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ORIGINAL ARTICLE

Skin cancer risk and shade: comparing the risk of foresters with other outdoor workers

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Abstract

Background Keratinocyte carcinoma (KC) is an increasingly important public health problem with an especially high prevalence in outdoor workers. In contrast to other occupations, foresters spend most of their outdoor time under the shade of trees.

Objectives We aimed to compare the unique sun exposure patterns and sun protection behaviour of foresters with those of other outdoor workers and their relation to the KC risk.

Methods In July 2018, a cross-sectional study was conducted at an international forestry fair using a questionnaire about health awareness and skin cancer screening by dermatologists to assess the prevalence of KC.

Results A total of 591 participants (78.7% male; mean age 46.8 ± 16.2 years) including 193 foresters were enrolled. Of all foresters, 72% experienced sunburns (solar erythema) within the past year and 50% of them experienced the worst sunburn during work. Foresters were most likely to often/always wear protective clothes (29.0%) but were least likely to often/always avoid midday sun (23.8%) and stay in the shade (31.1%). Having an outdoor profession or spending hours outside for leisure was negatively associated with sun protection. Skin examination revealed an overall KC prevalence of 16.7%, with 16.5% of foresters being affected.

Conclusion Despite being protected by trees, the risk of KC for foresters is comparable to that of other professional groups. Shade alone may not provide sufficient protection. Additional sun protection measures are necessary.

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Conflicts of interest

LT received speaker's honoraria by Beiersdorf Derma Medical GmbH. AZ has been an advisor and/or received speaker's honoraria and/or received grants by Galderma and Beiersdorf Derma Medical GbmH.

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Introduction

Keratinocyte carcinoma (KC) includes basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and actinic keratosis (AK) as a precursor of SCC. Due to worldwide climate change, KC is an increasingly important public health problem.[1–4] A worldwide rise in incidence and prevalence figures has been reported over the years.[5–8] A particularly high prevalence has been noted in studies including a large proportion of outdoor workers.[9–11] Due to their occupational exposure to ultraviolet radiation (UVR), outdoor workers are at a generally elevated risk for skin cancer; therefore, multiple AK and SCC cases have been established as occupational diseases in Germany since 2015.[12–15] Because of the heterogeneity among outdoor groups, differences in risk factors such as occupational sun exposure and related sun protective behaviours among various outdoor professions must be considered when examining the KC burden.[15–17]

There is broad evidence indicating that the KC burden can be lowered by behavioural changes such as adequate sun protection

measures.[4,16,18–20] On an individual level, it has been reported that some outdoor workers are unaware of their personal risk and do not sufficiently protect themselves.[16,21,22] On a population level, studies attributed inadequate usage of sun protection to unfavourable working conditions, such as dusty environments for farmers or absence of shade for roofers.[23,24] Essentially, one measure alone might not provide sufficient protection from UVR exposure. For example, when seeking shade, people often assume that their skin is fully protected; however, shade usually does not block UVR from all angles, and different types of shade vary regarding their protective efficacy.[25,26]

In addition to primary prevention, the utilization of secondary prevention is essential to lower the KC burden by early detection and adequate treatment. However, there are considerable differences in the health awareness of some outdoor professionals.[10,22] Consequently, to assess and lower the KC burden, it is necessary to investigate the heterogeneous group of outdoor workers regarding their occupational UVR exposure and their usage of preventive measures. Several studies have examined outdoor workers in general or farmers in particular,[22,27,28] but further occupation-specific studies on high-risk groups such as foresters are missing. Because foresters spend most of their work days in the forest, their UVR exposure is somewhat limited by the shade of trees. Accordingly, foresting is an outdoor profession with a unique UVR pattern compared to the majority of other outdoor professions. However, shade has received limited attention in terms of its protection ability in the current literature and foresters have never been assessed in this regard.

Therefore, our study aimed to examine foresters as an outdoor profession with unique UVR exposure and assess their sun protection behaviours, health awareness, and prevalence of KC and other skin diseases in comparison with that of other outdoor professionals and indoor workers. In analogy to a previous study in farmers recruited from an agricultural fair,[11] we took the opportunity of the international forestry fair in Munich to cover numerous outdoor workers from various professional backgrounds and geographic regions.

Methods

From 18 to 22 July 2018, a cross-sectional study was performed at the International Key Trade Fair for Forestry and Forest Technology (INTERFORST), a fair that takes place every 4 years in Munich, Germany. As part of a public health campaign organized by the German Social Insurance for Agricultural Professions ('Sozialversicherung für Landwirtschaft, Forsten und Gartenbau'), a skin examination comparable to that used for a previous study was offered.[11] The study was approved by the ethics committee of the Medical Faculty of the Technical University of Munich (reference 126/18 s). The inclusion criteria were that participants had to be 18 years or older, had to provide written informed consent, and had to be able to complete a German questionnaire.

Study questionnaire

A self-administrated questionnaire including 43 questions was used to assess age, gender, education and type of profession of the participants. The worker status of the participants in terms of outdoor and indoor work was obtained by the questions of how many hours they spent outside during working days and leisure time during summer and winter and whether their work was mainly outside, equal-parts-outdoor-and-indoor or mainly inside. Participants who indicated working more than 50% of work hours inside were classified as indoor workers.[28] Foresters, farmers and other outdoor workers (e.g. gardeners, construction workers) represented mainly outdoor workers. Additionally, people were asked about their 12-month prevalence of sunburns and sun-safety behaviour as follows: 'When staying outside, how often do you: (i) use sunscreen; (ii) avoid midday sun; (iii) wear a hat; (iv) wear protective clothes; (v) wear sunglasses; and (vi) stay in the shade?'. The responses were ranked using a 5-point Likert scale (0 = never, 1 = seldom, 2 = sometimes, 3 = often, 4 = always). Furthermore, questions covered general health awareness such as previous skin cancer screening or treatment by a dermatologist as well as the frequency of performing a self-examination. Questions also addressed individual problems regarding dermatological care such as being not good at examining their own skin for changes. People were also asked whether they were currently having (point prevalence) or if they had previously had (lifetime prevalence) any skin disease, which disease they had, who diagnosed the disease, and which symptoms they had. The questionnaire was based on validated items, wherever possible, and reviewed independently by five scientists experienced in dermatology, public health and statistics.[11,20,22,27,28]

On-site skin cancer screening

After completing the questionnaire, participants who volunteered to undergo skin cancer screening on-site by trained dermatologists in a separate protected examination cabin. As KC mainly occurs on sun-exposed areas, the examination mainly focused on these areas such as upper extremities and head; however, if participants reported conspicuous skin lesions on other body parts, then a full-body skin examination was performed. All screening results were recorded on a documentation form, and individuals with abnormal findings were referred to their local dermatologists for further examination.

Statistical analysis

After descriptive analyses, the main outcomes were categorized into four professional groups, that is foresters, farmers, other outdoor workers and indoor workers. The groups were compared for categorical variables by Pearson's chi-square test and for continuous variables by Student's *t*-test and one-way analysis of variance (ANOVA) with Bonferroni *post hoc*.

To assess sun-safety behaviour, a relative sun protection sum was calculated by summarizing scores of the six sun protection

measures (e.g. never = 0, always = 4) and then dividing by the number of given answers. Consequently, the lowest possible value was zero (never used any sun protection measures), and the highest value was four (always used all sun protection measures). The association between the sun protection score and possible determinants was quantified by univariate and multivariate linear regression analyses. Furthermore, univariate and multivariate logistic regressions were applied to assess variables that influenced the occurrence of KC. Significant factors ($P < 0.05$) identified in the univariate model were added to the multivariate model and were selected using backward selection with a level of stay of 0.05. Odds ratios (ORs) and adjusted ORs including 95% confidence intervals (CIs) were calculated.

Questionnaire data were digitalized by L.T. using Epi Info™ (Centers for Disease Control and Prevention, Atlanta, GA, USA). Sixty random questionnaires (10.1%) were entered twice by M.S. as a quality control measure (an error rate of 0.5%). These discrepancies were eliminated. All analyses were performed on available data with SPSS 25 (IBM Corp., Armonk, NY, USA).

Results

The study sample included 591 individuals (78.7% males) with a mean age of 46.8 ± 16.2 years. Besides foresters (n = 193) and farmers (n = 84), the sample comprised other outdoor workers (n = 129) such as construction workers (n = 16), gardeners

Table 1 Study characteristics stratified by occupational groups

Variable	Total (n = 591) n (%)	Foresters (n = 193) n (%)	Farmers (n = 84) n (%)	Other outdoor† (n = 129) n (%)	Indoor (n = 185) n (%)	P-values
Mean age SD, years	46.7 ± 16.2	46.6 ± 16.3	55.6 ± 15.6	46.8 ± 15.9	42.8 ± 15.0	<0.01
Gender						
Female	126 (21.3)	15 (7.8)	8 (9.5)	32 (24.8)	71 (38.4)	<0.01
Male	465 (78.7)	178 (92.2)	76 (90.5)	97 (75.2)	114 (61.6)	
School education level						
Low (≤10 years)	214 (36.1)	77 (39.9)	41 (48.8)	46 (35.7)	50 (27.0)	0.003
High (>10 years)	377 (63.7)	116 (60.1)	43 (51.2)	82 (63.6)	135 (73.0)	
Missing	1 (0.2)	0	0	1 (0.8)	0	
Hours spending outdoors (per day)						
Working day in summer	4.9 ± 3.6	6.9 ± 3.3	5.9 ± 3.1	5.5 ± 3.0	1.9 ± 2.2	<0.01
Working day in winter	4.1 ± 3.2	6.0 ± 3.2	5.1 ± 3.4	5.0 ± 2.7	3.5 ± 2.9	<0.01
Leisure time in summer	4.8 ± 2.9	5.1 ± 3.4	4.6 ± 3.1	5.0 ± 2.7	4.4 ± 2.2	0.069
Leisure time in winter	3.4 ± 2.5	3.5 ± 2.9	3.6 ± 2.7	3.7 ± 2.0	3.0 ± 2.1	0.071
Working in an employment relationship						
Yes	422 (71.4)	149 (77.2)	40 (47.6)	90 (69.8)	143 (77.3)	<0.01
Self-employed	153 (25.9)	43 (22.3)	43 (51.2)	32 (24.8)	35 (18.9)	
Missing	16 (2.7)	1 (0.5	1 (1.2)	7 (5.4)	7 (3.8)	
Do you have operational requirements for sun protection? (n = 422)						
Yes	61 (14.5)	26 (17.4)	5 (12.5)	14 (15.6)	16 (11.2)	0.400
Skin disease						
Yes, previously	25 (4.2)	10 (5.2)	4 (4.8)	6 (4.7)	5 (2.7)	0.870
Yes, recently	60 (10.1)	18 (9.3)	7 (8.3)	15 (11.6)	20 (10.8)	
No	503 (85.1)	164 (85.0)	73 (86.9)	106 (82.2)	160 (86.5)	
Missing	3 (0.5)	1 (0.5)	0	2 (1.6)	0	
Who diagnosed this skin disease? (n = 85)						
General practitioner	20 (23.5)	8 (28.6)	5 (45.5)	4 (19.0)	3 (12.0)	0.339
Dermatologist	56 (65.9)	17 (60.7)	5 (45.5)	15 (71.4)	19 (76.0)	
Self-diagnosis	4 (4.7)	2 (7.1)	1 (9.1)	0	1 (4.0)	
Other	1 (1.2)	0	0	1 (4.8)	0	
Missing	4 (4.7)	1 (3.6)	0	1 (4.8)	2 (8.0)	
Did you know that KC could be an occupational disease?						
Yes	169 (28.6)	57 (29.5)	21 (25.0)	40 (31.0)	51 (27.6)	0.782
No	422 (71.4)	136 (70.5)	63 (75.0)	89 (69.0)	134 (72.4)	

If incomplete information was available, a disclosure is made as 'missing'.
†Other outdoor workers included, for example gardeners, construction workers or in general people who spent at least half of their workday outside.

(n = 13) and indoor workers (n = 185) including office workers (n = 17) and employees (n = 14). During both summer and winter, foresters spent significantly more hours outside during a typical working day than all the other groups (each $P < 0.001$, Table 1, Fig. 1).

Sun protection behaviours

Figure 1 shows that foresters were most likely to experience sunburn within the last 12 months (71.5%) and half of them experienced sunburn during work. Only 17.4% of foresters and 12.5% of farmers reported having operational requirements for sun protection (Table 1). Compared to other outdoor professionals, foresters were more likely to often/always wear protective clothes (29.0%), but they were less likely to often/always avoid midday sun (23.8%). More than half of foresters (56.5%) indicated never/seldom use of sunscreen (Table 2).

Overall, indoor workers had the highest sun protection scores (1.96 ± 0.65) (Table 2). Thus, the type of profession had the greatest negative effect on sun protection behaviours, where the sun protection score was −0.179 lower for outdoor workers [β (95% CI) −0.179, (−0.290, −0.067), P = 0.002; Table 3].

General health awareness

The proportion without treatment by a dermatologist was highest among farmers (59.5%), and the proportion without skin cancer screening was highest among foresters (62.7%). Although 67.6% of the people would prefer to have a physician examine their skin rather than themselves, 51.9% agreed that it would be too time-consuming for them to consult a physician regularly. Additionally, 54.8% of all people and 54.4% of foresters particularly indicated that they are not very good at checking their own skin for changes. Therefore, 84.6% of the people indicated that they never/seldom performed self-examination (e.g. foresters: 86.1%; indoor workers: 87.6%).

According to the participants' self-disclosure, the point prevalence of any skin disease was 4.2% and the lifetime prevalence was 10.1% (Table 1). The most common diseases were KC (3.0%), eczema (2.4%), urticaria (1.5%), acne (1.5%) and psoriasis (1.0%). The most mentioned disease symptoms were pruritus (43.5%), dry skin (40.0%) and erythema (29.4%). For example, for psoriasis, the most reported symptom was desquamation (66.7%), whereas for eczema and urticaria, the most reported symptom was pruritus (85.7% and 77.8%, respectively).

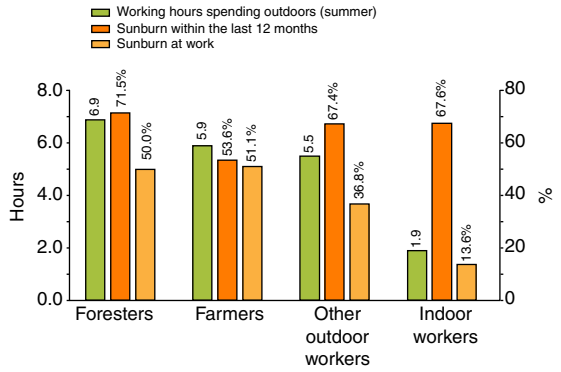

Figure 1 Average number of hours spending outdoors during working days in summer as well as proportion of participants who experienced at least one sunburn or experienced a sunburn at work within the last 12 months.

Result of the on-site skin cancer screening by trained dermatologists

Overall, 546 people (88.1% of foresters, 95.2% of farmers, 95.3% of other outdoor workers and 93.5% of indoor workers) also underwent the skin cancer screening on-site. The prevalence of the clinical diagnosis of AK was 15.2%, that of BCC was 1.8%, and of SCC was 0.2% among the participants, yielding an overall KC point prevalence of 16.7%. The highest prevalence of clinically diagnosed KC was found for farmers (33.8%), followed by foresters (16.5%) (Fig. 2). The mean age of all affected individuals was 63.5 ± 8.9 years. Moreover, a higher prevalence was detected in males (19.6% vs. 6.0%; P = 0.001). The univariate analysis suggested that only age was significant after applying multiple logistic regression models (OR = 1.13; 95% CI 1.10, 1.16) (Table S1).

According to self-disclosure, only 12 people had KC on the day of the study, whereas the dermatologists diagnosed KC in 91 participants. The highest discrepancies between self-disclosure and screening results were observed for farmers (1.3% vs. 33.8%) and foresters (2.9% vs. 16.5%; Fig. 3).

Skin diseases other than skin cancer diagnosed on-site

The prevalence of skin disease was 44.3% (including KC) and 34.6% (excluding KC). Dermatologists detected rosacea in 5.7% of the participants, eczema in 3.7%, psoriasis in 0.8%, and urticaria in 0.2%. Similar to KC, people 60 years of age or older more commonly had a skin disease (52.2%) than did people 50–59 years of age (30.6%; $P < 0.001$) and people 18–49 years of age (27.1%; $P < 0.001$). Unlike KC, a higher prevalence was observed in females (42.7% vs. 32.4%; P = 0.04). Many people were not aware that they had eczema or rosacea (Fig. 3).

Discussion

This study compared sunlight exposure and sun protection behaviour of foresters with those of two other groups of outdoor workers and a group of indoor workers. Compared to the other groups, foresters spent more time outdoors and were more affected by sunburns. Compared to farmers, foresters less commonly had KC; however, the KC prevalence of foresters was

Table 2 Sun protection behaviour of foresters, farmers, other outdoor workers and indoor workers

Variable	Total (n = 591)	Foresters (n = 193)	Farmers (n = 84)	Other outdoor† (n = 129)	Indoor (n = 185)	P-values
	n (%)	n (%)	n (%)	n (%)	n (%)	
Mean sun protection score ± SD	1.82 ± 0.67	1.79 ± 0.65	1.59 ± 0.65	1.81 ± 0.68	1.96 ± 0.65	0.001
Using sunscreen						
Never/seldom	287 (48.6)	109 (56.5)	52 (61.9)	63 (48.8)	63 (34.1)	<0.01
Sometimes	154 (26.1)	41 (21.2)	27 (32.1)	29 (22.5)	57 (30.8)	
Often/always	149 (25.2)	42 (21.8)	5 (6.0)	37 (28.7)	65 (35.1)	
Missing	1 (0.2)	1 (0.5)	0	0	0	
Avoiding midday sun						
Never/seldom	247 (41.8)	95 (49.2)	40 (47.6)	50 (38.8)	62 (33.5)	0.001
Sometimes	150 (25.4)	50 (25.9)	21 (25.0)	40 (31.0)	39 (21.1)	
Often/always	181 (30.6)	46 (23.8)	20 (23.8)	35 (27.1)	80 (43.2)	
Missing	13 (2.2)	2 (1.0)	3 (3.6)	4 (3.1)	4 (2.2)	
Wearing hat						
Never/seldom	189 (32.0)	46 (23.8)	29 (34.5)	46 (35.7)	68 (36.8)	0.012
Sometimes	142 (24.0)	54 (28.0)	11 (13.1)	28 (21.7)	49 (26.5)	
Often/always	247 (41.8)	91 (47.2)	40 (47.6)	51 (39.5)	65 (35.1)	
Missing	13 (2.2)	2 (1.0)	4 (4.8)	4 (3.1)	3 (1.6)	
Wearing protective cloths						
Never/seldom	306 (51.8)	80 (41.5)	46 (54.8)	75 (58.1)	105 (56.8)	0.005
Sometimes	155 (26.2)	53 (27.5)	18 (21.4)	32 (24.8)	52 (28.1)	
Often/always	120 (20.3)	56 (29.0)	16 (19.0)	22 (17.1)	26 (14.1)	
Missing	10 (1.7)	4 (2.1)	4 (4.8)	0	2 (1.1)	
Wearing sunglasses						
Never/seldom	278 (47.0)	101 (52.3)	56 (66.7)	60 (46.5)	61 (33.0)	<0.01
Sometimes	122 (20.6)	38 (19.7)	14 (16.7)	24 (18.6)	46 (24.9)	
Often/always	184 (31.1)	50 (25.9)	12 (14.3)	45 (34.9)	77 (41.6)	
Missing	7 (1.2)	4 (2.1)	2 (2.4)	0	2 (1.1)	
Seeking shade						
Never/seldom	90 (15.2)	40 (20.7)	17 (20.2)	20 (15.5)	13 (7.0)	<0.01
Sometimes	239 (40.4)	91 (47.2)	35 (41.7)	48 (37.2)	65 (35.1)	
Often/always	254 (43.0)	60 (31.1)	29 (34.5)	61 (47.3)	104 (56.2)	
Missing	8 (1.4)	4 (2.1)	3 (3.6)	0	3 (1.6)	

†Other outdoor workers included, for example gardeners, construction workers or in general people who spent at least half of their workday outside. If incomplete information was available, a disclosure is made as 'missing'.

similar to that of other outdoor workers. Screening for KC revealed serious underdiagnoses or unawareness of KC in all professional groups.

Our findings were in accordance with previous studies that working in an outdoor profession was negatively associated with UVR protection behaviours.[16,18,20,21,29] Although studies reported that approximately 80% of outdoor workers agreed that their risk of developing KC is increased when they are not protected from the sun,[21,22] several studies reported inadequate usage of sun protection measures.[10,16,18,21] Data reported for Germany indicated that regular usage of sunscreen among outdoor workers was 27.7% in general, and 18.8%, 38.6%, 46.1% among farmers, roofers and gardeners, respectively.[22] As the first study examining a large sample size of foresters, we found that only one-fifth of foresters often/always used sunscreen when outside. In line with the literature,[10,16,22] wearing a hat was the most prevalent sun protection measure and nearly half of the foresters often/always wore a hat. Although foresters tended to use sun protection more often compared to farmers, there was still a large proportion of foresters with inadequate protection behaviours. One reason may be that foresters generally spend many hours outside, but they are somewhat protected by the shade of trees when working in the forest; therefore, they might not understand the need to use additional sun protection measures. However, the protectiveness of shade largely depends on the type of shade, the size of the structure providing shade, and the distance of the structure from the person.[26] There is almost no evidence of the protectiveness of shade provided by trees in the context of KC prevention,[26] but many shade structures were found to inadequately protect against damaging UVR

Table 3 Mean sun protection score as well as associated factors detected in the univariate and multiple linear regression in the whole study sample (n = 591)

	Mean score†	Univariate β (95% CI), *P*-value	Multivariate β (95% CI), *P*-value
Age	–	+0.001 (−0.004, 0.003), 0.848	–
Gender			
Female	1.95 ± 0.69	1.00	–
Male	1.78 ± 0.66	−0.171 (−0.302, −0.040), 0.011	–
Education			
Low	1.76 ± 0.64	1.00	–
High	1.85 ± 0.68	+0.094 (−0.018, 0.206), 0.100	–
Profession			
Indoor	1.96 ± 0.65	1.00	1.00
Outdoor	1.76 ± 0.67	−0.203 (−0.318, −0.088), 0.001	−0.179 (−0.290, −0.067), 0.002
Hours spent outside...			
Working day summer	–	−0.033 (−0.048, −0.018), <0.001	–
Working day winter	–	−0.034 (−0.051, −0.017), <0.001	–
Leisure summer	–	−0.028 (−0.046, −0.009), 0.003	−0.026 (−0.044, −0.008), 0.005
Leisure winter	–	−0.021 (−0.042, 0.001), 0.062	–
Medical history of skin cancer			
No	1.82 ± 0.66	1.00	–
Yes	2.05 ± 0.67	+0.238 (−0.051, 0.527), 0.107	–
Knowing that KC is an occupational disease			
No	1.76 ± 0.66	1.00	–
Yes	1.96 ± 0.67	+0.199 (0.081, 0.317), 0.01	–
Previous screening			
No	1.76 ± 0.65	1.00	1.00
Yes	1.87 ± 0.68	+0.166 (0.057, 0.274), 0.003	+0.136 (0.029, 0.243), 0.013
Previous treatment by a dermatologist			
No	1.76 ± 0.65	1.00	–
Yes	1.87 ± 0.68	+0.107 (−0.001, 0.214), 0.052	–
Frequency of self-examination			
Seldom/never	1.77 ± 0.65	1.00	1.00
Regularly	1.96 ± 0.70	+0.185 (0.063, 0.307), 0.003	+0.190 (0.070, 0.310), 0.002

β, regression coefficient, CI, confidence interval.
†Mean value of relative the sun protection sum that was calculated by summarizing scores of six sun protection measures (0 = never, 1 = seldom, 2 = sometimes, 3 = often, 4 = always) and then dividing by the number of given answers. Consequently, the lowest possible value was zero (never used any sun protection measures), and the highest value was four (always used all sun protection measures).

exposure.[25,26] The fact that half of the foresters who experienced a sunburn within the past year sustained their worst sunburn during work suggested that the shade of trees does not provide sufficient protection. Consequently, it is important to increase foresters' awareness regarding the use of additional sun protection measures. In addition to increasing awareness, more workplace support from employers could be an important factor for better sun protection behaviour. As previous research suggested, lack of support has a negative effect on sun protection behaviours.[23,30,31] In this study, we found that fewer than one out of five outdoor workers had workplace requirements for sun protection. Accordingly, the lack of workplace support needs to be improved in the future.

Previous studies showed that many outdoor workers tended to underestimate their personal risk for developing KC; therefore, they did not consult a physician.[11,16,21] Underestimation of the individual risk might explain why more than half of the foresters had never been to a dermatologist and had never undergone a skin cancer screening. At the same time, more than half of the foresters indicated that they considered themselves incapable of checking their own skin for changes as insufficient, which might be why only the minority regularly checked their skin themselves. Consequently, both the lack of ability to check their own skin and the rare performance of skin examination might have contributed greatly to the fact that the prevalence of skin diseases detected by dermatologists on-site was four times higher than self-reported. Although the proportion of people who were not aware of their skin disease was lower compared to that of another study,[11] this proportion was still remarkably high. Problems such as lack of awareness might lead to not

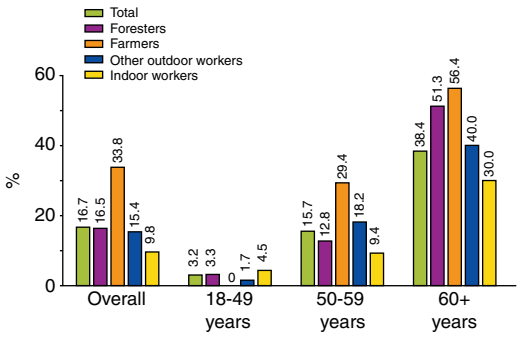

Figure 2 Overall point prevalence of clinical diagnosed KC, including AK, for foresters, farmers, other outdoor workers and indoor workers stratified by age. Foresters: $n = 170$, farmers: $n = 80$; other outdoor workers: $n = 123$; indoor workers: $n = 173$.

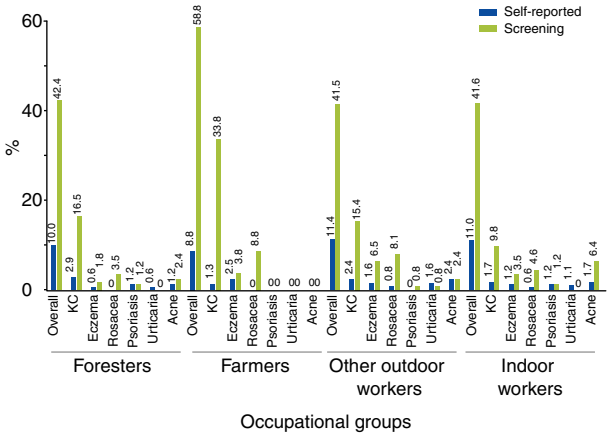

Figure 3 Comparison of the prevalence of skin diseases on the study day according to people's self-declarations and skin cancer screening performed by dermatologists. KC = actinic keratosis, squamous cell carcinoma and basal cell carcinoma; eczema = atopic dermatitis, hand eczema, seborrheic eczema and other eczema.

seeking treatment, incorrect self-treatment and the use of over-the-counter drugs that create a substantial economic burden and out-of-pocket expenses. Therefore, to decrease the individual and socioeconomic burdens of skin diseases, better access to health care and prevention campaigns should be offered. This would improve the general knowledge of skin diseases. Then, those affected could consult a physician earlier, which is necessary for early detection and adequate treatment.

As expected and reported in the literature,[10–13,32] the skin cancer screening revealed higher KC prevalence among outdoor workers than indoor workers. However, there were also differences in prevalence between various outdoor professions. For example, mountain guides and gardeners were at higher risk than farmers.[10] Interestingly, in this study, the highest KC prevalence was found in farmers. A reason for these various findings might due to the differences in occupational UVR exposure.[15] According to a nationwide German study, bricklayers, building workers and farmers were reported to have the highest number of hours working outside,[27] whereas in our study, foresters had the highest number. However, environmental factors influencing individual occupational UV exposure have to be taken into account when comparing the professions. For farmers, for example, it may be necessary to work in the field during the central hours of the day; therefore, they could experience substantial sun exposure.[15] In comparison, foresters perform most of their work in the forest, where they are at least somewhat protected by the shade of trees. Although the study could not confirm significant differences in KC development among various outdoor professions,[10] it suggested that outdoor workers are indeed a very heterogeneous group and that farmers might be at higher risk than foresters. Non-significant results might have been attributable to the small sample size of farmers included, and this should be considered in future research.

This study has some limitations. The study was performed at the INTERFORST; consequently, there was potential for selection bias. It is possible that the people who participated in this study had a higher level of health awareness and that older, sick or disabled people did not because they might be less likely to visit the fair. Accordingly, the generalizability is somewhat limited. Because a self-administered questionnaire was used, a response, recall or desirability bias could have influenced the answers and led to false estimations of the real risk behaviour. Although the questionnaire mainly included validated items and was reviewed by five scientists, the questionnaire itself was not fully validated. A further limitation was that not all people participated in the skin examination. Non-participants were significantly younger and worked as foresters; however, it is also conceivable that people who had a diagnosed and treated skin disease were less likely to have their skin checked. It is important to note that the prevalence of KC, including AK, BCC and SCC, might have been overestimated because the prevalence data were based on the clinical diagnosis and no biopsies were performed to confirm the detected cases. One study, however, suggested that the positive predictive value for the clinical diagnosis of AK was 74% in the general population and >95% in a population with a high frequency of skin cancer.[33]

Apart from these limitations, this study included a large number of individuals, especially foresters. The results showed that there was a considerable KC point prevalence among foresters, although they have some natural protection because of the shade of trees during work. This suggested that shade alone does not provide sufficient sun protection. Therefore, people should be aware that it is necessary to use more than one protective

measure to prevent KC. Future prevention and information campaigns should be adapted to the heterogeneous needs of various groups, and workplace requirements for sun protection measures for outdoor workers should be expanded to increase their frequency of usage.

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Supporting information

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

Table S1. Factors related to the occurrence of KC clinical diagnosed in the skin cancer screening on-site by trained dermatologists (results of the univariate and multivariate logistic regression).