UV Radiation, Latitude, and Melanoma in US Hispanics and Blacks

Shasa Hu, MD; Fangchao Ma, MD, PhD; Fernando Collado-Mesa, MD; Robert S. Kirsner, MD

Background: Little information exists on the epidemiology of melanoma and the role of solar radiation in the development of melanoma in pigmented populations.

Objective: To evaluate the relationship between exposure to solar radiation and the incidence of melanoma in US Hispanics and blacks.

Design: Population-based ecological study.


Subjects: Patients with invasive melanoma recorded by cancer registries.

Main Outcome Measures: We obtained age-adjusted, race/ethnicity- and sex-specific incidence rates of melanoma from similar time periods from the 6 cancer registries. The incidence rates were correlated with the annual mean UV index and the latitude of residency.

Results: For both Hispanics and blacks, the incidence of melanoma was positively associated with the UV index and negatively associated with the latitude of residency. Statistically significant correlation between melanoma and the UV index ($R=0.93; P=.01$) and latitude ($R=-0.80; P=.05$) was observed in black males. Hispanics and blacks have a significantly lower incidence of melanoma than whites, with blacks having the lowest rates of melanoma.

Conclusions: Exposure to solar radiation appears to play a role in the development of melanoma in both Hispanics and blacks. Sun protection and melanoma risk education should be performed in these populations.

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The incidence of skin cancers shows substantial variation among populations of different racial composition and geographic location. Among different racial groups, light-skinned populations have the highest rate of melanoma and nonmelanoma skin cancers, ie, basal cell and squamous cell carcinoma. The incidence of melanoma has been increasing faster than that of nearly every other cancer. Therefore, much attention has focused on the epidemiology and risk factors of melanoma in white populations.

A host of epidemiological evidence suggests that exposure to UV radiation (UVR) through sunlight is the major environmental risk factor for melanoma. Both constitutive factors, such as natural protection against UVR exposure, and behavioral factors, such as the amount of UVR exposure, are important modifiers in the risk of developing melanoma. Individuals with lighter natural skin color and greater tendency to burn (than tan) after sun exposure are at greater risk for melanoma. With regard to the amount of UVR exposure, epidemiological studies have demonstrated a negative correlation between latitude of residence and incidence and mortality rates of melanoma in homogeneous, light-skinned populations. Migrant populations that move closer to the equator develop melanoma at rates higher than in their country of origin, but lower than the rates prevailing among the native residents of their adopted country.

Little is known about the epidemiology and risk factors of melanoma in Hispanics and blacks. The lack of studies in these populations partly reflects the fact that Hispanics and blacks, both having darker skin pigmentation than whites, are at lower risk for developing skin cancers. The data on cancer among Hispanics are limited because of the difficulty of classifying...
Hispanic race/ethnicity. Although the incidence of melanoma is lower in Hispanics and blacks, melanomas in these populations are more likely to metastasize, and carry a poorer outcome than in whites.\textsuperscript{11,18-20} The worse outcome has been attributed to a higher proportion of acral lentiginous melanoma (ALM) and delayed presentation to care in Hispanics\textsuperscript{10,11,18} and blacks.\textsuperscript{19,21-23} It is not clear whether UVR exposure plays a similar role in these cancers in darker-pigmented populations.

From the public health and cancer control perspective, it is important to gain a better understanding of the epidemiological patterns of melanoma in minority groups. Hispanics are among the fastest-growing populations in the United States. In 2002, approximately 37.4 million Hispanics composed 13.3\% of the total US population.\textsuperscript{24} The Hispanic population is projected to reach 17\% of the total US population by 2020.\textsuperscript{25} As the population of Hispanics continues to increase, their cancer experience will have a substantially greater impact on cancer prevention and public health promotion in the United States.

**METHODS**

We extracted melanoma incidence data from population-based state cancer registries and compared cancer rates among different race/ethnicity groups. We also analyzed melanoma rates in relation to estimated annual UV index and latitude of residence.

**DATA SELECTION**

We selected US states with large Hispanic populations and readily accessible cancer data. California, Florida, Illinois, New Jersey, New York, and Texas met our selection criteria. According to the US Census Bureau 2000 reports, these states are among the 7 states (along with Arizona) with a population of more than 1 million Hispanics (Table 1).\textsuperscript{26} The populations in the 6 states represent 73\% of the total Hispanic population and 77\% of the total black population in the United States. Also, the cancer registries in these states are deemed by the National Program of Cancer Registries (NPCR) to have high-quality data collection; more than 95\% of melanoma cases in all 6 registries are confirmed by microscopy.\textsuperscript{27} These registries use Surveillance, Epidemiology, and End Results and North American Association of Central Cancer Registries standards and International Classification of Diseases for Oncology, Second Edition, codes for coding data and grouping of cancer sites. These states also represent the 4 distinctive regions of the United States: Northeast, Midwest, South, and West, therefore permitting the evaluation of the relationship between geographic location and cancer incidence. We extracted age-adjusted incidence rates to allow comparison of cancer incidence over time and across geographic regions and population subgroups, even when the age distributions were not comparable. The rates were adjusted to the 2000 US standard population. Data sets with the greatest similarity in time periods were selected for correlation analyses against UVR exposure. A total of 64,305 melanomas were included in our study. Cumulative cases of new melanomas by race/ethnicity and sex documented in each one of the cancer registries for specific time periods are presented in Table 2.\textsuperscript{26-33}

**EXPOSURE INFORMATION**

We used annual mean UV index and latitude data for each state as surrogate estimates of UVR exposure to facilitate the evaluation of cancer incidences in relation to UVR exposure and geographic locations. Geographic latitude of residence is a routinely used proxy measure for UVR exposure. The average north-to-

### Table 1. 2000 US Census Bureau Population Profile by Race/Ethnicity, Mean Annual UV Index in 1997, and Latitude of the 6 Study States

<table>
<thead>
<tr>
<th>State</th>
<th>Hispanic (Percent of Population)</th>
<th>Non-Hispanic White (Percent of Population)</th>
<th>Black (Percent of Population)</th>
<th>Mean Annual UV Index in 1997</th>
<th>Latitude, °</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>28.6 (15.1)</td>
<td>40.5 (62.0)</td>
<td>31.1 (15.9)</td>
<td>38</td>
<td>43.0</td>
</tr>
<tr>
<td>New Jersey</td>
<td>11.7 (13.3)</td>
<td>45.5 (37.8)</td>
<td>41.3 (13.6)</td>
<td>48</td>
<td>40.3</td>
</tr>
<tr>
<td>Illinois</td>
<td>1.5 (12.3)</td>
<td>11.4 (67.8)</td>
<td>2.6 (15.1)</td>
<td>47</td>
<td>39.8</td>
</tr>
<tr>
<td>Florida</td>
<td>2.6 (16.8)</td>
<td>10.4 (65.4)</td>
<td>1.7 (14.6)</td>
<td>75</td>
<td>27.5</td>
</tr>
<tr>
<td>Texas</td>
<td>6.6 (32.0)</td>
<td>10.3 (52.4)</td>
<td>2.0 (11.5)</td>
<td>67</td>
<td>31.3</td>
</tr>
<tr>
<td>California</td>
<td>10.1 (32.4)</td>
<td>2.2 (46.7)</td>
<td>1.8 (6.7)</td>
<td>67</td>
<td>37.3</td>
</tr>
</tbody>
</table>

*Source: US Census Bureau.\textsuperscript{26}†Source: National Weather Service.\textsuperscript{24}

### Table 2. Melanoma Count by Race/Ethnicity and Sex in the 6 Study States

<table>
<thead>
<tr>
<th>State</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>Hispanic</td>
<td>White</td>
</tr>
<tr>
<td>New York</td>
<td>76</td>
<td>76</td>
<td>3393</td>
</tr>
<tr>
<td>New Jersey</td>
<td>28</td>
<td>59</td>
<td>2685</td>
</tr>
<tr>
<td>Illinois</td>
<td>35</td>
<td>44</td>
<td>2541</td>
</tr>
<tr>
<td>Florida</td>
<td>73</td>
<td>161</td>
<td>5160</td>
</tr>
<tr>
<td>Texas</td>
<td>39</td>
<td>222</td>
<td>2884</td>
</tr>
<tr>
<td>California</td>
<td>44</td>
<td>645</td>
<td>8643</td>
</tr>
<tr>
<td>Total</td>
<td>295</td>
<td>1287</td>
<td>25306</td>
</tr>
</tbody>
</table>

*Black, Hispanic, and white are not mutually exclusive.†Black, Hispanic, and white are mutually exclusive.
Hispanic or Latino origin based on surname and maiden name varies within registries. The grouping of Hispanic or non-Hispanic population also differs. For instance, Hispanic, white, and black are 3 mutually exclusive populations in California and Texas.33,37 In New Jersey, New York, Illinois, and Florida, Hispanic is an ethnicity variable; therefore, cancer data for Hispanics may overlap with those of whites and blacks.

Standardized incidence rates by race/ethnicity and state of residency, along with 95% confidence intervals, are presented for females in Figure 1 and for males in Figure 2. For both sexes, melanoma rates were the highest among whites, lower among Hispanics, and lowest among blacks. This trend was observed for rates within each state and across the 6 states. As expected, among white females in each state, the incidence of melanoma was 4- to 6-fold and 7- to 18-fold higher than among Hispanic and black females, respectively. Among white males in each state, melanoma occurred 4 to 7 times more frequently than among Hispanics and 14 to 29 times more frequently than among black males. During 1995 to 1999, whites residing in California had the highest overall melanoma rate among both sexes: 18.2 per 100000 females and 28.8 per 100000 males. Hispanic females in California had the highest melanoma rate (4.2 per 100000 in 1995-1999) among female Hispanics, while Hispanic males in New Jersey had the highest rate (5.6 per 100000 in 1996-2000) among Hispanic males. In black males, the highest rates were observed in California and Florida (1.3 per 100000 for 1995-1999 and 1.3 per 100000 for 1989-1995, respectively). Florida also had the highest melanoma rate for black females (1.6 per 100000).

The mean annual UV index and latitude of residency were correlated with the incidence of melanoma in all race/ethnicity groups for both sexes (Table 3). The correlation coefficient between the incidence of melanoma and the UV index was 0.56 (P = .24) in Hispanic females and 0.41 (P = .42) in Hispanic males, but this did not reach statistical significance. There was a significant positive correlation between the incidence of melanoma and the annual mean UV index in black males (correlation coefficient, 0.93; P = .01). The melanoma incidence rates were negatively associated with the latitude of residency state, meaning that the lower the latitude, the higher the melanoma rates in all race/ethnic groups and in both sexes. The negative correlation was statistically significant in black males (correlation coefficient, −0.80; P = .05).

This is the first study to use large population-based data to examine the relationship between melanoma and UVR exposure in Hispanics and blacks in the United States. We confirmed the association between melanoma, race, and UVR exposure. We verified that the incidence rates

STATISTICAL ANALYSES
The standardized sex- and race/ethnicity-specific incidence data for melanoma were summarized with 95% confidence intervals. Pearson correlation analyses were performed to examine the correlation between the incidence rate of melanoma and the UVR index or latitude of the state of residency. The level of significance was set at P = .05, 2-sided, for all statistical analyses.

RESULTS
We obtained available cancer incidence data that included Hispanic ethnicity from the 6 state cancer registries. Only cases of invasive melanoma were calculated in the cancer rates. All 6 cancer registries determine Hispanic or Latino origin based on surname and maiden name in addition to self-reporting on medical record and death certificate.32,33,35 The protocol to impute Hispanic ethnicity from surname and maiden name varies within registries. The grouping of Hispanic or non-Hispanic population also differs. For instance, Hispanic, white, and black are 3 mutually exclusive populations in California and Texas.33,37 In New Jersey, New York, Illinois, and Florida, Hispanic is an ethnicity variable; therefore, cancer data for Hispanics may overlap with those of whites and blacks.

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of melanoma are the highest among whites, which confirms the protective role of constitutive pigmentation in the development of melanoma.

Variations in melanoma incidence within Hispanic and black populations in relation to UVR exposure and latitude also suggest that risk in these populations is modified by behavioral patterns, unknown cultural-environmental exposures, and socioeconomic factors, as well as constitutive characteristics. Studies have shown that severe sunburn or strong intermittent exposure, especially during childhood, is a high-risk exposure pattern.\textsuperscript{23,24} Adult recreational or intermittent sun exposure is also a risk factor for melanoma.\textsuperscript{40,41} However, these conclusions are based on studies in white populations; it is not clear whether intermittent exposure to UVR holds similar importance in Hispanics and blacks. Nonetheless, the lower rates of melanoma in Hispanics and blacks may be influenced, in part, by behavioral characteristics. Evidence suggests that both Hispanics and blacks in the United States have less high-risk sun behavior than non-Hispanic whites.\textsuperscript{42} Hispanics and blacks may also have a higher level of chronic sun exposure through occupational exposure than whites. According to the US Census, Hispanics\textsuperscript{24} and blacks\textsuperscript{43} were almost twice as likely to work as operators and laborers than non-Hispanic whites. Conversely, a greater proportion of non-Hispanic whites held managerial or professional occupations than Hispanics or blacks. Several studies have found that chronic and occupational exposure to sunlight paradoxically lowers the risk for melanoma.\textsuperscript{41,44}

The role of solar radiation in melanoma among non-whites has not been elucidated. Based on previous reports of increased proportion of ALM occurring in Hispanics and blacks,\textsuperscript{11,45-46} direct sun exposure was thought not to be an important etiologic factor for melanoma in these populations because ALM behaves differently from the superficial spreading type commonly seen in whites and because ALM occurs more often on body areas that are protected from the sun.\textsuperscript{23,47} We were not able to examine the role of UVR exposure specifically in the development of ALM, as incidence rates by melanoma subtype were not available. Nonetheless, we found that the rate of melanoma in both Hispanics and blacks increased with increasing annual UV index or lower latitude of residency. These results suggest that UVR exposure may have a greater than expected role in the development of melanoma in darker pigmented populations. We also found that the degree of the importance of UVR exposure in different races may vary within populations. While the association of melanoma with UVR exposure was seen in whites, blacks, and Hispanics, the association reached statistical significance only in black males ($P = .01$ for melanoma incidence and UV index; $P = .05$ for melanoma incidence and latitude). Our study is the first to demonstrate such a correlation between the incidence of melanoma and UVR exposure in blacks. Interestingly, one recent population-based study found that the mortality rates of melanoma in black males increased significantly with increasing levels of exposure to surface UV-B radiation; however, the authors did not report significant increases in melanoma incidence with UV-B irradiation in black males or females.\textsuperscript{49}

Several inherent limitations related to cancer data from population-based registries exist. First, the reliability of race- or ethnicity-specific rates depends on the accuracy of classification in cancer cases and in population estimates. Undercounts of both cancer cases and population may occur. Counts of melanoma cases in each registry likely underestimate the actual rates in the population because a portion of the cases that are diagnosed and treated on an outpatient basis are not reported to the registries. Inconsistencies and difficulties associated with defining Hispanic ethnicity suggest a general tendency for undercount of Hispanic populations. Information available from state cancer registries was limited to counts and incidence rates. Therefore, we did not perform correlation studies by tumor thickness or by melanoma subtype, such as ALM vs superficial spreading type.

We used melanoma data from 6 states in the United States. Although these states are representative of the regions in the United States and are made up of more than 70% of Hispanic and black populations in the United States, evaluation of wider geographic areas will provide a more accurate understanding of the epidemiological pattern of melanoma. Incidence rates in some registries differed in time periods, and consistent data from registries for a common time period were not available on Hispanics. Nevertheless, we believe that our results are valid, as the time periods are all within the last decade and the melanoma rates in Hispanics and blacks have been relatively stable.\textsuperscript{50,51} Also, the UV index from one or a few cities in a particular state was used to represent the actual UV index of that state, and was used as a surrogate measure of individual exposure and as such is at risk for ecological fallacy. We did not examine the individual sun exposure history or patterns in the study population; therefore, it is not known if or how these factors affected the strength of our analysis. Differences in racial composition and migration patterns among the various subgroups of Hispanics are ad-

<table>
<thead>
<tr>
<th>Table 3. Correlation Between Age-Adjusted (2000 US Population) Melanoma Incidence Rates and Mean Annual UV Index and Latitude of Residency by Race/Ethnicity and Sex</th>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Correlation coefficient</td>
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<tr>
<td>with latitude ($P$ value)</td>
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</table>

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ditional confounders in our studies. A person of Hispanic origin could be of any race or origin such as Mexican, Puerto Rican, Cuban, or Central or South American. For instance, Mexicans have more indigenous American heritage than Cubans, who have more of African genetic heritage. Within the United States, Hispanic populations vary with geographic location. The heterogeneity of constitutive skin pigmentation in the Hispanic populations complicates our analysis of melanoma rates against UVR exposure. Migration histories of the Hispanic populations are also unknown in our study. The majority of Hispanics in the United States are second-generation immigrants. The second generation of Hispanics likely have been adapting to the climatic conditions, cultural beliefs about sun exposure, and recreational practices in the United States. Whether Hispanics in the United States have acquired or modified their risk factors is not known, but ongoing studies are assessing sun behaviors and attitudes among Hispanics.

Although both Hispanics and blacks have lower rates of melanoma than whites, the impact of melanoma is of paramount importance from a public health perspective. It is predicted that the incidence of melanoma will continue to rise as a result of the continuing decrease in the concentration of stratospheric ozone as well as of the increasing exposure time to sunlight through leisure sunbathing, both of which increase exposure to solar UVR. Our study suggests that UVR exposure plays a role in the incidence of melanoma in darker-pigmented populations as well as in fair-skinned populations. Since improved preventive measures and educational efforts have affected the diagnosis and outcome of melanoma cases, it is not unreasonable that similar public education campaigns be directed at the nonwhite population as well.

Further studies, with a broader population base, that incorporate information on the racial/skin subtype among Hispanics and blacks, with more accurate estimates of sun exposure and stratification of melanoma subtypes, are needed to elucidate the role of UVR exposure as an etiologic factor in melanoma risk in these populations. Such comparisons of melanoma trends among different populations can help to better define the relative contributions of constitutive features, environmental exposures, and lifestyle to the development of melanoma.

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REFERENCES


C ongratulations to the winner of our April quiz, CPT Syed O. Ali, MC, USA, dermatology resident, San Antonio Uniformed Services Health Education Consortium, San Antonio, Tex. The correct answer to our April challenge was Merkel cell carcinoma. For a complete discussion of this case, see the Off-Center Fold section in the May ARCHIVES (Nandekar MA, Patterson RH, Bridgeman-Shah S, Rush W, Tomaszewski M-M. A large friable tumor overlying the left side of the mandible. Arch Dermatol. 2004;140:609-614).

Be sure to visit the Archives of Dermatology World Wide Web site (http://www.archdermatol.com) to try your hand at the Interactive Quiz. We invite visitors to make a diagnosis based on selected information from a case report or other feature scheduled to be published in the following month’s print edition of the ARCHIVES. The first visitor to e-mail our Web editors with the correct answer will be recognized in the print journal and on our Web site and will also receive a free copy of The Art of JAMA II.