

Increases in invasive melanoma in England, 1979–2006, by anatomical site

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Summary

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Conflicts of interest

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Background National melanoma incidence trends with details of anatomical site have not been previously described for England.

Objectives To describe site-specific trends in cutaneous melanoma for England as a whole during the last three decades.

Methods Anonymized data, 1979–2006, were obtained from national cancer registrations of all patients in England up to age 89 years with incident primary invasive cutaneous melanomas ($n = 124\,055$). Sex-specific age-standardized incidence rates and average annual percentage change in rates were calculated for each broad anatomical site.

Results Overall incidence rates of cutaneous melanoma in England, 1979–2006, were 81 and 100 per million, in males and females, respectively. Site-specific rates were consistently highest on the lower limbs in females followed by the trunk in males. Greatest annual increases occurred on the trunk in both sexes over 45 years (males 9·9%, females 6·8%), then upper limbs (males 8·7%, females 6·8%). Incidence trends in males relative to females varied little across sites apart from a more rapid rise in head/neck melanomas in males than in females after the 1980s.

Conclusions Invasive melanoma rates continue to rise in England, particularly on the trunk and arms, and in males on the head/neck. The steeper increases in melanoma rates among males are consistent with their greater sun exposure and poorer compliance with sun protection measures than females.

Incidence of cutaneous melanoma has been rising worldwide over the past few decades in countries with predominantly white populations.¹ The overall incidence of melanoma in the U.K. has almost doubled in the past two decades to 10·2 and 11·8 per 100 000 in males and females, respectively.² As elsewhere, background incidence markedly increases between early adulthood and seniority in the U.K., by 10-fold in males and 3·5-fold in females.² There is, however, evidence to suggest that the rising incidence of melanoma is at least partly explained by diagnostic drift, whereby lesions previously reported as benign are now reported as malignant, resulting in the rise in incidence being predominantly early, preinvasive disease.^{3–5}

Little recent information is available about the anatomical sites of occurrence of melanoma in the U.K. Based on a study in Scotland, 1979–2003, and another in Southeast England, 1960–98, trunk melanomas predominated in males (2·5–4·0

per 100 000), while lower limb tumours predominated in females (3·0–5·0 per 100 000).^{6,7} A detailed comparison of anatomical sites of melanoma in Western Scotland and Queensland, Australia, which accounted for relative surface areas of different body sites, showed that rates on the lower limbs of Scottish women under age 60 years were higher than on any other site (17·1 per 100 000 at ages 40–59 years).⁸ Beyond the U.K., analyses of site-specific trends have shown steep increases in incidence on the head/neck in both sexes, as well as on the trunks of males and lower limbs of females.^{7–12} Previous incidence studies grouping anatomical sites by the frequency with which they are exposed to the sun (i.e. occasionally exposed, regularly exposed, etc.) have shown significant increases in incident melanoma on occasionally exposed sites in both sexes.^{13,14}

Detailed national data on melanoma incidence trends by anatomical site have not been documented for England. These

data are needed in order to understand the changing patterns and causes of melanoma development and to inform targeted primary prevention strategies. The aim of this study therefore was to describe site-specific trends in cutaneous melanoma for England as a whole during the past three decades. To obviate the effect of diagnostic shift in the reporting of thin noninvasive melanomas, *in situ* melanomas were excluded *a priori* from these analyses.

Methods

Anonymized, individual-level, national cancer registry data were obtained from the Northern and Yorkshire Cancer Registry and Information Service for all people in England up to 89 years of age with a newly diagnosed, primary, invasive, cutaneous melanoma over the 28-year period, 1979–2006. Cancer registration in England is of a consistently high standard and the majority of cancers, including melanomas, are captured (98%). Histology reporting is the main source (at least 95%) for registration of new melanomas (South West Public Health Observatory, personal communication). Diagnostic criteria *per se* did not materially alter for invasive melanoma during the study period. Data were coded using the International Classification of Diseases (ICD) 9th revision from 1979 to 1994,¹⁵ while from 1995 onward the ICD 10th revision was used.¹⁶ For site-specific analyses, melanomas were categorized as occurring on the head and neck (ICD-09 and ICD-10 codes: 1720–1724, C43.0–C43.4), trunk (codes 1725, C43.5), upper limb (codes 1726, C43.6), lower limb (codes 1727, C43.7) or unspecified site (codes 1728–1729, and C.43.8–C.43.9). Annual mid-year national population estimates by sex, single year of age and calendar year were supplied by the Population Estimates Unit, Office of National Statistics (ONS).

Age was categorized as < 25, 25–44, 45–64 and 65–89 years and time periods were defined by 5-year intervals giving five complete quinquennia for study: 1982–1986, 1987–1991, 1992–1996, 1997–2001 and 2002–2006. Sex-specific incidence rates were calculated for each site and expressed per million person-years at risk. All incidence rates

were age-standardized to the European standard population.¹⁷ Person-years at risk were calculated for each subgroup from the population data provided. Average annual percentage change in incidence in each subgroup was estimated using the slope of the linear trend line fitted to the logarithm of incidence rates, by year of diagnosis. Thus, the average percentage change per year in incidence rates was estimated by $100*(e^b-1)$, where *b* = slope of the linear trend line.¹⁸ Significance was set at *P* < 0.05.

Results

Between 1979 and 2006 there were a total of 124 055 cases of primary invasive cutaneous melanoma diagnosed in England in persons up to age 89 years, three-quarters (*n* = 94 470) being diagnosed from 1990 to 2006. The overall age-standardized incidence rates 1982–2006 across all sites for males and females were 81 and 100 per million person-years at risk, respectively. Since 1979 the greatest proportion of all incident invasive melanoma in both sexes combined occurred on the lower limb (33%), followed by the trunk (25%), the upper limb (18%), and the head/neck (16%) with anatomical site unspecified in 8%. Highest site-specific incidence rates consistently occurred on female lower limbs followed by the male trunk.

Overall age-standardized invasive melanoma rates increased between consecutive 5-year intervals (Table 1) and across the whole study period at all specified anatomical sites in both sexes (Figs 1 and 2). Melanoma incidence on unspecified sites rose early in the study period but then plateaued so was not considered further. Comparing rates in 1982–86 to those in 2002–06, the most marked rises in incidence occurred on the trunk where rates rose almost fourfold from 15 to 56 per million in males, and over threefold in females from 9 to 29 per million (Table 1).

In every age group there were significant increases in melanoma rates over time for each anatomical site (*P*-values < 0.01) (Table 2). Greatest annual increases occurred on the trunk (9.9%) and upper limbs (8.7%) in males aged

Table 1 Age-standardized site-specific incidence rates (per 10⁶ person-years at risk) of cutaneous melanoma in males and females in England, by 5-year period (1982–2006)

Period	Head/neck		Trunk		Upper limb		Lower limb		All sites ^a											
	M	F	M	F	M	F	M	F	M	F										
1982–1986	858	7	1031	7	1524	15	1049	9	731	7	1466	12	911	8	4353	38	4537	40	8469	66
1987–1991	1334	11	1422	9	2448	23	1457	12	1079	10	1876	16	1290	11	5350	45	7005	60	11 122	84
1992–1996	1809	14	1715	10	3334	30	1869	16	1460	13	2528	20	1515	13	6035	49	9110	75	13 335	97
1997–2001	2409	18	2004	12	4605	39	2502	20	2038	15	3117	24	1798	15	6716	51	11 979	94	15 419	109
2002–2006	3439	25	2602	16	6931	56	3742	29	2997	26	4503	33	2469	19	8310	60	16 928	125	20 236	138
1982–2006	9849	15	8774	11	18 842	34	10 619	18	8305	14	13 490	21	7983	14	30 764	49	49 559	81	68 581	100

^aAll sites includes 4580 male and 4934 female cases with unspecified site (age-standardized rate of 7 per million for both sexes).

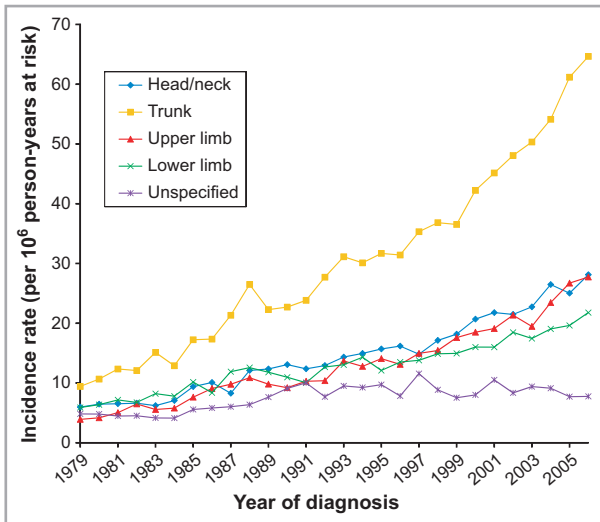


Fig 1. Incidence of cutaneous melanoma in males (per million person-years at risk) by anatomical site, in England, 1979–2006.

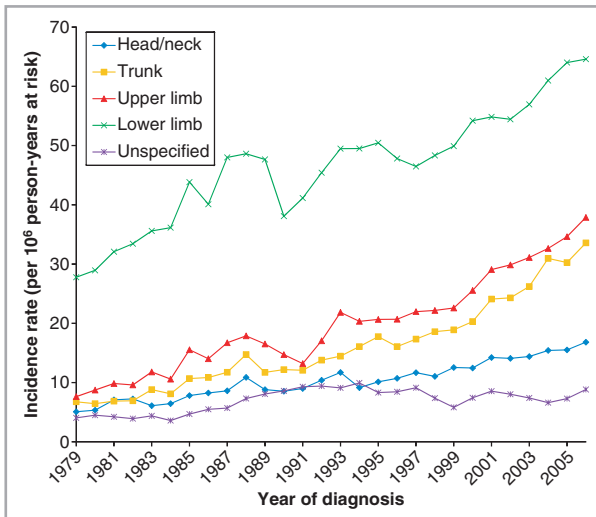


Fig 2. Incidence of cutaneous melanoma in females (per million person-years at risk) by anatomical site, in England, 1979–2006.

> 64 years. In females, the greatest increases were on the upper limb for the oldest age group (6.8%) and on the trunk in 45–64-year-olds (6.8%). Lowest annual increases in melanoma occurred on the lower limb in females < 65 years. Across all sites and age groups, the annual increase in incidence was 5.8% in males and 3.8% in females.

The magnitude of incidence rates in males relative to females (M : F) did not vary greatly over time across sites apart from divergence for head/neck melanoma (Fig. 3). Specifically, rate ratios for upper (~0.6) and lower (~0.3) limbs were consistent over the study period, with incidence remaining higher in females than in males at these sites. Despite M : F rate ratio fluctuations (1.4–2.1), incidence of trunk melanoma was always higher in males. In contrast, head/neck melanoma

showed similar rates among men and women in the 1980s (0.9) but from the early 1990s rates in men began to rise noticeably faster than the rise in women (M : F ratio ~1.6).

Discussion

In this study based on national cancer registry data, we have shown that incidence rates of invasive cutaneous melanoma have been increasing on all body sites, in both males and females, across the whole of England since 1979, to 2006. As elsewhere in the U.K., highest incidence rates were observed on the lower limb in females, but during the last three decades, increases in invasive melanoma in England have been most pronounced on the trunk in both sexes.

Several studies of anatomical incidence of invasive cutaneous melanoma have been conducted around the world, over varying time periods, and our results show that the actual site distribution of cutaneous melanomas appears similar to other countries with predominantly white-skinned populations, with trunk melanomas predominating in males and lower limb melanomas in females.^{6–13} Ours is the first study to characterize site-specific incidence trends of cutaneous melanoma in the English population, however, and to have analysed changes in site-specific rates in males relative to females. Most sites have maintained steady differences in melanoma incidence between men and women, but this was not true of the head/neck where rates in men and women were similar in the 1980s but diverged after the early 1990s, with rates in men rising faster, not only at older ages > 65 years, but also in the youngest men < 25 years.

Given that solar ultraviolet radiation (UVR) is the primary environmental cause of melanoma,^{19,20} a widespread increase in sun exposure is the likely explanation for rising melanoma trends in England and worldwide. Increases in recreational sun exposure have been facilitated by a growing industry of budget airlines in England and declining airfares^{21,22} making travel abroad to sunny destinations both accessible and affordable to people of all ages. Such vacations abroad have been linked directly to increasing melanoma incidence.^{21,22} At the same time, changes in clothing fashions have also resulted in increases in sun exposure on previously little-exposed body sites like the trunk and limbs,^{7,11,13,23,24} and such exposure is specifically associated with melanoma at these sites.^{20,25}

Meanwhile, the sunbed industry has provided a means of artificial UVR exposure in temperate England. Sunbed use, now recognized as a cause of melanoma,²⁶ is particularly prevalent among teens and young adults,²⁷ and thus may be the cause of some of the increase in melanoma in younger adults in England. Several studies have explored the relationship between sunbed use and melanoma and have noted significantly increased risk among sunbed users, particularly at earlier ages of first use.^{28–31} Further studies specifically among those highly exposed to UVR and among adolescents and young adults have noted significant positive dose–response relationships between sunbed usage and melanoma and have

Table 2 Average annual percentage change (AAPC) and 95% confidence limits (CL) of cutaneous melanoma incidence according to anatomical site, by sex and age group (1979–2006)

	Head/neck		Trunk		Upper limb		Lower limb		All sites ^a	
	AAPC (%)	95% CL	AAPC (%)	95% CL	AAPC (%)	95% CL	AAPC (%)	95% CL	AAPC (%)	95% CL
Males										
< 25 years	6.3	5.4, 7.2	4.2	3.5, 5.0	2.9	1.9, 3.8	3.2	2.4, 4.0	3.8	3.6, 4.0
25–44 years	4.0	3.6, 4.4	4.9	4.6, 5.2	5.5	5.0, 6.0	4.1	3.7, 4.5	4.4	4.1, 4.7
45–64 years	5.3	4.9, 5.7	6.7	6.4, 7.0	6.6	6.3, 7.0	4.5	4.2, 4.9	5.7	5.5, 6.0
65–89 years	6.8	6.6, 7.0	9.9	9.6, 10.2	8.7	8.4, 9.1	4.4	4.0, 4.8	7.2	7.1, 7.3
0–89 years	5.9	5.7, 6.1	6.8	6.5, 7.0	6.7	6.5, 7.0	4.3	4.0, 4.5	5.8	5.6, 6.0
Females										
< 25 years	5.1	3.9, 6.3	4.2	3.5, 4.8	5.2	4.4, 5.7	3.1	2.5, 3.6	3.9	3.5, 4.3
25–44 years	3.1	2.5, 3.6	5.8	5.4, 6.1	4.3	3.9, 4.6	1.3	1.0, 1.6	2.9	2.7, 3.2
45–64 years	4.1	3.8, 4.4	6.8	6.5, 7.0	5.3	5.0, 5.7	2.5	2.3, 2.7	3.8	3.6, 4.0
65–89 years	4.0	3.8, 4.3	5.1	4.7, 5.4	6.8	6.5, 7.0	4.6	4.3, 4.9	4.7	4.6, 4.9
0–89 years	3.9	3.6, 4.1	5.9	5.7, 6.1	5.3	5.0, 5.6	2.5	2.3, 2.8	3.8	3.6, 4.0

^aAll sites includes cases with unspecified site.

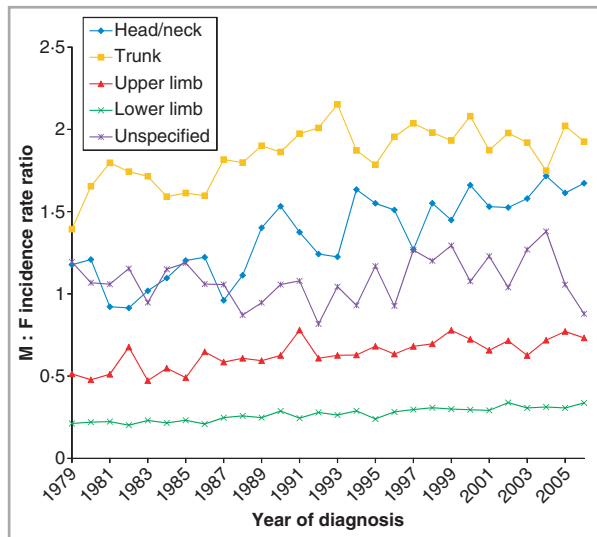


Fig 3. Cutaneous melanoma male to female (M : F) incidence rate ratios by anatomical site, in England, 1979–2006.

described site-specific increases in risk particularly for trunk melanomas.^{30,31} It is hoped that regulations recently implemented in the U.K. banning sunbed use among those under 18 years of age³² may mitigate these trends.

There is some controversy about whether or not the increases in melanoma incidence on trunk and limbs might be artefact, entirely explained by the shift from diagnosis of a proportion of benign naevi to stage I melanomas.⁵ While this diagnostic drift may indeed partly explain some recent general increases on trunk and limbs, it is more difficult to explain the continuing incidence rises on the head and neck (in males much more than females) as this anatomical region has been relatively unaffected by the diagnostic shift⁵ and is not sex-specific. With high cumulative UVR exposure leading

to the development of melanoma on the head and neck^{7,11,13,33} the steeper increase in males than in females on this site is consistent with ongoing higher levels of exposure of the face to UVR in males than in females at all ages, including youth. This is consistent with the general observation that women tend to be less photodamaged than men and have sustained fewer sunburns.^{34–36} They are also more informed about, and compliant with, health promotion measures than men.^{34,35} Women tend to be more conscious of their appearance and to perceive a suntan as a greater threat to attractiveness and health than their male counterparts.³⁵ Similarly, it is notable that melanoma mortality rates have stabilized in women although are still rising in men in England³⁷ suggesting that improved diagnosis has yet to benefit men with more advanced disease to the same degree as women.³⁸

The strengths of these findings are their national population base and their coverage of recent trends over almost three decades. While melanoma registration and data capture are currently of high quality,³⁹ there were some deficiencies in melanoma registration in England at the outset of the study period. Improved registration late in the study period, including the recording of multiple primary melanomas on different sites, could therefore have contributed to the observed increase in incidence rates overall, although this should not have affected anatomical sites differentially. Thus the relative site-specific distributions reported here should be accurate. Lack of information about precise anatomical subsites of melanomas prevented further insights into exact sites of UVR exposure which might be amenable to sun-protection measures (e.g. face vs. ear or leg vs. thigh). Laterality details were not available to us, although a previous report has shown a left-sided excess of cutaneous melanoma in England along with several other mainly white populations around the world.⁴⁰ Lack of adjustment for body surface area in the calculation of anatomical site-specific incidence rates may also be seen as a potentially

limiting factor, but as we were assessing only trends in melanoma incidence over time, body surface area would not have influenced the results and indeed our analyses are quite comparable to those of other studies which have adjusted for body surface area.^{8,11}

In conclusion, the incidence of invasive cutaneous melanoma on all body sites continued to rise in England among both sexes over the last three decades, with the greatest increases on the trunk, upper limbs and male head and neck. Melanoma prevention messages emphasizing the dangers of high UVR exposure, both outdoors in summer or on holiday abroad, and indoors from sunbeds, should continue to be a focus of public health initiatives in England. Men in particular should be encouraged to protect themselves from harmful sun exposure. Continued monitoring of trends in the incidence of cutaneous melanoma is required to track future changes in incidence rates and to assess the effectiveness of current public health messages.

What's already known about this topic?

- Incidence of cutaneous melanoma is still rising worldwide, particularly in countries with predominantly white populations.
- Diagnostic drift may account for some of the increases observed in rates.
- Rates increase with age and are generally highest on the trunk in males and on the lower limb in females.
- National-level site-specific melanoma incidence trends have not previously been described in England.

What does this study add?

- To our knowledge this is the first study to describe trends in invasive melanoma incidence trends by anatomical site, for England as a whole.
- Invasive melanoma rates continue to rise in England across all body sites, but particularly on the trunk and arms, and on the head/neck of males.
- The steeper increases in male rates are consistent with their greater ultraviolet radiation exposure and poorer compliance with health promotion messages compared with females.

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