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Recent trends in incidence of cutaneous melanoma among U.S. Caucasian young adults

Mark P. Purdue, **Laura Beane Freeman**, **William F. Anderson**, and **Margaret A. Tucker**
Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services, Rockville, MD, USA

TO THE EDITOR:

Recent findings suggest that non-melanoma skin cancer (NMSC) incidence in young adults is rising, particularly among U.S. young women (Christenson *et al.*, 2005). This raises the important question of whether incidence of cutaneous melanoma, the most lethal form of skin cancer, is similarly increasing in young adults. While melanoma incidence among U.S. older adults has been increasing for several decades, there have been indications that incidence may be stabilizing for birth cohorts born after 1945 (Dennis *et al.*, 1993;Hall *et al.*, 1999). However, in an analysis of melanoma trends between 1973 and 1997 in the Surveillance, Epidemiology, and End Results (SEER) Program, Jemal et al. noted evidence of an increase among women born after 1960 (Jemal *et al.*, 2001). Since that analysis, an additional seven years of SEER data have been collected. To better understand recent trends in melanoma incidence among young adults, we report findings from a re-analysis of SEER data, extended through 2004.

Our analysis was restricted to Caucasians from the nine registries that have contributed data to the SEER Program since 1973 (Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle, Utah). We calculated annual age-adjusted incidence (SEER Progam, 2007a) and mortality rates (SEER Program, 2007b) of invasive cutaneous melanoma among men and women aged 15–39, standardized to the 2000 U.S. population, using the software SEER*Stat version 6.3.6 (National Cancer Institute: http://seer.cancer.gov/seerstat/). We assessed trends in greater detail using joinpoint regression models, which identify changes in trends over successive segments of time and describe the estimated annual percent change (EAPC) in incidence within each segment (Kim *et al.*, 2000), using the software Joinpoint version 3.0 (National Cancer Institute: http://srab.cancer.gov/joinpoint/). Joinpoint analyses stratifying by melanoma stage (localized vs. regional/distant) and thickness (≤1mm vs. >1mm) were also performed. To describe age-specific trends by year of birth, we calculated incidence by five-year age groups and time periods, and plotted age-specific incidence by calendar year of birth (calculated from the age group midpoint). Additionally, age-period-cohort modeling was used to simultaneously adjust age-specific incidence trends for both calendar period and birth cohort effects (Tarone and Chu, 2000). All *p*-values are two-sided.

Overall, the age-adjusted annual incidence of melanoma among young men increased from 4.7 cases per 100,000 persons (95% confidence limits 3.8, 5.7) in 1973 to 7.7 per 100,000 in 2004 (6.8, 8.7). Among women, age-adjusted annual incidence per 100,000 increased from 5.5 (4.5,

Correspondence to: Dr. Mark Purdue, Division of Cancer Epidemiology and Genetics, National Cancer Institute, 6120 Executive Blvd, EPS 8009, Rockville, MD, 20892, USA. Email: purduem@mail.nih.gov.

Conflict of Interest
The authors state no conflict of interest.

6.6) in 1973 to 13.9 (12.7, 15.2) in 2004. Melanoma incidence increased among young men (EAPC=6.6; 95% CL 2.9, 10.4) and women (9.2; 6.8, 11.7) during the 1970s (Figure 1, Table 1). Starting around 1980, this pattern changed. For men, incidence leveled off between 1980 and 2004 (0.4; −0.2, 0.9). For women, the rate of increase in incidence declined from 1978 to 1987 (2.6; 1.5, 3.8) and stabilized from 1987 to 1992 (−0.6; −3.7, 2.6). After 1992, however, incidence began climbing again (2.7; 2.1, 3.4). Incidence among women from the 1990s onward increased both for thinner and thicker melanomas (≤1mm: 3.1; 2.5, 3.6. >1mm: 2.8; 1.6, 4.0), and was greater for regional and distant tumors (9.2; 3.8, 14.9) compared to localized lesions (1.9; 1.6, 2.3). Melanoma mortality rates for men and women declined from 1981 onward (men: −3.6; −4.5, −2.7. women: −2.3; −3.1, −1.5).

Age-specific incidence patterns by year of birth are presented in Figure 2. Male age-specific incidence rose steadily with each successive birth cohort until 1950, at which time incidence appeared to level off or decrease slightly. Female age-specific incidence by birth cohort increased steadily until around 1950; thereafter, incidence appeared to climb at a slower pace until 1965, at which point incidence appeared to begin accelerating. After adjustment for age and period effects, age-period-cohort modeling confirmed a change in the effect of birth cohort for women born between 1960 and 1965 (Supplementary Figure; slope change parameter = 0.2146; 95% CL 0.0576, 0.3716; p=0.007).

It is important to consider whether these trends may reflect changes in data quality, diagnosis or surveillance. There is evidence of increased underreporting of melanoma over time within the SEER program, with estimates as high as 17% of all cases (including *in situ* lesions) in two registries, although such a trend in underreporting cannot explain the observed increase in incidence among women (Seiffert, 1992;Merlino *et al.*, 1997). It is unlikely that a change in melanoma diagnostic criteria would account for our finding, since the effect of such a change would not be expected to be sex-specific. Changes in screening patterns may have led to earlier detection within this time period, with a higher rate of increase seen among superficial localized tumors compared to thicker lesions and regional or metastatic disease overall (Jemal *et al.*, 2001;Welch *et al.*, 2005). Indeed, the observed decrease in melanoma mortality rates after 1981 and previously reported evidence of general improvement in survival by stage over this time period are consistent with a shift towards earlier detection of disease through increased surveillance (Jemal *et al.*, 2001). However, in our analysis, the increasing trend among young women from the early 1990s onward was also observed for thicker and regional/distant tumors, which are less susceptible to misclassification. Moreover, our age-period-cohort analysis suggested that, after adjusting for age and period effects (the latter of which is reflective of changes in disease surveillance), the observed increase in incidence among women born after 1965 is consistent with a birth cohort effect (indicative of changes in disease risk factor prevalence across birth cohorts; (Tarone and Chu, 2000)). Thus, our findings are compatible with a real increase in incidence among young women, although we cannot rule out the effects of changes in surveillance.

The recent increase in incidence among young women parallels reported trends in exposure to ultraviolet radiation (UVR), the primary environmental cause of melanoma (Armstrong and Kricker, 2001). The prevalence of sunburn is increasing among U.S. adult men and women overall, although trends by age group have not been reported (Robinson *et al.*, 1997;Saraiya *et al.*, 2007). Among adolescents aged 16–18, both the prevalence of sunburn and the average number of days spent at the beach increased between sun surveys conducted in 1998 and 2004 (Cokkinides *et al.*, 2006). Tanning bed usage, which has been recently evaluated as a probable cause of melanoma (International Agency for Research on Cancer, 2007), is increasing among U.S. adults and is most prevalent among young women (Robinson *et al.*, 1997;Lazovich and Forster, 2005).

In conclusion, our analysis of SEER data suggests that melanoma incidence is increasing among young women. Additional studies are needed in order to clarify whether the increasing trends for melanoma and NMSC (Christenson *et al.*, 2005) are the result of changes in UVR exposure in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Abbreviations

CI, confidence interval; EAPC, estimated annual percent change; NMSC, non-melanoma skin cancer; SEER, the Surveillance, Epidemiology, and End Results (SEER) Program; UVR, ultraviolet radiation.

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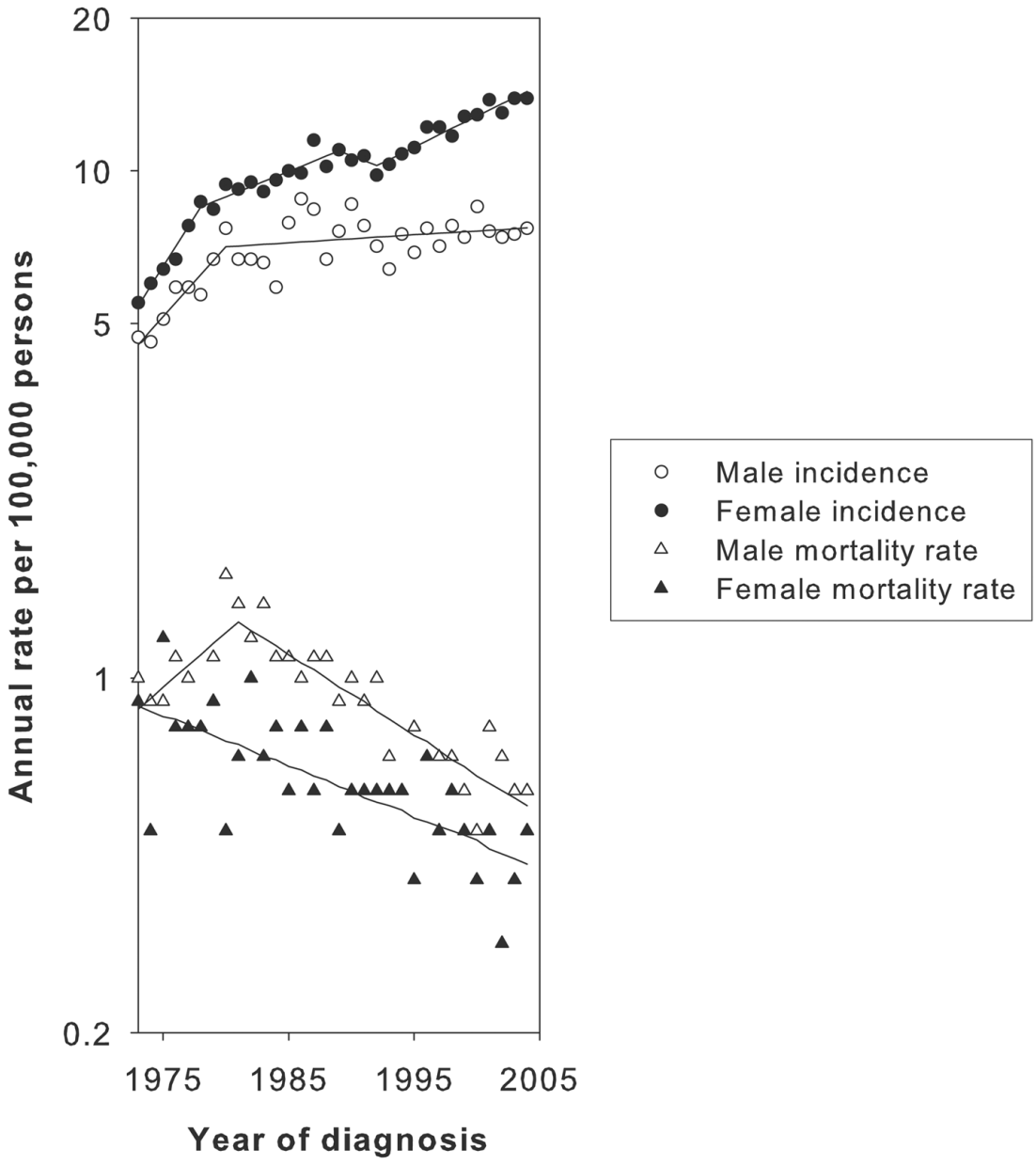

Figure 1.
Age-adjusted (to 2000 U.S. population) annual cutaneous melanoma incidence and mortality rates among Caucasian males and females aged 15–39 in the Surveillance, Epidemiology, and End Results Program areas from 1973 through 2004. The segments of uniform trend from the best-fitting Joinpoint models are also shown.

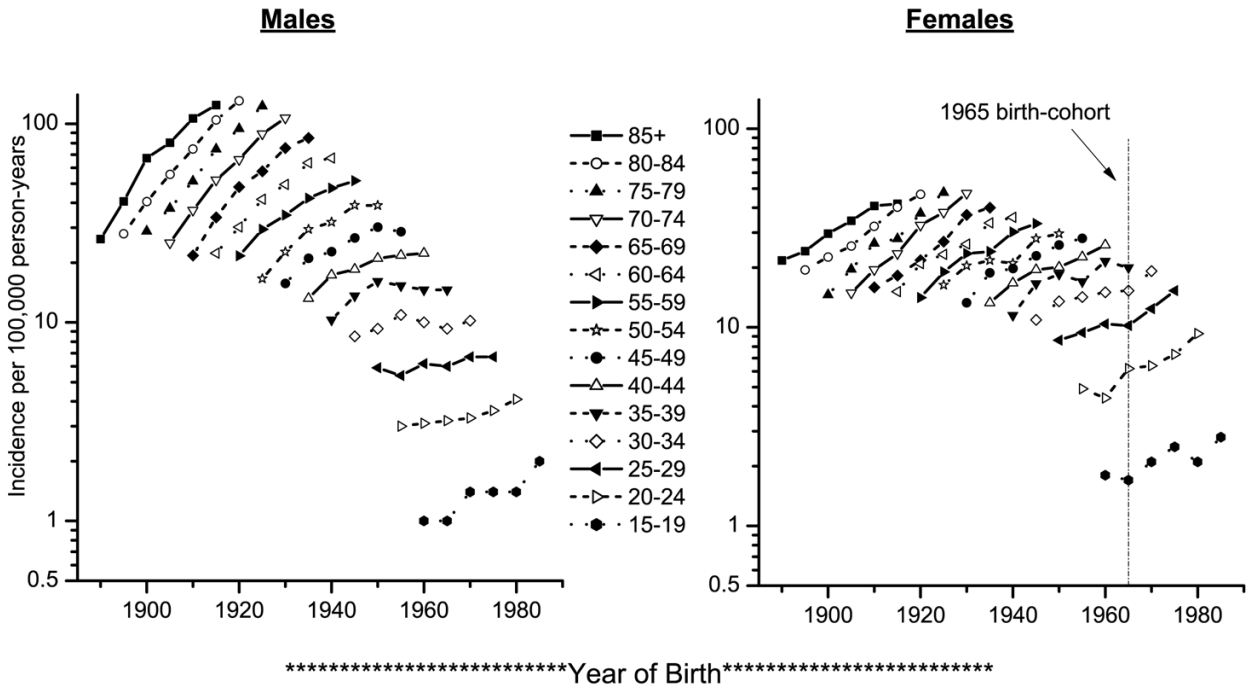

Figure 2.

Age-specific melanoma incidence among Caucasians stratified by sex and birth-cohort year in the SEER program from 1975–1979 through 2000–2004. The points vertically above each cohort year portray the cohort's age-specific incidence experience. The vertical line at 1965 on the x-axis of the plot for women represents the time point after which melanoma incidence begins increasing in subsequent cohorts.

Table 1

Estimated annual percent changes (EAPC) in incidence of melanoma and melanoma mortality among Caucasian males and females aged 15–39 in the SEER Program from 1973 through 2004.

	Years[1]	Trend 1 EAPC (95% CL)	Years	Trend 2 EAPC (95% CL)	Years	Trend 3 EAPC (95% CL)	Years	Trend 4 EAPC (95% CL)
Incidence								
Overall								
Males	1973–1980	**6.6 (2.9, 10.4)**	1980–2004	0.4 (−0.2, 0.9)				
Females	1973–1978	**9.2 (6.8, 11.7)**	1978–1987	**2.6 (1.5, 3.8)**	1987–1992	−0.6 (−3.7, 2.6)	1992–2004	**2.7 (2.1, 3.4)**
By Stage:								
Localized								
Males	1973–1980	**9.6 (4.9, 14.5)**	1980–2004	0.5 (−0.2, 1.2)				
Females	1973–1978	**15.8 (10.9, 21.0)**	1978–2004	**1.9 (1.6, 2.3)**				
Regional/Distant								
Males	1973–2004	**1.4 (0.6, 2.2)**						
Females	1973–1994	−0.9 (−2.5, 0.8)	1994–2004	**9.2 (3.8, 14.9)**				
By Thickness (1988 + only):								
<=1mm								
Males	1988–2004	**2.3 (1.2, 3.4)**						
Females	1988–2004	**3.1 (2.5, 3.6)**						
>1mm								
Males	1988–2004	−0.3 (−1.5, 1.0)						
Females	1988–2004	**2.8 (1.6, 4.0)**						
Mortality								
Males	1973–1981	**5.0 (0.3, 10.1)**	1981–2004	**−3.6 (−4.5, −2.7)**				
Females	1973–2004	**−2.3 (−3.1, −1.5)**						

EAPC = estimated annual percent change in melanoma incidence within jointpoint segment; CL = confidence limits. Statistically significant results in bold face type.

[1] Calendar period within joinpoint segment. Joinpoint modeling was done separately for males and females; hence, sex-specific joinpoint segments may differ.