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Abstract

Background Our aim was to describe the epidemiology of cutaneous malignant melanomas (CMMs) in males and females in the south east of England from 1960 to 1998. Birth cohort effects are important when describing the incidence of CMMs because fashions of dress affect whether different body sites are exposed to sunlight.

Methods We calculated the age-standardized incidence of all CMMs for 5 year periods from 1960 to 1998 and the age-specific and age-standardized incidence of CMMs at different sites for 5 year periods from 1980 to 1998. We plotted age-specific incidence rates against period of diagnosis and birth cohort.

Results The age-standardized incidence of CMMs increased from 1.3 to 7.1 per 100 000 person-years in males. Incidence increased from 2.4 to 7.8 per 100 000 person-years overall in females but levelled in the 1990s. Trunk CMMs had the highest incidence in males and the greatest increase in incidence. Lower limb CMMs had the highest incidence in females but their incidence decreased. The rate of increase of the age-specific incidence of trunk CMMs was greater for male birth cohorts before about 1945. The rate of increase of the incidence of lower limb CMMs was greater for female birth cohorts before about 1920.

Conclusions If current trends continue, the age-standardized incidence of CMMs in females will remain stable. The increase in the age-standardized incidence of CMMs in males was driven by increases in the age-specific incidence of trunk CMMs in men who were born before about 1949. As they age, age-standardized incidence should level.

Keywords: adult, England, epidemiology, melanoma

Introduction

The incidence of cutaneous malignant melanomas (CMMs) has increased in caucasian populations in many countries since the middle of the last century. It is thought that CMMs at different sites are caused by different levels and patterns of exposure to sunlight. Cumulative exposure may predispose to CMMs at sites that are usually exposed, such as the head and neck, whereas acute intense exposure may predispose to CMMs at sites that are only intermittently exposed, such as the legs. Supporting evidence for this includes the different age-specific patterns of incidence and the presence of different birth cohort effects for CMMs at different sites. Birth cohort effects are changes in the incidence of a cancer as a result of influences that affect particular generations, whereas period effects are due to influences that affect everyone during particular periods, regardless of their age. Birth cohort effects may be brought about by occupational and recreational sun exposure and fashions of dress, all of which affect whether different sites are exposed.

The Thames Cancer Registry covers a population of 14 million people in the south east of England. The aim of this study was to describe the epidemiology of CMMs in males and females in the south east of England using information from the Registry from 1960 to 1998. The objectives were to describe the trends in the age-standardized incidence of all CMMs and the age-specific and age-standardized incidence of CMMs by site, to describe birth cohort effects at particular sites, and to consider the contribution of the trends at particular sites to the overall changes in incidence.

Methods

Cancer registrations are activated by several routes including pathology reports where cancer is mentioned. At the Thames Cancer Registry, a data collection officer usually collects further information from the clinical record. Cancers diagnosed in South Thames residents have been registered with the Thames Cancer Registry since 1960, and cancers diagnosed in North Thames residents have been registered since 1985. Together, this area covers the London Region, Kent, Surrey, Sussex, Hertfordshire and Essex. The database is tumour based and registrations are checked to ensure that they are a new tumour and not, for example, a metastasis from an already registered tumour. Tumours...
registered before the introduction of the ICD10 coding system had retrospectively been assigned ICD10 codes and CMMs diagnosed from 1960 to 1998 were extracted using ICD10 code C43, malignant melanoma of skin. Ninety per cent of cases in males and 92 per cent of cases in females were microscopically verified. The number of CMMs diagnosed in males and females were tabulated by 5 year age group and period of diagnosis. We used the 5 year periods of diagnosis centred around 1962, 1967, 1972, 1977, 1982, 1987 and 1992, and the 4 year period of diagnosis from 1995 to 1998, labelled 1997. To describe the change in incidence over time in different age groups of males and females, we calculated age-specific incidence rates for each period by dividing the number of cases in 5 year age groups of males and females by the person-years at risk. To facilitate comparisons over time and with other European countries, we calculated age-standardized incidence rates by applying these age-specific rates to the European standard population.

Only 5 per cent of CMMs in males and 7 per cent of CMMs in females had a site specified before 1980. This increased to 87 per cent and 90 per cent, respectively, from 1980 onwards. Therefore, analyses related to site were restricted to CMMs diagnosed from 1980 onwards. Cases were subdivided using ICD10 sub-site codes as CMMs of the head and neck (ICD10 C43.0–4), trunk (ICD10 C43.5), upper limb (ICD10 C43.6), lower limb (ICD10 C43.7) and overlapping and unspecified CMMs (ICD10 C43.8–9).

The numbers diagnosed at each site in males and females were tabulated by age group and 5 year periods of diagnosis centred around 1982, 1987 and 1992, and the 4 year period of diagnosis from 1995 to 1998, labelled 1997. We calculated age-specific and age-standardized incidence rates for each period. The age-specific rates for 1995–1998 were taken to represent the rates for the 5 year period from 1995 to 1999. We created synthetic birth cohorts by subtracting each age group from each period of diagnosis and, to describe the effect of year of birth rather than the period of diagnosis, the age-specific incidence rates for males and females in each age group were also plotted against birth cohort. The birth cohorts are described by the central year.

**Results**

From 1960 to 1998, there were 19917 registrations of CMMs. Most (n = 12371) were in females. In males, the age-standardized incidence increased approximately fivefold from 1.3 (95 per cent confidence interval (CI) 1.1–1.5) to 7.1 (95 per cent CI 6.8–7.4) per 100 000 person-years (Fig. 1). The age-standardized incidence in females remained higher than that in males. However, the rate increased only approximately threefold from 2.4 (95 per cent CI 2.2–2.7) to 7.8 (95 per cent CI 7.5–8.2) per 100 000 person-years, and levelled in the last two 5 year periods compared with a continued increase in males. Although the num-

![Fig. 1 Age-standardized incidence of cutaneous malignant melanomas, 1960–1998, males and females, south east of England.](image-url)
The number and percentage of cutaneous malignant melanomas of the head and neck, trunk, upper limb, lower limb and overlapping and unspecified sites, 1980–1998, males and females, south east of England.

<table>
<thead>
<tr>
<th></th>
<th>Head and neck</th>
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<th>Lower limb</th>
<th>Overlapping and unspecified</th>
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<td>Males</td>
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<td>1980–1984</td>
<td>112</td>
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For each 5 year period, the highest percentages of CMMs were diagnosed on the trunk in males and the lower limb in females. The percentage of CMMs diagnosed on the lower limb in females decreased from 1980 to 1998, whereas the percentage diagnosed on the trunk in males was fairly constant. For both sexes, the number and percentage of CMMs of overlapping and unspecified site increased. Most of these cases did not have any site specified.

The age-standardized incidence of CMMs of the head and neck, trunk and upper limb increased in males from 1980 to 1998 (Fig. 2). CMMs of the trunk had the highest incidence and the greatest increase in incidence. In females, there were increases in the age-standardized incidence of CMMs of the trunk and upper limb. The age-standardized incidence of CMMs of the lower limb was highest but was stable over the study period.

In each 5 year period, the age-specific incidence of CMMs of the head and neck was low in males and females until about 60 years of age but thereafter incidence increased sharply (Fig. 3). In contrast, the age-specific incidence of CMMs at other sites tended to increase at a younger age followed by a plateau or decline in incidence in the older age groups. In the last 5 year period, the highest site and age-specific incidence (14.0 per 100,000 person-years) was in men aged over 85 years with CMMs of the head and neck. In females, the highest age-specific incidence in the last 5 year period was in those aged 70–74 years with CMMs of the lower limb (8.4 per 100,000 person-years). From 1980 to 1998, there was little change in the age at which incidence peaked for CMMs at each site in females or head and neck, lower limb or upper limb CMMs in males. However, the age at which the incidence of CMMs of the trunk peaked and then plateaued in males was greater in the later periods than in the earliest period.
Fig. 3 Age-specific incidence of cutaneous malignant melanomas of the head and neck, trunk, upper limb and lower limb, 1980–1998, males and females, south east of England.
The rate of increase of the incidence of CMMs of the trunk was greater for male birth cohorts before about 1945, and thereafter the rate of increase slowed (Fig. 4). The rate of increase of the age-specific incidence of CMMs of the lower limb was greater for female birth cohorts before about 1920, and also for females aged less than 30 years who were born in the 1960s and 1970s (Fig. 5). Although it was less clear, there may also have been a relationship between age-specific incidence and birth cohort for CMMs of the upper limb in males and females and CMMs of the lower limb in males with pivotal birth cohorts of 1945, 1925 and 1945, respectively. There was no obvious change in the rate of increase of age-specific incidence related to birth cohort for CMMs of the head and neck in both sexes or CMMs of the trunk in females.

Discussion

Strengths and weaknesses of the study

We have presented population-based incidence rates for the last 40 years for all CMMs and for the last 20 years for CMMs by site in the south east of England. The epidemiology of CMMs in England and Wales has been recently reviewed but this did not include incidence trends by site. The catchment population at the end of the study was around 14 million people, and this is larger than in many other studies describing the epidemiology of CMMs. For example, the catchment population of the Scottish Melanoma Group is around five million people.

Reporting to the Thames Cancer Registry has probably improved over the study period. Although it was not possible to quantify this improvement, it is unlikely to explain the marked increase in incidence that was observed in this study. Ideally, all CMMs should be microscopically verified and a small part of the observed increase in the overall incidence of CMMs is due to an increase in the number of microscopically unverified CMMs. However, the increase is much greater than could be explained by this and the overall pattern is unaffected by their exclusion. Furthermore, their exclusion may mean losing information and may introduce bias, as microscopic verification is dependent on a variety of factors, such as age.

The percentage of CMMs without a specified site increased from 1980 to 1998, and 17 per cent of CMMs in males and 14 per cent of CMMs in females that were diagnosed from 1995 to 1998 did not have a specified site. More complete information on the sites of CMMs would be helpful but a retrospective review of records would involve a substantial resource commitment and not all records would be available. We do not, therefore, know the true distribution of sites within the unspecified category. It would, however, have to be very markedly skewed to affect the overall pattern as the age-standardized incidence rates of CMMs...
of the trunk in males and of the lower limb in females were usually substantially higher than the rates at other sites.

It has been suggested that the emergence of a more innocuous form of CMM may explain the increase in the incidence of CMMs, supported by marked increases in thin CMMs and stable or slight increases in the incidence of thicker CMMs. Only 15 per cent of CMMs registered with the Thames Cancer Registry from 1980 to 1998 had a Breslow tumour thickness recorded and only 23 per cent had a Clark’s level of invasion. More complete clinical stage information is needed to interpret fully changes in incidence. The incomplete stage information may be due to incomplete recording by the clinician or the data collection officer. As with anatomical site, a retrospective review of records would involve a substantial resource commitment and not all records would be available. Cancer registration has recently been reviewed. In the future, it is envisaged that cancer registration data will be collected by hospital trusts. The cancer registries will now work closely with the trusts to assure and improve the accuracy and completeness of the data collected.

Comparison with results from other studies

The increase in the incidence of CMMs in the south east of England is similar to that seen elsewhere. The age-standardized incidence in the United States increased almost threefold in males and more than doubled in females from 1973 to 1997. However, the rate in the south east of England remains low compared with the United States and parts of the southern hemisphere. In New Zealand, the incidence age-standardized to the world population was 58 per 100 000 person-years in males and 55 per 100 000 person-years in females in 1995. The incidence age-standardized to the world population in Scotland in 1994 (6.0 per 100 000 person-years in males and 8.5 per 100 000 person-years in females) was also higher than the incidence in the south east of England for 1990–94 when this was age-standardized to the world population (4.5 per 100 000 person-years in males and 5.6 per 100 000 person-years in females). There could be several explanations for this including more complete reporting in Scotland.

Other studies have described the sites of CMMs, and results similar to this study have been reported from different parts of the world. In Scotland, CMMs of the trunk were most common and had the greatest increase in incidence in males from 1979–80 to 1993–94. In females, the incidence of CMMs of the lower limb was highest but, similar to this study, this levelled after the middle of the 1980s. In New Zealand, as in the south east of England, the increase with age in the incidence of CMMs of the trunk and limbs was steady, whereas the incidence of CMMs of the head and neck remained low until about 60 years and then increased rapidly. Trends between male and female birth
cohorts were also present for the trunk and limbs in New Zealand. Where results from different countries vary, given the site-specific theory of the aetiology of CMMs, this could be explained by different patterns of exposure to sunlight in different cultures and climates.

**Meaning of the study**

The incidence of CMMs in females in the south east of England levelled recently compared with a continued increase in males, although the rate in females remains higher than that in males. It has been suggested that a female excess reflects a hormonal aetiology that becomes important when incidence is low. However, low-incidence countries have not always had a female excess, and a consistent association between hormonal factors and the risk of CMMs in females has not been demonstrated.

It is more likely that different behaviours at different times among men and women alter their risk and the ratio of female to male incidence. Although ratios reported from different parts of the world vary widely, the rate of increase of age-standardized male incidence. Although previous ratios from different parts of the world vary widely, the rate of increase of age-standardized male incidence has been generally greater than that in females, as in this study.

Although CMMs of the lower limb still had the highest site-specific age-standardized incidence in females at the end of the study period, there was a slight decrease in their incidence. In males, CMMs of the trunk had the greatest increase in site-specific incidence and their incidence now approaches that of CMMs of the lower limb in females. Therefore, it appears that although the rate in females remained higher than that in males, it has been suggested that a female excess reflects a hormonal aetiology that becomes important when incidence is low. However, low-incidence countries have not always had a female excess, and a consistent association between hormonal factors and the risk of CMMs in females has not been demonstrated. It is more likely that different behaviours at different times among men and women alter their risk and the ratio of female to male incidence. Although ratios reported from different parts of the world vary widely, the rate of increase of age-standardized incidence in males has been generally greater than that in females, as in this study.

The most consistently proposed aetiology for CMMs is site related. Cumulative sunlight exposure predisposes to CMMs at sites that are usually exposed and acute intense exposure predisposes to CMMs at sites that are intermittently exposed. CMMs at different sites, therefore, should reflect sex-specific patterns of exposure and their changes over time. If the overall change in incidence is due to fashions or leisure activities in men and women born at particular times who exposed previously covered body sites, site-specific trends should be important in explaining the change.

The age-specific incidence curves for CMMs of the head and neck are a different shape from those for other sites. They are shallow until about 60 years when there is a steep increase in incidence. This supports the theory that CMMs of the head and neck are related to cumulative sunlight exposure. One might expect that fashions of dress are less likely to affect the incidence of CMMs of the head and neck. This is supported by the lack of a relationship between age-specific incidence and birth cohort. A minor part of the increase in the age-standardized incidence of all CMMs in males was due to the continued though modest increase in the incidence of CMMs of the head and neck and this was due to the increase in incidence in older age groups. The higher incidence of CMMs of the head and neck in males than in females may be due to less protective hairstyles or occupational exposure. CMMs of the head and neck were found to be more frequent in people working outdoors.

The increase in the age-specific incidence of CMMs of the trunk at a young age followed by a decline or plateau in incidence in older men and women supports the acute exposure hypothesis. The age at which the peak incidence of CMMs of the trunk occurred in males increased over time, and the peaks were in males who were born at similar times. This supports a relationship with birth cohort, and the rate of increase of age-specific incidence was greater for birth cohorts before about 1945 than for later birth cohorts. Therefore, the increase in the age-standardized incidence of CMMs of the trunk in males appears to have been driven by increases in age-specific incidence in men who were born before about 1949. As they become older, age-standardized incidence should level. If incidence peaks at 65 years of age, where the most recent peak was seen, we would continue to see a high incidence in this age group for about another 15 years. However, if cumulative exposure also accounts for some CMMs of the trunk, we may begin to see increased incidence in the oldest men.

The shape of the age-specific incidence curve for CMMs of the lower limb in females also supports the acute exposure hypothesis. The curve was relatively stable over the period examined, but cancer registration data from the 1960s showed a peak incidence in women in their 40s rather than their 60s and 70s, as was recently the case. This supports a birth cohort effect, and the rate of increase of the age-specific incidence of CMMs of the lower limb was greater for birth cohorts before about 1920 than for later birth cohorts. Women who were born in the late 1800s and early 1900s may have begun to expose their lower limbs to the sun as skirts shortened and leisure activities changed in the 1910s and 1920s. In contrast, it appears that women born after 1925 had lower-risk behaviours. The relatively stable age-specific incidence curve over the last 20 years suggests that the cohorts of women born before about 1920 have passed the age at which the peak incidence occurred. This recent stability in age-specific incidence has resulted in a levelling in age-standardized incidence at this site, which has resulted in an overall levelling in the age-standardized incidence of CMMs in females over the last 10–20 years.

**Summary**

This study suggests that, if current trends continue, the age-standardized incidence of CMMs in females will remain stable and the incidence in males may also stabilize in the future. When this occurs depends on the age at which the peak incidence of CMMs of the trunk occurs in men born up to the middle of the last century, which is partly due to the degree to which CMMs of the trunk in males are due to acute or more cumulative exposure. However, changes in behaviours made by birth cohorts...
of men and women over the second half of the last century must be maintained, particularly if the recent upturn in the rate of change of the age-specific incidence of CMMs of the lower limb in young women is to be reversed. Nearly 40 per cent of people surveyed in 1993 reported at least one episode of sunburn in the last 12 months, and the public must continue to be made aware of the need to protect themselves against excessive exposure to sunlight.

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