

Contact Dermatitis / Early View

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Characteristics of hand eczema in final-year apprentice nurses during the COVID-19 pandemic

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Abstract

Background

Apprentice nurses are considered at high risk to developing occupational skin diseases.

Objectives

This study assessed the frequency and origin of hand eczema, and work-related risk factors in apprentice nurses.

Methods

The study involved 240 final-year apprentice nurses (females 75%, median age 19 years) from vocational schools in Zagreb, Croatia. The study was performed in 2020/2021 and included a questionnaire and clinical examination by means of the Osnabrück Hand Eczema Severity Index (OHSI). Skin prick test (SPT) with natural rubber latex (NRL) allergen, and patch test with the basic series of allergens, and disinfectants, were performed in 42 apprentice nurses with hand eczema that lasted more than 3 months.

Results

Clinically observed and self-reported hand eczema were found in 49% and 46% of apprentice nurses, respectively. Those with observed changes were older and reported more days per month spent on practical work than those with healthy skin ($P = .001$).

Median OHSI was 4 (interquartile range 2-6). There were no positive SPTs to latex, and 11 (26%) apprentice nurses had positive patch test reactions to one or more tested allergens, mostly nickel.

Conclusions

Hand eczema was common in final-year apprentice nurses during the COVID-19 pandemic. It was mostly of irritative origin, associated with the duration of practical training, confirming cumulative effect of hazards on skin barrier.

1 INTRODUCTION

Healthcare workers (HCWs) are considered a high-risk working population for developing occupational skin diseases (OSDs), mainly contact dermatitis on the hands. According to studies from Germany, Denmark, and Sweden, the prevalence of hand eczema in HCWs, mostly nurses, is about 20%,¹⁻⁴ which is higher than the recently estimated lifetime prevalence in the general population of 14.5%.⁵ Among the most prominent risk factors for the development of hand eczema in nurses are wet work (frequent hand washing and wearing of protective gloves during work)^{2, 6-8} and atopic dermatitis.^{1, 9-13} The most frequently mentioned occupational contact allergens for nurses are nickel and cobalt salts, rubber additives, preservatives and disinfectants (formaldehyde, glutaraldehyde, chlorhexidine, mercury compounds), fragrances, and drugs (antibiotics, local anaesthetics, essential oils).^{7, 14-16} It has been pointed out that in cases where allergic contact dermatitis is suspected in HCWs, some occupational contact allergens, such as disinfectants and drugs, should be added to the basic series of contact allergens when patch testing is performed.¹⁷ HCWs are currently the occupational group most affected by natural rubber latex (NRL) allergies due to their frequent use of latex gloves. The current prevalence of latex allergy among HCWs is estimated at around 10%, which is twice as much in comparison with the general population, which exhibits an estimated latex allergy prevalence of 4.3%.¹⁸ However, the prevalence of NRL allergy in HCWs significantly differs between countries, being lower in high-income countries with efficiently implemented preventive measures.¹⁹ Usage of latex gloves remains common in Croatian HCWs.²⁰

Literature data suggest younger age as a risk factor for developing OSDs.^{1, 6, 7} It has been indicated that apprentices and young workers in high-risk professions should be considered vulnerable for developing injuries at work and occupational diseases, including OSDs.²¹ This was confirmed by a recent systematic review about the incidence of occupational contact dermatitis in HCWs,²² which showed that the incidence of occupational contact dermatitis is more than 100 times higher during apprenticeship compared with cohorts of HCWs. Our recent research suggests significant exposure of hairdressing and beautician apprentices to skin irritants and allergens during practical education in vocational schools, with early development of hand eczema already during vocational education in 40% of final-year hairdressing and 36% of final-year beautician apprentices.²³⁻²⁵ Studies about the prevalence

of hand eczema in apprentice nurses attending their final year of education showed a self-reported prevalence of 43% in Germany²⁶ and 31% in the Netherlands.²⁷ Patch testing has thus far rarely been performed in studies on apprentice nurses,^{12, 28} so data about the development of allergic contact dermatitis are scarce in this population.

The aim of this study was to assess the frequency of irritative and allergic hand contact dermatitis and sensitization to NRL in a sample of final-year Croatian apprentice nurses, as well as to explore work-related risk factors, including the COVID-19 pandemic.

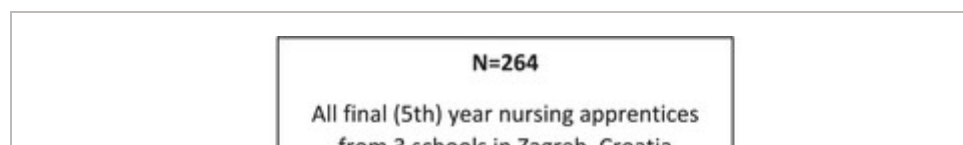
2 METHODS

2.1 Study population

All of the 264 nursing apprentices from three vocational schools in the city of Zagreb, Croatia, attending the final (fifth) year of education were invited to participate in the study with the permission of their school headmasters. The Croatian curriculum of vocational schools for nurses includes 2 years of general secondary education and 3 years of vocational education with practical work at healthcare facilities taking up around half of the total teaching hours. All of the participants were aged 18 years or older and gave their written informed consent before entering the study. Ethical approval for this study was granted by the Ethics Committee of the Institute of Medical Research and Occupational Health, Zagreb, Croatia (Ethics approval number: 100-21/20-11; class: 01-18/20-02-2/1). A total of 240 out of 264 apprentices attending the final year of education responded (response rate 90.9%) and were enrolled in the study (181 women [75%] and 59 men [25%]). The median age was 19 years (interquartile range [IQR] 19-20 years; total range 18-21 years).

Because of the varying degree of epidemiological restrictions during the course of the COVID-19 pandemic, recruitment and data collection were conducted in November and December 2020 and from February to May 2021, when all of the recruited apprentices went through training in schools and healthcare facilities together. The study protocol was implemented in the classrooms of the vocational schools under the prescribed epidemiological measures.

The flow diagram of the study protocol is presented in Figure 1. The protocol included for all 240 participants collecting data by questionnaire and clinical examination of the skin on the hands/wrists. Sixty participants with the history of hand eczema that lasted more than 3 months were defined as a group with chronic hand eczema and were invited to allergological skin testing. Among them, 50 participants also had clinically found skin changes on the examination. The response rate was 70% (ie, 42 apprentices agreed and were tested).



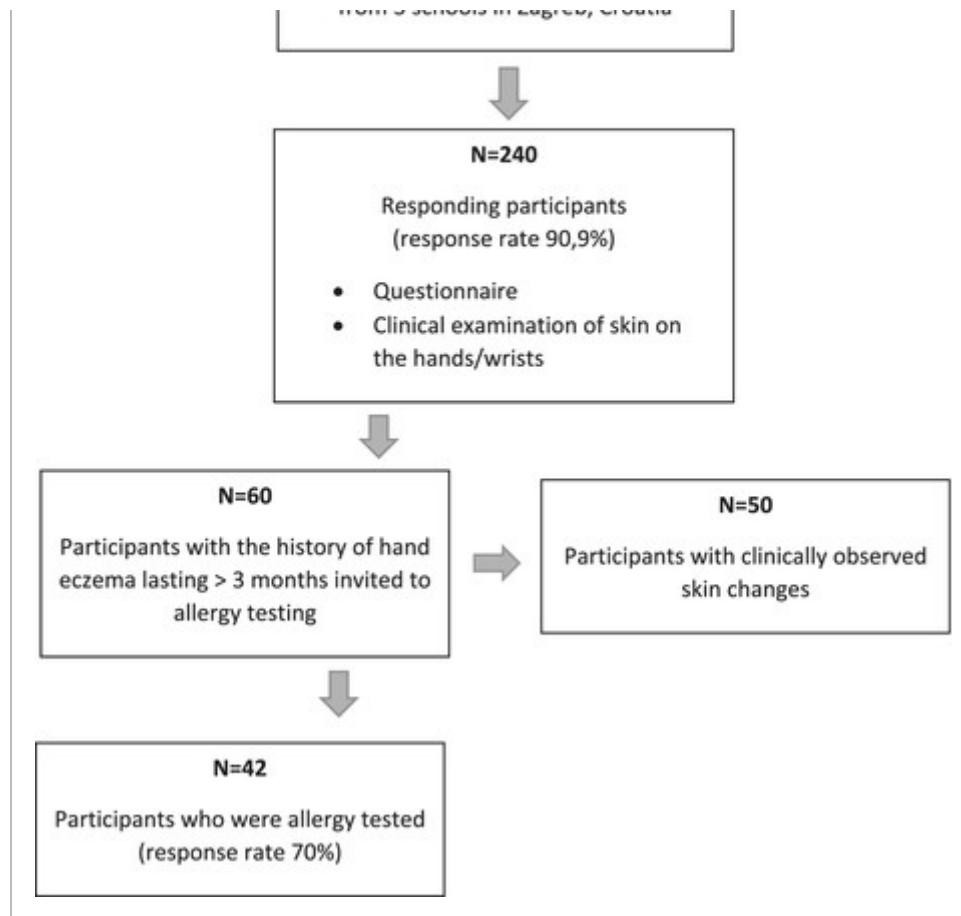


FIGURE 1

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Study protocol

2.2 Assessment

The participants filled-out a questionnaire based on the Nordic Occupational Skin Questionnaire (NOSQ-2002)²⁹ to record: (a) a history of skin symptoms on the hands (“Have you ever had hand eczema?”); (b) self-reported severity of eczema when it was at its worst, and at the present moment, rated on a scale from 0 (no eczema) to 10 (extremely bad eczema) (“How do you grade your eczema on a scale from 0 to 10?”); (c) work-related risk factors (frequency of washing hands, use of hand disinfectants and protective gloves at work); (d) if hand/wrist eczema began before or after their enrolment in a nursing school; (e) history of atopic dermatitis (“Have you ever had an itchy rash that has been coming and going for at least 6 months, and at some time has affected skin creases? By skin creases we mean folds of elbows, behind the knees, fronts of ankles, under buttocks, around the neck, ears, or eyes”).

Occupational physicians used the validated Osnabrück Hand Eczema Severity Index (OHSI) that scores the extent of skin affected by erythema, scaling, papules, vesicles, infiltration, and fissures^{30, 31} to clinically examine skin on the hands/wrist.

Standard skin prick test (SPT) was performed using commercial latex allergen, positive

control solution of histamine (10 mg/mL), and a negative buffer control solution (Diater Laboratorios, Madrid, Spain). A reaction was considered positive when the mean wheal diameter evaluated after 15 minutes was larger than that of the negative control by more than 3 mm, calculated as $(D + d)/2$, where D is the largest longitudinal diameter and d is its midpoint orthogonal diameter.^{32, 33} Standard patch testing was performed with a baseline series of commercial contact allergens (potassium dichromate, *p*-phenylenediamine, thiuram mix, neomycine sulfate, cobalt chloride, benzocaine, clioquinol, colophonium, paraben mix, N-isopropyl-N-phenyl-4-phenylenediamine, lanolin, mercapto mix, epoxy resin, Peru balsam, 4-tert-butylphenolformaldehyde resin, 2-mercaptobenzothiazole, formaldehyde, fragrance mix I, sesquiterpene lactone mix, quaternium 15, primin, methylisothiazolinone + methylchloroisothiazolinone, budesonide, textile dye mix) and additional disinfectants (chlorhexidine digluconate, benzalkonium chloride, glutaraldehyde) (Chemotechnique diagnostics, Malmo, Sweden) on Curatest plaster strips (Lohmann, Neuwied, Germany). Occlusion was removed on day 2 and skin reactions were read on days 2 and 3. A reaction was considered positive according to the ICDRG criteria when erythema, infiltration, or vesicles (“+,” “++,” or “+++”) were present on day 3.³⁴

2.3 Statistical analysis

Characteristics of the participants were summarized using descriptive statistics. The studied outcomes were one or more skin changes on clinical examination, severity of these changes expressed by OHSI score, self-reported hand eczema, and skin reactions to latex and contact allergens. The studied predictors of the outcomes were personal factors (age and sex) and work-related factors (duration of practical work, frequency of hand washing, hand disinfection, and glove usage). Significance of associations of the predictors with the outcomes was analysed with the Pearson chi-square test (or Fisher exact test if the subgroup frequency was <5) for categorical variables, and Mann–Whitney test for non-normally distributed continuous variables. The associations were considered to be statistically significant at a P value of <.05. Analyses were performed with the statistical software R Studio (Boston, MA, USA).³⁵

3 RESULTS

3.1 Characteristics of hand eczema

The characteristics of the study participants are summarized in Table 1, for the entire sample and in the subgroup of nursing apprentices with one or more skin changes found on clinical examination of hands (117 apprentices, 49% of the total sample) and in those without any changes (123 apprentices, 51%). Those with skin changes were slightly but significantly older than those with healthy skin (Table 1; Mann–Whitney test, $P < .001$). The most common skin changes on hands were erythema (103 apprentices, 88% of those with symptoms), infiltration (88 apprentices, 75%), and desquamation (33 apprentices, 28%). Papules were found in one (1%), vesicles in one (1%), and fissures in 15 (13%) apprentices.

Only in one apprentice the fissures were deep and haemorrhagic. Regarding the severity of symptoms, the median OHSI was 4 (IQR 2-6, total range 1-25). History of atopic dermatitis was similarly reported in participants with and without skin changes found on clinical examination. Around 10% more smokers were noted among participants who had changes on the clinical examination in comparison to those without skin changes, but the association did not reach significance (χ^2 test, $P = .077$; Table 1).

TABLE 1. Characteristics of nursing apprentices and differences between those with and without hand eczema

Characteristics	Total study sample (N = 240)	Apprentices with ≥1 skin changes on clinical examination (N = 117)	Apprentices without skin changes on clinical examination (N = 123)	P value	Apprentices with chronic HE ^a (N = 60)	Apprentices without HE ^b (N = 82)	P value
Age (y), median (IQR, TR)	19 (19-20, 18-21)	20 (19-20, 18-21)	19 (19-20, 18-21)	<.001	20 (19-20, 18-21)	19 (19-20, 18-21)	<.001
Women, n (%)	181 (75)	83 (71)	98 (80)	.116	49 (82)	60 (73)	.236
Smokers, n (%)	93 (39)	52 (44)	41 (33)	.077	32 (53)	22 (27)	.001
History of atopic dermatitis, n (%)	51 (21)	23 (20)	28 (23)	.557	15 (25)	13 (16)	.176
Practical work, median (IQR, TR)							
Days/month	13 (12-20, 3-30)	15 (12-20, 3-30)	12 (12-20, 3-26)	.001	12 (12-20, 3-25)	12 (12-20, 3-25)	.294
Hours/day	6 (5-7, 0.5-10)	6 (5-7, 3.5-10)	6 (5-7, 0.5-10)	.187	6 (5-7.5, 4-10)	6 (5-6, 0.5-10)	.221

Note: P-values less than 0.05 are presented in bold.
Abbreviations: HE, hand eczema; IQR, interquartile range; TR, total range.

- ^a Apprentices with the history of hand eczema that lasted more than 3 months.
- ^b Apprentices with no history of hand eczema ever in life and no skin changes on clinical examination.

Significance of difference was tested by chi-square test of Fisher exact test for categorical variables and Mann–Whitney test for noncategorical variables.

* Looking at the distribution of all categories between the groups with and without symptoms.

Self-reported hand/wrist eczema during lifetime was observed in 111 apprentices (46% of the total sample), and among them 84 (76%) stated that it began after their enrolment to the nursing school. On a scale of 0 to 10, the apprentices rated the severity of their current hand eczema with a median of 4 (IQR 3-5, total range 1-9), and when it was worst with a median of 6 (IQR 4-7, total range 0.5-10). Self-reported hand/wrist eczema during lifetime was reported in 70 (60%) participants who had changes on the clinical examination (N = 117), and in 41 (33%) participants without clinically found changes (N = 123). Comparison of apprentices with chronic hand eczema (history of hand eczema that lasted more than 3 months; N = 60) and those without hand eczema (no history of hand eczema and no clinically found symptoms; N = 82) determined significantly higher age and the frequency of smoking in apprentices with chronic hand eczema (Table 1). In the subgroup of apprentices with chronic hand eczema, 36 (60%) reported that eczema started after the beginning of the apprenticeship, and the same result was found for apprentices who were allergologically tested (25/42, 59.52%).

Results of the SPT and patch test reactions were investigated only by descriptive statistics due to the small number of tested participants and positive reactions. Of the 42 apprentices tested by SPT to latex and patch test to contact allergens, there were no positive reactions to latex, and 11 (26%) had a positive patch test reaction to one or more tested contact allergens, mostly metal salts (Table 2). Analysis regarding differences between the patch test-positive (N = 11) and patch test-negative (N = 31) participants did not find significant differences in all analysed parameters, including OHSI score and observed skin changes (data not shown).

TABLE 2. Eleven apprentices (26%) with positive patch test reactions (day 2/day 3 readings)

Contact allergens ^a	1	2	3	4	5	6	7	8	9	10	11
Nickel sulfate (5.0% pet.)	++/+++					0/++				0/++	
Cobalt chloride (1.0% pet.)		+/+					+/+				
Potassium bichromate (0.5% pet.)					+/+		0/+				
Paraben mix (16% pet.)											0/+
Colophonium (20.0% pet.)									+/++		
Clioquinol (5.0% pet.)				+/+							
2-mercapto-benzothiazole			+/+								

Contact allergens ^a	1	2	3	4	5	6	7	8	9	10	11
(2.0% pet.)											
Benzalconium chloride (0.1% pet.)								+/+			

^a pet., petrolatum; no positive skin reactions were observed to *p*-phenylenediamine (1.0% pet.), thiuram mix (1.0% pet.), neomycine sulfate (20.0% pet.), benzocaine (5.0% pet.), *N*-isopropyl-*N*-phenyl-4-phenylenediamine (0.1% pet.), lanoline (30.0% pet.), mercapto mix (2.0% pet.), epoxy resin (1.0% pet.), balsam of Peru (25.0% pet.), 4-tert-butylphenoleformaldehyde (1.0% pet.), formaldehyde (2.0% aqua), fragrance mix I (8.0% pet.), sesquiterpen lactone mix (0.1% pet.), quaternium 15 (1.0% pet.), primin (0.01% pet.), methylizotiazolinone (0.02% aqua), budesonide (0.01% pet.), textile dye mix (6.6% pet.), glutaraldehyde (0.2% pet.), and chlorhexidine digluconate (0.5% aqua).

3.2 Occupational risk factors

Practical work constituted most of the apprentices' curriculum for the last year of education. Those with skin changes reported more days and hours per month spent on practical work in comparison to those with healthy skin (Table 1). Work-related habits were not significantly associated with objectively found symptoms and self-reported hand eczema (when these participants were compared with those who reported never having hand eczema), except in a subgroup of apprentices with chronic hand eczema who significantly more frequently reported washing hands more than 20 times per day in comparison to those with no hand eczema (Table 1). Frequent hand washing (>20 times per day) was rarely reported in a total sample, one-third of apprentices reported disinfecting their hands for more than 20 times per day with alcohol-based hand disinfectants, and none reported disinfection of their hands with other types of disinfectants as frequently. Forty percent of participants reported wearing gloves for more than 2 hours per day. Duration of gloves usage per day was not significantly associated with skin symptoms, both when taking into consideration the distribution of all time-based categories (Table 1) and with a cut-off of 2 hours per day, which was investigated due to the small number of participants in extreme categories. Most apprentices reported wearing latex gloves without powder (119 apprentices of 238 who reported using gloves, 50%), while others reported wearing latex gloves with powder (58 apprentices, 24%), nitrile gloves (7%), and various combinations of latex, nitrile, PVC (polyvinyl chloride), and cotton gloves.

4 DISCUSSION

Half of the final-year apprentice nurses had clinically determined signs of skin inflammation on the hands/wrists, and 46% reported hand eczema during their lifetime, similar to a comparative German study (43%),²⁶ but much higher than in a comparative Dutch study

(31%).²⁷ Self-reported history of atopic dermatitis was not associated with clinically found skin changes. Our results suggest that the majority of hand eczema among our sample of apprentice nurses were of irritative origin. According to the results of patch testing, 26% of apprentices with chronic hand eczema had contact sensitization, mostly to ubiquitous allergens (ie, nickel, cobalt, chromium). Only 2 apprentices had possible occupational contact sensitization to a rubber additive (2-mercaptobenzothiazole) and a disinfectant (benzalconium chloride), respectively. Nickel was addressed as a possible occupational allergen from tools for HCWs.²⁸ However, the common non-occupational exposures to nickel from early life, and expected only occasional occupational exposures of a short duration to nickel from tools during vocational education do not suggest that found contact sensitization to nickel is occupationally relevant in our participants. In addition, while 76% of apprentices with self-reported hand eczema said that hand eczema occurred after their enrolment to vocational school, this proportion was 60% for patch tested apprentices. This difference is in line with more non-occupational sources of hand eczema in the subgroup of apprentices with chronic hand eczema, with sensitization to nickel being one of them. It should be mentioned that the field design of our study limited reading of patch test reactions to only days 2 and 3, and was not achievable around day 7,³⁴ which could result in some false-negative patch testing.

There is little comparative data in the literature regarding patch testing of apprentices. In an intervention study from Denmark by Held et al,²⁸ apprentice nurses were patch tested with 8 selected contact allergens evaluated as occupationally relevant: nickel, fragrance mix, formaldehyde and methylchloroisothiazolinone/methylisothiazolinone, colophonium, thiuram mix, mercapto mix, and mercaptobenzothiazole. Similarly to our study, patch testing revealed that contact sensitization was observed mainly with nickel (25% in the intervention group and 38% in the control group), whereas the other tested allergens were rarely positive (two participants to fragrance mix, two to colophonium, and one to mercapto mix). Apprentice nurses were patch tested also in a study by Smit et al,¹² using the European standard series valid at the time of the study, which included 23 of the most common allergens. In contrast to our study with patch testing performed at the end of apprenticeship, apprentices in the study by Smit et al¹² were patch tested at the start of the study (ie, during the first stage of practical training). Positive patch tests to one or more tested contact allergens were established in 32.5% of apprentice nurses, with nickel as the dominant allergen (24.1% tested positive to nickel), and contact sensitization was not found as a predictor of hand dermatitis.¹² These findings also support non-occupational origin of sensitization to nickel in apprentice nurses. Studies performed in samples of HCWs confirm the domination of irritative contact dermatitis in HCWs with OSDs,³⁶ particularly in women,¹⁷ but contact sensitization or allergic contact dermatitis was found at a higher proportion of around 50% in HCWs with hand eczema^{36, 37} compared with our results in apprentice nurses with hand eczema (26%). The most frequently found occupational contact allergy in HCWs with OSDs was to rubber additives in medical gloves (thiurams, diphenylguanidine), preservatives (formaldehyde, isothiazolinones), and disinfectants (glutaraldehyde).^{36, 38, 39} It

seems that the development of allergic contact dermatitis due to occupational allergens during apprenticeship is not common in nurses. In contrast to this, the development of irritative contact dermatitis seems common in this population, keeping in mind high proportions of self-reported hand eczema in this population in our study and studies from Germany and the Netherlands (31%-46%),^{26, 27} in contrast to HCWs who reported hand eczema prevalence at around 20%.¹⁻⁴ A recent systematic review suggested that a higher incidence of occupational contact dermatitis during apprenticeship compared with HCWs was due to the “healthy worker effect,” with the selection of susceptible persons during training.²²

Furthermore, we found no signs of type 1 NRL allergy among apprentice nurses with chronic hand eczema, despite the fact that most of them (74%) used only latex gloves during practical training. Again, there is little comparative data in the literature to confirm this. In a follow-up study on apprentices in dental hygiene published in 2001, the cumulative incidence for skin sensitization to latex was 6.4%.⁴⁰ Similar results were found in a Croatian study on dental workers (dentists, assistants, technicians) and students, with 7% of participants positive to the NRL allergen following an SPT.²⁰ In a study from Denmark, NRL allergy was diagnosed in 2.5% of HCWs with hand eczema,³⁷ but in a similar Australian population the prevalence of NRL allergy was as much as 13%.³⁶ A recent systematic review on OSDs in physicians showed the prevalence of NRL allergy within 2.4% to 14.9%.³⁹ Such differences in the prevalence of NRL allergy in HCWs are probably due to the varying extent of implemented preventive measures regarding NRL allergy in different countries. Prevention measures are implemented mostly in high-income countries, with indications of good effects in reducing NRL allergy. Because of the excellent properties of NRL as a raw material for medical gloves, banning the use of NRL is not recommended. However, efforts toward achieving lower protein content and cross-reactive structures in NRL products, as well as toward using powder-free NRL gloves should be increased, keeping in mind that the risk of NRL allergy is still present in occupational settings.^{19, 41}

Regarding the severity of hand eczema, the median OHSI was 4 (IQR 2-6, total range 1-25) in apprentice nurses, which is higher than in our previous study on final-year hairdressing apprentices (median 3, IQR 2-4).²⁵ On a scale of 0 to 10, the apprentices rated the severity of their current hand eczema with a median of 4 (IQR 3-5, total range 1-9), and when it was worst with a median of 6 (IQR 4-7, total range 0.5-10). In comparison to final-year hairdressing apprentices, the self-rating of current hand eczema severity was again higher in apprentice nurses than in hairdressing apprentices (median 1.5, IQR 0-3), but the rating of the most severe period of hand eczema was similar.²⁵ Although the most commonly observed skin changes on hands (erythema and infiltration) indicate development of mild contact dermatitis in apprentice nurses, signs of more severe clinical forms of contact dermatitis (desquamation and fissures) were also not rare. Altogether, our findings suggest a significant prevalence of irritative hand eczema in final-year apprentice nurses, with self-rated symptoms and clinical signs in line with a mild to moderate severity of disease, and no

association with the self-reported history of atopic dermatitis. One should keep in mind that our study was performed during the COVID-19 pandemic, which brought about new preventive hygiene regimens including increased frequency of hand washing and disinfection and protective glove usage in HCWs,⁴² with the consequence of an increase in the prevalence of skin damage on the hands of HCWs.^{43, 44} Such results cannot be discussed here normally due to the lack of prepandemic data. However, the higher prevalence and severity of clinically observed and self-reported hand eczema found in final-year apprentice nurses in comparison to final-year hairdressing apprentices,^{23, 25} and the lack of association with atopic dermatitis, could indicate a certain degree of impact of pandemic preventive hygiene regimens.

The apprentice nurses from this study showed in average good knowledge and behaviour regarding skin protection at work, rarely washing their hands more than 20 times per day and mostly using alcohol-based hand disinfectants. Alcohol-based hand disinfectants are considered less irritative than classical hand washing with soap and detergents in terms of OSD prevention.^{2, 36, 45} They were recommended as the first step of a good hand hygiene regimen in a recent position paper of European experts about the minimum standards in the prevention of occupational contact dermatitis.⁴⁶ A good hand hygiene regimen is even more important in pandemic conditions and has been emphasized from the beginning of the pandemic by additional educative material in the form of a brochure available to the general public in Croatian and English at the website of our institute.⁴⁷ Importance of adequate preventive behaviour is additionally emphasized in our results on a subgroup of apprentices with chronic hand eczema, which was associated with behavioural risk and lifestyle factors, including frequent hand washing and smoking. A number of studies reported association of smoking with the prevalence rate, severity, or poor prognosis of hand eczema, particularly in high-risk occupations.⁴⁸⁻⁵⁰ However, nurses cannot avoid wearing protective gloves at work and 40% of our participants wore gloves 2 or more hours per day, mostly latex gloves with powder. Work-related habits were separately not associated with clinical signs of hand eczema, including absence of latex allergy. Signs of hand eczema were significantly associated with the age of participants and the duration of exposure to combined risk factors at work, confirming the importance of cumulative hazardous effects on the skin barrier. Similar findings were found in our previous study comparing hairdressing apprentices from two Croatian regions with different durations of practical training, indicating that a higher extent of exposure to skin hazards was related to poorer skin barrier function observed by transepidermal water loss.⁵¹ In addition, skin lesions on the hands appeared more frequently with longer work experience in a sample of Croatian dental workers.²⁰

In conclusion, clinically observed and self-reported hand eczema was fairly common in final-year apprentice nurses during the COVID-19 pandemic, with the prevalence of 49% and 46%, respectively. Hand eczema was mostly of irritative origin, and mild to moderate severity. It was associated with the age of apprentices and duration of practical training, confirming a

cumulative effect of skin hazards on the skin barrier. Contact sensitization was present in 26% of apprentices with chronic hand eczema, but rarely to occupational allergens such as rubber additives and disinfectants, while immediate sensitization to the NRL allergen was not present. Chronic hand eczema was in apprentices additionally associated with frequent hand washing and smoking, emphasizing the importance of promoting protective behaviour and lifestyle, particularly in apprentices and young workers in high-risk occupations.

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AUTHOR CONTRIBUTIONS

Franka Šakić: Conceptualization (equal); data curation (equal); investigation (equal); project administration (lead); resources (lead); writing – original draft (equal); writing – review and editing (equal). **Željka Babić:** Data curation (equal); formal analysis (lead); investigation (equal); methodology (equal); writing – review and editing (equal). **Zrinka Franic:** Data curation (equal); investigation (equal); methodology (equal). **Jelena Macan:** Conceptualization (equal); data curation (equal); funding acquisition (lead); investigation (equal); methodology (equal); resources (equal); supervision (lead); writing – original draft (equal); writing – review and editing (equal).

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

Open Research



DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical restrictions.

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