

Self-reported skin exposure – validation of questions by observation

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The aim of this study was to validate questions regarding skin exposure using observation. The study group consisted of 40 individuals in 5 different occupations: nurse in an intensive care unit, car mechanic, hairdresser, kitchen worker, and office worker. The participants completed a questionnaire before the start of a working day. The questionnaire covered total skin exposure times to water, foodstuffs, chemicals, and occlusive gloves and also covered the frequency of hand-washing during a working day. Observers subsequently used a hand-held computer to register the time and the frequency of each exposure. A strong correlation between self-reports and observations was found for questions regarding exposure times to water, foodstuffs, and occlusive gloves and also a moderate correlation for questions regarding frequency of hand-washing. The present observation method was insufficient for estimating total exposure times to chemicals as the true exposure time is influenced by, e.g. the use of contaminated protective gloves and the efficacy with which the chemicals were removed. The inter-observer reliability showed a very strong correlation. We consider the questions regarding skin exposure to water, foodstuffs, protective gloves, and hand-washing to be useful for future studies. The observation method seems to be reliable, useful, and easy to apply.

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Hand eczema is the main occupational skin disease (1). Exposure to skin irritants in occupational life, as well as during domestic work and leisure time, is an important risk factor for hand eczema (2). Common skin irritants are water, chemicals, foodstuffs, and hand-washing. In epidemiological studies, job titles have often been used as a proxy for occupational skin exposure but do not permit estimation of variations in exposure within occupations or overtime in the same job. As exposure to skin irritants is considered an important cause of hand eczema, there is a need to survey the extent of exposure to skin irritants at work and during leisure time in the general population.

The ideal for assessing occupational exposure to skin irritants would be quantitative and qualitative measurements. Such methods are, however, not feasible in epidemiological studies. Videotape recording has been used for measuring skin exposure to cutting fluids (3). Some studies have tried to quantify the time of skin exposure through questionnaires (4, 5) and observations (6, 7). In a previous population-based study, individuals

with or without hand eczema were questioned regarding skin exposure (8). However, the questions were not validated.

Self-reports can be validated through observation. In this study, we observed and registered skin exposure using a hand-held computer. This method has been used earlier in ergonomic studies when validating questionnaires regarding work postures. It is easy to apply and seems to be reliable (9). The aim of this study was to validate questions regarding skin exposure using observation.

Subjects and Methods

Study population

The study group consisted of 40 volunteers from 5 different occupations. 4 are high-risk occupations for hand eczema, where high exposure to skin irritants is expected. The occupations selected were car mechanic, hairdresser, kitchen worker, and nurse in an intensive care unit (ICU). Office worker was selected as an occupation with expected low exposure to skin irritants. 8 subjects in each

occupation were included in the study. The study group consisted of 13 men and 27 women, and the mean age was 35 years (range 24–62 years). The mean daily working hours were 8 (range 7–9). The study was performed in Stockholm, Sweden, from August 2004 to February 2005.

Questionnaire

The questionnaires were handed to the participants by the observer immediately before the start of a working day. The subjects filled in the questionnaire and handed it back to the observer. It comprised questions regarding exposure to water, foodstuffs, chemicals, protective gloves, and hand-washing during a working day (Table 1). Questions regarding sex, occupation, age, and work hours per day were also included. The observers gave no further instructions or information.

Observers

2 observers (1 and 2) observed the car mechanics, hairdressers, kitchen workers, and ICU nurses. A third observer (IA) observed the office workers. To study the inter-observer reliability, 2 observers (1 and 2) simultaneously observed the same worker during a working day. 1 hairdresser and 1 kitchen worker were chosen for this purpose.

Observations

The observations were performed during 1 working day or 2 half-days (am + pm) for each participant. The durations of each exposure were registered continuously in real time during the whole working day, except for lunch breaks, using

a hand-held computer (palm). 6 circular fields on the computer display corresponded with exposure to water, chemicals, occlusive gloves, foodstuffs, hand-washing, or with 'no exposure', respectively. When the subjects exposed themselves to 1 of the exposures, the observer marked the appropriate circle on the display with the pen and timing was initiated. When the exposure was discontinued for any reason, the observer marked the 'no exposure' circle or a circle with another exposure. 2 separate exposures were on single occasions registered at the same time, e.g. water and chemicals in hairdressers. When gloves were used, no other exposure was registered simultaneously.

Data analysis and statistics

The FIT software system (J. Held, Swiss Federal Institute of Technology, Zurich, Switzerland) was used for data collection (10). The data were then transferred to a personal computer for analysis. The software calculated and stored start, stop, and total time of the observations. Information about the number of times the fields in the circles were activated during the work shift, and the mean duration of each event, was also supplied. The measurements gained through observation were considered as a 'gold standard'. The estimated average time for a hand-wash was 1 min. The estimated time for hand-disinfection (isopropanol and ethanol), evaporation included, was also 1 min and was registered as exposure to chemicals. The time, continuously measured in the observations, was classified into the ordinal response scale used in the questionnaire (Table 1). There were no missing data in the questionnaires or in the observations.

For statistical analysis, SPSS version 13.0 (SPSS Inc., Chicago, IL, USA) was used. The correlation between registered data and data from the questionnaire was calculated using Spearman's rank correlation. The observations showed that some of the time periods registered had short duration and high frequency. The chi-square test was used to investigate a possible relation between high frequency of registered exposure periods and overestimation of self-reported total exposure time. For each exposure, the subject was classified as 'high-exposed' if exposed more than 10 times a day, otherwise classified as 'low-exposed'. Further, for each exposure, the subjects were classified as either 'overestimators' or 'equal/underestimators' regarding their self-rating compared to the observed time. After cross-tabulating these 2 variables (high/low exposed and over/equal underestimators), a chi-square test was performed to test the

Table 1. Questions in the questionnaire regarding skin exposure

1. Are your hands, at work, exposed to water?*
- ☐ Not at all ☐ <1/2 h/day ☐ 1/2–2 h/day ☐ 2–5 h/day ☐ >5 h/day
2. Are your hands, at work, exposed to chemicals?*
- ☐ Not at all ☐ <1/2 h/day ☐ 1/2–2 h/day ☐ 2–5 h/day ☐ >5 h/day
3. Are your hands, at work, exposed to foodstuffs?*
- ☐ Not at all ☐ <1/2 h/day ☐ 1/2–2 h/day ☐ 2–5 h/day ☐ >5 h/day
4. How many hours a day, at work, do you use occlusive protective gloves (rubber or plastic)?
- ☐ Not at all ☐ <1/2 h/day ☐ 1/2–2 h/day ☐ 2–5 h/day ☐ >5 h/day
5. How many hours a day, at work, do you use non-occlusive protective gloves (textile or leather)?
- ☐ Not at all ☐ <1/2 h/day ☐ 1/2–2 h/day ☐ 2–5 h/day ☐ >5 h/day
6. How many times a day do you wash your hands at work?
- ☐ 1–10 times ☐ 11–20 times ☐ more than 20 times

*Time without protective gloves.

hypothesis that there were higher proportions of overestimators among those frequently exposed during the day.

For assessing the concordance among observers (raters), an intra-class correlation coefficient (ICC) was calculated (11). 6 possible measures of ICC are available. We chose the 2-way mixed model, in which raters are considered a fixed variable, while the targets are considered a random variable. This was applicable to our data as only 2 observers were available and the hairdresser and kitchen worker constituted a random sample. A high value indicates a high concordance between observers regarding their measurements.

No ethics approval was needed for the study according to the Ethics Committee of Karolinska Institutet, Stockholm (No. 04-135/4).

Results

The mean total observation time per individual was 494 min (range 385–546 min) (Table 2, panel a). The longest exposure times were observed for water in hairdressers and for occlusive gloves in ICU nurses. The highest numbers of exposure periods were noted for water in kitchen workers and hairdressers, chemicals in ICU nurses and hairdressers, and foodstuffs in kitchen workers (Table 2, panel b). Hairdressers were exposed to skin irritants for 62% of the working day (mean). The corresponding proportions for ICU nurses, kitchen workers, and car mechanics were 24%, 27%, and 3%, respectively. The mean exposure time to water for ICU nurses was 1 min (range 0–2 min) per working day (hand-washing was not included) (Table 2, panel a). Car mechanics used

non-occlusive gloves (textile) for a mean total time of 137 min (range 13–284 min) and the mean frequency of exposure periods was 15 (range 2–34).

Self-reported skin exposure in relation to observed exposure is presented in Table 3. The Spearman correlation coefficient varied between 0.369 and 0.732. Observations showed that 10% (4/40) washed their hands more than 10 times during a working day.

Table 4 presents self-reported skin exposure in relation to observed exposure expressed as underestimation, correct estimation, or overestimation. A tendency to overestimate was found for all the exposures. For water, 21 of the 40 volunteers overestimated the exposure. For hand-washing, the answers correlated with observed data in 30 of the 40 individuals. Those with 10 or more exposure periods for either exposure showed a statistically significant risk of overestimating their total exposure time to any of the exposures ($P < 0.001$).

Results from observations performed simultaneously by 2 observers are presented in Fig. 1. The observations by the 2 raters showed good concordance, with an ICC of 0.897–0.999.

Discussion

In this study, self-reports by questionnaire regarding skin exposure were validated with observations using a hand-held computer for registration, a method, which in previous ergonomic studies, has proved reliable and easy to apply (9). Validated questions are needed in population surveys and in prevention and intervention studies. To

Table 2. Observed skin exposure during a working day in relation to occupational group in 40 volunteers

	Nurses (<i>n</i> = 8) Mean (range)	Car mechanics (<i>n</i> = 8) Mean (range)	Hairdressers (<i>n</i> = 8) Mean (range)	Kitchen workers (<i>n</i> = 8) Mean (range)	Office workers (<i>n</i> = 8) Mean (range)
a) Exposed time in minutes					
Water	1 (0–2)	0 (0–1)	159 (101–215)	26 (3–56)	1 (0–12)
Chemicals	21 (11–44)	4 (0–14)	79 (31–120)	9 (0–23)	0 (0)
Foodstuffs	1 (0–6)	0 (0)	1 (0–10)*	33 (0–178)	0 (0)
Occlusive gloves	90 (25–166)	6 (0–47)	25 (0–87)	63 (0–327)	0 (0)
Hand-washing	7 (2–12)	5 (2–8)	8 (5–12)	9 (5–18)	3 (1–5)
Total skin exposure time [†]	120 (37–182)	15 (2–52)	272 (216–339)	140 (46–338)	4 (0–12)
Total observation time	498 (441–543)	540 (530–546)	441 (385–493)	510 (479–540)	477 (391–520)
Total skin exposure/day (%) [†]	24	3	62	27	1
b) Number of exposure periods					
Water	1 (0–4)	0 (0)	18 (7–25)	23 (1–62)	2 (0–12)
Chemicals	20 (4–28)	6 (0–15)	17 (7–20)	6 (0–13)	0 (0)
Foodstuffs	0 (0)	0 (0)	1 (0–1)*	20 (0–49)	0 (0)
Occlusive gloves	13 (3–18)	0 (0)	3 (0–9)	0 (0–6)	0 (0)
Hand-washing	7 (1–9)	5 (2–8)	8 (5–12)	9 (2–18)	3 (0–5)
Total number of exposure periods	41 (27–69)	11 (2–21)	47 (20–52)	61 (17–133)	5 (1–5)

*Serving coffee to customers.

[†]Time includes occlusive gloves.

Table 3. Self-reported skin exposure by questionnaire in relation to observed skin exposure during a working day in 40 volunteers*

Self-reported exposure		Observed exposure					Correlation†
Water	Not at all	Not at all	<1/2 hr	1/2–2 hr	2–5 hr	>5 hr	0.680
		7	2				
	<1/2 hr	7	4				
	1/2–2 hr	2	2	2	3		
	2–5 hr		2	1	1		
Chemicals	>5 hr		3	1	3		0.732
	Not at all	Not at all	<1/2 hr	1/2–2 hr	2–5 hr	>5 hr	
		10	1				
	<1/2 hr	2	8	2			
	1/2–2 hr		7	6			
Foodstuffs	2–5 hr		1	1			0.672
	>5 hr		1	1			
	Not at all	Not at all	<1/2 hr	1/2–2 hr	2–5 hr	>5 hr	
		25	1				
	<1/2 hr	4	3				
Occlusive gloves	1/2–2 hr	2	1				0.719
	2–5 hr			1			
	>5 hr		2		1		
	Not at all	Not at all	<1/2 hr	1/2–2 hr	2–5 hr	>5 hr	
		15		2			
Hand-washing	<1/2 hr	2		2			0.369
	1/2–2 hr	1	7	5	3	1	
	2–5 hr			1	1		
	>5 hr						
	1–10 times	1–10 times		11–20 times		>20 times	
		28		1			
	11–20 times	4		2			
	>20 times	4		1			

*Figures in bold indicate correspondence between self-reports and observations.

†Spearman's rank correlation coefficient.

our knowledge, few attempts have been made to validate questions regarding skin exposure.

We found a strong correlation between observations and self-reports regarding exposure to water, foodstuffs, and protective gloves (Table 3). The correlation was moderate regarding hand-washing, although 30 of the 40 respondents estimated their exposure correctly in the questionnaire according to the observations. We consider these questions to be useful in future studies, with the reservation of a weaker correlation for the hand-washing question. The question regarding exposure to chemicals showed a strong correlation, but observation showed some difficulties. Use of contaminated protective gloves and the efficacy with which chemicals are removed from the skin influence the true exposure time. The inherent properties of the chemicals, e.g. volatil-

ity, viscosity, stickiness, and diffusivity through glove materials, also influence the time of exposure. According to the observations in our study, the car mechanics were exposed to chemicals for only 4 min of the working day. They used textile gloves for a mean of 137 min per working day, and part of this time is probably to be considered as exposure to chemicals due to use of contaminated gloves. Because of these difficulties, we believe that observations as performed in this study are insufficient for estimating the true total exposure time to chemicals. In addition, direct measurements of the skin exposure are needed.

The participants tended to overestimate the total time in all the exposures (Table 4). About half overestimated their exposure time to water. There was an association between high frequency of exposure periods registered in all types of exposure and overestimation of total exposure time. A high frequency of exposure periods probably made the respondents feel that the work includes a long time with that exposure. The respondents also tended to overestimate their main occupational exposure, e.g. kitchen workers to foodstuffs (data not shown). The present questions elicited self-estimated total exposure time, while questions regarding number of exposure periods were included only for hand-washing. A high frequency of exposure periods to water might contribute to

Table 4. Self-reported skin exposure during a working day in relation to observed skin exposure (number of individuals) expressed as underestimation, correct estimation, or overestimation in 40 volunteers

Exposure	Underestimation	Correct	Overestimation
Water	5	14	21
Chemicals	3	24	13
Foodstuffs	1	28	11
Occlusive gloves	8	21	11
Hand-washing	1	30	9

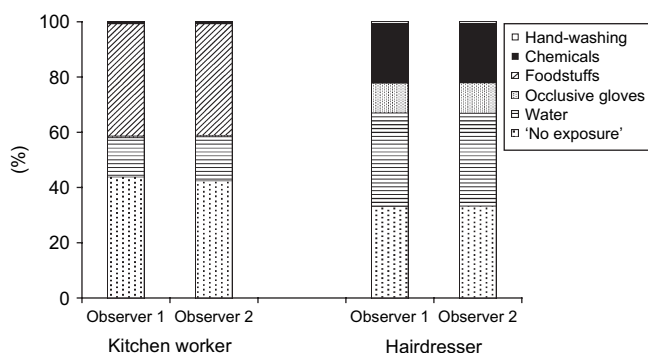


Fig. 1. Results regarding skin exposure from observation of 1 kitchen worker and 1 hairdresser by 2 observers simultaneously. The proportions of different exposures during the working day are shown.

hand eczema, and questions regarding frequency should be included in future surveys. In a Dutch study of wet work among nurses, observation showed less than half the duration of wet work compared to self-reports, and almost double the frequency of wet exposure periods (6). Answers to our question regarding hand-washing indicated the opposite, i.e. a tendency to overestimate the frequency of hand-washing.

We found the observation method used in this study easy to learn, and acceptance by the participants observed was good. However, the method is time-consuming and resource consuming. The comparison of the 2 observers simultaneously observing 2 participants, a hairdresser and a kitchen worker, showed very strong ICC (Fig. 1). Thus, we consider the present method reliable and useful for further validation or observational studies.

When validating the question on glove use by observation, no other exposure was registered simultaneously. Glove use was classified as skin exposure. Use of protective gloves, although intended as prevention, may be a risk factor for hand eczema (12). Short-term use probably gives a lower risk, but continuous and protracted use might contribute to hand eczema (13, 14).

The time was continuously measured in the observations, but in the questionnaire, an ordinal response scale was used. We consider the ordinal response scale more suitable for the responders, especially when estimating long exposure times. If the questionnaire was designed to have a continuum of answer possibilities, it would be fair to assume that the subjects would report their time of exposure rounded to the nearest half-hour or whole hour.

We studied individuals in 4 occupations with expected high exposure to skin irritants and in 1 occupation with expected low exposure. For estimating the total skin exposure time in different occupational groups, the results from our

observations must be used with caution. To what extent the observed working day reflects an average working day is influenced by the low number of participants in each group. However, the results regarding the hairdressers, a well-known high-risk occupation for hand eczema (15, 16), confirmed high exposure to skin irritants (62% of the working day). In Germany, occupational skin exposure to irritants has been subject to regulations since 1996 (17). According to the regulations, 'wet work' has been described as wet hands for more than 2 hr a day, use of occlusive protective gloves more than 2 hr a day, or hand-washing exceeding 20 times a day (1). According to our observations, no individuals were exposed to hand-washing exceeding 20 times a day.

In conclusion, we found a strong correlation between self-reports by questionnaire and observations regarding total time of skin exposure to water, occlusive gloves, and foodstuffs and a moderate correlation regarding frequency of hand-washing. We consider these questions to be useful for future studies. Observation as performed in this study is not a sufficient method for estimating the total exposure time regarding chemicals. The frequency of exposure periods might be of importance and should be further investigated.

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