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Wet work exposure and hand eczema among healthcare workers - a cross-sectional study

Short title: Wet work exposure and hand eczema among healthcare workers

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What is already known about this topic?

Frequent hand washing with soap and water is a risk factor for hand eczema in healthcare workers.

Use of disposable gloves might be associated with hand eczema in healthcare but data so far has been contradictory.

What does this study add?

There is a dose-dependent association between daily time with disposable gloves and hand eczema in healthcare workers.

The data do not support any dose-dependent association between the use of hand disinfectant and hand eczema in healthcare workers.

Summary

Background: Hand eczema is more common in healthcare workers compared to the general population. The hands are subject to changing occupational exposures due to mandatory hygiene regulations for health care workers.

Objectives: To describe the exposure due to hygiene procedures and investigate the associations between occupational hand washing, use of non-sterile gloves, and hand disinfectant and self-reported hand eczema.

Methods: Cross-sectional study with an electronic questionnaire distributed to 28 762 hospital employees in southern Sweden. Respondents working as nurses, assistant nurses or physicians constituted the group of healthcare workers analysed. Adjustments were made for gender, age, wet work at home, life-style factors and atopic dermatitis.

Results: 12 288 (43%) responded including 9051 healthcare workers. In this group the 1-year prevalence of self-reported hand eczema was 21%. On a daily basis, 30% reported hand washing with soap >20 times at work, 45% used hand disinfectants >50 times, and 54% used non-sterile gloves > 2 hours. After adjustment for confounding factors, a dose-dependent association with self-reported hand eczema was found for the daily number of hand washes with soap at work and time working with disposable gloves, but not for alcoholic disinfectant use. Hand washing outside work was not associated with self-reported hand eczema in the adjusted multivariate analysis.

Conclusions: In this study, we found a higher 1-year prevalence of self-reported hand eczema among Swedish healthcare workers than reported in the general population. Hand washing with soap and use of disposable gloves were associated with the occurrence of self-reported hand eczema in a dose-dependent way. Use of hand disinfectant was not associated with self-reported hand eczema

Introduction

Hand eczema (HE) in healthcare workers (HCW) is a matter of increasing concern. Revised hygiene procedures and introduction of new products lead to changing occupational hand exposure. HE in HCW has been studied previously but there are no recent data on the occurrence and causes of HE among hospital personnel in Sweden.¹⁻³ HE causes morbidity and economic costs associated with sick leave and treatment.⁴⁻⁶ Furthermore HE can lead to increased carriage of potentially hazardous microorganisms on eczematous skin of the hand,⁷⁻⁹ which indicates a possible risk for transmission of bacterial infections. HE can increase the risk for colonisation with methicillin-resistant *Staphylococcus aureus* among nurses.¹⁰

Healthcare work includes a significant amount of wet work due to mandatory hygiene procedures (alcoholic hand disinfectants before and after patient care, soap and water if hands are visibly dirty, and disposable gloves if contact with body fluids)¹¹ and wet work exposure is considered to be a major risk factor for occupational HE among healthcare personnel.^{12,13} Based on import trade data, it is likely that the exposure to non-sterile disposable rubber gloves has increased substantially.¹⁴ According to information from healthcare purchasing departments, 14-15 times more gloves are bought than 10-15 years ago (pers. comm.). Recently, we have noticed an increased number of HCW with occupational HE due to contact allergy to chemicals in sterile surgical gloves.¹⁵ This prompted us to further investigate occupational HE in relation to wet work exposures due to hygiene procedures, among HCW in our region, southern Sweden.

Methods

Study group and questionnaire

The questionnaire was distributed to all employees at hospitals in southern Sweden, i.e. the Counties of Blekinge, Halland (southern part), Kronoberg and Skåne. E-mail addresses to the hospital employees regardless of occupation were provided by the employers. Respondents reporting a profession as nurse, assistant nurse, or physician were defined as HCW and were selected for the subsequent analyses.

An electronic questionnaire using a web-based application (Relationwise Survey Solution, Kundkoll Sverige, Siljansnäs, Sweden) was distributed during the months of May to June and September to October 2014 to 28 762 employees at the hospitals of Southern Sweden. Two reminders were distributed electronically.

The occupational wet work exposures studied were daily use of disposable gloves, alcoholic hand disinfectant and hand washing with soap and water. Age, gender, wet work exposures outside work (hand washing with soap and water, kitchen work, caring for children ≤ 4 years of age), obesity, smoking, stress, and atopic dermatitis (AD) were analysed as possible confounding factors.

The prevalence figures presented in this report are the self-reported one-year prevalence data, based on the occurrence HE within the past 12 months ("Do you have hand eczema today" or "Have you had hand eczema on any occasion during the past 12 months?"). The latter question as well as questions on occupational wet work exposure have been validated.¹⁶⁻¹⁹ AD was defined as having a history of childhood eczema.²⁰ The question on perceived stress has, to our knowledge, not been validated, but it has been used in Swedish national public health surveys (21) and in two studies on hand eczema.^{22,23} Obesity was defined as BMI (body mass index) ≥ 30 .²⁴

Only a few basic questions were mandatory, while other questions were possible to leave unanswered. The respondents were initially asked about occupational wet work exposure, and then about HE and possible confounding factors. This as well as missing answers to non-mandatory questions lead to a varied number of respondents in the different analyses performed.

A short electronic questionnaire with two reminders was distributed to the non-responders 1-3 months later. It included questions about occupation, gender, 1-year prevalence of HE and exposure to disposable gloves.

Age, gender, and profession of the non-responders are not known. Data on gender and mean age of HCW were obtained from 3 of the 6 hospital administrations.

Statistics

The statistical analyses were performed using SPSS Version 22 statistical software package (IBM Corp.).

Descriptive statistics are presented for exposure data. For the analysis of associations between HE and exposures comparisons were made for the respondents reporting HE within the past 12 months as opposed to those reporting no history of HE in adult life. Thus, respondents with a history of HE earlier in adult life but not within the past 12 months were excluded in these analyses. AD respondents who answered "I don't know" were not included in the association analyses.

To assess possible correlations between work-related exposures, Spearman's correlation analysis was used. Possible associations between exposures and HE were first analysed with χ^2 tests. Odds ratios (OR) were analysed with univariate logistic regression. P for trend was tested by adding the categorical variable as continuous covariate in the regression model when data was consistent with a possible trend.

For the multivariate logistic regression analysis the exposure data for use of each one of non-sterile disposable gloves, hand disinfectant and hand washing were grouped into three groups ("low", "medium", and "high" exposure). In the first model OR for each exposure were analysed separately with logistic regression (single exposure). In the second model the three exposures were analysed simultaneously with logistic regression analysis. In the subsequent models additional adjustments for other variables were done. The additional adjustment factors included successively to the regressions models were i) gender and age, ii) wet work exposure outside work, iii) lifestyle factors, and iv) AD. Exposures and adjustment factors with a $p \leq 0.30$ were included in the multivariate analyses. Due to the high proportion of women in the study gender, although no significant association found in the univariate analysis, was included in the multivariate logistic regression.

To investigate if respondents with AD differed from non-AD with regard to the association between wet work exposure and HE, testing for interaction between AD and wet work variables in the fully adjusted logistic regression model (number 'iv') as denoted above) was performed by including a cross-product term (AD x Exposure) in the model. Interactions between stress and wet work exposures were tested in the same manner.

Ethical approval

The study was approved by the Regional Ethical Review Board, Lund, Sweden (2013/151, 2014/339).

Results

The overall response rate was 43% (12 288 out of 28 762). The main body of respondents (9313) was nurses and physicians. Among these, 262 had not answered the HE questions and were excluded from the subsequent analyses (Fig 1). The remaining 9051 constitute the HCW group (4762 nurses, 3135 assistant nurses, and 1154 physicians). The maximal sample size for the analyses of the associations between potential exposures and HE was 7712 (including the HCW with no history of HE as well as those with HE within the past 12 months, but excluding the 1339 HCW with a history of HE earlier but not within the past 12 months). Due to missing responses the maximal sample size for the analyses including the variable of daily time using non-sterile gloves was 5276.

In the HCW group the mean age was 45.9 years (standard deviation (SD) 12.0) and 87% (7846/9051) were female. Background characteristics are shown in Table 1.

Prevalence of hand eczema

The 1-year-prevalence in the HCW was 21% (1870/9051). More than one third (35%; 3209/9051) had experienced HE at some time in adult life.

Wet work exposures

Wet work exposures for the HCW group are shown in Table 2. On a daily basis, 30% (2682/9050) reported hand washing with soap >20 times at work, 45% (4053/8987) used hand disinfectants >50 times, and 54% (3404/6292) used non-sterile gloves >2 hours. There was a positive correlation between number of hand washes with soap and use of hand disinfectants (Spearman correlation coefficient $r = 0.40$, $p < 0.001$), between hand washes with soap and daily numbers pairs of non-sterile gloves ($r = 0.37$, $p < 0.001$), as well as a positive correlation between hand washes with soap and time spent with non-sterile gloves ($r = 0.29$, $p < 0.001$). Hand disinfectant use correlated both with daily numbers of pairs of gloves used ($r = 0.55$, $p < 0.001$) and with daily time spent with gloves ($p = 0.35$, $p < 0.001$). Furthermore, a positive correlation between hand washes at work and hand washes outside work was found ($r = 0.41$, $p < 0.001$).

Associations between hand eczema and wet work.

After logistic regression analysis, the association between HE and the number of daily hand washes and time spent with disposable non-sterile gloves remained significant (Table 3). There was no association between hand disinfectant use and HE ($p = 0.20$).

Using the same multivariate model, the association between HE and the daily number of pairs of non-sterile gloves, instead of daily time spent with non-sterile gloves, was also investigated. Frequent hand washing with soap was again associated with an increased OR for HE, but neither a high daily number of gloves nor a frequent use of hand disinfectant increased the OR for HE (Table S1 - see supporting information).

According to a German regulation, the definition of “wet work” includes “activities in which workers must wear protective gloves for more than 2 hours a day.”²⁵ Besides the results given in Table 3 we also calculated the OR for working with non-sterile gloves >2 hours/day compared to ≤ 2 hours/day. Using the fully adjusted model (the last model in Table 3) the OR (confidence interval (CI) 95%) for HE in this comparison was 1.34 (1.12-1.60).

Of the non-occupational wet work exposures neither hand washing with soap outside work nor children ≤ 4 years old at home were associated with HE in the adjusted multivariate analysis. Kitchen work was associated with HE (OR (CI 95%) 1,22 (1,01-1,48)); Table S2 - see supporting information).

Life-style factors

There was a significant association between HE and perceived stress in a dose-dependent manner (p for trend <0.001) and this association remained significant after correction for wet work exposures, age, gender, obesity, smoking, and AD. In univariate analysis smoking and obesity were associated with HE, but when corrected for wet work exposure, age, stress and AD, only obesity remained associated with HE (OR (CI 95%) 1.35 (1.03-1.78), $p = 0.03$) (Table S2 - see supporting information).

Atopic dermatitis

AD was reported by 22% (1969/8773). Among these, 34% (677/1969) reported HE within the past 12 months, compared to 15% (916/6094) ($p <0.001$) among those with no history of AD. The number of HCW with AD was inversely related to age (p for trend <0.001). AD was associated with HE (OR (CI 95%) 3.47 (2.91-4.16) (Table S2 - see supporting information). Interaction analysis based on the fully adjusted model in Table 3 did not show any significant interaction between AD and hand washing with soap ($p = 0.09$), hand disinfectant use ($p = 0.75$) or time spent with non-sterile gloves ($p = 0.22$). As an example, the OR (95% confidence interval (CI)) for HE with high exposure compared to low exposure of hand washing at work was 1.6 (1.2-2.1) for HCW without AD, and 1.3 (0.8-2.0) for HCW with AD.

There was no difference between HCW with or without AD regarding use of moisturisers at work (38% (739/1966) versus 37% (2274/6082) $p = 0.87$).

Non-responders

Of the 3086 who answered the short electronic questionnaire distributed to the non-responders 2501 worked as nurses, assistant nurses, or physicians. In this group the proportion of females was 84% (2090/2501) and the mean age was 44.8 years, SD 11.4. HE within the past 12 months was reported by 19% (466/2501), compared with 21% among the full respondents.

In the available hospital administration data the mean age 44.3 years and the proportion of females were 81% (10819/13303) (mean age 45.9 and 87% females among the full respondents).

Discussion

We found a 1-year prevalence of 21% for HE. The 1-year prevalence of hand eczema did not differ between assistant nurses, nurses, and physicians. There was a dose-dependent association between HE and hand washing with soap at work as well as use of non-sterile gloves, but no association with use of alcoholic hand disinfectants.

Prevalence of hand eczema

The 1-year prevalence of HE among HCW in our study is higher than the figures reported in the adult general population in Sweden: a total of 9.4% (11.3% for women only) and depending on age group 2.15-8.1% (1.9%-10.8% for women only).²⁶ However the AD prevalence reported was lower (16%, 18% for women only) than in our study.

Previous studies among HCW have reported varying 1-year prevalences ranging from 12-72%,^{13,27-36} in part due to different study groups, study methods, and possibly different exposures. Our findings are in accordance with studies conducted among HCW in hospitals reported from northern Europe (Denmark),^{32,34} but higher than reported in a Dutch study on hospital employees with a 1-year prevalence of 12%.³⁵

Wet work exposures

It is difficult to compare studies on wet work exposures due to different selections of study populations.^{12,13,32,36-39} In a hospital-based Danish study 12-19% of the HCW reported >20 hand washes daily, 46-48% used hand disinfectant use >20 times daily and 29-30% used occlusive gloves >2 hours daily.¹² The corresponding figures in our study was 30%, 85% and 54% respectively, thus a relatively higher daily exposure, possibly reflecting a change in occupational exposures during the past years. It is recommended to replace hand washing with disinfectant use whenever possible. In our study, albeit a high level of hand disinfectant use, the exposure to soap and water still was high. This is in line with a previous report. Interestingly in that study only 21% of nurses and 10% of midwives used disinfectants which gives an indication on the variation geographically and over time regarding exposures to hand disinfectants.

We also found a positive correlation between exposure to soap and to hand disinfectant in the present study. It could be that there still is a misconception that alcoholic disinfectants are more harmful to the skin than soap.⁴⁰ The frequencies of hand washing at work and off work were correlated indicating that personal habits could be of importance. It might also reflect that the hygiene campaigns have led to an increased awareness of the importance of preventing the spread of microbes, irrespective of at work or at home. Furthermore, discomfort from alcoholic disinfectants on active HE can lead to an increased use of soap. In our study 26% of those with HE reported stinging from disinfectant compared to 5% among those without HE. However, intervention studies do indicate that it is possible to get a shift towards less soap exposure in healthcare settings.⁴¹⁻⁴³

We found a dose-dependent association between occupational hand washing with soap and HE. This is in line with previous studies showing an association between hand washing and HE in HCW.^{12,32,36,44,45}

Use of disposable gloves per se has been associated with HE in clinical investigations.^{12,32,36} A dose-dependent association has been difficult to prove.¹² In two studies on the effect on the skin barrier function by working long time daily with occlusive gloves no significant change in transepidermal water loss was found.^{46,47} The data in our study do support that the time

with occlusive gloves is associated with HE in a dose-dependent way. A possible explanation of the contradictory results could be the high level of exposure to occlusion as well as a high exposure to soap in our study population.

In our study the HCW reported a frequent use of disinfectants, but no association with HE was found. Our data are in line with previous experimental and epidemiological studies findings that alcoholic hand disinfectants are less likely to cause irritant contact dermatitis compared to soap and water.^{12,32,45,48-50}

Although it is likely that irritant factors related to wet work are the major culprit for occupational hand eczema among healthcare workers, contact allergy to rubber chemicals in gloves or chemicals in soaps and disinfectants can contribute to the increased risk of hand eczema.^{13,15,51-56} However, the presence of contact allergy can only be addressed by patch testing.

Atopic dermatitis

As expected HE was more common among healthcare workers with AD.^{2,34,44,57} AD has often, but not invariably, been regarded to imply an increased susceptibility for irritant factors such as wet work.^{2,58-62} Experimental studies has often, but not invariably, showed an increased response to irritant exposure on non-lesional skin in atopics.⁶³⁻⁷⁰ Therefore we expected to find an interaction between AD and wet work exposures leading to an increased effect of wet work on the OR for HE. Yet, compared to non-AD responders we didn't see any increased effect of wet work exposures on the OR of HE in the AD group. In general, moisturiser can diminish the irritant effect of wet work exposure.⁷¹ Theoretically, a high use of hand moisturisers in the AD-group would counteract the effect of irritant exposure. However, there was no difference in moisturiser use between HCW with or without AD. Thus, our data shows that AD is an independent risk factor for HE (Table S2 - see supporting information). Yet the data do not support an increased susceptibility for wet work exposure in HCW with AD. This is in line with an older study that found that the relative increase in OR for HE was the same both in wet work and dry work among subjects with a history of atopic dermatitis.²

Life-style factors

Lifestyle factors like obesity, smoking and stress have been associated with HE although data are conflicting.^{22,23,72-74} Our data support an association of HE with obesity and perceived stress but not with smoking (Table S2 - see supporting information). The association with stress was dose-dependent.

Limitations

A low response rate is not unique in recent questionnaire studies among healthcare personnel.^{36,63,75,76} Supposing that the 1-year prevalence among the 16 474 non-responders was half or twice the 1-year prevalence found among the respondents would give a possible range (irrespective of profession) between 14% (3884/28762) - 30% (8559/28762).

A low response rate could carry a risk of bias regarding HE prevalence whereas a bias of the associations between HE occurrence and wet work exposures would be dependent on a skewed reporting of both eczema occurrence as well as wet work exposures, which is less likely. The amplitude of the difference of HE-prevalence between the full respondents and the short-form respondents (21% vs 19%) argues against an extreme selection of respondents with HE, but the figures on HE-prevalence should be interpreted with caution.

Due to administrative considerations beyond our control it was not possible to distribute the questionnaire during the winter months. Dry and cold weather is associated with aggravation of skin dryness and eczema of the hands.^{77,78} Recall bias could lead to underestimating the HE prevalence when answering the questions in late spring or early autumn.

The number of mandatory questions was kept low, due to the risk of increased drop-out rates associated with forced response in e-based surveys.^{79,80} In retrospect, it could have been wiser to have made the question on exposure levels for gloves mandatory, as these questions had fewer answers than the questions on hand washing and hand disinfectant frequencies (Table 2). However the difference in 1-year prevalence of HE between the HCW who had and those who had not answered the question on time with non-sterile gloves was small (20.7% and 20.4% respectively), and on the same magnitude as in the whole group of HCW. Thus it does not appear to have been a strong selection of HCW with HE among the respondents to this question.

Conclusions

The major exogenous factors associated with HE were occupational exposures to soap and gloves. HE is a frequent skin disease among HCW with consequences for both the individual worker and for the provided healthcare, especially concerning the adherence to hygiene measures. Proper preventive measures must be based on clinical investigations including patch-testing to establish the causes of HE. To survey the effects of changing work exposures, repeated studies are needed. Furthermore, there is a need for educational programmes directed at prevention and treatment of HE among HCW.^{43,81}

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Table 1 - Background characteristics stratified on hand eczema occurrence

		Total	Hand eczema			
			Never	Not within the past 12 months, but previously		Within the past 12 months
		n	n (%)	n (%)	n (%)	
Gender	female	7846	5031 (64)	1191 (15)	1624 (21)	
	male	1205	811 (67)	148 (12)	246 (20)	
	Total	9051	5842 (65)	1339 (15)	1870 (21)	
Age (years)	18-29	1075	665 (62)	121 (11)	289 (27)	
	30-39	1849	1082 (59)	251 (14)	516 (28)	
	40-49	2148	1399 (65)	304 (14)	445 (21)	
	50-59	2642	1722 (65)	473 (18)	447 (17)	
	60-67	1297	945 (73)	185 (14)	167 (13)	
	Total	9011	5813 (65)	1334 (15)	1864 (21)	
Profession	Assistant nurses	3135	2049 (65)	461 (15)	625 (20)	
	Nurses	4762	3061 (64)	717 (15)	984 (21)	
	Physicians	1154	732 (63)	161 (14)	261 (23)	
	Total	9051	5842 (65)	1339 (15)	1870 (21)	
Weekly working hours	<30 h	834	516 (62)	138 (17)	180 (22)	
	30-39 h	4969	3243 (65)	710 (14)	1016 (20)	
	40-60 h	2941	1875 (64)	448 (15)	618 (21)	
	Total	8744	5634 (64)	1296 (15)	1814 (21)	
Work schedule (predominantly)	Daytime	7898	5115 (65)	1156 (15)	1627 (21)	
	Night time	989	619 (63)	157 (16)	213 (22)	
	Total	8887	5734 (65)	1313 (15)	1840 (21)	
BMI	<30	7681	5050 (66)	1124 (15)	1507 (20)	

	≥30	800	488 (61)	125 (16)	187 (23)
	Total	8481	5538 (65)	1249 (15)	1694 (20)
Tobacco use - daily smoking	No	8035	5259 (66)	1192 (15)	1584 (20)
	Yes	646	408 (63)	85 (13)	153 (24)
	Total	8681	5667 (65)	1277 (15)	1737 (20)
Perceived stress (How often do you feel stressed?)	Never or only a few times per year	1853	1342 (72)	236 (13)	275 (15)
	Sometime every month	2690	1794 (67)	401 (15)	495 (18)
	Sometime every week	1897	1224 (65)	295 (16)	378 (20)
	Some days every week	1500	865 (58)	243 (16)	392 (26)
	Most days of the week	749	442 (59)	101 (14)	206 (28)
	Total	8689	5667 (65)	1276 (15)	1746 (20)
AD	No	6094	4433 (73)	745 (12)	916 (15)
	Yes	1969	876 (45)	416 (21)	677 (34)
	Don't know	710	421 (59)	122 (17)	167 (24)
	Total	8773	5730 (65)	1283 (15)	1760 (20)

n = number; d = day; h = hour; BMI = body mass index; AD = history of atopic dermatitis

Odds ratio for comparison of "never hand eczema" versus "hand eczema during the past year" see Table S2 (see supporting information)

Table 2 - Wet work exposures stratified on hand eczema occurrence

		Total	Hand eczema		
			Never	Not within the past 12 months, but previously	Within the past 12 months
		n	n (%)	n (%)	n (%)
<i>Occupational</i>					
Hand washing with soap at work	≤5/d	1354	906 (67)	194 (14)	254 (19)
	6-10/d	1917	1260 (66)	287 (15)	370 (19)
	11-20/d	3097	1986 (64)	458 (15)	653 (21)
	>20/d	2682	1690 (63)	400 (15)	592 (22)
	Total	9050	5842 (65)	1339 (15)	1869 (21)
Alcoholic hand disinfectant use	0-10/d	427	277 (65)	71 (17)	79 (19)
	11-20/d	951	642 (68)	134 (14)	175 (18)
	21-50/d	3556	2338 (66)	507 (14)	711 (20)
	51-100/d	3321	2077 (63)	518 (16)	726 (22)
	>100/d	732	463 (63)	102 (14)	167 (23)
	Total	8987	5797 (65)	1332 (15)	1858 (21)
Disposable non-sterile gloves - time	<0.5 h/d	901	612 (68)	136 (15)	153 (17)
	0.5-1 h/d	713	489 (69)	102 (14)	122 (17)
	1-2 h/d	1274	833 (65)	200 (16)	241 (19)
	2-3 h/d	1457	928 (64)	203 (14)	326 (22)
	3-5 h/d	1464	869 (59)	256 (17)	339 (23)
	> 5 h/d	483	287 (59)	72 (15)	124 (26)
	Total	6292	4018 (64)	969 (15)	1305 (21)
Disposable non-sterile gloves - number of pairs	≤5/d	1005	675 (67)	158 (16)	172 (17)
	6-10/d	884	574 (65)	126 (14)	184 (21)
	11-20/d	2015	1298 (64)	304 (15)	413 (21)
	21-50/d	2300	1419 (62)	373 (16)	508 (22)
	>50/d	257	144 (56)	42 (16)	71 (28)

	Total	6461	4110 (64)	1003 (16)	1348 (21)
<i>Non-occupational</i>					
Hand washing with soap off work	≤5/d	1999	1340 (67)	283 (14)	376 (19)
	6-10/d	4229	2769 (66)	643 (15)	817 (19)
	11-20/d	2194	1392 (63)	314 (14)	488 (22)
	>20/d	362	234 (65)	47 (13)	81 (22)
	Total	8784	5735 (65)	1287 (15)	1762 (20)
Kitchen work	<30min/d	2229	1507 (68)	321 (14)	401 (18)
	>30 min/d	5812	3709 (64)	867 (15)	1236 (21)
	Total	8041	5216 (65)	1188 (15)	1637 (20)
Cleaning or laundry work	<30min/d	4199	2748 (65)	607 (15)	844 (20)
	>30 min/d	3809	2454 (64)	574 (15)	781 (21)
	Total	8008	5202 (65)	1181 (15)	1625 (20)
Children ≤4 years old at home	No	5755	3839 (67)	816 (14)	1100 (19)
	Yes	1313	810 (62)	168 (13)	335 (26)
	Total	7068	4649 (66)	984 (14)	1435 (20)

n = number ; d = day ; h = hour ; min = minutes

Table 3 - Association between wet work exposures at work and "hand eczema within the past 12 months" versus "no history of hand eczema" among healthcare workers - logistic regression analysis

		Occupational wet work exposure - exposures analysed separately	Occupational wet work exposure - exposures analysed simultaneously n = 5276	Additional adjustment for gender and age n = 5258	Additional adjustment for wet work ^a exposure at home n = 3886	Additional adjustment for lifestyle factors ^b n = 3774	Additional adjustment for history of atopic dermatitis ^c n = 3460
		OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)
Disposable non-sterile gloves - time	Low (<1 h/d)	1	1	1	1	1	1
	Medium (1-3 h/d)	1.29 (1.10 - 1.52)	1.26 (1.06 - 1.49)	1.21 (1.02 - 1.44)	1.15 (0.94 - 1.40)	1.17 (0.95 - 1.43)	1.20 (0.97 - 1.50)
	High (>3 h/d)	1.60 (1.35 - 1.90)	1.56 (1.29 - 1.87)	1.50 (1.24 - 1.81)	1.42 (1.14 - 1.77)	1.42 (1.13 - 1.78)	1.47 (1.14 - 1.88)
Hand washing with soap at work	Low (0-10/d)	1	1	1	1	1	1
	Medium (11-20/d)	1.14 (1.01 - 1.29)	1.13 (0.97 - 1.32)	1.25 (1.06 - 1.46)	1.27 (1.05 - 1.53)	1.28 (1.06 - 1.55)	1.33 (1.08 - 1.64)
	High (>20/d)	1.22 (1.07 - 1.38)	1.03 (0.87 - 1.23)	1.25 (1.05 - 1.50)	1.31 (1.06 - 1.63)	1.30 (1.04 - 1.62)	1.43 (1.12 - 1.83)
Alcoholic hand disinfectant use	Low (0-20/d)	1	1	1	1	1	1
	Medium (21-50/d)	1.10 (0.94 - 1.29)	1.02 (0.82 - 1.28)	0.96 (0.76 - 1.20)	0.95 (0.73 - 1.23)	0.90 (0.69 - 1.18)	0.82 (0.61 - 1.09)
	High (>50/d)	1.27 (1.09 - 1.49)	1.05 (0.84 - 1.32)	0.92 (0.73 - 1.17)	0.95 (0.72 - 1.25)	0.91 (0.68 - 1.21)	0.76 (0.56 - 1.03)

OR = odds ratio ; CI = confidence interval ; h = hour ; d = day

^a) daily number of hand washes at home, kitchen worktime, number of children ≤ 4 years old

^b) body mass index (BMI), daily smoking, stress

^c) OR for all variables in this model is shown in Table S2 (see supporting information)

Figure 1 - Flow chart for inclusion in the present study

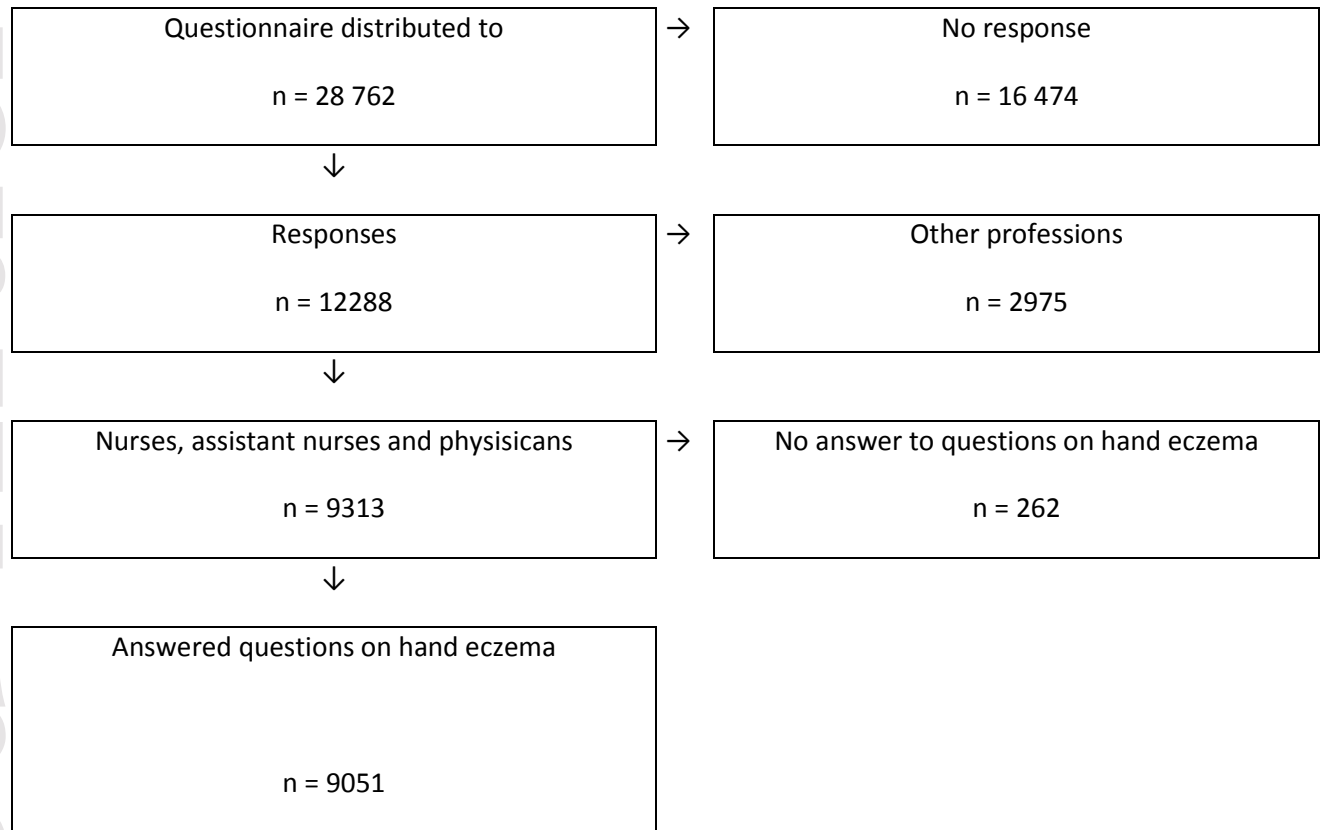


Table S1 - Association between wet work exposures at work and "hand eczema within the past 12 months" versus "no history of hand eczema" among healthcare workers - logistic regression analysis

		Occupational wet work exposure - exposures analysed separately	Occupational wet work exposure - exposures analysed simultaneously n = 5410	Additional adjustment for gender and age n = 5391	Additional adjustment for wet work ^a exposure at home n = 3982	Additional adjustment for lifestyle factors ^b n = 3868	Additional adjustment for history of atopic dermatitis ^c n = 3545
		OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)	OR (95% C.I.)
Disposable non-sterile gloves - number of pairs	Low (≤ 10 /d)	1	1	1	1	1	1
	Medium (11-20/d)	1.12 (0.95-1.31)	1.11 (0.93-1.32)	1.04 (0.88-1.24)	1.09 (0.89-1.33)	1.13 (0.92-1.39)	1.08 (0.86-1.35)
	High (> 20 /d)	1.30 (1.12-1.51)	1.27 (1.05-1.52)	1.17 (0.97-1.41)	1.01 (0.81-1.26)	1.00 (0.80-1.26)	0.99 (0.78-1.27)
Hand washing with soap at work	Low (0-10/d)	1	1	1	1	1	1
	Medium (11-20/d)	1.14 (1.01 - 1.29)	1.16 (1.00-1.36)	1.29 (1.10-1.51)	1.32 (1.10-1.58)	1.33 (1.10-1.60)	1.37 (1.12-1.68)
	High (> 20 /d)	1.22 (1.07 - 1.38)	1.07 (0.90-1.26)	1.30 (1.09-1.55)	1.38 (1.12-1.72)	1.36 (1.09-1.70)	1.51 (1.19-1.93)
Alcoholic hand disinfectant use	Low (0-20/d)	1	1	1	1	1	1
	Medium (21-50/d)	1.10 (0.94 - 1.29)	0.96 (0.77-1.20)	0.91 (0.72-1.13)	0.85 (0.66-1.11)	0.81 (0.62-1.06)	0.75 (0.56-0.99)
	High (> 50 /d)	1.27 (1.09 - 1.49)	0.98 (0.78-1.25)	0.89 (0.70-1.13)	0.90 (0.68-1.20)	0.87 (0.65-1.16)	0.74 (0.54-1.01)

Results are presented as odds ratios (95% confidence interval); d = day; h = hour; OR = odds ratio; CI = confidence interval

^a) daily number of hand washes at home, kitchen worktime, number of children ≤ 4 years old

^b) body mass index (BMI), daily smoking, stress

^c) OR for the variables in this model is shown in Table S2 (see supporting information)

Table S2. Odds ratios for "hand eczema within the past 12 months" compared to "no history of hand eczema" - univariate and multivariate logistic regression.

		univariate OR (95% CI)	p	multivariate OR (95% CI)	p
<i>Background characteristics</i>					
Gender	Males	1	0.82	1	0.86
	Females	1.06 (0.91 - 1.24)		1.02 (0.79 -1.32)	
Age (years)	18 -29	2.46 (1.98 - 3.05)	0.04	1.24 (0.86 -1.79)	0.04
	30 -39	2.70 (2.22 - 3.28)		1.54 (1.09 -2.18)	
	40 -49	1.80 (1.48 - 2.19)		1.09 (0.78 -1.51)	
	50 -59	1.47 (1.21 - 1.79)		1.14 (0.82 -1.59)	
	60 -67	1		1	
Weekly working hours	<30 h	1	0.43	not included	
	30-39 h	0.90 (0.75 - 1.08)			
	40-60 h	0.95 (0.78 - 1.15)			
Work schedule (predominantly)	Daytime	0.92 (0.78 - 1.09)	0.35	not included	
	Night time	1			
BMI	<30	1	0.006	1	0.03
	≥30	1.28 (1.08 - 1.53)		1.35 (1.03 -1.78)	
Tobacco use - smoking	No	1	0.03	1	0.38
	Yes	1.25 (1.03 - 1.51)		1.15 (0.84 -1.57)	
Perceived stress (How often do you feel stressed?)	Never	1	< 0.001	1	< 0.001
	Sometime every month	1.35 (1.14 - 1.59)		1.1 (0.9 -1.5)	
	Sometime every week	1.51 (1.27 - 1.79)		1.4 (1.1 -1.9)	
	Some days every week	2.21 (1.85 - 2.64)		2.0 (1.5 -2.6)	
	Most days of the week	2.27 (1.84 - 2.81)		2.2 (1.6 -3.1)	
Atopic dermatitis	No	1	< 0.001	1	< 0.001
	Yes	3.74 (3.31 - 4.23)		3.47 (2.91 -4.16)	
<i>Occupational wet work exposures</i>					
Hand washing with soap at work			0.01	1	0.01
	Low (0 -10/d)	1			
	Medium (11 -20/d)	1.14 (1.01 - 1.29)		1.33 (1.08 -1.64)	
	High (>20/d)	1.22 (1.07 - 1.38)		1.43 (1.12 -1.83)	
Alcoholic hand disinfectant use	Low (0 -20/d)	1	0.003	1	0.20
	Medium (21 -50/d)	1.10 (0.94 - 1.29)		0.82 (0.61 -1.09)	
	High (>50/d)	1.27 (1.09 - 1.49)		0.76 (0.56 -1.03)	
Disposable non -sterile gloves - time	Low (<1 h/d)	1	< 0.001	1	0.01
	Medium (1 -3 h/d)	1.29 (1.10 - 1.52)		1.20 (0.97 -1.50)	
	High (>3 h/d)	1.60 (1.35 - 1.90)		1.47 (1.14 -1.88)	
Disposable non -sterile gloves - number of pairs			0.002	separate analysis - see Table S2	
	Low (≤10/d)	1			
	Medium (11 -20/d)	1.12 (0.95 -1.31)			
	High (>20/d)	1.30 (1.12 -1.51)			
<i>Non-occupational wet work exposures</i>					
Hand washing with soap off work	Low (0 -10/d)	1	0.005	1	0.47
	Medium (11 -20/d)	1.05 (0.92 -1.21)		0.92 (0.74 -1.15)	
	High (>20/d)	1.25 (1.07 -1.45)		1.04 (0.80 -1.34)	
Kitchen work	<30 min/d	1	0.001	1	0.04
	>30 min/d	1.25 (1.10 - 1.42)		1.22 (1.01 -1.48)	
Cleaning or laundry work	<30 min/d	1	0.53	not included	
	>30 min/d	1.04 (0.93 - 1.16)			
Children ≤4 years old at home	No	1	< 0.001	1	0.17
	Yes	1.44 (1.25 - 1.67)		1.18 (0.93 -1.48)	

n = number of respondents; OR = odds ratio; CI = confidence interval; d = day; h = hour; BMI = body mass index

Exposures and adjustment factors with a p ≤0.30 in univariate analyses were included in the multivariate analysis. Daily number of non-sterile gloves were not included in this model, but were analysed in a separate multivariate model that did not include daily time with non-sterile gloves.

SUPPORTING INFORMATION

Questions providing the data for the present study

Are you:

- a woman
- a man

Year of birth?

At the moment, how many hours per week do you work?
....hours

Do you work mainly

- at day
- at night

Only one alternative can be ticked

What is your profession today?

- | | |
|-------------------|------------------------------------|
| Nurse | Biomedical technician |
| Assistant nurse | Physiotherapist |
| Physician | Occupational therapists |
| Cleaner | Social worker |
| Medical secretary | Other profession - please indicate |

Only one alternative can be ticked

Do you use ~~with~~ disposable gloves at work

- No
- Yes

Do you use non-sterile disposable gloves at work

- No
- Yes

Question shown if the answer was "Yes" on previous question

On average, how long time per day do you use non-sterile disposable gloves?

- More than 5 hours per day
- More than 3 hours per day
- More than 2 hours per day
- More than 1 hour per day
- More than 30 minute per day
- Less than 30 minutes per day

Only one alternative can be ticked

Question shown if the answer was "Yes" on the question on use of non-sterile disposable gloves

On average, how many pairs of non-sterile disposable gloves do you use per day?

- More than 50 per day
- More than 20 per day

- More than 10 per day
- More than 5 per day
- 1-5 per day per day
- Less than 1 per day

Only one alternative can be ticked

Question shown if the answer was “Yes” on the question on use of non-sterile disposable gloves

On average, how often do you wash your hands with soap and water at work?

- More than 20 times per day
- More than 10 times per day
- More than 5 times per day
- 1-5 times per day
- I don't use soap

Only one alternative can be ticked

Does the soap:

- feel good for your hands
- make your hands dry
- sting
- other – please indicate

More than one alternative can be ticked

On average, how often do you use alcoholic hand disinfectant at work?

- More than 100 times per day
- More than 50 times per day
- More than 20 times per day
- More than 10 times per day
- More than 5 times per day
- 1-5 times per day
- I don't use soap

Only one alternative can be ticked

Does the hand disinfectant:

- feel good for your hands
- make your hands dry
- sting
- other – please indicate

More than one alternative can be ticked

Do you use a hand moisturising cream at work?

- No
- Yes – On average how many times per day?

Do you have hand eczema today?

- No
- Yes

Have you had hand eczema on any occasion during the past 12 months?

- No
- Yes

Question shown if the answer was "No" on previous question

Have you had hand eczema on any occasion during the past 5 years?

- No
- Yes

Question shown if the answer was "No" on previous question

Have you in adult life ever had hand eczema on any occasion?

- No
- Yes

Question shown if the answer was "No" on previous question

On average, how often do you wash your hands with soap and water at home after work?

- More than 20 times per day
- More than 10 times per day
- More than 5 times per day
- Up till 5 times per day

Only one alternative can be ticked

How many children aged 0-4 years are there in your household?

.....
,

On average how long time per day do you do cook or do other kitchen work at home?

- More than 2 hours per day
- More than 30 minutes
- Less than 30 minutes

Only one alternative can be ticked

On average how long time per day do you clean or launder at home?

- More than 2 hours per day
- More than 30 minutes
- Less than 30 minutes

Only one alternative can be ticked

How tall are you ?

...cm

How much do you weigh?

...kg

Do you smoke daily?

- No
- Yes

How often do you feel stressed?

By stress we mean a state where you feel tense, restless, nervous, anxious or have trouble concentrating.

- Never or a few times per year
- About once a month
- About 1 day per week
- A couple days per week
- Most days of the week

Only one alternative can be ticked

Have you had childhood eczema?

- No
- Yes
- I don't know

Only one alternative can be ticked