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Fitzpatrick phototype disparities in identification of cutaneous malignancies by Google Reverse Image

To the Editor: Many US adults seek health information online, with a high volume of searches for cutaneous malignancies.[1] Because many dermatologic conditions are visually apparent, patients may use image-based search tools, such as Google Reverse Image (GRI), to augment text searches, potentially affecting use of health care services or patient-physician relationships.[2] We previously found that GRI showed moderate diagnostic frequency but limited accuracy for cutaneous neoplasms.[3] However, such modalities may be even less efficacious in skin of color.[3] We thus studied the effects of skin color on GRI accuracy in the identification of cutaneous neoplasms.

Basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and melanoma images from published dermatology textbooks (Table I) were categorized by 2 investigators as Fitzpatrick phototype (FP) I to III or IV to VI, with FP IV to VI representing skin of color. Equal numbers of BCC, SCC, and melanoma subtypes between FP groups were selected. Images with poor quality, absent subtype information, or discordant FP classifications were excluded. Twenty-five images per neoplasm and FP group were entered into GRI with the text prompt "skin" or "nail" to improve accuracy and relevance.[3] Diagnostic frequency was calculated as the percentage of images with at least 1 accurate diagnosis in the top 10 search results. Diagnostic accuracy and melanoma false positive rates were calculated as the proportion of the top 10 visually similar image results with the correct diagnosis or misdiagnosis as melanoma, respectively. Statistical significance was calculated using t tests in SAS, version 9.4 (SAS Institute, Cary, NC).

The diagnostic frequencies for BCC and SCC were significantly lower for FP IV to VI compared to FP I to III (Table II). Diagnostic accuracy was significantly lower, and melanoma false positive rates were significantly higher, in FP IV to VI for all neoplasms. BCC had the largest difference in accuracy (0.072 vs 0.232; $P < .001$) and melanoma false positive rate (0.268 vs 0.112; $P = .004$) between FP groups.

Our findings support the hypothesis that GRI performs more poorly for dermatologic queries in skin of color. This discrepancy may reflect insufficient availability of FP IV to VI images in GRI's database, leading to misinterpretation of features unique to this group by GRI's classification

Table I. Textbook sources for cutaneous malignancy photos

Title	Authors/editors	Publication year
Absolute Dermatology Review	Gloster Jr, et al	2016
Atlas of Geriatric Dermatology	Norman and Young Jr	2013
Atlas of Skin Cancers	Hendi and Martinez	2011
Atlas of Skin Disorders	Zhu et al	2018
Clinical Atlas of Skin Tumors	Baykal and Yazganoğlu	2014
Clinical Cases in Skin of Color	Love and Kundu	2016
Clinical Dermatology	Habif	2015
Dermatoanthropology of Ethnic Skin and Hair	Vashi and Maibach	2017
Dermatologic Atlas of Indigenous People	Florian et al	2017
Dermatology	Jain	2017
Dermatology Atlas for Skin of Color	Jackson-Richards and Pandya	2014
Dermatology for Skin of Color	Taylor and Kelly	2016
Dermatopathology	Busam	2009
Ethnic Dermatology	Dadzie et al	2013
Ferri's Fast Facts in Dermatology	Ferri et al	2010
Fitzpatrick's Color Atlas	Wolff et al	2017
Goodheart's Photoguide to Common Pediatric and Adult Skin Disorders	Goodheart and Gonzalez	2015
McKee's Pathology of the Skin	Calonje et al	2019
Pigmented Ethnic Skin and Imported Dermatoses	Orfanos et al	2018
Skin of Color	Alexis and Barbosa	2012
The Color Atlas and Synopsis of Family Medicine	Usatine et al	2019
Treatments for Skin of Color	Taylor et al	2011
Weedon's Skin Pathology Essentials	Johnston	2017

Table II. Diagnostic frequency, diagnostic accuracy, and melanoma false positive rate of cutaneous malignancies by Google Reverse Image

	Diagnostic frequency (SD)*			Diagnostic accuracy (SD)†			Melanoma false positive rate (SD)‡		
Neoplasm type	FP I to III (n = 25)	FP IV to VI (n = 25)	*P* value	FP I to III (n = 25)	FP IV to VI (n = 25)	*P* value	FP I to III (n = 25)	FP IV to VI (n = 25)	*P* value
BCC	0.880 (0.330)	0.360 (0.490)	<.001§	0.232 (0.160)	0.072 (0.124)	<.001§	0.112 (0.078)	0.268 (0.243)	.004§
SCC	0.960 (0.200)	0.440 (0.510)	<.001§	0.208 (0.119)	0.060 (0.087)	<.001§	0.064 (0.095)	0.160 (0.206)	.040§
Melanoma	0.680 (0.480)	0.480 (0.510)	.158	0.320 (0.323)	0.144 (0.187)	.023§	—	—	—

BCC, Basal cell carcinoma; *FP*, Fitzpatrick phototype; *SCC*, squamous cell carcinoma; *SD*, standard deviation.

*The diagnostic frequency was calculated as the percentage of the total images in each FP group that returned at least 1 correct diagnosis among the top 10 images returned.

†The diagnostic accuracy was calculated by using the proportion of the top 10 images returned containing the correct diagnosis for each inputted image.

‡The melanoma false positive rate was calculated by using the proportion of the top 10 images returned containing the incorrect diagnosis of melanoma for each inputted image.

§Statistically significant at the $P < .05$ level.

algorithm.[4] For example, inherent skin pigmentation and the higher occurrence of pigmented BCC[5] may lead to misclassifications of SCC and BCC as melanoma. In contrast, we did not find inferior accuracy rates for acral lentiginous melanoma in FP I to III in a subgroup analysis (not shown). We suspect this reflects adequate representation of acral lentiginous melanoma images in FP I to III in GRI's database, despite its lower incidence in FP I to III compared to FP IV to VI.[5]

Patients with skin of color often present with more advanced disease, potentially because of poorer screening or inadequate perceptions of risk.[5] Although GRI and similar technologies could theoretically reduce barriers to care, we wish to emphasize that GRI's already limited accuracy for cutaneous malignancies is still lower in skin of color. It is essential that emerging technologies used by patients and physicians alike avoid unintended biases in their algorithms that may be maintained in

systems for years to come, perpetuating current disparities. Ensuring fairness is critical for advancing health equity.

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Worldwide seasonal variation in search volume for cutaneous warts from 2004 to 2019

To the Editor: Several dermatologic conditions show seasonal variation, including visits for actinic keratosis, acne, and folliculitis.[1] In the well-known case of molluscum contagiosum, environmental conditions and behaviors that facilitate contact and fomite viral transmission[2] may give rise to clinically apparent seasonality. By analogy, the human papillomavirus serotypes responsible for cutaneous warts may plausibly show similar seasonal variation.

Google Trends (https://trends.google.com/) is a publicly available resource that presents monthly Google search volume data since 2004,[3] and it has been used to assess the incidences of various diseases.[3] We used Google Trends data for an exploratory study of worldwide and country-specific monthly search data from 2004 through 2018 for "wart," "genital wart" (GW), and "molluscum contagiosum" (MC) topics.[4] Google Trends normalizes search data to time and place of origin and reports a relative search volume index (SVI) scaled from 0 to 100. Cross-correlation and time-delay analyses were performed using the R Stats Package, version 3.5.1 (R Core Team, Vienna, Austria).

The worldwide MC and wart series showed clear seasonality, with a consistent 12-month period oscillation (Fig 1). Accordingly, cross-correlation between the wart and MC series was high ($r = 0.89$). Graphically, the seasonal components for the worldwide wart and MC series were approximately biphasic, both more clearly than for the GW series (Supplemental Fig 1, *A-C*; available via Mendeley at http://doi.org/10.17632/4wrt3rp3fh.2). Graphically clear wart series seasonality was present for the United States, Canada, Mexico, Spain, the United Kingdom, the Netherlands, Poland, Ukraine, Russia, Japan, Australia, and Argentina (and borderline present for Chile) but absent for Romania, Iran, Kazakhstan, the Philippines, Kenya, South Africa, Ecuador, Colombia, Peru, and Brazil. Among countries displaying wart seasonality, none showed similar variation in GW data. Pairwise comparison of the major contributors by hemisphere (United States, Japan, Argentina, Australia) (Fig 2) showed phase inversion of SVI oscillations across the equator.

Time-delay analysis showed maximum cross-correlation at zero lag for the latitude-concordant pairs (United States/Japan, Argentina/Australia; $r = 0.88$ and $r = 0.56$, respectively) and at 1 half-period lag for the latitude-discordant pairs (United States/Argentina, Japan/Australia; both $r = 0.65$). Whereas natural (weather) seasonality shows a 6-month phase shift between the Northern and Southern Hemispheres, these observations are consistent with underlying natural seasonality.

In this Google Trends analysis, both worldwide and country-specific SVIs for cutaneous warts—but not GW—showed marked and consistent yearly cyclic variation, spanning several continents and showing equatorial phase variability. These data