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Short communication

Does one's geographic location influence their use of sun protection? A survey of 3,185 U.S. Residents

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ABSTRACT

To determine if geographical differences exist in practice of sun protective behaviors across the United States, we performed a retrospective, cross-sectional analysis of data from the Health Information National Trends Survey 4 Cycle 3. Self-reported sun protective behaviors and demographic information were collected for individuals from nine regions across the United States in 2013. Regions followed United States census divisions, including New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific. Study participants included 3,185 people from nine census regions. Sun protection was uncommonly practiced in the United States. The use of sunscreen in the West North Central region was the lowest sun protective practice. Long pants were more commonly worn in the West South Central and the Pacific. Sun protective behavior rates are low for all geographic locations across the United States. Future public health campaigns should place less emphasis on geographical influences of sun protective behaviors and focus more so on comprehensive, nationwide sun prevention campaigns.

1. Introduction

In 2019, 96,480 estimated new cases of melanoma were diagnosed in the United States with 7,230 individuals dying from their disease (American Cancer Society, 2019). Keratinocyte carcinomas are also prevalent with 5.4 million cases of basal and squamous cell carcinomas diagnosed in 2012 (American Cancer Society, 2019). Previous research supports that individuals living in rural areas compared to urban areas are more likely to experience a higher melanoma incidence and mortality (Cunningham et al., 2019). Furthermore, prior research has indicated that regional differences in sun protective measures exist, with rural individuals from the Midwest and South being less likely to use sunscreen (Zahnd et al., 2010). The presenting stage of skin cancer is affected by cultural values, social values, socioeconomic status, and skin cancer awareness (Buster et al., 2012). Socioeconomic status, cultural values, and social values can all be influenced by the geographic location where an individual resides. We hypothesized that skin cancer prevention related variations may be influenced by geographic location. By analyzing geographical differences in sun protective behaviors across nine US census divisions, we sought to determine if geographic location influences sun protection practices.

2. Material and methods

We performed a retrospective, cross-sectional analysis of data from the Health Information National Trends Survey 4 (HINTS 4) Cycle 3, where self-reported sun protective behaviors and demographic information were collected for 3,185 people from nine U.S. regions from September 2013 through December 2013 (Nelson et al., 2004). The HINTS 4 Cycle 3 survey sample design used a single-mode mail survey with a sample design that had two stages with the first stage selecting a stratified sample of addresses and the second stage selecting one adult from each household that was sampled. Data from 2013 was used as this survey year included multiple sun protective questions in a skin protection section pertaining to primary preventive behaviors and this was the last time a survey of this type was used. In this project, regions are

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defined as census divisions, including New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific (Supplementary Fig. 1) (www2.census.gov). The use of sun protective measures were defined as "always or often use when outside for more than one hour on a warm sunny day" for questions on the following sun protective methods: long pants, shirt with sleeves that cover the shoulders, hat that shades the face, ears, and neck, sunscreen, and stay in the shade or under an umbrella." Multivariable logistic regression was used to assess the association between geographic region and prevalence of each sun protective behavior, adjusting for age, sex, race/ethnicity, income, education level, healthcare coverage, smoking status, marital status and personal history of skin cancer. Estimated prevalence (predictive margins) for each region were computed with these regression models. Of note, Multivariate Imputation by Chained Equations (MICE) was used for missing income and race/ethnicity (11.6% and 11.3%, weighted) (Nelson et al., 2004). The regression models were fit to 2,805 samples with complete data in outcomes and adjusting covariates. All statistical analyses were performed with R version 3.6.1 (R Core Team, 2019).

3. Results

Table 1 shows the estimated unadjusted and adjusted prevalence of sun protective behaviors. The adjusted percentage of wearing a shoulder-sleeved shirt was relatively high in all geographic regions (52.2%-65.7%, adjusted). However, the use of other measures were much lower, with sunscreen use in the West North Central region the lowest practice (19.5%; 95%CI: 12.1%-26.9%, adjusted). Sunscreen use was also low in East South Central (23.4%; 95%CI: 7.6%-39.1%, adjusted), East North Central (24.1%; 95%CI: 18.9%-29.2%, adjusted) and West South Central (26.5%; 95%CI: 20.1%–32.9%, adjusted) compared with New England (33.3%; 95%CI: 21.5%-45.1%, adjusted). Long pants tended to be more commonly worn in the West South Central (42.0%; 95%CI: 32.8%-51.1%, adjusted) and the Pacific (43.5%; 95%CI: 36.5%-50.5%, adjusted) compared to New England (25.0%; 95%CI: 12.4%-37.6%, adjusted) (Fig. 1).

4. Discussion

Analysis of sun protective behaviors at a specific, geographical level can provide information on where further education and public health resources are most needed. Previous research indicates that fewer than half of adults follow sun protection guidelines (Bocquier et al., 2016). We conducted a population level analysis to further understand the influence of geographic location on sun protective behaviors, across the United States.

We observed marked differences by various types of sun protection but only slight differences in sun protective behaviors across different regions. There was a higher percentage of wearing long pants in the West South Central and Pacific. However, it is possible that for some individuals, the use of sun protection clothing may be related to occupation required attire rather than intentional practice of sun protection. Sunscreen use was lower in the East North Central, West North Central, East South Central, and West South Central regions, however, significant associations for geographical regions were not apparent after adjustment for covariates. This may be attributed to lack of statistical power and covariate adjustment that explained the associations. Specifically, in our adjusted analyses, we observed more extreme odds ratios for some associations, but the confidence intervals also became much wider. This suggests that statistically significant and dermatologically meaningful associations may have been detected with a larger sample size.

Our research suggests that one's geographic region does not appear to be a decisive factor in sun protection practices. This contrasted with an earlier study that found regional differences in many of the sun protective measures, such as less use of sunscreen by rural Midwesterners and Southerners, although specific data was not shown (Zahnd et al., 2010). Adopting a nationally focused public health campaign may be more important than campaigns that focus on variations in sun protective practices by geographical region. Of greater concern is that sun protective behavior rates are low throughout the United States regardless of the type of sun protection. The nationwide elementary and middle school-based SunWise Program in the United States has been shown to have the potential to decrease skin cancer medical based costs as a result of educating school-aged children about sun safety to reduce the risk of future skin cancer development (Kyle et al., 2008). Additional nationwide comprehensive strategies, such as the SunSmart program in Australia, that encourages sun protection in pools, workplaces, schools, and outdoor venues would likely be beneficial in the United States (Montague et al., 2001; USDHHS, 2014).

There are several limitations. First, one may be concerned about the reliability of self-reported sun protection behaviors although concerns are somewhat mitigated by the low rate of reported sun protective

Table 1
Prevalence of sun protective behaviors by United States' Geographic Region in 2013.

		Long Pants	Hat	Shoulder-Sleeved Shirt	Seek Shade	Sunscreen
New England (n = 96)	unadjusted% (95% CI)	22.9 (10.1,35.7)	23.6 (11.5,35.6)	59.5 (44.5,74.6)	26.3 (14.9,37.6)	38.5 (25.1,51.8)
	adjusted % (95% CI)	25.0 (12.4,37.6)	24.3 (11.0,37.6)	58.4 (44.5,72.2)	26.2 (14.9,37.5)	33.3 (21.5,45.1)
Middle Atlantic (N = 375)	unadjusted % (95% CI)	36.2 (26.3,46.1)	22.6 (15.8,29.4)	60.7 (52.1,69.3)	24.8 (17.9,31.7)	29.5 (21.2,37.8)
	adjusted % (95% CI)	35.8 (26.7,44.9)	22.4 (16.3,28.4)	60.6 (51.7,69.6)	25.3 (18.5,32.1)	29.3 (22.1,36.5)
East North Central (N = 385)	unadjusted % (95% CI)	31.2 (24.3,38.0)	23.6 (16.8,30.3)	58.7 (50.9,66.6)	23.0 (17.6,28.5)	22.6 (17.7,27.5)
	adjusted % (95% CI)	30.5 (24.1,37.0)	23.3 (16.5,30.1)	58.2 (49.9,66.5)	23.4 (17.6,29.1)	24.1 (18.9,29.2)
West North Central (N = 134)	unadjusted % (95% CI)	32.0 (20.8,43.3)	21.0 (9.3,32.7)	66.5 (54.4,78.7)	22.2 (12.5,31.8)	22.3 (13.9,30.7)
	adjusted % (95% CI)	35.4 (24.2,46.6)	20.8 (9.2,32.4)	65.7 (54.8,76.5)	21.9 (11.9,31.9)	19.5 (12.1,26.9)
South Atlantic (N = 626)	unadjusted % (95% CI)	30.4 (24.7,36.0)	26.2 (21.1,31.2)	53.5 (47.0,60.0)	26.0 (20.9,31.0)	30.2 (23.3,37.2)
	adjusted % (95% CI)	29.2 (23.6,34.8)	24.9 (19.8,29.9)	52.2 (45.5,58.8)	25.8 (21.0,30.6)	31.4 (24.9,37.9)
East South Central (N = 159)	unadjusted % (95% CI)	41.2 (26.0,56.3)	32.0 (18.6,45.3)	58.3 (44.7,72.0)	21.3 (4.3,38.4)	22.2 (5.6,38.7)
	adjusted % (95% CI)	43.8 (29.4,58.1)	35.2 (23.1,47.2)	59.9 (43.4,76.3)	22.2 (5.9,38.6)	23.4 (7.6,39.1)
West South Central (N = 363)	unadjusted % (95% CI)	44.7 (35.7,53.7)	31.0 (23.0,39.0)	50.9 (43.4,58.4)	28.7 (20.4,37.0)	22.6 (16.7,28.5)
	adjusted % (95% CI)	42.0 (32.8,51.1)	31.1 (23.0,39.2)	53.3 (46.8,59.8)	28.2 (19.6,36.9)	26.5 (20.1,32.9)
Mountain (N = 210)	unadjusted % (95% CI)	36.4 (24.5,48.4)	25.3 (14.7,35.9)	54.5 (42.5,66.6)	34.5 (21.8,47.2)	29.5 (17.6,41.4)
	adjusted % (95% CI)	39.7 (28.3,51.0)	28.0 (18.3,37.6)	56.7 (45.5,67.9)	35.6 (22.3,48.9)	28.1 (18.2,38.0)
Pacific (N = 458)	unadjusted % (95% CI)	43.6 (36.9,50.2)	28.5 (23.3,33.6)	61.6 (54.7,68.5)	25.3 (19.6,31.0)	31.4 (26.0,36.9)
	adjusted % (95% CI)	43.5 (36.5,50.5)	28.1 (22.5,33.6)	61.0 (54.2,67.7)	24.2 (18.8,29.7)	28.3 (23.1,33.5)

Adjusting covariates include age, sex, race/ethnicity, income, education level, healthcare coverage, smoking status, marital status, and personal history of skin cancer.

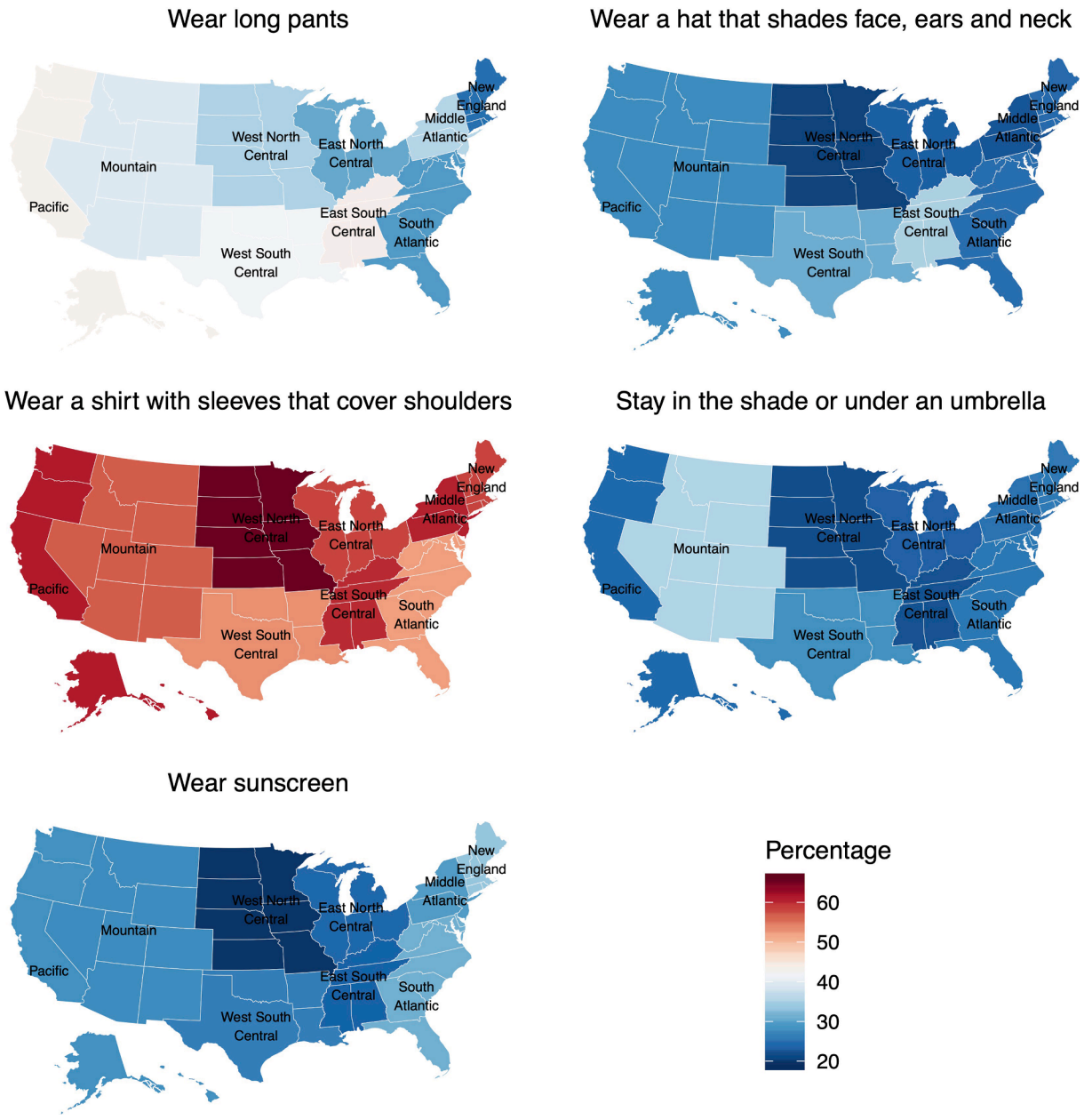

Fig. 1. Adjusted percentage of sun protective behaviors by United States region in 2013. Adjusting covariates include age, sex, race/ethnicity, income, education level, healthcare coverage, smoking status, marital status, and personal history of skin cancer.

behaviors. Secondly, even with more than 3,000 respondents, we are somewhat limited in identifying significant differences across nine discrete regions. In addition, data for potential confounders and demographic variables such as attire while working, job type, UV radiation level, and ambient temperature were not available and thus were not adjusted for in the analysis. Lastly, our survey asks about shirts that cover the shoulders which does not meet current sun safety recommendations as most health authorities, such as the US Surgeon General, recommend wearing long sleeve shirts for sun protection (USDHHS, 2014).

5. Conclusions

Public health campaigns should focus on population demographics where disparities in sun protective behaviors have already been shown to exist. For example, a previous study concluded that sunburn prevalence is highest among non-Hispanic whites, affluent adults, men, and younger adults regardless of regional location (Buller et al., 2011). Nationwide sunburn prevention public health campaigns that focus on these at-risk populations may be more effective than campaigns that emphasize a specific geographical location. Future research that clusters states by varying climates, such as mountainous and desert terrains, may contribute to additional understanding of sun preventive behaviors across different geographical regions. There are several public health implications from our research. Rates for each type of sun protective behaviors are low across all geographic regions in the United States. Our study supports that there are large deficits in primary prevention of skin cancer and additional behavioral counseling is needed to improve skin prevention behaviors for at risk populations. The United States Preventative Services Task Force concluded that sun protective behaviors in individuals of fair skin types can increase due to behavioral counseling interventions by clinicians (Grossman et al., 2018). A recent manuscript from 2018 that reviewed articles targeting behavioral interventions in skin cancer determined that there was little progress in multi-

intervention skin cancer behavioral interventions across the United States from 2000 to 2015 with research gaps including detecting skin cancer in high-risk populations, dissemination studies, and behavioral interventions (Geller et al., 2018). While prior research supports an influence of rural/urban areas in the practice of sun protective behaviors, our research does not support a difference by geographic location (Cunningham et al., 2019; Zahnd et al., 2010). Future public health campaigns often led by the CDC, other anti-cancer organizations, and family foundations should choose to focus on demographic disparities more so than geographic influence while deepening our understanding of how acculturation affects sun protective behaviors (Andreeva et al., 2009).

CRediT authorship contribution statement

Nicole L. Bolick: Conceptualization, Methodology, Investigation, Resources, Project administration. **Linglin Huang:** Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization. **Alan C. Geller:** Conceptualization, Methodology, Resources, Writing - review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contributions: Bolick, Huang, and Geller had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Bolick, Huang, and Geller. Acquisition, analysis, and interpretation of data: Bolick, Huang, and Geller. Drafting of Manuscript and revising critically for important intellectual content: Bolick, Huang, and Geller.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2020.101265.

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