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The magnitude of increased United States melanoma incidence attributable to ground-level ultraviolet radiation intensity trends

To the Editor: Ultraviolet (UV) radiation contributes to ≥90% of melanomas.[1] The amount of UV an individual receives depends on the time of day, season, time outdoors, cloud cover, altitude, geography, and personal sun-protective measures.[2] The Ultraviolet Index (UVI), provided by the United States (US) National Weather Service, measures daily ground-level UV intensity on a scale from 0 (nighttime) to 16 (noon at high altitudes, equatorial locations). Given the rising incidence of melanoma over the past several decades[3] and the possible association with climate change influences, this study aimed to assess US UVI trends and their potential impact on changes in melanoma incidence (MI).

Published UV intensity data[2] were used to derive the mean UVI during the summer months (June, July, and August) for 54 US cities annually from 2003 to 2019. Results were aggregated into 4 regions—South, West, Midwest, and Northeast—using US Census categorizations. Estimated cases of melanoma were obtained from the American Cancer Society[3] and correlated with US Census data for the non-Hispanic White (NHW) population. Linear regression analysis was performed to determine the relationship between year, UVI, and NHW-MI. The *t* test and analysis of variance with post hoc Tukey-Kramer testing were performed for continuous data comparisons, and χ^2 was performed for categorical analyses.

Linear regression found a significant temporal correlation between mean NHW-MI ($F_{1,15} = 94.423$, $R^2 = 0.863$, $P < .0001$), mean US summer UVI ($F_{1,15} = 15.114$, $R^2 = 0.502$, $P = .001$), and between mean US summer UVI and mean NHW-MI ($F_{1,15} = 6.937$, $R^2 = 0.316$, $P = .019$) (Fig 1 and Supplemental Fig 1, available via Mendeley at https://data.mendeley.com/datasets/fs8yhz3v2f/1). Furthermore, average daily UVI increased across all 54 cities studied (Supplemental Fig 2), with significantly higher increases in mean ± SD summer UVI in the South/West (10 ± 0.03) compared with Midwest/Northeast (0.08 ± 0.01, $P = .001$) (Supplemental Table I). Eleven of 12 states with the highest increasing rate of NHW-MI were from regions with greatest increasing rate of UVI (South/West; $\chi^2_{1,49} = 5.9802$, $P = .0145$) (Table I).

The potential amount of UV radiation received by the average American in the continental US has increased. Our regression model suggests that up to 30% of increases in NHW-MI could be directly or indirectly explained by increasing ground-level UV intensity. Furthermore, this relationship is supported by a significantly disproportionate representation of states in the highest quartile of NHW-MI rate increases located in US Census regions with the highest increases in UVI.

Limitations of the study include that US Census regions encompass overlapping latitudes. Data from Alaska, Hawaii, and Puerto Rico were omitted due to geography, but showed similar trends. Impact of individual UV protective behaviors on UV exposure was not assessed.[4] Non-White census data were excluded to remove this as a confounder to more accurately determine the impact of UVI trends given the lower number of melanomas in the group and the geographic density variance. Also, given the latency between UV exposure and the clinical appearance of melanoma, the current increasing UVI may better correlate with additional future MI increases. However, our studied period and analysis were constrained by the data available.

Our findings suggest rising ground-level UV intensity may have played a role in increasing NHW-MI. Further studies analyzing lag time/latency may help better elucidate this relationship. However, these findings reinforce the importance of physician-patient dialog surrounding UV radiation protective measures and could provide guidance for future public health initiatives to combat rising melanoma incidence.[5]

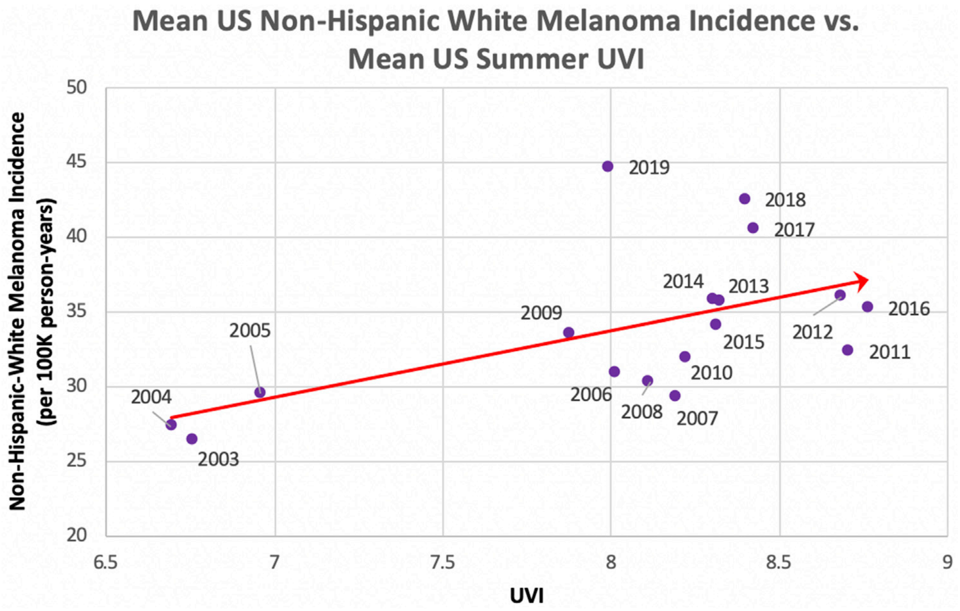

Fig 1. Mean United States (US) non-Hispanic White melanoma incidence vs mean US summer ultraviolet index (*UVI*) from 2003 to 2019 with linear regression. Mean US non-Hispanic White melanoma incidence correlates directly with mean US summer UVI. Linear regression graphically represented by the *red arrow*. Non-Hispanic White melanoma incidence = −1.991 + 4.462×(mean US summer UVI); $F_{1,15} = 6.938$, $R^2 = 0.316$, $P = .019$.

Table I. Top quartile for greatest change in non-Hispanic White (*NHW*) melanoma incidence per state by United States Census region from 2003 to 2019*

Rank	Region	State	NHW melanoma incidence rate of change†
1	West	New Mexico	1.903
2	South	South Carolina	1.891
3	West	California	1.881
4	South	Georgia	1.764
5	South	Florida	1.760
6	South	Delaware	1.719
7	South	Maryland	1.673
8	West	Washington	1.551
9‡	Northeast	New Jersey	1.495
10	South	Virginia	1.403
11	West	Utah	1.386
12	West	Oregon	1.386

*Eleven of 12 states with greatest increases in non-Hispanic White melanoma incidence fall in regions with the fastest increases in the Ultraviolet Index.

†$\chi^2_{1,49} = 5.9802$, $P = .0145$.

‡One of 12 states (New Jersey) is not from the South/West and may reflect sun-seeking behaviors of the state population.

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