of the workers. Fourthly, the examination by the dermatologists did not occur on the same day workers filled in the questionnaires, on the average 3 weeks afterwards. However, as dermatologists were asked to evaluate skin disorders during the past 12 months, and the workers reported symptoms during the past 12 months as well, the different moments of sampling may have affected the calculations on specificity and sensitivity only to a small extent.

Also, the exploratory epidemiological survey on dermal exposure to SMWF and dermatitis had several shortcomings. First, the cross-sectional design may have introduced selection bias. Both questionnaires showed a decreased risk for hand dermatitis among workers with at least 7 working year at the factory, suggesting a healthy-worker effect, which would result in an underestimation of prevalence of dermatitis. Secondly, our study size was small, and did not allow separate analyses for different degrees of dermatitis as measured with the skin-screening list. Thirdly, response rate was moderate in both exposed subjects (62%) and referents (66%) and may have positively or negatively biased the presented associations. However, non-responders had similar age [exposed: mean 37 (SD = 10), referents: 35 (SD = 11)] and working years [exposed: mean 9 (SD = 10), referents 8 (SD = 9)] as responders [exposed: mean age 37 (SD = 10), mean working years 12 (SD = 11), referents: mean age 36 (SD = 11) and mean working years 10 (SD = 9)]. Fourthly, assembly workers might not have been the most appropriate referent group because, although not exposed to MWF, they may be exposed to other risk factors for developing occupational hand dermatitis such as mechanical exposures: friction, pressure, and sharp objects. Referents reported to wash their hands more often than exposed, and reported to repair cars in their leisure time more often than exposed workers. Nevertheless, hand washing and repairing cars did not confound the found relations between exposure and dermatitis, as the crude PR did not alter after inclusion of these factors in the multivariate log-binomial regression model.

The results of the skin-screening list indicated a possible dose-effect relation between dermal exposure to SMWF and dermatitis on hands, forearms, and face, with PRs of 2.0 (95% CI: 0.7–5.1) and 2.4 (1.0–5.8) for workers exposed to low and high levels of SMWF, respectively. The exposure-effect relation was mainly seen in workers with high exposure to SMWF who reported skin disorders on forearms and, especially, face, but did not report disorders in the hands. This finding might be explained because skin on the forearms and face is thinner, and therefore more sensitive than skin on the hands. Consequently, when exposed to SMWF, workers may easily develop dermatitis on face and forearms than on the hands. Among workers with high dermal exposure levels to SMWF on the hands and forearms, in general, dermal exposure of the face was high as well (19).

The elevated risk on dermatitis on the hands, forearms and face is in congruence with a study on dermatitis among machine operators by Sprince et al. (10), who reported an increased odds ratio (OR 2.38; 95% CI: 1.02–5.56) for machine operators exposed to SMWF and a positive association between 'dermatitis' and 'skin or clothing reported to be wet from coolants more than 1 hr daily' (OR 6.53; 95% CI: 2.53–16.9). However, Sprince et al. (10) did not find an association for measured dermal exposure levels to SMWF on the mid-forearm and dermatitis. Limitations of the dermal dosimeter (surrogate skin pad method) that was placed on the mid-forearm, could be a possible explanation for the findings by Sprince et al. (10) As we assessed dermal exposure levels on the hands, forearms, as well as the face, our estimates probably resulted in a better measure for dermal exposure to SMWF.

In conclusion, we evaluated the accuracy of 2 questionnaires, a symptom-based questionnaire and a picture-based skin-screening list that appeared to detect different degrees of dermatitis. For the skin-screening list that measured more severe degrees of skin disorders, we found a significant association between workers grouped

according to dermal exposure levels to SMWF as assessed by DREAM (DREAM estimates were validated by measuring dermal exposure levels with VITAE), and the prevalence of dermatitis on the hands, forearms, and face.

In epidemiological surveys where workers are not seen by a dermatologist, the skin-screening list seems to be more appropriate for studying the relation between exposure to SMWF and dermatitis, because this questionnaire has a higher specificity resulting in less false positives than the symptom-based questionnaire. Nevertheless, its low sensitivity will create a problem if you are also interested in very mild degrees of dermatitis. In these cases, the symptom-based questionnaire should be used for screening purposes as its questions were designed to identify as many potential cases as possible and to exclude only persons definitely free of hand eczema, and subsequently, workers indicating having skin complaints should be seen by a dermatologist in order to identify false positives (11).

As our epidemiological survey had only an exploratory character, we recommend repeating this study on the relation between dermal exposure to SMWF and dermatitis in a larger population of metal workers and a referent group, ideally with a prospective, instead of a cross-sectional, design. It would be useful to include, in a future study, additional questions on self-reported dermatitis (21–23) that were developed more recently than our symptom-based questionnaire and may show better agreement with clinical evaluations by dermatologists.

References

1. Diepgen T L. Occupational skin-disease data in Europe. *Int Arch Occup Environ Health* 2003: 76: 331–338.
2. Diepgen T L, Coenraads P J. The epidemiology of occupational contact dermatitis. *Int Arch Occup Environ Health* 1999: 72: 496–506.
3. Meyer J D, Chen Y, Holt D L, Beck M H, Cherry N M. Occupational contact dermatitis in the UK: a surveillance report from Epiderm and Opra. *Occup Med (Lond)* 2000: 50: 265–273.
4. National Institute of Health and Safety (NIOSH). *What You Need to Know About Occupational Exposure to Metal Working Fluids*. 1998.
5. Gruvberger B, Isaksson M, Frick M, Ponten A, Bruze M. Occupational dermatoses in a metalworking plant. *Contact Dermatitis* 2003: 48: 80–86.
6. Pryce D W, White J, English J S, Rycroft R J. Soluble oil dermatitis: a review. *J Soc Occup Med* 1989: 39: 93–98.
7. Berndt U, Hinnen U, Iliev D, Elsner P. Hand eczema in metal worker trainees – an analysis of risk factors. *Contact Dermatitis* 2000: 43: 327–332.
8. de Boer E M, van Ketel W G, Bruynzeel D P. Dermatoses in metal workers. (I) Irritant contact dermatitis. *Contact Dermatitis* 1989: 20: 212–218.
9. de Boer E M, van Ketel W G, Bruynzeel D P. Dermatoses in metal workers. (II) Allergic contact dermatitis. *Contact Dermatitis* 1989: 20: 280–286.
10. Sprince N L, Palmer J A, Popendorf W, Thorne P S, Selim M I, Zwerling C, Miller E R. Dermatitis among automobile production machine operators exposed to metal-working fluids. *Am J Ind Med* 1996: 30: 421–429.
11. 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.
12. 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.
13. Van Wendel de Joode B, Brouwer D H, Vermeulen R, Van Hemmen J J, Heederik D, Kromhout H. Dream: a method for semi-quantitative dermal exposure assessment. *Ann Occup Hyg* 2003: 47: 71–87.
14. Van Wendel de Joode B, van Hemmen J J, Meijster T, Major V, London L, Kromhout H. Reliability of a semi-quantitative method for dermal exposure assessment (Dream). *J Expo Anal Environ Epidemiol* 2005: 15: 111–120.
15. Van Wendel de Joode B, Vermeulen R, van Hemmen J J, Fransman W, Kromhout H. Accuracy of a semi-quantitative method for dermal exposure (Dream). *Occup Environ Med* 2005: 62: 623–632.
16. Fenske R A, Leffingwell J T, Spear R C. A video imaging technique for assessing dermal exposure. I. Instrument design and testing. *Am Ind Hyg Assoc J* 1986: 47: 764–770.
17. Fenske R A, Wong S M, Leffingwell J T, Spear R C. A video imaging technique for assessing dermal exposure. II. Fluorescent tracer testing. *Am Ind Hyg Assoc J* 1986: 47: 771–775.
18. Bierman E P, Brouwer D H, van Hemmen J J. Implementation and evaluation of the fluorescent tracer technique in greenhouse exposure studies. *Ann Occup Hyg* 1998: 42: 467–475.
19. Van Wendel de Joode B, Bierman E P, Brouwer D H, Kromhout H. Dermal exposure assessment to semi-synthetic metal working fluids. *Occup Environ Med* 2005: 62: 633–641.
20. Skov T, Deddens J, Petersen M R, Endahl L. Prevalence proportion ratios: estimation and hypothesis testing. *Int J Epidemiol* 1998: 27: 91–95.
21. Svensson A, Lindberg M, Meding B, Sundberg K, Stenberg B. Self-reported hand eczema: symptom-based reports do not increase the validity of diagnosis. *Br J Dermatol* 2002: 147: 281–284.
22. Flyvholm M A, Susitaival P, Meding B et al. *Nordic Occupational Skin Questionnaire – NOSQ-2002. Nordic Questionnaire for Surveying Workrelated Skin Diseases on Hands and Forearms and Relevant Exposures*. Copenhagen, Nordic Council of Ministers, 2002: 1186.
23. Susitaival P, Flyvholm M A, Meding B, Kanerva L, Lindberg M, Svensson A, Olafsson J H. Nordic occupational skin questionnaire (NOSQ-2002): a new tool for surveying occupational skin diseases and exposure. *Contact Dermatitis* 2003: 49: 70–76.

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