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Prevalence and risk factors for hand eczema among professional hospital cleaners in Denmark: A cross-sectional questionnaire-based study

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Abstract

Background: Professional cleaners are commonly affected by hand eczema (HE) due to wet work and exposure to cleaning products in the work environment.

Objective: To investigate (1) the prevalence of HE in a group of professional hospital cleaners, (2) the association of HE with various comorbidities and self-reported signs/symptoms of skin lesions and (3) the association of HE with various occupational and personal risk factors in the same population.

Methods: A cross-sectional questionnaire-based study including all cleaners working in three hospitals in Denmark. The questionnaire was composed of 35 questions. Prevalence is reported using proportions with 95% confidence intervals and compared using difference of proportions and Fisher's exact test.

Results: A total of 122 out of 180 cleaners (response rate = 68%) participated in this study. The self-reported lifetime prevalence of HE among the cleaners was 30.3%, while the 1-year prevalence was 18.9%. HE was significantly associated with a history of atopic diseases. There was a significant correlation between having HE, and self-reported redness and itch of the hands in the last 12 months, as well as the use of hydrochloric acid ≥4 days/week during the last 12 months. Logistic regression analysis found HE significantly associated with washing hands ≥20 times during a working day and a history of atopic dermatitis.

Conclusion: Cleaners are at an elevated risk of developing HE. More focus on education/information regarding the prevention and treatment of HE is necessary for the cleaning profession. Self-reported redness and itching of the hands may be a useful prediction of HE in cleaners.

KEYWORDS
cleaning, contact allergy, dermatitis, sensitisation

1 | INTRODUCTION

Hand eczema (HE) is an inflammatory skin disorder and the most common occupational skin disease in high-risk workers including hairdressers, healthcare workers, metal workers and professional cleaners.[1] It is associated with a high frequency of medical consultations, sick leave and has socioeconomic and psychosocial consequences.[2–4] Risk factors for developing HE include wet work, having atopic dermatitis (AD), low age at onset of HE, contact allergy, tobacco use and cold/dry weather conditions.[1]

Professional cleaners are at particularly high risk of developing HE with a 1-year prevalence of 8%[5] and a lifetime prevalence of up to 28%[6–15] due to wet work and exposure to cleaning products.[5,16–17] Cleaning products are used extensively in hospitals and may contain preservatives, solvents, fragrances, and other compounds, which may cause irritation or sensitisation.[18] The most common allergies in cleaners are caused by rubber, biocides, nickel/cobalt and perfumes.[5,19–22] Consequences associated with HE in professional cleaners include significant impairment in quality of life, unscheduled absence from work, sick leave and disability.[5–6,11,23–27]

Even though wet work is a well-known risk factor for HE in cleaners, it may be possible that other occupational and personal factors also play a role in the development of HE. These may include the frequency of using protective gloves and specific cleaning products, and the level of information received about the prevention of HE in the workplace. Personal factors may include educational level, knowledge of skin care and skin protection, and the tendency to seek professional help when noticing symptoms of HE. However, knowledge about these risk factors is currently limited.

This study aimed to assess: (1) the prevalence of HE in a group of professional hospital cleaners, (2) the association of HE with various comorbidities and self-reported signs/symptoms of skin lesions and (3) the association of HE with various occupational and personal risk factors in the same population.

2 | METHODS

2.1 | Study population

Hospital cleaners in three Danish hospitals located in different geographical regions (Esbjerg, Odense and Svendborg) were invited to participate in the following questionnaire study, which was undertaken from April to May 2022. Inclusion criteria were professional cleaners ≥18 years old and having sufficient Danish skills. The managers of the various cleaning departments had been involved in planning the study to ensure support and involvement.[28] They were informed about the aims of the study and offered the opportunity to ask questions about the content of the questionnaire to be used.[28] Management representatives were responsible for inviting the cleaners to participate in the study and for distributing the questionnaires.[28] However, they had no influence on the content of the questionnaire.[28] All the cleaners had 5 weeks to complete the questionnaires.[28] If any participant had difficulties understanding the questionnaire, the management representatives were responsible for helping and explaining.[28] Participants were asked to return the questionnaire anonymously in a closed envelope. This study did not require any permission from the Regional Ethics Committee for the Region of Southern Denmark.

2.2 | Materials and methods

The questionnaire comprised a total of 35 questions covering the following: demographic information (5 questions), personal risk factors concerning HE (6 questions), occupational information and risk factors (6 questions), previous and current HE (3 questions), previous and current comorbidities (4 questions), knowledge of skin care and treatment of HE (10 questions), and self-evaluation of knowledge about skin care and protection (1 question). Questions about previous treatment and/or receiving information on the prevention and treatment of HE in the workplace were also included.

The questionnaire was pilot tested on 15 professional cleaners at Roskilde Hospital.[28] They were asked what they thought each question meant. If a question was not understood, the intended meaning was explained. Following this, the cleaners were asked how the question could be improved.[28] One question regarding gender was redefined (including more answer options) based on feedback.

Some questions from the Nordic Occupational Skin Questionnaire-2022 (NOSQ 2002) were used in the questionnaire.[29] These included questions about the presence and onset of HE as well as doctor visits due to HE (questions; D1, D5, D6 and D10).[29] Comorbidities, with respect to HE, were investigated using questions A2, A3, A4 and S5b, and symptoms and signs of HE were investigated using questions S1 and S2, from the same source.[29] Occupational risk factors for HE included the number of years working as a professional cleaner, and this was investigated using question G5, again from NOSQ 2002.[29]

In addition, the participants were asked about how often they used protective gloves in the last 12 months through a four-step scale. The options were: (1) <1 day/week, (2) between 1 and 3 days/week, (3) ≥4 days/week and (4) never. The participants were also asked how often they had used different cleaning products in the last 12 months by using a question, previously used in another study investigating HE in professional cleaners.[30] The options were: (1) <1 day/week, (2) 1–3 days/week, (3) ≥4 days/week, (4) never and (5) I do not know. The frequency of handwashing during a typical workday was investigated using question E8 from NOSQ 2002.[29] The options were: (1) 0–5 times per day, (2) 6–10 times per day, (3) 11–20 times per day and (4) more than 20 times per day. Questions F1 and F4 from the same source were used to investigate whether contact with certain materials at work made their eczema worse and if there was improvement during time off work.[29] The options for question F1 were: (1) no, (2) yes and (3) do not know. The options for question F4 were: (1) no, (2) yes, sometimes, (3) yes, usually and (4) do not know.

Cleaners' level of education was explored through a four-step scale, where the participants had to mark the highest educational level reached.[28] The options were: (1) no education at all, (2) elementary school, (3) vocational education and (4) higher education.[28] The demographic information included: (1) being born or raised in Denmark and (2) being born or raised outside of Denmark.[28] Those raised outside of Denmark were asked about their previous participation in Danish language courses with the following options: (1) Danish lessons level 1, (2) Danish lessons level 2, (3) Danish lesions level 3 (advanced), and (4) no Danish lessons.[28,31]

Knowledge of skin care and protection was explored through 10 multiple-choice questions based on previously validated recommendations.[32,33] These questions were used in a previous study.[33] Each question was explored with two to four statements for which participants had to mark one correct answer.

The following questions were used to ask the participants what they do to protect themselves from developing HE: Do you (1) use protective gloves all the time during the day, (2) use protective gloves when necessary, but for as short a time as possible, (3) avoid using protective gloves and (4) avoid hand moisturisers. The options were: (1) yes and (2) no. Self-evaluated knowledge of skin care and protection was measured on a scale from 0 to 10[28]; (0 = no knowledge, 10 = sufficient knowledge).

2.3 | Analysis

The characteristics of cleaners with and without HE were compared with respect to the different categorical outcomes using the difference between proportions with exact 95% confidence intervals (CIs) and Fisher's exact test for categorical data. Differences were defined as significant at $p < 0.05$. Multiple logistic regression was used to evaluate the adjusted effect of covariates selected among those found to be significant in the bivariate analyses. For these multivariate analyses, multiple imputation was used to account for missing covariate data. Knowledge was divided into three levels; high knowledge (9–10 correct answers), intermediate knowledge (5–8 correct answers) and low knowledge (0–4 correct answers); coding questions with no answer or more than one answer as incorrect. Self-evaluated knowledge was categorised as high (score 9–10), intermediate (score 5–8) or low (score 0–4). Analyses were done using SAS 9.4.

3 | RESULTS

3.1 | Study population and the prevalence of HE

One hundred eighty professional cleaners were invited to participate in the study. Of these, 122 (response rate = 68%) participated. Eighty-five per cent ($n = 104$) were female and 15% ($n = 18$) were male. 30.3% ($n = 37$) reported having, or having had HE, of whom 16% ($n = 6$) reported having HE currently and 19% ($n = 7$) reported having had HE in the last 12 months. Seventy-six per cent ($n = 28$) of those reporting HE claimed it to be work-related. The mean age of the participants with HE was 47.4 (years) ± 6.1 (standard deviation), while it was 44.8 ± 11.0 years in participants without HE. The majority of the participants were either born or raised in Denmark (88%, $n = 107$). Most of the non-Danish cleaners reported having received Danish language lessons at level two (86.6%, n = 13), which indicates they had an intermediate level of language skills. The majority of the study population reported either elementary school (42%, $n = 51$) or vocational education as their highest educational level (38%, $n = 46$). Most of the participants had worked either ≥10 years (49%, $n = 60$) or between 1 and 4 years (23%, $n = 28$; Table 1).

3.2 | The association of HE with various risk factors, comorbidities and self-reported signs/symptoms of skin lesions

The majority of the cleaners reported washing hands ≥20 times during a usual working day (57%, $n = 69$). Thirty-three per cent ($n = 26$) reported having previously received information about the prevention of HE in the workplace. (Table 1). Thirty-one per cent ($n = 29$) had previously received information about the treatment of HE in the workplace. Based on the total correct number of answers regarding knowledge of HE, 69% ($n = 83$) had an 'intermediate knowledge', 22% ($n = 27$) 'high knowledge' and 9% ($n = 11$) 'low knowledge'. Based on self-evaluated knowledge, 54% ($n = 66$) were categorised as having 'low knowledge', 43% ($n = 52$) 'intermediate knowledge' and 3% ($n = 4$) 'high knowledge'. The prevalence of HE differed significantly depending on the number of years working as a professional cleaner. Specifically, the prevalence was 43 percentage points higher among those working as a professional cleaner ≥10 years, compared to those working between 1 and 4 years. In addition, the prevalence was significantly 47 percentage points higher among those with washing hands ≥20 times a day, compared to those with washing hands <20 times a day. Discussing receiving information, the prevalence of HE was significantly 43 percentage points higher among those, who had previously received information about the prevention and 50 percentage points higher among those, who had previously received information about the treatment of HE compared to those, who had not received any. The prevalence of HE was significantly 29 percentage points higher among those with high level of knowledge compared to the reference group (Table 1).

Regarding comorbidities, a history of AD and asthma were all significantly associated with a higher prevalence of HE (AD: $p < 0.0001$; asthma; $p < 0.0015$). A history of rash from metal objects next to the skin was also significantly associated with a higher prevalence of HE ($p < 0.0006$; Table 2).

Six covariates (number of years working as a professional cleaner, number of handwashing during a working day, having previously received education/information about prevention of HE, having previously received education/information about the treatment of HE, level of knowledge of skin care and protection and history of AD) were included as covariates together with gender and age group in a multiple logistic regression model.

TABLE 1 Participants' characteristics and corresponding number of those with and without hand eczema (HE).

Variable	Total, *n*	*n* (%)	HE, *n* (%)	Difference (95% confidence interval, CI)[a]	*p* Value[b]
Demographic characteristics					0.27
Sex	122				
Male		18 (15%)	3 (17%)	−16% (−35% to 3%)	
Female		104 (85%)	34 (33%)	Ref.	
Age groups (years)	122				0.08
Under 20–35 years old		23 (19%)	3 (13%)	−18% (−34% to 5%)	
36–50 years old		34 (28%)	14 (41%)	10% (−9% to 31%)	
Over 50 years old		65 (53%)	20 (31%)	Ref.	
Country of birth	122				0.55
Born or raised in Denmark		107 (88%)	34 (32%)	12% (−18% to 30%)	
Born or raised outside of Denmark		15 (12.3)	3 (20%)	Ref.	
Receiving lessons in the Danish language at a public language school	122				0.89
I am Danish and have not received Danish language lessons at a public language school		105 (86%)	34 (32%)	Ref.	
I have received Danish lessons at level 1		1 (1%)	0 (0%)	−32% (−49% to 63%)	
I have received Danish lessons at level 2		13 (11%)	3 (23%)	−9% (−23% to 29%)	
I have received Danish lessons at level 3		1 (1%)	0 (0%)	−32% (−49% to 63%)	
I have not received any Danish language lessons before		2 (1%)	0 (0%)	−32% (−47% to 50%)	
Educational background	122				0.60
Elementary school		51 (42%)	16 (31%)	Ref.	
Vocational education		46 (38%)	15 (33%)	1% (−18% to 21%)	
Higher education		20 (16%)	6 (30%)	−1% (−24% to 24%)	
Non-education		5 (4%)	0 (0%)	−31% (−48% to 23%)	
Years working as a professional cleaner	122				**0.0002**
<1 year		13 (11%)	3 (23%)	−24% (−46% to 10%)	
1–4 years		28 (23%)	1 (4%)	−43% (−57% to −24%)	
5–9 years		21 (17%)	5 (24%)	−23% (−43% to 4%)	
≥10 years		60 (49%)	28 (47%)	Ref.	
Number of times of washing hands during a usual working day	122				**<0.0001**
<20 times/day		53 (43%)	2 (4%)	−47% (−60% to −33%)	
≥20 times/day		69 (57%)	35 (51%)	Ref.	
Receiving information about the prevention of HE before	80				**0.0002**
I have previously received this information		26 (33%)	16 (62%)	−43% (18.5)	
I have not previously received this information		54 (68%)	10 (19%)	Ref.	
Receiving information about the treatment of HE before	94				**<0.0001**
I have previously received this information		29 (31%)	19 (66%)	−50% (−68% to −28%)	
I have not previously received this information		65 (69%)	10 (16%)	Ref.	
Knowledge of skin care and protection based on 10 multiple-choice questions	121				**0.0174**
Low knowledge		11 (9%)	3 (27%)	4% (−19% to 39%)	
Intermediate knowledge		83 (69%)	19 (23%)	Ref.	
High knowledge		27 (22%)	14 (52%)	−29% (−50% to −8%)	
The self-confidence of knowledge: On a scale of 1–10, how much information do you know about HE?	122				0.33
Low knowledge		66 (54%)	17 (26%)	Ref.	

TABLE 1 (Continued)

Variable	Total, *n*	*n* (%)	HE, *n* (%)	Difference (95% confidence interval, CI)[a]	*p* Value[b]
Intermediate knowledge		52 (43%)	18 (35%)	−9% (−26% to 8%)	
High knowledge		4 (3%)	2 (50%)	24% (−18% to 66%)	

Note: significant *p* values are shown in bold.
[a]Exact CIs reported.
[b]Fisher's exact test reported.

TABLE 2 Health characteristics and corresponding number of those with and without hand eczema (HE).

Variable	Total, *n*	*n* (%)	HE, *n* (%)	Difference (95% confidence interval, CI)[a]	*p* Value[b]
History of atopic dermatitis	105				**<0.0001**
Yes		35 (33%)	25 (71%)	60% (40%–75%)	
No		70 (67%)	8 (11%)	Ref.	
History of 'hay fever' or other symptoms of nasal allergy	119				0.10
Yes		44 (37%)	17 (39%)	15% (−3% to 32%)	
No		75 (63%)	18 (24%)	Ref.	
History of allergy symptoms from eyes	118				0.14
Yes		43 (36%)	16 (37%)	13% (−5% to 31%)	
No		75 (64%)	18 (24%)	Ref.	
History of asthma	118				**0.0015**
Yes		24 (20%)	13 (54%)	30% (3%–51%)	
No		94 (80%)	23 (24%)	Ref.	
History of rash from metal objects next to skin	122				**0.0006**
Yes		50 (41%)	24 (48%)	30% (12%–46%)	
No		72 (59%)	13 (18%)	Ref.	

Note: Significant *p* values are shown in bold.
[a]Exact CIs reported.
[b]Fisher's exact test reported.

The logistic regression analysis showed that cleaners who washed their hands <20 times/day had a significantly lower risk of having HE compared to those with washing hands ≥20 times/day, and significantly more of them with HE had a history of AD compared with those without HE (adjusted odd ratio [OR] for washing hands: 0.05, 95% CI: 0.01–0.49; for AD [OR]: 43.5, 95% CI: 1.6–1219; Table 3).

Among those with a history of HE, 16% ($n = 6$) reported current HE, 19% ($n = 7$) reported having had HE in the last 12 months, 30% ($n = 11$) reported having had HE for more than 5 years ago and 35% ($n = 13$) reported having had HE between 1 and 5 years ago (Table 4). The majority reported onset of HE as an adult (76%, $n = 28$). Sixty per cent ($n = 22$) had not visited a doctor due to HE, whereas 41% ($n = 15$) reported having done so. Thirty-two per cent ($n = 12$) reported that contact with certain materials or chemicals in their work made their eczema worse, and 54% ($n = 19$) reported improvement in HE when away from work. In total, 22% ($n = 8$) of the cleaners with HE did not remember whether or not they had previously received treatment for HE, 38% ($n = 14$) had not received any treatment and 41% ($n = 15$) had received treatment for their HE (Table 4). Regarding skin signs and symptoms, having redness and itching were significantly associated with a higher prevalence of HE in the past 12 months (redness: $p < 0.02$; itching: $p < 0.03$; Table S1).

Regarding specific cleaning products, the use of hydrochloric acid ≥4 days/week was significantly associated with a higher prevalence of HE ($p < 0.0001$) (Table S2). Protective glove use <1 day/week was reported by 9.9% ($n = 12$) of the study population, whereas 10.7% ($n = 13$) reported using them between 1 and 3 days/week, and 79.4% ($n = 96$) reported using them ≥4 days/week. Most cleaners reported using protective gloves ≥4 days/week (84.6% of cleaners with HE and 78.7% of cleaners without HE). No statistically significant difference in the frequency of using protective gloves was found between the groups (Table S3).

3.3 | Behaviour to prevent HE

The results of the questions assessing the self-reported protective behaviour are presented in Table S4. Significantly more cleaners with HE ($n = 31$, 86.1%) than without HE ($n = 52$, 61.2%) claimed that

TABLE 3 Multivariate analysis comparing those with hand eczema (HE) to those without.

Variable	Adjusted OR (95% CI)[a]
Years working as a professional cleaner	
<1 year	0.36 (0.01–18.4)
1–4 years	0.05 (0.00–1.00)
5–9 years	0.05 (0.00–1.98)
≥10 years	Ref.
Number of times of washing hands during a usual working day	
<20 times/day	**0.05 (0.01–0.49)**
≥20 times/day	Ref.
Receiving information about the prevention of HE before	
I have previously received this information	2.52 (0.26–24.2)
I have not previously received this information	Ref.
Receiving information about the treatment of HE before	
I have previously received this information	2.35 (0.26–29.3)
I have not previously received this information	Ref.
Knowledge of skin care and protection based on 10 multiple-choice questions	
Low knowledge	11.0 (0.13–29.3)
Intermediate knowledge	Ref.
High knowledge	6.77 (0.87–52.8)
History of atopic dermatitis	
Yes	**43.5 (1.6–1219)**
No	Ref.

Note: Significant effects are shown in bold.
Abbreviations: CI, confidence interval; OR, odds ratio.
[a]Adjusted for gender, age group, number of years working as a professional cleaner, daily number of hand washing, having previously received information about the prevention and the treatment of HE, knowledge of skincare, and history of atopic dermatitis.

TABLE 4 Characteristics of cleaners with hand eczema ($n = 37$).

Variable	*n* (%)
When did you last have eczema on your hands?	
I have it just know	6 (16%)
In the last 12 months	7 (19%)
Between 1 and 5 years ago	13 (35%)
More than 5 years ago	11 (30%)
When did you first get eczema on your hands?	
Between 6 and 14 years of age	4 (11%)
Between 15 and 18 years of age	5 (14%)
Above 18 years of age	28 (76%)
Have you visited a doctor as an adult for your hand eczema?	
Yes	15 (41%)
No	22 (60%)
Have you noticed that contact with certain materials, chemicals or anything else in your work makes your eczema worse?	
Yes	12 (32%)
No	25 (68%)
Does your eczema improve when you are away from your regular work?	
Yes, sometimes/usually	19 (54%)
No	8 (22%)
Do not know	10 (27%)
Receiving treatment for hand eczema before	
I have previously received treatment before	15 (41%)
I have not previously received any treatment	14 (38%)
I do not remember	8 (22%)

they protect themselves from developing HE by avoiding the use of hand moisturisers ($p < 0.009$).

4 | DISCUSSION

The present study indicates that professional cleaners are at elevated risk of HE, with a self-reported lifetime prevalence of 30.3% and a self-reported 1-year prevalence of 18.9% compared with the background population with a lifetime prevalence of 14.5% and 1-year prevalence of 9.1%.[34] In a Turkish study including 236 hospital cleaners, the clinically determined point prevalence of HE was estimated to be 21.6%.[11] This was done by clinical examination by a dermatologist of those, who were prediagnosed with dermatitis based on a questionnaire, and also by using the Mathias criteria. The Mathias Criteria are seven objective criteria designed to establish probable occupational causation of HE.[11,35] In our study, the point prevalence of HE was 16.2%, determined by using a previously validated question from NOSQ 2002, and no clinical examination of the participants. In addition, in our study, the cause of HE (whether it was work-related or not) was based on the participants' own beliefs. In another study from New Zealand, including 425 cleaners, the self-reported lifetime prevalence of HE was estimated to be 25.2% and the self-reported 1-year prevalence to be 18.1%.[36] This is consistent with our study using the question from NOSQ 2002. However, the study population in the New Zealand study included cleaners from a variety of workplaces (hospitals, tertiary education institutions and commercial buildings),[36] which may involve different cleaning tasks and cleaning products. There may also have been behavioural differences between the cleaners. In a study from Spain investigating the same topic, the self-reported 1-year prevalence of HE was estimated to be 28% among 693 cleaners[30] and the diagnosis was based on HE symptoms and itch in the last 12 months. The study population included employees of 37 cleaning companies with different cleaning tasks compared to those of hospital cleaners.[30] Finally, in the study from Denmark, which included 86 hospital cleaners in 2015, the

self-reported point prevalence of HE was 11% and the self-reported lifetime prevalence was 12%.[37] However, the diagnosis of HE in this study was based on the question 'have you, or have you previously had HE'.[37] Our study was conducted just after the COVID-19 pandemic. The pandemic might initially have increased the frequency of handwashing, and the use of alcohol-based hand rubs and gloves. However, the 1-year prevalence of HE in our study had increased only to a limited extent compared to the study from New Zealand (defining HE based on the same question from NOSQ 2002). This might reflect the efficacy of hand hygiene recommendations given by the Danish health authorities during the pandemic, which subsequently has caused more awareness among professional cleaners at hospitals. Compared to the Danish study from 2015, the higher point prevalence and lifetime prevalence of HE in our study might be due to the differences in the prevention measures at the workplace, as well as the universal availability of personal protective equipment across the different geographic regions in Denmark.

In our study, HE was associated with handwashing ≥20 times/day, working as a professional cleaner ≥10 years, the possession of previously received information about the prevention and treatment of HE, as well as a high level of knowledge in skin care and protection, and a history of atopic diseases. However, when the effect of these confounding factors was removed in the logistic regression analysis, the risk of HE was higher only among those, who washed their hands ≥20 times/day and had a history of AD. Thus, the duration and frequency of wet work exposure are still the most validated risk factors for the development of HE which is consistent with previous studies.[3,36,38,39] Regarding AD, our findings are consistent with previous studies.[1,40] In accordance, up to one fourth of subjects with moderate-to-severe AD in childhood will develop HE to varying degrees in adult life.[41] Our results underline that subjects with atopic comorbidities should be advised not to perform wet work such as cleaning due to their increased risk of developing HE. In addition, health education and training in skin care and protection should be offered to those who nonetheless perform wet work. This primary intervention would also empower taking responsibility for one's own health.[1]

In the present study, HE was significantly associated with a history of rash from metal objects next to the skin. Red skin and symptoms of itch were also significantly associated with HE. This is consistent with clinical practice. In the Spanish study,[30] redness and fissures on the hands were the most prevalent signs reported by 20% ($n = 136$) of the cleaning workers. However, it was not investigated whether or not these signs were significantly more frequent in the cleaners with HE compared to those without. In a recent Danish study from 2022, including 795 healthcare workers, the correlation between self-reported signs/symptoms of skin lesions and self-reported HE was investigated.[42] The highest sensitivity and specificity were found for redness and itch, both separately and combined, and the study concluded that the combination of ≥2 signs (redness, scaling, fissures and vesicles) and symptom of itch reached a sensitivity of 52.7% and specificity of 93.9%.[42] The disparity between self-reported HE, and HE diagnosed based on self-reported signs and symptoms highlights the differences in the data, when discussing the prevalence of HE. In our study, many of the subjects in the dichotomised group without HE also reported signs and symptoms of HE, possibly suggesting that the real prevalence of HE might be higher, when asking about signs and symptoms.

Using protective gloves in order to reduce the risk of exposure to both the substances being cleaned and the cleaning products themselves is important. In our study, the majority of all cleaners, regardless of having HE used gloves ≥4 days/week. However (it should be noted that), the participants were only asked about using protective gloves and not cotton gloves, which is also important and recommended to be worn underneath, when protective gloves are used for more than 10 min.[1]

Regarding specific cleaning products, the highest prevalence of HE was observed among those who reported the use of hydrochloric acid ≥4 days/week. However, any conclusions about this should be viewed with caution. Firstly, this finding is concluded from questionnaire-based studies, where there is a risk of selection bias as well as recall bias. Secondly, it might be possible that some cleaners do not have knowledge about the ingredient of cleaning products but only know the product names. In this case, there is a risk of the cleaners not identifying the cleaning products correctly, which would have an impact on the validity of this outcome.

A significant correlation between HE and having previously received information about the prevention of HE as well as a related high level of knowledge in skin care and protection was found. However, the association did not persist in the logistic regression analysis. Among those with HE, only 62% reported previous information about the prevention of HE, and 66% reported having received treatment for HE. Among those with HE who had previously received information about prevention, the majority had either an intermediate (56.2%, $n = 9$) or high level of knowledge (31.2%, $n = 5$). The rest had a low level of knowledge (12.5%, $n = 2$). Based on our previous study,[28] including 142 participants, Danish hospital cleaners have a low degree of knowledge regarding skin care and protection, and workers who grew up outside of Denmark are in need of special attention.[28] This low degree of knowledge in this occupational group may lead to inadequate skin protection behaviour and thus, to a higher risk of developing HE. In the present study, being born or raised outside of Denmark was not associated with HE. A possible reason for this could be that almost 90% ($n = 107$) of the participants were born or raised in Denmark, and only a small number of workers with non-Danish backgrounds were included. Another reason could be that the risk of developing HE is often the result of multiple factors, rather than being attributable to a single cause. Based on findings from the present study, it is possible that there is a place for an improvement in education/information about the prevention of HE currently offered to the cleaners. This is because the majority were found to have only an intermediate level of knowledge despite having previously received information.

Notably, significantly more cleaners with HE than those without claimed not to use moisturisers to protect themselves from developing HE ($p < 0.009$). This is a matter of concern since using hand

moisturisers is an important part of the prevention and treatment of HE. It might be possible that this opinion is due to concerns about possible fragrances in hand moisturisers. However, this question addressed the general use of hand moisturiser. In our experience, discussing HE with cleaners is an opportunity to encourage them to use hand moisturisers and change their behaviour.

4.1 | Strength and limitations

Our study has some limitations. The diagnosis of HE was self-reported and not confirmed by a clinical assessment, and therefore misclassifications may have occurred. However, the NOSQ 2002 questionnaire is used extensively and is well-validated for HE. Nonetheless, some of our results might be affected by recall bias. It is possible that discrepancies in behavioural might be observed, when comparing the results of questionnaire-based with observational-based studies. Our results may also be affected by the healthy worker survivor effect. If subjects who are susceptible to HE or who have a history of HE, leave their cleaning jobs, then our study may have excluded those with severe cleaning-related HE. Selection bias is also important to mention. Both the exposure and outcome are assessed at the same point in time in our study, which might result in limitations when discussing causal inference. A further limitation of our study is the small overall sample size, and particularly the limited number of subjects with HE during the last 12 months. This might affect the results when discussing the symptoms of HE, and the frequency of using cleaning products as well as protective gloves. This limitation is also relevant when discussing the significance of the logistic regression model, where an unequal distribution of the participants in groups based on different characteristics might be noticed.

In conclusion, the results from the present study show that professional cleaners are at elevated risk of developing HE compared to the background population. Wet work and a previous history of AD are still the major risk factors, associated with HE in cleaners. More focus on education/information regarding the prevention and treatment of HE is necessary for the cleaning profession, since the prevalence of HE is high and the knowledge of skin protection is insufficient. We also suggest including self-reported signs/symptoms of HE (redness and itch) in future questionnaire studies investigating the prevalence of HE since self-reported HE might otherwise be underestimated.

AUTHOR CONTRIBUTIONS

Farnam Barati Sedeh: Investigation; conceptualization; writing – original draft; methodology; validation; writing – review and editing; formal analysis; software; project administration. **Thórunn Elísabet Michaelsdóttir:** Investigation; writing – original draft; methodology; validation; writing – review and editing. **Karl Bang Christiensen:** Writing – original draft; methodology; supervision. **Ole Steen Mortensen:** Conceptualization; investigation; writing – original draft; methodology; writing – review and editing; supervision. **Gregor Borut Ernst Jemec:** Supervision; writing – original draft. **Kristina Sophie Ibler:** Conceptualization; investigation; writing – original draft; supervision.

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CONFLICT OF INTEREST STATEMENT

Dr Gregor Borut Ernst Jemec reported receiving grants from AbbVie, LEO Foundation, Afyx, InflaRx, Janssen-Cilag, Novartis, UCB, CSL Behring, Regeneron, Sanofi, Boehringer Ingelheim, Union Therapeutics and Toosonix and personal fees from Coloplast, Chemocentryx, LEO Pharma, Incyte, Kymera and VielaBio. Dr Kristina Sophie Ibler has been part of advisory boards and received personal fees from Astra Zeneca, Leo Pharma, Sanofi Genzyme and Eli Lilly. Drs Gregor Borut Ernst Jemec and Kristina Sophie Ibler declare that none of the mentioned conflicts of interest had any influence on the content of this manuscript. The rest of the authors do not have any competing interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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