

Occupational skin cancer may be underreported

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ABSTRACT

INTRODUCTION: Skin cancer may, in some cases, be caused by occupational exposures. The aim of this study was to investigate the prevalence of and exposures leading to occupationally induced skin cancers in Denmark during a ten-year period.

MATERIAL AND METHODS: The study is a descriptive, register-based study comprising all patients with recognized occupational malignant and premalignant skin conditions in Denmark in the 01/01 2000-31/12 2009 period. Data were obtained from The National Board of Industrial Injuries and comprise information about diagnosis, occupational and domestic exposure, anatomic localization, occupation, degree of permanent disability, age and sex.

RESULTS: A total of 36 patients were recognized as occupational skin cancer cases. The mean age was 61 years (44-75 years), 31 men and five women. The most frequent diagnosis was basal cell carcinoma followed by squamous cell carcinoma. No cases of malignant melanoma were recognized. The primary risk factor for development of occupational skin cancer was ultraviolet (UV) exposure during outdoor working.

CONCLUSION: Data based on recognized cases of occupational skin cancer during a ten-year period in Denmark show that non-melanoma skin cancer was the most frequent diagnosis, while the primary risk factor was UV radiation in outdoor occupations. A total of 36 cases were reported over a period of ten years, and underreporting may be suspected. The purpose of the present study was to raise the awareness of occupational skin cancer, and on the basis of existing data to contribute to criteria for the diagnosis of occupational skin cancer.

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Skin diseases are the most frequently recognized group of occupational diseases in Denmark with more than 2,000 annual cases. The group mostly comprises cases of contact dermatitis, and only a few skin cancers. In Denmark, diseases can be recognized as occupationally provoked if they are included in the List of Occupational Diseases (LOD) according to Danish regulations, or, in exceptional cases, if they are accepted as occupational diseases by The Occupational Diseases Committee (Erhvervs sygdomsudvalget), which considers special cases where the exposure is not included in the list, but where a link to occupational exposures is, nevertheless, cred-

ible. Until 2005, skin cancer was deemed to be an occupational disease only when specific chemical exposures could be identified (e.g. tar, asphalt, anthracene and mineral oil) according to the LOD. However, in 2005 exposure to UV irradiation was added to the list [1], **Figure 1.**

Previous studies have related occupational skin cancers to ultraviolet (UV) exposure due to outdoor working, exposures to chemical carcinogens such as polycyclic hydrocarbons, tar and arsenic, as well as UV irradiation from welding, X-ray and industrial burns. The types of skin cancers mainly considered work-related are non-melanoma skin cancers (basal cell carcinoma (BCC) and squamous cell carcinoma (SCC)) [2]. Malignant melanoma is believed to be correlated with intermittent UV exposure rather than cumulative sun exposure, particularly early in life, and there is speculation as to whether this is also the case for BCC [3]. Other skin conditions considered work-related are premalignant affections such as Bowen's disease caused by arsenic exposure and actinic keratoses as well as malignant lentigo due to sunlight [2].

Denmark is a country with a high incidence of skin cancer. The number of registered cases of non-melanoma skin cancers (NMSC) in 2009 was 434 cases per 100,000 (11,251 per year in total in Denmark) [4]. For comparison, around 180,000 employees are engaged in outdoor work in Denmark (farming, gardening, forestry, fishing, raw material extraction, oil refineries and construction) [5, 6].

The aim of this study was to describe the prevalence and exposures leading to skin cancers recognized as occupational diseases in Denmark during a ten-year period. Relation to anatomic localization, degree of permanent disability and occupation was examined. This information is important for the understanding of skin cancer as an occupational disease, and may also serve to draw attention to the subject, the frequency of which might be underestimated.

MATERIAL AND METHODS

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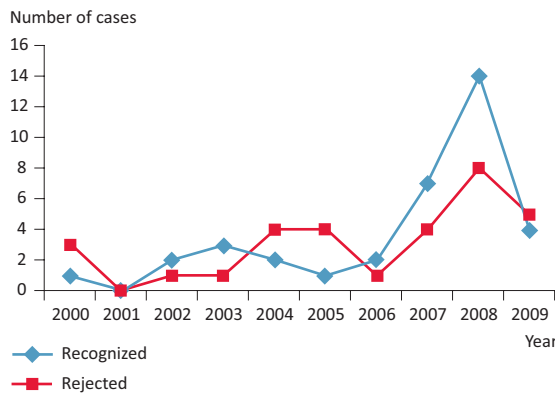
ORIGINAL ARTICLE

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FIGURE 1

Distribution on number of patients with recognized and rejected occupational skin cancer (non-melanoma skin cancers) during the 2000-2009 period.



posure, anatomic tumour localization, occupation and degree of permanent disability/financial compensation.

Patients were identified in the National Board of Industrial Injuries as notified with skin cancers recognized as occupational in accordance with the LOD (section A1, A3, B1, E1F, and F for cases recognized before 01/01 2005 and section K3 for cases recognized after 01/01 2005) [1]. Furthermore, a limited number of cases was accepted after evaluation in the Occupational Diseases Committee.

For patients with notified but rejected occupational skin cancers during the same period, only data on sex and age were obtained, since further information was not attainable. The study was approved by the Danish Data Protection Agency.

Trial registration: not relevant.

RESULTS

A total of 36 patients with skin cancer (or premalignant skin conditions) recognized as occupational disease within the defined period were identified, 31 men and five women, their mean age was 61 years (range 44-75 years).

In all, 32 patients were diagnosed with NMSC. Of these, two had both BCC and SCC concurrently. We therefore found 25 patients diagnosed with BCC and nine patients diagnosed with SCC (32 patients with 34 recognized cases of NMSC). Additionally, four patients did not have actual skin cancer, but were accepted as cases of occupational premalignant disease. One was diagnosed with erythroplasia of Queryat and three with actinic keratosis.

During the same period, 31 patients with skin cancer were notified but rejected. The rejected cases count-

ed eight women and 23 men, with a mean age of 63 years (calculated on the basis of each person's age in the year 2009).

The most frequent diagnosis was BCC, followed by SCC (**Table 1**). Ten patients had more than one tumour, and four patients had more than five tumours (one had more than 30 tumours and for another patient, 44 tumours were reported). Premalignant skin conditions were recognized according to the evaluation in the Occupational Diseases Committee, and this also applied to cases caused by sun exposure which were recognized before 2005. There were no recognized cases of malignant melanoma. The distribution of recognized and rejected cases during the 2000-2009 period is shown in Figure 1.

The predominant localization of tumours was on the face/scalp. In all, 24 (67%) of the 36 patients had tumours (or premalignant disease) located on the face/scalp. Other localizations were on the body and hands. Three persons had tumours located to the genitals. For 32 persons, the sequelae were scarring. In those cases, the worker's compensation rated according to the Permanent Injury Rating List was between 0% and 20% (Table 1). A 5% compensation corresponds to approx. 4,800 Euro for a 39-year-old person (for age over 39 years, the compensation was adjusted according to age) [7]. One person suffered from sequelae due to amputation of his penis (blacksmith's exposure to mineral oil) and one person due to amputation of two fingers (a nursing assistant's exposure to X-ray). For those persons, a much higher compensation (15% and 30%) was given. There was no information that any of the persons involved had been treated with immunosuppressive drugs. With respect to co-morbidity, one person had psoriasis and had been treated with UVB radiation for this disease for a short period of time.

For 24 (66%) patients, the malignant or premalignant skin conditions were recognized as caused by UV exposure in persons with outdoor work. Other recognized occupational exposures were asphalt work, welding, tar exposure and mineral oil exposure (**Table 2**). The mean occupational sun radiation exposure was 29 years (range 5-54 years), and for other exposures it was 29 years (range two weeks to 48 years). Gardening and construction work were the occupations with the highest number of recognized NMSC.

In the period from 01/01 2000 to 31/12 2004, eight patients had their cases recognized; and in the period from 01/01 2005 to 31/12 2009, 28 patients had their cases recognized (Figure 1).

DISCUSSION

During a ten-year period, only 36 patients with skin cancer had their disease recognized as occupational by the

National Board of Industrial Injuries in Denmark. The mean age was 61 years, as compared with a mean age of 34 years for persons with other occupational skin diseases [8], which is probably due to the fact that long exposure times are necessary to cause the types of cancers involved. As also found in previous studies, the persons involved were predominantly men [2, 9], and the most frequent diagnosis was NMSC.

Sun exposure is an important risk factor for the development of occupational skin cancer. This is consistent with previous findings. In their meta-analysis of 24 cohorts and case-control studies, Bauer et al [10] found a 40% increased risk for outdoor workers of developing basal cell carcinoma compared with indoor workers. They hypothesized that a substantial under-estimation of occupational skin cancer should be expected due to poor classification of indoor and outdoor tasks and occupations, and a lack of quantification of occupational and non-occupational UV exposures [10]. In their meta-analysis, Schmitt et al concluded that there is a significantly increased risk of developing SCC for people working outdoors [11].

In 2005, sunlight was added to the LOD resulting in a fourfold increase in the number of recognized cases in the period 2005-2009 in comparison with the period before 2005; while for skin cancer in general the number only doubled.

A previous retrospective register-based study (1984-1994) on notified cases of occupational non-melanoma skin cancer in Denmark found that the most commonly approved exposures were ionizing radiation, asphalt, tar and the like [12]. This differs from our study, presumably because their study was performed before the modification to the LOD in 2005 when UV exposure was included in the list.

The data present the number of patients with skin cancer recognized as occupational. How this actually relates to the real number of occupational skin cancers is unknown, since a significant under-reporting to the authorities may be expected. This is known from other occupational skin diseases [13]. Underreporting is probably much higher for skin cancers since these diseases have not traditionally been perceived as occupational. For pleural mesotelioma, which is a type of cancer virtually exclusively related to occupational exposure, a Danish study estimated an under-reporting to the National Board of Industrial Injuries of 55% [14]. Doctors in Denmark are required by law to report any suspected occupational disease to the National Board of Industrial Injuries, but despite this, we nevertheless believe that the results are associated with a significant under-reporting.

The general assumption has been that the accumulative effect of UV exposure is the primary risk of non-melanoma skin cancer. However, some studies indicate

TABLE 1

Frequency of different diagnoses in relation to sex, sequelae and worker compensation.

	Men	Women	Total	Sequelae	Worker compensation ^a , mean (range)
Patients, n	31	5	36	35	6 (0-30)
Average age (range), years	63	57	61 (44-75)	–	–
Average exposure time, years	31	18	29	–	–
Basal cell carcinoma, n	21	4	25 ^b	25	5
Squamous cell carcinoma, n	8	1	9 ^b	9	11
Erythroplasia of Queryat, n	1	–	1	1	0
Actinic keratosis, n	3	–	3	2	2

a) Worker compensation is traditionally given in %, where the economic equivalent of 5% is approx. 4,800 Euro.

b) Two patients had basal cell carcinoma and squamous cell carcinoma concurrently. Thus, the total number of basal cell carcinoma, squamous cell carcinoma, erythroplasia of Queryat and actinic keratoses is different from the total number of patients.

TABLE 2

Number of exposures leading to skin cancer, by occupation.

Occupation and exposure	UV	Asphalt	Welding	Tar	Radioactive radiation	Oils	Arsenic
Gardener/assistant to gardener	8	–	–	–	–	–	–
Construction worker	5 ^a	2 ^a	–	–	–	–	–
Welder/blacksmith	2 ^a	1	5 ^a	–	–	1	–
Hall inspector/technician	2	–	–	–	–	–	–
Plumber	1	–	–	–	–	–	–
Nurse/nursing assistant	–	–	–	–	2	–	–
Oil industrial worker/offshore worker	–	–	–	–	–	2	–
Carpenters/joiner	4 ^a	–	–	2 ^a	–	–	–
Mason	2	–	–	–	–	–	–
Farmer	1	–	–	–	–	–	–
Cable technician	–	–	–	1	–	–	–
Repairman in telecommunication industry	–	–	–	–	–	–	1
Pharmacy assistant	–	–	–	–	1	–	–

UV = ultraviolet

a) Exposure to both sun and asphalt work was described in two cases, and exposure to sun and tar in one. Welding was described as a secondary exposure to sun and asphalt in one case and to sun in another. Exposure to tar was secondary to sun exposure in one case, and exposure to asphalt was found to be secondary to sun in another case.

that BCC, such as malignant melanoma, is more likely to be induced by intermittent solar exposure than by the cumulative effect [2, 3, 9].

A Danish study found no relation between outdoor work and BCC. In contrast, they found a protective effect against skin cancer, presumably because of a more uniform exposure to UV radiation in the outdoor workers yielding a natural protection owing to tanning of the skin [15].

Since exposure leading to skin cancer takes place over a long period of time (in most cases several decades), differentiation between occupational exposure and recreational exposure is problematic, and only if the

Malignant melanoma is believed to be correlated with intermittent ultraviolet exposure, rather than cumulative sun exposure, particularly early in life.



cumulative occupational exposure exceeds the cumulative exposure during leisure time can the injury be considered occupational. Recreational sun exposure or hobbies with exposure such as industrial oils or UV radiation (e.g. repairing cars and sailing) are confounders. During the past decade, public awareness of the negative effects of sun exposure has increased, and this probably explains the increase in numbers of reported cases.

The predominant localization of occupational skin cancer on the face/scalp is not surprising, since this part of the body is particularly exposed in outdoor workers. This information is, however, important for future preventive intervention, where protection of the face should be emphasized. More surprisingly, three cases with genital involvement were reported, due to contamination with carcinogens such as mineral oils from hands to genitals during working hours. This localization of occupational skin cancer has been reported for more than a century, and it is surprising that the localization, nevertheless, remains relatively frequent. Since sequelae in this localization may be severe, this should also be included in future preventive strategies. Our data suggest that future preventive measures for people working in the sun should include sun protection focusing on the face/scalp and hands, and for people working with carcinogens (mineral oils and tar) it is important to stress hygiene measures before toilet use. Moreover, it is im-

portant that the high-risk occupations are made aware of the risks involved in their line of work. As an example of this, previous studies have shown a higher UV exposure for Danish than Irish gardeners which may be thanks to scheduled breaks during peak ambient UV exposure and presence of natural shade in the work environment for Irish gardeners [16]. A questionnaire based study on skin-protective measures has highlighted the importance of employer-led sun safety interventions for British construction workers [17].

CONCLUSION

The primary single risk factor for development of occupational malignant or premalignant skin conditions was sun exposure due to outdoor work. The occupations that were exposed to sun were predominantly gardening and construction work. This article is intended to raise awareness of occupational skin cancer, and the data should be interpreted in the light of the fact that an under-reporting is suspected, and that data given here may be only the tip of the iceberg.

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