

Prevalence of and work-related risk factors for hand eczema in a Norwegian general population (The HUNT Study)

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Summary

Background. Chemical exposures at work and at home may cause hand eczema. However, this has been scarcely described for Norway.

Objectives. To investigate the prevalence of, and occupational risk factors for, hand eczema in Norway.

Methods. Among 50 805 respondents (aged ≥ 20 years) to the third Nord-Trøndelag Health Study (HUNT3), 5757 persons reported ever having hand eczema, and 4206 answered a hand eczema questionnaire.

Results. The lifetime prevalences of hand eczema were 8.4% in men and 13.8% in women ($p < 0.001$), with onset at age ≤ 10 years in 24% (men) and 20% (women), and onset at age ≥ 30 years in 37% (men) and 25% (women) ($p < 0.001$). Work-related hand eczema affected 4.8% of the population, and was most frequently associated with health/social work (29%) and occupational cleaning (20%) in women, and with farming (26%) and industrial occupations (27%) in men. Cleaning detergents (75%) and other chemicals (36%) were the most common exacerbating factors.

Conclusions. The prevalence of hand eczema was 11.3%, and that of work-related hand eczema was 4.8%. Hand eczema was more common in women than in men, but with a later onset in men. Cleaning detergents were the most common aggravating factors. A large proportion of the Nord-Trøndelag population is employed in farming, providing the possibility to identify farming as an important risk factor for hand eczema.

Key words: atopic dermatitis; epidemiology; hand eczema; HUNT; occupational.

Hand eczema (HE) is a common dermatological disorder, and the most common work-related skin disease. Eczema located on the hands has important consequences for individual health, quality of life, and work, as well as for

health services and costs. HE can affect all age groups. The highest incidence has been found in early adulthood (1, 2). HE can be mild to severe, and often has a chronic or relapsing course (1, 3), potentially causing a reduction in life quality similar to that caused by generalized eczema (3), psoriasis, and asthma (4), and severe cases may have a profound impact on quality of life. Current research has shown that the association between HE and psychosocial problems in adult patients is much stronger than previously thought (5, 6).

Knowledge of the prevalence and risk factors for HE and, specifically, occupational HE in Norway is sparse. Previous studies dating from 2008 reported a prevalence

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of 8.2% in an adult Norwegian population, without information on sex differences or occupation (7), whereas, in a study from northern Norway, the self-reported cumulative incidence of HE was 13.6% (8), and was 6.5% in children aged 7–12 years (1995) (9). A review from 2010, mainly on data from Scandinavian countries, reported a lifetime prevalence of 15% (10).

Both endogenous and exogenous risk factors for HE have been reported, and eczema on the hands is often a result of the interplay between these. Childhood eczema is an important endogenous risk factor, and exposure to irritants, including wet work, and contact allergy are exogenous factors of significance (1, 3). HE is considered to be more common in women, probably because of exposures differing from those of men (10). In recent years, there has been an increased focus on the associations between lifestyle factors such as smoking and obesity and HE (7, 10, 11).

Regarding occupational risk factors for HE, most previous studies have focused on specific occupations. In a report published by the Norwegian Ministry of Labour in 2011, it was noted that the number of skin-irritating chemicals used in occupational settings were increasing more than that of other types of chemical, and that, overall, 9% of all employees reported being continuously exposed to skin-irritating compounds (12). A Norwegian study of occupational factors in a general population reported predictors of unspecific skin problems to be dry indoor air, water, and cleaning products (13). From international studies, it is known that cleaners have a higher prevalence of asthma and eczema than individuals who are not exposed to cleaning agents (14, 15).

The aim of this study was to investigate the prevalence of HE in a Norwegian population, the Nord-Trøndelag Health Study (HUNT), and to assess occupational risk factors associated with late onset of HE.

Methods

HUNT is a large population-based cross-sectional study that invited all citizens of the county of Nord-Trøndelag aged ≥ 20 years to participate in three surveys: HUNT1 (1984–1986), HUNT2 (1995–1997), and HUNT3 (2006–2008) (16). All Nord-Trøndelag citizens were invited for phases 2 and 3, regardless of whether they had participated in previous surveys. Nord-Trøndelag is one of 19 Norwegian counties, and is geographically situated in the central part of the country. The participants were invited to answer questionnaires, participate in interviews, and take part in clinical examinations (17). This article is based on information from questionnaire data and height and weight measurements in HUNT3.

A total of 50 805 adults participated in HUNT3 in the period October 2006 to June 2008. A questionnaire (Q1) was filled in at home before the respondents attended the basic health examination, and further questionnaires (Q2 and Q3) were given to participants following a health examination. Participants who gave an affirmative answer to a question on HE in Q1, namely 'Have you ever had or do you have eczema on the hands?', were identified as being eligible for a specific questionnaire on HE. In total, 5748 participants (3823 women and 1925 men) were invited to fill in an HE questionnaire (Fig. 1). Persons were not included if they were selected for more than two high-priority conditional questionnaires (diabetes, cardiovascular disease, and cancer) (17), as the number of Q3 questionnaires was limited to three. Four thousand two hundred and six participants responded to the HE questionnaire, including 2880 (75.3%) women and 1326 (68.9%) men (Fig. 1). Almost three-quarters of the individuals who received the questionnaire responded. The characteristics of responders and non-responders are shown in Table S1. Body mass index (BMI) was calculated

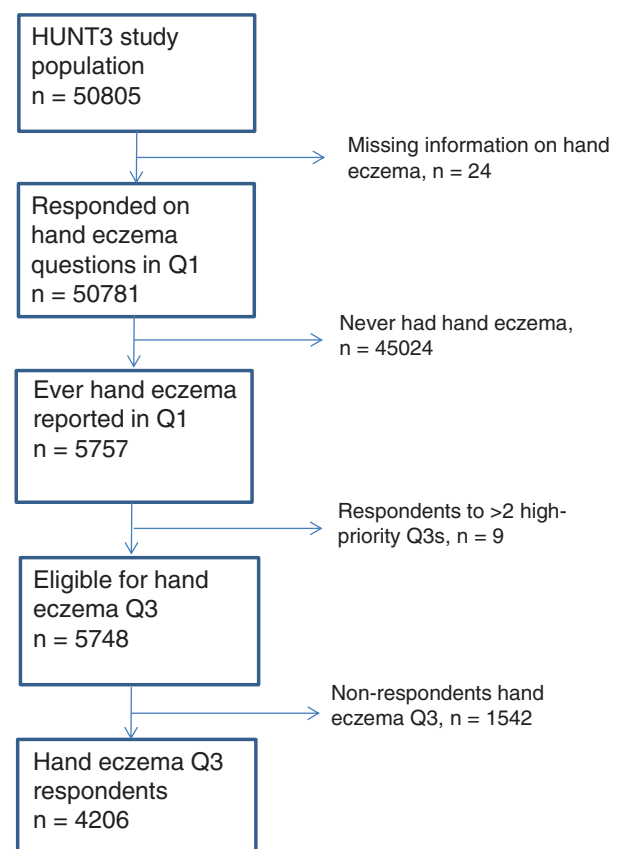


Fig. 1. Flow diagram for HUNT3 participants included in the study population.

from measured weight and height, as weight in kilograms per squared height in metres, and categorized according to the World Health Organization BMI classification (18).

Participants in HUNT have given written informed consent for data collection and storage, linkage to registries, and analyses. This project has been approved by the Regional Medical Ethics Committee (2014/1497/REK Midt).

Descriptive statistics for the study population were reported as mean or median and range for continuous variables, and count and percentages for categorical variables. Statistical differences between groups were calculated with the *t*-test (continuous variables) or the Chi² test (categorical variables). The associations between potential risk factors (reported in Q1 by the total HUNT3 population) for HE – sex, respiratory and allergic diseases, BMI, and smoking – were assessed by multiple Poisson regression analysis. STATA (StataCorp, College Station, TX, USA) version IC 14.0 was used for all analyses.

Results

Persons reporting HE in HUNT3 were more often women and current smokers, and more often reported a history of atopic disease or a parental history of atopic disease (all $p < 0.001$) (Table 1). The cumulative self-reported prevalence of HE was 11.3%, with 8.4% in men and 13.8% in women ($p < 0.001$). The corresponding figures for point prevalence were 2.7% in men and 4.0% in women.

Among the 4206 persons who answered the specific questionnaire on HE, the median ages at first onset of HE were 21 and 25 years in women and men, respectively (Table 2). Overall, 21% reported onset of HE before the age of 11 years. In women, the age of onset of HE peaked in adolescence (10–20 years) and early adulthood (20–30 years), and decreased with age (Fig. 2). In contrast, the age of onset of HE in men peaked in childhood (≤ 10 years) and after 30 years of age (Table 2); 36.7% had onset after the age of 30 years as compared with 25.1% of the women ($p < 0.001$). Among persons with onset of HE before or at age 10 years, 42% had current HE in adulthood at the time when they filled in the questionnaire (Table 2). Non-responders were more likely to be men, current smokers, and unemployed (Table S1).

Non-occupational risk factors for HE

Thirty-one per cent of the persons who answered the HE questionnaire reported having had childhood (atopic) eczema (Table 2). Among the responders to the HE questionnaire, more women than men reported current smoking, and the men with HE were more likely to be

overweight (BMI of ≥ 25 ; 50.6%) or obese (BMI of ≥ 30 ; 25.3%), whereas the majority of the women with HE were in the BMI group 18 to < 25 (normal weight) (36.9%) or in the overweight group (38.4%) (Table 2).

In multivariate analysis, asthma (ever), hay fever or allergic rhinitis (ever), and a family history of allergies, hay fever, nasal allergies (but not asthma), and smoking were all associated with HE (Table 3). Furthermore, as compared with normal weight, obesity (BMI ≥ 30) was associated with HE [adjusted relative risk = 1.11 (95%CI: 1.03–1.20)], whereas being overweight or skinny (BMI < 18.5) was not (Table 3).

Occupation and occupational consequences

In total, 4.8% of the total HUNT3 population ($n = 50\,805$) reported work-related HE. Persons with HE reported a higher frequency of sick leave, including medical certificate sick leave, than the HUNT3 participants without HE ($p < 0.001$; Table 1). Among those who answered the HE questionnaire, health/social work and cleaning were most frequently associated with HE in women (28.5% and 19.6%, respectively; Table 4), whereas, among men, work-related HE was most common among farmers (26.3%) and industrial workers (27.0%) (Table 4). These results refer to occupations reported as the only occupation that participants were involved in at the time of eczema onset (Table 4); the results were similar when part-time work was taken into account (Table S2). Work-related HE was reported by 61% of persons with HE, and, in both sexes, 41% reported that their HE condition improved when they were absent from work (Table 4). Six per cent of the women and 6.7% of the men had changed occupation because of HE (Table 4).

Materials associated with HE and patch test results

More women than men reported worsening of their HE when they were in contact with certain materials [66.6% versus 55.9%, respectively; $p < 0.001$ (Table 4)], whereas 23.6% of the participants could not tell whether skin contact with different materials aggravated their HE. Overall, cleaning detergents, other chemicals and water were the most frequently reported aggravating factors. Women reported a slightly higher number of irritants than men (mean number of irritants: 1.8 and 1.5, respectively), with some differences in the types of material regarded as aggravating factors (Table 5); oils and lubricants were more commonly reported by men (40.5%) than by women (6.5%) ($p < 0.001$; Table 5). Furthermore, 43.8% of the participants reported washing their hands between six and 10 times daily, and 17.4% of the women reported

Table 1. Baseline characteristics of the HUNT3 population according to the presence of hand eczema, as reported in the main questionnaire (Q1)

	Never hand eczema n = 45 024	Hand eczema n = 5757	p-value
Age (years), median (minimum, maximum)	54.1 (19, 100.8)	49.7 (19.3, 95.6)	
Sex (%)			
Female	53.1	66.5	<0.001
BMI (%)			
<18.5	0.6	0.7	
18.5 to <25	32.1	32.2	
25 to <30	44.7	42.0	
≥30	22.7	25.1	<0.001
Smoking habits (%)			
Never smoker	43.0	39.8	
Previous smoker	32.6	32.8	
Current smoker (daily and occasional)	24.4	27.4	<0.001
Disease history (%)			
Ever psoriasis	4.9	12.6	<0.001
Hay fever, nasal allergies	28.0	45.3	<0.001
Ever had asthma	10.8	18.9	<0.001
Family history of allergies, hay fever, rhinitis	48.0	64.3	<0.001
Family history of asthma	28.0	37.4	<0.001
Currently employed (%)	63.6 (n = 28 461)	69.2 (n = 3973)	<0.001
Current occupation at time of HUNT3 survey (%)			
Business and office	2.2	1.9	
Quarrying	0.3	0.2	
Construction work	6.9	4.5	
Fishing	1.1	0.9	
Trade	11.1	11.0	
Health/social work	19.8	26.1	
Hotel/restaurant	2.4	3.5	
Industry (except oil)	7.9	6.9	
Industry (oil/gas)	1.9	1.4	
Farming	9.8	9.4	
Hydropower	1.2	0.7	
Public administration	10.0	8.9	
Oil and gas	0.4	0.3	
Transportation	4.5	3.2	
Teaching	10.7	10.5	
Other	10.2	10.9	
Sick leave in the last 12 months (%)*	55.2 (n = 15 653)	59.6 (n = 2359)	<0.001
Sick leave with medical certificate from doctor (%)*	32.7 (n = 9198)	37.0 (n = 1448)	<0.001

BMI, body mass index.

Missing: hand eczema (n = 24); BMI (n = 402); smoking (n = 1428); psoriasis (n = 22); hay fever (n = 11 527); ever asthma (n = 22); family history of allergy (n = 1856); family history of asthma (n = 1907); currently employed (n = 275); working group (n = 4617); sick leave in last 12 months (n = 91); sick leave with medical certificate from doctor (n = 404).

*Sick leave refers to any condition, not specifically to hand eczema.

washing their hands >20 times daily, in contrast to men, 3% of whom reported washing their hands >20 times daily (Fig. 3).

Among persons who answered the HE questionnaire, 32.9% reported that skin contact with nickel (in buttons, buckles, jewellery, and earrings) or other metal objects caused a rash. Twenty-four per cent of the participants who had ever had HE gave an affirmative answer to the question: 'Have you ever had a patch test for allergies'.

Among this subgroup, comprising 1002 individuals (687 women and 315 men), 467 subjects (of whom 58% were women) reported that their test result was negative or that they did not remember the result of the test. Among the 535 subjects (77% women) who reported having been patch tested and recalled the positive result, reactions to nickel, fragrance allergens, preservatives and rubber chemicals were most often reported (Table 6). For all of the substances, except for epoxy resin and chrome, women

Table 2. Characteristics of 4206*persons who answered a hand eczema questionnaire

	All n = 4206	Women n = 2880	Men n = 1326	p-value†
Eczema in childhood (%)	31.6	32.0	30.7	0.14
Age at onset of hand eczema (years), median (minimum, maximum)	22 (0, 99)	21 (0, 99)	25 (0, 99)	
Onset of hand eczema, age (%)				
≤10 years	21.4	20.4	23.5	
>10 to ≤20 years	26.1	29.6	18.5	
>20 to ≤30 years	23.9	25.0	21.4	
>30 to ≤40 years	13.3	12.1	15.8	
>40 to ≤50 years	8.1	7.1	10.5	
>50 years	7.3	5.9	10.4	
Current hand eczema (%)	41.7	39.2	47.4	<0.001
Current hand eczema by age at onset (%)				
≤10 years	42.4	42.7	42.0	0.80
>10 to ≤20 years	36.2	34.3	42.9	0.02
>20 to ≤30 years	38.9	36.2	45.6	0.01
>30 to ≤40 years	47.4	41.5	57.0	<0.01
>40 to ≤50 years	52.2	52.4	52.0	0.90
>50 years	45.7	51.3	61.1	0.04
BMI (%)				
<18.5	0.6	0.7	0.4	
18.5 to <25	32.8	36.9	23.7	
25 to <30	42.3	38.4	50.6	
≥30	24.4	24.0	25.3	<0.001
Smoking (%)				
Never	40.2	40.3	40.1	
Previous	33.7	31.8	37.7	
Current	26.1	27.8	22.2	0.001
Other diseases (%)				
Psoriasis	11.7	10.7	14.0	≤0.01
Ever hay fever, nasal allergy	45.7	46.1	44.8	0.40
Ever had asthma	19.0	19.0	18.9	0.97
Family history of allergy, hay fever	64.9	68.9	56.3	<0.001
Family history of asthma	37.2	40.1	30.9	<0.001

BMI, body mass index.

*Of the 5757 participants who reported hand eczema in Q1 (Table 1), 4206 responded to the Q3 hand eczema questionnaire (Fig. 1). Missing: eczema in childhood (n = 50); age at onset of eczema (n = 286); current hand eczema (n = 91); BMI (n = 8); smoking (n = 92); psoriasis (n = 1); hay fever (n = 177); asthma (n = 1); family history of allergy (n = 96); family history of asthma (n = 119).

†p-value for difference between men and women.

were more likely than men to report positive test results. Hairdressing was the occupation in which patch testing was most frequently performed (40%).

Discussion

In our population-based survey, we found that HE was more common in women and that, for both men and women, a large proportion had HE onset in early childhood and after the age of 30 years. Persons with HE were more often obese and current smokers than the non-eczema group. Farming and industry were the occupations that were most frequently associated with HE onset in men. HE in women was most often associated with health/social work and working as

a cleaner. Cleaning detergents, water and chemicals were the most common aggravating factors for both sexes.

The lifetime prevalence and point prevalence of HE of 11% and 3.4%, respectively, in the present study was lower than the reported 15% and 4%, respectively, from the review paper by Thyssen et al. (10), but slightly higher than what has been reported in another study from Norway (8.2%) (7). However, in a study from northern Norway, the cumulative incidence of self-reported HE was 13.6% (8). Women reported a higher cumulative incidence (17.4%) than men (8.8%) (8). Cumulative incidence was not available for the present study population, but the lifetime prevalence was higher in women (13.8%) than in men (8.4%).

Table 3. Bivariate relative risk (RR) and adjusted relative risk (aRR) for ever having hand eczema by sex, history of respiratory and allergic diseases, smoking, and body mass index (BMI), by univariate (n = 50 805) and multivariate (n = 36 729*) Poisson regression analysis of the HUNT3 population with available information on all variables in the model

	RR (95%CI)	<i>p</i>	aRR (95%CI)	<i>p</i>
Sex (ref.: male)	1.65 (1.57–1.74)	<0.001	1.63 (1.53–1.73)	<0.001
Asthma (ever)	1.76 (1.66–1.87)	<0.001	1.36 (1.26–1.46)	<0.001
Asthma (family)	1.30 (1.25–1.36)	<0.001	1.02 (0.97–1.08)	0.34
Hay fever/nasal allergies (ever)*	1.93 (1.83–2.04)	<0.001	1.63 (1.54–1.73)	<0.001
Allergies/hay fever (family)	1.48 (1.42–1.53)	<0.001	1.29 (1.22–1.36)	<0.001
BMI				
18.5 to <25 (ref.)	–	–	1	–
<18.5	1.06 (0.79–1.44)	0.68	1.01 (0.71–1.44)	0.95
25 to <30	0.94 (0.89–1.00)	0.04	1.04 (0.97–1.11)	0.23
≥30	1.09 (1.02–1.16)	0.01	1.11 (1.03–1.20)	0.005
Smoking				
Never (ref.)	–	–	1	–
Previous	1.08 (1.02–1.14)	0.013	1.11 (1.05–1.19)	0.001
Current	1.19 (1.12–1.27)	<0.001	1.17 (1.09–1.26)	<0.001

*Information on hay fever/nasal allergies (ever) was reported in Q2, which was answered by 77.3% of those having answered Q1, and the number included in the multivariate model is therefore lower than that of the full HUNT3 population.

Table 4. Associations between hand eczema and occupations and occupation-related factors among persons who answered the hand eczema questionnaire

	All n = 4206*	Women n = 2880	Men n = 1326	<i>p</i> -value
Eczema on hands in connection with work (%)	60.8	60.2	61.9	0.3
Type of job when eczema started (%)†	n = 2249	n = 1511	n = 738	
Business and office	8.6	10.4	5.0	<0.001
Teaching	3.7	3.9	3.1	0.30
Workshop/industry	9.9	1.6	27.0	<0.001
Food industry/cooking	7.8	8.3	6.9	0.20
Farming	16.5	11.7	26.3	<0.001
Fishing	0.3	0.2	0.4	0.40
Transportation	1.1	0.0	3.4	<0.001
Hairdresser/barber	3.1	4.5	0.1	<0.001
Health/social work	20.1	28.5	2.9	<0.001
Cleaning	13.9	19.6	1.6	<0.001
Construction work	3.3	0.1	9.9	<0.001
Painting	0.8	0.3	1.9	<0.001
Other	11.2	10.8	11.9	0.45
Changed job because of eczema (%)	6.2	6.0	6.7	0.40
Eczema worsens after contact with certain materials (%)				
Yes	63.2	66.6	55.9	
No	13.3	11.6	16.9	<0.001
Don't know	23.6	21.9	27.2	
Eczema improvement when away from work (%)	41.2	41.6	40.5	0.50

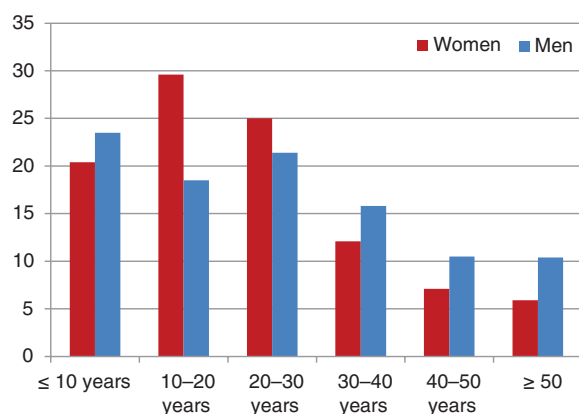
*Missing: eczema in connection with work [n = 168 (4%); women, n = 116 (4%); men, n = 52 (3.9%)]; changed job because of eczema [n = 108 (2.6%); women, n = 84 (2.9%); men, n = 24 (1.8%)]; eczema worsens after contact with materials [n = 244 (5.8%); women, n = 182 (6.3%); men, n = 62 (4.7%)]; eczema improvement when away from work [n = 416 (9.9%); woman, n = 316 (11%); men, n = 100 (7.5%)].

†n = 2249 provided information about their main occupation when eczema started. The list of jobs reported in the table were categories used specifically for the hand eczema questionnaire, and are therefore different from the occupations listed in Table 1.

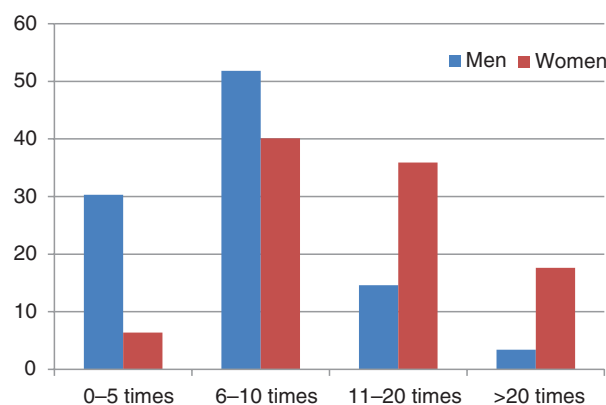
Table 5. Materials reported to aggravate hand eczema in persons who responded to the hand eczema questionnaire and who gave information on aggravating material, for entire subgroup and stratified by sex

Material	All (n = 2502) [†] %	Women (n = 1796) %	Men (n = 706) %	p-value*
Water	26.2	29.6	17.6	<0.001
Cleaning detergents	75.1	84.6	50.9	<0.001
Chemicals	36.0	33.4	42.6	<0.001
Solvents	23.7	19.9	33.4	<0.001
Paint	17.8	17.3	18.8	0.40
Oils and lubricants	16.1	6.5	40.5	<0.001
Foods	18.7	23.1	7.5	<0.001
Plants	14.6	16.2	10.5	<0.001
Animals	13.4	12.7	15.3	0.10
Other	19.0	18.7	19.7	0.60

*For difference between men and women.

[†]Information about aggravating material: missing, n = 244.**Fig. 2.** Onset of hand eczema in relation to age and sex (%).

The present study confirms atopic dermatitis and HE in childhood as important risk factors for HE in adulthood. We found that men had a peak of HE onset in early childhood (≤ 10 years), whereas, for women, onset often occurred in adolescence or early adulthood. Dotterud and Falk (9) found no sex difference for HE (reported by the parents) among children aged 7–12 years. In a cohort study of young adults (28–30 years), the 1-year prevalence of HE was 14.3%, with a higher prevalence in women and an incidence of 8.8 per 1000 person-years from adolescence to adulthood (19). In the present study, 42% of the participants who reported (retrospectively) onset by 11 years of age still suffered from HE during HUNT3, indicating a large proportion of early-onset HE among this large study population of adults, and many with persistent HE since childhood. However, the information was collected retrospectively, and we therefore cannot exclude the possibility of recall bias. It is well known that



Missing: n = 44

Fig. 3. Frequency of daily handwashing (among participants with hand eczema) in work and leisure (%).

HE is more common among women. Our study provides support for a Swedish study in which the risk of HE was only significantly related to sex in persons aged <30 years (2, 10). However, we found that men more frequently reported HE onset after 30 years of age than women, but the overall lifetime prevalence of HE was higher for women than for men. In accordance with a Swedish study among hairdressers, we found that the mean age at onset of HE was 22 years, whereas other studies with unselected populations have reported a higher mean age at onset (27 years) (20).

Our study showed that current smoking was more common among participants with than among those without HE. Previous studies reporting associations between smoking and HE have shown inconsistent results. An earlier Norwegian study found no association

Table 6. Reported patch test outcomes among participants who reported having been tested ($n = 1002$) for entire subgroup and stratified by sex

Allergen	All ($n = 1002$) %	Women ($n = 687$) %	Men ($n = 315$) %	<i>p</i> -value*
Positive result				
Nickel	28.9 ($n = 290$)	37.4	10.5	<0.001
Rubber chemicals	11.5 ($n = 115$)	13.5	7.0	0.003
Chromium	8.1 ($n = 81$)	7.6	9.2	0.38
Cobalt	5.6 ($n = 56$)	7.3	1.9	0.001
Epoxy resin	1.9 ($n = 19$)	1.0	3.8	0.003
Colophonium	5.0 ($n = 50$)	5.7	3.5	0.12
Preservatives, e.g. in creams	11.8 ($n = 118$)	14.6	5.7	<0.001
Fragrances	19.1 ($n = 191$)	23.9	8.9	<0.001
Other	32.8 ($n = 329$)	35.8	26.5	0.003
Negative†	19.9 ($n = 199$)	15.3	29.8	<0.001
Unknown/did not remember†	27.4 ($n = 275$)	24.9	33.0	0.007

Multiple positive patch test results possible.

*For difference between men and women.

†Including 7 individuals who reported both negative patch test results and unknown/did not remember.

between smoking and HE (7). In two reviews from 2015, Sørensen et al. indicated a possible association (21), whereas Lukács et al. were unable to identify an association (22). A study on obesity and HE (11) found that HE was more common in individuals who reported stress, obesity, and smoking. In the present study, men with HE were more likely to be obese than men without HE. Overweight and obesity were more common among men with HE than among women with HE.

In the present study, farming was the occupation that most men reported being involved in during HE onset. Farming has not been of great importance for HE in other studies, but this may be because of the inclusion of populations that differ from the HUNT population. The county, Nord-Trøndelag, on which this study is based is the county with the largest proportion of inhabitants employed in farming, fishery and forestry in Norway (8.1% as compared with 2.9% for Norway overall in 2008 in the 20–74-year age group (Statistics Norway) (23). The county has widely dispersed communities, and is thus ideal for studying both urban and rural living. On the basis of municipality, the participants in HUNT3 were broadly categorized as living in either urban or rural areas. Two-thirds of the HUNT3 population lived in rural areas, and a large proportion were involved in farming (14% and 4% of those living in rural and urban municipalities, respectively). However, both in urban and in rural areas, 20% were involved in healthcare professions. Nevertheless, in contrast to previous studies assessing occupational exposures and HE, the large proportion of rural residence and farming activity related to this in the HUNT3 population enabled us to identify farming as an important risk factor for HE. A study of Finnish farmers reported a higher prevalence of HE among women than

among men (24). However, the study was based on data collected in 1979, a time when women did most of the milking and were also more exposed to irritants and allergens than men (24). Newer epidemiological data on HE risk in farmers are scarce. In the HUNT population, slightly more women were likely to be involved in farming part-time, whereas for men farming was more likely to be the main activity, which may explain the higher frequency of farming-related HE in men than in women.

Wet work, for example hand washing >20 times daily (25), is a known exogenous risk factor for HE (26). Water was one of the most important aggravating factors for HE in the present study. Furthermore, there was a statistically significant difference between the proportions of women and men reporting hand washing >20 times daily, namely, 17.4% and 3%, respectively, indicating an important sex difference in exposure. This is lower than in the Swedish study, which reported separate exposure for leisure and work; skin exposure to water was reported to be 30% for women and 12% for men, as compared with 8% and 4%, respectively, at work (26). In the present study, occupational cleaning was the second most common occupation in women at the time of HE onset.

Contact allergies are among the known exogenous risk factors for HE. A diagnosis of contact allergy is determined by the outcome of patch testing, which is recommended in all patients with chronic HE (27). We found that nearly 1 in 4 of the HE population had completed patch testing. Nickel allergy was the most common contact allergy among the participants with positive patch test results. Of the hairdressers with HE, 40% had undergone patch testing, whereas the corresponding proportion of farmers reporting HE was 25.6%.

The prevalence of psoriasis was higher in the study population than in the background population. HE may be confused with other dermatoses, such as psoriasis, and vice versa. On the other hand, in a study of comorbidity in children, 24.5% of children with psoriasis also reported being affected by atopic eczema (28), and participants may have had coexisting inflammatory skin diseases.

A validation study on self-reported psoriasis in HUNT3 suggested that self-reported psoriasis may be underestimated, largely because of underdiagnosed scalp psoriasis (29).

A strength of this study is the large population size and the high response rate to the HE questionnaire. Almost three-quarters of the individuals who received the questionnaire responded. On comparison of the characteristics of the responders and non-responders, the non-responders were more likely to be men, current smokers, and unemployed (Table S1). The total participation rate in HUNT3 was 54%; non-participants had lower socioeconomic status, had higher mortality, and showed a higher prevalence of several chronic diseases (30).

Participants in the present study include the adult population from a large geographical area in Norway. Although the high proportion of farmers makes it difficult to generalize the findings to other populations, examining a region that includes both urban and rural living enables us to identify work-related HE risk which would not be possible in studies on urban populations or specific occupational groups. The present study has a cross-sectional design. Thus, the data do not allow us to estimate the contributions of specific occupational groups to the risk of HE. For retrospectively collected data, underreporting may result in an underestimation of the prevalence of disease. The information in this study was reported in adulthood, and this may cause a recall bias regarding information from childhood. One study found that the validated question 'Have you had childhood eczema' could overestimate atopic eczema as a risk factor for HE in adult population surveys (31). Furthermore, although childhood eczema appears to be an important risk factor for the later development of HE, this information was only reported by the HE population, and could therefore not be included in the analyses assessing multiple potential risk factors for HE. The HE questionnaires do not constitute a validated tool, but were constructed from questionnaires used in other studies. The sources were, however, not documented, and it is therefore difficult to know which of the questions have previously been validated.

In analyses of lifestyle-related factors, socioeconomic factors can confound the results. HUNT3 does not include information on income, and we were therefore unable to take this into account. However, information on smoking,

which was accounted for in our analyses, can be regarded as a surrogate measure for socioeconomic status.

Thirty-two per cent of the study population gave an affirmative answer to the question regarding whether skin contact with metal objects, potentially releasing nickel (in buttons, buckles, jewellery, earrings, or other metal objects), caused a rash. The validity of self-reporting of nickel allergy has been found to be low by others, and it may result in an overestimation of the true prevalence of nickel allergy (32). The present study includes information on self-reported patch test results, which other studies often lack. Patch test results are important when the prevalence of contact allergy is investigated. However, we cannot exclude the possibility that recall bias can influence the results; for example, in a previous study, females had better recall than men, and recall of the correct allergens was negatively correlated with the number of diagnosed allergies, and the number of years since patch testing (33).

Conclusion

The prevalence of HE in the HUNT population was 11.3%, and the prevalence of work-related HE in the population was 4.8%. In agreement with other studies, we found that HE is more common in women. However, our study provides novel findings in terms of a high incidence of HE in early childhood and a higher incidence of HE in men than in women after 30 years of age. Owing to the large proportion of the Nord-Trøndelag population employed in farming, we were able to identify farming as an important risk factor for HE in men.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Characteristics of responders and non-responders to the hand eczema questionnaire in HUNT3.

Table S2. Distribution of work, total number (main occupation and second occupation).

References

- Coenraads P-J. Hand eczema is common and multifactorial. *J Invest Dermatol* 2007; **127**: 1568–1570.
- Meding B, Jarvholm B. Incidence of hand eczema – a population-based retrospective study. *J Invest Dermatol* 2004; **122**: 873–877.
- Bauer A. Hand dermatitis: uncommon presentations. *Clin Dermatol* 2005; **23**: 465–469.
- Moberg C, Alderling M, Meding B. Hand eczema and quality of life: a population-based study. *Br J Dermatol* 2009; **161**: 397–403.
- Boehm D, Schmid-Ott G, Finkeldey F et al. Anxiety, depression and impaired health-related quality of life in patients with occupational hand eczema. *Contact Dermatitis* 2012; **67**: 184–192.
- Dalgard F J, Gieler U, Tomas-Aragones L et al. The psychological burden of skin diseases: a cross-sectional multicenter study among dermatological out-patients in 13 European countries. *J Invest Dermatol* 2015; **135**: 984–991.
- Bo K, Thoresen M, Dalgard F. Smokers report more psoriasis, but not atopic dermatitis or hand eczema: results from a Norwegian population survey among adults. *Dermatology* 2008; **216**: 40–45.
- Dotterud L K, Smith-Sivertsen T. Allergic contact sensitization in the general adult population: a population-based study from Northern Norway. *Contact Dermatitis* 2007; **56**: 10–15.
- Dotterud L K, Falk E S. Contact allergy in relation to hand eczema and atopic diseases in north Norwegian schoolchildren. *Acta Paediatr* 1995; **84**: 402–406.
- Thyssen J P, Johansen J D, Linneberg A, Menné T. The epidemiology of hand eczema in the general population – prevalence and main findings. *Contact Dermatitis* 2010; **62**: 75–87.
- Anveden Berglind I, Alderling M, Meding B. Life-style factors and hand eczema. *Br J Dermatol* 2011; **165**: 568–575.
- Arbeidsdepartementet. Meld. St. 29. Melding til Stortinget. Felles ansvar for eit godt og anstendig arbeidsmiljø. Arbeidsforhold, arbeidsmiljø og sikkerheit, 2011. Det kongelige arbeidsdepartement.
- Alfonso J H, Thyssen J P, Tynes T et al. Self-reported occupational exposure to chemical and physical factors and risk of skin problems: a 3-year follow-up study of the general working population of Norway. *Acta Derm Venereol* 2015; **95**: 959–962.
- Bauer A. Contact dermatitis in the cleaning industry. *Curr Opin Allergy Clin Immunol* 2013; **13**: 521–524.
- Lynde C B, Obadia M, Liss G M et al. Cutaneous and respiratory symptoms among professional cleaners. *Occup Med (Lond)* 2009; **59**: 249–254.
- Holmen J, Midthjell K, Forsen L et al. A health survey in Nord-Trøndelag 1984–86. Participation and comparison of attendants and non-attendants. *Tidsskr Nor Lægeforen* 1990; **110**: 1973–1977.
- Krokstad S, Langhammer A, Hveem K et al. Cohort Profile: the HUNT Study, Norway. *Int J Epidemiol* 2013; **42**: 968–977.
- WHO. *Global Database on Body Mass Index*: WHO, Geneva, 1997, Available at: <http://apps.who.int/bmi/> (last accessed 12 May 2016)
- Mortz C G, Bindslev-Jensen C, Andersen K E. Hand eczema in The Odense Adolescence Cohort Study on Atopic Diseases and Dermatitis (TOACS): prevalence, incidence and risk factors from adolescence to adulthood. *Br J Dermatol* 2014; **171**: 313–323.
- Hald M, Berg N D, Elberling J, Johansen J D. Medical consultations in relation to severity of hand eczema in the general population. *Br J Dermatol* 2008; **158**: 773–777.
- Sørensen J A, Clemmensen K K, Nixon R L et al. Tobacco smoking and hand eczema – is there an association? *Contact Dermatitis* 2015; **73**: 326–335.
- Lukács J, Schliemann S, Elsner P. Association between smoking and hand dermatitis – a systematic review and meta-analysis. *J Eur Acad Dermatol Venereol* 2015; **29**: 1280–1284.
- Statistics Norway Sysselsetting, registerbasert, 2009: Available at: <https://www.ssb.no/statistikkbanken/selecttable/hovedtabellHjem.asp> (last accessed 27 September 2016)
- Susitaival P, Husman L, Horsmanheimo M et al. Prevalence of hand dermatoses among Finnish farmers. *Scand J Work Environ Health* 1994; **20**: 206–212.
- Agner T. Wet work – home and away. *Br J Dermatol* 2013; **168**: 1153–1154.
- Meding B, Lindahl G, Alderling M et al. Is skin exposure to water mainly occupational or nonoccupational? A population-based study. *Br J Dermatol* 2013; **168**: 1281–1286.
- Menné T, Johansen J D, Sommerlund M, Veien N K. Hand eczema guidelines based on the Danish guidelines for the diagnosis and treatment of hand eczema. *Contact Dermatitis* 2011; **65**: 3–12.
- Augustin M, Radtke M A, Glaeske G et al. Epidemiology and comorbidity in children with psoriasis and atopic eczema. *Dermatology* 2015; **231**: 35–40.
- Modalsli E H, Snekvik I, Asvold B O et al. Validity of self-reported psoriasis in a general population: the HUNT Study, Norway. *J Invest Dermatol* 2016; **136**: 323–325.
- Langhammer A, Krokstad S, Romundstad P et al. The HUNT study: participation is associated with survival and depends on socioeconomic status, diseases and symptoms. *BMC Med Res Methodol* 2012; **12**: 143.
- Stenberg B, Lindberg M, Meding B, Svensson A. Is the question ‘Have you had childhood eczema?’ Useful for assessing childhood atopic eczema in adult population surveys? *Contact Dermatitis* 2006; **54**: 334–337.
- Josefson A, Farm G, Meding B. Validity of self-reported nickel allergy. *Contact Dermatitis* 2010; **62**: 289–293.
- Jamil W N, Erikssohn I, Lindberg M. How well is the outcome of patch testing remembered by the patients? A 10-year follow-up of testing with the Swedish baseline series at the Department of Dermatology in Örebro, Sweden. *Contact Dermatitis* 2012; **66**: 215–220.

Supplemental table S1: Characteristics of responders and non- responders to the hand eczema questionnaire in HUNT3

	Responders n=4,206	Non-responders n=1,541	p- value
Age [~~4~~median (min, max)]	50.0 (19.3, 95.6)	48.9 (19.3, 90.8)	
Gender (%)			
Female	68.5	61.1	<0.001
BMI (%)			
< 18.5	0.6	0.9	
[18 -<25>	32.8	30.8	
[25-<30>	42.2	41.3	
≥30	24.4	27.1	0.10
Smoking habits (%)			
Never smoker	40.2	38.6	
Previous -smoker	33.7	30.0	
Current smoker (daily and occasional)	26.1	31.4	<0.001
Disease history (%)			
Ever psoriasis	11.7	15.1	<0.001
Hay-fever, nasal allergies	45.7	41.6	0.10
Ever had asthma	19.0	18.7	0.80
Family history of allergies, hay-fever, rhinitis	64.9	62.5	0.20
Family history of asthma	37.2	38.0	0.10
Currently employed (%)	70.4 (n=2,957)	66.3 (n=1,018)	0.003
Current occupation at time of survey HUNT 3 (%)			
Business and office	1.95	1.9	
Quarrying	0.2	0.1	
Construction work	4.1	5.8	
Fishing	0.8	1.0	
Trade	10.9	11.4	
Health/ social work	26.1	26.0	
Hotel/ restaurant	3.6	3.4	
Industry (without oil)	6.6	7.6	
Industry (Oil/ gas)	1.3	1.6	
Farming	9.0	10.4	
Hydropower	0.7	0.6	
Public administration	9.2	7.7	
Oil- and gas	0.3	0.2	
Transportation	3.2	3.3	
Teaching	11.5	7.7	
Other	10.7	11.2	
*Sick leave last 12 months (%)	59.2 (n=1,746)	60.5 (n=613)	0.50
*Sick leave medical certificated by doctor (%)	36.3 (n=1,061)	38.7 (n=387)	0.20

Missing: responders: BMI (n=8); smoking (n=92); psoriasis (n= 1); hay fever (n= 177); ever asthma (n= 1); family history of allergy (n=96); family history of asthma (n=119); currently employed (n=3); working group (n= 4, 617); sick leave last 12 months (n =8);Sick leave medical doctor (n=37)

Non-responders: BMI: (n=14), smoke(n=44) ; asthma(n= 0), psoriasis (n=0), hay fever(n= 1070); family history of allergy(n=47); family history of asthma (n=52) currently employed (n=6);sick leave(no= 4);sick leave medical doctor (n=19) *Sick leave refer to any condition, not specified for HE

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Supplemental table S2: Distribution of work, Total number (main work and second works)

	Total	Women	Men	p-value
Type of job when eczema started (%)				
Business and Office	6.6	8.0	3.7	<0.001
Teaching	2.9	3.2	2.3	0.20
Workshop/industry	11.8	2.6	31.3	<0.001
Food industry/ cooking	10.8	12.0	8.2	0.005
Farming	21.4	16.5	31.8	<0.001
Fishing	0.9	0.5	2.0	<0.001
Transportation	1.6	0.1	4.8	<0.001
Hairdresser/barber	3.5	5.1	0.1	<0.001
Health/social work	23.0	32.8	2.4	<0.001
Cleaning	23.1	31.9	4.6	<0.001
Construction work	4.9	0.1	15.1	<0.001
Painting	3.1	1.9	5.5	<0.001
Other	10.4	10.2	10.9	0.61