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UV-induced occupational skin cancer: setting the prerequisites for evidence based prevention

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AFFIDAVIT

I, Alexander Gustav Stefan Zink, born on April 27, 1984 in Munich, Germany, hereby declare, that the submitted thesis entitled

UV-induced occupational skin cancer: setting the prerequisites for evidence based prevention

is my own work. I have only used the sourced indicated and have not made unauthorized use of services of a third party. Where the work of others has been quoted or represented, the source is always given.

I further declare that the submitted thesis or parts thereof have not been presented as part of an examination degree to any other university.

Munich, 20. December 2018

Alexander Zink

CONFIRMATION OF CONGRUENCY BETWEEN PRINTED AND ELECTRONIC VERSION OF THE DOCTORAL THESIS

I, Alexander Gustav Stefan Zink, born on April 27, 1984 in Munich, Germany, hereby declare, that the electronic version of the submitted thesis, entitled

UV-induced occupational skin cancer: setting the prerequisites for evidence based prevention

is congruent with the printed version both in content and format.

Munich, 20. December 2018

Alexander Zink

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List of abbreviations

AK	Actinic keratosis
BCC	Basal cell carcinoma
BK5103	Squamous cell carcinoma or multiple actinic keratoses of the skin caused by natural UV irradiation as occupational disease with the number BK 5103 of the German ordinance on occupational diseases
DALY	Disability-Adjusted Life Years
IARC	International Agency for Research on Cancer
KC	Keratinocyte carcinoma
MRC	Medical Research Council
NMSC	Non-melanoma skin cancer
SCC	Squamous cell carcinoma
UVR	UV-radiation
WHO	World Health Organization

Publication list

Zink A, Thomé F, Schielein M, Spinner CD, Biedermann T, Tizek L. Primary and secondary prevention of skin cancer in mountain guides: attitude and motivation for or against participation. J Eur Acad Dermatol Venereol. 2018; 32: 2153-2161

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Zink A, Rüth M, Watzele R, Nigg CR, Rehfuess EA. Failure of a Print Media Sun Safety Campaign to Reach High-risk Occupational Groups. Acta Derm Venereol. 2018; 98: 811-812

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Doctoral thesis

Introductory summary

Skin cancer is the most common malignancy in the fair-skinned population worldwide and is categorized as melanoma or non-melanoma skin cancer (NMSC) [1, 2]. The most common forms of NMSC are basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and actinic keratosis (AK), a carcinoma in situ with histology similar to SCC [3, 4]. Since recently, BCC, SCC, and AK are defined as keratinocyte carcinomas (KC) because of the shared lineage with epidermal keratinocytes [1, 5, 6]. Despite very high cure rates, KC is responsible for a significant number of deaths each year, worldwide [5, 6]. Furthermore, compared to melanoma [5, 6, 8], AK pose a higher level of impairment at the country-level in terms of Disability-Adjusted Life Years (DALY) [7], which is associated with an enormous health economic impact [9-15]. For Germany, it is estimated that there are approximately 200,000 new cases of BCC and SCC each year, and approximately 1.7 million new cases of AK. Furthermore, these numbers are estimated to increase within the next few years and even double by 2030 [16-18]. Main risk factor for KC is solar UV radiation (UVR) [1, 2], which was classified as a human carcinogen by the International Agency for Research on Cancer (IARC) in 1992 [19]. Naturally, humans with high UVR exposure, such as outdoor workers, have a higher risk for skin cancer. Indeed, there is sufficient evidence to confirm that individuals in Germany with long-standing occupational outdoor activities have a significantly higher risk for developing SCC compared to the general population [20-25]. Consequently, as of January 1st, 2015, "*squamous cell carcinoma or multiple actinic keratoses of the skin caused by natural UV irradiation*" was added to the list of occupational diseases of the German ordinance on occupational diseases as BK No. 5103 (BK5103) [26, 27]. As defined by BK5103, AK are considered multiple if more than five single lesions occur in a year, or are confluent in an area > 4 cm² ("field cancerization"). In contrast to SCC and AK, BCC is not categorized as occupational disease. Nonetheless, there is growing evidence that outdoor workers have a substantially higher risk

for BCC compared to the general population which in the future might lead to the classification of BCC as an occupational disease for the approximately 3 million outdoor workers in Germany [28-30].

Since the introduction of BK5103, healthcare professionals and associations of outdoor professions, as well as insurance companies and political institutions, have been collectively and persistently demanding highly effective and sustainable evidence-based prevention efforts to lower the burden of occupational skin cancer [31-33]. Therefore, corresponding prevention trials for outdoor professions are inescapable. The framework developed by the Medical Research Council (MRC) is a valuable tool in the development and evaluation of preventive interventions that contain several interacting components and is considered to be the standard framework for such complex interventions [34-36]. Using this framework, the planning and evaluation of a complex intervention would require to identify "number of groups to be targeted by the intervention", "number and difficulty of behaviors required by those receiving the intervention" and "number and variability of outcomes", which may work best if tailored to local circumstances [35, 37]. When used in the development and evaluation of complex interventions towards the elaboration of effective, evidence-based prevention of occupational skin cancer, the following implications apply among others: (1) High-risk groups for KC should be identified within the heterogeneous group of outdoor professions and their current behaviors as well as associated difficulties fully understood. (2) Outcomes embedded in their daily work routine should be precisely determined. (3) Methods of dissemination should be specified and explored for successful implementation.

Accordingly, the aim of the doctoral thesis was to identify a number of high-risk groups for BK5103 within the heterogeneous group of outdoor professions to be targeted by complex interventions, the number and variability of outcomes, potential routes of dissemination for complex interventions, and to gain an in-depth understanding of work-related, lifestyle-related, as well as sun-related behavior and associated difficulties of outdoor workers.

Different outdoor professions have different risks - a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners, and mountain guides

The aim of the first paper in this thesis, "*Different outdoor professions have different risks - a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides*" was to identify outdoor professions considered high-risk for KC and to assess the risks of occupational skin cancer in different outdoor professions. It was published in the *Journal of the European Academy of Dermatology and Venereology* (ISI Citation Report 2017: Impact factor: 4.287, Ranking: 7/63 (Dermatology)) and has been featured in Wiley's Research Headlines, a biweekly mailing sent to over 1,800 subscribing journalists to promote a selection of the most newsworthy research published across Wiley's journals. This study has triggered enormous interest worldwide and received an Altmetric Attention Score (an indicator of the amount of attention that a research output has received) of "*in the top 5% of all research outputs scored by Altmetric*" [38, 39].

As described above, after the acceptance of BK5103 in Germany and in other countries [26, 27, 31, 40], outdoor workers have been declared a high-risk group for occupational skin cancer by several institutions [1, 2, 29, 41, 42]. Outdoor workers, however, include numerous, heterogeneous outdoor professions that cannot be summarized using a single, collective risk of skin cancer and in particular BK5103 for this population. Few studies have tried to categorize different professions based on their typical UVR exposure during work [43]. None of these studies, however, have compared the risk and prevalence of UVR induced skin cancer in different outdoor professions [44], although this is an inevitable necessity for the development of targeted, sustainable, and socio-economically effective prevention campaigns. Therefore, the aim of this study was to compare the prevalence of SCC, BCC, and AK in different outdoor professions together with their associated risk behavior.

For this comparison, farmers, gardeners, and mountain guides were chosen as typical outdoor professions with very high UVR exposure [41, 42, 45-49]. Office workers of a large Munich-based company served as the control group. A total of 563 individuals (mean age 46.9 ± 13.8 years) participated in the study. Subjects completed a paper-based self-reported questionnaire and received a full-body skin examination by an experienced dermatologist using a dermatoscope [50]. There were 348 outdoor workers (135 farmers, 123 gardeners, 90 mountain guides) and 215 office workers. Despite being considered typical "prototype" outdoor workers, approximately three-fourths of gardeners (74.8%) and mountain guides (70.6%) reported that their typical working day consists of more than 4 hours working outdoors compared to only 48.4% of farmers. At the same time, skin cancer screening attendance rates were about twice as high in mountain guides (57.8%) compared to farmers (31.9%) and gardeners (27.6%). When questioned regarding the use of sun protection, almost all of the mountain guides (98.9%), 73.2% of gardeners, and 55.6% of farmers reported using sunscreen during work outdoors. For comparison, the majority (81.9%) of indoor workers reported fewer than two hours of UVR exposure, not using sunscreen (53.5%), and not using sun protective clothing (96.3%) during a typical working day. However, the skin cancer screening attendance rate for indoor workers (61.4%) was higher than for any outdoor profession.

Regarding KC prevalence, skin cancer screening revealed – as expected – a higher rate in the three outdoor professions compared to the office workers: 33.3% of all mountain guides, 27.4% of farmers, and 19.5% of gardeners were clinically diagnosed with KC compared to 5.6% of indoor workers. Mountain guides, gardeners and farmers, all had significantly higher risk of KC compared to indoor workers. Comparison of the three outdoor professions to each other, however, revealed that mountain guides had a significantly higher KC risk than farmers.

These results dramatically demonstrate that prototype outdoor workers cannot be considered as one single group. As shown here for farmers, gardeners and mountain guides: different outdoor professions have a different risk for skin cancer and, in particular, the UVR induced

BK5103. Simultaneously, the study results also reveal perhaps the most critical weakness of primary and secondary prevention of skin cancer; individuals with higher risk for KC show poorer preventive behavior whereas individuals with lower risk for KC show higher preventive behavior. Despite limitations in the study design, these results highlight that future prevention strategies should fundamentally be tailored to the individual local requirements and specific outdoor professions to be effective and sustainable. Using the MRC framework, complex interventions should be separately tailored to farmers, mountain guides, gardeners, and other outdoor professions.

According to the MRC framework, understanding current behaviors and associated difficulties in the respective professions is an important requirement for successful interventions. Recognizing individual motivations regarding the use of sun protection or seeking skin cancer screening, could be the key to developing effective prevention strategies. This was the rationale of the second and third study of this Ph.D. thesis.

Primary and secondary prevention of skin cancer in mountain guides: attitude and motivation for or against participation.

Primary prevention strategies, such as using sunscreen, wearing hats or other sun protective gear, and undergoing skin cancer screenings for early detection of skin cancer (secondary prevention), are especially poor in mountain guides according to previous publications [46-48]. Although these prevention efforts appear easy-to-use and with a low barrier due to their non-invasive nature, there are several additional reasons and possible explanations for this conflicting finding. They have, however, received limited attention in previous studies.

Hence, the aim of the second paper in this Ph.D. thesis was to evaluate motivations for or against sun-protective behavior during the workday of outdoor professions with substantial UVR exposure. Mountain guides were chosen since previous studies have highlighted the UVR exposure and substantial risk of KC in this outdoor profession compared to other outdoor

professions as described above [45-48]. Understanding the individual motivations of mountain guides is essential according to the MRC framework to successfully develop and evaluate target-oriented awareness and prevention campaigns.

To address every professional and active mountain guide in Germany, the study was planned in cooperation with all three mountain guide associations in Germany (*Verband staatlich geprüfter Berg- und Skiführer*, *Verband deutscher Polizeiberg- und –skiführer*, *Verband Deutscher Heeresbergführer*). All active members in these associations were asked by their presidents to participate in the study. The questionnaire assessed demographic data (age, gender, educational level), individual work characteristics, years of experience as mountain guide, average number of mountain tours per year, knowledge regarding UVR and skin cancer, as well as primary and secondary prevention measures used in daily working life. Furthermore, participants were asked to rate their individually perceived skin cancer risk and potential reasons for or against participating in skin cancer screenings on a Likert scale.

The results showed that despite continuous recommendations of skin cancer prevention by healthcare professionals, insurance companies, and public health institutions, there are several practical reasons for the non-implementation of these recommendations in real life. Nonetheless, compared to previous studies, German mountain guides appear to have gained some knowledge on UVR and primary prevention, which might indicate the success of several previous studies and information campaigns particularly for the German mountain guide population [45-48]. In contrast to primary prevention of skin cancer, however, secondary prevention efforts are still very poor with lack of knowledge, lack of insight and an individually perceived status of good health, being the three main reasons. Motives for having attended a skin cancer screening can be summarized under the fear of skin cancer and a general high interest in personal health. To increase the participation rate of skin cancer screenings, a simple but focused awareness and education strategy could be successful and should be explored in future studies.

Gaining detailed understanding and in-depth insight into the target population for future complex interventions was the rationale of the third study of the Ph.D. project, a qualitative study on perspectives towards skin cancer prevention in a high-risk outdoor population.

"Try to make good hay in the shade, it won't work!" – A qualitative interview study on the perspectives of Bavarian farmers regarding primary prevention of skin cancer

Qualitative research is one scientific method used to understand a research problem from the perspective of the target population. One of the great strengths of qualitative research is its ability to obtain complex descriptions of how individuals perceive and experience a specific topic of research [51-54]. Applied to the Ph.D. research question of BK5103 in outdoor workers, qualitative research can reveal information about the "human" side of UVR and skin cancer prevention and deliver insights into contradictory behaviors of outdoor workers that should be addressed in future interventions. Influencing factors such as gender roles, social norms, and other internal and external barriers not yet apparent in the literature, can also be identified with qualitative methods [51].

As a result, the aim of the third study in this Ph.D. thesis, titled "*Try to make good hay in the shade, it won't work" - A qualitative interview study on the perspectives of Bavarian farmers regarding primary prevention of skin cancer*" was to provide in-depth insights and broad understanding of the perspectives of farmers regarding primary prevention of skin cancer as well as to grasp its impact on implementing sun protective behavior. This qualitative study was conducted using semi-structured individual interviews with farmers in two different regions of Bavaria: Lower Bavaria and Allgäu. To assess potential differences in individual views related to age and/or agricultural specialization, farmers had to be between 18 and 30 years or 60 years and older and working as a dairy and/or crop farmer, to be included in the study. All interviews were audio-recorded, transcribed verbatim, and then analyzed using the qualitative content analysis by Mayring [51]. The main determinants of individual viewpoints on skin cancer

prevention were overall knowledge and awareness of UVR exposure and KC, perceived individual barriers to implementing sun protective measures, individual experiences, and farm life-specific circumstances. Particularly, lacking awareness and lacking knowledge regarding UVR and skin cancer was identified as one of the main reasons for not implementing sun protection in daily work. Self-perceived overall good health was typically reported as a reason against primary prevention efforts. Individually perceived challenges during work, such as not being able to apply sunscreen during work due to dirty hands, dust, or other job and farm life-related barriers were further reasons for not using sun protection. On the other hand, communication with fellow farmers, such as having talked to someone affected by skin cancer, or negative individual experiences, such as having suffered a severe sunburn, positively influenced primary prevention measures. These are in contrast to a previous publication which reported that one's own body image influences sun-related behavior [55]. Thus, future studies with the long-term aim of developing prevention campaigns and their respective interventions in farmers should focus on a broad dissemination of easy-to-understand information regarding skin cancer caused by UVR exposure and the analysis of strategies to promote self-efficacy. Based on the study results with sun screen being the main focus of farmers regarding sun protection, the promotion of combining different sun protection measures beyond sunscreen with each other should as well be studied in further (qualitative) studies.

Previous interventions for skin cancer prevention focused on media placement of sun protection messages on television, radio, billboards, and in print. Typically, these messages were targeted at the individual, organizational, and/or community level rather than specifically addressing high-risk groups for skin cancer [56-61]. However, campaigns targeted at the general population or subpopulations of particular interest, such as the recreational industry [58], cannot be easily translated to occupational groups with year-round high UVR exposure or specific occupational tasks, even when they are proven to be highly effective [59, 62]. As

described above, an essential concern for any future prevention strategy targeted to outdoor workers is determining how to best reach the target population.

Failure of a Print Media Sun Safety Campaign to Reach High-risk Occupational Groups

The aim of the fourth publication of this Ph.D. thesis, titled "*Failure of a print media sun safety campaign to reach high-risk occupational groups*" and published in *Acta Dermatol-Venereologica* (ISI Citation Report 2017: Impact Factor 3.127, Ranking 11/63 Dermatology), was to explore whether specific outdoor workers could be effectively reached by a print media sun safety campaign. Specifically, the range and impact of sun protection messages placed in different profession-specific, special interest magazines was assessed in terms of reaching one of the outdoor working groups with the highest UV exposure in Germany: farmers and agricultural workers. This campaign had a national component that addressed all of Germany and a regional component that specifically addressed the Free State of Bavaria. General information on skin cancer and related primary prevention recommendations were placed in agricultural magazines with a combined circulation of 1.45 million. These messages included an invitation to visit the study website for further information on skin cancer and prevention, and to participate in a brief online survey targeted to a national audience. This survey consisted of 11 questions on skin cancer and the implementation of prevention measures in daily life. The level of response and engagement by farmers and agricultural workers was assessed by analyzing the number of visitors on the study website for one month following each publication. Messages in national and regional publications were placed three months apart to prevent overlap and were compared with a control period without publication to ensure validity.

Despite considerable effort addressing 1.45 million agricultural households at the national and regional level, the impact was surprisingly low with a response rate of 0.01%. Only 140 individuals (128 following the national and 12 following the regional publication) visited the study website. Furthermore, the average time spent on the website was just over one minute

(range: 9 seconds – 5 minutes, 2 seconds). While it is possible that farmers received an educational benefit from the sun protection messages that were placed in the journals, the campaign and approach of combining printed sun protection messages with an internet-based assessment had to be declared a failure based on the response rate. In general, future studies on skin cancer prevention should explore how these target populations can be reached more effectively. Identifying the best possible access to these professions is one aspect, and perhaps the most essential, of future prevention strategies that lower the global burden of occupational skin cancer in outdoor professions.

In summary, the four studies in this Ph.D. thesis contribute to the foundation of research used in the development and evaluation of complex interventions for target-oriented skin cancer prevention programs specifically designed for outdoor workers, using the MRC framework. Furthermore, these studies identified high-risk groups to be targeted by future interventions, revealed difficulties surrounding their current risk behaviors, identified numerous outcomes to be addressed and evaluated a specific dissemination approach as ineffective. Complex interventions aiming at the long-term goal of evidence-based prevention of UV-induced occupational skin cancer seem overdue to lower the burden of occupational skin cancer.

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Articles

Article I

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ORIGINAL ARTICLE

Different outdoor professions have different risks – a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides

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Abstract

Background One of the main risk factors for non-melanoma skin cancer (NMSC), the most common cancer worldwide, is solar ultraviolet radiation (UVR). This has led to the recognition of NMSC as occupational disease for outdoor workers in several countries. However, outdoor professions are a very heterogeneous group with diverse daily activities and associated UVR exposure.

Objective To compare the prevalence of NMSC and associated risk behaviour in different outdoor professions.

Methods Cross-sectional study among outdoor workers (farmers, gardeners, mountain guides) and indoor workers (office employees) as control group using a paper-based questionnaire on UVR exposure and protective behaviour followed by a skin examination by a dermatologist.

Results A total of 563 participants (46.9% women, 46.9 ± 13.8 years) consisting of 348 outdoor workers (38.8% farmer, 35.3% gardener, 25.9% mountain guides) and 215 indoor workers were included in the study between March and September 2017. NMSC incl. actinic keratosis was diagnosed in 33.3% of mountain guides, 27.4% of farmers, 19.5% of gardeners and in 5.6% of indoor workers. Significant differences were seen between the outdoor professions with mountain guides at highest risk compared to farmers (OR = 2.6, 95% CI = 1.2–5.7). Substantial differences between the professions were also seen in skin cancer screening attendance rates (indoor worker 61.4%, mountain guides 57.8%, farmers 31.9%, gardeners 27.6%), daily UVR exposure during work and protective behaviour such as sunscreen use during work.

Conclusion Different outdoor professions have significant different risks for NMSC and show different risk behaviour. Tailoring prevention efforts to different professions based on their individual needs could be the key to lower the global burden of (occupational) NMSC.

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Conflicts of interest

None declared for this study.

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Introduction

Non-melanoma skin cancer (NMSC) is the most common cancer worldwide with a tremendous individual and socioeconomic impact.[1–4] Solar UV-radiation (UVR) exposure is the main risk factor for NMSC, which has led to the official recognition of NMSC as occupational disease for outdoor workers in some countries including Australia, Denmark, France, Germany, Italy and Romania.[2,5–7] In Germany, only squamous cell carcinoma and more than five actinic keratoses per year were accepted of the many different subtypes of NMSC[3,4] as occupational disease.[5,6] Other NMSC forms such as basal cell carcinoma (BCC) and merkel cell carcinoma are not included, although there is some evidence, that UV exposure might play a role in the pathogenesis of both.[3,8,9] Especially for BCC, UVR might be crucial for the development of some BCC subtypes with typical UV-induced DNA damage signatures.[3,10]

Despite all the evidence of UVR as a main risk factor for NMSC,[3,11] there are still some open questions. One is the rare

finding of NMSC on the back of the neck despite being a body area with enormous UVR exposure during work and outside activities and probably the most prominent area, at which most human beings had experienced at least one sunburn before.[12,13] Another open question is why some individuals develop solar elastosis rather than NMSC despite severe cumulative lifetime UVR exposure. Previous studies found that wrinkling may protect from NMSC, but so far the protective factors have not yet been identified.[14] By studying and comparing individuals of different outdoor professions with high cumulative UV exposure, the identification of different UV-induced response patterns could be initiated to answer these open questions.

In unison, outdoor workers have been declared high-risk groups for developing (occupational) NMSC by health-care professional and experts worldwide.[3,15,16] But outdoor professions in general are too heterogeneous to be summarized simply by the term 'outdoor workers'. Some efforts have been made in Germany to categorize professions based on their typical UVR lifetime exposure during work as cut-off for NMSC.[17] But studies comparing the prevalence of NMSC and associated risk behaviour in different outdoor professions and indoor workers as control group are rare.[18] However, these studies are highly needed to identify extreme high-risk groups for NMSC and other skin diseases within the high-risk group of outdoor professions to develop target-oriented, substantial and socio-economic efficient prevention campaigns. Because they seem to be the key for substantial reduction of the burden of NMSC and other occupational skin diseases worldwide,[2,19,20] the comparison of the prevalence of NMSC and other skin diseases and associated risk behaviour in different outdoor professions was the objective of our study.

Materials and methods

This cross-sectional study was approved by the ethics committee of the Medical Faculty of Technical University of Munich. Farmers, gardeners and mountain guides were included as previously shown outdoor professions with significant cumulative UVR exposure.[16,21–25] Office workers of a large Munich-based company served as control group. Farmers were recruited at regional meetings of the Bavarian Farming Association (Bayerischer Bauernverband) around Munich, gardeners at the City of Munich's mandatory Health Day for its community gardeners and mountain guides at the annual meeting of the Association of German Police Mountain Guides (VdPBS) in Bavaria, Southern Germany between March and September 2017. All participants were 18 years of age or older and were included in the study if they provided written informed consent. Participants filled out a paper-based questionnaire followed by a skin examination by a board-certified dermatologist. At the Health Day for gardeners, the study's examination was one of several health stations including for example blood pressure and visual tests, at which all gardeners took part in. At the other meetings, the study was continuously promoted by the associations' presidents and representatives to ensure a high participation rate. For the office workers, the study was announced 4 weeks in advance by the work council in their monthly newsletter; interested participants signed up for the full-body skin examination and completed the study questionnaire on one of two available study days.

Questionnaire and skin examination

To assess socio-demographic and work characteristics, knowledge and use of primary and secondary prevention measures, 10 questions were chosen based on previous studies[22,24,25] (also see Table 1). After self-completion of the paper-based questionnaire, participants underwent the skin examination[26] by experienced dermatologists of the Department of Dermatology and Allergy, Technical University of Munich using a dermatoscope. The skin type according to Fitzpatrick[27] was assessed together with the colour of eyes and hair. Every abnormal skin finding including its location was meticulously documented. Participants with dermatologic findings and especially NMSC (including actinic keratosis as early in situ squamous cell carcinoma[28]) were given a detailed recommendation and referred to a local dermatologist for further evaluation and treatment. Participants were not followed up for further histologic evaluation due to the large patient number from different and remote areas of Bavaria as well as due to previous studies having shown that NMSC is correctly diagnosed by experienced dermatologists in up to 94% of all cases solely by clinical examination.[29]

Statistical analysis

Descriptive data were generated for all questionnaire variables. To assess differences between the study groups, participants were categorized into five age groups (18–39, 40–49, 50–59, 60–69, 70 years and older) and according to their profession into the groups 'farmers', 'gardeners', 'mountain guides' and 'office workers'.

The Spearman correlation coefficient was used to assess the association between participants' characteristics and the appearance of dermatological diseases. In addition, two logistic regression models using the complete-case analysis (98.9%) were applied to generate adjusted odds ratios (OR) and 95% confidence intervals (CI). In the first analysis, the occurrence of dermatological diseases in general was defined as outcome variable, whereas NMSC was set as dependent variable in the second analysis. Age, sex, profession, previous skin cancer screening and previous treatment by a dermatologist were used as explanatory variable in both analyses. Significance levels were set a priori at 0.05. All questionnaire and screening documentations were digitalized twice using Epi Info™ (Centers for Disease Control and Prevention, Atlanta). The two datasets were subsequently compared and discrepancies corrected by checking the source data. Data management and statistical analyses were performed using IBM SPSS Statistics 24 (IBM Corporation, Armonk, NY, USA).

Table 1 Baseline characteristics of the study population ($N = 563$)

	Total *n* (%)	Farmers *n* (%)	Gardeners *n* (%)	Mountain guides *n* (%)	Indoor workers *n* (%)
	563 (100)	135 (100)	123 (100)	90 (100)	215 (100)
Sex					
Women	264 (46.9)	76 (56.3)	48 (39.0)	5 (5.6)	135 (62.8)
Men	299 (53.1)	59 (43.7)	75 (61.0)	85 (94.4)	80 (37.2)
Age					
Mean (SD)	46.9 ± 13.8	56.7 ± 11.6	43.7 ± 13.0	47.7 ± 11.5	42.2 ± 13.1
18–39 years	174 (30.9)	10 (7.4)	37 (30.1)	21 (23.3)	106 (49.3)
40–49 years	118 (21.0)	19 (14.1)	31 (25.2)	26 (28.9)	42 (19.5)
50–59 years	177 (31.4)	48 (34.1)	48 (39.0)	35 (38.9)	46 (21.4)
60–69 years	67 (11.9)	46 (34.1)	7 (5.7)	4 (4.4)	10 (4.7)
70 years +	25 (4.4)	12 (8.9)	0	4 (4.4)	9 (4.2)
Missing answer	2 (0.4)	0	0	0	2 (0.9)
UVR exposure during typical working day					
<2 h	201 (35.7)	29 (21.5)	7 (5.7)	4 (4.7)	176 (81.9)
2–4 h	109 (19.4)	35 (25.9)	21 (17.1)	20 (22.4)	18 (8.4)
4–6 h	75 (13.3)	28 (20.7)	11 (8.9)	30 (32.9)	6 (2.8)
>6 h	157 (27.9)	38 (28.1)	81 (65.9)	34 (37.6)	4 (1.9)
Missing answer	21 (3.7)	5 (3.7)	3 (2.4)	2 (2.4)	11 (5.1)
What sunscreen do you use during a typical working day?					
No SPF	209 (37.1)	60 (44.4)	33 (26.8)	1 (1.1)	115 (53.5)
SPF 6–10	21 (3.7)	8 (5.9)	4 (3.3)	2 (2.2)	7 (3.3)
SPF 15–25	122 (21.7)	36 (26.7)	25 (20.3)	25 (27.8)	36 (16.7)
SPF 30–50	166 (29.5)	24 (17.8)	47 (38.2)	47 (52.2)	48 (22.3)
SPF 50+	41 (7.3)	6 (4.4)	14 (11.4)	14 (15.6)	7 (3.3)
Missing answer	4 (0.7)	1 (0.7)	0	1 (1.1)	2 (0.9)
Do you wear sun protective clothing during work?					
No	494 (87.7)	119 (88.1)	95 (77.2)	73 (81.1)	207 (96.3)
Yes	61 (10.8)	16 (11.9)	28 (22.8)	16 (17.8)	1 (0.5)
Missing answer	8 (1.4)	0	0	1 (1.1)	7 (3.3)
Do you wear a hat or other headgear during work?					
No	308 (54.7)	59 (43.7)	38 (30.9)	22 (24.4)	189 (87.9)
Yes	247 (43.8)	76 (56.3)	85 (69.1)	67 (74.4)	19 (8.8)
Missing answer	8 (1.4)	0	0	1 (1.1)	7 (3.3)
Have you ever undergone a skin cancer screening before?					
No	299 (53.1)	92 (68.1)	87 (70.7)	38 (42.2)	82 (38.1)
Yes	261 (46.4)	43 (31.9)	34 (27.6)	52 (57.8)	132 (61.4)
Missing answer	3 (0.5)	0	2 (1.6)	0	1 (0.5)
Have you ever consulted a dermatologist before?					
No	238 (42.3)	66 (48.9)	67 (54.5)	27 (30.0)	78 (36.3)
Yes	320 (56.8)	68 (50.4)	54 (43.9)	63 (70.0)	135 (62.8)
Missing answer	5 (0.9)	1 (0.7)	2 (1.6)	0	2 (0.9)

Results

Baseline

A total of 563 people (264 women, 299 men) participated in the study with a mean age of 46.9 ± 13.8 years. Of these, 215 (38.2%) were office (indoor) workers, 348 (61.8%) outdoor workers (135 farmers, 123 gardeners, 90 mountain guides) (Table 1). Gardeners in average spend more hours outside per working day compared to farmers and mountain guides with 74.8% of all gardeners, 48.4% of all farmers and 70.6% of all mountain guides typically working more than 4 h per day outside. The majority (81.9%) of all indoor workers answered the same question with <2 h as expected due to working in offices and being outside only for example during breaks or errands (Table 1, Fig. 1).

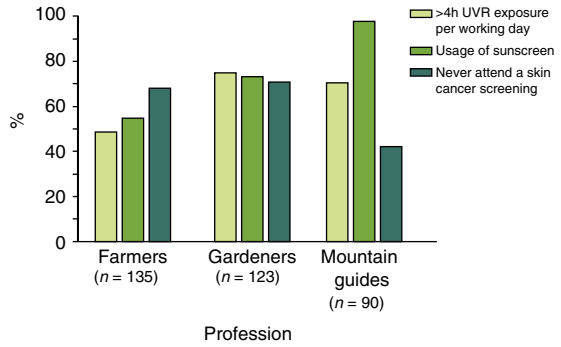

Figure 1 Percentage of farmers, gardeners and mountain guides with typically more than 4 h solar ultraviolet radiation exposure and usage of sunscreen during a typical working day as well as undergone a previous skin cancer screening.

Risk behaviour

Overall, 53.1% of all participants had never been to a skin cancer screening by any medical doctor before. The highest skin cancer screening attendance rates were reported by indoor workers and mountain guides with 61.4% and 57.8%, respectively. These rates were nearly twice as high as in farmers (31.9%) and gardeners (27.6%). Asked for having consulted a dermatologist ever before, 62.8% of the indoor workers and 70.0% of the mountain guides answered with a *yes*, compared to 50.4% of all farmers and 43.9% of all gardeners. The majority of mountain guides (98.9%) reported to typically use sun screen with a sun protection factor (SPF) during work outside compared to 73.2% of all gardeners and 55.6% of all farmers. Furthermore, mountain guides used higher SPF compared to the other outdoor professions. Wearing sun protective clothing during work was reported only by a small portion (11.9–22.8%) of outdoor professions, whereas the majority (56.3–74.4%) stated to wear a hat (Table 1).

Clinical examination

The dermatologists diagnosed at least one abnormal skin condition in 310 participants, yielding an overall point prevalence of 55.1%. Affected participants were older (mean age of participants with skin findings 50.6 years vs. mean age of participants without skin diseases 42.4 years) and more likely men (61.9% vs. 47.3%). In general, a moderate correlation between skin findings and age was observed (r_s = 0.322, P = 0.01). In the age categories, the point prevalence of skin findings continuously increased with age starting at 33.3% in age group 18–39 years up to 72.0% in the age group 70+ years. Compared to the youngest age group, the risk for skin findings was significantly higher in all other age groups. In general, men (OR = 2.7, 95% CI = 1.6–4.7), farmers (OR = 2.7, 95% CI = 1.6–4.8) and gardeners (OR = 4.6, 95% CI = 2.7–7.9) were more likely to suffer from a skin disease compared to indoor workers (Table 2).

Non-melanoma skin cancer

Non-melanoma skin cancer (NMSC) including its precursors was detected in 103 individuals, leading to an overall point prevalence of 18.3%. The vast majority of NMSC was detected at sun exposed sites with 83.4% in the face (44.4%) and forehead (39.0%). Not a single case was found on the back of the neck. The mean age of affected participants was 57.8 ± 10.3 years with the highest prevalence in participants aged 70 years and older (52.0%) and a moderate correlation between NMSC and age (r_s = 0.36, $P < 0.001$). NMSC was further associated with outdoor professions (r_s = 0.22, $P < 0.001$) with noticeable higher NMSC rates in all outdoor workers (mountain guides 33.3%, farmers 27.4%, gardeners 19.5%) compared to indoor workers (5.6%) (also see Fig. 2). Mountain guides (OR = 5.9, 95% CI = 2.4–14.6), gardeners (OR = 4.0, 95% CI = 1.7–9.5) and farmers (OR = 2.3, 95% CI = 1.0–5.0) had a significant higher risk for NMSC than indoor workers. But even when comparing the outdoor professions with each other, mountain guides (OR = 2.6, 95% CI = 1.2–5.7) had a significant higher risk for NMSC and other skin diseases compared to farmers (Table 3).

Discussion

Our findings show that different outdoor workers have different risks for NMSC and other skin diseases. Numerous publications are available on assessing the prevalence and risk of NMSC in

Table 2 The seven most common skin findings in farmers, gardeners, mountain guides and indoor workers

Diagnoses	Total *n* (%)	Farmers *n* (%)	Gardeners *n* (%)	Mountain guides *n* (%)	Indoor worker *n* (%)
Solar elastosis	31 (5.5%)	9 (6.7%)	17 (13.8%)	16 (17.8%)	5 (2.3%)
Eczema (hand, atopic, seborrheic, nummular)	30 (5.3%)	6 (4.4%)	6 (4.9%)	1 (1.1%)	17 (7.9%)
Erythrosis interfollicularis colli	28 (5.0%)	5 (3.7%)	6 (4.9%)	16 (17.8%)	1 (0.5%)
Lentigo solaris	20 (3.6%)	8 (5.9%)	11 (8.9%)	7 (7.7%)	1 (0.5%)
Xerosis cutis	19 (3.4%)	5 (3.7%)	9 (7.3%)	3 (3.3%)	5 (2.3%)
Guttate hypomelanosis	12 (2.1%)	3 (2.2%)	7 (5.7%)	5 (5.6%)	2 (0.9%)
Psoriasis	11 (2.0%)	3 (2.2%)	4 (3.3%)	1 (1.1%)	3 (1.4%)

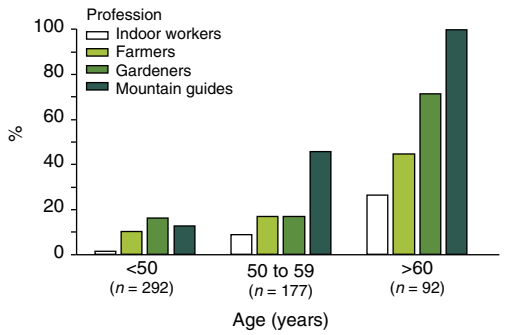

Figure 2 Point prevalence of NMSC (incl. actinic keratosis) in farmers, gardeners, mountain guides and indoor workers stratified by age.

Table 3 Logistic regression model to assess the association between different risk factors of non-melanoma skin cancer (incl. actinic keratosis) and other abnormal skin findings

	All skin findings Adjusted OR (95% CI)	NMSC Adjusted OR (95% CI)
Age		
18–39 years	1.00	1.00
40–49 years	**2.07 (1.22–3.51)**	**6.27 (2.01–19.52)**
50–59 years	**3.64 (2.20–6.02)**	**9.06 (3.07–26.76)**
60–69 years	**6.93 (3.19–15.03)**	**52.18 (15.46–176.11)**
70 years and older	**7.67 (2.81–20.94)**	**96.20 (23.51–393.61)**
Sex		
Female	1.00	1.00
Male	**2.73 (1.59–4.70)**	**2.48 (1.35–4.59)**
Outdoor professions compared with indoor workers		
Farmers	**2.73 (1.59–4.70)**	**2.25 (1.01–5.04)**
Gardeners	**4.60 (2.70–7.85)**	**4.03 (1.71–9.51)**
Mountain guides	0.87 (0.48–1.58)	**5.93 (2.42–14.55)**
Indoor worker	1.00	1.00
Professions compared with farmers		
Farmers	1.00	1.00
Gardeners	1.69 (0.90–3.15)	1.79 (0.86–3.72)
Mountain guides	**0.32 (0.16–0.62)**	**2.64 (1.22–5.70)**
Indoor worker	**0.63 (0.43–0.94)**	**0.45 (0.20–0.99)**

outdoor workers compared to the general population and indoor workers.[2,6,30,31] But very few studies so far compare the respective risks of different outdoor workers within the substantially heterogeneous group of outdoor professions. However, it seems essential to evaluate individual outdoor workers not only based on their profession, but rather based on his or her explicit individual occupation and daily specialized tasks, which is underlined by this study.

In this study, the overall NMSC prevalence in outdoor workers was higher compared to indoor workers as expected and previously published.[6–9,11,15,30] The point prevalence of NMSC in police mountain guides in this study (33.3%) is comparable to NMSC rates of 33.9%[21] and 43.5%[22] in state-certified mountain guides published in 2010 and 2016, respectively. The point prevalence of NMSC in farmers (27.4%) and gardeners (19.5%) overall seems to be in line with the literature,[16,32,33] although exact reference values could not be found. Several of the most common diagnosed skin findings (solar elastosis, erythrosis interfollicularis colli, lentigo solaris) are well known to be triggered by UVR, which further underlines the need for UVR protection. With respect to sun protection during work, the vast majority of mountain guides (98.9%) reported daily usage, which is contrast to the above mentioned previous studies.[21,22] An explanation could be regular Health Days with prevention campaigns organized by the Police Union, who the police mountain guides belong to, but not the state-certified mountain guides. However, the NMSC prevalence of both groups is comparably high, which puts hitherto existing prevention efforts into question.

NMSC risk and protective behaviour of farmers, gardeners and mountain guides with its striking differences are remarkable. All three groups are counted among the prototype outdoor professions. But not only do they substantially diverge in sunscreen use, skin cancer screening attendance. They even have distinctive UVR exposures during daily work, which is probably the essential factor for defining the term 'outdoor profession'.

Comparing different outdoor occupations with each other as well as a control group with respect to skin diseases and NMSC including associated risk and protective behaviour is one strength of this study. Furthermore, the study design with a real-life setting at local outdoor professionals meetings beyond a typical health-care setting included an unreferred population who never or rarely seek health care – 43.2% had never been to a dermatologist. At the same time, the study design is also the main limitation of the study. Including participants at local meetings poses the risk of selection bias. Individuals who have never been to a dermatologist might have been especially eager to participate as well as individuals with previously diagnosed skin cancer or individuals with exceptionally high-risk behaviour. This could have led to an overestimation of the real prevalence of NMSC and skin diseases in the assessed population, although the findings are consistent with the literature where available. As always in case of self-completed questionnaires, desirability bias cannot fully be excluded and might have led to an underestimation of the real UVR exposure and an overestimation of protective behaviour, although self-reported sun exposure has been shown to produce valid measures of UVR exposure.[34] A further limitation is that participants with NMSC or other skin diseases were not followed up for histologic evaluation. Although correct diagnosis of experienced dermatologists solely by clinical examination is reported in up to 94% of all cases,[29] misdiagnosis cannot be excluded.[35]

Our findings highlight the need for evidence-based prevention campaigns adjusted to individual needs and specifications of different outdoor working professions. Different outdoor workers have different risks. Possible solutions could be interventions focusing on motivational interviewing,[36] social support[37] or cognitive behavioural approaches.[38] Other approaches could also be individual daily measurement and automated feedback of occupational (and free-time) UVR exposure with wearable gadgets[17,39,40] and nudging.[41,42] Both however are very challenging today to realize due to enormous financial burdens, missing evaluations and validations in large studies and no further evaluated concrete nudging ideas. Until today, there is no single study with an approach to nudge outdoor workers towards healthier, more UV-protective directions.

Future studies should therefore focus on designing and establishing prevention campaigns for different outdoor professions. Including assessments of individual risk using wearable gadgets should be considered and new approaches with nudging rather than regulations seem particularly worthwhile. In summary, the best chance at lowering the enormous burden of (occupational) NMSC and skin diseases could be to tailor prevention efforts to different outdoor workers according to their individual needs hand in hand with occupational associations.

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Article II

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ORIGINAL ARTICLE

Primary and secondary prevention of skin cancer in mountain guides: attitude and motivation for or against participation

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Abstract

Background Outdoor professionals such as mountain guides are at a substantial risk of developing non-melanoma skin cancer (NMSC) due to solar ultraviolet radiation (UVR) exposure. Despite major recent primary prevention efforts, studies on secondary skin cancer prevention efforts are limited and corresponding data on outdoor workers scarce.

Objective To assess the sun protective behaviour and individual motivations for or against skin cancer screening examinations in the German mountain guide population to aid in the development of effective awareness and prevention strategies.

Methods A cross-sectional study among all registered mountain guides in Germany was conducted using a 35-item online questionnaire on primary and secondary prevention of NMSC as well as perceived barriers for prevention.

Results A total of 145 mountain guides participated in the study in January 2017. Of these, 86.2% reported using sunscreen often or always, 62.1% with a sun protection factor (SPF) of 30–50% and 60.7% had undergone dermatological examination by a medical professional. The most common reasons for using secondary prevention efforts were hope of an early diagnosis (77.3%), fear of skin cancer (73.9%) and the intention to be aware of one's own health (70.5%). The main reasons for not doing so were absence of conspicuous skin conditions (63.2%) and feeling healthy (59.6%).

Conclusion Awareness of prevention strategies recommended by the scientific community is low among affected occupationally high-risk mountain guide populations. Understanding the specific needs of this high-risk group is essential for the development of sustainable awareness and prevention strategies.

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Conflicts of interest

None declared.

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Introduction

Non-melanoma skin cancer (NMSC) is the most common cancer worldwide with an increasing incidence reported since 1960[1–3] and presents an enormous socioeconomic burden.[4–6] Solar ultraviolet radiation (UVR) is the main risk factor for NMSC,[7–9] and evidence strongly suggests that outdoor workers have a significantly higher risk of NMSC compared to those in other professions.[10,11] This has led to acceptance of NMSC as an occupational disease in several countries including in Germany, in 2015.[10,12,13]

Previous studies have shown that outdoor workers, and mountain guides in particular, are at a very high occupational risk for NMSC.[14–17] Mountain guides often experience prolonged exposure (of up to 8 h) to solar UVR during tours of high mountains which do not offer natural tree shade.[15,16] Furthermore, the intensity of UVR increases by about 10% per 1000 vertical meters due to thinning of the atmosphere[18] and an insufficient cloud shield.[19] In addition, snowfields, icefields and glaciers reflect up to 80% of UV radiation.[18] Therefore, individual sun protection and cancer prevention efforts seem particularly important for mountain guides. General recommendations for primary prevention of NMSC include wearing long-sleeved shirts and trousers, UV-proof sunglasses and a hat, as well as the use of sunscreen.[20–22] To detect NMSC at an early stage

(=secondary prevention), a full-body skin examination by a dermatologist every 2 years beginning at the age of 35 years which is fully covered by health insurance has been proposed in Germany.[23] Irrespective of recent discussion on efficacy and overall benefit of different primary and secondary prevention efforts,[22–24] a combination of both strategies could be the key to lower the burden of occupational NMSC.

However, within the last few years, several publications have shown that NMSC prevention strategies like using sun protection and undergoing skin cancer screening are not highly prevalent among outdoor professionals, especially mountain guides,[10,16,17,25–28] despite the ease of compliance and non-invasive nature of these strategies. Various reasons are conceivable for these observations, but so far most have received only limited attention in respective studies. The aim of our study therefore was to assess NMSC prevention care in the daily life of mountain guides as well as the individual motivations of these guides for or against the implementation of secondary prevention; our results will aid in the development of sustainable awareness and prevention strategies.

Methods

Mountain guides, defined as a subgroup of outdoor workers with previously shown excessive sun exposure and high risk for NMSC, were included in this cross-sectional study.[14,16] Inclusion criteria were an age of 18 years or older, German citizen and being a professional and active member of one of the three major mountain guide associations in Germany, namely the Association of German Mountain and Ski Guides (VdBS, *Verband staatlich geprüfter deutscher Berg- und Skiführer*), the Association of German Police Mountain Guides (VdPBS, *Verband deutscher Polizeiberg- und -skiführer*) and the Association of German Army Mountain Guides (VdHBF, *Verband deutscher Heeresbergführer*). There were no exclusion criteria. All three associations have an accurately defined curriculum with year-round training for all seasons including examinations for mountain tours in summer as well as in winter. Accordingly, included mountain guides are active throughout the year with hiking tours in summer and ski tours in winter. The presidents of the three associations e-mailed the study information and details of the study's online questionnaire to their members and further requested their participation via telephone calls.

Questionnaire

Based on previous studies,[16,17,27,29] an online questionnaire consisting of 35 questions was designed to assess socio-demographic data (age, sex, education), individual work characteristics (membership in a mountain guide association, work experience as a mountain guide in years, year-round average number of mountain tours per month), individual primary and secondary prevention measures, and associated perceived barriers to undergoing screening.

Education level was categorized as *lower* (lower secondary school certificate or no graduation), *medium* (upper secondary school certificate) or *higher* (general qualification for university entrance). With respect to perceived risk and risk behaviour, mountain guides were asked for their skin type (based on skin, hair, and eye colour, and the tendency to tan as defined by Fitzpatrick[30]), if they experienced a sunburn within the last year, if they had previously been diagnosed with skin cancer or a precursor of skin cancer and if they had 50 moles or more on their body.

Primary prevention measures were assessed by the frequency of sunscreen use during mountain tours (*never, rarely, often* and *always*) and the sun protection factor (SPF) of the commonly used sunscreen (SPF 6–10, SPF 15–25, SPF 30–50 or SPF 50+). With regard to secondary prevention of NMSC, mountain guides were asked if and how often they had undergone a skin cancer screening within the last 6 years, if they regularly performed self-examinations, and how well-informed they considered themselves to be on topics of skin cancer and skin cancer screening. Participants were also asked to rate their individual risk for NMSC on a 4-point Likert scale from 'unlikely' to 'likely', and to score the statement 'Skin cancer is a disease associated with severe physical and mental suffering' with 'yes, in most cases', 'yes, in some cases' or with 'no, never'.

To address factors influencing the individual implementation of secondary prevention measures, mountain guides were asked to rate the reasons for attending or not attending a skin cancer screening on a 3-point Likert scale with 1 indicating 'not at all compelling' and 3 indicating 'extremely compelling'.

Statistical analysis

Descriptive data were generated to describe the baseline characteristics of the study population. Differences between the three groups were analysed using the non-parametric Kruskal–Wallis test. If a significant difference was detected, the Mann–Whitney *U*-test was performed to detect significant differences between groups.

To assess the association between specific items and previous skin examinations, a multivariate logistic regression model using a backward elimination method was applied to generate odds ratios (ORs) and 95% confidence intervals (CIs). In the analysis, age (<50 years, ≥50 years), education, average number of year-round tours per month (0–5 tours, 6–10 tours, 11–15 tours, >15 tours), having more than 50 moles, previous skin cancer, skin type, knowledge about skin cancer and skin cancer screening, personal risk assessment, regular self-examination, and knowing people diagnosed with skin cancer were used as independent variables. Significance was assumed at $P \leq 0.05$ for all tests. All data were analysed using the software SPSS version 24 (IBM Corporation, Armonk, NY, USA).

Results

Between January and February 2017, a total of 145 mountain guides completed the online questionnaire. Of these, 96.6% (140 of 145) were men, the modal age group was 50–59 years (36.6%), and the least represented age group was that aged below 30 years (0.7%). As per the responses, 63 were VDBS mountain guides, 58 were army mountain guides (VdHBF), and 24 were police mountain guides (VdPBS). The overall response rate of active members of all mountain guide associations was 31.5% (145 of 460) and was 22.6% (63 of 279) for VDBS, 54.2% (58 of 107) for VdHBF and 32.4% (24 of 74) for VdPBS mountain guides. Most participants had an experience of up to 10 years (31.0%) or that between 21 and 30 years (27.6%), and 44.8% of participants conducted an average of >10 tours every month. A comparison among the groups showed that VDBS mountain guides conducted significantly more tours per month on average than did the other two groups (VDBS vs. VdHBF, $P = 0.027$; VDBS vs. VdPBS, $P = 0.022$; Table 1).

Overall, 60.7% of the participants had previously undergone a skin cancer screening, although the rate was significantly lower among VdHBF compared to that among VDBS (44.8% vs. 76.2%, $P < 0.001$) mountain guides. Moreover, there were significant differences among people with and without a previous skin examination regarding age ($P = 0.002$), education ($P = 0.025$), average number of tours per month ($P = 0.040$), a self-reported good or sufficient knowledge about skin cancer ($P < 0.001$) or skin cancer screening ($P < 0.001$), as well as the percentage of people knowing the German regulations for skin examinations ($P < 0.001$, Fig. 1).

Most mountain guides (37.5%) reported only one previous skin cancer screening within the last 6 years, whereas about one-third (34.0%) reported at least three screenings in the same time period. About two-thirds of all mountain guides (64.1%) did not know that a skin cancer screening every 2 years is covered by compulsory health insurance in Germany. When analysing the rate of regular self-examination in those who reported doing so, no significant differences were seen between the groups (41.3% in VDBS, 41.4% in VdHBF, and 58.3% in VdPBS, $P = 0.311$). Although 98.7% of participants reported that they were aware of UVR as the main risk factor for skin cancer, only half (47.6%) considered themselves as likely or somewhat likely to develop skin cancer in their lifetime. The majority (78.7%) of participants considered skin cancer to be a disease associated with severe physical and mental suffering in some or most cases, whereas 17.2% responded that skin cancer was not associated with severe physical and mental suffering (Table 2).

Participants who previously underwent skin cancer screening ($n = 88$) reported that the hope of an early diagnosis (77.3%), the fear of skin cancer (73.9%) and the intention to stay healthy (70.5%) were the most compelling reasons for undergoing a skin examination. Recommendations by relatives (13.6%) or having 50 moles or more (14.8%) were the least mentioned reasons for undergoing screening. Most common reasons reported by people who never underwent skin examinations were that they did not yet see a need due to the absence of conspicuous skin findings (63.2%) and an overall good health (59.6%). Not being aware of compulsory insurance coverage for regular skin cancer screenings was stated as a reason by 42.1% of participants for not undergoing screening (Table 3, Fig. 2).

Logistic regression analysis revealed that previous skin cancer screening was significantly associated with age (OR = 3.5, 95% CI = 1.2–10.6), higher education (OR = 9.9, 95% CI = 1.3–76.5), a self-reported good or sufficient knowledge about skin cancer screening (OR = 33.7, 95% CI = 10.0–113.5), regular self-examinations (OR = 5.23, 95% CI = 1.6–17). Moreover, people having 6–10 mountain tours per month had a nearly nine times higher chance to undergo a skin cancer screening (OR = 8.6, 95% CI = 1.7–43.5) than people having 0–5 tours (Table 4).

Discussion

Our study demonstrates an overall good sun protection behaviour in mountain guides, with sufficient knowledge on risk factors and primary prevention behaviour of NMSC. However, a poor secondary prevention strategy was observed, mainly due to lack of insight, knowledge, as well as an individually perceived status of good health. Evidence suggests that recent sun protection awareness strategies and campaigns[14–17] have been successful in reaching mountain guides, but may not have been successful in increasing awareness about the importance of early NMSC detection.

The incidence of regular sunscreen use has been reported as 65.6% among mountain guides[16] and 27.7% among farmers, gardeners and roofers, compared to that of about 78% in the general population.[31–33] In contrast, in this study, we found that over 80% of participants reported regular use of sunscreen during work; this may be explained by the increased awareness of skin cancer and the role of sun protection, as a consequence of previous campaigns and studies targeting German mountain guides.[14–17] The vast majority (96.6%) of participants in this study were men, and it is well known that men are less likely to use sun protection at work than women[34–36]; this implies that awareness of the need for sun protection may have increased. However, over 50% of mountain guides reported sunburn experience within the last year, implying that sun protection in mountain guides is inadequate and needs to be improved. Almost every participating mountain guide (98.7%) reported awareness of UVR as the main risk factor for NMSC, but at the same time, more than half (51.0%) ranked their individual NMSC risk as low, which highlights the need for further awareness strategies.

Table 1 Baseline characteristics of 145 participating mountain guides in Germany, belonging to three different mountain guide associations

	Total (*n* = 145) (%)	VDBS (*n* = 63) (%)	VdHBF (*n* = 58) (%)	VdPBS (*n* = 24) (%)
Sex				
Male	140 (96.6)	59 (93.7)	57 (98.3)	24 (100)
Female	5 (3.4)	4 (6.3)	1 (1.7)	0
Age				
<30 years	1 (0.7)	0	1 (1.7)	0
30–39 years	40 (27.6)	11 (17.5)	24 (41.4)	5 (20.8)
40–49 years	22 (15.2)	10 (15.9)	8 (13.8)	4 (16.7)
50–59 years	53 (36.6)	26 (41.3)	17 (29.3)	10 (41.7)
60–69 years	11 (7.6)	6 (9.5)	3 (5.2)	2 (8.3)
>69 years	18 (12.4)	10 (15.9)	5 (8.6)	3 (12.5)
Education				
Low	12 (8.3)	5 (7.9)	6 (10.3)	1 (4.2)
Medium	42 (29.0)	10 (15.9)	20 (34.5)	12 (50.0)
High	86 (59.3)	47 (74.6)	29 (50.0)	10 (41.7)
Missing	5 (3.4)	1 (1.6)	3 (5.2)	1 (4.2)
Years of experience				
0–10 years	45 (31.0)	13 (20.6)	25 (43.1)	7 (29.2)
11–20 years	26 (17.9)	14 (22.2)	7 (12.1)	5 (20.8)
21–30 years	40 (27.6)	18 (28.6)	14 (24.1)	8 (33.3)
31–40 years	18 (12.4)	9 (14.3)	8 (13.8)	1 (4.2)
41–50 years	13 (9.0)	7 (11.1)	3 (5.2)	3 (12.5)
>50 years	3 (2.1)	2 (3.2)	1 (1.7)	0
Mountain tours per month (year-round)				
0–5 tours	49 (33.8)	16 (25.4)	22 (37.9)	11 (45.8)
6–10 tours	31 (21.4)	12 (19.0)	14 (24.1)	5 (20.8)
11–15 tours	27 (18.6)	12 (19.0)	10 (17.2)	5 (20.8)
16–20 tours	18 (12.4)	10 (15.9)	7 (12.1)	1 (4.2)
21–25 tours	4 (2.8)	1 (1.6)	2 (3.4)	1 (4.2)
>25 tours	16 (11.0)	12 (19.0)	3 (5.2)	1 (4.2)
Sunburn within the last year				
No	61 (42.1)	30 (47.6)	21 (36.2)	10 (41.7)
Yes	83 (57.2)	33 (52.4)	37 (63.8)	13 (54.2)
Missing	1 (0.7)	0	0	1 (4.2)
50 moles or more				
No	107 (73.8)	52 (82.5)	38 (65.5)	17 (70.8)
Yes	37 (25.5)	11 (17.5)	20 (34.5)	6 (25.0)
Missing	1 (0.7)	0	0	1 (4.2)
Skin type				
Type 1	6 (4.1)	1 (1.6)	2 (3.4)	3 (12.5)
Type 2	65 (44.8)	27 (42.9)	27 (46.6)	11 (45.8)
Type 3	56 (38.6)	27 (42.9)	22 (37.9)	7 (29.2)
Type 4	17 (11.7)	7 (11.1)	7 (12.1)	3 (12.5)
Missing	1 (0.7)	1 (1.6)	0	0
Previously diagnosed with skin cancer				
No	117 (80.7)	50 (79.4)	51 (87.9)	16 (66.7)
Yes	28 (19.3)	13 (20.6)	7 (12.1)	8 (33.3)

VDBS, State Certified Mountain Guide Association (*Verband staatlich geprüfter deutscher Berg- und Skiführer*); VdHBF, Association of Army Mountain Guides (*Verband deutscher Heeresbergführer*). VdPBS, Association of German Police Mountain Guides (*Verband deutscher Polizeiberg- und -skiführer*).

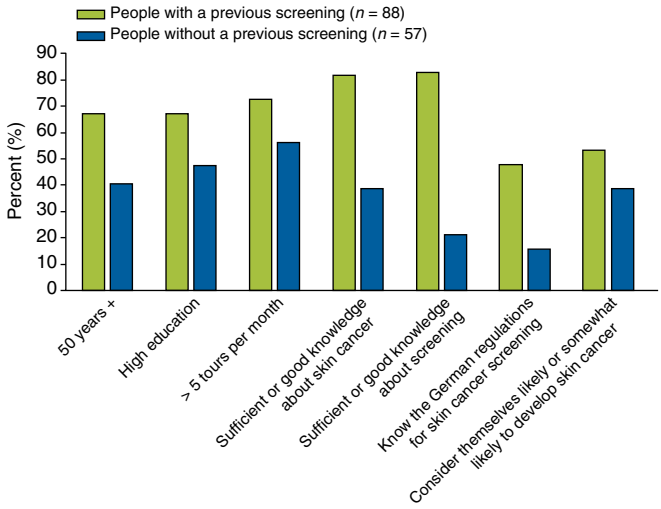

Figure 1 Selected characteristics of participants with and without a previous skin cancer screening.

The findings of our study for secondary prevention are consistent with previous studies in mountain guides: about 66% of mountain guides in this study had never attended a skin cancer screening before, compared to about 50% in other studies.[14–17] However, these screening rates are higher compared to those in other outdoor populations, reported to be 46% in glider pilots[27] and 32.6% in farmers, roofers and gardeners in Germany[37]; a US study has reported similar rates in farmers.[34] Today, 10 years after the introduction of compulsory skin cancer screening in Germany (in 2008),[24] about one-third of the eligible general population has undergone at least one skin cancer screening.[38,39] Previous efforts as reported above for primary prevention[14–17] may have contributed to the increased prevalence of skin cancer screening. However, the rate of screening is yet inadequate considering the high prevalence of NMSC (including actinic keratosis) of about 40% in mountain guides[14,16]; it is important to note that our data show that 40% of participants consider themselves insufficiently informed about skin cancer and skin cancer screening. In fact, two-thirds of the population did not know that they were eligible for a compulsory screening every 2 years starting at an age of 35 years. Similar to evidence from other studies,[29] secondary prevention in our study was more likely to be practiced by those with higher education. Consistent with previous studies,[35,40,41] we found a significant association between high perceived skin cancer knowledge and a higher likelihood of undergoing skin cancer screening. Likewise, self-health awareness was reported as the main reason for undergoing skin cancer screening, whereas low self-health awareness was reported as a reason for not having undergone a skin examination. Nonetheless, studies have shown that the behaviour of outdoor workers can be significantly improved by education geared towards skin cancer prevention.[26]

One of the strengths of this study is that all mountain guides in Germany were addressed, via the three German professional associations. Mountain guides in Germany constitute a well-characterized outdoor professional group and have been evaluated by previous studies for NMSC and the risk for developing NMSC, as well for trends in sun protective behaviour.[14–17] This allowed us to conduct a general comparison of the study results as well as a separate evaluation of primary and secondary prevention measures.

This study has several limitations. The overall response rate was not very high. Additionally, selection bias cannot be ruled out considering that individuals especially concerned about skin cancer or those with a previous skin cancer diagnosis were more likely to have participated. Data collection using an online questionnaire promoted by e-mail may also have led to selection of younger participants or of those more inclined to use the Internet. The age distribution of the participants adds credence to the above idea. Another limitation inherent to data collected using self-completed questionnaires is recall and social desirability bias, which may have led to an overestimation of primary and secondary prevention incidence. Although there is evidence of a high concordance between self-report and observation in other outdoor workers,[42] the above-mentioned limitations as well as the small number of participants do not easily allow a generalization of our findings to other outdoor-working groups.

Compared to previous studies of the same population, our study revealed significant improvements with respect to primary NMSC prevention; sustained implementation of

Table 2 Self-reported primary prevention, secondary prevention, awareness and perception of skin cancer

	Total (n = 145) (%)	VDBS (n = 63) (%)	VdHBF (n = 58) (%)	VdPBS (n = 24) (%)
How often do you use sunscreen at work?				
Never/rarely	20 (13.8)	11 (17.5)	8 (13.8)	1 (4.2)
Regularly/always	125(86.2)	52 (82.5)	50 (86.2)	23 (95.8)
Which SPF do you use at work?				
Low (SPF 6–10)	1 (0.7)	0	0	1 (4.2)
Medium (SPF 15–25)	32 (22.1)	13 (20.6)	14 (24.1)	5 (20.8)
High (SPF 30–50)	90 (62.1)	41 (65.1)	34 (58.6)	15 (62.5)
Very high (SPF 50+)	22 (15.2)	9 (14.3)	10 (17.2)	3 (12.5)
Have you ever undergone a skin examination by a medical doctor (=skin cancer screening)?				
No	57 (39.3)	15 (23.8)	32 (55.2)	10 (41.7)
Yes	88 (60.7)	48 (76.2)	26 (44.8)	14 (58.3)
How many skin cancer screenings did you have within the last 6 years?				
1	33 (37.5)	15 (31.3)	14 (53.8)	4 (28.6)
2	19 (21.6)	13 (27.1)	4 (15.4)	2 (14.2)
≥3	30 (34.0)	15 (31.3)	7 (26.9)	8 (57.2)
Missing	6 (1.1)	5 (10.3)	1 (3.8)	0
Do you know the regulations for skin cancer screening in Germany?				
No	93 (64.1)	37 (58.7)	42 (72.4)	14 (58.3)
Yes	51 (35.2)	26 (41.3)	15 (25.9)	10 (41.7)
Missing	1 (0.7)	0	1 (1.7)	0
Do you regularly check your skin for abnormalities ('self-examination')?				
No	81 (55.9)	37 (58.7)	34 (58.6)	10 (41.7)
Yes	64 (44.1)	26 (41.3)	24 (41.4)	14 (58.3)
How well do you see yourself informed about skin cancer?				
Inadequate/not at all	51 (35.2)	14 (22.2)	30 (51.7)	7 (29.2)
Good/adequate	94 (64.8)	49 (77.8)	28 (48.3)	17 (70.8)
How well do you see yourself informed about skin cancer screening in general?				
Inadequate/not at all	60 (41.4)	17 (27.0)	33 (56.9)	10 (41.7)
Good/adequate	85 (58.6)	46 (73.0)	25 (43.1)	14 (58.3)
Did you know that solar UVR is the main risk factor for skin cancer?				
No	1 (0.7)	0	1 (1.7)	0
Yes	143 (98.7)	63 (100)	57 (98.3)	23 (95.8)
Missing	1 (0.7)	0	0	1 (4.2)
How likely do you see yourself at risk for developing skin cancer?				
Unlikely/Somewhat unlikely	74 (51.0)	33 (52.4)	30 (51.7)	11 (45.8)
Likely/Somewhat likely	69 (47.6)	28 (44.4)	28 (48.3)	13 (54.2)
Missing	2 (1.4)	2 (3.2)	0	0
Do you think skin cancer is a disease associated with severe physical and mental suffering?				
Yes, in most cases	72 (49.7)	34 (54.0)	29 (50.0)	9 (37.5)
Yes, in some cases	42 (29.0)	18 (28.6)	15 (25.9)	9 (37.5)
No, never	25 (17.2)	7 (11.1)	12 (20.7)	6 (25.0)
Missing	6 (4.1)	4 (6.3)	2 (3.4)	0

SPF, sun protection factor; VDBS, State Certified Mountain Guide Association (*Verband staatlich geprüfter deutscher Berg- und Skiführer*); VdHBF, Association of Army Mountain Guides (*Verband deutscher Heeresbergführer*). VdPBS, Association of German Police Mountain Guides (*Verband deutscher Polizeiberg- und -skiführer*).

regular skin examinations would broaden the prevention approach with possible tertiary prevention strategies and lead to a lower skin cancer incidence.[23,43,44] Future studies in larger populations with an added emphasis on the importance of early detection of NMSC are needed. As mountain guides constitute a small occupational group with specialized requirements for their daily work, the findings of our study as well as the proposed suggestions have to be evaluated in other outdoor professions and in the general population.

Table 3 Reasons for or against participating in secondary prevention of skin cancer, as self-reported by mountain guides

Reasons for having undergone a skin cancer screening (n = 88)	'Crucial'
Hope of an early detection of skin cancer to get cured	77.3%
I am afraid of skin cancer	73.9%
I want to make sure to stay healthy	70.5%
I have a high UV exposure (at work/at leisure)	64.8%
In case of skin cancer, I do not want to blame myself for being negligent	51.1%
Recommendation by a physician	47.7%
I wanted to have a conspicuous skin lesion checked by a physician	43.2%
Recommendation by my partner/my spouse	28.4%
Many sunburns in childhood	27.3%
Fair skin type	21.6%
Previous diagnosis of skin cancer	19.3%
The health examination is 'free' for me	18.2%
Relative/friend diagnosed with skin cancer	14.8%
I have more than 50 moles	14.8%
Recommendation by a relative	13.6%
Reasons for *not* having undergone a prior skin cancer screening (n = 57)	
I do not have a conspicuous skin lesion	63.2%
I am perfectly healthy.	59.6%
I did not know that a skin cancer screening is covered by my health insurance	42.1%
I always protect myself sufficiently	28.1%
I do not know a physician close to my home where I can go for a skin examination	26.3%
I generally do not go to the doctor.	24.6%
I am not sufficiently informed about the pros and cons as well as the utility of the screening.	22.8%
I have never thought about skin cancer.	21.1%
I do not have the time for a skin cancer screening	15.8%
I had to pay for the screening	7.0%
I do not want to sacrifice my free time for a doctor's visit	7.0%
I am afraid of potentially being diagnosed with skin cancer	5.3%
I am too young to have skin cancer	3.5%
I feel uncomfortable about a doctor examining my skin	1.8%
The physician may make a wrong diagnosis	0
Skin cancer screening is an unnecessary examination	0

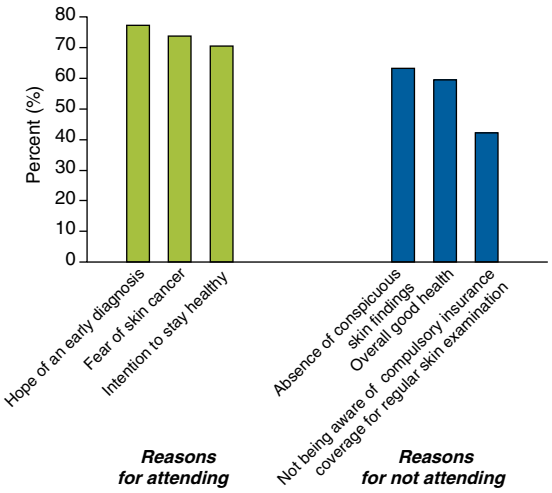

Figure 2 Most common reasons for or against attending a skin cancer screening before.

Table 4 Variables significantly associated with previous skin cancer screening

Covariate	Adjusted OR (95% CI)
Age	
<50 years	1.00
≥50 years	**3.50 (1.16–10.56), P = 0.026**
Education	
Low	1.00
Medium	5.65 (0.74–43.11), P = 0.095
High	**9.87 (1.28–76.46), P = 0.028**
Mountain tours per month	
≤5 tours	1.00
6–10 tours	**8.63 (1.72–43.45), P = 0.009**
11–15 tours	2.04 (0.46–9.15), P = 0.350
>15 tours	1.35 (0.35–5.10), P = 0.663
Knowledge about skin cancer screening	
Not at all/insufficient	1.00
Sufficient/good	**33.67 (9.99–113.51), P < 0.001**
Regular self-examination	
No	1.00
Yes	**5.23 (1.61–17.03), P = 0.006**

OR, odds ratio; CI, confidence interval.
Significant results are bold printed. Multivariate logistic regression model using backward selection was applied. The odds ratio was adjusted for age, education, knowledge about skin cancer screening, performance of regular self-examination and having a relative or friend diagnosed with skin cancer.

Conclusion

Well-designed and detailed recommendations for primary and secondary prevention of NMSC for outdoor professions have been described. However, our study has shown that in real life, several predictable reasons prevent implementation of these recommendations. These obstacles can be addressed successfully by simple and focused awareness and education programmes with multimodal and interdisciplinary approaches. The findings of our study can be applied to develop and implement a broad cancer prevention strategy for outdoor professions, which may substantially lower the global burden of (occupational) NMSC.

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Article III

Zink A, Schielein M, Wildner M, Rehfuess E. “Try to make good hay in the shade, it won’t work!” – A qualitative interview study on the perspectives of Bavarian farmers regarding primary prevention of skin cancer

"Try to make good hay in the shade, it won't work!" - A qualitative interview study on the perspectives of Bavarian farmers regarding primary prevention of skin cancer

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"Try to make good hay in the shade, it won't work!" - A qualitative interview study on the perspectives of Bavarian farmers regarding primary prevention of skin cancer

Farmers' perspectives on skin cancer prevention

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Bulleted statements:

What's already known about this topic?

- Outdoor professions have a substantially increased risk for keratinocyte carcinoma (KC) induced by solar UV-radiation (UVR) but typically show poor sun-protective behavior

What does this study add?

- This qualitative interview study identifies farmers' perspectives on primary prevention of KC and their determinants
- Lack of awareness and knowledge as well as barriers associated with the demands of daily agricultural work are highlighted as factors that limit sun protective behavior

What are the clinical implications of the work?

- Strategies to increase self-efficacy beyond basic efforts to raise awareness of KC and UVR could be the key to prevent KC in farmers
- Further qualitative studies are needed to explore different intervention options that can successfully overcome barriers to implementing sun protection

Abstract

Background: Solar ultraviolet radiation (UVR) is the main risk factor for keratinocyte carcinoma (KC) turning outdoor workers into a high-risk population for KC. Sun protection efforts are crucial for KC prevention, but are not typically implemented by outdoor professions during daily work.

Objective: To explore the attitudes of Bavarian farmers regarding sun protective measures in daily work and to understand perceived barriers and unmet needs.

Methods: Farmers were recruited through the Bavarian Farmers Association in Bavaria, Southern Germany. Qualitative semi-structured interviews were conducted with participants between December 2017 and March 2018. Interviews were recorded, transcribed verbatim and analysed using qualitative content analysis according to Mayring.

Results: Twenty farmers (11 women, 9 men, 9 in the age group 18-30 years, 11 in the age group >60 years) participated in the study. Knowledge and awareness of UVR exposure and KC, perceived individual barriers to implementing sun protective measures, individual experiences and farm life-specific circumstances emerged as key areas influencing the perspectives of farmers regarding the primary prevention of KC. Female farmers tended to take a more positive stance on sun protection, whereas male farmers showed a lower overall interest.

Conclusion: Knowledge and awareness of KC and UVR exposure is very limited among Bavarian farmers with serious perceived barriers due to the demands of daily agricultural work. Further qualitative studies are needed to identify intervention options that can increase skin cancer awareness and that can successfully overcome real barriers to implementing sun protection.

Introduction

Keratinocyte carcinoma (KC), previously also known as non-melanoma skin cancer (NMSC) or as "white skin cancer" (lay expression among the German population), is the most common malignancy in the fair-skinned population worldwide.[1-3] The term KC includes all skin carcinomas of shared lineage with epidermal keratinocytes.[3-4] These include basal cell carcinoma (BCC), spinocellular carcinoma (SCC) and actinic keratosis (AK), a KC in situ with dysplastic keratinocytes similar to SCC.[5-6] Despite the high cure rate, KC are responsible for a large number of deaths worldwide every year.[3,4] Furthermore, compared to melanoma, they cause a higher burden of disease when measured using Disability-Adjusted Life Years.[3,8] Today, KC pose an enormous socio-economic burden[7,9-11] which is likely to increase even further within the next years considering the increasing incidence worldwide.[12,13] Accordingly, effective and sustainable awareness and prevention strategies are urgently needed.[12-14]

In general, the risk of developing KC depends on genetic and phenotypic as well as environmental factors. The main modifiable risk factor, however, is UV radiation (UVR) of the sun, which logically leads to KC primarily occurring on light-exposed parts of the body.[1,15-17] Especially outdoor workers and in particular farmers, typically exposed to UVR during daily work and up to 40 hours per week[18] are at a substantially higher risk of KC compared to indoor workers.[19-21] This has led to the recognition of KC as an occupational disease of outdoor workers in several countries worldwide including Germany.[23,24] In Germany, about 2-3 million individuals are categorised as "outdoor workers".[25] By law, German employers are bound to protect their workers from UVR using organisational and technical measures such as avoiding the sun during its peak-intensity around midday or providing sun protection measures at work.[24] The vast majority of farmers, however, are self-employed and therefore these regulations do not apply. At the same time, several previous studies have shown that among the outdoor professions farmers have one of the highest rates

of KC with poor primary prevention measures during work.[20,26,27] Only a small minority of farmers regularly use sunscreen, wide-brimmed hats, sunglasses, long-sleeved clothing or other UVR protective measures.[17,20]

The main objective of this study was to explore the perspectives of Bavarian farmers regarding sun protective measures in daily work as well as to understand perceived barriers and unmet needs associated with sun protection, UVR exposure and KC. A secondary objective was to explore potential differences between male and female farmers, age groups and different types of agricultural labour.

Materials and methods

A qualitative interview study was undertaken in two regions of Bavaria ("Lower Bavaria" and "Allgäu") in Southern Germany using face-to-face semi-structured interviews. Bavaria is a major agricultural area in Germany with 106,718 farm holdings and with agriculture as a major pillar of the rural Bavarian economy with an annual gross value added of €2.3billion. Agricultural specializations vary across geographical regions of Bavaria with Allgäu being typical for dairy farming and Lower Bavaria for crop farming.[28]

The study was reviewed and approved by the Ethics Committee of the Faculty of Medicine at Technical University of Munich (reference 409/17S). All participants were 18 years or older and provided written informed consent.

Study population

Eligible were farmers aged 18-30years and aged 60years or over to facilitate comparisons of younger and more experienced farmers. In Allgäu, farmers had to own a dairy farm whereas farmers in Lower Bavaria had to own a crop farm to allow for an exploration of potential differences related to agricultural specialization. The chairmen of two administrative

agricultural districts of the Bavarian Farmers Association ("Bayerischer Bauernverband") were asked to identify representative farmers with farms that were typical of their respective district based on agrarian structure, farm and land size and farm type as well as the degree of technology used in everyday farm life. Participants were initially approached by telephone by these chairmen and invited to participate in the study. Farmers that agreed to be contacted for study participation where then phoned by the first author who provided information about the study, assessed the farmers' eligibility for participation and responded to any questions about the study and made an appointment for the face-to-face interview.

Instrument and measures

Using relevant literature[17,24,29-33] and the manual for conducting qualitative interviews published by Helfferich[34], a topic guide consisting of open end questions was developed to answer the primary research aims (Table 2). A pilot interview was conducted with one chairman, himself a crop farmer, to clarify unclear questions and to obtain an estimate of the duration of the interview.

All interviews took place in the farm house of participants with no one else being present except babies or pre-school children. One male interviewer (first author, dermatologist) carried out the semi-structured interviews which were audio-recorded. Participants were aware of the research goals as well as the researcher's characteristics (name, job position, research interest). After every interview, the interviewer took field notes describing (1) the interview context, (2) his subjective overall impression and (3) self-reflection. The interviewer did not know any of the participants prior to the study and there were no repeat interviews.

Data analysis

All interviews were transcribed verbatim by the interviewer (first author) and the second author. Names of participants were replaced with double brackets. Qualitative content

analysis according to Mayring[35] was used for the analysis of the interview data. This included the familiarisation via slow reading of the data and an analysis by the stepwise combination of deductive and inductive construction of codes classified into main categories and subcategories based on the structure of the topic guide. The first three transcripts were coded independently by the first and second author. Coding discordances were discussed and re-coded as necessary. The remaining transcripts were coded by the first author and the findings, structure and interpretation discussed with all authors. Primary prevention against KC was defined as "adequate", if sunscreen is regularly applied and a wide-brimmed hat as well as a sleeved-shirt worn during work. Data management and analysis was performed using the qualitative data software package, Atlas.ti, version 8. All interviews were conducted in German. Quotes provided in the following sections were selected based on their representation of key themes and were translated into English by professional translators.

Results

A total of 25 farmers were contacted, of whom 20 farmers (11 women, 9 men) were recruited for the study and interviewed between December 2017 and March 2018 (Table 1). Interviews lasted between 13 and 37 minutes (mean 24.4 minutes). The following main categories emerged as key areas influencing the perspectives of farmers regarding the primary prevention of KC: Knowledge and awareness of UVR exposure and KC, perceived individual barriers to implementing sun protection measures, individual experiences and farm life-specific circumstances.

Knowledge and awareness of UVR exposure and KC

The vast majority of farmers reported to have heard of skin cancers other than melanoma but generally did not to know anything about them.

"I've heard about it somewhere. But, to be honest, I know nothing about it." (female, dairy, older)

The risk of developing skin cancer for farmers compared to the general population was perceived in a very heterogeneous manner. About half of respondents attributed a higher risk, the other half did not. There were no obvious differences between gender, younger and older farmers.

"*I had a lot of sunburns, especially after hoeing sugar beets the whole day. Probably my risk for skin cancer is high.*" (male, crop, older)

"I am a dark skin type. I don't think that I have a higher risk for skin cancer." (female, dairy, older)

Older farmers, especially females, reported to talk about sun protection with families and friends, but also at agricultural meetings; men rarely did so. In addition, women stated that they were trying to motivate their families, friends and fellow farmers to use sun protection at work:

"I always tell my husband to 'put on a hat' outside. I hope that protects him." (female, crop, older)

"Everyone is responsible for themselves, including sun protection" (male, crop, younger)

Perceived individual barriers to implementing sun protection measures

The vast majority of participants mainly referred to sunscreen when talking about sun protection measures; avoiding the midday sun, seeking shade and wearing long-sleeved clothes or sunglasses seemed of considerably lower interest. Only two older female farmers talked about sun protection measures in a comprehensive manner.

The majority of reported barriers against sun protection measures related to the use of sunscreen; a few respondents stated that they do not see the need for using sunscreen. Inconvenience to apply sunscreen, not having or wanting to take the time for sunscreen application, forgetting about it or the unpleasantness of sunscreen were especially commonly mentioned by, but not limited to, male and younger farmers.

"I don't like applying sunscreen. It doesn't feel right. That's not me." (male, dairy, younger)

"I am healthy I don't need sunscreen." (male, crop, older)

Farmers, regardless of age, farm specialty and gender, complained about several barriers beyond their control limiting sunscreen use. Dust and dirt exposure, especially in the fields, combined with sunscreen texture was described as one of the major problems.

"There's always a lot of dust in the crop fields. It will stick to me when I use sunscreen and that's awfully annoying" (male, crop, older)

Especially male farmers of all ages and agricultural specializations further reported a number of perceived barriers to using sun protection measures beyond sunscreen. The unpleasantness of wearing long-sleeved clothing in the heat or not being able to avoid sun exposure were particularly pertinent:

"Making hay with long-sleeved trousers and shirts is impossible. It is simply too hot" (male, crop, younger)

Individual experiences

Perceived skin cancer susceptibility was mainly reported by female farmers and only rarely by men. Female farmers were motivated to engage in sun protective behaviours by sunburns and other sun- and heat-associated health problems.

"I didn't care about sun protection until I got a severe sunburn with blisters. Now I am more careful" (female, dairy, younger)

"When you get older you automatically avoid the heat in summer. It makes you feel ill" (female, crop, older)

Older farmers in both regions reported positive experiences of using sun protection measures mainly by wearing hats; this was not found for younger farmers.

"Since my wife bought me a hat a couple of years ago I don't get sunburns on my ears anymore." (male, crop, older)

Several older farmers, both male and female, reported a perceived higher intensity of the sun compared to the last decades with an influence on their behavior:

„*20 years ago, the sun wasn't so aggressive. Today, you even get sunburned in April*" (female, crop, older)

Farm life-specific circumstances

Work-related procedures affected individual views on the possibilities of and limitations to implementing different primary prevention measures. Seeking shade and avoiding sun exposure is hardly feasible due to weather- and season-dependent requirements:

"You can only thresh if the weather is nice and dry. Of course there's a lot of sun." (male, crop, younger)

"Try to make good hay in the shade. It won't work" (female, crop, older)

At the same time all older farmers highlighted dramatic changes over the last decades. Farming used to be a lot of hard manual labour dependent on good weather with intensive sun exposure. Today, new developments with high-tech agricultural machines and gear have changed farming practices and substantially reduced overall UVR exposure:

"*We used to hoe sugar beets by hand the whole day from sunrise to sunset. Today, we have tractors with a cab.*" (male, crop, older)

Unmet needs

Several farmers, primarily females of both age groups, suggested that more should be done by agricultural associations and the government to encourage primary prevention of KC in farmers.

> *"The farmers' association should supply us with more information. When especially should I protect myself?"* (male, crop, older)
>
> *"Why aren't there any articles on skin cancer in the Bavarian Farming Journal? Everybody reads it."* (female, crop, younger)

Furthermore, older farmers, especially female farmers in both regions, frequently reported a pressing need to inform young farmers to increase their sun protective behaviour. In contrast, several younger farmers, primarily males, were relatively critical about the way sun protection messages are delivered:

> *"Much more attention should be payed to skin cancer and sun. Especially to men. They are much more out in the fields and get more sun than women."* (female, crop, older)
>
> *"Plain, easygoing information would be nice. Not always these scare tactics like the gross pictures on cigarette packages."* (male, dairy, younger)

Discussion

This early-stage study gives an insight into the perspectives of farmers concerning primary prevention of KC. It sets the scene for potential further qualitative studies aiming to develop prevention strategies for farmers. Studies looking at factors associated with the use of primary prevention of KC have shown that the decision for or against sun protection represents a complex behaviour determined by a range of different factors.[36]Here we have shown that

knowledge and perception of KC and UVR, individually perceived barriers to using sun protection, individual experiences with sunburn and skin cancer as well as farm life-specific circumstances are key decision making factors in the decision to apply or not to apply sun protection measures. This suggests that a combination of raising awareness and knowledge and demonstrating that primary prevention measures can easily be integrated in daily farm life may be a promising way forward.

Various social cognitive models have been used to explain the variation in acceptance and implementation of primary prevention measures against skin cancer. The Theory of Planned Behavior[37]for example defines three elements guiding individual decisions: a favorable or unfavorable "attitude toward the behavior" (e.g. perceived efficacy of sunscreen), "perceived behavioral control" (e.g. perceived ease to use sun protection measures in daily work) and perceived social pressure or "subjective norm" (e.g. perception that the majority of people use or do not use sunscreen). Another relevant model is the Health Belief Model[38], which was originally developed to assess barriers to vaccination by the psychosocial factors "perceived susceptibility and seriousness", "perceived efficacy" and concerns and influences facilitating or discouraging primary prevention of KC in the case of this study. Many of the determinants included in these two models were found to play a major role in the decision-making process of farmers. For instance, those who considered themselves to be at high risk of skin cancer also reported applying sunscreen during daily work.

There are groups of farmers inclined to use sun protection and others who clearly reject sun protection, with no obvious differences between the group of dairy and crop farmers. Female farmers, especially older female farmers, tend to take a more positive stance on sun protection and act more or less accordingly, whereas male and especially young male farmers showed low interest in sun protection overall. Similar to previous findings in other outdoor professions[39,40] the decision not to engage in primary prevention can at least partly be attributed to a lack of knowledge on KC and UVR. Beyond basic strategies to raise awareness

however, strategies to increase self-efficacy could be the key to prevent KC in farmers. Even when avoiding sun exposure is not possible, for example when making hay, other solutions can be found to reduce individual UVR exposure.

The vast majority of participating farmers mainly referred to sunscreen when talking about sun protection. Other measures, such as avoiding midday sun, wearing long-sleeved clothing, a hat or sunglasses and seeking shade received limited attention. Promoting a combination of different sun protection measures, which is recommended as the most effective way of preventing KC[42,43], could have a significant impact, especially among farmers particularly concerned about using sunscreen.

Positive individual experiences with sun protection measures seem to increase the use of primary prevention measures, i.e. having successfully tried out sun protection measures and having avoided sunburns makes it more likely to implement respective measures. This could bring strategies promoting to try out sun protection into focus.

Negative experiences such as having a family member or friend with skin cancer or personally having suffered from severe sunburns seems to have strongly influenced the perceived need of sun protection. Farmers without respective experiences and typically underestimating the need for sun protection in this study therefore might be led by "unrealistic optimism" as described in previous studies.[30,36,44] This may point to the importance of narrative storytelling to convey information on the prevention of KC in farmers.[45]

This study has both strengths and limitations. Limitations include the rather short duration of the interviews, with some of the data being less rich than originally intended. While the sample size was adequate overall, we may not have reached data saturation for all potentially contrasting views – for example, of older male versus younger female farmers. With the interviewer being a dermatologist, we cannot exclude the possibility of social desirability bias influencing the responses of participants.[46]Importantly, the researchers being convinced of and engaged with sun protection may have influenced the way the data were analysed and

interpreted; moreover, the first three interviews were coded in duplicate but subsequent interviews were not. The study reflects the perspectives of farmers in Bavaria owning a crop or dairy farm and cannot easily be transferred to other areas and other occupational groups including farmers with different agricultural specialization such as a chicken farm. Nevertheless, this early-stage qualitative interview study provided several valuable insights into the views of farmers on primary prevention of KC. It thus represents an important starting point for the development of sustainable and effective preventions strategies targeting Bavarian farmers.[47]

In conclusion, determinants of farmers' perspectives on KC prevention are identified in this early-stage study and highlight a lack of awareness and knowledge about KC and UVR as well as significant barriers associated with the demands of daily farm life, whether rearing animals or crop. Future prevention strategies should therefore focus on disseminating information on KC risk and primary prevention measures that are easy to use in daily life and tailored to farmers' needs. The focus of future qualitative research should be on how to best reach farmers and on how to best communicate the respective information in order to increase sun protection and to lower the burden of KC among farmers.

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Tables and Figures

Table 1: Study population

Figure 1: Interview guideline for semi-structured individual interviews with farmers. Exact wording changed between some interviews depending on given answers and all interviews were in German language.

Table 1: Characteristics of participants

Participant	Age (years)	Gender	Farm specialization	Region in Bavaria, Southern Germany
P1	29	Male	Crop	Lower Bavaria
P2	25	Male	Dairy	Allgäu
P3	62	Male	Crop	Lower Bavaria
P4	28	Male	Crop	Lower Bavaria
P5	60	Male	Dairy	Allgäu
P6	64	Male	Dairy	Allgäu
P7	27	Female	Dairy	Allgäu
P8	68	Female	Dairy	Allgäu
P9	60	Female	Dairy	Allgäu
P10	61	Female	Dairy	Allgäu
P11	63	Female	Crop	Lower Bavaria
P12	64	Female	Crop	Lower Bavaria
P13	29	Female	Dairy	Allgäu
P14	27	Female	Dairy	Allgäu
P15	25	Female	Crop	Lower Bavaria
P16	29	Female	Crop	Lower Bavaria
P17	71	Female	Crop	Lower Bavaria
P18	27	Male	Dairy	Allgäu
P19	62	Male	Crop	Lower Bavaria
P20	64	Male	Crop	Lower Bavaria

Table 2: Topic guide for semi-structured interviews (shortened for publication)

Main question	Probing questions	Aim
Have you ever heard of skin cancer other than melanoma and if yes, what do you know about it?	• How would you describe the risk for skin cancer for farmers? • What do you think are risk factors for skin cancer? • What do you know about skin cancer and solar UV radiation?	**Understanding farmers' perception of non-melanoma skin cancer and risk factors**
Do you use sun protection during work? If yes, why? If not, why not?	• Do you use sunscreen during work? Why / why not? - What SPF does your sunscreen have and why? - Where and how often do you typically apply sunscreen and why? • During daily work, do you Seek shade, avoid midday sun, wear long-sleeved clothes, wear a hat? Why / Why not? • How important is sun protection for you? Why / why not?	**Understanding farmers' attitudes towards and views regarding the use of primary prevention measures in daily work**
In your opinion, what are the difficulties in applying sun protection measures in everyday working life?	• What are difficulties in using sunscreen / wearing hats / seeking shade during work? • How do your work-specific circumstances influence sun protection? • How do you deal with these barriers and difficulties?	**Understanding barriers to implementing primary prevention measures in daily farm work**
What are your hopes for the future with respect to skin cancer and the sun?	• Do you have ideas for improving sun protection for farmers? • How do you think recommendations and / or programs to prevent skin cancer should look like? • What would the ideal sun protection look like for you to be implement in daily work? • Is there anything politics and/or occupational associations can or should do?	**Understanding farmers' unmet needs with respect to primary prevention of non-melanoma skin cancer**

Article IV

Zink A, Rüth M, Watzele R, Nigg CR, Rehfuess EA. Failure of a Print Media Sun Safety Campaign to Reach High-risk Occupational Groups. Acta Derm Venereol. 2018; 98: 811-812

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Failure of a Print Media Sun Safety Campaign to Reach High-risk Occupational Groups

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Non-melanoma skin cancer (NMSC) is the most common cancer worldwide (1). With a large proportion of the adult German population currently at risk, it is estimated, that the prevalence of NMSC will double by 2030 (2). Main risk factor for NMSC is solar ultraviolet (UV) radiation (3), which has led to the classification of NMSC as an occupational disease for outdoor workers in some countries (4). Naturally, sun protection during outdoor work and leisure is the main target of many interventions conducted at individual, organizational and community levels (5). Typically, these campaigns place messages via television, radio, billboards and print media with the aim of promoting sun-protective behaviour (6). They usually target general or recreational sun behaviours among the general population, or among children and adolescents, which means they are difficult to implement in adult high-risk occupational groups with their specific tasks (6–8). Previous studies in occupational professions have focused mainly on seasonal or permanent, predominantly male, workers, who are often employed by the recreation industry (9, 10).

In Germany, farmers and agricultural workers are at very high risk of NMSC (11), but, to date, effective prevention measures for this occupational group have received limited attention. The aim of this study was therefore to explore to what extent the placement of sun protection messages in different profession-specific special interest magazines could effectively reach male and female farmers and other agricultural workers in Germany.

METHODS

The study consisted of a national and regional approach placing general information on NMSC and associated sun-protective behaviour in print media. This placement of information was combined with an invitation to visit a study website for further information, as well as to participate in a brief online survey. Eleven questions based on previous studies (11) addressed risk and protective behaviour during work.

At the national level, the information was placed in the free member magazine of the German farmers' compulsory health and accident insurance. The magazine is published 4 times a year, contains up-to-date information on a range of topics, including healthcare, and has a circulation of 1.35 million across Germany. Publication was on 2 June 2017 (Table SI[1]).

At the regional level, analogous to the national level, the same information was published in the Bavarian Agricultural Journal on 15 September 2017. This special-interest journal is Germany's highest-circulation subscription agricultural journal, with a circulation of approximately 100,000 copies reaching 85% of all Bavarian farms (12). The weekly magazine provides agricultural professions with the latest news on all aspects of agricultural life, including finance, health and agricultural market prices, thereby ensuring a large and continued readership.

In both cases, the responses and engagement of the target audiences were assessed based on the number of website visits during the 1-month period following publication of the printed campaigns. In addition, the total time spent on the website and completion of the online questionnaires were assessed. Usage statistics and audience characteristics (age, sex, location) were tracked through Google Analytics dashboards. The same descriptive analysis was performed for comparison over a 1-month control period, 2 months after the Bavarian approach.

RESULTS

During the month after national publication, a total of 128 individuals (46.1% women) of all age groups (> 18 years) visited the website for mean 1 min 2 s. Interestingly, website visitors were located in 10 of 16 German Federal States, with no visitors from Eastern Germany (Fig. S1[1]).

[1]https://www.medicaljournals.se/acta/content/abstract/10.2340/00015555-2958

Table I. Characteristics of the website visitors during the 1-month period after the national launch, the Bavarian launch and a 1-month control period

	National	Bavaria	Control period
Publication date	2 Jun 2017	15 Sep 2017	n.a.
Website analysis	2 Jun–2 Jul 2017	15 Sep–15 Oct 2017	15 Dec 2017–15 Jan 2018
Agricultural households receiving the information	1,350,000	100,008	0
Visitors on website, *n*	128	12	1
Sex, *n* (%)			
Women	59 (46.1)	5 (41.7)	0
Men	69 (53.9)	7 (58.3)	1 (100)
Age groups, *n* (%)			
18–24 years	35 (27.3)	2 (16.6)	0
25–34 years	43 (33.6)	4 (33.3)	1 (100)
35–44 years	20 (15.6)	2 (16.6)	0
45–54 years	16 (12.5)	2 (16.6)	0
55–64 years	7 (5.5)	1 (8.3)	0
> 65 years	7 (5.5)	1 (8.3)	0
Time spent on website, mean (range)	1 min 2 s (9 s–5 min 2 s)	1 min 49 s (16 s–4 min 57 s)	3 s
Geographical region, *n*	10 of 16[a]	7 of 96[b]	Russia
Completed questionnaires, *n*	0	3	0
Devices used, %			
Desktop	59.4	58.3	100
Tablet	33.6	41.7	0
Mobile	7.0	0	0

[a]German federal states, [b]Bavarian districts.

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The majority of visitors used desktop computers (59.4%), none completed the online questionnaire (**Table I**).

Following the Bavarian publication, there were 12 website visitors (41.7% women) from 7 out of 96 districts in Bavaria (Fig. S2[1]). Mean time spent on the website was 1 min 49 s using desktop computers (58.3%) or tablets (41.7%) (Table I). Three visitors completed the questionnaire.

In the control period without preceding publication, one visitor was registered on the website, but no connection was found with the campaign (Table I).

DISCUSSION

A printed awareness and information campaign on NMSC and its prevention was distributed among 1.45 million agricultural households across Germany. The target audience was invited to visit the campaign website for further information and to participate in a brief online survey. Only 140 individuals visited the website during the observation period. This does not exclude that other farmers did not receive any educational benefit from the print campaign. However, the website response rate (0.01%) revealed a failure to reach a meaningful proportion of the target population, making it impossible to assess the impact of the campaign on sun-protective behaviour.

Possible explanations for this failure are manifold (8) and include that printed messages might were overlooked and that the factual messages may have been inappropriate for farmers, or a combination of these features.

The postal-based approach was designed to reach all agricultural households in Germany, but combining it with a link to a website may have been a major cause of the very low response rate. Readers might have not wanted to spend extra time by visiting the study website. Previous studies have shown that postal-based campaigns are the most economical option, usually having higher response rates compared with other media campaigns (8, 13).

An important limitation of this study is its exploratory nature. We know that the print media were delivered to the target households, but we do not have any information on how many people read or even saw the message. Furthermore, limited internet access and/or experience, especially in older age groups, could have led to an underestimation of the real interest among the target group. However, visitors from all age groups visited the website. In Germany, 95% of farmers use the internet and 75% of them go online every day, which is one of the highest rates worldwide for agricultural professions (14).

In summary, the approach of placing messages in print media combined with an internet-based assessment of response does not appear to be appropriate for reaching agricultural populations in Germany. Future studies on NMSC prevention among outdoor workers should invest in exploring how these high-risk occupational groups might be reached more effectively (15). Finding the best possible access route to these groups could be the key to lowering the burden of NMSC among farmers and other outdoor workers.

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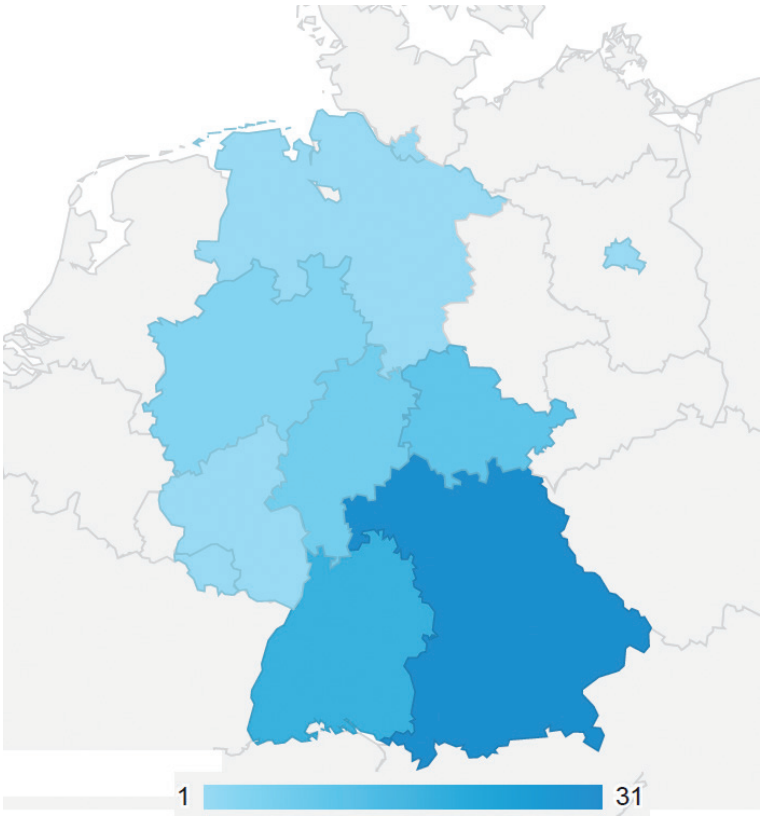

Fig. S1. Location of 128 website visitors in 10 (blue) of 16 Federal States of Germany during the national campaign. Depth shading indicates the number of visitors from 1 to 31 in every single state (see key).

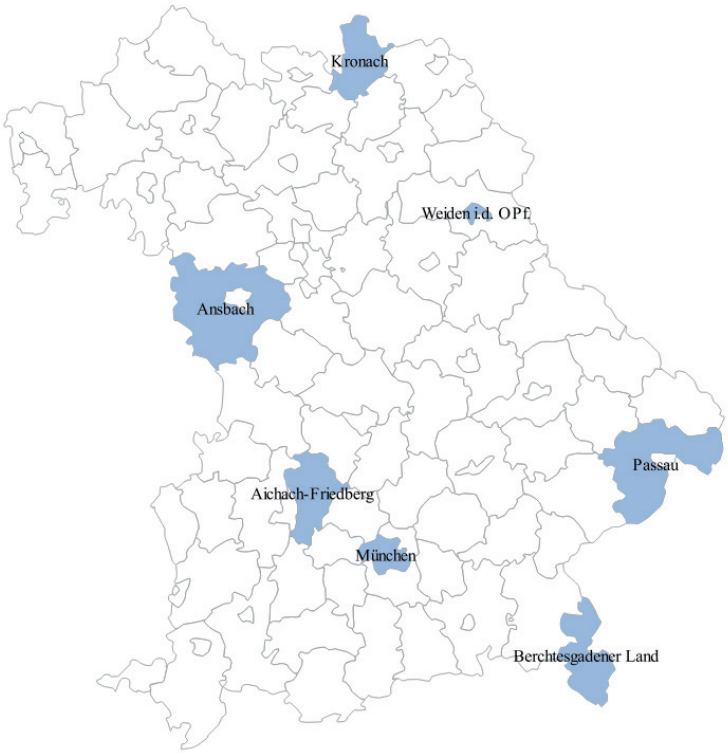

Fig. S2. Location of 12 website visitors in 7 (blue) of 96 districts of the State of Bavaria in Southern Germany during the Bavarian campaign.

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