Malignant melanoma of the skin is still a relatively uncommon tumour in Denmark, but like in other developed countries it is growing rapidly in importance (Jensen & Bolander, 1980). In the past 40 years, the age-standardized incidence rate has increased 5- to 6-fold in both sexes. This increase is anticipated to continue since there is a clear cohort associated risk (Osterlind, 1983). Melanoma mortality has doubled since 1955.

Like other types of skin cancer, malignant melanoma has been related to ultraviolet light exposure, but the increase in incidence is particularly pronounced for parts of the body which are normally protected with clothes and only occasionally exposed to sunlight. Comparison of the incidence rates of cutaneous malignant melanoma (CMM), basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) for different anatomic sites may therefore reflect differences and similarities with regard to risk factors. Population-based incidence rates of these skin cancer types have been compared in the present paper.

Most previous reports on anatomic sites of malignant melanoma have used large body locations (e.g. head, trunk, upper limb, lower limb). In this paper we also present detailed data on anatomic site and histopathological subtype from a population-based case-series where information was collected as part of a case-control investigation.

Material and methods

Cancer registry data

Since 1943, incident cases of cancer in Denmark have been reported to the Danish Cancer Registry by hospital departments, pathology laboratories and practising physicians, mainly dermatologists ( Clemmesen, 1965; Danish Cancer Registry, 1983). All tumours in the Registry diagnosed since 1 January 1978 have been coded and classified by site, morphology and behaviour as given in the International Classification of Diseases for Oncology (ICD-O) (1976).

Only one skin cancer of each morphologic type is recorded per person, with an indication in the register of persons with multiple skin cancers of a given type located to more than one site of the body. Incidence rates are therefore based on the number of persons with tumours rather than the number of tumours. All cases of malignant melanoma, basal cell carcinoma and squamous cell carcinoma of the skin diagnosed in the period January 1978 to December 1982 were identified in the Cancer Registry. Rates were calculated as average annual incidence rates per 100,000 persons with the Danish population on 1 January 1980 as the denominator. The incidence rates have been age-standardized to the World Population by the direct method (Waterhouse et al., 1982). The estimated age effect was calculated as suggested by Stevens and Mooijavkar (1984).

Melanoma case-series

The case-series consists of patients aged 20 to 79 years, in a geographically well-defined eastern part of Denmark. These patients were reported to the Cancer Registry with a diagnosis of skin melanoma from 1 October 1982 to 31 March 1985. Patients notified with lentigo maligna melanoma (LMM) were not included. About 50% of all Danes live in East Denmark. A total of 577 cases entered the study. The histopathological specimens were procured from the primary pathology department and the tumours were reviewed by one of us (KH-J) and classified according to McGovern et al. (1973), as superficial spreading, nodular, lentigo maligna, or unclassifiable melanoma. Twenty-six cases were excluded either because they were not primary melanoma (14) or were classified as lentigo maligna melanoma (12) leaving 551 cases available for analysis. In addition, the specific anatomic site was abstracted from the medical records. In order to compute incidence rates for the lentigo maligna melanomas, information from the case series (i.e., the cases notified as malignant melanoma, not otherwise specified, which turned out to be LMM on review) was combined with the cases notified to the Cancer Registry as LMM for the same geographic area and time period as the case-series.

For each age-group the total number of skin melanoma (any type) in Denmark was prorated according to the corresponding age-specific distribution of the melanoma subtypes in the case-series. Age and subtype specific rates could thus be calculated, and age-standardized rates estimated.

The relative density of melanomas per unit surface area was calculated using the estimates for body surface area produced by Lund and Browder (1944). Standardized inci-
idence rates for the detailed anatomic sites were then estimated by multiplying the relative tumour density with the average sex specific incidence rate for the body as a whole.

Results
A total of 15,227 cases with cancer of the skin and a specified histology were notified to the Cancer Registry from 1978 to 1982. Of these, 2,376 were malignant melanomas, 10,846 were basal cell carcinomas, and 2,005 squamous cell carcinomas, Table I. An additional 5% of non-melanoma skin cancers were either not histologically verified or had unspecified histology. These cases have not been included in the study.

All together 60% of the skin melanomas are diagnosed among women, whereas BCC occur with similar frequency among the sexes and only 32% of the squamous cell carcinomas occur in women. In males the age-adjusted incidence rates of CMM and SCC are of a similar magnitude around 6–6.5 per 100,000, whereas the rate is 5 times higher for BCC. In females the rate of CMM is more than 3 times higher than the rates for SCC, and a third the incidence rates for BCC, Table I.

The annual average age-specific rates for each cell type are shown in Figure 1. The incidence for CMM increases steeply to around 35–45 years when it levels off. A female excess is present throughout the age-span, till the age of 80 years, but it is most pronounced in the age-groups below 40 with a male:female ratio of 0.5. For both BCC and SCC the incidence rates increase exponentially with age. For BCC the slope of the estimated age effect is 6.5 and 5.4 in males and females, respectively, and for SCC 4.1 in males and 3.4 in females. The slopes for BCC is at a significantly higher level compared to SCC. The rates of BCC in males and females are almost the same until age 50 when the rate in males increases to a level of 30% above that in females. For SCC a male predominance is seen in all age-groups (with a single exception), increasing to a male:female ratio of 3 in age groups from 60 years and above.

The anatomic distribution of CMM differs between the sexes while the sex specific patterns are quite similar for BCC and SCC. About 20% of the melanomas arise on the face, scalp and neck, compared with 70–80% of all BCC and SCC (Table I). In spite of the much higher rates of CMM than SCC in women, rates for the face, scalp and neck are similar. By contrast the male rates of SCC for the face, scalp and neck are 3 times higher than CMM although the total rates of the two diseases are similar. In males the incidence of CMM is highest for the trunk (2.9 per 10^5) followed by face, scalp and neck (1.3 per 10^5). In females the incidence of CMM is highest for the legs (3.8 per 10^5) followed by

### Table I Number of skin cancers in Denmark 1978–1982,* percent of all specified ( ) and average annual age-standardized incidence rates per 100,000, according to sex, histological type and anatomic site

| Malignant melanoma | Basal cell carcinoma | Squamous cell carcinoma |
|--------------------|----------------------|------------------------|
| **Males** | **Females** | **Males** | **Females** | **Males** | **Females** |
| N | Inc | N | Inc | N | Inc | N | Inc |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Face, scalp and neck** | | | | | | | |
| 207 | 1.3 | 211 | 1.0 | 4,082 | 21.9 | 3,740 | 16.4 | 973 | 4.7 |
| (22.5) | (15.1) | (80.2) | (77.5) | (76.3) | (66.7) | |
| **Trunk** | | | | | | | |
| 444 | 2.9 | 365 | 2.3 | 772 | 4.6 | 788 | 4.1 | 57 | 0.3 |
| (48.3) | (26.1) | (15.1) | (16.4) | (4.5) | (8.7) | (8.7) | (8.7) | |
| **Arms** | | | | | | | |
| 98 | 0.6 | 208 | 1.2 | 122 | 0.7 | 123 | 0.5 | 197 | 1.0 |
| (10.7) | (14.8) | (2.4) | (2.5) | (15.4) | (17.1) | (17.1) | (17.1) | |
| **Legs** | | | | | | | |
| 170 | 1.1 | 617 | 3.8 | 116 | 0.6 | 173 | 0.8 | 49 | 0.3 |
| (18.5) | (44.0) | (2.3) | (3.6) | (3.8) | (7.5) | |
| **Multiple, NOS** | | | | | | | |
| 30 | 0.2 | 26 | 0.1 | 495 | 2.6 | 435 | 1.9 | 78 | 0.4 |
| | | | | | | |
| **Total** | 949 | 6.1 | 1,427 | 8.4 | 5,587 | 30.4 | 5,259 | 23.7 | 1,354 | 6.7 |

*Cases not histologically verified and skin cancer not otherwise specified with regard to histology have been excluded; *World Standard Population; *Not otherwise specified with regard to anatomic site.

![Figure 1](image-url) Age-specific incidence rates of malignant melanoma, basal cell carcinoma and squamous cell carcinoma of the skin according to sex in Denmark, 1978–1982.
The differences in incidence rates for melanoma, basal cell carcinoma, and squamous cell carcinoma of the skin, according to sex and anatomical site in Denmark, 1978–1982, are illustrated in Figure 2.

For trunk melanomas in both sexes, 60% of the lesions occurred on the back and a similar proportion on the female lower limb occurred on the leg. Of the melanomas on the trunk (2.3 per 10^3). Some 15% of BCC are located on the trunk and a similar proportion of SCC affect the arms in both sexes.

Figure 2 compares the age-adjusted incidence rates for each cell type by sex and anatomical site. Males have higher rates of skin cancers than females for most anatomical sites. The exceptions are CMM and BCC on the legs and CMM on the arms (Figure 3) where the risks are higher in women in particular for CMM.

The age-specific incidence curves for CMM exhibit a different course for tumours at different anatomical locations (Figure 4). For the face, scalp and neck the rates increase exponentially with age in both sexes with no discernible sex differences. In these cross-sectional data melanomas of the trunk in both sexes show a steep increase starting in adolescence to peak at age 50–60 years in males, whereas the female peak is at age 35 years after which a levelling off or fall is seen; under age 40 the risk is slightly higher in females than in males. The female preponderance for melanomas of the arms and legs is seen at all ages; for both sites, a pattern similar to that of the trunk is seen.

Cutaneous malignant melanoma – Anatomical site and subtype

The detailed site distribution of the 551 cutaneous malignant melanomas in the case series is shown in Table II, as well as the tumour density per unit surface area relative to that of the whole body and the estimated standardized incidence rate per unit surface.

For males, the highest estimated incidence is seen for melanoma of the back (19.5 per 10^3) followed by face (14.0 per 10^3) and chest (9.8 per 10^3). The leg (below the knee) in females is associated with the highest risk (17.6 per 10^3) followed by the back (12.6 per 10^3), and face (10.1 per 10^3). Melanoma incidence rates in males are higher for locations above the waist, compared to females who predominate for surfaces below the waist. For legs below the knee, women have a 5 times higher incidence than males and for the hip and thigh a 3.5-fold increased risk.

Figure 3 Male to female ratio of the age-standardized incidence rates for malignant melanoma, basal cell carcinoma and squamous cell carcinoma of the skin according to anatomical site in Denmark, 1978–1982.
Table II  Anatomical site distribution of 551 cases of malignant melanoma of the skin (excluding lentigo maligna melanoma), the relative incidence per unit of surface area, the estimated standardized incidence rate and the male to female ratio

| Anatomical site     | Surface area (%) | Number of cases | Relative tumour density | Estimated standardized incidence rate per 10² | Male/female ratio |
|---------------------|------------------|-----------------|-------------------------|-----------------------------------------------|-------------------|
|                     |                  | Males | Females | Males | Females | Males | Females | Males | Females | Males | Females | |
| Face                | 3.5              | 19    | 13      | 2.3   | 1.2     | 14.0  | 10.1     | 1.4  |
| Scalp and neck      | 5.5              | 13    | 9       | 1.0   | 0.5     | 6.1   | 4.2      | 1.5  |
| Chest               | 10.6             | 40    | 23      | 1.6   | 0.6     | 9.8   | 5.0      | 2.0  |
| Back                | 10.6             | 79    | 50      | 3.2   | 1.5     | 19.5  | 12.6     | 1.5  |
| Abdomen and buttocks| 10.8             | 9     | 12      | 0.4   | 0.4     | 2.4   | 3.4      | 0.7  |
| Upper arm           | 8.0              | 17    | 28      | 0.9   | 1.1     | 5.5   | 9.2      | 0.6  |
| Forearm and hand    | 11.0             | 7     | 15      | 0.3   | 0.4     | 1.8   | 3.4      | 0.5  |
| Hip and thigh       | 19.0             | 17    | 57      | 0.4   | 1.0     | 2.4   | 8.4      | 0.3  |
| Leg                 | 14.0             | 20    | 93      | 0.6   | 2.1     | 3.7   | 17.6     | 0.2  |
| Foot                | 7.0              | 14    | 16      | 0.9   | 0.7     | 5.5   | 5.9      | 0.9  |
| Total               | 100.0            | 235   | 316     | 1.0   | 1.0     | 6.1   | 8.4      |      |

*Male; bFemale.

feet, 5 and 4 occurred on the foot sole in males and females respectively. On the hip, thigh and leg, melanomas occurred more frequently on the anterior (93 cases) than on the posterior surface in females (47 cases), while this was only true for the male hip and thigh. No consistent pattern was seen for the arms.

In the case series 72% of the melanoma were of the superficial spreading subtype, 18% nodular and 10% unclassifiable (Table III). These proportions did not differ between the sexes. As expected the nodular and unclassifiable tumours tended to invade more deeply than superficial spreading melanoma, but no differences were seen with
regard to level of invasion for the sexes for either superficial spreading melanoma ($X^2 = 7.27; P = 0.12$) or nodular melanoma ($X^2 = 2.12; P = 0.55$).

The estimated age-specific incidence curves by subtype are shown in Figure 5. Lentigo maligna melanoma, shows a progressive rise in incidence with age from about 40 years while superficial spreading and nodular melanoma are seen with a slight increase in incidence from adolescence to age 50 followed by a levelling off. The slopes of the estimated age effect of LMM were 5.0 and 5.4 in males and females, respectively, and did not differ from the slopes estimated for non-melanoma skin cancer (i.e., BCC and SCC). The estimated age-standardized rates of superficial spreading melanoma (4.0 per 10^3 in males and 5.8 per 10^3 in females) are 4 times higher than the rates for nodular melanoma (1.0 per 10^3 in males and 1.4 per 10^3 in females) and more than 10 times the rates for lentigo maligna melanoma (0.3 per 10^3 in males and 0.5 per 10^3 in females).

Discussion

The introduction of the International Classification of Disease for Oncology (1976) has made it possible to study and compare the basic epidemiologic characteristics of the three most important morphological types of skin cancers in a nationwide material. To our knowledge such population-based comparisons have not previously been undertaken since few cancer registries record all types of skin cancers.

Most patients with non-melanoma skin cancer are treated outside hospital wards. Registration is therefore difficult and often assumed to be incomplete. The Danish Cancer Registry among others receives notifications from practising dermatologists, and even if it cannot be excluded that the incidence rates may be influenced by under-reporting it is striking that the incidence of squamous cell carcinoma is quite similar to the rates reported from all the Nordic countries (Waterhouse et al., 1982). Furthermore, the emphasis of this paper is the comparison of the distributions of various skin cancer types in the population. There is no reason to believe that under-reporting should differentially affect males and females, age-groups, or anatomic sites. This is corroborated by findings similar to ours in a survey carried out in the United States in connection with the Third National Cancer Survey (Scotto et al., 1983). The population-based case series of malignant melanoma may be assumed to be representative of all incident cases in the country since no major geographic or age-differences are seen for this disease in Denmark (Carstensen & Jensen, 1986). All our cases were reviewed and subtyped by one pathologist. By comparison only some 55% of the melanoma cases are routinely reported to the Cancer Registry with mention of a specific subtype.

Cancer of the skin is generally considered as two diseases, melanomas and non-melanomas, with different epidemiological and clinical characteristics. Sunlight is the most important etiologic factor which has been suggested for these types of skin cancer (International Agency for Research on Cancer, 1986). While non-melanoma skin cancers and the lentigo maligna melanoma subtype may result from the total cumulative lifetime sun-exposure, it has been hypothesized that other melanoma subtypes result from intermittent exposure to more intense sunlight (Elwood & Hislop, 1982; Holman et al., 1983).

| Table III | Frequency of malignant melanoma of the skin according to subtype and sex, reviewed in the melanoma case-series (excluding lentigo maligna melanoma) |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------|
| Sex       | Superficial spreading melanoma | Nodular melanoma | Unclassifiable melanoma | Total |
| Males     | 172 (73)                      | 38 (16)          | 25 (11)                  | 235 (100) |
| Females   | 227 (72)                      | 62 (20)          | 27 (8)                   | 316 (100) |
| Total     | 399 (72)                      | 100 (18)         | 52 (10)                  | 551 (100) |

![Figure 5](image) Estimated age-specific incidence rates of cutaneous malignant melanoma, according to sex and histological subtype in Denmark.
The present population-based study shows that various skin cancer types in Denmark are characterized by specific age- and sex-relationships which are specific for a given anatomic site. The clearly different patterns of disease occurrence indicate that different factors may influence the etiology of the three major skin cancer types, as well as subtypes of CMM.

Since information on histological subtype of melanoma and of other skin cancers is available only from a single time period it is not possible to estimate and compare mathematically true age-dependence in these cross-sectional data which undoubtedly represent an interaction of age- and birth-cohort effects. The analysis of earlier (Stevens & Moolgavkar, 1984) as well as newer data (Osterlind et al., in review) from Denmark have shown that the different time trends and age-distribution of melanoma rates, for separate anatomic sites can be reconciled to a common age relationship and site specific cohort differences. LMM is likely to show little or no association with birth cohorts and such association may also be minor for BCC and SCC. When we estimate the age relationship as suggested by Stevens and Moolgavkar (1984) and our new data the age-curve to be consistent with those estimated for various subsites of melanoma (Osterlind et al., in review) and for the squamous cell and basal cell carcinoma. The slope for BCC is greater than the SCC slope indicating that the incidence increases more rapidly with age for BCC than for SCC. In addition this increase is more rapid in males than in females for both histologic types. Our results further emphasize that this increase in melanoma incidence with age does not differ from that seen for most other malignant tumours (Cook et al., 1969). Some 80% of both LMM, BCC and SCC occur on the face, scalp and neck where chronic exposure to sunlight is most pronounced. However, the clear male predomiance of SCC of face, scalp and neck (male:female ratio = 3:1) is at variance with observations for BCC and LMM indications that the risk of developing any melanoma is similar in both sexes.

Malignant melanoma is one of the most rapidly increasing types of cancer in Denmark and other European countries. The reported increase has been paralleled by a shift in the age distribution, with a larger proportion of younger people being diagnosed and treated. The pattern of increasing incidence has been noted for both men and women, and for all age groups. However, the increase has been more pronounced in women, particularly in young age groups.

The increase of malignant melanoma has been attributed to increased sun exposure, especially in sunlight-exposed parts of the body. The association between sun exposure and the risk of melanoma is well established, and the use of protective measures such as sunscreen, clothing, and hat use has increased in response to this increasing awareness. The rise in incidence of melanoma in Denmark parallels similar trends observed in other countries, and the increase has been more pronounced in women, particularly in young age groups.

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