Increasing Incidence of Cutaneous Melanoma in Queensland, Australia

R. MacLennan,* A. C. Green, G. R. C. McLeod, N. G. Martin

**Background:** Queensland, Australia, had the world's highest incidence rates of invasive cutaneous melanoma in the 1970s. **Purpose:** The purpose of this study was to monitor trends in melanoma incidence in Queensland. **Methods:** We studied two time periods in which ascertainment was comparable. **Results:** In the 7.5 years up to 1987, the incidence of invasive melanoma in Queensland increased by more than one half in women (to 42.89 per 100,000) and more than doubled in men (to 55.81 per 100,000), with the most dramatic increase seen in men over age 50 years. This higher increase in men is a reversal of the previously higher rates in women. In

Received January 27, 1992; revised June 1, 1992; accepted June 9, 1992.

Supported by grants from the Queensland Cancer Fund, the Queensland Department of Health, and the National Health and Medical Research Council.

We thank Dr. Ian Ring, Queensland Cancer Registry, for access to registry data; Queensland pathologists and laboratory staff for providing access to their files; Ms. Philippa Youl and Ms. Anna Chung for data quality control; and Mr. Ulrich Kehren, Ms. Lea Mangahas, and Ms. Ros Paterson for database management.

R. MacLennan, A. C. Green, N. G. Martin, Queensland Institute of Medical Research, Brisbane, Australia.

G. R. C. McLeod, Queensland Melanoma Project, Princess Alexandra Hospital, Brisbane.

*Correspondence to: Robert MacLennan, M.B., B.S., Queensland Institute of Medical Research, 300 Herston Rd., Brisbane, Qld., Australia 4029.
Queensland, cumulative risks of total cutaneous melanoma (in persons aged 0-74 years), including preinvasive melanoma, have increased to one in 14 in men and to one in 17 in women. There were large increases in age-standardized incidence rates of thin lesions (<0.75 mm) in both sexes but not of in situ lesions, and there were also increases in thicker lesions, especially on the backs of males. **Conclusions:** Although increased awareness and earlier diagnosis appear to have accompanied increased incidence, increased exposure to solar UV radiation during the past 50 years appears to be the most likely explanation for the rise in incidence rates. **Implications:** A better understanding is needed of the causes of melanoma and of the complex relationships between constitutional factors, ambient UV radiation, and sun-exposure behavior. [J Natl Cancer Inst 84:1427–1432, 1992]

If the worldwide incidence of cutaneous melanoma continues to rise at the same rapid rate observed over the last four decades, it is likely that the incidence of melanoma will overtake that of lung, bowel, and breast cancers in White populations early in the 21st century. Among cancer registries in six continents reporting for the period up to 1982 (1), the highest incidence rates of cutaneous melanoma in both males and females were in Queensland, Australia, followed by the “White” population of Hawaii and then by other populations within Australia and New Zealand.

In this study, we report on new population-based trends in melanoma incidence in Queensland that demonstrate an extraordinary increase in melanoma incidence. We present incidence rates for preinvasive and invasive disease according to the histological classification and the thickness of the lesions.

**Methods**

The Queensland Cancer Registry was established in 1982 and has reported cancer incidence up to 1985. A project was established in 1989 to more rapidly monitor melanoma incidence and to assess the completeness of melanoma-case notification to the Queensland Cancer Registry by pathology laboratories. Because records were readily available in laboratories, the calendar year 1987 was selected initially for study and is compared here with a similar survey of all laboratories over a 12-month period in 1979 and 1980.

**Case Ascertainment**

Pathology reports for all primary cutaneous melanomas (International Classification of Diseases, 9th revision, site codes 172.0-172.9 and 232.0-232.9) diagnosed between July 1, 1979, and June 30, 1980, were gathered from 24 government, hospital, and private pathology laboratories throughout Queensland, largely during personal visits by A. C. Green to each laboratory (2). In Queensland, it is extremely rare for a clinically diagnosed cutaneous melanoma not to be examined histologically. Our quality-control procedures for the 1987 study included verification of notification by comparing pathology laboratory indexes and written reports of all melanomas diagnosed in 1987 with lists of all cases in the Queensland Cancer Registry. All major laboratories were visited, and other laboratories with only a few cases provided lists from their indexes. Information from pathology reports of 111 previously unregistered cases comprising 58 lentigo maligna and 53 superficial spreading melanomas was thus added to the Queensland Cancer Registry 1987 melanoma data. Missing registry data on melanoma morphology among 140 cases were obtained in 120 cases by visits to hospital medical records departments.

**Pathology**

Pathology was coded for 1979/1980 during visits to data sources according to McGovern (3); for 1987, pathology reports were coded according to the first edition of the International Classification of Disease for Oncology (ICD-O) (4). Although the code 8742/2 is used for lentigo maligna (Hutchinson’s melanotic freckle) whether or not melanoma is also diagnosed, we have added a code to allow more valid future analysis of time trends, since some laboratories were unaware that lentigo maligna alone is notifiable. A large number of lesions in the 1987 study coded as “melanoma not otherwise specified” (ICD-O group 8720/3) would have been distributed among other McGovern (3) categories in the 1979/1980 study. Persons with more than one primary melanoma were excluded when a previous primary melanoma was known; this situation was more likely to occur for the 1987 study than for the 1979/1980 study due to the ability in 1987 to cross-check against previous notification to the Queensland Cancer Registry. Measured thickness of invasive lesions (5) was recorded in the pathology reports of 91% of the males and of 90% of the females and has been grouped for analysis.

Only persons who resided in Queensland were included. Although it was impossible to distinguish aboriginal Australians who constitute approximately 2% of the Queensland population, melanoma has rarely been recorded in aborigines. Population denominators were from the Australian Bureau of Statistics for June 1980 and June 1986 (census year). Directly age-standardized rates and their confidence limits (using the binomial approximation method to calculate standard errors) were calculated as described by Boyle and Parkin (6). The cumulative rates and risks were calculated according to Day (7); for this calculation, estimates of cumulative risk for persons aged 0-74 years are approximated from the cumulative rate, and the effects of other diseases, such as those occurring in middle age, are ignored. All incidence rates for 1979/1980 and 1987 were age standardized to the standard world population (6), and invasive melanoma was also age standardized to the U.S. population of 1970 (8).

**Results**

**Total Melanoma**

In a comparison of two 12-month periods, 7.5 years apart, the total incidence of melanoma in Queensland, age standardized to the world population, almost doubled in males and increased by 50% in females in 1987 compared with that in 1979/1980 (Table 1). By 1987, cumulative risks (in persons aged 0-74
years) of any type of melanoma, based on the cumulative rates, increased to approximately one in 14 in males and one in 17 in females (Table 1).

### Preinvasive Melanoma

Incidence rates of all types of preinvasive melanoma were similar in males and in females in both 1979/1980 and 1987. Over the 7.5-year period to 1987, incidence rates increased by about 50% in males and females (Table 1). Rates of lentigo maligna rose substantially. Rates of in situ lentigo maligna decreased but remained higher in males than in females. Rates of in situ superficial spreading melanoma increased by 58% in males and 37% in females, but were nevertheless higher in females during both time periods.

### Invasive Melanoma

During a 7.5-year period and from a baseline of 22.6 in males and 25.8 in females in 1979/1980, age-standardized rates (world population) of invasive melanoma increased by 116% in males and 53% in females to 48.9 and 39.7 per 100,000, respectively (Table 1). The values of the rates in 1987 were even higher when standardized to the U.S. population of 1970 (55.8 per 100,000 in males and 42.9 per 100,000 in females). Estimates of cumulative risk (for persons aged 0-74 years) of invasive melanoma were approximately one in 19 in males and one in 25 in females (Table 1). Cutaneous metastatic melanomas from an unknown primary melanoma were reported in 44 persons (34 male and 10 female) in 1987, but these lesions were not collected in the 1979/1980 survey which preceded a population-based case-control study. The age-incidence curves of invasive melanoma altered strikingly from 1979/1980 to 1987, particularly in males over 50 years old (Fig. 1). Although rates among females increased substantially in the 7.5 years between 1979/1980 and 1987, they did not show the steep rise that was seen in males at older ages.

Invasive lentigo maligna melanoma (located predominantly on the face) doubled in males but did not increase in females (Table 1) during the 7.5 years to 1987. Superficial spreading melanoma increased by 84% in males and 38% in females. There were small decreases (14% in males and 16% in females) in the incidence of nodular melanoma. Other invasive lesions also greatly increased. In 1987, these lesions included melanomas arising in a giant nevus in 14 males and in 10 females, but a very high proportion were not classified as to histogenetic type.

### Thickness Categories

The largest increases in the age-standardized incidence rates by thickening...
ness categories (Table 2) were in invasive melanomas that were less than 0.75 mm (267% increase in males and 70% in females). These melanomas were predominantly superficial spreading melanomas. The next thickness category (0.75-1.49 mm) increased by 115% in males and 208% in females. Although lesions 1.50-2.24 mm increased more in females (73%) than in males (19%), very thick lesions (>2.25 mm) increased more in males in the 7.5 years to 1987.

The incidence of very thick lesions (i.e., ≥3.00 mm) almost doubled in males (superficial spreading and nodular melanoma increased equally) but changed little in females.

**Discussion**

The current international epidemic of melanoma appears to be particularly intense in Queensland, with rates in this population the highest ever reported. There is no evidence that the peak has been reached.

To what extent are the increases real and not simply due to the increased reporting of lesions? Increased reporting from sources other than pathology laboratories after the establishment of a cancer registry in 1982 cannot explain the increase, since almost all melanomas

### Table 2. Invasive melanoma incidence rates by sex and tumor thickness, Queensland, 1979/1980 and 1987*

<table>
<thead>
<tr>
<th>Sex</th>
<th>Tumor thickness, mm</th>
<th>1979/1980</th>
<th>1987</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No data on thickness</td>
<td>&lt;0.75</td>
<td>0.75-1.49</td>
</tr>
<tr>
<td>Male</td>
<td>No. of cases</td>
<td>82</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Age-standardized rate†</td>
<td>6.64</td>
<td>6.62</td>
</tr>
<tr>
<td></td>
<td>95% confidence interval</td>
<td>5.19-8.08</td>
<td>5.13-8.10</td>
</tr>
<tr>
<td>Female</td>
<td>No. of cases</td>
<td>85</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>Age-standardized rate†</td>
<td>6.64</td>
<td>12.57</td>
</tr>
<tr>
<td></td>
<td>95% confidence interval</td>
<td>5.20-8.09</td>
<td>10.51-14.62</td>
</tr>
<tr>
<td>Male</td>
<td>No. of cases</td>
<td>59</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>Age-standardized rate†</td>
<td>3.91</td>
<td>24.31</td>
</tr>
<tr>
<td></td>
<td>95% confidence interval</td>
<td>2.89-4.92</td>
<td>21.75-26.87</td>
</tr>
<tr>
<td>Female</td>
<td>No. of cases</td>
<td>56</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>Age-standardized rate†</td>
<td>3.49</td>
<td>21.38</td>
</tr>
<tr>
<td></td>
<td>95% confidence interval</td>
<td>2.54-4.44</td>
<td>18.95-23.81</td>
</tr>
</tbody>
</table>

†Excludes 34 male and 10 female cutaneous metastases from unknown primary tumors.
‡Rate per 100 000 age adjusted to the standard world population, with 95% confidence intervals (6).
that are clinically diagnosed in Queensland are confirmed by histology, although the histologically confirmed cases are not always reported to the registry. The same comprehensive sources, i.e., pathology laboratories, were systematically covered for both time periods.

Is the rise an artifact of the ascertainment of lesions at an earlier stage in their history? The increases in invasive melanoma were double those in preinvasive melanoma in males (who had the larger increase). This pattern of larger increases in invasive than in preinvasive melanoma was found for all types combined, for superficial spreading melanoma, and for lentigo maligna melanoma in males (but not in females, whose rates did not change). Further, although there were increases in thin invasive lesions in both males and females, males also had substantial increases in thick lesions. Such a rise would not be expected if malignant lesions were being systematically harvested earlier. The steep rise in the incidence of lentigo maligna, located mainly on the face, may indicate greater public or medical practitioner awareness that would generally lead to increased diagnosis rates. Increased awareness does not explain the increase in thick lesions which were predominantly found on the backs of males aged 50 years and over.

We conclude that, although the increased rates of registered melanoma (especially of invasive melanoma) appear to indicate a true increase in incidence, this rate increase has been accompanied by earlier diagnosis. Incidence rates for nodular melanoma fell (Table 1), but there was a greater incidence of thick lesions (Table 2). The marked increase in melanoma recorded in our data was predominantly in invasive melanoma.

The reasons are unknown for the divergent age-incidence curves among males compared with females after age 50 years, which were apparent in 1987 but were absent in 1979/1980. Strikingly similar changes in the patterns of age-incidence curves to those in Fig. 1 are seen in the Surveillance, Epidemiology, and End Results (SEER) Program incidence data in the United States between 1973-1975 and 1985-1987 (9) and in data reported by the South Australian cancer registry for the 10 years from 1979 to 1989 (10,11). These similar changes in widely separated populations are consistent with some similar type of prior environmental exposure, though increased ascertainment cannot be excluded. It is likely that a real increase in incidence would be accompanied by greater public awareness and, thus, by earlier diagnosis. The differences, however, that have emerged between males and females in Australia without differential health promotion campaigns, and an increase rather than a decrease in incidence rates of thick melanomas in Queensland males, are evidence against enhanced ascertainment as an explanation for our increases.

To what extent could patterns of environmental exposure explain the contrasts and changes in incidence in Queensland? The environmental factor underlying the worldwide increase in cutaneous melanoma is considered to be exposure to solar UV radiation. Considering that the rise in incidence is evident in men aged 55 years in 1987, the most likely explanation would be a change in behavior, perhaps more in men than in women, in the past 40-50 years. White populations such as ours have spent a large proportion of increased leisure time outdoors, often in pursuit of a suntan, which is highly regarded as a symbol of beauty, health, and wealth. Nevertheless, analytical epidemiological studies are required to confirm that at least part of these recent increases in melanoma is attributable to such behavior.

The discovery of the "Antarctic ozone hole" in the late 1970s by Farman et al. (12) led to the monitoring of stratospheric ozone over Australia. It has been calculated (13) that stratospheric ozone losses in the decade from 1980 to 1990 would have increased effective or biologically active UVB radiation over Darwin (in the far north of Australia) by 3.1% and over Brisbane (in southeastern Queensland) by 4.5%. Most of Queensland’s population lives in or near Brisbane and, thus, theoretically had a potential increase in UVB radiation exposure of approximately 3% over a 7.5-year period. It seems highly improbable that this relatively small and largely theoretical increase in UVB radiation exposure could have led to the large rise in melanoma that we have observed. If we hope to curb the rising trends in melanoma, a better understanding is needed of the causes of melanoma and of the complex relationships between constitutional factors, ambient UV radiation, and sun-exposure behavior. The possibility of increasing stratospheric ozone depletion makes this need even more urgent, not only in the population in Australia but also in other susceptible populations, such as those in the United States.

1Ed. note: SEER is a set of geographically defined, population-based central tumor registries in the United States, operated by local nonprofit organizations under contract to the National Cancer Institute (NCI). Each registry annually submits its cases to the NCI on a computer tape. These computer tapes are then edited by the NCI and made available for analysis.
References

(1) Cancer Incidence in Five Continents, vol 5. IARC Publ No. 88, Lyon: IARC, 1987