Aus dem Institut für Medizinische Informationsverarbeitung, Biometrie und Epidemiologie
(IBE) der Universität München

Dissertation

zum Erwerb des Doctor of Philosophy (Ph.D.) an der
Medizinischen Fakultät der

Ludwig-Maximilians-Universität zu München

Medical Care for Skin Cancer: Using Unconventional Settings to Identify Determinants for Targeted Prevention Campaigns

vorgelegt von

Linda Tizek

aus

Krefeld, Deutschland

Jahr
2020

Mit Genehmigung der Medizinischen Fakultät
der Universität München

Berichterstatter:	PD Dr. Dr. med. Alexander Zink, MPH
Mitberichterstatter:	Prof. Dr. Markus Ege
Dekan:	Prof. Dr. med. dent. Reinhard Hickel
Datum der Verteidigung:	02. November 2020

Affidavit

I, Linda Tizek, hereby declare, that the submitted thesis entitled

Medical Care for Skin Cancer: Using Unconventional Settings to Identify Determinants for Targeted Prevention Campaigns

is my own work. I have only used the sources indicated and have not made unauthorized use of services of a third party. Where the work of others has been quoted or reproduced, 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, 17. July 2020

Linda Tizek

Confirmation of congruency between printed and electronic version of the doctoral thesis

I, Linda Tizek, hereby declare, that the submitted thesis entitled

Medical Care for Skin Cancer: Using Unconventional Settings to Identify Determinants for Targeted Prevention Campaigns

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

Munich, 17. July 2020

Linda Tizek

Table of contents

List of Abbreviations

AK	Actinic keratosis
BCC	Basal cell carcinoma
BK 5103	Squamous cell carcinoma or multiple actinic keratosis of the skin caused by natural UV irradiation
GP	General practitioner
INTERFORST	Internationale Leitmesse für Forstwirtschaft und Forsttechnik (‘International trade fair for forestry and forest technology’)
KC	Keratinocyte carcinoma
NMSC	Non-melanoma skin cancer
SCC	Squamous cell carcinoma
UVR	Ultraviolet radiation
ZLF	Bayerisches Zental-Landwirtschaftsfest (‘Bavarian Central Agricultural Festival’)

Publication List

Tizek L, Schielein MC, Rüth M, Szeimies R-M, Philipp-Dormston WG, Braun SA et al. Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities. Acta Derm Venereol 2019; 99(9):797–804.

Tizek L, Schielein MC, Berger U, Seifert F, Biedermann T, Böhner A et al. Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap. Eur J Dermatol 2020.

Tizek L, Schielein MC, Berger U, Ege MJ, Schneider S, Zink A. Skin cancer risk and shade: comparing the risk of foresters with other outdoor workers. J Eur Acad Dermatol Venereol 2020.

Tizek L, Schielein MC, Schuster B, Ziehfreund S, Biedermann T, Zink A. Effekte einer unkonventionellen Hautkrebs-Präventionskampagne: Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen. [Effects of an unconventional skin cancer prevention campaign: Impacts on the sun protection behavior of outdoor workers]. Hautarzt 2020; 71(6):455–62.

Doctoral Thesis: Introductory Summary

Skin cancer, the most common malignancy in Caucasians worldwide, is an enormous public health problem due to impaired quality of life of affected individuals and its economic impact on health care systems (1–5). The most common types of skin cancer are melanoma and keratinocyte carcinoma (KC). KC, previously known as non-melanoma skin cancer (NMSC), compromises basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and in a broader sense actinic keratosis (AK) as a carcinoma in situ (1, 3). While KC has a lower mortality rate than melanoma, the incidence of KC is 18 to 20 times higher (1). Continuously rising KC incidence and prevalence have been reported globally for several decades (4, 6–9). Data for Germany show that the combined incidence of BCC and SCC increased from 43.1 cases per 100,000 individuals in 1998 to 105.2 cases per 100,000 individuals in 2010, indicating an increase of 144.1% (8). According to another German study, the age-standardized combined prevalence of BCC and SCC increased by 52.0% between 2009 and 2015, with a prevalence of 1126.9 cases per 100,000 individuals in 2009 and 1708.2 cases per 100,000 individuals in 2015 (10). Similarly, the incidence of AK has been rising and some studies reported an AK prevalence higher than 60% depending on the study participants' characteristics, the region, and data source (11–16).

Since solar ultraviolet radiation (UVR) was declared to have carcinogenic effects in humans in 1992 (17) , many studies have demonstrated that UVR is the main risk factor for KC (18–20). Accordingly, people with a high cumulative sun exposure, such as outdoor workers, have a higher risk for KC (21, 22). It was demonstrated that people with long-time outdoor work experience have a twofold increased risk for SCC and AK compared to the general population (21) and thus 'squamous cell carcinoma or multiple actinic keratosis of the skin caused by natural UV irradiation' was introduced as a new occupational disease (BK No. 5103) in Germany in 2015 (23).

In general, the burden of KC can be lowered with adequate application of primary (e.g. using sunscreen, wearing a hat, avoiding midday sun) and secondary (skin cancer screening) prevention measures (2, 20, 24, 25). However, as previous studies indicated an insufficient usage of these measures (26, 27), several factors, such as those described below, must be considered for a successful implementation of prevention approaches.

Firstly, it is important to adapt prevention strategies to the special needs of the respective target group. It was shown previously that prevention campaigns for KC based on a top-down

approach without personal intervention can fail if they do not consider the interest of the population (28). Accordingly, examining a population's interest in health-related topics is important before implementing a prevention campaign. As the Internet is a widely used source of health-related information, an unconventional approach to investigating a population's interest is to analyze Internet search engine data (29–31). The advantage of such analyses is that they provide an overview of people's interest in different aspects of a disease, such as symptoms, treatment, or localization, which could help to identify unmet needs (32–34). In addition, they are suited to detect disease trends and make forecasts for several diseases (35–39).

Secondly, another important factor for the successful implementation of prevention campaigns is the identification of regions with a high burden of KC. These regions have a higher medical need and are where prevention campaigns are required the most. Usually data from cancer registries are used to examine the burden of malignancies. KC, however, is not reported by default in the majority of cancer registries, and thus it is difficult to assess the KC burden across Germany (2, 6). Several studies using health care data already suggested that there is a high KC burden due to its rising incidence and prevalence in the last decades (6, 8, 10). However, to assess and lower the KC burden, a holistic approach that also considers real-life data is needed, since regional variations in health care utilization exist (40–42).

Thirdly, possible differences among population groups regarding sun protection behavior and individual risk have to be analyzed. Systematic reviews on primary prevention measures of KC revealed that there were substantial differences in the frequency of using sun protection measures within different outdoor professions (26, 43). Additionally, duration of occupational sun exposure varies for different outdoor professions. An evaluation of the KC risk showed that while farmers, gardeners, and mountain guides had a significantly higher risk compared to indoor workers, mountain guides had a two-times higher risk for KC than farmers (15). Another study showed that farmers, bricklayers, and gardeners reported the longest sun exposure per working day (44, 45). Accordingly, the diversity in the group of high-risk outdoor workers means that differences between the various professions have to be taken into account. While there is a lot of evidence about the sun protection behavior and KC prevalence for some outdoor professions such as farmers (14, 45–48) and mountain guides (15, 44, 49, 50), more evidence is needed for other outdoor professions, which are rarely or not at all studied so far.

Considering these aspects, the aim of this doctoral thesis was to generate knowledge needed for the creation and implementation of targeted and effective prevention campaigns by using

unconventional real-life settings and methods for data collection in order (i) to analyze the interest of a population searching for skin cancer-related information online, (ii) to examine regional patterns in the KC burden and the utilization of medical care, and (iii) to analyze the risk behavior of an outdoor profession that is not well studied so far. By conducting a follow-up study, another aim of the Ph.D. thesis was to evaluate whether unconventional settings are not only suitable for answering research questions but also for increasing the sun protection behavior and knowledge of the target population.

Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities

Adapting prevention strategies to the needs and interests of a population was shown to have a positive impact on health awareness (51–54). Qualitative studies are a suitable tool for analyzing needs of smaller and well-defined study populations and can serve as a basis for creating individualized strategies (48, 55, 56). To analyze the interest of large and diverse populations, however, big data such as Internet search analyses are more useful and previously showed promising results (33–35). Approximately 90% of the German population uses the Internet, with 95% of this group using Google as its primary search engine (57, 58). People use search engines for various reasons ranging from finding the latest gossip about Justin Bieber to obtaining information about serious health issues (59, 60). People affected by diseases as well as their relatives often use the Internet to receive initial or additional information about their disease (31, 60). For example, nearly 80% of melanoma patients across Germany stated that they use the Internet to find information about health issues (31). A US-based study even demonstrated a correlation between the number of registered melanoma cases and Internet search volume (36). In 2018, a study examined the Google search volume related to skin cancer across Germany to investigate what this population wanted to know about the disease in general (33). However, owing to the study design, the study was unable to demonstrate regional differences in search frequency and interest (33).

Therefore, the aim of the first study of the Ph.D. project was to investigate geographical variations in search volume and behavior in nine large German cities (Berlin, Hamburg, Munich, Cologne, Stuttgart, Nuremberg, Muenster, Magdeburg, Recklinghausen). The skin cancer-related search volume was examined between July 2014 and June 2018 using Google AdWords Keyword Planner, which identifies relevant keywords for a topic (e.g. ‘skin cancer’) and provides the average monthly Google search volume for the respective keywords over the

last 48 months. All keywords related to skin cancer were qualitatively reviewed and assigned to one of the following three categories: ‘NMSC’, ‘melanoma’, or ‘skin cancer in general’. Since there were at least 209 keywords in each category, the assigned keywords for each category were further classified into five subcategories: ‘treatment’, ‘identifying’, ‘localization’, ‘questions’, or ‘general’ if the search term did not fit in any of the four other subcategories. To assess differences within the cities, the absolute search volume was set in relation to the respective number of inhabitants and calculated as searches per 100,000 inhabitants.

A total of 1,047 keywords were identified, resulting in an overall search volume of 3,460,980 queries. It was observed that people tended to search for skin cancer without further specification, as half of the keywords (n=566) referred to ‘skin cancer in general’ and the highest search volume was observed for the subcategory ‘general’ in each of the three categories (NMSC: 934,780 searches; melanoma: 443,930 searches; skin cancer in general: 642,050 searches). Although the highest search volume was found for the subcategory ‘general’, the highest number of keywords was assigned to ‘identifying’ skin cancer. Many people searched for ‘images’, ‘symptoms’, and ‘how to identify’ skin cancer, which suggests that people may use the Internet prior to consulting a physician and thus emphasizes the importance of the Internet as source of health-information.

Considering the whole study period, the lowest number of searches per 100,000 inhabitants was observed in Berlin (n=32,693), whereas the highest number was observed in Stuttgart (n=50,005). Considering the respective categories, significant differences were observed between some cities. For example, in the category ‘skin cancer in general’, the number of searches per 100,000 inhabitants focusing on ‘localization’ was significantly lower in Berlin (n=1,009) than in Cologne (n=2,065), Stuttgart (n=2,630), Nuremberg (n=2,355), Muenster (n=2,710), and Recklinghausen (n=2,737). Furthermore, in Recklinghausen, a significantly higher number of searches per 100,000 inhabitants focusing on identifying NMSC (n=5,219) was found compared to in Berlin (n=1,894) and Hamburg (n=2,359). Regarding the category ‘melanoma’, a significantly higher number of searches regarding ‘identifying’ and ‘treatment’ was observed in Recklinghausen (n=2,386 and n=1,175, respectively) compared to in Berlin (n=797 and n=348, respectively). Like in the aforementioned study from the USA (35), a correlation between the Google search volume related to melanoma and the cancer registry data for the age-standardized incidence of melanoma was detected (61–63). The number of search queries also increased during summer, which matches findings in the current literature (33, 64).

However, considering all nine cities, no noticeable increase in the total number of searches was observed during the entire study period, which was contrary to the study which investigated the search volume for the whole of Germany (33). It was assumed that this difference was partly due to the fact that rural areas were not considered in this study. A higher proportion of outdoor workers live in rural areas, and people in rural areas tend have a limited access to medical specialists when compared to those in urban areas. Internet use may have also increased in recent years in rural areas, whereas it was already high in urban counterparts.

The study concluded that the analysis of Google search volume in different cities allowed for the identification of cities with specific health care needs. This information might be particularly relevant for cities or regions with a lower supply of physicians or a high proportion of high-risk groups. Furthermore, as the Internet is a commonly used source for health information, offering reliable, evidence-based, and easy-to-find information via trust-worthy websites is important.

In this study, I was responsible for the data preparation and analysis as well as the writing of the manuscript. Firstly, I screened all 1,203 keywords provided by the Keyword Planner and assigned them to the respective categories. Secondly, I performed the data analysis as described in the paper. Thirdly, I wrote the first draft of the manuscript, which was sent to the coauthors. After revising the manuscript according to the coauthors' comments and then sending the final version to all coauthors for approval, I was responsible for submitting the paper.

Besides gaining a better understanding of people's interest, developing a comprehensive and differentiated overview of health awareness and disease burden in high-risk populations is necessary for creating targeted prevention campaigns. Thus, the rationale of the second study of the Ph.D. project was to assess the disease burden in various regions based on real-life data collected outside of a typical medical setting.

Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap

Previous studies indicated that there are regional variations in KC prevalence and in the usage of health care across Germany (40, 41). On the one hand, a lower utilization of medical care was shown to be associated with individual characteristics such as higher age and male gender (65, 66). Moreover, many individuals who are affected by a skin disease or outdoor workers who are at a higher risk for KC often do not consult a physician, as they are not aware of their disease or underestimate their individual risk (2, 14, 44, 67, 68). On the other hand, systemic

disease or underestimate their individual risk (2, 14, 44, 67, 68). On the other hand, systemic circumstances such as a lower density of specialists in some rural areas are responsible for lower utilization rates of medical care in these regions (69–71).

As there are many rural areas with a high proportion of outdoor workers in Bavaria, the study aimed to investigate regional differences in medical need and care across Bavaria by offering an on-site skin cancer screening to visitors of a large agricultural fair, the 'Bayerisches Zentral-Landwirtschaftsfest' (ZLF, 'Bavarian Central Agricultural Festival'). With approximately 300,000 visitors, the ZLF is the largest agricultural fair in Southern Germany, occurring every four years simultaneously with the Munich Oktoberfest. Before being examined by a trained dermatologist, participants were asked to fill out a self-administered questionnaire that included questions on age, gender, place of residence, profession, and previous health care utilization.

A total of 2,483 people (mean age 51.8 ± 15.2 years, 54.7% women, 54.2% farmers) living in 89 of 96 Bavarian regions were included in the study. Of these, most lived in environs (65.1%), followed by rural areas (28.8%) and urban areas (6.1%). People living in urban areas reported a significantly higher attendance rate in a previous skin cancer screening (49.3%) than people living in rural areas (35.9%). Similarly, the proportion of people having a previous treatment by a dermatologist was considerably higher among people living in urban areas (65.1%) than among people living in rural areas (51.4%). In response to the question about which health care professional the participants would initially consult if they had a visible skin condition, over 60% of the participants from the environs and the rural areas said that they would first seek medical aid from a general practitioner (GP). In contrast, it was found that people living in urban areas reported being twice as likely to initially consult a dermatologist than people living in rural areas. Furthermore, working in an indoor profession, having a medical history of skin cancer, and being aware of KC were positively associated with consulting a dermatologist first.

According to the results of the skin cancer screening performed by the dermatologists, the skin cancer burden was higher among people living in environs and rural areas than among people living in urban areas. For example, the highest AK burden was observed among people from the environ Munich (43.6%) and the rural area Haßberge (44.4%). In addition, the highest combined burden of BCC and SCC was found in the rural area Cham (6.3%) and the rural area Ansbach (5.6%). The overall higher burden along with lower utilization rates of medical care in rural areas underlines the importance of improving people's knowledge about skin cancer

and access to healthcare services to ensure that they can benefit from early detection and treatment.

During the nine days at the ZLF, I helped with collecting the data on-site. Together with a few other people, I collected the participants' questionnaires and then gave participants the documentation form for the skin cancer screening. After finishing the data collection, I digitalized all the data for the 2,483 participants once and checked them for discrepancies after they were digitalized a second time by another person. In the next step, I performed the entire data analysis with some assistance from Dr. Ursula Berger. After having analyzed the data, I prepared the entire manuscript, including figures, which was then critically revised by all coauthors. In the last step, after all coauthors had approved the final manuscript, I was responsible for the submission.

By achieving a large sample size in only nine days, this study demonstrated that an unconventional setting is a valuable approach to offering people convenient access to health examinations and that the rural populations seem to be an especially vulnerable group in terms of skin cancer prevention. In this study at an agricultural fair, a high number of farmers participated. However, as outdoor workers are a heterogeneous group with regard to their sun protection behavior (26, 44, 43), occupational sun exposure (45), and skin cancer risk (15), a third study was performed at the 'Internationale Leitmesse für Forstwirtschaft und Forsttechnik' (INTERFORST, 'international trade fair for forestry and forest technology') to reach a large population of foresters. The INTERFORST takes place every four years, and in 2018 around 50,000 visitors came to see the latest innovations in forest technology presented by 453 national and international companies.

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

The aim of this cross-sectional study was to evaluate the risk behavior, health awareness, and KC risk of foresters, since no studies on this outdoor profession had been conducted so far. Comparable to the study described above, a skin cancer screening was offered in combination with a questionnaire containing, among others, questions on sun-safety behavior and barriers regarding dermatological care. People were asked to state on a five-point Likert scale how often they used various primary prevention measures such as applying sunscreen, wearing hats, and wearing protective clothes (0 = never, 1 = seldom, 2 = sometimes, 3 = often, and 4 = always). A relative sun protection score was calculated by summarizing the scores of all six sun

protection measures and dividing this by the number of given answers. Accordingly, participants with a higher score reported a better sun protection behavior.

A total of 591 individuals (mean age 46.8 ± 16.2 years, 21.3% women) participated in the study, with 193 people working as foresters, 84 as farmers, 129 as other outdoor workers, and 185 people as indoor workers. Foresters reported the highest number of outdoor working hours (6.9 ± 3.3 hours in summer; 6.0 ± 3.2 hours in winter) as well as the highest proportion of sunburns within the last year (71.5%). Half of the foresters indicated that they experienced a sunburn during work. Despite working mainly in forests, foresters were the least likely to report to often/always seek shade (31.1%), but they were the most likely to report to often/always wear protective clothes (29.0%). The calculation of the sun protection score revealed that foresters reported a better sun protection behavior than farmers (1.8 ± 0.7 vs. 1.6 ± 0.7) but worse than indoor workers (2.0 ± 0.7). Overall, the study found that working in an outdoor profession was associated with worse sun protection behavior, indicating that outdoor workers implement primary prevention efforts less frequently.

Additionally, the proportion of participants without a previous skin cancer screening was the highest among foresters (62.7%). In general, a major problem regarding dermatological care that half of all participants reported was that consulting a physician regularly was too time-consuming. At the same time, more than half of the participants indicated that they were not very good at checking their own skin for skin changes. Together with an inadequate knowledge about skin conditions, the insufficient ability to check one's own skin might be responsible for the large discrepancy between self-disclosure on the prevalence of skin diseases and the results of the medical skin cancer screening; while only 2.9% of the foresters reported being affected by KC at study examination, the dermatologist detected KC in 16.5% of the foresters. Accordingly, the prevalence of KC among foresters was comparable to that of other outdoor professions even though foresters' UVR exposure is somewhat limited by the shade of trees during most of their working time. Thus, the study's conclusion was that the shade of trees might not be sufficient to protect foresters from developing KC and that their awareness of using additional primary sun protection measures and of consulting a physician regularly have to be improved.

In this third Ph.D. project, I contributed substantially to the study design. At the beginning, I performed a literature search to investigate important aspects related to the topic. A first draft of the questionnaire was discussed in detail with all members of my TAC during the first meeting and was subsequently adapted. In addition to the questionnaire, I prepared all other

documents such as the study protocol, which were necessary for the ethics committee approval. During the data collection at the INTERFORST, I, along with a few other people, were responsible for recruiting the numerous participants, handing them the questionnaires, and answering any questions that arose. I then performed the data digitalization and preparation before discussing the main points of the data analysis with my TAC members in the second meeting. Like in the aforementioned two studies, I wrote the manuscript, which was revised critically by the coauthors, and then submitted the manuscript to the journal.

Considering the results of the two cross-sectional studies mentioned above, unconventional settings appear to be highly suitable for reaching a large share of the target population. While the main aim of the two studies was to collect data about sun protection behavior and the burden of KC, another goal of the questionnaire in combination with the skin examination was to influence people's sun protection behavior and their awareness of skin disease. To evaluate how the study participation had influenced sun protection behavior and health care utilization, a follow-up study was performed among some of the participants of the first study at the ZLF.

Effekte einer unkonventionellen Hautkrebs-Präventionskampagne: Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen

For this follow-up study, all individuals of the ZLF study who voluntarily agreed to participate in an additional study were contacted by mail. One year after the initial study at the ZLF, participants received the same questionnaire as well as evaluation questions, which aimed to investigate whether the subjective awareness regarding sun protection and skin conditions had improved.

A total of 773 individuals were contacted, of which 400 returned the questionnaire (response rate 52.8%). In comparison to the initial study, a higher proportion of outdoor workers reported using sun protection measures; for applying sunscreen the proportion increased by four percentage points, avoiding midday sun by 24 percentage points, wearing a hat by 13 percentage points, and wearing protective clothes by 12 percentage points. Overall, 42.7% of the respondents stated that they were more conscious about protecting themselves from the sun, with 44% of the outdoor workers reporting to use sunscreen more regularly. Nearly two thirds of all participants indicated that they were more aware of skin conditions since the initial study. This proportion was significantly higher in outdoor workers (68.8%) than in indoor workers (55.8%). Furthermore, 81.0% of the study participants reported that they would consult a dermatologist earlier in case of a conspicuous skin condition. Almost every participant (95.8%)

stated that the initial study was a good approach to improve awareness of skin diseases. There was still a great demand among the target population, however, as 67.5% of the participants desired further prevention campaigns regarding skin cancer and sun protection.

This fourth project provides insight into how sun protection behavior and awareness of KC changed due to a prevention campaign performed in an unconventional setting. The results suggested that settings beyond the typical medical setting can be another approach to implementing targeted and effective prevention campaigns.

My contribution in this fourth study includes the following: data collection, data digitalization, and data analysis. I then wrote the first draft of the manuscript, adapted it to the coauthors' comments, and submitted it to the journal.

In summary, the four studies in this Ph.D. thesis allow for an in-depth visualization of people's interest regarding skin cancer. They also help to assess the KC burden in various regions and outdoor professions, to obtain an overview of the real-life usage of primary and secondary prevention measures, and to evaluate the effectiveness of targeted studies. Considering all aforementioned studies, the results suggested that despite all the current prevention programs on skin cancer, which have been carried out in Germany for many years, the knowledge and protection behavior of certain population groups is still insufficient. However, simultaneously these groups seem to have a great interest in the topic of skin cancer based on the high number of Google searches, the high participation rate in the performed cross-sectional studies, and the desire for further prevention campaigns. For a successful implementation, it is essential that future prevention campaigns are adapted to the specific need and awareness of the respective target group and that they provide convenient access to health information and care.

References

Literature Cited

1. Apalla Z, Lallas A, Sotiriou E, Lazaridou E, Ioannides D. Epidemiological trends in skin cancer. Dermatol Pract Concept 2017; 7(2):1–6.

2. Zink A. Trends in the treatment and prevention of keratinocyte carcinoma (non-melanoma skin cancer). Curr Opin Pharmacol 2019; 46:19–23.

3. Albert MR, Weinstock MA. Keratinocyte carcinoma. CA: A Cancer Journal for Clinicians 2003; 53(5):292–302.

4. Diepgen TL, Mahler V. The epidemiology of skin cancer. Br J Dermatol 2002; 146 Suppl 61:1–6.

5. Karimkhani C, Dellavalle RP, Coffeng LE, Flohr C, Hay RJ, Langan SM et al. Global Skin Disease Morbidity and Mortality: An Update From the Global Burden of Disease Study 2013. JAMA Dermatol 2017; 153(5):406–12.

6. Leiter U, Keim U, Eigentler T, Katalinic A, Holleczek B, Martus P et al. Incidence, Mortality, and Trends of Nonmelanoma Skin Cancer in Germany. J Invest Dermatol 2017; 137(9):1860–7.

7. Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. Br J Dermatol 2012; 166(5):1069–80.

8. Rudolph C, Schnoor M, Eisemann N, Katalinic A. Incidence trends of nonmelanoma skin cancer in Germany from 1998 to 2010. J Dtsch Dermatol Ges 2015; 13(8):788–97.

9. Xiang F, Lucas R, Hales S, Neale R. Incidence of nonmelanoma skin cancer in relation to ambient UV radiation in white populations, 1978-2012: empirical relationships. JAMA Dermatol 2014; 150(10):1063–71.

10. Augustin J, Kis A, Sorbe C, Schäfer I, Augustin M. Epidemiology of skin cancer in the German population: impact of socioeconomic and geographic factors. J Eur Acad Dermatol Venereol 2018; 32(11):1906–13.

11. Eder J, Prillinger K, Korn A, Geroldinger A, Trautinger F. Prevalence of actinic keratosis among dermatology outpatients in Austria. Br J Dermatol 2014; 171(6):1415–21.

12. Schaefer I, Augustin M, Spehr C, Reusch M, Kornek T. Prevalence and risk factors of actinic keratoses in Germany--analysis of multisource data. J Eur Acad Dermatol Venereol 2014; 28(3):309–13.

13. Ferrándiz C, Plazas MJ, Sabaté M, Palomino R. Prevalence of actinic keratosis among dermatology outpatients in Spain. Actas Dermosifiliogr 2016; 107(8):674–80.

14. Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A. Skin diseases are more common than we think: screening results of an unreferred population at the Munich Oktoberfest. J Eur Acad Dermatol Venereol 2019; 33(7):1421–8.

15. Zink A, Tizek L, Schielein M, Bohner A, Biedermann T, Wildner M. Different outdoor professions have different risks - a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. J Eur Acad Dermatol Venereol 2018; 32(10):1695–701.

16. Lee JH, Kim YH, Han KD, Park YM, Lee JY, Park YG et al. Incidence of Actinic Keratosis and Risk of Skin Cancer in Subjects with Actinic Keratosis: A Population-based Cohort Study. Acta Derm Venereol 2018; 98(3):382–3.

17. International Agency for Research on Cancer. IARC monographs on the evaluation of carcinogenic risks to humans: solar and ultraviolet radiation. Lyon; 1992. (IARC monographs on the evaluation of carcinogenic risks to humans; vol 55).

18. Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. Journal of photochemistry and photobiology. B 2001; 63(1-3):8–18.

19. Madan V, Lear JT, Szeimies R-M. Non-melanoma skin cancer. Lancet 2010; 375(9715):673–85.

20. Nagarajan P, Asgari MM, Green AC, Guhan SM, Arron ST, Proby CM et al. Keratinocyte Carcinomas: Current Concepts and Future Research Priorities. Clin Cancer Res 2019; 25(8):2379–91.

21. Schmitt J, Seidler A, Diepgen TL, Bauer A. Occupational ultraviolet light exposure increases the risk for the development of cutaneous squamous cell carcinoma: a systematic review and meta-analysis. Br J Dermatol 2011; 164(2):291–307.

22. Fartasch M, Diepgen TL, Schmitt J, Drexler H. The relationship between occupational sun exposure and non-melanoma skin cancer: clinical basics, epidemiology, occupational disease evaluation, and prevention. Dtsch Arztebl Int 2012; 109(43):715–20.

23. Diepgen TL. New developments in occupational dermatology. J Dtsch Dermatol Ges 2016; 14(9):875–89.

24. Kornek T, Augustin M. Skin cancer prevention. J Dtsch Dermatol Ges 2013; 11(4):283-96.

25. Gordon LG, Scuffham PA, van der Pols JC, McBride P, Williams GM, Green AC. Regular sunscreen use is a cost-effective approach to skin cancer prevention in subtropical settings. J Invest Dermatol 2009; 129(12):2766–71.

26. Reinau D, Weiss M, Meier CR, Diepgen TL, Surber C. Outdoor workers' sun-related knowledge, attitudes and protective behaviours: a systematic review of cross-sectional and interventional studies. Br J Dermatol 2013; 168(5):928–40.

27. Paul SP. Ensuring the Safety of Sunscreens, and Their Efficacy in Preventing Skin Cancers: Challenges and Controversies for Clinicians, Formulators, and Regulators. Front Med (Lausanne) 2019; 6:195.

28. Zink AGS, Ruth 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(8):811–2.

29. European citizens' digital health literacy: Report. Brussels, Belgium: European Commission; 2014. (Flash Eurobarometer; vol 404).

30. Amante DJ, Hogan TP, Pagoto SL, English TM, Lapane KL. Access to care and use of the Internet to search for health information: Results from the US National Health Interview Survey. J Med Internet Res 2015; 17(4):e106.

31. Ebel M-D, Stellamanns J, Keinki C, Rudolph I, Huebner J. Cancer Patients and the Internet: A Survey Among German Cancer Patients. J Cancer Educ 2017; 32(3):503–8.

32. Hopkins ZH, Secrest AM. Public Health Implications of Google Searches for Sunscreen, Sunburn, Skin Cancer, and Melanoma in the United States. Am J Health Promot 2019; 33(4):611–5.

33. Seidl S, Schuster B, Ruth M, Biedermann T, Zink A. What Do Germans Want to Know About Skin Cancer? A Nationwide Google Search Analysis From 2013 to 2017. J Med Internet Res 2018; 20(5):e10327.

34. Zink A, Schuster B, Ruth M, Pereira MP, Philipp-Dormston WG, Biedermann T et al. Medical needs and major complaints related to pruritus in Germany: a 4-year retrospective

analysis using Google AdWords Keyword Planner. J Eur Acad Dermatol Venereol 2019; 33(1):151–6.

35. Tizek L, Schielein M, Ruth M, Stander S, Pereira MP, Eberlein B et al. Influence of Climate on Google Internet Searches for Pruritus Across 16 German Cities: Retrospective Analysis. J Med Internet Res 2019; 21(7):e13739.

36. Wehner MR, Nead KT, Linos E. Correlation Among Cancer Incidence and Mortality Rates and Internet Searches in the United States. JAMA Dermatol 2017; 153(9):911–4.

37. Ginsberg J, Mohebbi MH, Patel RS, Brammer L, Smolinski MS, Brilliant L. Detecting influenza epidemics using search engine query data. Nature 2009; 457(7232):1012–4.

38. Mavragani A, Ochoa G, Tsagarakis KP. Assessing the Methods, Tools, and Statistical Approaches in Google Trends Research: Systematic Review. J Med Internet Res 2018; 20(11):e270.

39. Ling R, Lee J. Disease Monitoring and Health Campaign Evaluation Using Google Search Activities for HIV and AIDS, Stroke, Colorectal Cancer, and Marijuana Use in Canada: A Retrospective Observational Study. JMIR Public Health Surveill 2016; 2(2):e156.

40. Leiter U, Eigentler T, Garbe C. Epidemiology of skin cancer. Adv Exp Med Biol 2014; 810:120–40.

41. Augustin J, Schäfer I, Thiess P, Reusch M, Augustin M. Regionale Unterschiede in der Versorgung des Basalzellkarzinoms. Hautarzt 2016; 67(10):822–8.

42. Schäfer I, Augustin M, Krensel M, Augustin J. Real world data sources for health services research on skin cancer. Hautarzt 2019; 70(1):29–35.

43. Ziehfreund S, Schuster B, Zink A. Primary prevention of keratinocyte carcinoma among outdoor workers, the general population and medical professionals: a systematic review updated for 2019. J Eur Acad Dermatol Venereol 2019; 33(8):1477–95.

44. Zink A, Wurstbauer D, Rotter M, Wildner M, Biedermann T. Do outdoor workers know their risk of NMSC? Perceptions, beliefs and preventive behaviour among farmers, roofers and gardeners. J Eur Acad Dermatol Venereol 2017; 31(10):1649–54.

45. Schneider S, Diehl K, Schilling L, Spengler M, Greinert R, Görig T. Occupational UV Exposure and Sun-Protective Behaviour in German Outdoor Workers: Results of a Nationwide Study. J Occup Environ Med 2018; 60(11):961–7.

46. Silk KJ, Parrott RL. All or nothing… or just a hat? Farmers' sun protection behaviors. Health Promot Pract 2006; 7(2):180–5.

47. Smit-Kroner C, Brumby S. Farmers sun exposure, skin protection and public health campaigns: An Australian perspective. Prev Med Rep 2015; 2:602–7.

48. Zink A, Schielein M, Wildner M, Rehfuess EA. '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. Br J Dermatol 2019; 180(6):1412–9.

49. Zink A, Thome 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(12):2153–61.

50. Zink A, Koch E, Seifert F, Rotter M, Spinner CD, Biedermann T. Nonmelanoma skin cancer in mountain guides: high prevalence and lack of awareness warrant development of evidence-based prevention tools. Swiss Med Wkly 2016; 146:w14380.

51. Wright B, Winslade M, Dudley D, Cotton W, Hamer A. Protect your skin and let the fun begin: The results of an intervention to improve NSW primary schools' implementation of the SunSmart Program. Health Promot J Austr 2019; 30(2):267–71.

52. Misitzis A, Beatson M, Siegel JA, Korgavkar K, Walker J, Weinstock MA. An increase in sunscreen use in a population resistant to sun protection. J Am Acad Dermatol 2019; 81(6):1441–2.

53. Hedevik H, Guorgis G, Anderson CD, Falk M. Sustainable effect of individualised sun protection advice on sun protection behaviour: a 10-year follow-up of a randomised controlled study in primary care. BJGP Open 2019; 3(3).

54. Tabbakh T, Volkov A, Wakefield M, Dobbinson S. Implementation of the SunSmart program and population sun protection behaviour in Melbourne, Australia: Results from cross-sectional summer surveys from 1987 to 2017. PLoS Med 2019; 16(10):e1002932.

55. Rocholl M, Ludewig M, John SM, Bitzer EM, Wilke A. Outdoor workers' perceptions of skin cancer risk and attitudes to sun-protective measures: A qualitative study. J Occup Health 2020; 62(1):e12083.

56. Ziehfreund S, Schuster B, Biedermann T, Zink A. Understanding roofers' sun protection behaviour: a qualitative study. J Eur Acad Dermatol Venereol 2019; 33(5):e193-e195.

57. Statista. Search engine [cited 2018 May 10]. Available from: URL: https://de.statista.com/themen/111/suchmaschinen/.

58. Koch W, Frees B. ARD/ZDF-Onlinestudie 2017: Neun von zehn Deutschen online [cited 2018 May 10]. Available from: URL: http://www.ard-zdf-onlinestudie.de/files/2017/Artikel/917_Koch_Frees.pdf.

59. Gabarron E, Lau AYS, Wynn R. Is There a Weekly Pattern for Health Searches on Wikipedia and Is the Pattern Unique to Health Topics? J Med Internet Res 2015; 17(12):e286.

60. Beck F, Richard JB, Nguyen-Thanh V, Montagni I, Parizot I, Renahy E. Use of the internet as a health information resource among French young adults: Results from a nationally representative survey. J Med Internet Res 2014 May; 16(5):e128.

61. Cancer Registry Bavaria. All neoplasms [cited 2018 Jul 5]. Available from: URL: http://www.krebsregister-bayern.de/lgl_abfrage_d.php.

62. Cancer Registry North Rhine-Westphalia. All neoplasms [cited 2018 Jul 5]. Available from: URL: http://www.krebsregister.nrw.de/index.php?id=146.

63. Common Cancer Registry of the Federal States Berlin, Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt and the Free States Saxony and Thuringia. GKR-Krebsatlas; 2018 [cited 2018 Jul 5]. Available from: URL: https://www.gemeinsames-krebsregister.de/atlas/atlas.html.

64. Bloom R, Amber KT, Hu S, Kirsner R. Google Search Trends and Skin Cancer: Evaluating the US Population's Interest in Skin Cancer and Its Association With Melanoma Outcomes. JAMA Dermatol 2015; 151(8):903–5.

65. Anastasiadou Z, Schäfer I, Siebert J, Günther W, Reusch M, Augustin M. Participation and health care provision of statutory skin cancer screening in Germany - a secondary data analysis. J Eur Acad Dermatol Venereol 2016; 30(3):424–7.

66. Tille F, Gibis B, Balke K, Kuhlmey A, Schnitzer S. Soziodemografische und gesundheitsbezogene Merkmale der Inanspruchnahme und des Zugangs zu haus- und fachärztlicher Versorgung – Ergebnisse einer deutschlandweiten Bevölkerungsbefragung von 2006 bis 2016. Z Evid Fortbild Qual Gesundhwes 2017; 126:52–65.

67. Janda M, Stoneham M, Youl P, Crane P, Sendall MC, Tenkate T et al. What encourages sun protection among outdoor workers from four industries? J Occup Health 2014; 56(1):62–72.

68. Grandahl K, Ibler KS, Laier GH, Mortensen OS. Skin cancer risk perception and sun protection behavior at work, at leisure, and on sun holidays: A survey for Danish outdoor and indoor workers. Environ Health Prev Med 2018; 23(1):47.

69. Kis A, Augustin M, Augustin J. Regional healthcare delivery and demographic change in Germany - scenarios for dermatological care in 2035. J Dtsch Dermatol Ges 2017; 15(12):1199–209.

70. Hansen H, Pohontsch NJ, Bole L, Schäfer I, Scherer M. Regional variations of perceived problems in ambulatory care from the perspective of general practitioners and their patients - an exploratory focus group study in urban and rural regions of northern Germany. BMC Fam Pract 2017; 18(1):68.

71. Fennell KM, Martin K, Wilson CJ, Trenerry C, Sharplin G, Dollman J. Barriers to Seeking Help for Skin Cancer Detection in Rural Australia. J Clin Med 2017; 6(2).

Publication I: Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities

Tizek L, Schielein MC, Rüth M, Szeimies R-M, Philipp-Dormston WG, Braun SA et al. Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities. Acta Derm Venereol 2019; 99(9):797–804.

Acta Dermato-Venereologica

InCites Journal Citation Reports 2019

Impact factor: 4.016 Ranking: 7/68 (Dermatology)

Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities

Linda TIZEK[1,2], Maximilian C. SCHIELEIN[1,2], Melvin RÜTH[1], Rolf-Markus SZEIMIES[3], Wolfgang G. PHILIPP-DORMSTON[4,5], Stephan A. BRAUN[6], Christine HECKER[7], Bernadette EBERLEIN[1], Tilo BIEDERMANN[1] and Alexander ZINK[1]

[1]Department of Dermatology and Allergy, School of Medicine, Technical University of Munich, [2]The Institute for Medical Information Processing, Biometry, and Epidemiology, LMU Munich, Munich, [3]Department of Dermatology and Allergology, Vest Clinic, Recklinghausen, [4]Hautzentrum Koeln, Klinik Links vom Rhein, Cologne, [5]Faculty of Health, University Witten-Herdecke, Witten, [6]Department of Dermatology – General Dermatology and Venereology, Münster University Medical Center, Muenster, and [7]Department of Dermatology, Nuremberg Hospital North, Nuremberg, Germany

Skin cancer is a major public health issue, which could be reduced through prevention programmes. However, prevention utilization is not very prevalent. It is therefore important to understand individuals' interest in skin cancer. Google AdWords Keyword Planner was used to identify the search volume of terms relating to skin cancer in 9 German cities between July 2014 and June 2018. From a total of 1,203 identified keywords, 1,047 search terms were related to skin cancer, which had a search volume of 3,460,980 queries for the study period. Most terms referred to "identifying skin cancer". For melanoma, the number of Google searches per 100,000 inhabitants correlated with the cancer registry data for melanoma incidence rates (men: r = 0.810, women: r = 0.569). Assessment of this data for the different cities further enabled identification of regional variations, which could help to identify areas with a high need for targeted prevention campaigns.

Key words: skin cancer; melanoma; non-melanoma skin cancer; Google; search analysis; retrospective study; keratinocyte; risk assessment.

Accepted May 9, 2019; E-published May 10, 2019

Acta Derm Venereol 2019; 99: 797–804.

Corr: Alexander Zink, Department of Dermatology and Allergy, School of Medicine, Technical University of Munich, Biedersteiner Str. 29, DE-80802 Munich, Germany. E-mail: alexander.zink@tum.de

SIGNIFICANCE

This study examined the Google search volume for skin-cancer-related terms in 9 German cities. Overall, 3.5 million searches related to skin cancer were observed between July 2014 and June 2018. Most of these searches focused on the identification of skin cancer (e.g. ABCD and pictures of skin cancer). In general, the number of search queries per 100,000 inhabitants was lower in larger cities, such as Berlin or Hamburg, in comparison with Stuttgart or Muenster. Analysis of the differences in search behavior between cities could help to identify areas with a high need for targeted prevention campaigns.

Skin cancer, including non-melanoma skin cancer (NMSC) and melanoma, is the most common carcinoma among Caucasians worldwide (1–4), with increasing incidence during recent decades (5–9). While the incidence of NMSC is 18–20 times higher than that of melanoma (1, 3), melanoma is more often fatal (10, 11). Thus, skin cancer presents an enormous socioeconomic burden (12–14), which could be reduced by early detection, diagnosis and treatment (15, 16). Specifically, the incidence of NMSC can be reduced through sun-protection measures (17–19). Despite substantial efforts to comprehensively implement primary prevention strategies (e.g. seeking shade, wearing sun protective clothing, using sun-screen) and secondary prevention strategies (e.g. regular self-examination, regular dermatological check-ups, skin cancer screening campaigns) (20), studies have shown that utilization of such strategies is not highly prevalent (21–23), particularly among individuals who spend a lot of time outdoors (24–27).

One way to investigate reasons for not using skin cancer prevention measures is to focus on the interest in skin cancer among the general population (28). As the Internet is a commonly used source of health information, search engine analysis represents a novel tool for investigating the general interest in various topics (16, 28–33). In Germany, approximately 90% of inhabitants use the Internet (34). More specifically, 95% use Google as their primary search engine (35), and 57% have used the Internet to search for health-related information (36). For example, a German study among patients with melanoma reported that 63% indicated the Internet as the most important source of media information (37). One US study revealed a positive correlation between Internet search volume and the incidence and mortality rates of melanoma and other common cancers (38). Additional studies have revealed an increasing number of Google searches related to health information in recent years (30, 39).

The aim of the present study was to investigate German inhabitants' interest in skin cancer, and whether geographical differences in interest have emerged, by analyzing Google search volumes in 9 German cities. Furthermore, the number of search queries within each city was compared with data from respective cancer registers in order to determine whether there was a correlation between interest and cancer incidence rates.

doi: 10.2340/00015555-3214
Acta Derm Venereol 2019; 99: 797–804

Table I. Subcategorization of identified keywords related to skin cancer in Germany from July 2014 to June 2018

Subcategories	Non-melanoma skin cancer		Melanoma		Skin cancer in general[a]	
	Keywords ($n = 272$)[b]	Search volume ($n = 1,290,050$)	Keywords ($n = 209$)[c]	Search volume ($n = 671,440$)	Keywords ($n = 566$)[d]	Search volume ($n = 1,499,490$)
Treatment of skin cancer	15	29,300	31	55,710	47	145,450
Identifying skin cancer	123	260,870	67	116,500	233	501,100
Localization of skin cancer	60	71,130	33	36,690	130	157,030
Questions on skin cancer	28	34,150	33	34,760	133	158,180
General	76	934,780	63	443,930	114	642,050

[a]Skin cancer in general=all search terms contained only "skin cancer". [b]Thirty keywords were assigned to at least 2 subcategories. [c]Eighteen keywords were assigned to at least 2 subcategories. [d]Ninety-two keywords were assigned to at least 2 subcategories.

METHODS

Study design

A retrospective longitudinal study using Google AdWords Keyword Planner was carried out to identify the search volume of terms related to skin cancer between July 2014 and June 2018 in 9 large cities across Germany (Berlin, Hamburg, Munich, Cologne, Stuttgart, Nuremberg, Muenster, Magdeburg and Recklinghausen). Although Google AdWords Keyword Planner is used primarily to detect keywords for optimizing Google marketing campaigns, this tool can also be used for scientific purposes (30, 32, 33). The software provides monthly search volume data as estimated by Google. Search volume represents the total number of searches for selected keywords. To assess search volume within a specific field, words or phrases related to the topic are initially entered into the Keyword Planner; subsequently, the program finds keywords that are most relevant to the topic (40). Accordingly, 13 German terms were identified: "skin cancer" ("Hautkrebs"), "white skin cancer" ("weißer Hautkrebs"), "light skin cancer" ("heller Hautkrebs"), "nonmelanocytic skin cancer" ("nicht melanozytärer Hautkrebs"), "non-melanoma skin cancer" ("nicht melanozytärer Hautkrebs"), "NMSC" ("nicht melanozytärer Hautkrebs"), "basalioma" ("Basaliom"), "basal cell carcinoma" ("Basalzellkarzinom"), "spinalioma" ("Spinaliom"), "squamous cell carcinoma" ("Plattenepithelkarzinom"), "black skin cancer" ("schwarzer Hautkrebs"), "melanoma" ("Melanom") and "malignant melanoma" ("Malignes Melanom").

Statistical analysis

The authors reviewed and categorized all keywords into 6 groups, namely the German terms for "skin cancer in general", "NMSC", "melanoma", "skin alterations", "other malignant diseases" and "unspecific". However, keywords that were not associated with skin cancer were excluded from the analysis (e.g. "breast cancer"). Those keywords assigned to skin cancer-related categories were further classified into "treatment of skin cancer" (e.g. "NMSC treatment," "prevention"), "identifying skin cancer" (e.g. "skin cancer ABCD," "symptoms"), "localization of skin cancer" (e.g. "skin cancer on the face") or "questions on skin cancer" (e.g.

Table II. Comparison of the absolute and relative Google search volume of terms related to skin cancer in 9 German cities from July 2014 to June 2018

	Berlin *n* (%)	Hamburg *n* (%)	Munich *n* (%)	Cologne *n* (%)	Stuttgart *n* (%)	Nuremberg *n* (%)	Muenster *n* (%)	Magdeburg *n* (%)	Reckling-hausen *n* (%)
Inhabitants	3,574,830	1,810,438	1,464,301	1,075,935	628,032	511,628	311,846	238,136	114,003
Proportion of non-native Germans (58)	17.6	16.2	25.5	19.2	24.6	21.9	10.3	8.6	10.7
Incidence of melanoma[a]									
Men	9.8–12.9	12.2–16.0	14.7–23.4	23.4–29.1	n. a.	20.8–28.4	15.4–25.5	13.6–22.6	19.1–20.8
Women	8.7–11.1	11.5–14.0	12.0–22.0	25.2–29.1	n. a.	16.6–21.1	20.6–25.6	12.2–20.2	20.0–26.7
Searches related to skin cancer	985,660	591,890	617,060	435,090	314,050	228,440	146,150	93,150	49,490
NMSC	377,280	220,120	236,910	158,100	111,480	80,280	52,750	35,200	17,930
Melanoma	182,170	110,960	125,430	85,890	63,170	46,400	29,850	18,420	9,150
Skin cancer in general[b]	426,210	260,810	254,720	191,100	139,400	101,760	63,550	39,530	22,410
Searches per 100,000 inhabitants									
Searches related to skin cancer	27,572	32,693	42,140	40,438	50,005	44,650	46,866	39,116	43,411
NMSC	10,559	12,158	16,179	14,694	17,751	15,691	16,915	14,781	15,728
Treatment	189 (1.7)	249 (2.0)	315 (1.9)	352 (2.3)	441 (2.4)	502 (3.1)	600 (3.4)	621 (4.0)	851 (5.1)
Identification	1,894 (17.5)	2,359 (18.8)	3,102 (18.6)	2,917 (19.2)	4,027 (21.9)	3,817 (23.4)	3,970 (22.7)	4,413 (28.4)	5,219 (31.1)
Localization	464 (4.3)	688 (5.5)	822 (4.9)	894 (5.9)	1,095 (5.9)	1,085 (6.6)	1,196 (6.8)	1,197 (7.7)	1,246 (7.5)
Questions	239 (2.2)	323 (2.6)	413 (2.5)	396 (2.6)	552 (3.0)	526 (3.2)	468 (2.7)	559 (3.6)	623 (3.7)
General	8,029 (74.2)	8,914 (71.1)	12,006 (72.1)	10,615 (70.0)	12,299 (66.8)	10,404 (63.7)	11,278 (64.4)	8,722 (56.2)	8,728 (52.4)
Melanoma	5,172	6,129	8,566	7,983	10,058	9,069	9,572	7,735	8,026
Treatment	348 (6.7)	490 (7.8)	652 (7.4)	698 (8.5)	931 (9.0)	911 (9.8)	1,055 (10.8)	932 (11.7)	1,175 (14.2)
Identification	797 (15.3)	1,000 (15.9)	1,373 (15.7)	1,372 (16.7)	1,852 (17.9)	1,910 (20.5)	1,979 (20.3)	1,999 (25.2)	2,386 (28.9)
Localization	247 (4.7)	340 (5.4)	467 (5.3)	475 (5.8)	624 (6.0)	534 (5.7)	523 (5.4)	428 (5.4)	386 (4.7)
Questions	232 (4.5)	313 (5.0)	412 (4.7)	461 (5.6)	650 (6.3)	502 (5.4)	500 (5.1)	462 (5.8)	439 (5.3)
General	3,580 (68.8)	4,129 (65.8)	5,860 (66.9)	5,193 (63.3)	6,289 (60.8)	5,443 (58.5)	5,714 (58.5)	4,111 (51.8)	3,860 (46.8)
Skin cancer in general	11,977	14,406	17,395	17,761	22,196	19,889	20,379	16,600	19,657
Treatment	1,097 (8.7)	1,423 (9.2)	1,740 (9.4)	1,718 (9.0)	2,094 (8.8)	1,970 (9.2)	2,171 (9.9)	1,587 (8.8)	2,412 (11.3)
Identification	3,885 (30.9)	4,802 (31.1)	5,810 (31.2)	5,874 (30.8)	7,425 (31.1)	6,980 (32.5)	6,962 (31.8)	6,517 (36.1)	7,570 (35.4)
Localization	1,009 (8.0)	1,527 (9.9)	1,802 (9.7)	2,065 (10.8)	2,630 (11.0)	2,355 (10.9)	2,710 (12.4)	1,919 (10.6)	2,737 (12.8)
Questions	1,008 (8.0)	1,512 (9.8)	1,818 (9.8)	1,979 (10.4)	2,572 (10.8)	2,420 (11.3)	2,248 (10.3)	2,121 (11.7)	2,377 (11.1)
General	5,569 (44.3)	6,163 (39.9)	7,438 (40.0)	7,436 (39.0)	9,159 (38.4)	7,785 (36.2)	7,805 (35.6)	5,921 (33.3)	6,307 (29.5)

[a]Registered age-standardized incidence per 100,000 inhabitants between 2011 and 2014. [b]Skin cancer in general=search terms contained only "skin cancer".
NMSC: non-melanoma skin cancer.

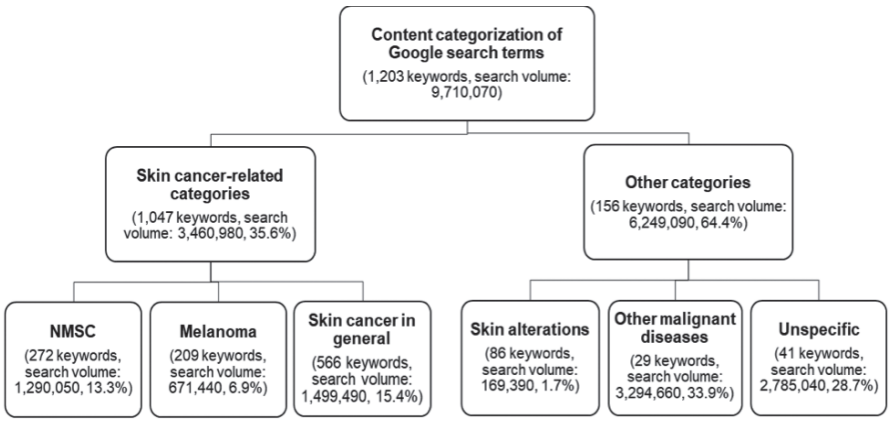

Fig. 1. Content categorization of search terms identified by Google AdWords Keyword Planner. NMSC: non-melanoma skin cancer; skin cancer in general: search terms contained only "skin cancer". All search terms were individually screened and assigned to categories. All terms that did not fit in any of those categories were classified as "unspecific".

"what are the risk factors for skin cancer?"). Searches that did not fit any of these subcategories were placed in a "general" (e.g. "white skin cancer") category. Keywords matching various criteria were assigned to several subcategories (**Table I**).

Descriptive data were generated for the identified keywords. To assess differences in search behavior per 100,000 inhabitants between cities (41), one-way analysis of variance (ANOVA) was used. Pearson's correlation coefficient was further used to investigate the relationship with age-standardized incidence of melanoma for men and women in the year 2014, since cancer registry data for melanoma incidence are available up to 2014 (**Table II**) (42–45). IBM SPSS Statistics (Version 25, IBM Corporation, Armonk, NY, USA) was used for all statistical analyses. Spatial analyses using geodata for administrative boundaries from the German Federal Agency for Cartography and Geodesy (46) were performed using a geographic information system (QGIS version 2.14.22, QGIS Development Team, 2016, Minden, Germany).

RESULTS

Overall, 1,203 keywords were identified, resulting in a search volume of 9,710,070 queries for the period from July 2014 to June 2018. Of these, 156 keywords were excluded from the final analysis, as they referred to "other malignant diseases" (e.g. "lung cancer"), "skin alterations" (e.g. "new mole") or were not assignable terms (e.g. "chemotherapy"). The remaining 1,047 keywords had an overall search volume of 3,460,980 queries and were assigned to the following categories: 272 referred to "NMSC" and 209 to "melanoma". A total of 566 terms did not fit into either the "NMSC" or "melanoma" category, as the terms contained only "skin cancer" and were thus included in the "skin cancer in general" category (**Fig. 1**). The most commonly searched keywords were "skin cancer" (n=454,140), "white skin cancer" (n=407,630), "basalioma" (n=191,730), "melanoma" (n=152,900), and "black skin cancer" (n=124,720).

Comparisons between cities

As expected, Berlin (n=990,550), Hamburg (n=591,890) and Munich (n=617,060) had the largest overall search volumes, as they are Germany's largest cities by population. However, the highest number of search queries per 100,000 inhabitants was observed in Stuttgart and Muenster, with 50,005 and 46,866 searches, respectively. In comparison, the lowest per capita rates were observed in Hamburg (n=32,693) and Berlin (n=27,572, **Fig. 2**). In total, the mean relative number of searches was 35,573 per 100,000 inhabitants.

The category "skin cancer in general" had the highest search volume, with 1,499,490 queries. Within this category, most keywords referred to "identifying skin cancer" (n=233, Table I). Of these keywords, almost half focused on images of skin cancer (n=102), which

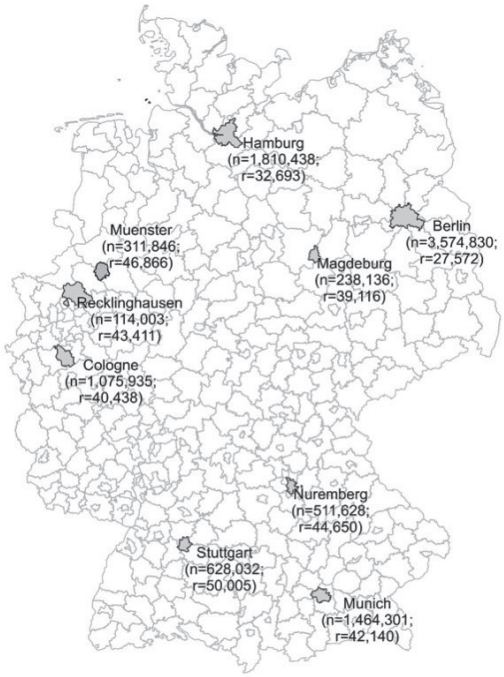

Fig. 2. Google search volume of skin cancer-related terms in 9 German cities from July 2014 to June 2018. n: number of inhabitants; r: number of search queries per 100,000 inhabitants.

had a mean search volume of 5,150 searches/100,000 inhabitants, being highest in Recklinghausen (7,570 searches/100,000 inhabitants) and lowest in Berlin (3,852 searches/100,000 inhabitants). The analysis revealed significant differences only in the subcategories of "localization" and "questions" within some cities. For example, the number of searches/100,000 inhabitants including information on the localization was significantly lower in Berlin ($n=1,009$) than in all other cities except for Hamburg ($n=1,527$, $p=0.974$), Munich ($n=1,802$, $p=0.334$) and Magdeburg ($n=1,919$, $p=0.124$).

A total of 1,290,050 searches focused on NMSC. Therefore, the highest search volume was observed in the subcategory "general" ($n=934,780$), followed by "identifying" ($n=260,870$, Table I). While there were no significant differences in the overall number of searches within the cities, a significantly higher number of searches/100,000 inhabitants focusing on identifying were observed in Recklinghausen ($n=5,219$) compared with Berlin ($n=1,894$, $p=0.003$) and Hamburg ($n=2,359$, $p=0.025$, Table II).

A mean of 6,901 searches/100,000 inhabitants referred to melanoma, ranging from 5,172 to 10,058. Compared with NMSC, a significantly higher number of searches regarding "identifying", but also regarding "treatment", was observed in Recklinghausen compared with Berlin ($p=0.004$ and $p=0.037$, respectively). In 2014, the highest age-standardized melanoma incidence rate was 28.4/100,000 for men in Nuremberg and 29.1/100,000 for women in Cologne. During the same year, the highest numbers of searches/100,000 inhabitants related to melanoma were observed in Stuttgart ($n=1,283$), Nuremberg ($n=1,179$), Munich ($n=1,053$) and Cologne ($n=1,031$). A significantly high correlation between the number of search queries and the incidence rate in men ($r=0.810$, $p=0.015$) was identified. This correlation was stronger than the correlation with the incidence rate in women ($r=0.569$, $p=0.141$).

Time course of search behavior

Across all cities, the highest number of searches was in July 2015 (NMSC: $n=38,180$, melanoma: $n=20,450$, and skin cancer in general: $n=40,580$) and the lowest was in December 2017 (NMSC: $n=19,750$, melanoma: $n=12,100$, and skin cancer in general: $n=21,320$). Each year, the monthly number of search queries was higher in the spring and summer than in the autumn and winter. Apart from these seasonal variations, the number of Google searches remained relatively stable over the entire study period (**Fig. 3**a).

Figs 3b and c outline Google search trends per 100,000 inhabitants in each city. Except for Cologne, Magdeburg and Recklinghausen, the highest number of search queries/100,000 inhabitants was in July 2015 for each remaining city (Berlin: $n=889$, Hamburg: $n=957$, Munich: $n=1,481$, Stuttgart: $n=1,621$, Nuremberg: $n=1,499$ and Muenster: $n=1,456$). Across the 3 aberrant cities, most searches were observed during June 2017 in Cologne ($n=1,092$), June 2016 and May 2017 in Magdeburg ($n=1,033$) and May 2018 in Recklinghausen ($n=1,316$). While Nuremberg had the highest search query range (606–1,499 searches/100,000 inhabitants), the lowest range was observed in Hamburg (499–957 searches/100,000 inhabitants).

DISCUSSION

The aim of the present study was to investigate general interest in skin cancer across Germany and whether specific geographical differences exist regarding search volume and terms of interest. Furthermore, the number of search queries/100,000 inhabitants in each city was compared with melanoma cancer registry data to assess whether there was a correlation.

Previous studies have shown that Google search analyses are an effective tool for assessing disease trends (38), as well as understanding health information seeking behavior (28, 30, 32, 33). In total, almost 3.5 million Google searches related to skin cancer were observed within 4 years in our study, representing 17.6% of all skin cancer-related Google searches across all of Germany ($n=19,849,230$) (30). When comparing the number of Google searches/100,000 inhabitants across the cities, we found that Berlin ($n=27,572$) and Hamburg ($n=32,693$) had a comparatively low number. However, in comparison with the number of search queries/100,000 inhabitants regarding pruritus, the search volume of skin cancer-related queries was nearly twice as high (Berlin: $n=13,641$; Hamburg: $n=18,303$) (47). In general, the present study revealed, that within the context of skin cancer, especially when searching for NMSC, many people searched for general information. In addition, there was great interest in skin cancer identification ($n=879,650$). In all categories, nearly half of the search terms that were classified as "identifying" were used to search for images (NMSC: 72/123 keywords, melanoma: 30/67 keywords, and skin cancer in general: 102/233 keywords). Many individuals also searched for symptoms or how to identify skin cancer, which indicates that people may use the Internet for skin disease information prior to consulting a physician.

The Google data for 2014 showed that Nuremberg ($n=1,179$), Munich ($n=1,053$) and Cologne ($n=1,031$) had some of the highest numbers of melanoma searches/100,000 inhabitants. Cancer registry data on melanoma incidence (42–45) showed that the age-standardized incidences were comparatively high in Nuremberg and Cologne (Table II). Analysis revealed a high correlation between the data, which was stronger in men ($r=0.810$) than in women ($r=0.569$). Accordingly,

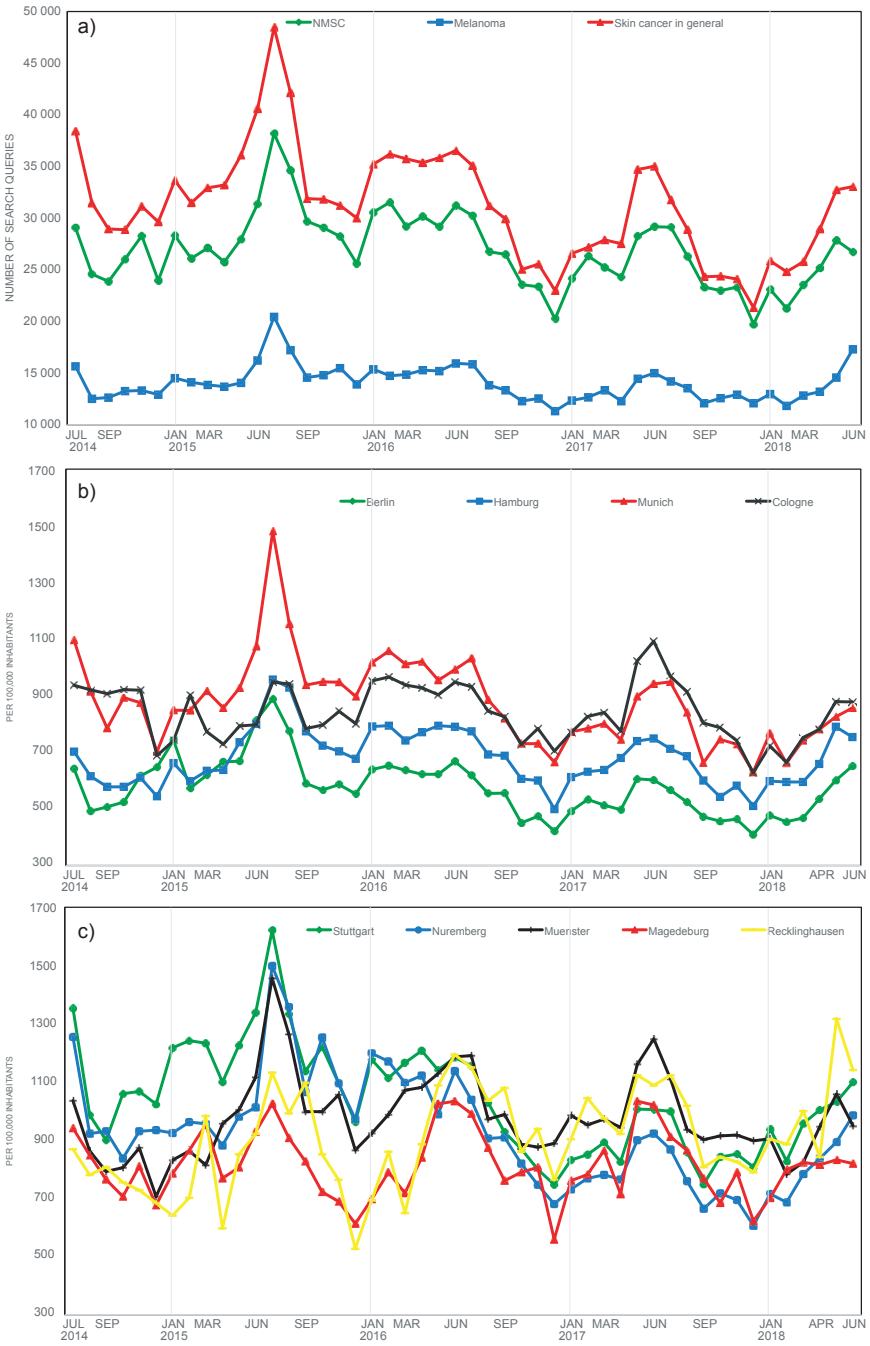

Fig. 3. Trends in Google search volume of skin cancer related terms from July 2014 to June 2018. (a) In 9 large German cities ($n = 9{,}729{,}149$ inhabitants). (b) In 4 German cities with more than 1 million inhabitants. (c) In 5 German cities with less than 1 million inhabitants.

this study confirms that the search volume somewhat represents cancer incidence rates, as previously shown by Wehner et al. in the US (38). This correlation might be due to the fact that the Internet is the most important source of media information for people affected by melanoma (37). Another study revealed that people with skin cancer who use the Internet for health-related information regarding their diagnosis were more likely to be younger, female and more-highly educated (48). Our analysis of Google searches, however, enables no conclusion as to users' age, sex, or education. It is possible that such associations between searching information and actually having skin cancer could be due to various demographics of the population sampled in the present study. Thus, it is possible that there is a clear correlation between search volume and registered incidence

(also in the context of NMSC), but this comparison is not feasible, as many registries exclude NMSC or are incomplete (42–45).

The results of the current study are consistent with previous studies showing a higher number of searches during the summer (30, 39). This could be due to the fact that diagnoses of NMSC and melanoma are more common in the late spring and early summer (49), which could influence an increase in search volume. In addition to these factors, search volume might be influenced by public health policies and media campaigns (50). For example, the peak search volume in July 2015 might have resulted from the recognition of NMSC as an occupational disease for outdoor workers in Germany during this time-frame (51, 52). Furthermore, the annual increase in search queries in May might be a result of the prevention campaign Euromelanoma, which uses various means of public communication (e.g. newspapers, radio) to promote skin cancer awareness and information (53).

Similar to a previous US study, the number of search queries observed in the present study remained relatively stable, with the exception of seasonal differences (39). However, these results are in contrast to a previous study from Germany, which revealed an increase in Google searches related to skin cancer between 2013 and 2017 (30). A possible explanation for these disparate findings could be that the prior study examined search volumes across the whole of Germany, while the current study focused on a smaller subset of the population. Thus, there could be differences in search behavior based on a variety of population factors (e.g. age, rural vs. urban residence, etc.). For example, outdoor workers (e.g. farmers) who have NMSC more frequently (23, 27, 54–56), and thus might have a greater interest in skin cancer, typically live in rural areas (and rural areas were not examined in the present study). Furthermore, the recognition of NMSC as an occupational disease of outdoor workers might have a large impact on the observed increases in Google searches, which were not extensively assessed in the present study.

Study limitations

Some limitations of this study should be noted. Even though 90% of the German population uses the Internet (34) and 95% of users rely on Google as a search engine (35), younger aged groups use the Internet more frequently. More than 90% of individuals aged 14–39 years use the Internet every day, while only 44% of people aged 60 years and older do so (34). Thus, we may have underestimated the specific terms searched by people with skin cancer, as older individuals are affected more frequently (2, 3, 10). Although no clear association between the percentage of non-native Germans and the number of search terms was found in this study, the study results might be somewhat influenced by this factor, as only German terms for skin cancer were considered. Another limitation is that only the search volumes within large German cities were examined; these could be different in rural areas that are more likely to have an undersupply of physicians (57) as well as a higher proportion of outdoor workers, who have a higher risk for NMSC (54). Furthermore, the correlation detected between the number of searches and melanoma incidence might be overestimated, as data for both were available only for the year 2014. Data on melanoma incidence further separates between men and women, while Google does not provide information on users' general demographics. A further limitation was that the monthly search volumes were based on estimates from a Google algorithm, with no further information. Thus, it is not possible to fully assess data precision. Finally, Google suggests an automatic completion of search terms, which might bias people's search behavior. Often-searched terms are possibly more easily searched, while less frequently searched terms are neglected.

Conclusion

The results of this study show a correlation between the number of searches and incidence of melanoma in large German metropolitan areas. Thus, Google search analyses are extremely useful for obtaining an overview of a population's interest in skin cancer. Since there was a high proportion of general searches, or searches that focused on the identification of skin cancers, the study indicates that, in all likelihood, in addition to people with a skin cancer diagnosis, many unaffected people might look for health-related information on the Internet before consulting a physician. Thus, there is great potential for improving people's awareness by offering comprehensive and reliable information via the Internet, for example through government-funded trustworthy information/websites about skin cancer. In general, it seems to be useful to monitor a potential increase in knowledge due to the Internet. Future studies might first examine people's baseline knowledge and then measure how people searched for information, which websites are frequently consulted, whether the received information is satisfactory, and whether knowledge is gained. The further analysis of different cities could enable the identification of regional variations; for example, regional undersupply of public health information. Given that there is a correlation between the number of search queries and the incidence of melanoma, future research could focus on regions with a low supply of physicians or a high proportion of outdoor workers to better analyze whether there are some areas with a specifically high need for receiving certain prevention campaigns.

ACKNOWLEDGEMENT

This work was supported by the German Research Foundation (DFG) and the Technical University of Munich within the funding programme Open Access Publishing.

REFERENCES

1. Apalla Z, Lallas A, Sotiriou E, Lazaridou E, Ioannides D. Epidemiological trends in skin cancer. Dermatol Pract Concept 2017; 7: 1–6.
2. Madan V, Lear JT, Szeimies R-M. Non-melanoma skin cancer. The Lancet 2010; 375: 673–685.
3. Diepgen TL, Mahler V. The epidemiology of skin cancer. Br J Dermatol 2002; 146 Suppl 61: 1–6.
4. Zink A. Trends in the treatment and prevention of keratinocyte carcinoma (non-melanoma skin cancer). Curr Opin Pharmacol 2019; 46: 19–23.
5. Augustin J, Kis A, Sorbe C, Schäfer I, Augustin M. Epidemiology of skin cancer in the German population: impact of socioeconomic and geographic factors. J Eur Acad Dermatol Venereol 2018; 32: 1906–1913.
6. Rudolph C, Schnoor M, Eisemann N, Katalinic A. Incidence trends of nonmelanoma skin cancer in Germany from 1998 to 2010. J Dtsch Dermatol Ges 2015; 13: 788–797.
7. Xiang F, Lucas R, Hales S, Neale R. Incidence of nonmelanoma skin cancer in relation to ambient UV radiation in white populations, 1978–2012: empirical relationships. JAMA Dermatol 2014; 150: 1063–1071.
8. Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. Br J Dermatol 2012; 166: 1069–1080.
9. Ziehfreund S, Schuster B, Zink A. Primary prevention of keratinocyte carcinoma among outdoor workers, the general population and medical professionals: a systematic review updated for 2019. J Eur Acad Dermatol Venereol 2019 Feb 23. [Epub ahead of print].
10. Miller AJ, Mihm MC, JR. Melanoma. N Engl J Med 2006; 355: 51–65.
11. Lewis KG, Weinstock MA. Nonmelanoma skin cancer mortality (1988–2000): the Rhode Island follow-back study. Arch Dermatol 2004; 140: 837–842.
12. Pil L, Hoorens I, Vossaert K, Kruse V, Tromme I, Speybroeck N, et al. Burden of skin cancer in Belgium and cost-effectiveness of primary prevention by reducing ultraviolet exposure. Prev Med 2016; 93: 177–182.
13. Guy GP, Machlin SR, Ekwueme DU, Yabroff KR. Prevalence and costs of skin cancer treatment in the U.S., 2002–2006 and 2007–2011. Am J Prev Med 2015; 48: 183–187.
14. Stang A, Stausberg J, Boedeker W, Kerek-Bodden H, Jöckel K-H. Nationwide hospitalization costs of skin melanoma and non-melanoma skin cancer in Germany. J Eur Acad Dermatol Venereol 2008; 22: 65–72.
15. Watson M, Thomas CC, Massetti GM, McKenna S, Gershenwald JE, Laird S, et al. CDC Grand Rounds: Prevention and Control of Skin Cancer. MMWR Morb Mortal Wkly Rep 2015; 64: 1312–1314.
16. Kelati A, Baybay H, Atassi M, Elfakir S, Gallouj S, Meziane M, et al. Skin cancer knowledge and attitudes in the region of Fez, Morocco: a cross-sectional study. BMC Dermatol 2017; 17: 2.
17. Gordon LG, Scuffham PA, van der Pols JC, McBride P, Williams GM, Green AC. Regular sunscreen use is a cost-effective approach to skin cancer prevention in subtropical settings. J Invest Dermatol 2009; 129: 2766–2771.
18. John SM, Trakatelli M, Gehring R, Finlay K, Fionda C, Wittlich M, et al. CONSENSUS REPORT: recognizing non-melanoma skin cancer, including actinic keratosis, as an occupational disease – a call to action. J Eur Acad Dermatol Venereol 2016; 30 Suppl 3: 38–45.
19. Diepgen TL, Fartasch M, Drexler H, Schmitt J. Occupational skin cancer induced by ultraviolet radiation and its prevention. Br J Dermatol 2012; 167 Suppl 2: 76–84.
20. Henrikson NB, Morrison CC, Blasi PR, Nguyen M, Shibuya KC, Patnode CD. Behavioral counseling for skin cancer prevention: evidence report and systematic review for the US Preventive Services Task Force. JAMA 2018; 319: 1143–1157.
21. Anastasiadou Z, Schäfer I, Siebert J, Günther W, Reusch M, Augustin M. Participation and health care provision of statutory skin cancer screening in Germany – a secondary data analysis. J Eur Acad Dermatol Venereol 2016; 30: 424–427.
22. Gavin A, Boyle R, Donnelly D, Donnelly C, Gordon S, McElwee G, et al. Trends in skin cancer knowledge, sun protection practices and behaviours in the Northern Ireland population. Eur J Public Health 2012; 22: 408–412.
23. Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A. Skin diseases are more common than we think: screening results of an unreferred population at the Munich Oktoberfest. J Eur Acad Dermatol Venereol 2019 Mar 19. [Epub ahead of print].
24. 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.
25. Zink A, Wurstbauer D, Rotter M, Wildner M, Biedermann T. Do outdoor workers know their risk of NMSC? Perceptions, beliefs and preventive behaviour among farmers, roofers and gardeners. J Eur Acad Dermatol Venereol 2017; 31: 1649–1654.
26. Zink A, Schielein M, Wildner M, Rehfuess EA. "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. Br J Dermatol 2019 Mar 12. [Epub ahead of print].
27. Tizek L, Krause J, Biedermann T, Zink A. Satisfaction of mountain guides with high sun protection as a tool to prevent non-melanoma skin cancer. J Eur Acad Dermatol Venereol 2017; 31: 1825–1827.
28. Seth D, Gittleman H, Barnholtz-Sloan J, Bordeaux JS. Association of socioeconomic and geographic factors with Google trends for tanning and sunscreen. Dermatol Surg 2018; 44: 236–240.
29. Beck F, Richard J-B, Nguyen-Thanh V, Montagni I, Parizot I, Renahy E. Use of the internet as a health information resource among French young adults: results from a nationally representative survey. J Med Internet Res 2014; 16: e128.
30. Seidl S, Schuster B, Rüth M, Biedermann T, Zink A. What do Germans want to know about skin cancer? A nationwide Google search analysis from 2013 to 2017. J Med Internet Res 2018; 20: e10327.
31. Amante DJ, Hogan TP, Pagoto SL, English TM, Lapane KL. Access to care and use of the Internet to search for health information: results from the US National Health Interview Survey. J Med Internet Res 2015; 17: e106.
32. Zink A, Rüth M, Schuster B, Darsow U, Biedermann T, Ständer S. Pruritus in Deutschland – eine Google-Suchmaschinenanalyse. Hautarzt 2019; 70: 21–28.
33. Zink A, Schuster B, Rüth M, Pereira MP, Philipp-Dormston WG, Biedermann T, et al. Medical needs and major complaints related to pruritus in Germany: a 4-year retrospective analysis using Google AdWords Keyword Planner. J Eur Acad Dermatol Venereol 2019; 33: 151–156.
34. Koch W, Frees B. ARD/ZDF-Onlinestudie 2017: Neun von zehn Deutschen online [cited 2018 Jul 5]. Available from: http://www.ard-zdf-onlinestudie.de/files/2017/Artikel/917_Koch_Frees.pdf.
35. Statista. Search engine [cited 2018 Jul 6]. Available from: https://de.statista.com/themen/111/suchmaschinen/.
36. European Commission. European citizens' digital health literacy: report. Brussels: European Commission; 2014.
37. Brütting J, Bergmann M, Meier F. Informations- und Hilfsangebote: Empfehlungen von Ärzten und Nutzung durch Melanom-Patienten; 2017 [cited 2019 Mar 20]. Available from: https://www.egms.de/static/de/meetings/dkvf2017/17dkvf338.shtml.
38. Wehner MR, Nead KT, Linos E. Correlation among cancer

incidence and mortality rates and internet searches in the United States. JAMA Dermatol 2017; 153: 911–914.
39. Bloom R, Amber KT, Hu S, Kirsner R. Google search trends and skin cancer: evaluating the us population's interest in skin cancer and its association with melanoma outcomes. JAMA Dermatol 2015; 151: 903–905.
40. Google AdWords. Reach the right customers with the right keywords [cited 2018 Jul 5]. Available from: https://adwords.google.com/intl/en/home/tools/keyword-planner/.
41. Statista. Germany's largest cities [cited 2018 Jul 20]. Available from: https://de.statista.com/statistik/daten/studie/1353/umfrage/einwohnerzahlen-der-grossstaedte-deutschlands/.
42. Cancer Registry Bavaria. All neoplasms [cited 2019 Mar 20]. Available from: http://www.krebsregister-bayern.de/lgl_abfrage_d.php.
43. Cancer Registry North Rhine-Westphalia. All neoplasms [cited 2019 Mar 20]. Available from: http://www.krebsregister.nrw.de/index.php?id=146.
44. Common Cancer Registry of the Federal States Berlin, Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt and the Free States Saxony and Thuringia. GKR-Krebsatlas; 2018 [cited 2019 Mar 20]. Available from: https://www.gemeinsames-krebsregister.de/atlas/atlas.html.
45. Association of Population Based Cancer Registries in Germany. GEKID-Atlas [cited 2019 Mar 20]. Available from: https://atlas.gekid.de/CurrentVersion/atlas.html.
46. Federal Agency for Cartography and Geodesy (BKG). Administrative areas [cited 2018 Jul 7]. Available from: http://www.geodatenzentrum.de/geodaten/gdz_rahmen.gdz_div?gdz_spr=deu&gdz_akt_zeile=5&gdz_anz_zeile=1&gdz_unt_zeile=0&gdz_user_id=0.
47. Tizek L, Schielein M, Rüth M, Ständer S, Pereira MP, Eberlein B, et al. Influence of climate on geographic pruritus internet searches: a retrospective analysis of Google searches in 16 German cities; 2019 [cited 2019 Mar 20]. Available from: https://preprints.jmir.org/preprint/13739.
48. Ludgate MW, Sabel MS, Fullen DR, Frohm ML, Lee JS, Couper MP, et al. Internet use and anxiety in people with melanoma and nonmelanoma skin cancer. Dermatol Surg 2011; 37: 1252–1259.
49. Quatresooz P, Piérard-Franchimont C, Piérard GE. Space-time clustering and seasonality in diagnosing skin cancers in Wallonia (south-east Belgium). Dermatology (Basel) 2008; 217: 48–51.
50. Garside R, Pearson M, Moxham T. What influences the uptake of information to prevent skin cancer? A systematic review and synthesis of qualitative research. Health Educ Res 2010; 25: 162–182.
51. Diepgen TL. New developments in occupational dermatology. J Dtsch Dermatol Ges 2016; 14: 875–889.
52. Hommel T, Szeimies R-M. Aktinische Keratosen. Hautarzt 2016; 67: 867–875.
53. Stratigos AJ, Forsea AM, van der Leest RJT, Vries E de, Nagore E, Bulliard J-L, et al. Euromelanoma: a dermatology-led European campaign against nonmelanoma skin cancer and cutaneous melanoma. Past, present and future. Br J Dermatol 2012; 167 Suppl 2: 99–104.
54. Zink A, Tizek L, Schielein M, Böhner A, Biedermann T, Wildner M. Different outdoor professions have different risks – a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. J Eur Acad Dermatol Venereol 2018; 32: 1695–1701.
55. Zink A, Hänsel I, Rotter M, Spinner CD, Böhner A, Biedermann T. Impact of gliding on the prevalence of keratinocyte carcinoma and its precursors: a cross-sectional study among male pilots in Bavaria. Acta Derm Venereol 2017; 97: 393–394.
56. Zink A, Koch E, Seifert F, Rotter M, Spinner CD, Biedermann T. Nonmelanoma skin cancer in mountain guides: high prevalence and lack of awareness warrant development of evidence-based prevention tools. Swiss Med Wkly 2016; 146: w14380.
57. Kis A, Augustin M, Augustin J. Regional healthcare delivery and demographic change in Germany – scenarios for dermatological care in 2035. J Dtsch Dermatol Ges 2017; 15: 1199–1209.
58. Statistisches Bundesamt. Migration. Integration. Regionen: Ausländeranteil; 2018 [cited 2018 Dec 13]. Available from: https://service.destatis.de/DE/karten/migration_integration_regionen.html.

Publication II: Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap

Tizek L, Schielein MC, Berger U, Seifert F, Biedermann T, Böhner A et al. Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap. Eur J Dermatol 2020.

European Journal of Dermatology

InCites Journal Citation Reports 2019

Impact factor: 2.782 Ranking: 23/68 (Dermatology)

Eur J Dermatol 2020; xx(x): 1-8

Linda TIZEK[1, 2]
Maximilian C. SCHIELEIN[1, 2]
Ursula BERGER[2]
Florian SEIFERT[3]
Tilo BIEDERMANN[1]
Alexander BÖHNER[1]
Alexander ZINK[1]

[1] Technical University of Munich, School of Medicine, Department of Dermatology and Allergy, Biedersteinerstr. 29, 80802 Munich, [2] Ludwig-Maximilians University Munich, Institute for Medical Information Processing, Biometry and Epidemiology (IBE), Marchioninistr. 15, 81377 Munich, [3] Hautärzte Oberland, Tegernseerstr. 3, 83703 Gmund, Germany

Reprints: Alexander Zink <alexander.zink@tum.de>

Article accepted on 21/12/2019

Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap

Background: The management of keratinocyte carcinoma (KC) and actinic keratosis (AK) as well as the number of dermatologists differ across the Bavarian counties in Germany. *Objectives:* To determine regions with low utilization rates of dermatological care and a high medical need due to AK and KC burden. *Materials and methods:* A cross-sectional study of 2,483 people was carried out during the Munich Oktoberfest in September 2016. Participants from urban, semi-urban and rural areas completed a questionnaire and received a medical examination on site by dermatologists. *Results:* The rate of previous skin cancer screening and previous treatment by dermatologists ranged from 18.8% to 58.6% and from 34.3% to 75.4% for all regions, respectively. Over 60% of people living in the environs or rural areas would consult a dermatologist first if they found a visible skin condition. Thus, people living in urban areas were twice as likely as people living in rural areas to consult a dermatologist first (odds ratio = 2.16; 95% CI: 1.38-3.39). Comparing the three different locations, dermatologists detected the highest AK burden among people living in rural areas (27.3% of the participants) and the highest KC burden among people living in urban areas (3.4% of the participants). *Conclusion:* In rural areas, a high AK burden coupled with a low utilization rate of dermatological care was observed. To effectively address these problems, a broader implementation of alternative medical resources, such as teledermatology, might improve access to health care.

Key words: keratinocyte carcinoma, actinic keratosis, dermatologists, Bavaria, Germany, care, burden, urban, rural

Keratinocyte carcinomas (KC), including basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), are the most common types of cancer worldwide, and the incidence of KC has continued to increase over many years [1-4]. In Germany, the mean age-standardized KC prevalence was 1,708.2 ± 398.0 per 100,000 individuals in 2015, which represents an increase of 52.0% compared with that in 2009 [5]. The prevalence of actinic keratosis (AK), which is a precursor of SCC, is higher, and ranges from <1% to >60% depending on, for example, age, gender, or profession [5-9]. Outdoor workers who experience high levels of occupational sun exposure are at an increased risk of developing AK and KC [10-13]. Although primary or secondary prevention measures can reduce the burdens [4, 14], problems exist regarding their implementation [15, 16]. For example, the usage of preventative measures, including the use of sunscreen, is not very common among outdoor workers [17-19]. Moreover, in relation to problems associated with health care utilization, regional variations exist between urban and rural areas regarding physician-patient ratios and the availability of dermatological services [20, 21]. While access to primary care is similar in urban and rural areas of Germany [22-24], people living in urban areas are more likely to consult specialists [20, 25]. The Bavarian Association of Panel Doctors (KVB) is responsible for the needs-based contractual medical care based on statutory health insurance by the state of Bavaria in southern Germany [26]. Bavaria comprises 79 planning areas in which the number of dermatologists is determined based on physician-patient ratio. However, considerable differences exist regarding the number of dermatologists across Bavaria, and there are areas with an excessive number of dermatologists (≥110%), for example, Miesbach county (251.2%), and areas where there are extreme shortages (<110%), for example, Weiden/Neustadt an der Waldnaab county (58.4%) [26].

Describing and analysing regional variations is important for detecting differences in the burden of skin cancer and for the implementation of suitable treatment that complies with the guidelines [27]. As KC and AK are not reported in cancer registries [4, 28], and the KVB data do not indicate that urban areas of Bavaria have more dermatologists than the environs or rural areas in general [26], this study aimed to determine the level of awareness of KC and AK among and the medical needs of an unreferred population living in different areas of Bavaria, based on a skin cancer screening and questionnaire that was completed at the unconventional setting of the Munich Oktoberfest.

doi:10.1684/ejd.2020.3752

To cite this article: Tizek L, Schielein MC, Berger U, Seifert F, Biedermann T, Böhner A, Zink A. Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap. *Eur J Dermatol* 2020; xx(x): 1-8 doi:10.1684/ejd.2020.3752

Methods

Study population

From 17 to 25 September 2016, a cross-sectional study was performed during the "Bavarian Central Agricultural Festival" (Bayerisches Zentral-Landwirtschaftsfest [ZLF]) [29]. The ZLF takes place every four years as part of the Munich Oktoberfest. It is one of the largest trade fairs in Germany. Around 300,000 people from across Germany attend the festival, especially those from Bavaria. In conjunction with the German "Social Insurance for the Agricultural Profession" (Sozialversicherung für Landwirtschaft, Forsten und Gartenbau), all visitors were offered free health examinations (*e.g.* skin cancer screening, hearing test) [29, 30].

All participants completed a self-administered, paper-based, 23-item questionnaire, with the study team being available for assistance. Whenever possible, questions were based on validated questionnaires [13, 17, 18]. The questions assessed sociodemographic characteristics, overall health awareness and whether participants had a skin disease such as atopic dermatitis, psoriasis, skin cancer, or urticaria. With regards to the health services utilized, the participants were asked if they had undergone skin cancer screening previously or if they had ever been to a dermatologist. Participants were also asked whether they would initially consult a general practitioner (GP), dermatologist, or other (*e.g.* pharmacist) if they had a visible skin condition. The postal codes reported were used to identify the areas in which the participants lived. When examining regional differences, only areas within the state of Bavaria were considered, because the vast majority of the participants lived in Bavaria. Areas ($n = 35$) in which at least 30 of the participants lived were eligible for further analyses to determine regional differences. To assess whether differences exist regarding health care utilization across Bavaria, all of the Bavarian areas analysed were categorized into three types: (1) urban areas (cities with at least 100,000 inhabitants); (2) environs (urban areas with at least 50% of the inhabitants living in medium-sized towns [20,000-99,999 inhabitants] or areas with at least 150 inhabitants/km^2); and (3) rural areas (sparsely populated rural areas with less than 50% of the inhabitants living in medium-sized towns or less than 100 inhabitants/km^2). The categories were chosen in accordance with the criteria from the German Federal Institute for Research on Building, Urban Affairs and Spatial Development and from a previous study [20, 31]. Data on the number of dermatologists in each area was obtained from the KVB [26].

After completing the questionnaire, (volunteering) participants attended a skin examination by three trained dermatologists on-site using a dermatoscope in separate examination cabins. As AK and KC mainly occur on sun-exposed areas, the screening focused on these areas, such as the head, and took around ten minutes. For participants who indicated that they had a conspicuous skin condition elsewhere, the whole body was inspected, which extended the examination time. All findings were carefully recorded on a documentation form and the affected participants received written recommendations for medical treatment from a local dermatologist.

The study was approved by the ethics committee at the Medical Faculty of the Technical University of Munich (Reference 385/16 s). All individuals provided written informed consent prior to study participation and had to be $\geq$18 years old to participate in the study.

Statistical analyses

Descriptive data were generated for all variables. To examine differences within the study population, one-way analysis of variance (ANOVA) was applied for continuous variables and the Pearson's chi-squared test was used to evaluate the categorical variables. The proportion of people who had undergone skin cancer screening previously, the proportion of people who would initially consult a GP or a dermatologist, and the burden of AK and KC were estimated for each area that had at least 30 participants and 95% - Bootstrap confidence intervals (CI) were calculated (1,000 samples).

Univariate and multiple mixed effects logistic regression modelling using type of area as random effect were applied to assess the factors that influence people's decisions whether to consult a dermatologist first in the event of a conspicuous skin condition. In this analysis, age, gender, the type of profession (outdoor or indoor), the area type (urban, environs, or rural), previous knowledge about skin cancer, a medical history of skin cancer, previous skin cancer screening, previous treatment by a dermatologist, a participant's self-disclosure about being affected by a skin disease at study examination, and the number of dermatologists in the area ($<$110% or $\geq$110%) were selected as explanatory variables. These variables were chosen on the basis of the literature and logical amendment [20, 25, 32]. Significant factors were selected in backward selection and adjusted odds ratios (ORs) were calculated together with 95% CIs. Additional fixed-effects logit models were used to investigate associations with the occurrence of AK and KC, respectively, using the same risk factors as before.

Epi Info™ (Centers for Disease Control and Prevention, Atlanta, USA) was used for data digitalization. All data were entered twice and were subsequently assessed for discrepancies. If discrepancies existed, the source data were accessed and amended as necessary. The corrected data were imported into IBM®SPSS® Statistics 24 (IBM Corporation, Armonk, NY, USA) and R (R Studio Inc., Boston, MA, USA) for data management and statistical analyses. Spatial analyses were performed using a geographic information system (QGIS 2.14.22; QGIS.ORG, Grüt, Switzerland) and geodata from the German Federal Agency for Cartography and Geodesy [33] which describe the administrative boundaries. The analyses were performed using the data available.

Results

Based on their postal codes, the participants lived in 145 areas across Germany (*supplementary figure 1*). This study included 2,483 individuals living in Bavaria (54.7% females) with a mean age of 51.8 $\pm$ 15.2 years (range: 18-90 years). The participants lived in 89 of the 96 Bavarian areas, with most of the people living in the environs (65.1%). No significant differences were evident regarding age or gender within the area types. However, the proportion of outdoor

Table 1. Comparison of selected characteristics of people living in urban areas, the environs or rural areas within Bavaria ($n = 2,483$).

	Total ($n = 2,483$)	Urban areas[a] ($n = 152$)	Environs[b] ($n = 1,617$)	Rural areas[c] ($n = 714$)
Age				
Mean age ± SD	51.8 ± 15.2	49.6 ± 16.6	51.9 ± 15.4	52.1 ± 14.7, $p = 0.255$[d]
Gender				
Female	1,358 (54.7%)	93 (61.2%)	892 (55.2%)	373 (52.2%), $p = 0.190$[e]
Male	1,125 (45.3%)	59 (38.8%)	725 (44.8%)	341 (47.8%)
Profession				
Farmer	1,346 (54.2%)	7 (4.6%)	918 (56.8%)	421 (59.0%), $p < 0.001$[e]
Other type of outdoor	156 (6.3%)	7 (4.6%)	105 (6.5%)	44 (6.2%)
worker	910 (36.6%)	125 (82.2%)	551 (34.1%)	234 (32.8%)
Indoor worker	71 (2.9%)	13 (8.6%)	43 (2.7%)	15 (2.1%)
Not reported				
Hours spent outside per working day				
Summer:	5.9 ± 3.6	3.7 ± 3.3	5.9 ± 3.5	6.4 ± 3.6, $p < 0.001$[d]
mean ± SD	3.8 ± 2.9	2.2 ± 2.2	3.8 ± 2.9	4.1 ± 2.9, $p < 0.001$[d]
Winter:				
mean ± SD				
Previous skin cancer screening				
No	1,441 (58.0%)	74 (48.7%)	919 (56.8%)	448 (62.7%), $p = 0.001$[e]
Yes	997 (40.2%)	75 (49.3%)	666 (41.2%)	256 (35.9%)
Not reported	45 (1.8%)	3 (2.0%)	32 (2.0%)	10 (1.4%)
Previous treatment by a dermatologist				
No	1,055 (42.5%)	50 (32.9%)	673 (41.6%)	332 (46.5%), $p = 0.005$[e]
Yes	1,373 (55.3%)	99 (65.1%)	907 (56.1%)	367 (51.4%)
Not reported	55 (2.2%)	3 (2.0%)	37 (2.3%)	15 (2.1%)
Choice of initial contact if participant had a visible skin condition				
GP	1,507 (60.7%)	60 (39.5%)	979 (60.5%)	468 (65.5%), $p < 0.001$[e]
Dermatologist	767 (30.9%)	79 (52.0%)	495 (30.6%)	193 (27.0%)
Other	55 (2.2%)	4 (2.6%)	36 (2.2%)	15 (2.1%)
Not reported	154 (6.2%)	9 (5.9%)	107 (6.6%)	38 (5.3%)
Participant's self-disclosure about a skin disease at the time of the study				
No	2,004 (80.7%)	124 (81.6%)	1,297 (80.2%)	583 (81.7%), $p = 0.697$[e]
Yes	384 (15.5%)	22 (14.5%)	259 (16.0%)	103 (14.4%)
Not reported	95 (3.8%)	6 (3.9%)	61 (3.8%)	28 (3.9%)

SD: standard deviation
[a] *Cities with at least 100,000 inhabitants*
[b] *Urban areas and rural areas with signs of agglomeration*
[c] *Sparsely populated rural area*
[d] *p value (ANOVA) based on comparison between urban areas, the environs and rural areas*
[e] *p value (Chi^2-test) based on comparison between urban areas, the environs and rural areas*

workers was significantly higher in the environs (56.8%) and rural areas (59.0%) (*table 1*).

Regional comparisons regarding health care utilization

The overall participation rate in prior skin cancer screening was 40.2%, which was slightly higher among females (42.2%) than males (37.7%). The skin cancer screening utilization rates varied according to region, and ranged from 58.6% (Bootstrap 95% CI: 41.4-75.9) in the environ Dingolfing-Landau to 18.8% (Bootstrap 95% CI: 8.3-31.3) in the environ Unterallgäu (*Figure 1A and supplementary table 1*).

The proportion of people with a previous treatment by a dermatologist ranged from 34.4% (Bootstrap 95% CI: 20.0-48.6) in the rural area Straubing-Bogen to 75.4% (Bootstrap 95% CI: 64.9-86.0) in the environ Ebersberg (*figure 1B*). Over 60.0% of the participants from the environs and rural areas responded that they would seek medical assistance from a GP first if they had a visible skin condition. In the environ Dingolfing-Landau, even more than 80% would consult a GP first (*supplementary table 1*). People living in urban areas were twice as likely as people living in rural areas to consult a dermatologist first (OR = 2.16, 95% CI: 1.38-3.39). In general, people with a medical history of skin cancer were most likely to consult a dermatologist first (OR = 3.84, 95% CI: 2.41-6.27), whereas males were least likely (OR = 0.60, 95% CI: 0.48-0.74) (*table 2*).

A total of 15.5% of the participants responded to be affected by a skin disease at the time of the study (*table 1*).

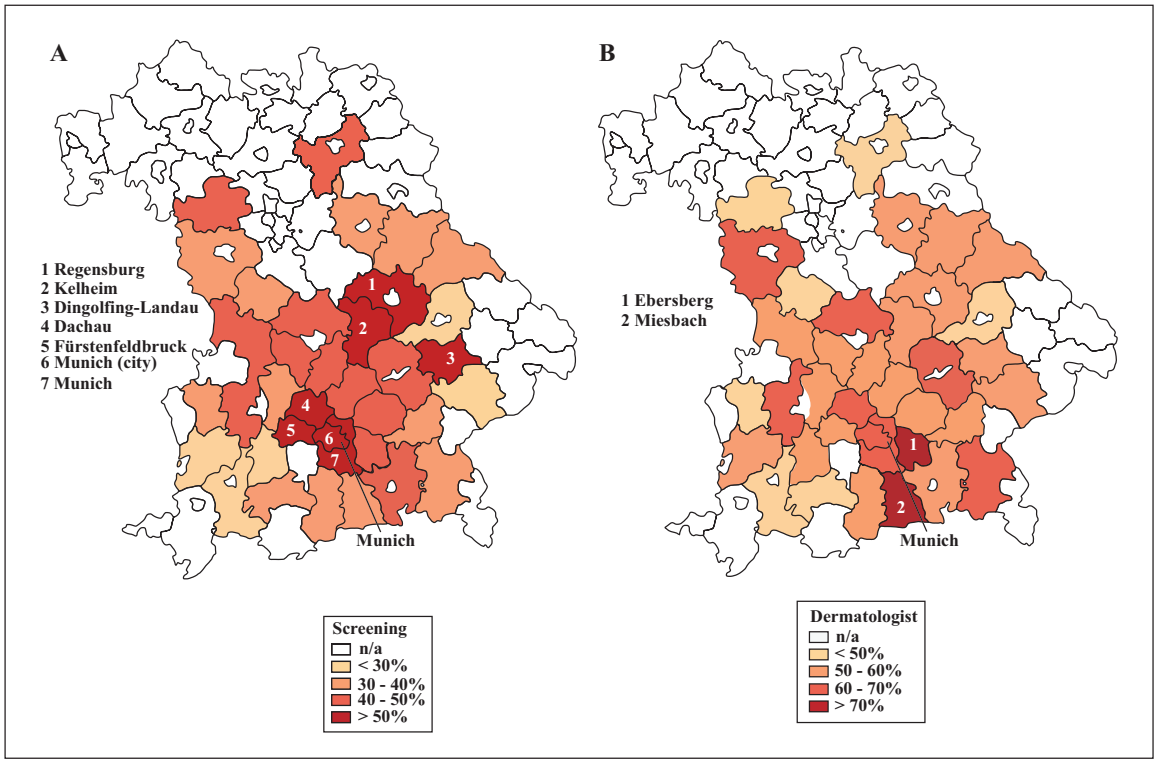

Figure 1. Percentage of people with previous skin cancer screening (**A**) and previous treatment by a dermatologist (**B**) according to areas in which at least 30 of the study participants lived ($n = 35$).

Table 2. Factors related to the decision to directly consult a dermatologist for a conspicuous skin condition (results based on univariate and multiple mixed logistic regression).

Variable	Univariate		Multiple	
	OR	**95% CI**	**OR[a]**	**95% CI**
Age	1.00	0.99 - 1.00	-	-
Gender (reference: female)	0.50	0.42 - 0.60	0.60	0.48 - 0.74
Profession (reference: indoor)	0.46	0.38 - 0.55	0.63	0.50 - 0.79
Area type (reference: rural) **Urban** **Environs**	 3.09 1.22	 2.14 - 4.48 1.01 - 1.49	 2.16 1.05	 1.38 - 3.40 0.83 - 1.31
Knowledge about KC or AK	1.97	1.64 - 2.38	1.25	1.01 - 1.56
Medical history of skin cancer	6.39	4.29 - 9.72	3.84	2.41 - 6.27
Previous skin cancer screening	2.90	2.42 - 3.47	1.84	1.48 - 2.29
Previous treatment by a dermatologist	4.15	3.41 - 5.08	2.66	2.13 - 3.35
Self-disclosure about a skin disease at study examination	1.89	1.50 - 2.37	1.37	1.05 - 1.78
Number of dermatologists (reference: <110%)	1.20	0.91 - 1.57	-	-

OR: Odds ratio; CI: confidence interval. Significant results are presented in bold
[a] *Age and the number of dermatologists in the area (<110% or ≥110%) were not selected as significant factors based on the backward selection algorithm*

Clinical examination

Overall, 2,368 individuals (95.4%) also underwent skin cancer screening on-site, with no significant differences in mean age or proportion of females between participants and non-participants. Dermatologists diagnosed AK in 25.5% of the participants (21.5% from urban areas, 27.2% from the environs, and 27.3% from rural areas). The highest AK burden was observed among people from the environ Munich (43.6%; Bootstrap 95% CI: 30.9-56.4) and the

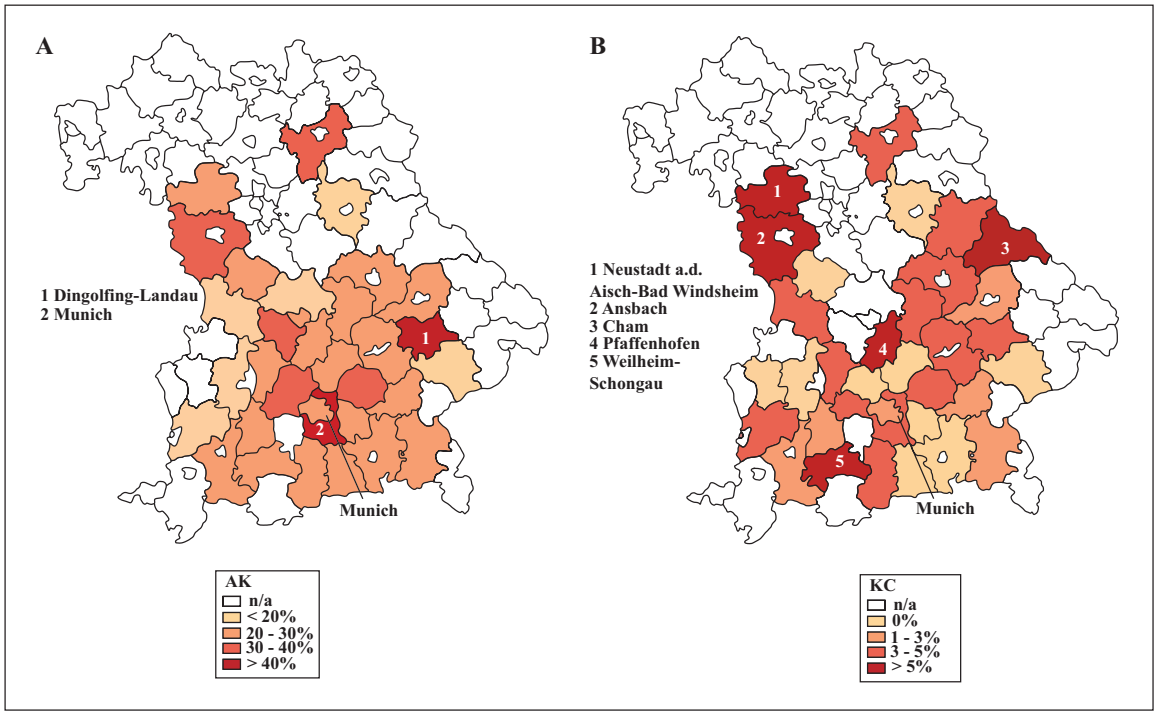

Figure 2. Burden of actinic keratosis (**A**) and keratinocyte carcinoma (**B**) in Bavarian areas in which at least 30 of the study participants lived ($n = 35$).

rural area Haßberge (44.4%; Bootstrap 95% CI: 22.2-66.7) (*figure 2A, supplementary table 1*). Being male (OR = 3.86, 95% CI: 3.07-4.84), having a medical history of skin cancer (OR = 4.70, 95% CI: 2.94-7.53), and older age (OR = 1.10, 95% CI: 1.09-1.10) were associated with a higher risk of AK (*table 3*).

In total, KC was diagnosed in 2.7% of participants (3.4% from urban areas, 2.9% from the environs, and 2.5% from rural areas). The highest KC burden was observed in the rural area Cham (6.3%; Bootstrap 95% CI: 0.0-15.6), followed by the rural area Ansbach (5.6%; Bootstrap 95% CI: 0.0-13.9) (*figure 2B, and supplementary table 1*). Like AK, a higher risk was associated with male gender (OR = 2.04, 95% CI: 1.19-3.51) or older age (OR = 1.06, 95% CI: 1.03-1.08) (*table 3*).

Discussion

This study compared the utilization of dermatological care and needs associated with skin diseases across areas of Bavaria. Nearly two thirds of people living in rural areas would consult a GP first. At the same time, AK burden was detected to be highest in rural areas.

Considerable regional differences were apparent regarding the utilization rates of skin cancer screening, with lowest rates observed among people living in rural areas. The different rates might be associated with differences in the number of dermatologists across the areas [26, 32]. Previous findings showed that 80% of people who had undergone prior skin cancer screening had been assessed by a dermatologist during their last examination [34]; a lower number of dermatologists might make it more unlikely for people to attend these health examinations. Another explanation for a lower participation rate in rural areas might be due to a high proportion of outdoor workers, who were shown to have a low utilization rate of skin cancer screening [12, 17, 18].

Furthermore, people living in urban areas are more likely to seek specialist medical assistance [20, 25]. Similarly, we found that people living in urban areas were twice as likely as people living in the environs to consult a specialist initially. Yet, over three quarters of the participants in some of the areas indicated that they would visit a GP first if they had a visible skin condition. In another study, younger people and females were more likely to consult a specialist [25]. Although this study's findings did not reveal an association with the number of dermatologists, it was assumed that visits to dermatologists were somewhat related. In "Lower Bavaria", in particular, some regions have shortages of dermatologists [26], and it is anticipated that the number will continue to deteriorate [32]. Thus, it might be important to consider alternative means of healthcare delivery and to identify people's specific medical needs using, for example, telemedicine or internet search analyses [4, 32, 35]. Teledermatology could help to lower the barrier associated with long distances, however, people seemed unaware of the benefits as only 32.3% of people living in rural areas were willing to use teledermatology [36]. Accordingly, to improve health care access in rural areas, not only in Bavaria but also across Germany, broader implementation is needed.

In line with other studies, older people and males had a higher risk of AK [5-9]. The univariate analysis indicated that the AK burden is higher in the environs and rural areas, which might be due to a high proportion of outdoor workers in this study [12, 16]. Although we did not find a significant

Table 3. Factors associated with the occurrence of AK and KC (based on fixed-effects logit regression).

Variable	AK				KC			
	Univariate		Multiple		Univariate		Multiple	
	OR	95% CI	OR[a]	95% CI	OR	95% CI	OR[a]	95% CI
Age	**1.10**	**1.09-1.10**	**1.09**	**1.08-1.10**	**1.07**	**1.05-1.09**	**1.06**	**1.03 - 1.08**
Gender (reference: female)	**4.22**	**3.47-5.15**	**3.70**	**2.95-4.65**	**2.36**	**1.43-4.00**	**1.91**	**1.12 - 3.34**
Profession (reference: indoor)	**2.40**	**1.95-2.98**	-	-	**1.81**	**1.04-3.31**	-	-
Area type (reference: rural)								
Urban	0.68	0.44-1.05	-	- -	**1.38**	**0.45-3.54**	-	- -
Environs	0.99	0.81-1.22	-		**1.18**	**0.68-2.13**	-	
Knowledge about KC or AK	1.14	0.95-1.38	-	-	**1.51**	**0.90-2.63**	-	-
Medical history of skin cancer	**6.99**	**4.70-10.58**	**4.39**	**2.77-7.09**	**3.62**	**1.70-7.01**	-	-
Previous skin cancer screening	**1.32**	**1.10-1.59**	-	-	**1.74**	**1.06-2.87**	-	-
Previous treatment by a dermatologist	1.16	0.96-1.40	-	-	**1.22**	**0.74-2.06**	-	-
Self-disclosure about a skin disease at study examination	1.12	0.87-1.44	-	-	**0.86**	**0.39-1.67**	-	-
Number of dermatologists (reference <110%)	0.88	0.67-1.16	-	-	**0.98**	**0.49-2.25**	-	-

OR: odds ratio, CI: confidence interval. Significant results are presented in bold

[a] *Profession, area type, knowledge about KC or AK, previous skin cancer screening, previous treatment by a dermatologist, self-disclosure about presence of a skin disease, and the number of dermatologists in the area (<110% or ≥110%) were not selected as significant factors based on the backward selection algorithm*

association between KC burden and area types, the univariate analysis indicated a higher burden among people living in urban areas. This finding concurs with the results from a previous study that was based on the prevalence of KC according to treatment, and showed that the prevalence was higher in urban regions in general [21]. In one study, the Bavarian areas of Ansbach, Erding, Günzburg, and Berchtesgardener Land had considerably higher rates of KC than expected [5]. Despite a small number of study participants living in various areas, our real-world data show some similarities with these secondary data since a higher burden was detected among people living in Ansbach and Erding.

There are some study limitations. The study was performed at the ZLF, hence, there was a potential for a selection bias. In general, older, sick, and disabled people might have been less likely to visit the festival. The ZLF participants' mean age was slightly higher compared to that of the general population (urban: 49.6 vs. 41.8 years; environs: 51.9 vs. 43.3 years; rural: 52.1 vs. 44.3 years, relative to the general population [37]) because people had to be ≥18 years to participate in the study. Moreover, people who had higher levels of health awareness or females might have been more likely to participate in the study. This might explain the higher proportion of female participants compared to that in the general population (urban: 61.2% vs. 48.8%; environs: 55.2% vs. 50.0%; rural: 52.2% vs. 49.8%, relative to the general population [37]). Although participants had unlimited time to complete the questionnaire, a bias due to individuals' recall, response or desire to complete the questionnaire was possible as we used a self-administered questionnaire. To analyse the differences among the Bavarian areas, all areas with at least 30 participants were considered. The low numbers of people in some areas might have led to under- or over-estimation of the respondents' actual health behaviour and disease burden. Due to the specific study population, study results might be limited in their representation of the whole Bavarian population, however, the mixed models used could help to identify associated factors. As there were also considerable differences in the number of participants from the areas, Bootstrap 95% CI was calculated to partly address this problem. Moreover, given that the participants who were considered to have AK and KC did not undergo histological confirmation of their diagnoses, the AK and KC rates may have been further overestimated.

Conclusion

Despite these limitations, this large study population that comprised 2,483 people from 89 Bavarian areas has provided a comprehensive insight into regional differences in healthcare utilization and medical needs associated with skin cancer. Given that a higher AK burden was consistently found in rural areas, the study's findings emphasize the importance of improving access to health services and people's knowledge to ensure that they can benefit from early detection and treatment. To improve people's knowledge, it would be useful to investigate medical care requirements. Thus, it might be important to consider alternative means of healthcare delivery and to identify specific medical needs using, for example, telemedicine or internet search analyses, to address the issue of increasing shortages of medical specialists in rural areas. ■

Disclosure. *Financial support: This work was supported by unrestricted research grants from Beiersdorf Dermo Medical GmbH and Novartis Pharma GmbH. Conflicts of interests: none.*

Annexe A. Supplementary data

Supplementary data (Figure S1, Table S1) associated with this article can be found, in the online version, at doi:10.1684/ejd.2020.3752.

References

1. Madan V, Lear JT, Szeimies R-M. Non-melanoma skin cancer. *Lancet* 2010; 375: 673-85.

2. Nehal KS, Bichakjian CK. Update on keratinocyte carcinomas. *N Engl J Med* 2018; 379: 363-74.

3. Xiang F, Lucas R, Hales S, Neale R. Incidence of nonmelanoma skin cancer in relation to ambient UV radiation in white populations, 1978-2012: empirical relationships. *JAMA Dermatol* 2014; 150: 1063-71.

4. Zink A. Trends in the treatment and prevention of keratinocyte carcinoma (non-melanoma skin cancer). *Curr Opin Pharmacol* 2019; 46: 19-23.

5. Augustin J, Kis A, Sorbe C, Schäfer I, Augustin M. Epidemiology of skin cancer in the German population: impact of socioeconomic and geographic factors. *J Eur Acad Dermatol Venereol* 2018; 32: 1906-13.

6. Eder J, Prillinger K, Korn A, Geroldinger A, Trautinger F. Prevalence of actinic keratosis among dermatology outpatients in Austria. *Br J Dermatol* 2014; 171: 1415-21.

7. Schäfer I, Mohr P, Zander N, Fölster-Holst R, Augustin M. Association of atopy and tentative diagnosis of skin cancer - results from occupational skin cancer screenings. *J Eur Acad Dermatol Venereol* 2017; 31: 2083-7.

8. Stockfleth E. The importance of treating the field in actinic keratosis. *J Eur Acad Dermatol Venereol* 2017; 31: 8-11.

9. Hommel T, Szeimies R-M. Actinic keratoses. *Hautarzt* 2016; 67: 867-75.

10. Schmitt J, Seidler A, Diepgen TL, Bauer A. Occupational ultraviolet light exposure increases the risk for the development of cutaneous squamous cell carcinoma: a systematic review and meta-analysis. *Br J Dermatol* 2011; 164: 291-307.

11. Diepgen TL. New developments in occupational dermatology. *J Dtsch Dermatol Ges* 2016; 14: 875-89.

12. Zink A, Tizek L, Schielein MC, Böhner A, Biedermann T, Wildner M. Different outdoor professions have different risks - a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. *J Eur Acad Dermatol Venereol* 2018; 32: 1695-701.

13. Zink A, Hänsel I, Rotter M, Spinner CD, Böhner A, Biedermann T. Impact of gliding on the prevalence of keratinocyte carcinoma and its precursors: a cross-sectional study among male pilots in Bavaria. *Acta Derm Venereol* 2017; 97: 393-4.

14. Kornek T, Augustin M. Skin cancer prevention. *J Dtsch Dermatol Ges* 2013; 11: 283-96.

15. Ziehfreund S, Schuster B, Zink A. Primary prevention of keratinocyte carcinoma among outdoor workers, the general population and medical professionals: a systematic review updated for 2019. *J Eur Acad Dermatol Venereol* 2019; 33: 1477-95.

16. Zink A, Thomé F, Schielein MC, 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: 2153-61.

17. Tizek L, Krause J, Biedermann T, Zink A. Satisfaction of mountain guides with high sun protection as a tool to prevent non-melanoma skin cancer. *J Eur Acad Dermatol Venereol* 2017; 31: 1825-7.

18. Zink A, Wurstbauer D, Rotter M, Wildner M, Biedermann T. Do outdoor workers know their risk of NMSC? Perceptions, beliefs and preventive behaviour among farmers, roofers and gardeners. *J Eur Acad Dermatol Venereol* 2017; 31: 1649-54.

19. Grandahl K, Ibler KS, Laier GH, Mortensen OS. Skin cancer risk perception and sun protection behavior at work, at leisure, and on sun holidays: a survey for Danish outdoor and indoor workers. *Environ Health Prev Med* 2018; 23: 47.

20. Hansen H, Pohontsch NJ, Bole L, Schäfer I, Scherer M. Regional variations of perceived problems in ambulatory care from the perspective of general practitioners and their patients - an exploratory focus group study in urban and rural regions of northern Germany. *BMC Fam Pract* 2017; 18: 68.

21. Augustin J, Erasmi S, Reusch M, Augustin M. Methods of analyzing regional dermatological care as exemplified by the city of Hamburg. *J Dtsch Dermatol Ges* 2015; 13: 661-73.

22. Koller D, Eisele M, Kaduszkiewicz H, *et al.* Ambulatory health services utilization in patients with dementia – Is there an urban-rural difference? *Int J Health Geogr* 2010; 9: 59.

23. Boehmer D, Schuster B, Krause J, Darsow U, Biedermann T, Zink A. Prevalence and treatment of allergies in rural areas of Bavaria, Germany: a cross-sectional study. *World Allergy Organ J* 2018; 11: 36.

24. Schielein MC, Tizek L, Rotter M, Konstantinow A, Biedermann T, Zink A. Guideline-compliant prescription of biologicals and possible barriers in dermatological practices in Bavaria. *J Eur Acad Dermatol Venereol* 2018; 32: 978-84.

25. Tille F, Gibis B, Balke K, Kuhlmey A, Schnitzer S. Sociodemographic and health-related determinants of health care utilisation and access to primary and specialist care: results of a nationwide population survey in Germany (2006-2016). *Z Evid Fortbild Qual Gesundhwes* 2017; 126: 52-65.

26. Kassenärztliche Vereinigung Bayerns. Versorgungsatlas Hautärzte: Darstellung der regionalen Versorgungssituation sowie der Altersstruktur in Bayern 2018. Available at: https://www.kvb.de/fileadmin/kvb/dokumente/UeberUns/Versorgung/KVB-Versorgungsatlas_Hautaerzte.pdf (accessed 12 Dec 2018).

27. Schäfer I, Augustin M, Krensel M, Augustin J. Real world data sources for health services research on skin cancer. *Hautarzt* 2019; 70: 29-35.

28. Leiter U, Keim U, Eigentler T, *et al.* Incidence, mortality, and trends of nonmelanoma skin cancer in Germany. *J Invest Dermatol* 2017; 137: 1860-7.

29. Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A. Skin diseases are more common than we think: screening results of an unreferred population at the Munich Oktoberfest. *J Eur Acad Dermatol Venereol* 2019; 33: 1421-8.

30. Tizek L, Schielein MC, Spinner CD, *et al.* New perspectives on health prevention. Prevalence of hypertension, hypacusis and balance disorders at the Munich Oktoberfest 2016. *MMW Fortschr Med* 2019; 161: 9-14.

31. Federal Institute for Research on Building, Urban Affairs and Spatial Development. Siedlungsstrukturelle Kreistypen - Laufende Raumbeobachtung - Raumabgrenzungen 2018. Available at: http://www.bbsr.bund.de/cln_032/nn_1067638/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/Kreistypen4/kreistypen.html (accessed 06 Mar 2018).

32. Kis A, Augustin M, Augustin J. Regional healthcare delivery and demographic change in Germany - scenarios for dermatological care in 2035. *J Dtsch Dermatol Ges* 2017; 15: 1199-209.

33. Federal Agency for Cartography and Geodesy. Administrative areas. Available at: http://www.geodatenzentrum.de/geodaten/gdz_rahmen.gdz_div?gdz_spr=deu&gdz_akt_zeile=5&gdz_anz_zeile=1&gdz_unt_zeile=0&gdz_user_id=0 (accessed 07 Jul 2018).

34. Eissing L, Schäfer I, Strömer K, *et al*. Perception of statutory skin cancer screening in the general population: current findings on participation, knowledge and evaluation. *Hautarzt* 2017;68:371-6.

35. Tizek L, Schielein MC, Rüth M, *et al*. Interest in skin cancer in urban populations: a retrospective analysis of Google search terms in nine large German cities. *Acta Derm Venereol* 2019;99:797-804.

36. Schuster B, Ziehfreund S, Tizek L, Krause J, Biedermann T, Zink A. Is the Bavarian population open for teledermatology? A cross-sectional study in rural and urban regions of Bavaria, Germany. *Gesundheitswesen* 2019. PMID:31529446 [Epub ahead of print].

37. Statisitche Ämter des Bundes und der Länder. Regionaldatenbank Deutschland 2019. Available at: https://www.regionalstatistik.de/genesis/online/data;sid=76B5D8A3A4F6A5D29D8101735542F7F8.reg1?operation=abruftabelleBearbeiten&levelindex=2&levelid=1568900863868&auswahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&selectionname=12411-07-01-4&auswahltext=&werteabruf=Werte-abruf (accessed 23 Sep 2019).

Publication III: Skin cancer risk and shade: Comparing the risk of foresters with other outdoor workers

Tizek L, Schielein MC, Berger U, Ege MJ, Schneider S, Zink A. Skin cancer risk and shade: comparing the risk of foresters with other outdoor workers. J Eur Acad Dermatol Venereol 2020.

Journal of the European Academy of Dermatology and Venereology

InCites Journal Citation Reports 2019

Impact factor: 5.248 Ranking: 5/68 (Dermatology)

DOI: 10.1111/jdv.16560 JEADV

ORIGINAL ARTICLE

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

L. Tizek,[1,2] M.C. Schielein,[1,2] U. Berger,[2] M.J. Ege,[3] S. Schneider,[4] A. Zink[1,*]

[1]Department of Dermatology and Allergy, Technical University of Munich, School of Medicine, Munich, Germany
[2]Institute for Medical Information Processing, Biometry and Epidemiology (IBE), Ludwig-Maximilians University Munich, Munich, Germany
[3]Dr. von Hauner Children's Hospital, Member of the German Center of Lung Research (DZL), Ludwig-Maximilians University Munich, Munich, Germany
[4]Medical Faculty Mannheim, Mannheim Institute of Public Health, Social and Preventive Medicine (MIPH),Heidelberg University, Mannheim, Germany
*Correspondence: A. Zink. E-mail: alexander.zink@tum.de

Abstract

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

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

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

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

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

Received: 13 January 2020; Accepted: 7 April 2020

Conflicts of interest

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

Funding sources

This work was supported by an unrestricted research grant from Novartis Pharma GmbH. The funder was not involved in study design, data collection, data analysis or publication decisions, but approved the manuscript.

Introduction

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

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

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

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

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

Methods

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

Study questionnaire

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

On-site skin cancer screening

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

Statistical analysis

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

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

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

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

Results

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

Table 1 Study characteristics stratified by occupational groups

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

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

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

Sun protection behaviours

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

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

General health awareness

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

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

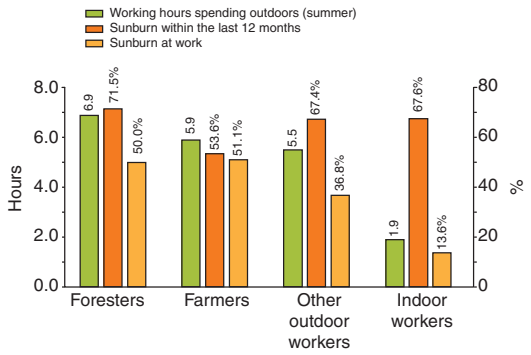

Figure 1 Average number of hours spending outdoors during working days in summer as well as proportion of participants who experienced at least one sunburn or experienced a sunburn at work within the last 12 months.

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

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

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

Skin diseases other than skin cancer diagnosed on-site

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

Discussion

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

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

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

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

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

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

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

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

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

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

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

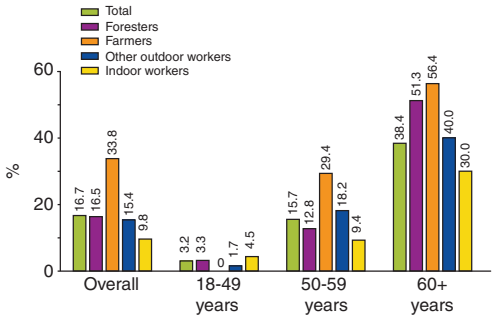

Figure 2 Overall point prevalence of clinical diagnosed KC, including AK, for foresters, farmers, other outdoor workers and indoor workers stratified by age. Foresters: $n = 170$, farmers: $n = 80$; other outdoor workers: $n = 123$; indoor workers: $n = 173$.

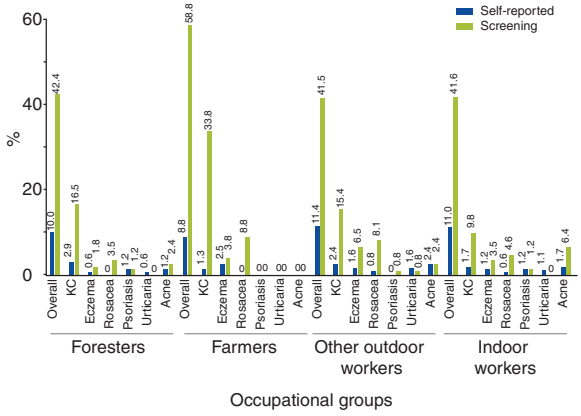

Figure 3 Comparison of the prevalence of skin diseases on the study day according to people's self-declarations and skin cancer screening performed by dermatologists. KC = actinic keratosis, squamous cell carcinoma and basal cell carcinoma; eczema = atopic dermatitis, hand eczema, seborrheic eczema and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

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

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

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

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

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

Acknowledgements

We thank the 'Sozialversicherung für Landwirtschaft, Forsten und Gartenbau' for organizing the public health campaign and for the opportunity to be part of it. In addition, we thank Marie Hörl, Alexander Böhner and all other employees for their contribution to the recruitment and examination of participants.

References

1 Nehal KS, Bichakjian CK. Update on keratinocyte carcinomas. *N Engl J Med* 2018; **379**: 363–374.
2 Rogers HW, Weinstock MA, Feldman SR, Coldiron BM. Incidence estimate of nonmelanoma skin cancer (keratinocyte carcinomas) in the US population, 2012. *JAMA Dermatol* 2015; **151**: 1081–1086.
3 Apalla Z, Lallas A, Sotiriou E *et al*. Epidemiological trends in skin cancer. *Dermatol Pract Concept* 2017; **7**: 1–6.
4 Zink A. Trends in the treatment and prevention of keratinocyte carcinoma (non-melanoma skin cancer). *Curr Opin Pharmacol* 2019; **46**: 19–23.
5 Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. *Br J Dermatol* 2012; **166**: 1069–1080.
6 Rudolph C, Schnoor M, Eisemann N, Katalinic A. Incidence trends of nonmelanoma skin cancer in Germany from 1998 to 2010. *J Dtsch Dermatol Ges* 2015; **13**: 788–797.
7 Xiang F, Lucas R, Hales S, Neale R. Incidence of nonmelanoma skin cancer in relation to ambient UV radiation in white populations, 1978–2012: empirical relationships. *JAMA Dermatol* 2014; **150**: 1063–1071.
8 Lee JH, Kim YH, Han KD *et al*. Incidence of actinic keratosis and risk of skin cancer in subjects with actinic keratosis: a population-based cohort study. *Acta Derm Venereol* 2018; **98**: 382–383.
9 Schaefer I, Augustin M, Spehr C *et al*. Prevalence and risk factors of actinic keratoses in Germany–analysis of multisource data. *J Eur Acad Dermatol Venereol* 2014; **28**: 309–313.
10 Zink A, Tizek L, Schielein MC *et al*. Different outdoor professions have different risks – a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. *J Eur Acad Dermatol Venereol* 2018; **32**: 1695–1701.
11 Tizek L, Schielein MC, Seifert F *et al*. Skin diseases are more common than we think: screening results of an unreferred population at the Munich Oktoberfest. *J Eur Acad Dermatol Venereol* 2019; **33**: 1421–1428.
12 John SM, Trakatelli M, Gehring R *et al*. Consensus report: Recognizing non-melanoma skin cancer, including actinic keratosis, as an occupational disease – a call to action. *J Eur Acad Dermatol Venereol* 2016; **30** (Suppl 3): 38–45.
13 Schmitt J, Seidler A, Diepgen TL, Bauer A. Occupational ultraviolet light exposure increases the risk for the development of cutaneous squamous cell carcinoma: a systematic review and meta-analysis. *Br J Dermatol* 2011; **164**: 291–307.
14 Diepgen TL. New developments in occupational dermatology. *J Dtsch Dermatol Ges* 2016; **14**: 875–889.
15 Modenese A, Korpinen L, Gobba F. Solar radiation exposure and outdoor work: an underestimated occupational risk. *Int J Environ Res Public Health* 2018; **15**: 2063.
16 Smit-Kroner C, Brumby S. Farmers sun exposure, skin protection and public health campaigns: an Australian perspective. *Prev Med Rep* 2015; **2**: 602–607.
17 Woods CE, O'Shea E, Barrett F *et al*. Occupational exposure: rural Australian farmers' sun-protective behaviours. *J Public Health (Berl.)* 2019; **24**: 652.
18 Ziehfreund S, Schuster B, Zink A. Primary prevention of keratinocyte carcinoma among outdoor workers, the general population and medical professionals: a systematic review updated for 2019. *J Eur Acad Dermatol Venereol* 2019; **33**: 1477–1495.
19 Gordon LG, Scuffham PA, van der Pols JC *et al*. Regular sunscreen use is a cost-effective approach to skin cancer prevention in subtropical settings. *J Invest Dermatol* 2009; **129**: 2766–2771.
20 Køster B, Søndergaard J, Nielsen JB *et al*. Knowledge deficit, attitude and behavior scales association to objective measures of sun exposure and sunburn in a Danish population based sample. *PLoS ONE* 2017; **12**: e0178190.
21 Grandahl K, Ibler KS, Laier GH, Mortensen OS. Skin cancer risk perception and sun protection behavior at work, at leisure, and on sun holidays: a survey for Danish outdoor and indoor workers. *Environ Health Prev Med* 2018; **23**: 47.
22 Zink A, Wurstbauer D, Rotter M *et al*. Do outdoor workers know their risk of NMSC? Perceptions, beliefs and preventive behaviour among farmers, roofers and gardeners. *J Eur Acad Dermatol Venereol* 2017; **31**: 1649–1654.
23 Zink A, Schielein MC, Wildner M, Rehfuess EA. '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. *Br J Dermatol* 2019; **180**: 1412–1419.
24 Ziehfreund S, Schuster B, Biedermann T, Zink A. Understanding roofers' sun protection behaviour: a qualitative study. *J Eur Acad Dermatol Venereol* 2019; **33**: e193–e195.
25 Ou-Yang H, Jiang LI, Meyer K *et al*. Sun protection by beach umbrella vs sunscreen with a high sun protection factor: a randomized clinical trial. *JAMA Dermatol* 2017; **153**: 304–308.
26 Religi A, Backes C, Moccozet L *et al*. Body anatomical UV protection predicted by shade structures: a modeling study. *Photochem Photobiol* 2018; **94**: 1289–1296.
27 Schneider S, Diehl K, Schilling L *et al*. Occupational UV exposure and sun-protective behaviour in German outdoor workers: results of a nationwide study. *J Occup Environ Med* 2018; **60**: 961–967.
28 Grandahl K, Eriksen P, Ibler KS *et al*. Measurements of solar ultraviolet radiation exposure at work and at leisure in Danish workers. *Photochem Photobiol* 2018; **94**: 807–814.
29 Görig T, Diehl K, Greinert R *et al*. Prevalence of sun-protective behaviour and intentional sun tanning in German adolescents and adults: results of a nationwide telephone survey. *J Eur Acad Dermatol Venereol* 2017; **32**: 225–235.
30 Schilling L, Schneider S, Görig T *et al*. "Lost in the sun"-The key role of perceived workplace support for sun-protective behavior in outdoor workers. *Am J Ind Med* 2018; **61**: 929–938.
31 Glanz K, Buller DB, Saraiya M. Reducing ultraviolet radiation exposure among outdoor workers: state of the evidence and recommendations. *Environ Health* 2007; **6**: 22.
32 Grandahl K, Olsen J, Friis KBE *et al*. Photoaging and actinic keratosis in Danish outdoor and indoor workers. *Photodermatol Photoimmunol Photomed* 2019; **35**: 201–207.
33 Venna SS, Lee D, Stadecker MJ, Rogers GS. Clinical recognition of actinic keratoses in a high-risk population: how good are we? *Arch Dermatol* 2005; **141**: 507–509.

Supporting information

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

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

Publication IV: Effekte einer unkonventionellen Hautkrebs-Präventionskampagne: Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen

Tizek L, Schielein MC, Schuster B, Ziehfreund S, Biedermann T, Zink A. Effekte einer unkonventionellen Hautkrebs-Präventionskampagne: Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen. [Effects of an unconventional skin cancer prevention campaign: Impacts on the sun protection behavior of outdoor workers]. Hautarzt 2020; 71(6):455–62.

Hautarzt

InCites Journal Citation Reports 2019

Impact factor: 0.681 Ranking: 63/68 (Dermatology)

Der Hautarzt

Originalien

Hautarzt
https://doi.org/10.1007/s00105-020-04574-7

Linda Tizek[1,2] · Maximilian C. Schielein[1,2] · Barbara Schuster[1,2] · Stefanie Ziehfreund[1] · Tilo Biedermann[1] · Alexander Zink[1]

[1] Fakultät für Medizin, Klinik und Poliklinik für Dermatologie und Allergologie am Biederstein, Technische Universität München, München, Deutschland

[2] Institut für medizinische Informationsverarbeitung, Biometrie und Epidemiologie (IBE), Ludwig-Maximilians-Universität München, München, Deutschland

Effekte einer unkonventionellen Hautkrebs-Präventionskampagne

Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen

Die Krankheitslast von aktinischen Keratosen und Keratinozytenkarzinomen kann durch primäre und sekundäre Präventionsmaßnahmen gesenkt werden. Allerdings stellt die mangelhafte Reichweite v. a. bei der Hochrisikogruppe der Außenberufstätigen ein schwerwiegendes Problem dar. Daher galt es beim ersten Untersuchungszeitpunkt, Personen einen einfachen Zugang zu einer Kampagne zum Thema Sonnenschutz und Wahrnehmung von Hautveränderungen zu bieten und in dieser Folgeerhebung zu untersuchen, ob sich 1 Jahr später bei den Teilnehmern eine Verbesserung diesbezüglich feststellen ließ.

Hintergrund

Aktinische Keratosen (AK) und Keratinozytenkarzinome (KK) stellen aufgrund ihrer hohen Prävalenz und Inzidenz sowohl ein enormes individuelles als auch gesundheitsökonomisches Problem dar [11, 14, 16]. In Deutschland werden seit Jahrzehnten steigende Inzidenzen berichtet [10, 11, 17]. So ist beispielsweise die Prävalenz von KK zwischen 2009 und 2015 um 52 % auf 1708 (±398) Fälle pro 100.000 gesetzlich Versicherten gestiegen [1]. Diese Krankheitslast ist besonders hoch bei den 2,5 bis 3 Mio. Außenberufstätigen in Deutschland [4], da diese aufgrund ihrer beruflichen UV-Exposition ein erhöhtes Risiko haben [5, 18].

Die Verwendung von Sonnenschutzmaßnahmen ist enorm wichtig für die Prävention von AK und KK [9], allerdings finden diese oft nur geringen Zuspruch in Hochrisikogruppen [13, 27, 28]. Häufig genannte Hürden hierfür sind, dass sie schlichtweg vergessen werden oder der Gebrauch als unnötig und lästig empfunden wird [13, 27, 29]. Ein anderer Grund ist jedoch oftmals unzureichendes Wissen [22, 26, 27]. Studien zeigten, dass sowohl das Schutzverhalten als auch die Risikowahrnehmung durch Interventionen verbessert werden können [8, 12, 25]. Mangelhafte Reichweiten stellen jedoch ein schwerwiegendes Problem bei Präventionskampagnen dar [7, 19]. So wurde beispielsweise eine mediale Kampagne, die potenziell 1,45 Mio. Menschen aus landwirtschaftlichen Haushalten in ganz Deutschland erreichen sollte, für gescheitert erklärt, weil die Response-Rate nur 0,01 % betrug [30].

Da Personen, die in ländlichen Regionen leben, generell seltener einen Facharzt konsultieren [2, 21], wurde beim Bayerischen Zentral-Landwirtschaftsfest (ZLF) 2016 in München eine Studie mit dem Ziel durchgeführt, Menschen aus ländlichen Regionen und insbesondere jenen, die in Außenberufen tätig sind, auf möglichst einfachem Weg einen Zugang zu gesundheitlichen Vorsorgeleistungen zu bieten, um so eine hohe Akzeptanz und Teilnehmerrate zu erreichen [24]. Die Studie beinhaltete die Aufklärung der Teilnehmer über Hauterkrankungen und die gesundheitlichen Risiken der UV-Strahlung sowie die Erfassung des individuellen Risikoverhaltens. Außerdem führten Dermatologen ein Hautkrebsscreening durch, um die Krankheitslast von Hauterkrankungen in der Studienpopulation zu erfassen. Ziel dieser Folgeerhebung war es zu untersuchen, ob sich 1 Jahr nach Studiendurchführung das Risikoverhalten und der Umgang mit Hauterkrankungen durch das Angebot und die Aufklärung bei der Subpopulation, insbesondere bei den Außenberufstätigen, verändert haben.

Methodik

Datenerhebung

Die Daten dieser Querschnittstudie basieren auf einer Folgebefragung von Teilnehmern, die 2016 bei einer Erstbefragung auf dem ZLF im Rahmen eines Gesundheitschecks in Kooperation mit der Sozialversicherung für Landwirtschaft, Forsten und Garten-

Published online: 23 March 2020

Tab. 1 Charakteristiken der Studienpopulation der Folgebefragung 2017 und der ZLF(Bayerisches Zentral-Landwirtschaftsfest)-Studie 2016 [24]

	Folgebefragung 2017			ZLF-Studie 2016		
	Insgesamt (*n* = 400)	**Außenberufe[a] (*n* = 240, 60,0 %)**	**Innenberufe (*n* = 154, 38,5 %)**	**Insgesamt (*n* = 2701)**	**Außenberufe[a] (*n* = 1621, 60,0 %)**	**Innenberufe (*n* = 996, 36,9 %)**
Alter						
Durchschnittsalter ± SD	*54,5 ± 13,5*	*57,1 ± 11,4*	*50,2 ± 15,3*	*51,9 ± 15,3*	*55,0 ± 13,3*	*45,5 ± 16,3*
18 bis 39 Jahre	54 (13,5 %)	16 (6,7 %)	37 (24,0 %)	552 (20,4 %)	197 (12,2 %)	352 (35,3 %)
40 bis 49 Jahre	50 (12,5 %)	25 (10,4 %)	25 (16,2 %)	413 (15,3 %)	243 (15,0 %)	170 (17,1 %)
50 bis 59 Jahre	130 (32,5 %)	89 (37,1 %)	40 (26,0 %)	750 (27,8 %)	511 (31,5 %)	235 (23,6 %)
60 bis 69 Jahre	124 (31,0 %)	82 (34,2 %)	40 (26,0 %)	688 (25,5 %)	475 (29,3 %)	174 (17,5 %)
70+ Jahre	32 (8,0 %)	22 (9,2 %)	9 (5,8 %)	235 (8,7 %)	158 (9,7 %)	48 (4,8 %)
Fehlende Angabe	*10 (2,5 %)*	6 (2,5 %)	3 (1,9 %)	*63 (2,3 %)*	37 (2,3 %)	17 (1,7 %)
Geschlecht						
Frauen	204 (51,0 %)	100 (41,7 %)	100 (64,9 %)	1445 (53,5 %)	711 (43,9 %)	697 (70,0 %)
Männer	195 (48,8 %)	139 (57,9 %)	54 (35,1 %)	1248 (46,2 %)	909 (56,1 %)	299 (30,0 %)
Fehlende Angabe	*1 (0,3 %)*	1 (0,4 %)	0	*8 (0,3 %)*	1 (0,1 %)	0

SD Standardabweichung
[a]Außenberufe = Landwirte und andere Außenberufe

bau teilgenommen haben [23]. Das ZLF ist eine der größten multinationalen Landwirtschaftsmessen und findet alle 4 Jahre zeitgleich mit dem Münchner Oktoberfest statt. Da keinem Besucher die Möglichkeit vorenthalten werden sollte, an der Gesundheitsmaßnahme teilzunehmen, konnte jeder Besucher, der wollte und die Einschlusskriterien erfüllte, an der Studie teilnehmen. Durch das gewählte Setting sollten aber v. a. viele Außenbeschäftigte, wie beispielsweise Landwirte, erreicht werden.

Bei Studieneinschluss wurde jeder Teilnehmer ($n = 2701$) gefragt, ob er auf freiwilliger Basis seine Kontaktdaten angeben möchte, um zu einem späteren Zeitpunkt noch einmal befragt zu werden. Alle Personen, die noch einmal an der Befragung teilnehmen wollten, wurden 14 Monate nach der ZLF-Studie im Dezember 2017 per Post kontaktiert. Sie erhielten den identischen 2-seitigen Fragebogen wie bei der Erstbefragung, eine weitere Seite mit Evaluationsfragen und einen frankierten Rücksendeumschlag. Der Fragebogen erfasste neben allgemeinen Personendaten (Alter, Geschlecht, Beruf), das individuelle Sonnenschutzverhalten, die Inanspruchnahme von Gesundheitsleistungen sowie das Vorliegen dermatologischer Erkrankungen, wie beispielsweise Neurodermitis, Psoriasis, Urtikaria oder Akne. Die Evaluationsfragen zielten unter anderem darauf ab zu untersuchen, ob sich das subjektive Bewusstsein der Teilnehmer hinsichtlich Sonnenschutz bzw. Hautveränderungen verbessert hat und ob sie sich weitere Präventionskampagnen oder -angebote zu diesem Thema wünschen.

Für die Studienteilnahme mussten die Teilnehmer mindestens 18 Jahre alt sein und nach entsprechender Aufklärung ihre schriftliche Einwilligung geben. Die Studie wurde von der zuständigen Ethikkommission der Fakultät für Medizin der Technischen Universität München genehmigt (Aktenzeichen 385/16 s). Sie wurde im Einklang mit nationalem Recht und gemäß der Deklaration von Helsinki von 1975 durchgeführt.

Statistische Datenauswertung

Die statistische Auswertung wurde mit IBM SPSS Statistics 25 (IBM Corporation, Armonk, NY, USA) durchgeführt. Alle Variablen wurden zunächst deskriptiv ausgewertet. Um mögliche Assoziationen und Unterschiede innerhalb der Studienpopulation zu identifizieren, wurden Subgruppen (Außen- und Innenberufstätige) mithilfe von Chi^2-Tests verglichen ($\alpha = 0{,}05$).

Ergebnisse

Studienpopulation

Insgesamt wurden 773 der 2701 ursprünglichen Teilnehmer im Zuge der Folgeerhebung postalisch kontaktiert, wobei 16 Briefe aufgrund falscher Adressen nicht zustellbar waren. Von diesen 757 Personen sendeten 400 den ausgefüllten Fragebogen wieder zurück, was einer Response-Rate von 52,8 % entspricht. Die Teilnehmer waren zwischen 19 und 86 Jahre alt, und das Durchschnittsalter betrug 54,5 (±13,5) Jahre. Etwa die Hälfte der Teilnehmer war weiblich (51,0 %), und mehr als 60 % waren in Außenberufen tätig (Landwirte 56,3 %, andere Außenberufstätige 3,8 %). Im Vergleich zur ZLF-Studie 2016 waren keine deutlichen Unterschiede hinsichtlich der Charakteristiken der Teilnehmer ersichtlich (**Tab. 1**).

Auswertung Fragebogen

Knapp 54,2 % der Außenberufstätigen gaben an, während eines typischen Arbeitstages keine Sonnencreme zu verwenden. Dies entsprach einem Rückgang um 3 Prozentpunkte im Vergleich zur ZLF-Studie 2016 (57,7 %). Von den Außenberufstätigen, die Sonnencreme verwendeten, nutzten die meisten einen LSF (Lichtschutzfaktor) 30 bis 50 (44,5 %).

Hautarzt https://doi.org/10.1007/s00105-020-04574-7

L. Tizek · M. C. Schielein · B. Schuster · S. Ziehfreund · T. Biedermann · A. Zink

Effekte einer unkonventionellen Hautkrebs-Präventionskampagne. Auswirkungen auf das Sonnenschutzverhalten von Außenberufstätigen

Zusammenfassung

Hintergrund. Die Krankheitslast von aktinischen Keratosen und Keratinozytenkarzinomen kann durch Primär- und Sekundärprävention gesenkt werden. Allerdings finden diese Maßnahmen oft nur geringen Zuspruch, v. a. bei der Hochrisikogruppe der Außenberufstätigen.
Ziel. Ziel dieser Folgebefragung war es zu untersuchen, ob sich 1 Jahr nach einer Präventionskampagne zum Thema Sonnenschutz und Wahrnehmung von Hautveränderungen bei der Studienpopulation, insbesondere bei Außenberufstätigen, eine Verbesserung diesbezüglich feststellen ließ.
Material und Methoden. Alle Teilnehmer, die sich bei einer Studie beim Bayerischen Zentral-Landwirtschaftsfest 2016 bereit erklärten, noch einmal befragt zu werden, wurden 2017 per Post kontaktiert und erhielten den identischen Fragebogen sowie Evaluationsfragen bezüglich möglicher Verhaltensänderungen.
Ergebnisse. Insgesamt nahmen 400 Personen an der Folgebefragung teil (Response-Rate 52,8 %). Von den 240 Außenberufstätigen gaben 45,0 % an, sich bewusster vor der Sonne zu schützen, und 68,8 %, bewusster auf Hautveränderungen zu achten. Etwa 85,0 % der Außenberufstätigen würden nun früher einen Dermatologen aufsuchen, und 65,8 % wünschten sich weitere Präventionskampagnen zum Thema Hautkrebs und Sonnenschutz.
Diskussion. Insgesamt gab die Mehrheit der Befragten an, ein verbessertes Sonnenschutzverhalten und eine bessere Wahrnehmung von Hautveränderungen nach der Intervention zu haben. Basierend auf den Eigenangaben, zeigte sich v. a. bei Außenberufstätigen eine Verbesserung, was die Wichtigkeit solcher zielgruppenorientierten Präventionskampagnen für die Senkung der Krankheitslast unterstreicht.

Schlüsselwörter

Aktinische Keratosen · Hochrisikogruppe · Keratinozytenkarzinom · Sonnenschutz · Primärprävention

Effects of an unconventional skin cancer prevention campaign. Impacts on the sun protection behavior of outdoor workers

Abstract

Background. The disease burden of actinic keratoses and keratinocyte carcinoma can be reduced by primary and secondary prevention. However, these measures are often poorly received, especially among the high-risk group of outdoor workers.
Objectives. The aim of this follow-up study was to investigate whether an improvement in sun protection and awareness of skin changes could be observed among the study population, especially outdoor workers, one year after a prevention campaign focusing on this topic.
Materials and methods. In 2017, all participants who initially participated in a study at the Bavarian Central Agricultural Festival 2016 and agreed to participate in the follow-up study were contacted by mail and received the same questionnaire and evaluation questions regarding possible behavioral changes.
Results. A total of 400 people took part in the follow-up study (response rate 52.8%). Of the 240 outdoor workers, 45.0% said they were more conscious of protecting themselves from the sun and 68.8% said they were more aware of skin changes. About 85.0% of outdoor workers indicated that they would consult a dermatologist earlier and 65.8% desired further prevention campaigns regarding skin cancer and sun protection.
Conclusion. Overall, the majority of participants reported that they had improved sun protection behavior and awareness of skin changes after the intervention. Based on the participants' self-disclosure, especially outdoor workers tended to use sun protection measure more frequently. These findings underline the importance of target group-oriented awareness and prevention campaigns to reduce the burden of skin cancer.

Keywords

Actinic keratoses · High-risk group · Keratinocyte carcinoma · Sun protection · Primary prevention

Die am häufigsten verwendete Sonnenschutzmaßnahme während der Arbeit war bei den Außenberufstätigen das Tragen einer Kopfbedeckung (79,0 %). Im Vergleich zur ZLF-Studie 2016 stieg der Anteil um knapp 13 Prozentpunkte. Der Anteil an Außenberufstätigen, die versuchten, während der Arbeit die Mittagssonne zu meiden, stieg auf das Doppelte an (2016: 23,2 % vs. 2017: 47,1 %). Ebenso verhielt es sich beim Anteil an Personen, die Sonnenschutzkleidung trugen (2016: 12,5 % vs. 2017: 24,8 %). Insgesamt sank der Anteil an Außenberufstätigen, die keinerlei Sonnenschutzmaßnahmen während der Arbeit verwendeten, um 13 Prozentpunkte (2016: 23,1 % vs. 2017: 10,1 %).

Ein besseres Schutzverhalten scheint sich auch während der Freizeit eingestellt zu haben. Im Jahr 2017 gaben sowohl 7 von 10 Außen- als auch Innenberufstätigen an, eine Kopfbedeckung in ihrer Freizeit zu tragen, während es 2016 jeweils 6 von 10 Teilnehmern waren. Der Anteil an Außenberufstätigen, die die Mittagssonne mieden oder Schutzkleidung trugen, stieg im Vergleich zu 2016 ebenfalls an, allerdings wurden diese Maßnahmen im Vergleich zum Tragen einer Kopfbedeckung immer noch deutlich seltener verwendet (Meiden der Mittagssonne: 54,9 %; Schutzkleidung: 17,3 %). Diese Zahlen waren in etwa vergleichbar mit denen von Innenberufstätigen (Mei-

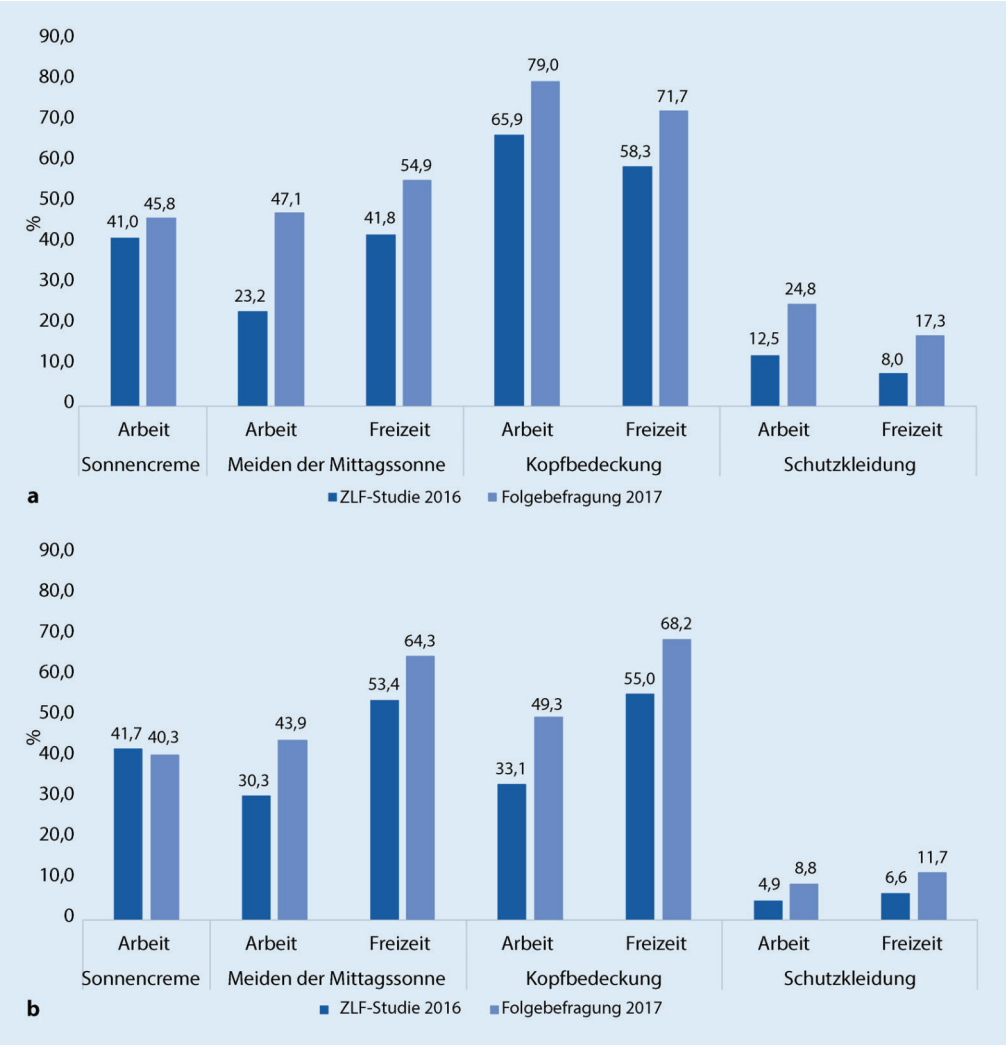

Abb. 1 ◀ Verwendung von verschiedenen Sonnenschutzmaßnahmen von Außen- und Innenberufstätigen während der Arbeit und der Freizeit zum Zeitpunkt der ZLF(Bayerisches Zentral-Landwirtschaftsfest)-Studie 2016 und zum Zeitpunkt der Folgebefragung 2017. **a** Außenberufstätige, **b** Innenberufstätige

den der Mittagssonne: 64,3 %; Schutzkleidung: 11,7 %, ◘ **Abb. 1**).

Die Teilnehmer gaben ebenfalls eine erhöhte Inanspruchnahme von medizinischen Leistungen an. Während 2016 49,7 % der Außenberufs- und 62,2 % der Innenberufstätigen bereits bei einem Dermatologen in Behandlung waren, waren es 2017 59,6 % bzw. 74,0 %.

Insgesamt gaben 42,7 % der Befragten an, sich seit der ZLF-Studie 2016 bewusster vor der Sonne zu schützen. Diesbezüglich bestand kein signifikanter Unterschied zwischen den Berufsgruppen (Außenbeschäftige: 45,0 % und Innenbeschäftigte: 37,7 %, $p = 0{,}139$). Auf die Frage, inwiefern sich die Personen besser schützen würden, gaben 44,3 % der Außen- und 44,1 % der Innenberufstätigen die generelle oder regelmäßigere Verwendung von Sonnencreme an. Während bei den Außenberufstätigen zudem das Tragen von Schutzkleidung um ca. 11 % zunahm, achteten Innenberufstätige vermehrt auf das Meiden der Mittagssonne (14,7 %, ◘ **Abb. 2**).

Insgesamt sagten 63,5 % der Teilnehmer, sie hätten seit der ZLF-Studie 2016 ein erhöhtes Bewusstsein für Hautveränderungen. Gemäß der Eigenangabe gaben Außenberufstätige signifikant häufiger an, bewusster auf Hautveränderungen zu achten als Innenberufstätige (68,8 % vs. 55,8 %, $p = 0{,}008$).

Insgesamt würden 81,0 % im Falle einer Hautveränderung früher einen Dermatologen aufzusuchen. Mit 85,0 % der Außenberufstätigen war dieser Anteil signifikant höher als bei Innenberufstätigen (74,0 %, $p < 0{,}001$). Generell bestand ein großer Wunsch nach weiteren Präventionskampagnen zum Thema Hautkrebs und Sonnenschutz (67,5 %). Fast alle Personen (95,8 %) empfanden die ZLF-Studie als einen guten Ansatz, um die Wahrnehmung von Hauterkrankungen zu verbessern (◘ **Abb. 3**).

Diskussion

Ziel der Folgebefragung war es zu evaluieren, ob sich 1 Jahr nach einer Interventionsmaßnahme, die beim unkonventionellen Setting des Bayerischen Zentral-Landwirtschaftsfest 2016 durchgeführt wurde [24], um eine Vielzahl an Außenbeschäftigten zu erreichen, eine Verbesserung bezüglich der Wahrnehmung von Hautkrebs und Verwendung

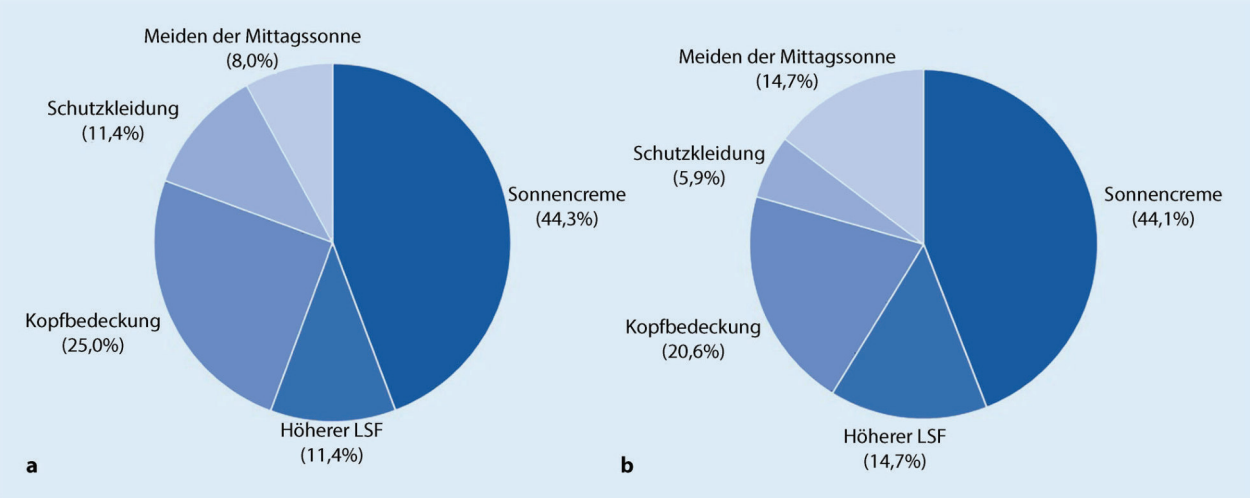

Abb. 2 ▲ Verwendete Schutzmaßnahmen von Teilnehmern, die sich seit der Präventionskampagne auf dem ZLF (Bayerisches Zentral-Landwirtschaftsfest) 2016 [24] bewusster vor der Sonne schützen. **a** Außenberufstätige, **b** Innenberufstätige. *LSF* Lichtschutzfaktor, Sonnencreme (z. B. generell eincremen oder regelmäßiger eincremen), Schutzkleidung (z. B. Kleidung mit langen Ärmeln)

von Sonnenschutzprodukten bei den Teilnehmern feststellen ließ.

Eine generelle Hürde von Präventionsmaßnahmen ist deren flächendeckende Reichweite in der Bevölkerung. Ein Vergleich verschiedener Befragungsmethoden deutete darauf hin, dass mit Telefonbefragungen die höchste Response-Rate erzielt werden kann und bei personalisierten Postbefragungen nur noch etwa jeder Zehnte teilnimmt [19]. Die Rücklaufquote in dieser Studie war mit mehr als 50 % jedoch deutlich höher als in der Literatur beschrieben. Dies lässt sich vermutlich darauf zurückführen, dass nur Personen, die besonders motiviert und interessiert an gesundheitlichen Themen sind, sich bereit erklärt haben, erneut kontaktiert zu werden. Obwohl im Allgemeinen Frauen dazu tendieren, häufiger an Studien teilzunehmen [2, 6], bestand in dieser Studie kein signifikanter Unterschied bezüglich der Geschlechterverteilung.

Frühere Studien, die darauf abzielten, die Verwendung von Sonnenschutzmaßnahmen und die individuelle Risikowahrnehmung zu verbessern, zeigten, dass nach der jeweiligen Intervention häufiger Sonnencreme verwendet wurde [12, 25]. In dieser Folgebefragung berichtete fast die Hälfte der Außenberufstätigen, ein besseres Sonnenschutzverhalten entwickelt zu haben, allerdings zeigte sich die geringste Verbesserung bei der Verwendung von Sonnencreme. Entsprechend den Angaben im Fragebogen ist der Anteil an Außenberufstätigen, die während der Arbeit im Freien keine Sonnencreme verwendeten, vermeintlich gleichgeblieben (2016: 57,7 % vs. 2017: 54,2 %). Interessanterweise gab dennoch die Hälfte der Teilnehmer, die sich bewusster schützten, an, öfters Sonnencreme zu verwenden. Somit lässt sich zwar eine minimale Verbesserung bei diesen Außenberufstätigen feststellen, allerdings war der Anteil, der keine Sonnencreme verwendete, im Vergleich zu anderen Außenberufsgruppen deutlich höher. Bei Bergführern lag der Anteil beispielsweise nur bei 1,1 %, bei Dachdeckern bei 13,6 % und bei Gärtnern zwischen 19,2 % und 26,8 % [27, 28]. Eine Erklärung für diese deutlichen Unterschiede könnte sein, dass die hier betrachtete Außenberufsgruppe zu 94 % aus Landwirten bestand, die unter anderem aufgrund eines staubigen Arbeitsumfelds dazu neigen, seltener Sonnencreme zu verwenden [29].

Im Einklang mit anderen Studien [12, 25] deuten die Daten darauf hin, dass die Befragten vorsichtiger hinsichtlich ihrer Sonnenexposition waren. Fast die Hälfte der befragten Außenberufstätigen gab an, die Mittagssonne zu meiden, was einem Zuwachs von 17 Prozentpunkten entsprach. Interessanterweise wurde in einer Interventionsstudie ein signifikanter Rückgang des Tragens von Sonnenschutzkleidung beobachtet [25], was widersprüchlich zu unseren Daten ist. Sowohl Außen- als auch Innenberufstätige berichteten, vermehrt Schutzkleidung zu tragen. Dieser Unterschied könnte auf die verschiedenen Studienpopulationen zurückzuführen sein, da in unserer Studie das Durchschnittsalter bei 54,5 Jahren lag, während bei der anderen Studie teilweise auch Kinder untersucht wurden [25].

Die Mehrheit der Teilnehmer gab an, nach der Erstbefragung ein gesteigertes Bewusstsein zu haben. Inwiefern dies der Wirklichkeit entspricht, kann diese Studie, allein basierend auf den Eigenangaben der Teilnehmer, nicht beantworten, allerdings sprechen die Daten dafür, dass die Teilnehmer zumindest ein erhöhtes Bewusstsein im Hinblick auf die Notwendigkeit der Verbesserung von Sonnenschutz als auch der Wahrnehmung von Hautveränderungen haben. So gaben knapp 7 von 10 Außenberufstätigen an, bewusster auf Hautveränderungen zu achten, und fast 9 von 10, dass sie nun früher einen Dermatologen aufsuchen würden. Diese angegebene Verbesserung wäre wichtig, da durch ein frühzeitiges Aufsuchen eines Dermatologen sowohl Primär- als auch Sekundärprävention ge-

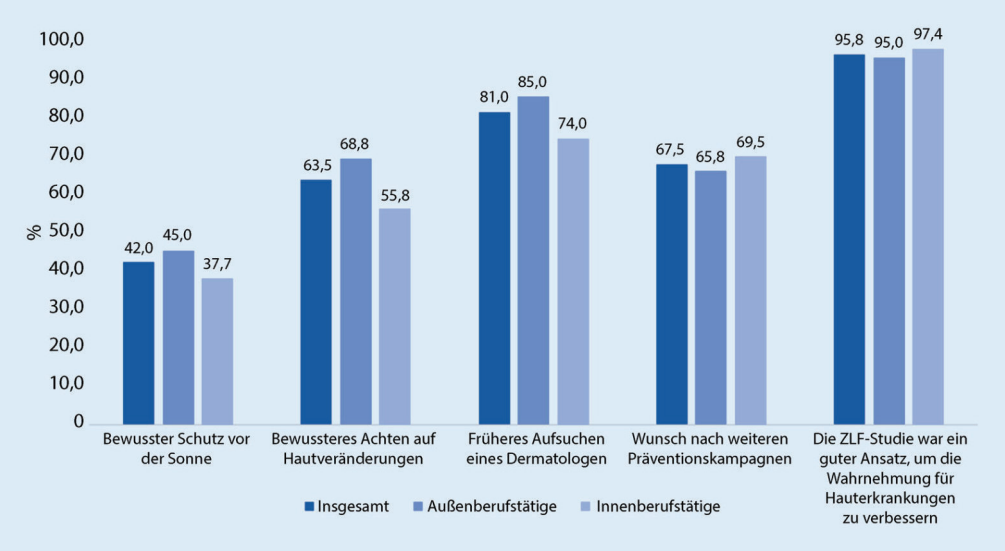

Abb. 3 ◀ Ergebnisse der Evaluationsfragen der Folgeerhebung der ZLF(Bayerisches Zentral-Landwirtschaftsfest)-Studie 2016

stärkt werden können. So kann im Falle einer Erkrankung möglichst früh mit einer passenden Therapie begonnen werden, wodurch die sozioökonomische Belastung von AK und KK reduziert werden kann [14, 15].

Trotz zahlreicher Präventionskampagnen zum Thema Hautkrebs [3, 6, 20] demonstrierte eine vorherige Studie, dass sich über die Hälfte der Befragten weitere Informationen zu Präventionsmaßnahmen wünschte [27]. In dieser Befragung äußerten sogar zwei Drittel der Befragten den Wunsch nach weiteren Präventionskampagnen wie der ZLF-Studie. Hierbei wäre es wichtig, dass zukünftige Gesundheitsprogramme v. a. auch die Heterogenität der verschiedenen Außenberufsgruppen beachten, da sich diese beispielsweise hinsichtlich ihrer beruflichen UV-Exposition und Krankheitslast deutlich unterscheiden [28].

Limitationen

Bei dieser Studie sind einige Limitationen zu beachten. Generell kann es durch das Setting der ursprünglichen Erhebung, einer Landwirtschaftsmesse, zu einem Selektionsbias gekommen sein. Ältere oder kranke Personen werden wahrscheinlich seltener eine solche Messe besuchen. Zudem werden v. a. Personen, die ein landwirtschaftliches Interesse haben, eine derartige Messe aufsuchen. Dies ist allerdings eher positiv, da das Studienziel war, viele Außenberufstätige zu untersuchen, was angesichts des hohen Anteils an Landwirten erreicht wurde. Bei Teilnehmern dieser Folgebefragung kann außerdem davon ausgegangen werden, dass sie ein erhöhtes Interesse an gesundheitlichen Themen haben, da sie sich explizit für die Folgebefragung zur Verfügung stellten. Eine weitere Limitation ist, dass nicht nachvollziehbar ist, inwieweit sich das Schutzverhalten und das Bewusstsein jedes Einzelnen verbessert haben, da die Angaben beider Befragungen anonym waren und die Daten der zweiten Befragung daher nicht der ersten Befragung zugeordnet werden können. Des Weiteren beruhen die Daten auf Selbstangaben, weshalb es zu einer Verzerrung durch soziale Erwünschtheit oder einem „recall bias“ gekommen sein kann.

Ausblick

Insgesamt gaben die meisten Teilnehmer eine Verbesserung des Schutzverhaltens sowie des Bewusstseins für Hautveränderungen an. Ungeachtet dessen hat jedoch noch immer ein erheblicher Anteil an Personen ein unzureichendes Schutzverhalten. Genau diese Population gilt es, durch weitere Präventionskampagnen gezielt zu erreichen. Da nahezu alle Personen fanden, dass der Ansatz einer Präventionskampagne auf einem Landwirtschaftsfest ein sehr guter Ansatz war, um die Wahrnehmung von Hautveränderungen zu verbessern, könnten zukünftige Kampagnen ähnliche Settings nutzen, um durch einen einfachen Zugang zu Gesundheitsleistungen eine möglichst hohe Teilnehmerrate zu erreichen und so zur Senkung der Krankheitslast von AK und KK beizutragen.

Fazit für die Praxis

- **Die Studie konnte zeigen, dass durch die Präventionskampagne, die an einem unkonventionellen Setting, einer Landwirtschaftsmesse, durchgeführt wurde, eine große Teilnehmerzahl der Zielgruppe der Außenberufstätigen erreicht werden konnte.**
- **Ein Jahr nach Studiendurchführung berichtete die Mehrheit der Außen- und Innenberufstätigen von einer Verbesserung des Sonnenschutzes sowie der Wahrnehmung von Hauterkrankungen, was v. a. für Außenberufstätige galt.**
- **In der Bevölkerung scheint der Bedarf weiterer Präventionskampagnen, die ähnliche Settings nutzen könnten, groß zu sein, da immer noch ein erheblicher Anteil an Personen ein unzureichendes Sonnenschutzverhalten aufweist und zwei Drittel den Wunsch nach weiteren Präventionskampagnen äußerten.**

Korrespondenzadresse

Linda Tizek, MPH
Fakultät für Medizin,
Klinik und Poliklinik
für Dermatologie und
Allergologie am Biederstein,
Technische Universität
München
Biedersteiner Str. 29,
80802 München, Deutschland

PD. Dr. Dr. med. Alexander Zink, MPH
Fakultät für Medizin, Klinik und Poliklinik für Dermatologie und Allergologie am Biederstein, Technische Universität München
Biedersteiner Str. 29, 80802 München, Deutschland
alexander.zink@tum.de

Förderung. Teile dieser Studie wurden finanziell unterstützt von der Novartis Pharma GmbH.

Funding. Open Access funding provided by Projekt DEAL.

Einhaltung ethischer Richtlinien

Interessenkonflikt. L. Tizek, M.C. Schielein, B. Schuster, S. Ziehfreund, T. Biedermann und A. Zink geben an, dass kein Interessenkonflikt besteht.

Alle beschriebenen Untersuchungen am Menschen oder an menschlichem Gewebe wurden mit Zustimmung der zuständigen Ethikkommission, im Einklang mit nationalem Recht sowie gemäß der Deklaration von Helsinki von 1975 (in der aktuellen, überarbeiteten Fassung) durchgeführt. Von allen beteiligten Patienten liegt eine Einverständniserklärung vor.

Literatur

1. Augustin J, Kis A, Sorbe C, Schäfer I, Augustin M (2018) Epidemiology of skin cancer in the German population. impact of socioeconomic and geographic factors. J Eur Acad Dermatol Venereol 32(11):1906–1913
2. Boehmer D, Schuster B, Krause J, Darsow U, Biedermann T, Zink A (2018) Prevalence and treatment of allergies in rural areas of Bavaria, Germany. A cross-sectional study. World Allergy Organ J 11(1):36
3. Correia O, Correia B, Duarte AF (2017) A skin cancer prevention campaign. Spreading the word on sugar packets. JAMA Dermatol 153(2):129–130. https://doi.org/10.1001/jamadermatol.2016.4232
4. Diepgen TL, Drexler H, Elsner P, Schmitt J (2015) UV-irradiation-induced skin cancer as a new occupational disease. Hautarzt 66(3):154–159
5. Diepgen TL (2016) New developments in occupational dermatology. J Dtsch Dermatol Ges 14(9):875–889
6. Diffey BL, Norridge Z (2009) Reported sun exposure, attitudes to sun protection and perceptions of skin cancer risk. A survey of visitors to cancer research UK's sunsmart campaign website. Br J Dermatol 160(6):1292–1298
7. Eissing L, Schäfer I, Strömer K, Kaufmann R, Enk A, Reusch M, Augustin M (2017) Perception of statutory skin cancer screening in the general population: current findings on participation, knowledge and evaluation. Hautarzt 68(5):371–376
8. Hingle MD, Snyder AL, McKenzie NE, Thomson CA, Logan RA, Ellison EA, Koch SM, Harris RB (2014) Effects of a short messaging service-based skin cancer prevention campaign in adolescents. Am J Prev Med 47(5):617–623
9. Kornek T, Augustin M (2013) Skin cancer prevention. J Dtsch Dermatol Ges 11(4):283–296
10. Leiter U, Keim U, Eigentler T, Katalinic A, Holleczek B, Martus P, Garbe C (2017) Incidence, mortality, and trends of nonmelanoma skin cancer in Germany. J Invest Dermatol 137(9):1860–1867
11. Lucas R, McMichael T, Smith W, Armstrong BK (2006) Solar ultraviolet radiation. Global burden of disease from solar ultraviolet radiation. Environmental burden of disease series, Bd. 13. World Health Organization, Geneva
12. Millán-Cayetano JF, Delgado-Sánchez N, Aguilar-Bernier M, Rivas-Ruiz F, Blázquez-Sánchez N, Fernández-Canedo I, de Troya-Martín M (2019) Skin cancer prevention. Evaluation of an intervention focused on primary care. Popul Health Manag 22(3):278–279. https://doi.org/10.1089/pop.2019.0024
13. Nahar VK, Ford MA, Boyas JF, Brodell RT, Hutcheson A, Davis RE, Beason KR, Bass MA, Biviji-Sharma R (2014) Skin cancer preventative behaviors in state park workers. a pilot study. Environ Health Prev Med 19(6):467–474
14. Nehal KS, Bichakjian CK (2018) Update on keratinocyte carcinomas. N Engl J Med 379(4):363–374
15. Pil L, Hoorens I, Vossaert K, Kruse V, Tromme I, Speybroeck N, Brochez L, Annemans L (2016) Burden of skin cancer in Belgium and cost-effectiveness of primary prevention by reducing ultraviolet exposure. Prev Med 93:177–182
16. Rogers HW, Weinstock MA, Feldman SR, Coldiron BM (2015) Incidence estimate of nonmelanoma skin cancer (keratinocyte carcinomas) in the U.S. population, 2012. JAMA Dermatol 151(10):1081–1086
17. Rudolph C, Schnoor M, Eisemann N, Katalinic A (2015) Incidence trends of nonmelanoma skin cancer in Germany from 1998 to 2010. J Dtsch Dermatol Ges 13(8):788–797
18. Schmitt J, Seidler A, Diepgen TL, Bauer A (2011) Occupational ultraviolet light exposure increases the risk for the development of cutaneous squamous cell carcinoma: a systematic review and meta-analysis. Br J Dermatol 164(2):291–307
19. Sinclair M, O'Toole J, Malawaraarachchi M, Leder K (2012) Comparison of response rates and cost-effectiveness for a community-based survey. Postal, internet and telephone modes with generic or personalised recruitment approaches. BMC Med Res Methodol 12:132
20. Stratigos AJ, Forsea AM, van der Leest RJT, de Vries E, Nagore E, Bulliard J-L, Trakatelli M, Paoli J, Peris K, Hercogova J, Bylaite M, Maselis T, Correia O, Del Marmol V (2012) Euromelanoma. A dermatology-led European campaign against nonmelanoma skin cancer and cutaneous melanoma. Past, present and future. Br J Dermatol 167(2):99–104
21. Tille F, Gibis B, Balke K, Kuhlmey A, Schnitzer S (2017) Soziodemografische und gesundheitsbezogene Merkmale der Inanspruchnahme und des Zugangs zu haus- und fachärztlicher Versorgung – Ergebnisse einer deutschlandweiten Bevölkerungsbefragung von 2006 bis 2016. Z Evid Fortbild Qual Gesundhwes 126:52–65
22. Tizek L, Schielein MC, Rüth M, Szeimies R-M, Philipp-Dormston WG, Braun SA, Hecker C, Eberlein B, Biedermann T, Zink A (2019) Interest in skin cancer in urban populations. A retrospective analysis of Google search terms in nine large German cities. Acta Derm Venereol 99(9):797–804
23. Tizek L, Schielein M, Spinner CD, Watzele R, Kratzer P, Böhner A, Seifert F, Biedermann T, Zink A (2019) New perspectives on health prevention. Prevalence of hypertension, hypacusis and balance disorders at the Munich Oktoberfest 2016. MMW Fortschr Med 161(4):9–14
24. Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A (2019) Skin diseases are more common than we think. Screening results of an unreferred population at the Munich Oktoberfest. J Eur Acad Dermatol Venereol 33(7):1421–1428
25. Wu YP, Nagelhout E, Aspinwall LG, Boucher KM, Parsons BG, Kohlmann W, Kaphingst KA, Homburger S, Perkins RD, Grossman D, Harding G, Leachman SA (2018) A novel educational intervention targeting melanoma risk and prevention knowledge among children with a familial risk for melanoma. Patient Educ Couns 101(3):452–459
26. Ziehfreund S, Schuster B, Zink A (2019) Primary prevention of keratinocyte carcinoma among outdoor workers, the general population and medical professionals. A systematic review updated for 2019. J Eur Acad Dermatol Venereol 33(8):1477–1495
27. Zink A, Wurstbauer D, Rotter M, Wildner M, Biedermann T (2017) Do outdoor workers know their risk of NMSC? Perceptions, beliefs and preventive behaviour among farmers, roofers and gardeners. J Eur Acad Dermatol Venereol 31(10):1649–1654
28. Zink A, Tizek L, Schielein M, Böhner A, Biedermann T, Wildner M (2018) Different outdoor professions have different risks—a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. J Eur Acad Dermatol Venereol 32(10):1695–1701
29. Zink A, Schielein M, Wildner M, Rehfuess EA (2019) '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. Br J Dermatol 180(6):1412–1419
30. Zink AGS, Rüth M, Watzele R, Nigg CR, Rehfuess EA (2018) Failure of a print media sun safety campaign to reach high-risk occupational groups. Acta Derm Venereol 98(8):811–812

Acknowledgements

During the last three years, I was supported by so many inspiring people, whom I want to thank. Finishing my Ph.D. project would not have been possible without their invaluable help.

First of all, I would like to thank Alexander Zink. You are one of the best supervisors I could imagine having. It is fascinating to see how our research group has developed over the past years because of your exciting project ideas, your cooperation, and your continuous support. At the same time, I would like to thank my other scientific mentors and Ph.D. Thesis Advisory Committee, who have provided valuable input on the development and execution of my studies: Prof. Dr. Markus Ege and Dr. Ursula Berger, who have supported me from the beginning, Prof. Dr. Bernadette Eberlein, who thankfully supervised me from the beginning on behalf of the TUM, and Prof. Dr. Manfred Wildner, who joined as a new supervisor at the end of my Ph.D.

I would also like to thank Prof. Ulrich Mansmann, who provided the opportunity to do my Ph.D. thesis at the IBE. Furthermore, I would like to acknowledge Dr. Magda Radermacher, Monika Darchinger, and Dr. Annette Hartmann for organizing the Ph.D. program.

In particular, I would like to thank my wonderful colleagues Maximilian Schielein, Barbara Schuster, and Stefanie Ziehfreund. I am happy to not only have had the opportunity to work together with you in our building of happiness, but to also share with you so many awesome memories as friends. In addition, I would also like to thank Alexander Böhner, Florian Seifert, Marie Hoerl, and the numerous other helpers who supported me in collecting data at the ZLF and INTERFORST. Thank you!

I would like to express my thanks to all coauthors, institutions, and companies for their collaboration as well as their agreement to use the publications for my Ph.D. thesis. Namely, I would like to thank the *'Sozialversicherung für Landwirtschaft, Forsten und Gartenbau'* for the great organization and cooperation which have made the studies possible. I would also like to thank the whole team of '*Kapwa Marketing'*, especially Melvin and John Rüth, with whom I had an extraordinary experience in the Philippines.

Finally, I would like to thank my family and friends. I am indescribably grateful for the support from my parents and my brothers. And to my dearest friends, who have become my family in Munich. I hope you don't mind that I put down in words how wonderful life is while you're in the world!

Scientific Publications

Weber A, **Tizek L**, Biedermann T, Zink A. High-risk body sites for actinic keratosis in outdoor and indoor workers: A retrospective review. J Am Acad Dermatol 2020.

Schielein MC, **Tizek L**, Schuster B, Ziehfreund S, Liebram C, Eyerich K et al. Always Online? Internet Addiction and Social Impairment in Psoriasis across Germany. J Clin Med 2020; 9(6).

Kaczmarczyk R, Bauerdorf F, **Tizek L**, Biedermann T, Zink A. A network analysis of the EADV 2019 conference. J Eur Acad Dermatol Venereol 2020.

Schielein MC, **Tizek L**, Schuster B, Ziehfreund S, Biedermann T, Zink A. Genital Psoriasis and Associated Factors of Sexual Avoidance - A People-centered Cross-sectional Study in Germany. Acta Derm Venereol 2020; 100(10):adv00151.

Tizek L, Schielein MC, Berger U, Ege MJ, Schneider S, Zink A. Skin cancer risk and shade: comparing the risk of foresters with other outdoor workers. J Eur Acad Dermatol Venereol 2020.

Tizek L, Schielein MC, Berger U, Seifert F, Biedermann T, Böhner A et al. Regional differences in medical needs and care for skin cancer across Bavaria: confronting the gap. Eur J Dermatol 2020.

Tizek L, Schielein MC, Schuster B, Ziehfreund S, Biedermann T, Zink A. Effekte einer unkonventionellen Hautkrebs-Präventionskampagne: Auswirkungen auf das Sonnenschutz-verhalten von Außenberufstätigen [Effects of an unconventional skin cancer prevention campaign: Impacts on the sun protection behavior of outdoor workers]. Hautarzt. 2020.71(6):455-462.

Frasheri L, Schielein MC, **Tizek L**, Mikschl P, Biedermann T, Zink A. Great green tea ingredient? A narrative literature review on epigallocatechin gallate and its biophysical properties for topical use in dermatology. Phytother Res 2020.

Schielein MC, **Tizek L**, Seifert F, Biedermann T, Zink A. Versorgung von chronisch entzündlichen Hauterkrankungen: Gehen Betroffene zum niedergelassenen Dermatologen? [Health care of chronic inflammatory skin diseases: Do affected individuals seek dermatological care?]. Hautarzt. 2019;70(11):875-882.

Schuster B, Ziehfreund S, **Tizek L**, Krause J, Biedermann T, Zink A. Wie offen ist die bayerische Bevölkerung für Teledermatologie? Eine Querschnittsstudie in ländlichen und

städtischen Regionen Bayerns [Is the Bavarian Population Open for Teledermatology? A Cross-Sectional Study in Rural and Urban Regions of Bavaria, Germany]. Gesundheitswesen. 2019.

Tizek L, Schielein M, Rüth M, Ständer S, Pereira MP, Eberlein B et al. Influence of Climate on Google Internet Searches for Pruritus Across 16 German Cities: Retrospective Analysis. J Med Internet Res 2019; 21(7):e13739.

Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A. Response to 'Letter to the editor' by Wienholtz et al. entitled 'The many faces of rosacea: liberal diagnostic criteria have ramifications on disease prevalence and accuracy'. J Eur Acad Dermatol Venereol 2019; 33(11):e428.

Tizek L, Schielein MC, Rüth M, Szeimies R-M, Philipp-Dormston WG, Braun SA et al. Interest in Skin Cancer in Urban Populations: A Retrospective Analysis of Google Search Terms in Nine Large German Cities. Acta Derm Venereol 2019; 99(9):797–804.

Tizek L, Schielein M, Spinner CD, Watzele R, Kratzer P, Böhner A, Seifert F, Biedermann T, Zink A. Neue Perspektiven zur Gesundheitsprävention: Prävalenz von Hypertonie, Hypakusis und Gleichgewichtsstörungen beim Münchner Oktoberfest [New perspectives on health prevention. Prevalence of hypertension, hypacusis and balance disorders at the Munich Oktoberfest 2016]. MMW Fortschr Med. 2019. 161(Suppl 4):9-14.

Tizek L, Schielein MC, Seifert F, Biedermann T, Böhner A, Zink A. Skin diseases are more common than we think: screening results of an unreferred population at the Munich Oktoberfest. J Eur Acad Dermatol Venereol 2019; 33(7):1421–8.

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(12):2153–61.

Zink A, **Tizek L**, Schielein M, Böhner A, Biedermann T, Wildner M. Different outdoor professions have different risks - a cross-sectional study comparing non-melanoma skin cancer risk among farmers, gardeners and mountain guides. J Eur Acad Dermatol Venereol 2018; 32(10):1695–701.

Schielein MC, **Tizek L**, Rotter M, Konstantinow A, Biedermann T, Zink A. Guideline-compliant prescription of biologicals and possible barriers in dermatological practices in Bavaria. J Eur Acad Dermatol Venereol 2018; 32(6):978–84.

Tizek L, Krause J, Biedermann T, Zink A. Satisfaction of mountain guides with high sun protection as a tool to prevent non-melanoma skin cancer. J Eur Acad Dermatol Venereol 2017; 31(11):1825–7.