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Hands4U

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Document Version
Publisher's PDF, also known as Version of record

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Hands4U: the effects of a multifaceted implementation strategy on hand eczema prevalence in a healthcare setting. Results of a randomized controlled trial

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Summary

Background. Healthcare workers have an increased risk of developing hand eczema. A multifaceted implementation strategy was developed to implement a guideline to prevent hand eczema among healthcare workers.

Objectives. To investigate the effects of the implementation strategy on self-reported hand eczema and preventive behaviour.

Methods. A randomized controlled trial was performed. A total of 48 departments (n = 1649) were randomly allocated to the multifaceted implementation strategy or the control group. The strategy consisted of education, participatory working groups, and role models. Outcome measures were self-reported hand eczema and preventive behaviour. Data were collected at baseline, and 3, 6, 9 and 12 months of follow-up.

Results. Participants in the intervention group were significantly more likely to report hand eczema [odds ratio (OR) 1.45; 95% confidence interval (CI) 1.03–2.04], and they reported significantly less hand washing (B, − 0.38; 95%CI: − 0.48 to − 0.27), reported significantly more frequent use of a moisturizer (B, 0.30; 95%CI: 0.22–0.39) and were more likely to report wearing cotton undergloves (OR 6.33; 95%CI: 3.23–12.41) than participants in the control group 12 months after baseline.

Conclusions. The strategy implemented can be used in practice, as it showed positive effects on preventive behaviour. More research is needed to investigate the unexpected effects on hand eczema.

Key words: hand eczema; healthcare workers; implementation; randomized controlled trial; workplace.

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Hand eczema is one of the most prevalent occupational diseases (1). Although the aetiology of the condition is multifactorial (2), the work environment can have a large influence, as workers can be exposed to skin irritants during their work (3). In the healthcare setting, many irritants are handled during work, such as water (from frequent hand washing) and protective gloves (4). Therefore, healthcare workers are at risk of developing hand eczema (5). A recent study in The Netherlands showed that almost half of healthcare workers reported symptoms related to hand eczema (6).

Hand eczema has a large impact on the patient's health-related quality of life (7, 8), and it has a poor long-term prognosis (9). In addition, there are consequences for society as a whole, as the annual societal costs of occupational hand eczema are nearly €9000 per patient (10).

Because of the high prevalence of hand eczema among healthcare workers, and the impacts on the individual and society, several studies have focused on the primary and secondary prevention of occupational hand eczema in a healthcare setting (11–14). Although all four studies showed an effect on (part of) the preventive behaviour of healthcare workers (11–14), and three showed effects on clinical symptoms of hand eczema (11, 13, 14), these studies also had shortcomings. In two of the studies the follow-up period was very short (12, 13), and in the study of Dulon et al. the response at follow-up for the intervention group was < 30% (11). Moreover, Löffler et al. (14) and Held et al. (12) focused on individual workers rather than healthcare departments as a whole, and factors at a departmental level – such as support of a supervisor and colleagues – might influence the implementation of, in this case, recommendations to prevent hand eczema (15). More research is thus needed to investigate how to prevent hand eczema in a healthcare setting.

The Netherlands Society of Occupational Medicine (NVAB) developed a guideline containing evidence-based recommendations with the goal of preventing hand eczema in an occupational setting (16). Unfortunately, many new guidelines are not implemented in practice (17). Therefore, we designed a multifaceted implementation strategy to prevent hand eczema among healthcare workers by implementing the evidence-based recommendations from the guideline. The multifaceted implementation strategy was evaluated as a two-armed randomized controlled trial, called the Hands4U study. The primary aim of the Hands4U study was to investigate the effects of the multifaceted implementation strategy on self-reported

hand eczema by healthcare workers 1 year after baseline. Secondary aims were to investigate the effects of the strategy on (i) self-reported symptoms related to hand eczema, (ii) self-reported health of the skin, and (iii) behaviour related to the prevention of hand eczema.

Materials and Methods

Study design

This study was a two-armed randomized controlled trial. Randomization to the control or the intervention group was performed at a departmental level. Healthcare workers within the intervention departments received the multifaceted implementation strategy, whereas healthcare workers in the control departments received a minimal implementation strategy. Data were collected at baseline, and at 3, 6, 9 and 12 months after baseline. The data collection started in April 2011(18) and ended in June 2013.

The Medical Ethics Committee of the VU University Medical Centre in Amsterdam approved the study protocol. The Medical Ethics Committee decided that participants did not have to sign an informed consent form, as departments were included as a whole.

Study population

The study population for this study was recruited from three university hospitals: one academic centre for dentistry, two general hospitals, and two nursing homes from different cities in The Netherlands. Departments could participate when the workers within the department handled irritants during their work (e.g. water, soap, gloves, and food). A total of 48 departments were recruited between April 2011 and May 2012. Inclusion criteria for workers at those departments were: (i) being employed at one of the participating hospitals; (ii) being able to fill out Dutch questionnaires; (iii) being aged between 18 and 64 years; and (iv) working for at least 8 hr weekly. Not handling irritants during work was the only exclusion criterion.

Randomization, stratification, and blinding

To avoid contamination between healthcare workers within departments, randomization took place at the level of departments and, for practical reasons, it took place before the baseline measurements. Pre-stratification was used to establish equal groups at the departmental level, with the markers being the risk of hand eczema and whether the workers had contact with patients. Workers

Table 1. Main recommendations for the prevention of hand eczema according to the Netherlands Society of Occupational Medicine guideline (16)

1. When there is no visible contamination of the hands, use an alcohol-based hand disinfectant instead of water and soap to disinfect the hands*
2. Wear gloves when performing wet work
3. Wear cotton undergloves when you wear gloves for longer than 10 min
4. Use a moisturizer on a daily basis to nurse the skin and do not use a body lotion
5. Do not wear jewellery at work
6. Perform as little wet work as possible

*This means that the use of disinfectant should be increased and the use of water and soap should be decreased.

were not informed about the design of the study and the outcome of the randomization. Only the department managers were informed about the randomization outcome and study design. Workers within all participating departments (intervention and control) received information about the goal of the study (the prevention of hand eczema in healthcare workers) via a letter and a leaflet.

It was impossible to blind researchers, occupational nurses, and department managers. Detailed information about the randomization, stratification and blinding has been described previously (18).

Intervention group: multifaceted implementation strategy

The intervention group received the multifaceted implementation strategy. This strategy contained several components, namely participatory working groups, role models, an educational programme, including reminders, and a leaflet. All components were guided by a trained occupational nurse. A detailed description of the implementation strategy can be found elsewhere (18).

Leaflet. The leaflet contained the evidence-based recommendations for the prevention of hand eczema. These recommendations were derived from the guideline 'Contact Dermatitis' from the NVAB (16) (Table 1).

Participatory working groups. The participatory working groups constituted the main component of the multifaceted implementation strategy. Within every intervention department, one working group was formed. The goal of the working group was to identify problems with compliance with the recommendations, to find solutions for these problems, and to implement the solutions within their department. Every working group met three times.

Role models. Alongside the meetings of the participatory working groups, the members were trained to become role models for their colleagues, the so-called 'Dermacoaches'. The Dermacoaches learned how to stimulate and motivate their colleagues to perform behaviours related to the prevention of hand eczema, and to put this into practice within their department.

Education and reminders. During a short educational session planned during regular meetings, all workers within intervention departments were informed about their risk of developing hand eczema, the prevention of hand eczema, and how to use the preventive measures. All workers who were present at the educational session received a bag with one moisturizer, a pair of cotton under gloves, and two disinfectants. If necessary, more sessions were held at a department to increase the reach of the education. Afterwards, the Dermacoaches placed posters with key messages (which functioned as reminders) at relevant places throughout the department.

Control group

In the control group, the same leaflet was distributed as to the intervention group. This leaflet was considered to be a minimal implementation strategy.

Data collection

All workers included in the study received the baseline questionnaire. Baseline measurements were conducted in January, February, March, April, May, September, and November, depending on the time of enrolment of a department. The workers who filled out the baseline questionnaire also received questionnaires at 3, 6, 9 and 12 months after baseline. To enlarge the response to the questionnaires, we sent a maximum of three reminders. Questionnaires were mainly distributed via e-mail (online questionnaire), and in some cases – on request – via postal mail (printed questionnaires).

Outcome measures

Hand eczema (primary outcome measure). The primary outcome measure of this study was the prevalence of hand eczema presence in the past 3 months, as measured with the Nordic Occupational Skin Questionnaire – 2002 (NOSQ-2002) (19, 20), which was used as a tool for self-reporting. We combined the questions D1 ('Have you ever had hand eczema?'), D2 ('Have you ever had eczema on your wrists or forearms?'), and D5 ['When did you last have eczema on your hands, wrists, and forearms? (I have

it just now; not just now, but within the past 3 months; between 3 and 12 months ago; more than 12 months ago)'] to create a dichotomous measure. The presence of hand eczema in the past 3 months was defined as answering 'yes' to question D1 or D2, and choosing one of the following answer categories for question D5: 'I have it just now' or 'Not just now, but within the past 3 months'. This measure was assessed every 3 months.

Symptoms related to hand eczema. We used a symptom-based questionnaire to assess whether or not participants reported symptoms related to hand eczema. This questionnaire was derived from a questionnaire from the NVAB containing questions about the occurrence of specific symptoms related to hand eczema in the past 3 months (16). The questionnaire contained the following questions: 'Did you have one of the following complaints on your hands or fingers in the past 3 months?' [Vesicles on palms, back of hands or side of fingers (yes/no); red and swollen hands or fingers (yes/no); red papules on hands or fingers (yes/no); scaling on hands or fingers (yes/no); itchy hands or fingers (yes/no); hands or fingers with fissures (yes/no)]. The presence of hand eczema symptoms was defined as having at least one symptom related to hand eczema in the past 3 months. In addition, we separately reported on the symptoms: red and swollen hands or fingers; itchy hands or fingers; and scaling on hands or fingers. The reason behind choosing these particular three symptoms was that we expected the participants in our study to have a mild form of hand eczema (6), and these three symptoms are associated with mild hand eczema (16, 21). All of these measures were assessed every 3 months.

Health of the skin. Workers assessed the health of the skin on their hands by means of the following question: 'How would you judge the health of your hands/forearms at the moment on a scale from 0 to 10?' (0, unhealthy skin; 10, healthy skin). This question was based on question D12 of the NOSQ-2002 (19). This question was included in the questionnaire at baseline, and after 6 and 12 months.

Preventive behaviour related to hand eczema. A partially modified version of the NOSQ-2002 was used to measure the behaviour of the healthcare workers regarding their compliance with the recommendations for the prevention of hand eczema included in the NVAB guideline. These recommendations are shown in Table 1 (19, 20). As the questions had to be in accordance with the specific work environment of the healthcare workers, these modifications were necessary. We will describe, per question, whether we modified the specific question, and, if so, how we modified it.

For the frequency of hand washing per day, the original question E8 from the NOSQ-2002 was used without modification: 'How many times a day do you wash your hands during a usual working day? (1, 0−5 times; 2, 6−10 times; 3, 11−20 times; 4, more than 20 times)'.

Second, we measured the frequency of disinfectant use. A new question was constructed based on question E8 to ask about the frequency of using disinfectant, as the NOSQ-2002 did not incorporate a question for this behaviour: 'How many times a day do you use disinfectant during a usual working day?' (1, 0−5 times; 2, 6−10 times; 3, 11−20 times; 4, more than 20 times).

Third, we modified question E1 of the NOSQ-2002 to measure the average duration of wearing gloves per day. Originally, this question consisted of two questions ['Have you ever used protective gloves in your work' (no, never; yes, at present; yes, but not at present) and 'How many hours per day on average?']. From these two original questions, we constructed a single question: 'How many hours do you wear gloves during a usual working day?'

Four new questions were constructed to measure the use of moisturizers, body lotion, jewellery, and cotton undergloves. We used question E1 of the NOSQ-2002 as the foundation for these questions. An example of one of these newly constructed questions is: 'Do you wear cotton undergloves during your work?' (0, no, never; 1, yes, once in a while; 2, yes, daily). We decided to dichotomize the following questions, owing to the distribution of the answers: body lotion, wearing jewellery (0, yes daily/yes, once in a while; 1, no, never); and cotton undergloves (0, no, never; 1, yes, once in a while/yes, daily).

We measured exposure to wet work by means of the original question E5 from the NOSQ-2002 ('What are you doing or handling in your work at present?'). However, we changed the term 'wet work' into 'Activities where your hands become wet or moist'. We also added an extra answer category ('never'), creating the following answer categories: 1, never; 2, less than 0.5 hr; 3, 0.5−2 hr; 4, more than 2 hr.

Except for the question on wet work, all of the questions were assessed every 3 months. The question on exposure to wet work was measured at baseline, and at 6 and 12 months after baseline.

In addition to the separate questions on preventive behaviour, we constructed a measure for total compliance with the recommendations in Table 1. Therefore, a sum score was created, ranging from 0 to 5, in which a participant received 1 point for each of the following behaviours: (i) performing wet work for <2 hr a day;

(ii) washing the hands ≤20 times a day; (iii) not using body lotion; (iv) not wearing jewellery during work; (v) using a moisturizer at least six times a day. This score was created for both baseline and for as the 6-month and 12-month marks. The cut-off points for these behaviours were based on the guideline 'Contact Dermatitis' from the NVAB (16). For the other behavioural determinants, such as the use of cotton undergloves and the use of disinfectant, the guideline did not contain directions for cut-off points. Therefore, the use of cotton undergloves and the use of disinfectant were not included in the compliance measure.

Covariates. At baseline, we assessed age (years), sex (male/female), number of working hours per week, number of years working in present job, having patient-related tasks (yes/no), and education level. Low or middle education was operationalized as follows: primary school, middle education, basic vocational education, secondary vocational education, or high-school degree. Higher education was operationalized as follows: higher vocational education or university degree.

Psychosocial work characteristics were measured at baseline by means of a Dutch version of Karasek's Job Content Questionnaire, containing the constructs 'decision authority' and 'co-worker support (22)'. We calculated the mean scores of the questions belonging to that construct.

Having an atopic predisposition was measured at baseline by means of a questionnaire from the NVAB (16). The questionnaire contained the following questions: 'Have you ever had an itching skin disease (yes/no)?', 'Have you ever had eczema at the flexural areas of your elbows or knees, your ankles or neck? (yes/no)', 'Do you have eczema at the moment at these skin areas or anywhere else? (yes/no)', 'If you had an itchy skin disease, did it start before you were 2 years old? (yes/no)', 'Have you ever had asthma, hay fever, or chronic bronchitis? (yes/no)', and 'Did you have a dry skin in the last 12 months? (yes/no)'. For every positive answer, the participant received 1 point. For the question 'If you had an itching skin disease, did it start before you were 2 years old? (yes/no)', the participant received 2 points. When a participant scored 3 points or more, we considered the participant to have an atopic predisposition.

Skin exposure during leisure time was measured at baseline by means of two questions: 'In the past 12 months, did you perform activities outside work – like gardening, fixing cars, or swimming – that involved skin exposure? (yes/no)', and 'In the past 12 months, did you perform care-related tasks outside work – like informal care, or care for children? (yes/no)'.

Statistical analyses

Linear and logistic multilevel analyses with random coefficients were performed to evaluate the effects of the multifaceted implementation strategy. The ordinal outcome variables were analysed with linear multilevel analyses. The outcome measures were hand eczema, hand eczema symptoms, health of the skin, and behavioural outcome measures. A four-level structure was used for all outcome measures [repeated measures (time); worker; department; and hospital]. For all analyses, the effect of interest was the difference between the control and intervention groups during the follow-up period of 12 months. All analyses were adjusted for the baseline values of the particular outcome variable.

For each outcome measure, both a crude and an adjusted analysis were performed. In the adjusted analyses, the following covariates were added to the models for all outcome measures: sex, age, education level, patient-related tasks, co-worker support, decision latitude, and working hours per week. In addition to the outcome measures on hand eczema (symptoms) and health of the skin, the following covariates were added to the model: atopic predisposition, skin exposure in leisure time, and the number of years working in the present job. For all other outcome measures, the following covariates were used: having hand eczema at baseline, and having hand eczema symptoms at baseline. We chose other covariates per outcome measure on the basis of the literature and the nature of the outcome measures.

The outcome measure 'wearing gloves' (hr/day) was analysed only for the subgroup of participants who performed wet work at baseline. This was necessary because the recommendation to wear gloves is applicable only to workers who perform wet work.

In this study, we considered a *p*-value of <0.05 to be statistically significant. All multilevel analyses were performed with MLWIN 2.18 (Centre for Multilevel Modelling, University of Bristol), and the other analyses were performed with IBM SPSS™ STATISTICS 20.0.

In addition to the multilevel analyses, we used transition models(18) as a secondary analysis to model transitions from hand eczema over time within a person, as hand eczema is a relapsing disease(1). These models enabled investigation of the effect of the intervention on the changes in the 3-month prevalence of hand eczema (primary outcome measure). The probability of reporting hand eczema given no hand eczema at the previous measurement occasion, and the probability of not reporting hand eczema given hand eczema at the previous measurement occasion, were modelled by means of a logistic mixed model. The transition models were conducted in STATA®
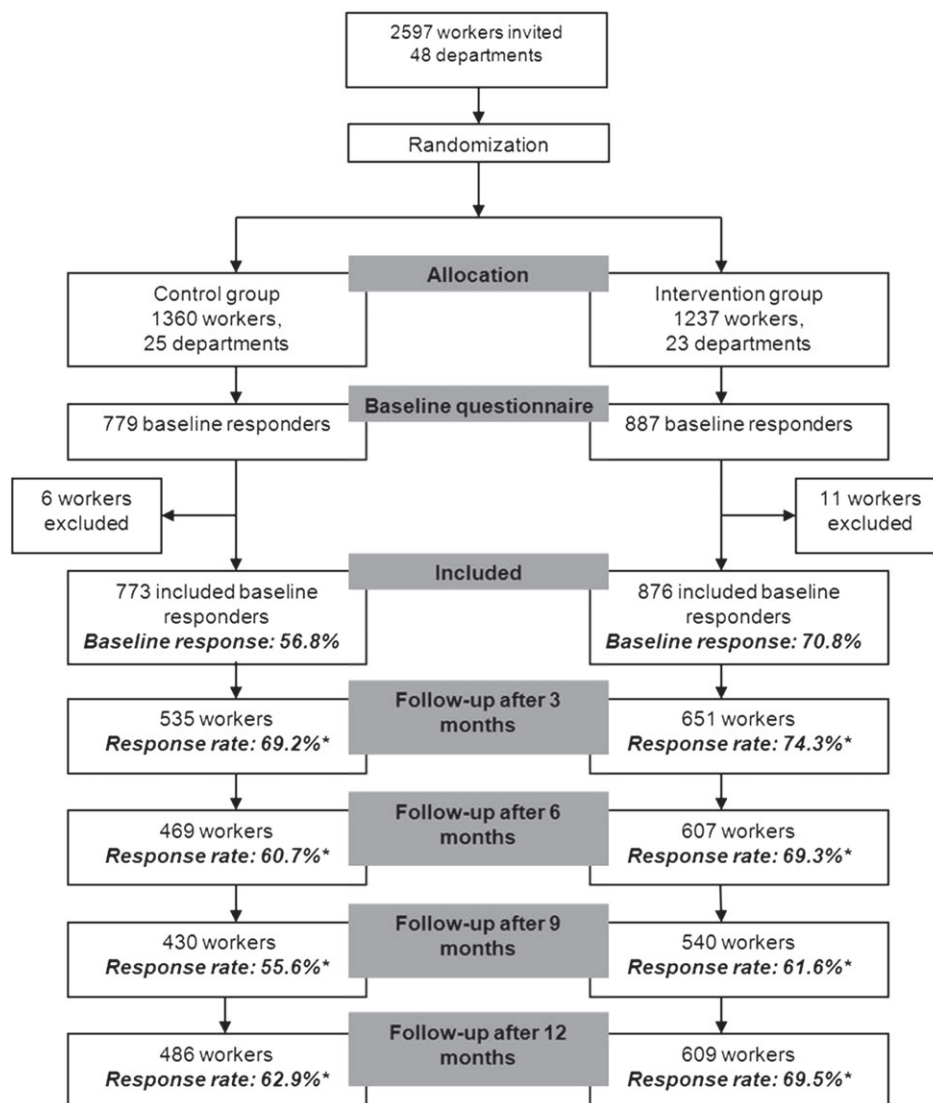
Fig. 1. Flow hart of participants during the phases of the trial based on the primary outcome measure.

version 11.2 (StataCorp), and were adjusted for covariates as necessary (23, 24).

Results

Figure 1 shows a flow chart based on the primary outcome measure of the study. At the start of the study, 2597 healthcare workers were invited to participate. Of those invited, 1666 responded to the baseline questionnaire (64.2%). In total, 17 of the 1666 respondents were excluded, because they worked for <8 hr a week (n = 7), or because they did not handle irritants during their work (n = 10). We included 1649 participants in the study, each of whom received follow-up questionnaires every 3 months until 12 months after baseline. At 12 months, 1095 participants (66.4%) filled out the question on the primary outcome measure (hand eczema). The non-responders at 12 months (33.6%) were 3 years younger, had worked 2 years less for their present employer and experienced less support from their colleagues (0.05 points) than the total population at baseline.

The baseline characteristics for the intervention and control groups are shown in Table 2. In the intervention group, 69.4% of the participants performed patient-related tasks and 57.4% had a high education level, as compared with 81.2% and 51.7%, respectively, in the control group.

Table 2. Baseline characteristics

	Total	Control group (n = 773)	Intervention group (n = 876)
Female, n (%)	1641	603 (78.3)	683 (78.4)
Education*, n (%)	1640	–	–
Low/middle	–	372 (48.3)	371 (42.6)
High	–	398 (51.7)	499 (57.4)
Age (years), mean (SD)	1635	40.8 (11.3)	40.7 (11.5)
Working hours per week, mean (SD)	1636	30.2 (8.8)	29.8 (8.1)
Years working at present company, mean (SD)	1638	11.3 (9.9)	12.3 (10.7)
Patient-related task (yes), n (%)	1641	626 (81.2)	604 (69.4)
Colleague support, mean (SD)	1600	3.1 (0.4)	3.1 (0.4)
Decision authority, mean (SD)	1603	2.8 (0.5)	2.8 (0.4)
Being exposed to irritants outside work (yes), n (%)	1625	673 (88.7)	774 (89.4)
Performing care-related tasks outside work (yes), n (%)	1625	309 (40.7)	369 (42.6)
Having an atopic predisposition (yes), n (%)	1633	203 (26.4)	212 (24.5)
Symptoms related to hand eczema at baseline (yes), n (%)	1635	359 (46.7)	361 (41.6)
Hand eczema at baseline (yes), n (%)	1649	80 (10.3)	64 (7.3)

SD, standard deviation.

*Low/middle education = primary school, middle education, basic vocational education, secondary vocational education, high-school degree; high education = higher vocational education or university degree.

Hand eczema (symptoms) and health of the skin

At baseline, 7.3% of the intervention group and 10.3% of the control group reported having had hand eczema in the past 3 months (Table 3). Having symptoms compatible with hand eczema in the past 3 months was reported by 41.6% of the intervention group and by 46.7% of the control group at baseline. Figures 2 and 3 show the prevalence of self-reported hand eczema and hand eczema symptoms during the study period.

Table 4 shows that the intervention group was significantly more likely to report hand eczema [odds ratio (OR) 1.45; 95% confidence interval (CI) 1.03−2.04] and hand eczema symptoms (OR 1.31; 95%CI: 1.06−1.61) 12 months after baseline than the control group. No statistically significant effects were found for the health of the skin, scaling, and redness.

Table 5 shows the effects of the intervention on the transitions of hand eczema. The intervention had an effect on the transition from not having hand eczema to having hand eczema (OR 1.71; 95%CI: 1.08−2.71) as compared with the control group. For the transition from having hand eczema to not having hand eczema, there was no statistically significant effect for the intervention group as compared with the control group.

Behaviour

The scores for washing hands, using disinfectant and wet work were between 2.3 and 2.8, respectively, for the intervention and the control groups at baseline on a scale from 1 to 4 (Table 3). At baseline, few people wore cotton undergloves, used body lotion or wore jewellery during work.

Statistically significant effects were found after 12 months (Table 4) for hand washing (B, −0.38; 95%CI: −0.48 to −0.27), use of a moisturizer (B, 0.30; 95%CI: 0.22−0.39), wearing cotton undergloves (OR 6.33; 95%CI: 3.23−12.41) and compliance with the guideline as a whole (B, 0.12; 95%CI: 0.02−0.21) when the intervention group was compared with the control group. This means that the intervention group reported less hand washing, reported more frequent use of a moisturizer, were significantly more likely to report using cotton undergloves and reported higher compliance with the NVAB guideline than the control group after 12 months.

Discussion

The multifaceted implementation strategy showed a negative effect after 12 months of follow-up on the primary outcome measure (self-reported hand eczema) for both the logistic multilevel analysis and the transition model, and on self-reported hand eczema symptoms, as compared with the control group. This implies that the intervention group was more likely to report hand eczema and hand eczema symptoms after 12 months than the control group. In contrast, the strategy had a positive effect (in terms of compliance with the NVAB guideline) on the frequency of hand washing (reduction), the use of a moisturizer, wearing cotton undergloves, and compliance with the guideline of the NVAB as a whole. The multifaceted strategy therefore succeeded in implementing the NVAB guideline, as preventive behaviour improved, but, within the time-frame of our study, showed negative effects on self-reported hand eczema (symptoms). This raises the

Table 3. Descriptive statistics for the outcome measures at baseline and at 3, 6, 9 and 12 months of follow-up

Outcome measure	Scale	Baseline		3 months		6 months		9 months		12 months	
		Control (n = 773)	Intervention (n = 876)	Control (n = 536)	Intervention (n = 651)	Control (n = 471)	Intervention (n = 607)	Control (n = 433)	Intervention (n = 546)	Control (n = 486)	Intervention (n = 611)
Hand eczema											
Hand eczema (yes), n (%)	–	80 (10.3)	64 (7.3)	61 (11.4)	89 (13.7)	39 (8.3)	57 (9.4)	35 (8.1)	59 (10.9)	47 (9.7)	69 (11.3)
Symptoms (yes), n (%)	–	359 (46.7)	361 (41.6)	198 (37.0)	268 (41.2)	143 (30.5)	198 (32.7)	146 (33.7)	197 (36.2)	158 (35.5)	198 (37.4)
Scaling (yes), n (%)	–	125 (16.2)	149 (17.1)	83 (15.5)	101 (15.5)	58 (12.4)	84 (13.9)	51 (11.8)	76 (14.0)	63 (14.1)	85 (16.0)
Itch (yes), n (%)	–	190 (24.7)	182 (21.0)	98 (18.3)	143 (22.0)	85 (18.1)	100 (16.5)	74 (17.1)	114 (21.0)	82 (18.3)	113 (21.3)
Redness/swollen (yes), n (%)	–	72 (9.4)	75 (8.6)	51 (9.5)	74 (11.4)	32 (6.8)	36 (5.9)	39 (9.0)	56 (10.3)	41 (9.2)	48 (9.1)
Healthy skin, mean (SD)*	0–10	8.3 (1.7)	8.4 (1.7)	–	–	8.5 (1.5)	8.4 (1.6)	–	–	8.2 (1.8)	8.1 (1.7)
Behaviour											
Hand washing, mean (SD)†	1–4	2.5 (1.0)	2.3 (1.0)	2.4 (0.9)	1.9 (0.8)	2.5 (0.9)	2.0 (0.9)	2.4 (0.9)	1.9 (0.8)	2.4 (0.9)	2.0 (0.9)
Use of disinfectant, mean (SD)‡	1–4	2.6 (1.1)	2.7 (1.1)	2.6 (1.1)	2.6 (1.1)	2.6 (1.1)	2.7 (1.1)	2.7 (1.1)	2.7 (1.1)	2.6 (1.1)	2.7 (1.1)
Wet work, mean (SD)†	1–4	2.8 (0.9)	2.6 (0.9)	–	–	2.8 (0.8)	2.6 (0.8)	–	–	2.7 (0.9)	2.5 (0.8)
Use of moisturizer, mean (SD)‡	0–2	0.9 (0.7)	0.9 (0.7)	0.8 (0.7)	1.0 (0.7)	0.9 (0.7)	1.1 (0.7)	0.8 (0.7)	1.1 (0.7)	0.9 (0.7)	1.2 (0.7)
Wearing gloves (hours), mean (SD)	–	2.3 (1.9)	2.2 (1.8)	2.2 (1.7)	1.9 (1.6)	2.3 (1.8)	2.0 (1.7)	2.2 (1.7)	1.8 (1.6)	2.3 (1.0)	2.2 (1.0)
Use of body lotion (no, never), n (%)	–	636 (85.8)	765 (89.8)	489 (92.1)	607 (94.0)	406 (88.3)	555 (93.4)	391 (90.7)	517 (95.4)	379 (85.9)	478 (92.8)
Wearing jewellery (no, never), n (%)	–	526 (85.8)	706 (83.7)	480 (90.4)	551 (85.3)	420 (91.5)	503 (84.7)	395 (91.6)	468 (86.3)	415 (93.7)	437 (84.9)
Wearing cotton undergloves (once in a while/daily), n (%)	–	19 (2.6)	16 (1.9)	10 (1.9)	13 (2.0)	14 (3.0)	53 (8.8)	7 (1.6)	46 (8.5)	11 (2.5)	56 (10.9)
Compliance with guideline, mean (SD)‡	0–5	3.4 (0.8)	3.4 (0.7)	–	–	3.5 (0.7)	3.6 (0.6)	–	–	3.5 (0.7)	3.7 (0.6)

SD, standard deviation.

*The higher the score on this scale, the healthier are the hands.

†The higher the score on this scale, the lower is compliance with the recommendations for the prevention of hand eczema.

‡The higher the score on this scale, the higher is compliance with the recommendations for the prevention of hand eczema.
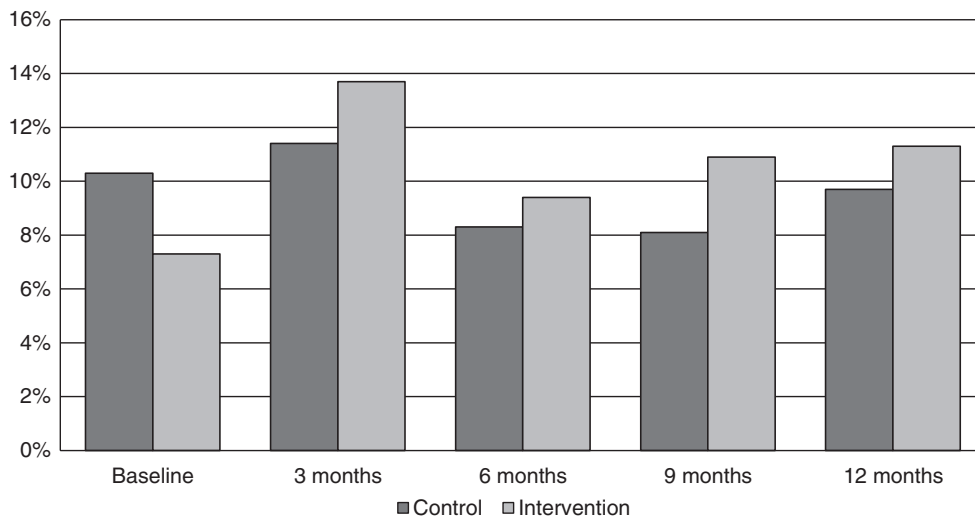
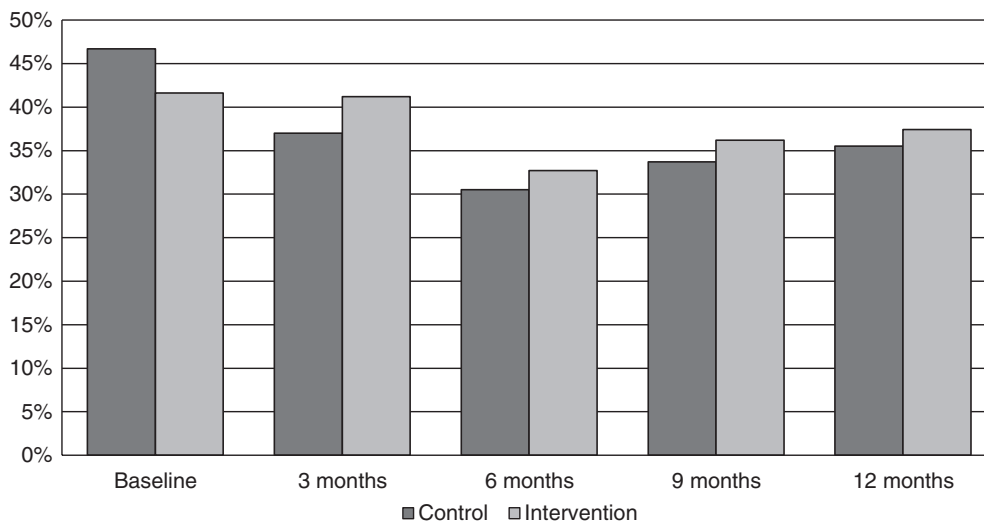**Fig. 2**. Self-reported hand eczema in the past 3 months.

Fig. 3. Self-reported symptoms related to hand eczema in the past 3 months.

question of how the implementation could have been successful while not leading to positive health outcomes for the healthcare workers.

Interpretation of results

The recommendations from the guideline that were implemented are evidence-based (25), and have been used in several trials that have obtained positive results for hand eczema outcomes after implementation (11, 14, 26). It is therefore unlikely that the increase in self-reported hand eczema could be a result of the improvement in behaviour based on the recommendations.

In this study, we used a self-reported measure for hand eczema, namely the NOSQ-2002. A study of Meding and Barregard showed that this type of questionnaire underestimates the prevalence of hand eczema by 30–60% as compared with assessment by a dermatologist (27). In the present study, we focused on a change in hand eczema over time. However, change becomes more difficult to establish when the prevalence of hand eczema is underestimated, as there is little room for improvement.

Apart from the underestimation reported by Meding and Barregard (27), the study population in the present study showed a 3-month prevalence of hand eczema at baseline that was lower than that found in

Table 4. Overall intervention effects for the outcome measures during 12 months of follow up (control group as reference category)

	Crude model	Adjusted model
Hand eczema[a]		
Hand eczema (yes), OR (95%CI)	1.51 (1.09–2.09)*	1.45 (1.03–2.04)*
Symptoms (yes), OR (95%CI)	1.29 (1.05–1.57)*	1.31 (1.06–1.61)*
Scaling (yes), OR (95%CI)	1.00 (0.76–1.32)	1.05 (0.79–1.39)
Redness/swollen (yes), OR (95%CI)	1.12 (0.81–1.54)	1.18 (0.84–1.64)
Itch (yes), OR (95%CI)	1.29 (1.01–1.63)*	1.32 (1.03–1.68)
Healthy skin (range: 0–10), B (95%CI)	− 0.09 (− 0.24 to 0.06)	− 0.08 (− 0.23 to 0.08)*
Behaviour[b]		
Washing hands (range: 1–4), B (95%CI)	− 0.38 (− 0.48 to − 0.27)*	− 0.38 (− 0.48 to − 0.27)*
Use of disinfectant (range: 1–4), B (95%CI)	0.04 (− 0.09 to 0.17)	0.06 (− 0.06 to 0.17)
Use of moisturizer (range: 0–2), B (95%CI)	0.29 (0.20–0.38)*	0.30 (0.22–0.39)*
Wearing gloves (hr/day), B (95%CI)	− 0.15 (− 0.48–0.18)	− 0.17 (− 0.52–0.19)
Wearing cotton undergloves (once in a while/daily), OR (95%CI)	5.35 (2.60–11.03)*	6.33 (3.23–12.41)*
Wearing jewellery (no, never), OR (95%CI)	0.95 (0.49–1.85)	1.00 (0.53–1.91)
Use of body lotion (no, never), OR (95%CI)	1.51 (0.95–2.39)	1.42 (0.88–2.28)
Wet work (range: 1–4), B (95%CI)	− 0.05 (− 0.15 to 0.05)	− 0.05 (− 0.14 to 0.04)
Compliance with guideline (range: 0–5), B (95%CI)	0.12 (0.02–0.21)*	0.12 (0.02–0.21)*

CI, confidence interval; OR, odds ratio.

[a]In the adjusted model, we included the following covariates: sex, age, education level, patient-related tasks, co-worker support, decision latitude, working hours per week, atopic predisposition, skin exposure in leisure time, and the number of years working at the present job.

[b]In the adjusted model, we included the following covariates: sex, age, education level, patient-related tasks, co-worker support, decision latitude, working hours per week, having hand eczema at baseline, and having hand eczema symptoms at baseline.

*$p < 0.05$.

Table 5. Intervention effects on the course of hand eczema during 12-months of follow-up, with time and having an atopic predisposition as covariates

	OR	95%CI	p-value
From no hand eczema to hand eczema	1.71	1.08–2.71	0.02
From hand eczema to no hand eczema	0.79	0.44–1.42	0.43

CI, confidence interval; OR, odds ratio.

other studies using the same questionnaire (6). On the basis of this, we hypothesized that healthcare workers in The Netherlands are less familiar with hand eczema because they may be less able to recognize their symptoms as hand eczema (6). Therefore, the educational session given during the intervention period might have increased awareness among the participants in the intervention group concerning their hand eczema symptoms. They may have evaluated their symptoms – which might have already been present at baseline – differently after the educational session. This might have led to an increase in hand eczema reports at follow-up as compared with the control group that may be independent of a change in clinical status. In addition, they might have been more likely to report not only hand eczema, but also more hand eczema symptoms, following the increased awareness in terms of symptom recognition. A study on prevention of hand eczema in auxiliary nurses found comparable results for self-reported skin problems: the intervention group reported more symptoms after the intervention than the control group (although the difference was not significant), whereas, for subclinical skin changes, a positive effect was found for the intervention group (12). The study concluded that the health education during the intervention period might have increased awareness of symptoms among the participants, and could thus explain the increase in self-reported symptoms (12). The same might have occurred in our intervention group. This hypothesis might also be supported by the fact that almost all educational sessions in the Hands4U study were given within 3 months after baseline, and that the highest prevalence of self-reported hand eczema in the intervention group was also seen after 3 months. In contrast, the increased awareness of hand eczema (symptoms) might have had positive effects on behaviour. Being more aware of hand eczema might be a stimulus for people to comply with the recommendations for the prevention of hand eczema, as they take their symptoms more seriously.

Another point to consider is the development of hand eczema and its progress. Although the induction period for the development of hand eczema is relatively short in healthcare workers (4 years) (1), it is unlikely that the hand eczema prevalence could double within just 3 months in the intervention group. Moreover, it is questionable whether we could have expected a decrease in hand eczema prevalence after 12 months of follow-up,

as behaviour needed to change before the prevalence of hand eczema could change. The study of Löffler et al. (14), for instance, found positive effects on the prevalence of hand eczema after 18 and 36 months of follow-up. Their last follow-up was 1 year after the end of the intervention period (14), whereas our last follow-up was only 8 months after the intervention period (18). Moreover, even after our intervention period, it is probable that not every solution was implemented within each department.

A final point of to consider is that Fig. 2 shows that the prevalence of hand eczema decreased from 3 to 6 months of follow-up in the intervention group. We do not know what caused this decrease: a decrease in awareness or a decrease in hand eczema among the intervention participants. However, the control group showed a similar pattern as the intervention group at 6–12 months of follow-up, suggesting that this decrease might have been caused by factors outside the intervention. More research is needed to investigate what this decrease means.

Apart from the unexpected increase in self-reported hand eczema (symptoms), the multifaceted implementation strategy improved preventive behaviour related to hand eczema in the group that received the multifaceted implementation strategy. The effects on behaviour after 12 months were stable or were even larger than the effects after 6 months (28). This indicates that implementation of the NVAB guideline was successful.

Strengths and limitations

This is the largest study ever performed on the primary and secondary prevention of hand eczema in a healthcare setting, with a sample of >1500 participants. In addition, this is the first study in The Netherlands that has used a multifaceted implementation strategy to prevent hand eczema in an occupational setting. Another strength of this study was that randomization to the control or intervention group was performed at the departmental level, minimizing the risk of contamination between the two groups. Furthermore, the study population seems to be representative of the total population of healthcare workers in The Netherlands with regard to the average age and male/female ratio (29, 30). A final strength is that the statistical method used ensured that every person who filled out at least one follow-up questionnaire was included in the analyses.

One limitation of our study is the use of a self-reported questionnaire to measure behaviour, and the fact that we could not blind the participants for the intervention. This might have led to an overestimation of the healthcare workers' behaviour, because the healthcare workers knew what kind of behaviour was expected from them.

This could have led to socially desirable answers. In addition, we did not use an objective measure to assess hand eczema, but a self-reported measure. As discussed before, this could have led to underreporting of hand eczema at baseline and an increase at follow-up, owing to more realistic reporting of hand eczema in the intervention group. The questionnaire was also not tested *a priori* in the target population. Testing the questionnaire beforehand might have helped us to optimize the questionnaire. Another limitation was that there was a non-response rate of >30% at the final follow-up measurement. However, the differences between the baseline values of the non-responders and the baseline values of the total population were minimal.

Implications for research and practice

One important lesson that can be drawn from this study is that there is a need for a validated instrument with which to assess hand eczema in large samples that is not influenced by awareness following – for instance – an education session. Clinical examinations are not feasible in large samples, as this would be too expensive, time-consuming, and difficult to arrange. Therefore, more research is needed to develop such an instrument.

We expect that, when participants have undergone an educational session, a verbal questionnaire will probably always be biased by the increased awareness following this educational session. An idea would be to incorporate a photographic guide in the (digital) questionnaire with which the participants have to assess their own hands. For example, a photographic guide for dermatologists to use was evaluated by Coenraads et al. (31), and was validated for patients' own assessment by Hald et al., who found good inter-rater agreement between patients and dermatologists (32). However, this guide assessed the severity of hand eczema rather than the prevalence, and was used only in patients, most of whom are often at the more severe end of the severity spectrum of the disease as compared with the population of the Hands4U trial. A new photographic guide should thus be developed for the self-reporting of hand eczema in an occupational setting that includes both individuals with hand eczema and those without hand eczema. A disadvantage of this sort of guide is that it might still be influenced by increased awareness, as the participants themselves determine whether or not they have hand eczema.

Another option would be to let healthcare workers take photographs of their hands – by using their smartphones – and send these pictures to blinded assessors for assessment. Research has shown that >85% of medical providers use some type of smartphone (33), giving

them easy access to a camera. The advantage of using this method is that the assessment will be objective and blinded, and will not be biased by the participants themselves. However, there are practical problems concerning this method, such as costs for the assessments, and the quality of the photographs Therefore, another option could be to arrange blind assessments of a representative sample of the total study population instead of the whole study population, and to extrapolate the outcomes to the total population.

The disadvantage of the aforementioned options is that the development of a new instrument takes a lot of time. Therefore, another method to diminish the effect of the education on self-reported hand eczema in the intervention group would be to educate the control group as well. The education of the control group should consist of how the participants can recognize hand eczema themselves, and not the prevention of hand eczema, so that the control group is only minimally contaminated by the education. Both groups should then be able to better recognize hand eczema. An additional option would be to search for questions related to hand eczema that assess objective facts related to hand eczema rather than questions that are influenced by awareness.

As the multifaceted implementation strategy was effective in implementing the NVAB guideline, we postulate that it can be used in practice to improve the preventive behaviour of healthcare workers. However, more research is needed to investigate how hand eczema prevalence will change over time following the use of this strategy. To study these effects, a longer follow-up period is recommended.

Conclusions

Although the intervention group showed a negative effect for self-reported hand eczema as compared with the control group, the multifaceted implementation strategy was effective in implementing evidence-based recommendations for hand eczema in a healthcare setting. Therefore, the strategy can be used in practice, because it showed positive effects on preventive behaviour – such as hand washing (reduction), the use of a moisturizer, and the use of cotton undergloves – and this behaviour is based on evidence-based recommendations for the prevention of hand eczema. More research is needed to investigate the unexpected effects on hand eczema and to investigate the long-term effects of this strategy on hand eczema.

Acknowledgement

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