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ORIGINAL ARTICLE

Occupational skin cancer screening: Results of a cross-sectional study at the city drainage company Munich

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Abstract

Background: Since skin cancer incidence and prevalence are rising steadily, the prevention of skin cancer has gained importance. People with high sun exposure at work are at special risk, and prevention measures by the employer may lower the risk, especially for keratinocyte carcinoma.

Objectives: The aim of the study was to evaluate the results of a large-scale skin cancer screening campaign at the city drainage company Munich where the cohort consisted mainly of outdoor workers.

Methods: In 2023, a skin cancer screening campaign was conducted at the city drainage company Munich. Sun exposure and protection measures of each participant were assessed using a questionnaire. Dermatologists identified clinical signs for sun damage and skin cancer by whole-body skin examination.

Results: A total of 290 participants (72.8% male; mean age 43.7 ± 11.5 years) were enroled. 36.6% showed clinical signs of sun damage correlating with male gender, higher age, and more hours spent outdoors per day. Clinical examination revealed a suspect finding of skin cancer, a preliminary stage, or a lesion requiring clinical control to avoid skin cancer development in 19.3% of participants. Participants with atypical melanocytic lesions were mostly female and showed a high skin cancer awareness. This was concluded from the fewer signs of sun damage, a higher percentage of previous screening participation, and more regular self-examination.

Conclusions: Whole-body examination for skin cancer screening at work is a valuable tool to encourage participation in this preventive measure. It may help identify people at risk either by clinical signs for sun damage or risk exposure which can be assessed with a simple questionnaire. Based on this result, the screening interval may be adopted individually.

KEYWORDS
occupational prevention, screening, skin cancer, sun damage

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INTRODUCTION

The most common skin cancers are melanoma and keratinocyte-related malignancies such as basal cell carcinoma and squamous cell carcinoma. While melanoma has a high potential to metastasize and, therefore, mainly contributes to skin cancer mortality, keratinocyte carcinoma (KC) grows locally destructive but bears a far lower risk for metastasis formation. In most types of skin cancer, there is a close relationship between ultraviolet (UV) light exposure and the likelihood to develop the malignancy.[1,2] Interestingly, the massive rise in skin cancer incidence is often traced back to an increased UV exposure over the last decades.[3,4]

In addition to sun exposure during leisure activities, a substantial part of the population is also affected by occupational UV exposure while working outdoors. Fortunately, UV-induced skin cancer was recognized in Germany as an occupational disease paving the way for a raised awareness and for the implementation of preventive measures at the workplace.[5,6] Primary prevention includes regular theoretical and practical trainings about UV protection measures as well as the provision of, for example, sunscreen, sunglasses, hats, etc., by the employer. As a form of secondary prevention, skin cancer screening by whole-body examination may help identify skin cancer at an early stage.[7,8] Despite the controversies surrounding whole-population skin cancer screening programmes due to missing evidence for mortality reduction,[9] screening in adaption to the different risk factors such as age, sex, ethnicity, geography, socioeconomic factors, and access to health care seems reasonable.[8] Since especially outdoors workers are at risk for skin cancer due to a high cumulative UV exposure, regular screening programmes provided by the employer may be a valuable tool for secondary prevention.[10,11] Despite its well-known need in outdoor professionals,[12] large studies analyzing the impact of occupational health campaigns offering especially whole-body examinations as a form of secondary prevention, are missing so far.

We here report the results of a large-scale skin cancer screening measure at the city drainage company Munich as part of an occupational health campaign. The participants mainly consisted of outdoor workers, but also some indoor workers with clerical activities. The aim of the study was to investigate the overall risk for skin cancer of workers at the city drainage company and to derive specific preventive measures from these data.

METHODS

As part of an occupational health campaign, 290 employees of the city drainage company Munich took part in a dermatological skin cancer screening programme in 2023. Slots for 290 participants were available at a total number of eligible employees of 1.100. All participants provided written consent for their participation, and the study had been approved by the ethics committee of the Medical Faculty of the Technical University of Munich (reference 197/15s).

Before the examination, each participant filled out a questionnaire on UV-related risk behaviour and prevention measures. The self-administered questionnaire asked for information regarding sunburns in childhood and adulthood. Participants had to choose amongst the given answers (1) never; (2) rarely; (3) once per summer; (4) more than twice per summer. The questions also covered the performance of self-examination, history of skin cancer, previous participation in a skin cancer screening, and the application of sun protection factor (SPF) on a normal sunny day. Furthermore, the number of hours spent outdoors on a regular day was documented.

Thereafter, a detailed whole-body examination focusing on the occurrence of skin cancer was conducted by a dermatologist with the aid of a mobile dermatoscope. Atypical lesions were documented, and either a follow-up or therapy/excision was recommended. The respective participants were then referred to their local dermatologists for further follow-up or treatment. In addition, age, gender, skin type according to Fitzpatrick (I-VI), number of nevi, and signs of sun damage were documented. The following findings were regarded as signs of sun damage: Cutis rhomboidalis nuchae (CRN), Erythrosis interfollicularis colli (EIC), Morbus Favre-Racouchot (FC), actinic keratosis (AK), and lentigo solaris (LS).

To better understand sun exposure and sun protection practices, participants were divided into two groups: with and without signs of sun damage in the examination. Both groups were characterized by their answers on the questionnaire. Next, the pathological findings related to skin cancer were further analyzed by type of finding, treatment recommendation, and gender of the participant. Moreover, the number of nevi, skin type, and questionnaire results of participants with an atypical melanocytic lesion (ML) were compared to participants without any atypical ML.

Data were analyzed and visualized using Microsoft Office and Graph Pad Prism 10. For comparison of respective groups for categorical variables the Fisher's exact test was used because of the small sample size in some cases. For continuous variables the unpaired t-test or the Mann–Whitney test were applied. Before, normal distribution was assessed by a QQ plot and calculation of the Kolmogorov–Smirnov test. The threshold for statistical significance was set at $p < 0.05$.

RESULTS

The 290 participants (72.8% male) had a mean age of 43.7 ± 11.5 years. The results of the questionnaire from the whole study population, as well as skin type and number of nevi assessed by a dermatologist, can be found in Table 1. Differences between male and female participants were identified. Women were more likely to perform regular self-examinations (31.6%) compared to men (18.5%), spent less time outdoors and applied more SPF (Table 1).

Of all participants, 36.6% showed signs of sun damage in the whole-body examination (Figure 1a). CRN was the most frequently detected sign of sun damage, followed by EIC (Figure 1b). The proportion of participants with sun damage was significantly higher in the male population (Figure 1c), and individuals with sun damage were older (mean 47.9 vs. 41.4 years; Figure 1d). Furthermore, the group with signs of sun damage reported a significantly higher number of hours spent outdoors per day despite a large variation of the answers (Figure 1e). This group tended to less everyday use of SPF (Figure 1f) and showed a slightly larger proportion of individuals who never perform self-examination (Figure 1g). The distribution of sunburns in childhood and the present, skin type, as well as the frequency of a previous participation in a skin cancer screening was comparable between the two groups (Figure S1a–d).

Upon examination of the whole body, 80.7% of all participants did not show any clinical signs of skin cancer or precursors (Figure 2a). When an atypical skin lesion was suspected, excision was recommended in 50% of the cases, while future clinical controls were advised in 50% of cases. (Figure 2b). Atypical MLs were diagnosed in 8.6%, AK in 3.4%, and KC in 3.1% of the participants. For atypical MLs, mainly clinical control was recommended (Figure 2c). KC or precursor lesions were more prevalent in male participants (Figure 2d), and here, recommendations for excision or therapy were frequent (Figure 2c).

Next, the group of participants with at least one atypical ML was analyzed. In comparison to participants without any atypical ML, a higher number of nevi was observed (Figure 3a). Also, the proportion of participants with skin type I or II was slightly higher in the group with an atypical ML (Figure 3b). Contrarily, signs of sun damage tended to be less frequent (Figure 3c), while previous participation in skin cancer screening was slightly more frequent in individuals with an atypical ML, even if not significant (Figure 3d). Moreover, high SPF, especially SPF 50, was used slightly more frequently (Figure 3e), while the number of hours spent outdoors per day was significantly lower (Figure S2a). Regarding

TABLE 1 Study characteristics and survey results of all participants.

Variable	Participants (*N* = 290)	Female (*N* = 79; 27.2%)	Male (*N* = 211; 72.8%)
Age (years)			
Mean	43.7	42.8	44.1
SD	11.5	11.0	11.6
Sunburns in childhood			
Never	81 (27.9%)	18 (22.8%)	63 (29.9%)
Rarely	122 (42.1%)	44 (55.7%)	78 (37.0%)
Once a year	62 (21.4%)	11 (13.9%)	51 (24.2%)
>Twice a year	23 (7.9%)	5 (6.3%)	18 (8.5%)
Missing	2 (0.7%)	1 (1.3%)	1 (0.5%)
Sunburns in the present			
Never	81 (27.9%)	11 (13.9%)	70 (33.2%)
Rarely	134 (46.2%)	47 (59.5%)	87 (41.2%)
Once a year	56 (19.3%)	15 (19.0%)	41 (19.4%)
>Twice a year	16 (5.5%)	5 (6.3%)	11 (5.2%)
Missing	3 (1.0%)	1 (1.3%)	2 (0.9%)
Self-examination			
Never	72 (24.8%)	10 (12.7%)	62 (29.4%)
Rarely	152 (52.4%)	44 (55.7%)	108 (51.2%)
Regularly	64 (22.1%)	25 (31.6%)	39 (18.5%)
Missing	2 (0.7%)	0	2 (0.9%)
Number of hours spent outside per day			
Mean	4.46	2.65	5.13
SD	2.87	1.40	2.98
≤1 h	22 (7.6%)	10 (12.7%)	12 (5.7%)
1.5–3.0 h	110 (37.9%)	46 (58.2%)	64 (30.3%)
3.5–5.0 h	67 (23.1%)	19 (24.1%)	48 (22.7%)
5.5–8.0 h	56 (19.3%)	3 (3.8%)	53 (25.1%)
>8 h	34 (11.7%)	0	34 (16.1%)
Missing	1 (0.3%)	1 (1.3%)	0
Skin cancer diagnosed in the past			
Yes	7 (2.4%)	2 (2.5%)	5 (2.4%)
No	283 (97.6%)	77 (97.5%)	206 (97.6%)
Skin cancer screening performed in the past			
Yes	180 (62.1%)	57 (72.2%)	123 (58.3%)
No	110 (37.9%)	22 (27.8%)	88 (41.7%)

(Continues)

TABLE 1 (Continued)

Variable	Participants (*N* = 290)	Female (*N* = 79; 27.2%)	Male (*N* = 211; 72.8%)
Use of sun protection factor on a normal day			
None	109 (37.6%)	15 (19.0%)	94 (44.5%)
SPF 10–20	17 (5.8%)	8 (10.1%)	9 (4.2%)
SPF 30	99 (34.1%)	31 (39.2%)	68 (32.2%)
SPF 50	65 (22.4%)	25 (31.6%)	40 (19.0%)
Skin type			
I	28 (9.7%)	6 (7.6%)	22 (10.4%)
II	202 (69.7%)	65 (82.3%)	137 (64.9%)
III	45 (15.5%)	8 (10.1%)	37 (17.5%)
IV	10 (3.4%)	0	10 (4.7%)
V	2 (0.7%)	0	2 (0.9%)
VI	3 (1.0%)	0	3 (1.4%)
Number of nevi			
<20	136 (46.9%)	32 (40.5%)	104 (49.3%)
20–50	123 (42.4%)	37 (46.8%)	86 (40.8%)
>50	31 (10.7%)	10 (12.7%)	21 (10.0%)

Abbreviation: SPF, sun protection factor.

self-examination, sunburns in the present as well as in childhood, no significant differences between the two groups could be observed (Figure S2b–d).

DISCUSSION

This study investigated signs of chronic sun damage and skin cancer in 290 employees of a city drainage company. Since outdoor workers are at higher risk for developing UV-related skin cancer, this skin cancer screening campaign was organized by the occupational health management of the firm.

Apart from KC, CRN, EIC, FC, and LS are common benign signs indicating chronic UV exposure.[13] They are preferentially observed in aged skin.[14] Also, in our study, clinical signs of sun damage were mainly observed in older participants. Furthermore, participants who spent more time outdoors were more likely to have clinical signs of sun damage, although the answers in our questionnaire showed a large variation. Regarding everyday use of SPF and self-examination, a tendency for missing protection behaviours was observed in participants with signs of sun damage, even though this was not significant. This may be in line with previous studies suggesting insufficient UV protection behaviour in outdoor workers even though they are conscious about the risk of developing skin cancer.[11,15] In this study, however, the hours spent outdoors were not differentiated concerning work- and leisure-related activities. This limits statements on work-related sun damage and skin cancer development. Interestingly, chronic sun damage was observed in this relatively young group (mean age 43.7 years). As chronic UV exposure is the most relevant risk factor for KC,[1] this indicates the need for further measures to prevent the development of KC. Moreover, early signs of sun damage, as assessed here, as well as results of a questionnaire on UV exposure, may be used as a general tool for KC risk evaluation. Accordingly, additional UV protection measures and more frequent clinical examinations could be initiated. Of note, the proportion of individuals with signs of sun damage and KC was far larger in the male cohort compared to the female group. This may be explained by a higher health awareness of females translating into the use of more UV protection measures as previous studies suggest.[16–18]

In this study, AK or KC was diagnosed at 6.5% amongst employees of the Munich drainage company. In a similar study amongst 81 sewer workers of comparable age, the incidence of KC or AK was only 3.7%.[10] However, the low number of 3 AK or KC out of 81 cases in total reported by Lang and colleagues is prone to errors in up-scaling. Here, employees of different professions were included amongst some may have higher sun exposure compared to the study performed by Lang et al. In fact, it is described that amongst outdoor professions, skin cancer risk can differ substantially.[11,12] Compared to mountain guides, farmers and gardeners, the incidence of AK and KC was far lower in our cohort of employees of the Munich drainage company who also work in the underground partly.[11,12]

Apart from the identification of KC, whole-body screenings aim for the early detection of melanoma which has a far better prognosis at thin vertical tumour thickness.[19] In this cross-sectional study of relatively young age (mean 43.7 ± 11.5 years), a large proportion of atypical findings was related to MLs. This is in line with evidence that atypical MLs are more frequent in younger populations.[14] In addition, an overrepresentation of female participants in the group with atypical MLs (35.1% female) compared to the whole study population (27.2% female) was observed. This reflects the higher prevalence of melanoma in females until the age of 34.[20]

The group with at least one atypical ML showed also higher numbers of nevi which is considered a well-known risk factor for melanoma.[21] At the same time, sun protection measures seemed to be used more frequently in this group, since there were fewer signs of sun damage and more use of SPF 50, even though not statistically significant. Similarly, the proportion of participants with a

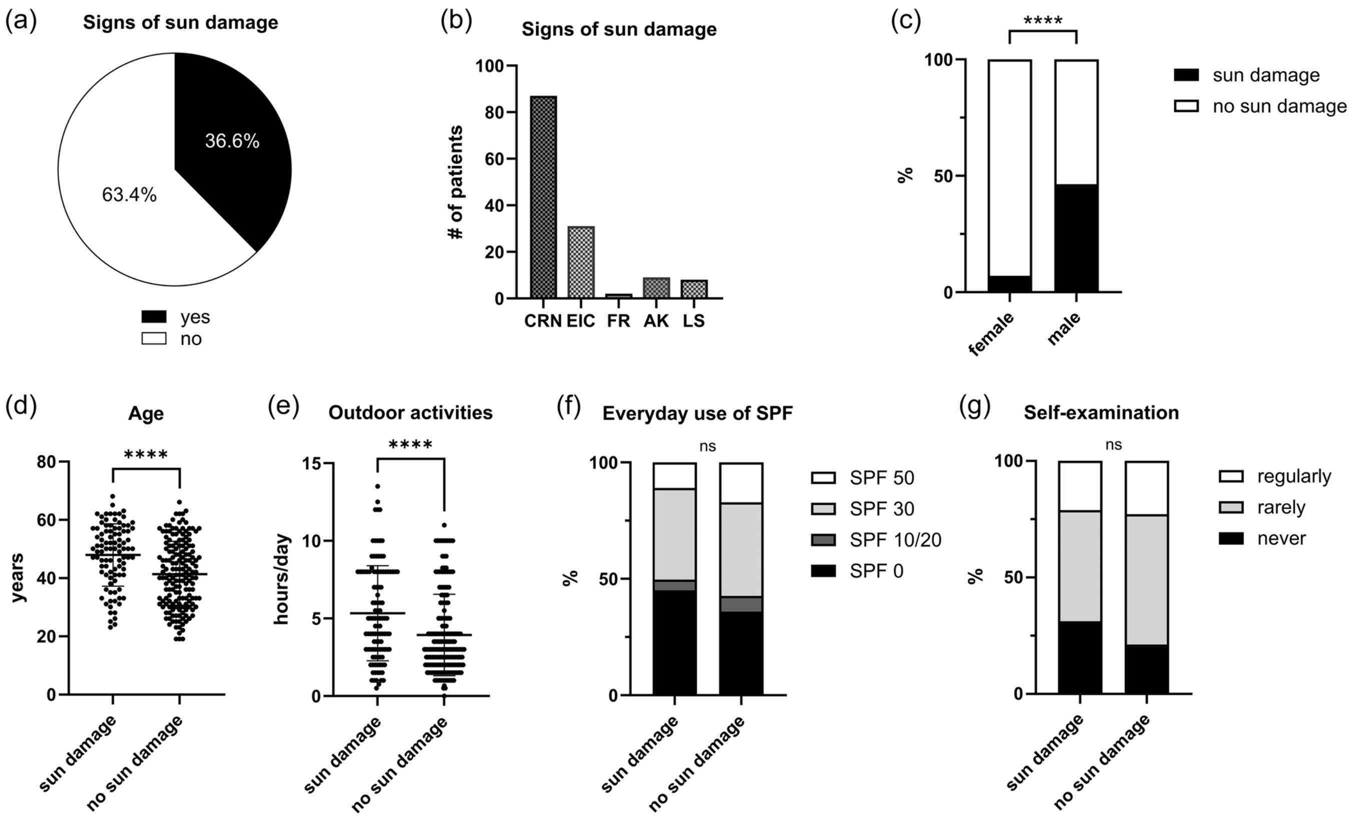

FIGURE 1 Comparison of participants with and without clinical signs of sun damage. By whole-body examination, participants were categorized as with or without clinical signs of sun damage (a). (b) Number of patients with signs of sun damage respectively: Cutis rhomboidalis nuchae (CRN), Erythrosis interfollicularis colli (EIC), Morbus Favre-Racouchot (FC), actinic keratosis (AK) and lentigo solaris (LS). (c) Proportion of participants with and without sun damage for the female and male subgroups. Fisher's exact test: ****$p < 0.0001$. Comparison of participants with/without sun damage related to age (d; unpaired t-test: ****$p < 0.0001$), hours spent outdoors per day (e; Mann–Whitney test: ****$p < 0.0001$), everyday use of SPF (0, 10/20, 30 or 50; f; Fisher's exact test: ns) and self-examination (g; Fisher's exact test: ns). SPF, sun protection factor.

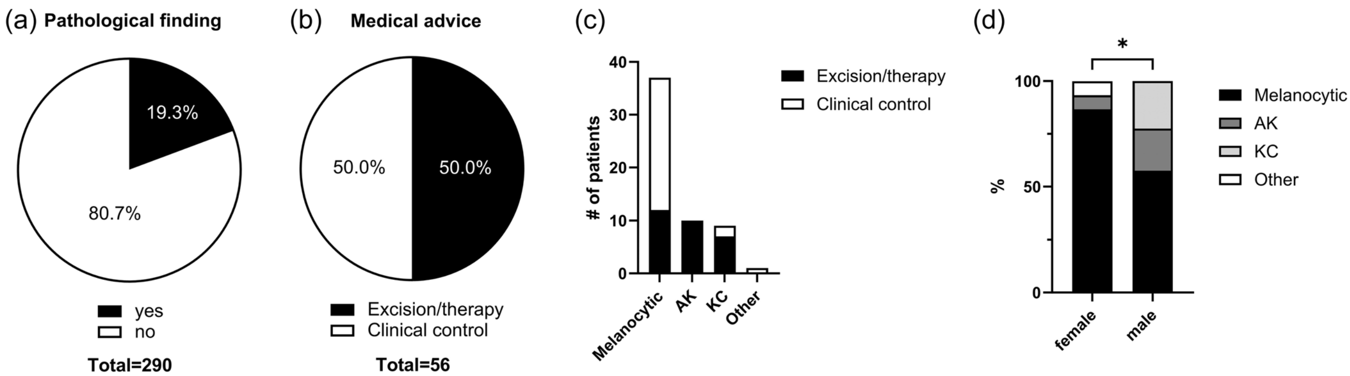

FIGURE 2 Skin-cancer-related findings after whole-body examination. Frequency of pathological signs suspicious for skin cancer after whole-body examination (a). Type of medical advice (excision/therapy or clinical control) in case of pathological finding (b). Distribution of medical advice in dependence of the type of pathological finding (c). Categorization of pathological findings (melanocytic, AK, KC and other) dependent on the gender (d; Fisher's exact test: *$p = 0.0205$).

history of skin cancer screening was higher. Also, self-examination as a useful tool for early detection associated with better long-term survival[22] was performed slightly more often. However, these findings may also be explained by a female overrepresentation in the group with atypical MLs. Different gender-based lifestyle and work characteristics may also be the reason for the differences in the number of hours spent outdoors. Further limitations of this

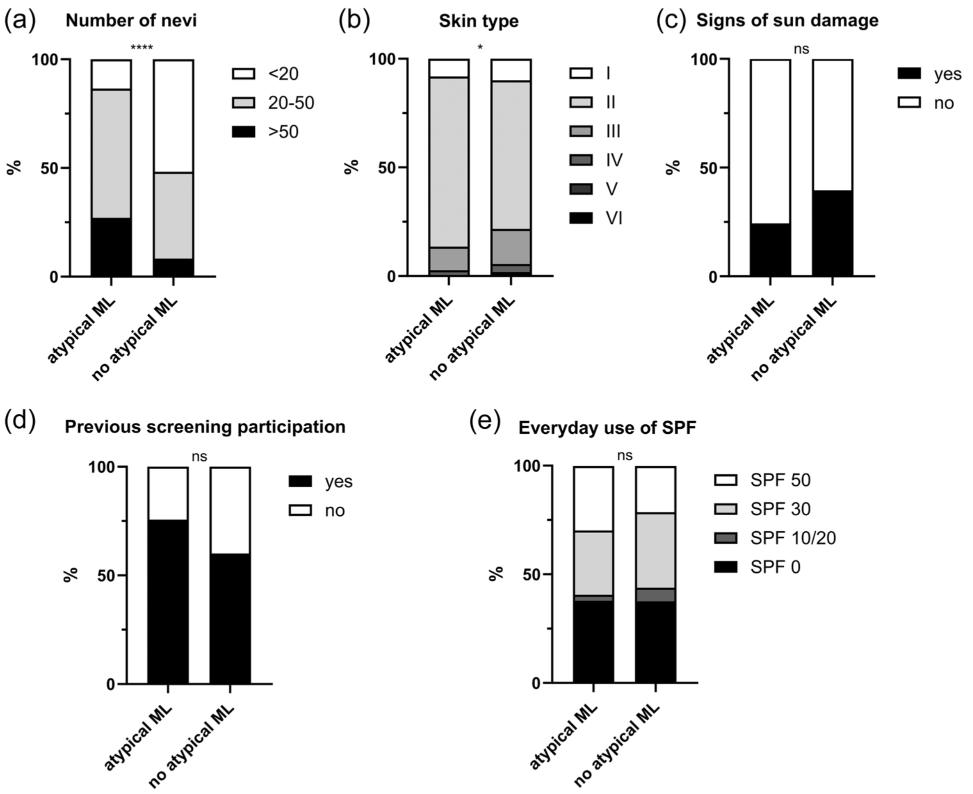

FIGURE 3 Comparison of participants with and without clinical signs of an atypical melanocytic lesion (ML). Distribution of groups (with and without any atypical ML) concerning the number of nevi (a), skin type (b), clinical signs of sun damage (c), previous screening participation (d), and everyday use of SPF (e). Fisher's exact test: ****$p < 0.0001$ and *$p = 0.0137$. SPF, sun protection factor.

study are related to a relatively small sample size. This causes partially small numbers per group. In the analyses on the different skin types e.g., skin types IV–VI are underrepresented. Respectively, larger cohort studies are needed to focus on occupational skin cancer development in these subgroups. Moreover, a selection bias cannot be ruled out since participation was voluntary. Therefore, it can be assumed that skin cancer awareness is higher in the study population in comparison to the overall cohort of employees at the city drainage company.

In summary, skin cancer screening as described here may be a suitable tool for sun damage identification and occupational skin cancer prevention. The additional use of a questionnaire screening for risk factors may help to identify participants at high risk for skin cancer.

CONCLUSIONS

Findings from this occupational skin cancer screening campaign led to the diagnosis of skin cancer and the identification of signs of sun damage. However, larger and longitudinally designed studies on the impact of systematic health campaigns offering whole-body examination as a form of secondary prevention are needed. Hereby, an adopted proceeding in accordance to the individual risk for skin cancer development may be reasonable to investigate. Accordingly, clinical signs of sun damage raised here with CRN, EIC, FC, AK, and LS, as well as individual risk factors assessed by a questionnaire, could be used to adopt skin cancer screening intervals.

Furthermore, the study showed implications for future practice concerning the occupational health management of this specific firm. Based on our study, there is potential to improve the rate of self-examination, SPF application, and participation in skin cancer screenings.

AUTHOR CONTRIBUTIONS

Kristine E. Mayer: Conceptualization; data acquisition; writing—original draft; visualization. **Matthias Schreier** and **Christine Gross**: Planning of the study; organization of screening days. **Sophia Wasserer**: Data acquisition; visualization. **Katja Kranen** and **Patrick Wustrow**: Data acquisition. **Tilo Biedermann** and **Alex Zink**: Writing—review & editing. **Oana-Diana Persa**: Conceptualization, writing—review & editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data is available on request from the authors.

ETHICS STATEMENT

Ethical approval was given by the ethics committee of the faculty of medicine of the Technical University of Munich. All patients in this manuscript have given written informed consent for participation in the study and the use of their de-identified, anonymized, aggregated data and their case details for publication.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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