Safety and Health at Work 9 (2018) 398–407

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.org

Original Article

Skin Protection Seminars to Prevent Occupational Skin Diseases: Results of a Prospective Longitudinal Study in Apprentices of High-risk Professions

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ARTICLE INFO

Article history:
Received 14 August 2017
Received in revised form
16 February 2018
Accepted 12 May 2018
Available online 23 May 2018

Keywords:
contact dermatitis
health knowledge
intervention study
occupational skin diseases
vocational education

ABSTRACT

Background: Occupational skin diseases (OSDs) are frequent in professions with exposure to skin hazards. Thus, a health educational intervention for apprentices of high-risk professions was conducted. It was the aim of this study to gain insight into possible effects of this intervention.
Methods: A one-time skin protection seminar was conducted in 140 apprentices of health-related and non-health–related professions [trained cohort (TC)]. In addition, 134 apprentices of the same occupations were monitored [untrained cohort (UTC)]. The OSD-specific knowledge and the skin condition of the hands were assessed at baseline (T0), after the seminar (T1), and after 6 (T2) and 12 months (T3).
Results: The OSD-specific knowledge increased in all cohorts from T0 to T3, but we found a significantly higher knowledge in the TC at T2 ($p < 0.001$, t = 3.6, df = 196, 95% confidence interval = 0.9, 3.3) and T3 ($p < 0.001$, t = 3.8, df = 196, 95% confidence interval = 1.0, 3.2) compared to the UTC. Our results indicated a better skin condition of the hands in the TC of the health-related professions but not in the non-health–related professions.
Conclusion: The study indicates that an educational intervention may positively influence the disease-specific knowledge and the prevalence of OSD in apprentices. However, definite conclusions cannot be drawn because of the heterogeneous study cohorts and the study design. Future research should aim at tailoring primary prevention to specific target groups, e.g., in view of the duration and frequency of skin protection education, different professions, and gender-specific prevention approaches.

1. Introduction

Occupational skin diseases (OSDs) are among the most frequent work-related diseases in Europe with an estimated incidence of 0.5–1 per 1.000 workers per year [1–3]. For the last decades, the cases of suspected OSD are reported as the predominant occupational disease to the German employers' liability insurance associations [4]. OSDs are usually associated with impairments of quality of life and the ability to work and represent a considerable economic burden [5,6]. Several occupational branches with regular exposure to skin hazards have been identified as "high-risk professions" such as hairdressing, health care, food processing, building and construction, and metalworking [3,7]. Consequently, prevention programs are of utmost importance.

In the past, special focus has been laid on the development and implementation of secondary and tertiary prevention measures for patients with already existing OSDs and the evaluation of short- and long-term effects [8–13]. Educational interventions teaching behavioral patterns to maintain healthy skin are a promising approach in patients with OSD [8,14–17] because the individual

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2093-7911/$ – see front matter
https://doi.org/10.1016/j.shaw.2018.05.003

skin protection behavior (e.g., skin protection against hazardous substances with gloves, regular application of creams) can have a strong impact on the onset of an OSD and its disease course. Beyond, education corresponds to one of the five action areas of the programmatic World Health Organization Ottawa Charta. Health education aims at promoting personal skills and enabling and educating people in health topics to increase control over their own health. These actions should be implemented in institutions and settings such as schools [18].

Educational interventions for OSD prevention have already been evaluated in workers [19–26] and apprentices [27–31]. However, few studies have followed up apprentices of high-risk professions and examined long-term effects of these interventions. Compared to studies on secondary and tertiary prevention, more OSD primary prevention effort is needed in Germany. Apprentices are a promising target groups for primary (behavioral) prevention because early interventions during apprenticeship enables learning and adopting skin protective behavior right from the start of the professional career. Implementing skin protection education in the theoretical training for apprentices in vocational schools is a promising approach to reach this target group.

Against this background, a one-time health educational intervention (skin protection seminar) was conducted in apprentices of high-risk professions which was embedded in the concerted German awareness and action campaign "Week of occupational skin diseases" (WOOD) [32] which is part of the overall "Healthy skin@work" Euro-prevention campaign led by the European Academy of Dermatology and Venereology, aimed at contributing to the prevention of OSD in Germany.

As part of this campaign, apprentices of different health-related and non-health–related occupations were chosen as target groups to take into consideration that OSDs occur in workers of diverse occupational settings. This educational intervention was accompanied by a prospective longitudinal study to gain insight into possible effects of the skin protection seminar by assessing the disease-specific knowledge and by monitoring the prevalence of skin change of the hands of the apprentices. In this article, we present the results of the 6-months and 12-months follow-up.

2. Materials and methods

2.1. Study design and cohorts

The health educational intervention (one-time skin protection seminar) was conducted in four vocational schools in Osnabrück, Germany, between September 2010 and November 2010. This was accompanied by a prospective longitudinal study with a 1-year study period to gain insight into possible intervention effects. During the 1-year study period, data were collected at baseline before the intervention (T0), immediately (T1), and 6 (T2) and 12 months (T3) after the intervention. As part of the action campaign "WOOD" [32], convenience sampling [33] was used to recruit regional schools that were willing to participate.

The intervention was conducted in seven classes with a total of 140 apprentices from six different occupations (two classes with doctor's assistants, one class with nursing assistants, geriatric nurses, motorcar mechanics, cutting machine operators and metalworkers, respectively). In the following, this group is referred to as trained cohort (TC). In addition, seven school classes with a total of 134 apprentices of the same occupations were monitored as cohort who had not received a skin protection seminar as part of the WOOD action campaign [32]. In the following, this group is referred to as untrained cohort (UTC).

The schools were requested to assign classes with apprentices in an early stage of apprenticeship, preferably at the beginning of the 1st year of vocational education because early intervention enables learning and adopting skin protective behavior right from the start of the professional career.

Owing to timetables and absence of school because of practical training, this could not be ensured for all classes. Thus, the classes of the TCs and UTCs ranged from the beginning of the 1st to the 3rd year of apprenticeship (Table 1). In addition, the classes were assigned to the TC or UTC by the participating schools themselves and not by the study center. This method of allocation met the demands of the participating school because it minimized disturbances, for example because of fixed timetables and intermittent and mandatory practical training periods as part of the vocational

Table 1
Overview of the study cohorts at baseline (T0), immediately (T1, TC only), 6 months (T2), and 12 months (T3) after the intervention and the participants' age, gender, and year of apprenticeship at baseline (T0).

Study cohort		T0	T1	T2	T3	Complete data sets (T0–T3)	Mean age at T0	Year of apprenticeship at T0 (*beginning* of each year)	Female	Male
		n	n	n	n	n [%]	yrs		n [%]	n [%]
Total cohort (all professions)	TC	140	139	118	108	99 [70.7]	20.4	n. a.	54 [54.5]	45 [45.5]
	UTC	134	n. a.	111	110	99 [73.9]	20.2	n. a.	63 [63.6]	36 [36.4]
Health-related professions[*]	TC	85	84	70	64	59 [69.4]	19.4	n. a.	53 [89.8]	6 [10.2]
	UTC	88	n. a.	75	70	66 [75.0]	20.9	n. a.	60 [90.9]	6 [9.1]
Non-health–related professions[†]	TC	55	55	48	44	40 [72.7]	21.8	n. a.	1 [2.5]	39 [97.5]
	UTC	46	n. a.	36	40	33 [71.7]	18.9	n. a.	3 [9.1]	30 [90.9]
Doctor's assistants (2 classes per TC/UTC)	TC	43	43	35	33	30 [69.8]	17.1	1st	30 [100]	–
	UTC	49	n. a.	44	41	39 [79.6]	20.1	1st	39 [100]	–
Nursing assistants (1 class per TC/UTC)	TC	19	19	13	11	10 [52.6]	18.8	1st	9 [90.0]	1 [10.0]
	UTC	16	n. a.	14	11	11 [68.8]	17.8	1st	9 [81.8]	2 [18.2]
Geriatric nurses (1 class per TC/UTC)	TC	23	22	22	20	19 [82.6]	23.5	2nd	14 [73.7]	5 [26.3]
	UTC	23	n. a.	17	18	16 [69.6]	25.1	1st	12 [75.0]	4 [25.0]
Motorcar mechanics (1 class per TC/UTC)	TC	18	18	15	16	13 [72.2]	18.5	2nd	–	13 [100]
	UTC	15	n. a.	9	15	9 [60.0]	18.8	2nd	–	9 [100]
Cutting machine operators (1 class per TC/UTC)	TC	18	18	16	13	12 [66.7]	20.0	3rd	–	12 [100]
	UTC	13	n. a.	11	10	10 [76.9]	19.4	3rd	3 [30.0]	7 [70.0]
Metalworkers (1 class per TC/UTC)	TC	19	19	17	15	15 [78.9]	26.1	2nd	1 [6.7]	14 [93.3]
	UTC	18	n. a.	16	15	14 [77.8]	18.6	3rd	–	14 [100]

n, absolute number; n. a., not applicable; n. s., not significant; TC, trained cohort; UTC, untrained cohort; yrs, years.
[*] Doctor's assistants, nursing assistants, and geriatric nurses.
[†] Motorcar mechanics, cutting machine operators, and metalworkers.

training. For these organizational and practical constraints, randomization of classes was not feasible, and the cohorts were heterogeneous in terms of their phase of apprenticeship (1st, 2nd, 3rd year, Table 1). The TC and UTC of each profession attended the same school. Thus, contamination of possible intervention effects could not be excluded.

For the abovementioned reasons, the study does not meet the common methodological requirements for a (randomized) controlled intervention study, and the comparability between the TC and UTC is limited. However, we decided to monitor the UTC to collect exploratory data on the possible courses of the outcome parameters under standard conditions (treatment-as-usual, i.e. regularly structured apprenticeship and school curriculum in Lower Saxony, Germany) to allow for a preliminary appraisal of possible training effects.

The regional school authority of the state of Lower Saxony approved the study. The apprentices gave informed written consent for participation. In case of underage participants (<18 yrs), the parents were asked to give informed written consent. After data collection at T3, the intervention was also conducted in the UTCs.

2.2. Skin protection seminar and theoretical framework

The intervention was a one-time skin protection seminar with an average duration of 90 minutes. It was based on the Health Action Process Approach as framework which basically distinguishes between a motivational phase in which intentions are developed and a volitional phase in which health-related behavior is planned and performed [34]. The intervention aimed at improving knowledge of OSD and at positively influencing cognitions that are relevant for the motivation and the formation of an intention regarding an appropriate skin protection behavior, for example self-efficacy and risk perception, to reduce the prevalence of OSD by appropriate skin protection behavior [34].

The intervention was conducted by one of four health educationalists of the University of Osnabrück. All health educationalists had a university degree related to educational sciences and worked in a specialized center for occupational dermatology. The health educationalists were experienced in patient education (skin protection seminars) for patients with OSD following a given curriculum (manual) as part of outpatient and inpatient interdisciplinary prevention programs [8,9,11,35]. It was important that the educational interventions of this study were conducted by skilled professionals who were able to tailor the seminar to specific occupational situations and to the needs of the individual participants, e.g. the individual apprentices' questions.

The educational intervention was identical for all seven classes and six professions regarding the basic structure and consisted of the following five topics: (a) introduction and relevance of OSD, (b) structure and functions of the skin, (c) exogenous occupation-related and endogenous risk factors, (d) pathogenesis of OSD, and (e) measures of systematic skin protection (skin protection, skin care, and mild skin cleansing). Owing to the time provided by the schools, the classroom situation between health educationalist and apprentices was teacher-centered, but active participation of the apprentices was stimulated by a conversational teaching style that fostered the collaboration of the participants, for instance by asking questions (e.g., in terms of their experiences regarding skin protection) and by involving the apprentices in hands-on skin protection experiments.

The intervention in all classes was based on a digital presentation with an identical basic structure. The presentation differed concerning target group–specific adjustments, e.g. the adaption of occupation-specific risk factors for health- and non-health–related professions, examples of different types of protective gloves (e.g., single use gloves in health-related professions or mechanical gloves for non-health–related professions) and aspects of skin-compatible hand disinfection and hand hygiene. The interventions were identical in terms of technical equipment, short skin protection experiments, pictures and models (e.g., photographs of hand eczema, brick-and-mortar model of the structure of the horny layer, photograph of a reusable glove with a gauntlet that is folded back to avoid water entering the glove), and a short movie to summarize the anatomy of the skin, the pathogenesis of OSD, and skin care and skin protection (duration: 2 minutes).

Despite these approaches to standardize the intervention, educational interventions are always complex and consist of multiple, interacting elements [36] such as the behavior of teachers who deliver an intervention, the learners with their individual knowledge, attitudes, beliefs and questions, the social interaction during an intervention, etc. Thus, the skin protection seminars in the seven classes were not completely identical which usually poses a methodological challenge to the identification of "effective" elements.

2.3. Co-interventions and structures of the apprenticeship

Apart from the skin protection seminar, the face-to-face examination of the hands by a dermatologist as well as the completion of the questionnaires (e.g., the knowledge test with focus on OSD and skin protection) might have acted as co-interventions in the TC and UTC. These co-interventions could have raised attention and awareness to the topic of OSD and skin protection and could have stimulated a discussion of the topic among the apprentices.

Moreover, vocational training in Germany usually consists of practical training (e.g., following specific vocational training regulations in enterprises) [37] and teaching at vocational schools following a given curriculum (e.g., provided by the Standing Conference of the Ministers of Education and Cultural Affairs, Germany or the Lower Saxony Ministry of Culture) [38,39]. Occupational health and safety at work is always included in the practical and theoretical parts of the apprenticeship irrespective of the profession. Furthermore, the topic "skin" is usually a specific teaching content of the curriculum of health-related professions, e.g. for nursing assistants who learn about the anatomy and physiology of the skin and about skin care for older people [39]. These structures of apprenticeship also represent co-interventions for this study. However, the practical implementation (e.g., in terms of skin protection contents in detail, didactical design, and time frame) can differ for it depends on the individual teacher or instructor.

The skin protection seminars were the only elements of the action campaign "WOOD" [32] that specifically targeted apprentices and vocational education and training. Beyond, there were no other co-interventions in the study period to the best of our knowledge.

2.4. Outcome parameters and instruments

A self-administered standardized written questionnaire with closed questions was handed out to the apprentices to collect data on preexisting skin disorders and sociodemographic data.

The knowledge of OSD was assessed with a condensed form of the validated German "Occupational Skin Diseases Knowledge Questionnaire (OSD-KQ)" [8,40]. The original OSD-KQ comprises 65 items regarding disease-specific aspects that have been identified to be relevant for patients suffering from OSD. This instrument was shortened (OSD-KQ-short) to adapt it to the purpose of this study and the target group (apprentices). The OSD-KQ-short contains 30

of the original items with a special focus on practical relevance regarding skin protection (see Appendix 1 for English translation of the German items for the purpose of this article). This short version was not revalidated for the purpose of this study. However, 293 apprentices of health-related professions (nurses, pediatric nurses, and geriatric nurses) participated in the original validation study [40]. Thus, comprehensibility of the items of the OSD-KQ-short can be assumed for the health-related professions, and comparative data in terms of item difficulty are available.

The OSD-KQ-short consists of statements which have to be marked as right or wrong (dichotomous response format). In addition, the alternative "I don't know" is offered to avoid random guessing of the correct answer [40]. A correct answer is counted as "1" and a false answer, "I don't know," or missing answers are counted as "0" since both reflect a lack of knowledge. This results in a maximum score of 30. The overall difficulty of the long OSD-KQ is medium and the difficulty of the single items varies (low, medium, and high) [8,40].

The skin of each apprentice was examined by an occupational dermatologist who inspected the hands, wrists, and elbow flexures and registered the prevalence of any type of skin changes (e.g., dry skin, erythema, and fissures). Eight different dermatologists acted as examiners at T0, T2, and T3 for the 14 classes (seven per TC and UTC for six professions) at a total of 42 measurement points (Table 1). All examiners were experienced in recognizing any type of (early) pathological skin changes owing to their employment in a specialized center for occupational dermatology. The examiners were constantly involved in research projects that comprised the assessment of skin changes [9,35]. As part of an inpatient rehabilitation program for patients suffering from OSD, all examiners took part in regular ward rounds which ensured constant professional exchange in terms of detecting and evaluating any type of skin changes. Beyond, we have not carried out specific assessment training for the specific purpose of this study. Blinding of the examiners was not possible because of practical constraints.

To obtain information on previous or present atopic dermatitis, the dermatologists asked about flexural eczema. Furthermore, the self-administered questionnaire contained the following question: "Have you or have you ever had a skin rash in the flexures of joints, for example knees or elbows (neurodermatitis, atopic/endogen eczema)?"

Owing to the limited time-frame provided for the skin protection seminar and the data collection, we had to decide against more comprehensive but also time-consuming scores to assess disease severity and atopy.

2.5. Data analysis

Data were collected and analyzed with Microsoft Excel 2010 and SPSS Statistics for Macintosh, version 23.0 (IBM Corp., Armonk, NY, USA).

According to the Kolmogorov–Smirnov test, the results of the OSD-KQ-short showed normal distribution for all cohorts and subcohorts. Thus, parametric *t* tests were used to analyze differences of the knowledge score. Means and standard deviations are given. A repeated measures analysis of variance with the within-subject factor "knowledge test score" with three levels (time points T0, T2, T3) and the between-subject factor "cohort" (TC, UTC) was conducted to analyze changes in the disease-specific knowledge over time in different cohorts.

Chi-square test and Fisher's exact test (expected value < 5) were applied for calculation of significances of contingency tables and for dropout analyses. The homogeneity of variances in independent samples was analyzed with Levene's test. A significance level of 0.05 was chosen.

3. Results

3.1. Study cohorts and dropouts

As shown in Table 1, the mean age was 20.4 years for the TC and 20.2 years for the UTC. Mostly men worked in the three non-health–related professions (metalworkers, cutting machine operators, and motorcar mechanics), and predominantly, women were employed in the health-related professions (nursing assistants, geriatric nurses, and doctor's assistants). There was no significant difference between the TCs and UTCs with regard to the gender distribution (Chi-square test or Fisher's exact test).

Complete data sets for all assessments (T0–T3) of the knowledge test were available for 70.7% of the TC (n = 99) and 73.9% of the UTC (n = 99). These cases were used for further analysis. Incomplete data sets (dropouts) resulted from nonresponses or absences at one or more follow-ups. The dropout analyses revealed no systematic differences regarding age, gender, history of flexural eczema, skin condition, or knowledge of OSD between the dropouts and the study cohorts at baseline (T0).

3.2. Knowledge of OSD

As shown in Table 2, the average score achieved in the OSD-KQ-short increased in almost all TCs and UTCs from T0 (baseline) to T3 (12-months follow-up). In all TCs, the knowledge score values were highest immediately after the intervention (T1) followed by a decrease of knowledge to T2 and T3 which, however, still remained higher compared to T0. The knowledge scores of most UTCs, in contrast, showed a consistent increase over time from T0 to T3. Apprentices of health-related professions usually achieved a higher knowledge score compared to the non-health–related cohort (e.g. at T3: health-related UTC: 19.1, non-health–related UTC: 16.6).

In direct comparison, the UTC cohort (all professions combined) scored significantly higher in the knowledge test than the TC at baseline [*t* test for independent samples: $p = 0.036$, t = -2.1, df = 196, 95% confidence interval (CI) = -2.2 to -0.1]. In contrast, the TC performed significantly better both at T2 (*t* test for independent samples: $p < 0.001$, t = 3.6, df = 196, 95% CI = 0.9–3.3) and T3 (*t* test for independent samples: $p < 0.001$, t = 3.8, df = 196, 95% CI = 1.0–3.2). At both T2 and T3, the TCs of the health-related and non-health–related subcohorts scored significantly higher than the respective UTCs (*t* tests for independent samples: details of test statistics not shown).

A repeated measures analysis of variance with the within-subject factor "knowledge test score" with three levels (time points T0, T2, and T3) and the between-subject factor "cohort" (TC and UTC) showed a significant main effect ($F = 82.8$, df = 2, $p < 0.001$); there was a significant increase of OSD-specific knowledge over the times of measurement. Furthermore, it revealed a significant interaction between the two variables "cohort" and "knowledge test score" ($F = 23.8$, df = 2, $p < 0.001$). This means that the two cohorts differ in relation to the increase of OSD-specific knowledge over the times of measurement.

The 30 single items of the OSD-KQ and the percentages of the correct answers at T0 and T3 are shown in the Appendix 1. The percentages of correct answers highly varied between the different items which are presumably influenced by a different item difficulty. For instance, nearly all apprentices of the TC (T0: 93.9, T3: 93.9%) and UTC (T0: 93.9, T3: 88.9%) correctly recognized item 5d ("Single use gloves can be used twice at a maximum.") as being wrong at T0 and T3. This item had been characterized as less difficult in the validation study of the original long-form of the OSD-KQ [40]. In contrast, only few apprentices of both cohorts (TC: 22.2%, UTC: 15.2%) identified item 6c ["Syndets (synthetic

Table 2
Knowledge test scores (OSD-KQ-short) at baseline (T0), immediately (T1, TC only), 6 months (T2) and 12 months (T3) after the intervention in the different cohorts.

Cohort		n	Year of apprenticeship at T0	T0		T1		T2		T3	
				Mean score	SD	Mean score	SD	Mean score	SD	Mean score	SD
Total cohort (all professions)	TC	99	n. a.	15.4	3.9	24.0	3.3	19.6	4.0	20.4	3.5
	UTC	99	n. a.	16.5	3.8	n. a.		17.5	4.2	18.2	4.4
Health-related professions*	TC	59	n. a.	15.9	3.7	24.5	2.7	20.3	4.0	21.1	3.1
	UTC	66	n. a.	16.9	3.8	n. a.	n. a.	18.4	3.7	19.1	4.2
Non-health–related professions†	TC	40	n. a.	14.7	4.2	23.3	3.9	18.5	3.9	19.3	3.7
	UTC	33	n. a.	15.9	3.8	n. a.	n. a.	15.7	4.7	16.6	4.5
Doctor's assistants	TC	30	1st	14.3	3.5	24.3	2.4	19.7	3.9	20.9	2.8
	UTC	39	1st	16.6	3.7	n. a.	n. a.	18.2	4.0	19.5	3.6
Nursing assistants	TC	10	1st	16.1	2.0	24.0	4.6	17.9	2.8	21.4	3.2
	UTC	11	1st	15.5	4.5	n. a.	n. a.	17.1	3.2	16.9	5.6
Geriatric nurses	TC	19	2nd	18.3	3.4	24.9	2.0	22.7	3.6	21.2	3.6
	UTC	16	1st	18.5	3.5	n. a.	n. a.	19.9	3.0	19.6	4.0
Motorcar mechanics	TC	13	2nd	14.9	5.3	24.3	2.8	19.2	4.4	20.8	4.2
	UTC	9	2nd	15.9	3.7	n. a.	n. a.	17.0	3.0	17.1	4.1
Cutting machine operators	TC	12	3rd	14.7	2.5	23.8	3.2	18.6	3.1	18.1	2.4
	UTC	10	3rd	16.3	2.9	n. a.	n. a.	16.7	2.5	17.4	3.6
Metalworkers	TC	15	2nd	14.5	4.4	22.1	5.0	17.9	4.2	18.9	3.9
	UTC	14	3rd	15.6	4.6	n. a.	n. a.	14.1	6.3	15.6	5.1

n, absolute number; n. a., not applicable; n. s., not significant; OSD-KQ, Occupational Skin Diseases Knowledge Questionnaire; TC, trained cohort; UTC, untrained cohort; SD, standard deviation.
* Doctor's assistants, nursing assistants, and geriatric nurses.
† Motorcar mechanics, cutting machine operators, and metalworkers.

detergents) are a good alternative to natural soaps because they also have a good cleaning performance in an acid environment."] as being correct in the long-term follow-up (T3) which had been characterized as medium to very difficult item [40]. Interestingly, the medium difficult item 5e ("In order to avoid water entering into reusable gloves, one should fold back the gauntlet of the glove.") was marked as "correct" by few participants at baseline (TC: 29.3%, UTC: 23.2%) which notably increased only in the trained apprentices at T3 (TC: 85.9%, UTC: 30.3%) (for details: see Appendix 1).

3.3. Skin condition

Table 3 shows the results of the dermatological examination of the hands regarding the prevalence of any skin changes. At baseline, 19.4% of the TC (n = 18) and 7.7% of the UTC (n = 7) showed any signs of skin changes at the hands (Chi-square test: $p = 0.021$, $\chi^2 = 5.33$, df = 1). At the end of the study (T3), skin changes of the hands were reported for 18.3% of the TC (n = 17) and 29.7% of the UTC (n = 27) (Chi-square test: not significant). Over the period of 1 year, the prevalence of skin changes increased in the UTC and remained stable in the TC.

As regards the year of apprenticeship, skin changes were observed in five of 101 first-year apprentices (5.0%, all health-related professions) in contrast to 20 of 83 second- or third-year apprentices (24.1%, all non-health–related professions and nine geriatric nurses).

With regard to the professional subgroups, skin changes were found significantly less often on the hands in the TC of the health-related professions at both T2 (Chi-square test: $p = 0.005$, df = 1, $\chi^2 = 7.77$) and T3 (Chi-square test: $p = 0.038$, df = 1, $\chi^2 = 4.30$). This difference was not observed in the non-health–related professions (Chi-square tests: not significant at T2 and T3).

The incidence for "skin changes on the hands" between T0 (baseline) and T3 (1 year) was 14.7% for the TC and 29.8% for the UTC. Analyzed by subgroups, the lowest incidence rate was found in the health-related TC (8.9%), followed by the non-health–related TC (23.3%), the health-related UTC (28.3%), and the non-health–related UTC (33.3%). One year after the intervention (T3), the fact of being in the health-related UTC was associated with a 2.6-fold increased risk to develop skin changes on the hands [OR (odds ratio): 2.62, 95% CI = 1.04–6.61]. No difference was found for the non-health–related professions (OR: 1.24, 95% CI = 0.42–3.68).

At T0, T2, or T3, no significant differences were found regarding the prevalence of skin changes at the elbows flexures and at the wrists between the TCs and UTCs and subcohorts (data not shown). No statistically significant correlation between the prevalence of skin changes and the level of knowledge of OSD could be detected.

Table 3
Results of the dermatological examination in terms of skin changes of the hands at baseline (T0), 6 months (T2), and 12 months (T3) after the intervention in the different cohorts.

Cohort		Year of apprenticeship at T0	T0	T2	T3
			% [n]	% [n]	% [n]
Total cohort (all professions)	TC (n = 93)*	n. a.	19.4 [18]	23.7 [22]	18.3 [17]
	UTC (n = 91)*	n. a.	7.7 [7]	40.7 [37]	29.7 [27]
Health-related professions†	TC (n = 58)	n. a.	22.4 [13]	19.0 [11]	13.6 [8]
	UTC (n = 61)	n. a.	1.6 [1]	42.6 [26]	29.5 [18]
Non-health–related professions‡	TC (n = 35)	n. a.	14.3 [5]	31.4 [11]	25.7 [9]
	UTC (n = 30)	n. a.	20.0 [6]	36.7 [11]	30.0 [9]
Doctor's assistants	TC (n = 30)	1st	6.7 [2]	20.0 [6]	20.0 [6]
	UTC (n = 36)	1st	0 [0]	52.8 [19]	27.8 [10]
Nursing assistants	TC (n = 10)	1st	20.0 [2]	20.0 [2]	10.0 [1]
	UTC (n = 10)	1st	10.0 [1]	30.0 [3]	30.0 [3]
Geriatric nurses	TC (n = 18)	2nd	50.0 [9]	16.7 [3]	5.6 [1]
	UTC (n = 15)	1st	0 [0]	26.7 [4]	33.3 [5]
Motorcar mechanics	TC (n = 12)	2nd	25.0 [3]	66.7 [8]	33.3 [4]
	UTC (n = 9)	2nd	55.6 [5]	55.6 [5]	0 [0]
Cutting machine operators	TC (n = 12)	3rd	16.7 [2]	16.7 [2]	0 [0]
	UTC (n = 7)	3rd	0 [0]	28.6 [2]	28.6 [2]
Metalworkers	TC (n = 11)	2nd	0 [0]	9.1 [1]	45.5 [5]
	UTC (n = 14)	3rd	7.1 [1]	28.6 [4]	50.0 [7]

n, absolute frequency; n. a., not applicable; TC, trained cohort; UTC, untrained cohort.
* Because of missing values the TC and UTC cohorts are smaller than in Table 2 (n = 99).
† Doctor's assistants, nursing assistants, and geriatric nurses.
‡ Motorcar mechanics, cutting machine operators, and metalworkers.

3.4. History of flexural eczema

At baseline, 12.1% of the UTC (n = 12) stated a history of flexural eczema in the self-administered questionnaire and 13.1% (n = 13) when asked by the dermatologist. Slightly larger percentages were found in the TC (questionnaire: 18.2%, n = 18, interview: 19.2%, n = 19). When merging the results of both survey methods ("yes" in interview and/or questionnaire), 26.3% (n = 26) of the TC and 16.2% (n = 16) of the UTC reported to have had flexural eczema at any time of their life. The baseline frequencies were not significantly different between TC and UTC and the different subcohorts.

At T0 and T3, we found no association between the prevalence of skin changes on the hands and a positive history of flexural eczema in the TC or UTC.

4. Discussion

This longitudinal study aimed at gaining insight into possible effects of a one-time skin protection seminar. Twelve months after the educational intervention, the knowledge of OSD had increased during apprenticeship in almost all cohorts and professions, but our results indicate higher knowledge scores in the TCs. Under the given conditions of the study, our results indicate a lower prevalence and incidence of any skin changes of the hands in the health-related TC compared to the UTC (OR: 2.62, 95% CI = 1.04–6.61). These effects were not seen in the trained and untrained non-health–related cohorts (OR: 1.24, 95% CI = 0.42–3.68). In the following, we will discuss these results in consideration of the study cohorts, the study design, and previous studies.

4.1. Study cohorts

The health-related professions of this study (doctor's assistants, nursing assistants, and geriatric nurses) were female-dominated (89.8%) while the non-health–related professions (motorcar mechanics, cutting machine operators, metalworkers) were male-dominated (90.9%). These findings are in line with current statistics in Germany regarding the choice of apprenticeship [41].

Owing to organizational constraints at school-level (timetables, absence of school for practical training) and practical constraints, the schools chose the classes and assigned them either to the skin protection seminar group (TC) or to the UTC. Randomization was not possible. At baseline, most health-related classes were at the beginning of their 1st year of apprenticeship (exception: TC of geriatric nurses, 2nd year). In contrast, all classes of the non-health–related professions were either at the beginning of their 2nd or 3rd year of apprenticeship. Consequently, these advanced apprentices have already experienced more theoretical training at school as well as more practical training in their enterprises, and they have been exposed to occupational irritants and allergens for a longer period of time. These study conditions and limitations (see below: heterogeneous cohorts, no randomization, and possible contamination between classes at the same school) are important for the discussion and interpretation of the results. Thus, the comparison between cohorts in this study shall be considered as preliminary and exploratory.

4.2. Knowledge of OSD

We found an average of 51% of correct answers (15.4/30 questions) in the overall TC at baseline that increased to 80% (T1), 65% (T2), and 68% (T3). This is in line with other studies reporting a gain of OSD-specific knowledge because of health education [28,31]. These studies and studies that assessed the disease-specific knowledge in patients [8,28,31,42–44] indicate that a mean value of nearly 100% of correct answers can usually not be expected in knowledge tests following an intervention and that the knowledge score values usually decrease over time after the intervention [8,44]. Thus, a permanently increased knowledge compared to baseline (T0) is a more realistic aim of the intervention than maintaining the high score values seen immediately after the intervention.

The increase of knowledge observed not only in the TCs but also in the UTCs may have been caused by different reasons: first, the regular follow-ups, which included face-to-face dermatological examination and the knowledge test itself, might have acted as co-interventions by attracting the attention or even interest of the UTCs on the topic of OSD and second, occupational safety and health is a mandatory part of the apprenticeship, hence integrated in the curricula of vocational education at school [38,39] and as part of the mandatory practical training at the enterprises [37]. These co-interventions and possible confounding factors are however similar both for the UTCs and the TCs.

In general, disease-specific knowledge is characterized as a necessary, yet not sufficient, prerequisite for behavioral change [40,45–48]. Knowledge changes induced by the intervention can be immediately measured as "proximal" parameter as opposed to more "distal" parameters such as effects on the skin condition [49]. As no correlation between the amount of knowledge and the prevalence of skin changes was found in this study, future research should also evaluate other intermediate variables such as socio-cognitive parameters and the skin protection behavior.

Apart from the discussion of knowledge scores, the analysis of single items of the knowledge test can be helpful for the development and evaluation of educational interventions. The example of item 5e ("In order to avoid water entering into reusable gloves, one should fold back the gauntlet of the glove.") shows that those apprentices who had attended the skin protection seminar remembered a specific skin protection behavior to a higher proportion (TC: 85.9% vs. UTC: 30.3%) even after 1 year. This might have been supported by the high practical relevance of the information, a photography showing such a glove as part of the standardized digital presentation, and/or the corresponding hand-on part of the seminar.

4.3. Skin condition

In the 6- and 12-months follow-ups (T2/T3), we found more apprentices with skin changes on the hands in the UTC (T2: 40.7%, T3: 29.7%) than in the TC (T2: 23.7%, T3: 18.3%). Previous intervention studies in apprentices [27,29–31] also found a better skin condition and/or lower hand eczema prevalence in their intervention group when compared to the respective controls. However, the method of data collection and periods of follow-up varied. In a study by Bregnhøj et al, significantly fewer hairdressing trainees reported having had hand eczema during training 18 months after the study begun compared to controls (intervention group: 19.4%, controls: 28.3%) [27]. Löffler et al [29] described a significantly lower 3-year prevalence of morphological skin changes in their intervention group of health-care trainees (66.7%, controls: 89.3%) and a 4.8-fold higher risk of skin changes in the untrained controls. Bauer et al [30,50] found a point prevalence of 29.1% for hand dermatitis in their controls of bakery apprentices compared to 13.3% in their intervention group. After a 2-year study period in hairdressing apprentices, Riehl [31] identified a lower percentage of hairdressing apprentices with morphological skin changes in their intervention group (10.5%) than in their controls (25.0%). These results corroborate our exploratory findings that primary prevention can contribute to reduce the prevalence of skin changes. However, comparability between the studies is limited because the

methods of data collection vary, as do the definitions of "skin changes", for example hand eczema [27], irritant skin changes [29], hand dermatitis [29,30], and morphological efflorescences [31].

In our study, skin changes at the hands have been described for 19.4% (n = 18) of the TC and 7.7% (n = 7) of the UTC at baseline (T0). Of these 25 apprentices, only five are first-year apprentices (all health-related professions) and 20 are second- or third-year apprentices (all non-health–related professions and nine geriatric nurses). We assume that a longer exposure to occupational irritants and allergens during practical training may have led to these observed differences at baseline. Biased data resulting from the method of data collection (see below) may be another explanation.

Apart from that, some first-year apprentices also presented skin changes at T0. The same observation—skin changes at study enrollment—has been described in previous studies, for example with a prevalence of 17% for hand dermatitis in health-care workers [29] and 5.5% in bakers [30], 1.5–3.0% for hand eczema [27], and 13.7%–27.7% for morphological skin changes [31] in hairdressers. Preexisting skin diseases are a possible explanation, for example atopic dermatitis.

4.4. History of flexural eczema

Atopic skin diathesis has been described as a risk factor for OSD [51–53]. Owing to a limited time frame for the study at schools, we decided to focus on the assessment of "history of flexural eczema" instead of a comprehensive atopy score. Flexural eczema is one of the pivotal clinical characteristics of atopic dermatitis in adults [54–58]. Berndt et al described the history of flexural eczema as risk factor for the development of hand eczema in metalworking trainees [59], while this was not found by Uter et al in hairdressing apprentices in a 1-year follow-up [60]. In our sample, we could not find a relationship between a positive history of flexural eczema and skin changes on the hands. This observation could be explained by several reasons, for instance an increased awareness and skin care behavior particularly in "skin sensitive" persons [60] but also methodological limitations of our study. Possible associations between atopy and flexural eczema in apprentices of different professions as well as the effects of primary prevention should be further investigated with established instruments to assess atopy, atopic dermatitis, as described by Hanifin and Rajka [54] and Diepgen et al [55,56], as well as clinical severity of occupational hand eczema, as inter alia proposed by Dulon et al and Skudlik et al [61,62].

4.5. Differences between the health-related and non-health–related subcohorts

Although the comparability between the health-related and non-health–related cohorts is limited in this study, (e.g., due to different phases of apprenticeship and heterogeneous groups), we would like to point out and discuss some of the differences we have observed for they might stimulate future research.

In our study, apprentices in health-related professions usually achieved higher scores in the knowledge test than the non-health–related professions. We assume that this observation is caused by the fact that the anatomy of the skin, skin diseases, skin protection, and hand hygiene behavior and/or skin care of older people are a mandatory part of the theoretical and practical vocational training (e.g., as specified in the curriculum for the nursing assistants, [39]).

Differences were even more pronounced when evaluating the skin condition of the hands: it was significantly better in the health-related TCs compared to their UTCs while no intervention effects were detected in the non-health–related subcohorts. This observed difference might be explained by one or several of the following reasons: (a) the educational intervention was inadequate to affect the prevalence and incidence of OSD in the non-health–related target group and needs modifications, for instance, in terms of target group specific, tailored contents, methods, or the form approaching the target group; (b) a one-time educational intervention is not sufficient for effective primary prevention of OSD in non-health–related apprentices, thus more refresher education is needed. In contrast, the topics skin, skin care and protection and hand hygiene are mandatory parts of the curricula for the practical and theoretical vocational training in health-related professions. This might function as "refresher" or "booster" for the skin protection seminar; (c) conducting the intervention at the beginning of the 2nd or 3rd year of apprenticeship (motorcar mechanics, cutting machine operators, metalworkers) is less effective than immediately at the beginning of the 1st year (doctor's assistants, nursing assistants); and (d) the participants' gender was important suggesting the need for more gender-specific prevention programs. A recent study corroborates this explanation since this study indicates a poorer disease-specific knowledge in male patients with OSD compared to female patients [63]. Apart from these explanations, our observations might have also been biased by methodological limitations as outlined below.

4.6. Strengths and limitations

Several limitations of this study need to be addressed. Randomization was not possible for organizational constraints at school-level (e.g., different timetables, absence of school because of mandatory practical training periods). Cluster randomization would have improved the level of evidence. This would have ideally been randomization of schools [29], instead of single classes to avoid contamination, e.g., exchange and communication between pupils. Thus, contamination between the apprentices at the same school could not be excluded in our study. For the same organizational and practical constraints, the study relied on convenience sampling, and the classes were chosen by the schools and not by the study center. One disadvantage of convenience sampling is that results cannot be generalized to the population [33], i.e. to all apprentices of in health-related and non-health–related occupations. It could not be ensured that all classes were at the beginning of their first year of apprenticeship at study enrollment, which would have enabled assessment of the skin condition without previous occupational exposure of all participants.

For data protection reasons, it was not possible to contact the dropouts to gather information on possible reasons for leaving the profession, of which one cause might have been acquiring a work-related skin disorder. This could have led to a bias of data. Moreover, a longer follow-up time (>1 year) would give further insight into the long-term effectiveness of the intervention.

In terms of data collection methods, blinding of the eight dermatologists would have further improved the quality of data as well as previous assessment training. In addition, a validated atopy score should be preferred to determine the atopic skin diathesis.

The cohorts and subcohorts (TC, UTC) were mostly comparable in terms of gender, age, knowledge, skin condition, history of flexural eczema, and preexisting skin problems. This was not the case for the year of apprenticeship. However, in the case of baseline differences in the outcomes (knowledge, skin changes), they were in favor of the UTC (for example higher prior knowledge of OSD and better skin status of the hands at T0). This makes it even more notable that effects were observed in the TCs.

Besides these limitations, it is a strength of this prospective longitudinal study to provide data of an UTC to allow for a preliminary and exploratory comparison. Even though this study does not fulfill the standards of a randomized controlled intervention

study, the design is superior to an uncontrolled pre–post intervention study. The 1-year follow-up period is another strength of this study for it allows gaining insight not only in short-term but also in possible long-term effects.

To the best of our knowledge, this is the first study that examines six different occupational groups at the same time with the same data collection methods. Apart from methodological limitations, this allows for interesting insights into different effects of the same one-time educational intervention.

In summary, we conclude that "one-size-fits-all" does not apply for educational interventions and future studies should focus "educational basic research" on the individual needs of target groups in terms of skin protection training, e.g. apprentices in male-dominated or female-dominated occupations. In addition, the frequency of health education (one-time vs. repeated/refresher interventions) could be adapted to apprentices in different professions, for instance more skin protection training for apprentices in non-health–related occupations since the topic is not mandatory part of their usual theoretical and practical training.

Future intervention studies should be conducted as high-quality randomized controlled trials to evaluate target group tailored economic and time-efficient interventions for apprentices in the different "high-risk" professions and to permanently transpose these interventions into apprenticeship structures to prevent OSD. In order to consolidate a sustainable and profound skin protection education into vocational education and training, teachers are promising multipliers who play a pivotal role in the occupational safety and health knowledge transfer [64].

Conflict of interest

The authors declare that there is no conflict of interest regarding the subject of this article.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.shaw.2018.05.003.

Appendix 1. Percentage of correct answers for each item of the OSD-KQ at baseline (T0) and at the 1-year follow-up (T3) [trained cohort (TC): n = 99, untrained cohort (UTC): n = 99]

Item of the OSD-KQ (short version)	T0 (baseline)				T3 (1-year follow-up)			
	TC		UTC		TC		UTC	
	%	n	%	n	%	n	%	n
1(a) Eczema can develop due to the defatting of the horny layer. Defatting is the result of multiple hand washing or caused by solvents and diluting agents.	68.7	68	70.7	70	88.9	88	82.8	82
1(b) Injuries of the horny layer (e.g., from metal shavings and sharp-edged parts) do not represent a particular risk for a skin disease because no particles penetrate into the skin.	73.7	73	73.7	73	91.9	91	85.9	85
1(c) Alkaline cleansers with a high pH value (approx. 10) are better tolerated by the skin than cleansers with a neutral pH value.	75.8	75	78.8	78	83.8	83	79.8	79
2(a) One internal risk factor for a skin disease is atopy. Atopy is a hereditary disorder affecting the skin and mucosa.	36.4	36	40.4	40	56.6	56	35.4	35
2(b) Atopy is a specific risk factor for persons often exposed to wet work (e.g., extended use of gloves, health care professions, and hairdressers).	49.5	49	46.5	46	60.6	60	51.5	51
3(a) Putting gloves and skin products at disposal are the responsibility of the social accident insurance covering occupational diseases.	44.4	44	38.4	38	57.6	57	51.5	51
3(b) When using skin care and skin protection creams, particularly the palm of the hands need to be well creamed.	10.1	10	30.3	30	29.3	29	34.3	34
3(c) Wearing jewelry (rings, bracelets) do not harm the skin if skin protection products have been applied previously.	60.6	60	52.5	52	76.8	76	62.6	62
4(a) Skin protection products can also be applied on dirty hands.	82.8	82	84.8	84	93.9	93	83.8	83
4(b) Skin protection creams have mainly the task to support the regeneration of the skin.	17.2	17	15.2	15	16.2	16	19.2	19
4(c) There exists no skin protection product which protects against all risks.	79.8	79	79.8	79	87.9	87	81.8	81
4(d) The choice for a skin protection product will depend on the professional activity and the harmful substances confronted with during the activity.	68.7	68	71.7	71	83.8	83	72.7	72
4(e) Skin protection creams act as a "liquid" or "invisible" glove because they are impermeable to hazardous substances.	47.5	47	65.7	65	65.7	65	72.7	72
5(a) Skin protection creams offer a better protection against hazardous working material than gloves.	85.9	85	87.9	87	92.9	92	85.9	85
5(b) The use of powdered latex gloves is to be avoided as they represent a particularly high risk for allergies.	36.4	36	46.5	46	72.7	72	60.6	60
5(c) Gloves should be only worn on a dry and clean skin.	52.5	52	70.7	70	84.8	84	75.8	75
5(d) Single use gloves can be used twice at a maximum.	93.9	93	89.9	89	93.9	93	88.9	88
5(e) In order to avoid water entering into reusable gloves, one should fold back the gauntlet of the glove.	29.3	29	23.2	23	85.9	85	30.3	30
5(f) Reusable gloves should be hung to dry after use.	56.6	56	59.6	59	83.8	83	61.6	61
5(g) If possible, gloves should be worn during the whole working day.	71.7	71	79.8	79	87.9	87	82.8	82
6(a) Preferably, a strong cleansing product (e.g., cleansing pastes) should be used in order to reduce the washing time of the cleansing process.	76.8	76	78.8	78	75.8	75	80.8	80
6(b) Skin cleansing products with an alkaline pH value (10) should be preferably used to achieve good cleaning results.	43.4	43	65.7	65	61.6	61	65.7	65

(continued on next page)

(*continued*)

Item of the OSD-KQ (short version)	T0 (baseline)				T3 (1-year follow-up)			
	TC		UTC		TC		UTC	
	%	n	%	n	%	n	%	n
6(c) Syndets (synthetic detergents) are a good alternative to natural soaps because they also have a good cleaning performance in an acid environment.	7.1	7	17.2	17	22.2	22	15.2	15
6(d) Detergents should be generously spread over the skin so as to dissolve quickly the dirt on the skin.	47.5	47	47.5	47	59.6	59	57.6	57
7(a) Brushes and pumice stones are particularly suitable for cleaning soiled hands.	37.4	37	46.5	46	66.7	66	65.7	65
7(b) Hands should be washed quite often in order to avoid any skin infections.	31.3	31	26.3	26	61.6	61	43.4	43
7(c) After washing the hands should be rubbed dry extensively.	22.2	22	21.2	21	45.5	45	31.3	31
8(a) Skin care creams create a protective film and thus protect against harmful substances.	29.3	29	38.4	38	35.4	35	61.6	61
8(b) Skin care creams should be mainly applied after work and during leisure time.	70.7	70	84.8	84	81.8	81	82.8	82
8(c) Only skin care creams containing medicinal herbs or natural scents should be used.	30.3	30	21.2	21	30.3	30	20.2	20

n, absolute number; OSD-KQ, Occupational Skin Diseases Knowledge Questionnaire.

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