Cutaneous Melanoma Mortality among the Socioeconomically Disadvantaged in Massachusetts

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ABSTRACT

Objectives. To identify groups for melanoma prevention and early detection programs, this study explored the hypothesis that survival with cutaneous melanoma is disproportionately lower for persons of lower socioeconomic status.

Methods. Massachusetts Cancer Registry and Registry of Vital Records and Statistics data (1982 through 1987) on 3288 incident cases and 1023 deaths from cutaneous melanoma were analyzed. Mortality/incidence ratios were calculated and compared, predictors of late stage disease were examined with logistic regression analysis, and a proportional hazards regression analysis that used death registration as the outcome measure for incident cases was performed.

Results. Lower socioeconomic status was associated with a higher mortality/incidence ratio after adjustment for age and sex. For education, the mortality/incidence ratio was 0.37 in the lower group vs 0.25 in the higher group (rate ratio = 1.48, 95% confidence interval [CI] = 1.08, 2.03). Late stage disease was independently associated with lower income (rate ratio for lowest vs highest tertile = 1.64, 95% CI = 1.20, 2.25), and melanoma mortality among case patients was associated with lower education (rate ratio = 1.52, 95% CI = 1.09, 2.13).

Conclusions. Melanoma patients of lower socioeconomic status may be more likely to die from their melanoma than patients of higher socioeconomic status. Low-SES communities may be appropriate intervention targets. (*Am J Public Health.* 1996;86:538–543)

Introduction

Cutaneous melanoma is often curable when diagnosed and treated at an early stage, while late disease is nearly always fatal.[1,2] Detection of melanoma at an early, curable stage has been the goal of numerous education and screening programs throughout the world.[3–6] The effectiveness of such efforts may be increased by identifying population groups most at risk for fatal melanoma and targeting education and early detection programs to such groups.

One potential means for identifying population subgroups at risk is through measures of socioeconomic status (SES). While epidemiologic studies have shown that melanoma incidence rates are higher in populations of the highest social class,[7–13] fewer studies have investigated SES and melanoma mortality or survival.[14–17] In general, these studies have not included multiple measures of both SES and early detection (e.g., case fatality and stage of diagnosis). For other types of cancer, patients of lower SES tend to have higher mortality relative to incidence and more often die from their disease.[18–29] Since similar analyses of cutaneous melanoma were lacking, we examined the relationship of SES to melanoma incidence and mortality in population-based data from Massachusetts.

Methods and Materials

Incidence and Mortality Data

We obtained data on all incident cases of cutaneous melanoma in Massachusetts from 1982 to 1987 through the Massachusetts Cancer Registry. For each incident case, the registry recorded the patient's age (stratified into five groups: 20 to 44 years, 45 to 54 years, 55 to 64 years, 65 to 74 years, and 75 years and over), sex, race (White, non-White), stage at diagnosis (local, distant, and regional), town, zip code, and address. We restricted the analysis to White residents 20 years of age and above, who account for greater than 95% of melanoma cases diagnosed in Massachusetts.

Death certificate data for melanoma were complete for 1982 through 1987. Age, sex, race, town, zip code, and address were recorded for each death.

SES Markers

Neither the registry nor vital statistics records had direct, individual information concerning income and education status. As an indirect measure of SES, we used data on the percentage of high school graduates and median household income derived from the 1980 Massachu-

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This paper was accepted August 17, 1995.

Editor's Note. See related editorials by Link and Phelan (p 471) and Jefferys (p 474) in this issue.

setts census for the census tract or zip code in which the case patient resided. Whenever possible, we used census tract (83% of incident cases and 77% of deaths) rather than zip code (17% of cases and 13% of deaths; 10% of deaths could not be assigned) since the defined geographic area was smaller (an estimated 4000 residents per census tract vs an estimated average of 30 000 persons per zip code). We observed no significant differences in age and sex distributions for patients with measures of education or income assigned by census tract or zip code.

For purposes of analysis, we classified cases and deaths into three categories for each SES measure using group cutoffs from other published cancer analyses.[11,30] Educational status (defined as percentage of high school graduates per area) was categorized as lower (<62%), middle (62% to 82%), and higher (83%+), and the case distribution was 14%, 48%, and 38%, respectively. Median household income was categorized as lower (<$15 000), middle ($15 000 to $24 999), and higher (>$25 000), and the distribution of cases in the three categories was 20%, 59%, and 21%, respectively.

Education and income were considered as two alternative measures of SES, with some consideration given to education as a preferred measure.[31] In our data, the two indirect measures of SES were highly correlated ($r = .70$). In all multivariate analyses, separate models for each measure were evaluated and presented.

TABLE 1—Adjusted Melanoma Incidence and Mortality in Massachusetts (1982 through 1987) among Whites 20 Years of Age and Older, by Year, Age, Sex, and Measures of Socioeconomic Status

	Mortality Rate[a] (No.)	Incidence Rate[a] (No.)	Mortality/ Incidence Ratio	95% Confidence Interval
Year				
1982	4.35 (165)	12.44 (472)	0.35	0.29, 0.42
1983	4.82 (183)	13.15 (499)	0.37	0.32, 0.43
1984	4.38 (166)	13.08 (496)	0.33	0.28, 0.39
1985	4.46 (169)	16.19 (614)	0.28	0.23, 0.33
1986	4.30 (163)	17.00 (645)	0.25	0.20, 0.30
1987	4.67 (177)	14.82 (562)	0.32	0.27, 0.37
Age, y				
20–44	1.55 (185)	7.58 (907)	0.20	0.17, 0.24
45–54	4.43 (149)	15.30 (515)	0.29	0.24, 0.35
55–64	6.80 (233)	21.16 (726)	0.32	0.28, 0.37
65–74	8.10 (201)	25.38 (630)	0.32	0.27, 0.37
75+	14.22 (255)	28.50 (511)	0.50	0.43, 0.58
Sex				
Female	3.12 (414)	12.40 (1579)	0.25	0.22, 0.28
Male	6.32 (609)	17.21 (1709)	0.37	0.33, 0.40
Education				
Higher	3.86 (279)	15.53 (1236)	0.25	0.21, 0.29
Middle	3.30 (466)	10.80 (1579)	0.31	0.27, 0.34
Lower	2.49 (175)	6.66 (463)	0.37	0.31, 0.44
Income				
Higher	3.75 (166)	14.03 (677)	0.27	0.23, 0.32
Middle	3.25 (532)	11.24 (1926)	0.29	0.26, 0.32
Lower	3.01 (222)	9.12 (674)	0.33	0.28, 0.38

[a]Per 100 000. Sex-specific rates were age adjusted to the 1980 Massachusetts population. Education- and income-specific rates were age and sex adjusted to the 1980 Massachusetts population.

Data Analysis

Annual incidence and mortality rates were computed from the 1980 census of all White residents of Massachusetts 20 years of age and older (Table 1). Census tracts and zip codes were assigned to each of the three education and income categories, and total 1980 census population counts of White residents within each category were obtained. Adjusted rates were computed by means of the direct method, as described by Rothman[32]; all sex-specific rates were adjusted for age, and all education- and income-specific rates were adjusted for age and sex.

We performed three analyses using the SAS software program.[33] First, we determined incidence and mortality rates within each stratum of age, sex, education, and income and computed adjusted stratum-specific mortality/incidence ratios as approximations of case fatality rates (Table 1). Ninety-five percent confidence intervals (CIs) for mortality/incidence ratios were obtained by determining the approximate variance assuming that the number of deaths and the number of incident cases followed Poisson distributions. This implies use of the sum of the inverse counts as an approximation of the variance for a log ratio of rates and follows from the standard Taylor series expansion approach.[34,35]

Second, we ascertained the proportion of case patients with advanced stage melanoma (distant, regional) by diagnosis year, age, sex, and measures of education or income. We performed logistic regression analysis to determine whether SES measures joined other variables as independent predictors of advanced stage melanoma (Table 2). Because of their high intercorrelation, the two SES measures, education and income, were never placed in the same model. The two primary models both included indicator terms for specific year of diagnosis, five categories of age, and sex. One model then evaluated education and the other evaluated income (three categories each). In two additional models, tests of trends were performed across categories for either education or income.[35] Patients in whom stage was unknown (9.6%) were excluded from these analyses.

Third, we performed a test of the association of SES with melanoma survival based on recorded melanoma mortality of registered case patients. We attempted to link all incident cases from the cancer registry with death certificate data, linking records by the patients last name, first name, date of birth, and town of residence. We then conducted survival analyses of case patients using registration of death from melanoma as the measure of outcome. Because death certificate data were complete only through 1987, incident cases diagnosed after 1986 were not included in this analysis. This provided a minimum of 1 year of death registration monitoring for all patients. Vital status was not independently confirmed for case patients without death registration, and, for purposes of this analysis, it was assumed that they had survived their cancer through 1987. Thus, for any patient without a death certificate, follow-up time was the interval from the date of diagnosis until 1987. To check this

TABLE 2—Stage at Diagnosis among 2973 Melanoma Patients in Massachusetts, 1982 through 1987

	Advanced Stage,[a] %	Risk Ratio (95% Confidence Interval)	
		Model with Education	Model with Income
All patients	16.6	... ...	... ...
Year			
1982	20.2	1.0[b] ...	1.0[b] ...
1983	18.5	0.86 (0.62, 1.20)	0.87 (0.63, 1.22)
1984	16.6	0.75 (0.53, 1.06)	0.75 (0.54, 1.06)
1985	13.5	0.59 (0.42, 0.83)	0.60 (0.43, 0.84)
1986	15.6	0.71 (0.52, 0.99)	0.72 (0.52, 1.00)
1987	16.3	0.75 (0.54, 1.04)	0.76 (0.55, 1.06)
Age, y			
20–44	14.5	1.0[b] ...	1.0[b] ...
45–54	14.5	0.94 (0.69, 1.30)	0.96 (0.69, 1.32)
55–64	17.3	1.16 (0.87, 1.53)	1.17 (0.88, 1.54)
65–74	16.6	1.09 (0.81, 1.45)	1.06 (0.79, 1.43)
75+	21.8	1.62 (1.21, 2.18)	1.59 (1.18, 2.13)
Sex			
Female	13.2	1.0[b] ...	1.0[b] ...
Male	19.7	1.64 (1.34, 1.99)	1.64 (1.34, 1.99)
Education			
Higher	15.1	1.0[b] ...	... ...
Middle	17.0	1.17 (0.95, 1.45)	... ...
Lower	19.2	1.31 (0.98, 1.75)	... ...
Income			
Higher	12.2	... ...	1.0[b] ...
Middle	17.3	... ...	1.50 (1.15, 1.96)
Lower	19.1	... ...	1.64 (1.20, 2.25)

Note. Three hundred fifteen patients in whom stage was unknown are excluded.
[a]Distant, regional disease.
[b]Referent category.

assumption, we confirmed the results of this model by repeating the analysis, limiting follow-up to much shorter periods of 1, 2, and 3 years per person. The results were unchanged and are not presented. Case patients who died from other causes were censored. Other censoring of the case series was unknown but was assumed to be minimal.

Proportional hazards (Cox) regression was conducted to identify independent predictors of time to death from melanoma. All models included indicator terms for year of diagnosis, age, and sex; separate models contained terms for education and income. Two sets of Cox regression models were performed: one set with terms for stage of melanoma at diagnosis and one set without such terms (Table 3). Also, tests of trends across categories of variables were conducted in an additional series of models.[35]

Results

From 1982 through 1987, 3288 incident cases of melanoma and 1023 deaths from melanoma were recorded among White Massachusetts residents 20 years of age and older (Table 1).

Mortality/Incidence Ratios

There appeared to be variation in both incidence and mortality according to measures of education and income. Melanoma incidence among those in the higher education group was more than twice that of those in the lower education group; a slightly weaker trend was found for income (Table 1). The melanoma mortality rate also rose with increasing SES, although the trend was less striking.

In contrast, mortality/incidence ratios were highest among persons of lowest education and income. Mortality/incidence ratios ranged from 0.25 among those in the higher education group to 0.37 among those in the lower education group (rate ratio = 1.48, 95% CI = (1.08, 2.03) (test for trend; $F = 12.9$, $P < .01$). For income, mortality/incidence ratios ranged from 0.27 in the higher group to 0.33 in the lower group (risk ratio = 1.22, 95% CI = 0.90, 1.65) (test for trend, $F = 9.2$, $P < .05$).

Associations with Stage at Diagnosis

Overall, 493 (16.6%) case patients for whom stage was known had advanced stage melanoma at the time of diagnosis (Table 2). The proportion of case patients with advanced stage disease increased among older patients, was higher in men than in women, and appeared to vary inversely with the income measure.

Multivariate logistic regression analysis confirmed independent associations for age, sex, and income (the risk ratio for the lowest vs highest tertiles was 1.64, 95% CI = 1.20, 2.25); from a second model with ordinal terms for year, age, and income, the risk ratio for trend across the three categories of income was 1.26 (95% CI = 1.08, 1.46). The association with education was weaker and not statistically significant (risk ratio = 1.31, 95% CI = 0.98, 1.75); from a second model, the risk ratio for trend across the three categories of education was 1.15 (95% CI = 1.00, 1.32).

Survival Analysis of Case Patients

A death certificate was registered for 308 (11.2%) of the 2726 cases of melanoma diagnosed between 1982 and 1986 (Table 3). The interval between diagnosis and death ranged from 4 days to 5.5 years; the median interval was 15 months. For all cases, death registration was monitored for up to 6 years, with a median of 3 years, 2 months. Because some deaths were not registered, we assumed, in three separate confirmatory analyses, that survivors had exactly 1 year, 2 years, and 3 years of follow-up.

Registered mortality appeared to be highest in the low category of education, with little difference between the middle and highest categories. The association with education was confirmed in proportional hazards regression analysis that accounted for length of follow-up and the other study variables, including stage (risk ratio for lowest vs highest tertile of education = 1.52, 95% CI = 1.09, 2.13). No independent association with income was found in this analysis.

Stage at diagnosis was not included in one set of proportional hazards regression models because we considered it a potentially strong intervening variable with respect to how SES (and sex) may influence mortality from melanoma. Stage was found to be a very powerful independent predictor of mortality (risk ratio for

TABLE 3—Registered Mortality among 2726 Incident Melanoma Patients in Massachusetts, 1982 through 1986

	Registered Mortality, %	Risk Ratio (95% Confidence Interval)			
		Model with Education	Model with Income	Model with Education & Stage	Model with Income & Stage
All patients	11.2	... ...	... ...	... ...	... ...
Year					
1982	15.5	1.0[a] ...	1.0[a] ...	1.0[a] ...	1.0[a] ...
1983	14.7	1.04 (0.75, 1.45)	1.04 (0.75, 1.45)	1.11 (0.78, 1.57)	1.09 (0.77, 1.55)
1984	13.9	1.11 (0.78, 1.56)	1.10 (0.78, 1.55)	1.37 (0.95, 1.97)	1.32 (0.92, 1.91)
1985	8.7	0.85 (0.59, 1.23)	0.85 (0.58, 1.23)	1.16 (0.78, 1.74)	1.13 (0.76, 1.69)
1986	5.7	0.83 (0.55, 1.26)	0.84 (0.55, 1.27)	1.07 (0.68, 1.70)	1.07 (0.67, 1.69)
Age, y					
20–44	7.8	1.0[a] ...	1.0[a] ...	1.0[a] ...	1.0[a] ...
45–54	9.7	1.20 (0.80, 1.78)	1.21 (0.82, 1.81)	1.26 (0.93, 1.92)	1.28 (0.84, 1.94)
55–64	12.4	1.49 (1.06, 2.09)	1.53 (1.09, 2.15)	1.55 (1.09, 2.22)	1.63 (1.14, 2.33)
65–74	10.6	1.24 (0.86, 1.80)	1.25 (0.86, 1.81)	1.30 (0.89, 1.91)	1.34 (0.91, 1.96)
75+	17.7	2.40 (1.70, 3.39)	2.40 (1.71, 3.38)	2.33 (1.62, 3.33)	2.34 (1.63, 3.35)
Sex					
Female	7.8	1.0[a] ...	1.0[a] ...	1.0[a] ...	1.0[a] ...
Male	14.4	1.95 (1.53, 2.47)	1.94 (1.53, 2.46)	1.79 (1.39, 2.31)	1.78 (1.38, 2.29)
Stage					
Early	6.5	... ...	... ...	1.0[a] ...	1.0[a] ...
Late	37.5	... ...	... ...	6.83 (5.37, 8.69)	6.78 (5.33, 8.63)
Education					
Higher	10.2	1.0[a] ...	... ...	1.0[a] ...	... ...
Middle	10.9	1.07 (0.83, 1.38)	... ...	0.93 (0.71, 1.22)	... ...
Lower	14.2	1.48 (1.07, 2.04)	... ...	1.52 (1.09, 2.13)	... ...
Income					
Higher	10.5	... ...	1.0[a] ...	... ...	1.0[a] ...
Middle	10.6	... ...	0.99 (0.74, 1.33)	... ...	0.82 (0.60, 1.12)
Lower	13.7	... ...	1.27 (0.90, 1.78)	... ...	1.05 (0.74, 1.51)

[a]Referent category.

late vs early stage = 6.83, 95% CI = 5.37, 8.69 from the multivariate model). However, dropping it from the model had only a modest effect on the results, increasing the risk ratio for income to 1.27 (95% CI = 0.90, 1.78) (lowest vs highest tertile) and slightly decreasing the ratio for education to 1.48 (95% CI = 1.07, 2.04).

Discussion

Mounting evidence indicates that SES is a key marker for cancer prognosis.[18–29] Because mortality from cutaneous melanoma is rising steeply in the United States,[36–38] there is concern about the experience of socioeconomically disadvantaged individuals diagnosed with melanoma.

In our analysis, we found higher mortality/incidence ratios to be associated with lower SES measures, suggesting that patients of lower SES may have a higher case fatality rate. We also found evidence that persons with low SES measures have proportionately more advanced stage disease at diagnosis, suggesting that the mortality/incidence ratio differential may be due in part to delayed presentation of melanoma. Finally, lower education was associated with decreased survival among case patients, and this association was not diminished by adjustment for stage at diagnosis. This suggests that a study of the health behavior of less educated persons might explain their apparently lower survival.

In previous analyses of SES and melanoma, decreased survival has been reported among persons in Australia and Sweden[14–16] classified as low SES based on occupation or indirect measures of social class.

In our study from Massachusetts, we specifically chose the ratio of mortality to incidence as a means for evaluating the relative contribution of SES in late presentation of melanoma or delay in clinical diagnosis or seeking treatment. The mortality/incidence ratio is considered an estimate of the case fatality rate ("the cumulative incidence of death among those who develop an illness"[32]) and bears a strong inverse association with survival.[39] The mortality/incidence ratio is likely to be most valid as a measure of case fatality when both incidence and mortality are stable, a condition that, unfortunately, does not strictly apply in our analysis.[39] Nevertheless, we found relatively high mortality/incidence ratios among men and older patients, subgroups known to have higher fatality rates.[36–38,40] Also, our conclusions based on the mortality/incidence ratio analysis are essentially confirmed and complemented by results from the analysis of predictors of stage at diagnosis and from the linked death registration analysis.

We chose to examine melanoma stage and survival with both education and income independently. Both are SES measures, serving as proxies for a broad spectrum of life-styles and characteristics that may influence cancer survival.[18–29,31] We chose not to overinterpret the variation in the associations with income or education in our analysis because of their lack of clear distinction, particularly when proxy variables were used.

The models evaluating risk of melanoma death associated with SES, performed with and without adjustment for stage of disease, leave open a variety of interpretations. First, late stage clearly predicts who will die. If all of the association between SES and survival were explained by stage at diagnosis, this would suggest that the survival disadvantage of low SES resulted entirely from later stage of cancer presentation and treatment. Our data suggest, however, that low SES carries survival disadvantages beyond those conveyed by late stage. Low education and income often characterize persons with the least access to and facility with the health care system and may be markers for other characteristics that influence cancer survival.

There are several limitations and potential biases in these analyses. Studies of social class and cancer that use census tract data to assign characteristics to individuals based on home address,[31] (as was the case in the current study) assume that all individuals in a geographic area share the same attribute (income or education level). Undoubtedly, this method involves some misclassification; such misclassification, if it occurs randomly, would bias toward the null and indicate no difference between SES categories.[31] Nevertheless, bias in the use of proxy measures of SES remains a possible explanation for our findings.

We could not control for ethnic or cultural factors that may predispose certain individuals to live in low-SES areas and have an increased risk of melanoma. Similarly, urban–rural differences, barriers to health care, and other factors often related to SES may have confounded our analysis.

Limitations of registry data also must be noted. The Massachusetts Cancer Registry did not collect information on thickness of the lesion at diagnosis; this more informative prognostic factor would further clarify the role of low education or low income. Furthermore, the finding with respect to survival is somewhat limited by the fact that we did not contact case patients without death registration to confirm vital status and assumed that they were alive at the end of 1987. Population migration (e.g., those of lower SES have less means to leave the state) is also a potential problem in these analyses. Finally, there is the possibility that incomplete registration of melanoma cases may be correlated with higher education or income, leading to bias in the mortality/incidence ratio. If so, the observed difference between higher and lower categories of education and income in the analysis may have been underestimated.

Conclusions

These findings raise several melanoma control issues for future studies. For example, do low- and high-SES at-risk individuals differ in their awareness of risk factors and warning signs for melanoma? Do at-risk persons from lower and higher social classes differentially practice skin cancer prevention and early detection? Do system barriers (e.g., access to a regular physician or dermatologist, cost of treatment) differ for at-risk populations, thus adversely affecting outcomes?

Because our study reported on data in only one state and used ecological measurements, we recommend replication of this effort with direct measures elsewhere. Such studies could suggest whether future melanoma educational and early detection campaigns directed to both the at-risk population and the medical community should increase their emphasis in low-SES communities. Despite their overall lower risk of melanoma, residents of low-SES communities (in particular, high-risk residents) may be appropriate or even preferred targets for melanoma education and early detection programs because of their potentially greater risk of late stage and lethal cancer. □

Acknowledgments

This research was funded in part by the Dr Donald Gauthier Melanoma Research Fund and the Judge Bernard Cohen Cancer Control Research Fund.

We thank Dr Michael Schmitz for his painstaking work reviewing multiple death certificates and the Massachusetts Cancer Registry and Massachusetts Department of Public Health (Commissioner David Mulligan) for their important contributions. We also thank the anonymous reviewers for their many helpful comments.

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