THE COST OF DIVERSITY: AN ANAYLSIS OF REPRESENTATION AND COST BARRIERS IN STOCK PHOTO LIBRARIES FOR HEALTH EDUCATION MATERIALS, 2021

by

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The cost of diversity: An analysis of representation and cost barriers in stock photo libraries for health education materials, 2021

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Abstract

INTRODUCTION: Ineffective health communication can drive health disparities and limit the effectiveness of interventions to reduce health disparities. Stock photo libraries are a critical tool for developers of patient education and intervention materials. It is not clear how well stock photo libraries represent communities bearing disproportionate burdens of disease.

METHODS: We conducted a search using five popular stock image libraries (Adobe Stock Images, Canva, Getty Images, Microsoft Office Image Library, and Pixabay) in November 2021 to evaluate diversity and representation in health-related stock photos. We searched for five key preventive health topics: healthy eating, exercising, quitting smoking, vaccination, and pregnancy. The images (N=495) were coded for representation of perceived minoritized racial/ethnic identity, skin color using the Massey-Martin Skin Color scale, markers of high socioeconomic status (SES), and access costs. We established inter-rater coding reliability.

RESULTS: The representation of perceived minoritized people, darker skin color, and inclusion of markers of high SES varied greatly by the search term and database. After excluding images without people or with ambiguous representation, 51.5% of images across all databases depicted a person of a perceived minoritized racial/ethnic identity. Images in databases with any paywall were significantly more likely to depict a person of perceived minoritized racial/ethnic identity, depict darker skin colors, and significantly less likely to contain markers of high SES identity than images in databases that were free to use.

DISCUSSION: We found it costs more to develop quality health education materials for minoritized populations and that do not represent high SES populations. This may hinder the development of effective communication interventions.

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Background

Representation matters in health promotion efforts, and the lack of representation is an issue of health equity. Examples of the lack of representation abound. Medical and nursing education have been shown to fail to address diversity by race, ethnicity, and gender for both professionals and patients in textbooks (Curry 2001; Louie 2018; Parker 2017). Consumer facing web sites for prostate cancer screening under-represent Black and Latinx men (Loeb 2022) and cancer information materials have similar problems (King 2015).

Culturally-tailored communications that are relevant to minoritized groups can contribute to reducing health disparities between these groups and their counterparts (Campbell 2006), which is why it is important to have resources available for the creation of culturally-tailored patient education material. One critical resource for developing health promotion materials – be they web sites, apps, or brochures – is diverse stock imagery. While studies are sparse, there is some documentation of gaps in existing sources of imagery for health educators (Buller 2015). One of the leading causes of preventable death and disease are chronic diseases (GBD 2019 Diseases and Injusries Collaborators 2020). Along with policies and systems interventions, producing effective patient education materials regarding preventive care is essential to mitigating the effects of these preventable diseases on communities (Kreps, 2006). A robust array of stock photos representing human diversity must be available for the creation of these tailored materials.

Health promotion should recognize the importance of market segmentation or the creation of different messages and materials for different groups (Grier 2010; Kreuter 2014). Additionally, culturally-specific[1] interventions are a strategy to ensure that one-size-fits-all interventions do not exacerbate inequities. Creating health education materials that represent the population receiving the materials likely improves the effectiveness of materials: Specifically, culturally-tailored interventions have been shown to be more effective by increasing the *relevance* of the message and thereby increasing *engagement* (Strecher 2008), both of which increase the likelihood of knowledge retention or behavior change. Other researchers have shown that identifying with the people in the imagery can influence behavioral intentions (Buller 2018; Buller 2019). For example, patient perception that a treatment/procedure is not the norm for peers in their population can serve as a barrier for the patient pursuing the treatment/procedure (Schmid 2017).

We were interested in investigating the diversity and representation of minoritized groups in popular stock image libraries that may be used to create patient education materials. We were also interested in exploring if there are disproportionate barriers (such as paywalls and images that require a cost to use) to access images featuring representation by gender presentation, perceived racial/ethnic minoritized identities, and visual markers of socioeconomic status. Specifically, we sought to answer two research questions: (1) How well do stock photo libraries represent the diversity of communities at risk of preventable diseases? And (2) is there a correlation between the portrayal of minoritized groups and the presence of barriers (e.g., paywalls) to access the imagery?

[1] To minimize confusion, we follow Kreuter's definition and define *tailoring* as strategies that are personalized to an individual and *targeting* as strategies that are designed to reach a population subgroup based on shared characteristics (Kreuter 2003). Interventions designed for a specific cultural audience are also referred to as "culturally-specific" interventions.

Methods

To answer the research questions, we conducted a quantitative content analysis (Riffe 2005) of stock photos from five stock photo libraries. We searched five stock photo libraries Canva, Microsoft Office Image Library, Pixabay, Adobe Stock Images and Getty Images in November 2021. In each stock photo library, we conducted five separate searches. We developed terms based on plain language searches, and we incorporated feedback on real-world search practices reported by community health workers on a grant advisory panel. The five terms relating to preventive health were used: (1) "people eating healthy", (2) "people exercising," (3) "people quitting smoking," (4) "people vaccination," and (5) "pregnant woman." These terms were selected because of their importance to chronic disease prevention. We also included pregnancy given the historic neglect of maternal and child health and important role of health education in maternal health services. The first 25 images displayed for each search were downloaded, given a unique identification number, and stored for coding.

We developed a codebook to translate qualitative characteristics of the imagery into quantitative data. Each image was coded using 12 categories. We next briefly describe these measures; readers interested in the full codebook can find it online. We first coded for relevance and barriers access. These were relevance of the image to the search topic (e.g., we excluded images of veterinary vaccination), and presence of paywall in the database even if the individual image was not behind the paywall, presence of a cost to access the individual image. Each of these was coded as a binary variable.

We then coded for the presence of people and their characteristics. We coded for the presence of at least one person (cartoons and animations were not counted as people) and the presence of multiple people. We assessed characteristics based on what a reasonable person might assume to be the characteristics of the person or persons depicted. First, based on context clues and gender norms, we assessed gender presentation into three categories: perceived male, perceived female, and perceived non-binary gender. Second, we coded for perceived age, which we categorized into four groups: 0 – neonate, infant, and toddler, 1 – school-aged child, adolescent, 2 – young adult, middle-aged adult, and 3 – older adult. If multiple people were present in the image, the youngest and oldest individuals were coded. Age was only coded if there was a visible face in the image. Third, the coder then similarly assessed if a reasonable viewer of the image would think there was a person of a minoritized racial/ethnic identity depicted in the image. We then coded skin color, which is more easily measured than racial/ethnic identity and is itself correlated with social experiences (Klonoff 2000). Specifically, we used the Massey-Martin Skin Color Guide (Massey 2003) to score and record the skin color(s) of individuals in each photo. The original scale ranges from 1 (lightest) to 10 (darkest). The scale was consolidated into ranges 1-3, 4-6 and 7-10 to improve the reliability of the metric, being coded ordinally as 1,2 and 3, respectively. If multiple people were present in an image, the lightest and darkest skin tones were recorded. Following recommendations from Hannon and DeFina (2016), we referenced the skin color chart directly while coding images. Finally, we coded for the presence of indicators of perceived high socioeconomic status such as the presence

of expensive French cookware in photos of kitchens. Any category that was not relevant to the image or that could not be conclusively determined/was unknown for the image was coded with "99."

Figure X. Skin color coding adapted from Massey-Martin Skin Color Guide/New Immigrant Survey

Source: Massey, Douglas S., and Jennifer A. Martin. 2003. The NIS Skin Color Scale.

To establish reliability, we used Krippendorff's alpha (Hayes 2007). First, two coders independently coded 32 test images; reliability ranged from -0.05 to 0.93. We discussed differences in coding and revised the coding category definitions. The two coders then coded 25 new test images and retested reliability for items with less than alpha=0.75. After the second test, Krippendorff's alpha ranged from 0.75 to 1.0, indicating adequate intercoder reliability.
We conducted data management in SPSS v. 27/Macintosh (IBM, Chicago, IL) and analyses in Stata IC/16.1/Macintosh (StataCorp, College Station, TX). We first calculated frequencies and percentages of responses from each coding category and stock photo site. We then implemented logistic regression models to test the association between stock photo site and characteristics with three outcomes: perception as representing a minoritized racial/ethnic group, skin color, and having a marker of high SES present. We implemented the models as having a dichotomous outcome (perceived representation of a minoritized racial/ethnic group, marker of SES present) or an ordinal outcome (skin color). Because our models had some variables where combinations of characteristics had zero images, we used logistic regression models with penalized likelihood or Firth methods to reduce small-sample bias in maximum likelihood estimation (Firth 1993) as implemented in the Stata command firthlogit. The East Carolina University and Medical Center IRB reviewed our research protocol and determined it to be not-human-subjects research (UMCIRB #21-001983).

Results

Table 1. Number and Proportion of Relevant Images, DATE, N=495

	Healthier Diet	Physical Activity	Pregnancy	Quitting Smoking	Vaccination	Farmworkers	Women Farmworkers
				N (%)			
Adobe	25 (20.7%)	25 (20.7%)	25 (24.5%)	23 (31.9%)	22 (27.8%)	23 (31.5%)	21 (30.0%)
Canva	25 (20.7%)	25 (20.7%)	25 (24.5%)	24 (34.7%)	18 (22.8%)	25 (34.2%)	24 (33.3%)
Getty	23 (19.0%)	25 (20.7%)	25 (24.5%)	24 (33.3%)	25 (31.6%)	24 (32.9%)	25 (35.7%)
Microsoft	24 (19.8%)	24 (19.8%)	4 (3.9%)	0 (0%)	5 (6.3%)	0 (0%)	0 (0%)
Pixabay	24 (19.8%)	22 (18.2%)	23 (22.5%)	0 (0%)	9 (11.4%)	1 (1.4%)	0 (0%)
TOTAL	121 (19.0%)	121 (19.0%)	102 (16.0%)	72 (11.3%)	79 (12.4%)	73 (11.4%)	70 (11.0%)

Table 2. Characteristics of stock photo images by database, N=495

	Adobe Stock Images	**Canva**	**Getty Images**	**Microsoft Office Image Library**	**Pixabay**	**Total**
Characteristics coded			**N (%)**			
Presence of visible face in image						
Yes – Face visible	74 (63.2%)	45 (38.5%)	60 (50.0%)	15 (57.7%)	16 (38.1%)	210 (49.8%)
No visible faces	43 (36.8%)	72 (61.5%)	60 (50.0%)	11 (42.3%)	26 (61.9%)	212 (50.2%)
Perceived gender presentation in image						
Male present in image	46 (47.4%)	39 (54.9%)	15 (18.3%)	9 (52.9%)	5 (13.9%)	114 (37.6%)
Female present in image	86 (89.6%)	68 (90.7%)	77 (93.9%)	10 (58.8%)	33 (91.7%)	274 (89.5%)
Non-Binary person present in image	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Ages represented in images with one person						
Neonate-toddler present in image	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Child, adolescent present in image	2 (5.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (16.7%)	4 (3.4%)
Young adult, adult present in image	32 (86.5%)	15 (88.2%)	37 (88.1%)	7 (87.5%)	10 (83.3%)	101 (87.1%)
Older adult present in image	3 (8.1%)	2 (11.8%)	5 (11.9%)	1 (12.5%)	0 (0.0%)	11 (9.5%)
Ages represented in images with one multiple people						
Youngest person in image is young neonate-toddler	0 (0.0%)	0 (0.0%)	3 (10.0%)	0 (0.0%)	1 (25.0%)	4 (3.4%)
Oldest person in image is young neonate-toddler	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Youngest person in image is child, adolescent	1 (1.7%)	0 (0.0%)	1 (3.3%)	2 (20.0%)	0 (0.0%)	4 (3.4%)
Oldest person in image is child, adolescent	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (10.0%)	0 (0.0%)	1 (0.8%)
Youngest person in image is young adult/adult	23 (38.3%)	26 (46.4%)	9 (30.0%)	3 (30.0%)	0 (0.0%)	61 (51.3%)

Oldest person in image is young adult/adult	21 (35.0%)	25 (44.6%)	9 (30.0%)	4 (40.0%)	1 (25.0%)	19 (16.0%)
Youngest person in image is older adult	6 (10.0%)	2 (3.6%)	2 (6.7%)	0 (0.0%)	1 (25.0%)	11 (9.2%)
Oldest person in image is older adult	9 (15.0%)	3 (5.4%)	6 (20.0%)	0 (0.0%)	1 (25.0%)	19 (16.0%)
Racial/ethnic representation						
Person of minoritized racial/ethnic identity present	28 (42.4%)	21 (48.8%)	42 (67.7%)	6 (60.0%)	4 (26.7%)	95 (51.5%)
No person of minoritized racial/ethnic identity present	38 (57.6%)	22 (51.2%)	20 (32.3%)	4 (40.0%)	11 (73.3%)	101 (48.5%)
Skin tone representation						
Images with one person						
Images scoring 1-3 (lightest skin tone)	52 (82.5%)	46 (83.6%)	53 (63.9%)	13 (81.3%)	29 (90.6%)	193 (77.5%)
Images scoring 4-6	11 (17.5%)	8 (14.5%)	24 (28.9%)	2 (12.5%)	2 (6.3%)	47 (18.9%)
Images scoring 7-10 (darkest skin tone)	0 (0.0%)	1 (1.8%)	6 (7.2%)	1 (6.3%)	1 (3.1%)	9 (3.6%)
Images with multiple people						
Images scoring 1-3 (lightest skin tone) for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 1-3	44 (44.9%)	52 (49.1%)	24 (36.4%)	8 (50.0%)	4 (50.0%)	132 (44.9%)
Darkest skin tone present was 1-3	29 (29.6%)	40 (37.8%)	13 (19.7%)	6 (37.5%)	4 (50.0%)	92 (31.3%)
Images scoring 4-6 for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 4-6	5 (5.1%)	1 (0.9%)	9 (13.6%)	0 (0.0%)	0 (0.0%)	15 (5.1%)
Darkest skin tone present was 4-6	19 (19.4%)	5 (4.7%)	17 (25.8%)	2 (12.5%)	0 (0.0%)	43 (14.6%)
Images scoring 7-10 (darkest skin tone) for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 7-10	0 (0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Darkest skin tone present was 7-10	1 (1.0%)	8 (7.5%)	3 (4.5%)	0 (0.0%)	0 (0.0%)	12 (4.1%)
Socioeconomic status						
Indicators of High Socioeconomic Status	19 (16.2%)	14 (12.0%)	3 (2.5%)	5 (20.0%)	7 (17.5%)	48 (11.5%)
No Indicators of High Socioeconomic Status	98 (83.8%)	103 (88.0%)	117 (97.5%)	20 (80.0%)	33 (82.5%)	371 (88.5%)

Note: Not all coding characteristics are present for all images. Thus, numbers do not sum within each coding category to total.

Table 3. Characteristics Number and Proportion of Images Representing the Indicated Group by Search Topic, N=495

	Healthier Diet	**Physical Activity**	**Pregnancy**	**Quitting Smoking**	**Vaccination**	**Total**
Characteristics coded			**N (%)**			

Visible Face						
Visible Face(s) Present	50 (61.7%)	82 (76.6%)	50 (50.5%)	15 (21.4%)	13 (20.0%)	210 (49.8%)
No Visible Face(s)	31 (38.3%)	25 (23.4%)	49 (49.5%)	55 (78.6%)	52 (80.0%)	212 (50.2%)
Perceived Gender Presentation in Image						
Male	24 (46.2%)	47 (51.1%)	2 (2.1%)	11 (52.4%)	30 (68.2%)	114 (37.6%)
Female	51 (92.7%)	77 (85.6%)	98 (100.0%)	12 (63.2%)	36 (81.8%)	274 (89.5%)
Non-Binary	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Age – Images with One Person						
Neonate-toddler present in image	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Child, adolescent present in image	3 (12.5%)	0 (0.0%)	1 (2.3%)	0 (0.0%)	0 (0.0%)	4 (3.4%)
Young adult, adult present in image	21 (87.5%)	28 (80.0%)	43 (97.7%)	9 (75.0%)	0 (0.0%)	101 (87.1%)
Older adult present in image	0 (0.0%)	7 (20.0%)	0 (0.0%)	3 (25.0%)	1 (100%)	11 (9.5%)
Age – Images with Multiple People						
Youngest person in image is young neonate-toddler	3 (5.6%)	0 (0.0%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	4 (2.5%)
Oldest person in image is young neonate-toddler	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Youngest person in image is child, adolescent	1 (1.9%)	1 (1.1%)	2 (33.3%)	0 (0.0%)	0 (0.0%)	4 (2.5%)
Oldest person in image is child, adolescent	0 (0.0%)	1 (1.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)
Youngest person in image is young adult/adult	18 (33.3%)	37 (42.0%)	0 (0.0%)	1 (50.0%)	5 (50.0%)	61 (38.1%)
Oldest person in image is young adult/adult	18 (33.3%)	34 (38.6%)	3 (50.0%)	1 (50.0%)	4 (40.0%)	60 (37.5%)
Youngest person in image is older adult	5 (9.3%)	6 (6.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	11 (6.9%)
Oldest person in image is older adult	9 (16.7%)	9 (10.2%)	0 (0.0%)	0 (0.0%)	1 (10.0%)	19 (11.9%)
Racial/Ethnic Minority Status						
Person of Minoritized Racial/Ethnic Identity	22 (47.8%)	33 (54.1%)	19 (43.2%)	5 (33.3%)	22 (73.3%)	101 (51.5%)
No Person of Minoritized Racial/Ethnic Identity	24 (52.2%)	28 (45.9%)	25 (56.8%)	10 (66.7%)	8 (26.7%)	95 (48.5%)
Skin tone representation						
Images with one person						
Images scoring 1-3 (lightest skin tone)	33 (84.6%)	34 (72.3%)	66 (77.6%)	51 (81.0%)	9 (60.0%)	193 (77.5%)
Images scoring 4-6	6 (15.4%)	9 (19.1%)	17 (20.0%)	12 (19.0%)	3 (20.0%)	47 (18.9%)
Images scoring 7-10 (darkest skin tone)	0 (0.0%)	4 (9.5%)	2 (2.4%)	0 (0.0%)	3 (20.0%)	9 (3.6%)
Images with multiple people						

Images scoring 1-3 (lightest skin tone) for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 1-3	37 (44.0%)	52 (48.1%)	5 (35.7%)	5 (41.7%)	33 (43.4%)	132 (44.9%)
Darkest skin tone present was 1-3	28 (33.3%)	37 (34.3%)	4 (28.6%)	5 (41.7%)	18 (23.7%)	92 (31.3%)
Images scoring 4-6 for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 4-6	5 (6.0%)	2 (1.9%)	2 (14.3%)	1 (8.3%)	5 (6.6%)	15 (5.1%)
Darkest skin tone present was 4-6	7 (8.3%)	13 (12.0%)	3 (21.4%)	1 (8.3%)	19 (25.0%)	43 (14.6%)
Images scoring 7-10 (darkest skin tone) for score of lightest and darkest person depicted among people present						
Lightest skin tone present was 7-10	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Darkest skin tone present was 7-10	7 (8.3%)	4 (3.7%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	12 (4.0%)
Socioeconomic Status						
Indicators of High Socioeconomic Status	15 (18.8%)	26 (24.8%)	6 (6.1%)	1 (1.4%)	0 (0.0%)	48 (11.5%)
No Indicators of High Socioeconomic Status	65 (81.3%)	79 (75.2%)	93 (93.9%)	69 (98.6%)	65 (100%)	371 (88.5%)

Table 4. Prediction of representation in stock photos in adjusted and unadjusted models

	Perceived Minoritized Racial/Ethnic Group Represented (Y vs. N)		**Increasing Likelihood of Darker Skin Color Represented**		**Marker of High SES Pictured (Y vs. N)**	
	Unadjusted OR (95% CI)	Adjusted aOR (95% CI)	Unadjusted OR (95% CI)	Adjusted aOR (95% CI)	Unadjusted OR (95% CI)	Adjusted aOR (95% CI)
Visible Face						
No Visible Face	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Visible Face	**0.47 (0.23-0.96)**	0.57 (0.24-1.36)	1.18 (0.76-1.83)	1.11 (0.65-1.91)	1.01 (0.98-1.04)	1.04 (0.99-1.09)
Paywall Presence for at Least Some Images in Database						
No Paywall	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Paywall	**2.08 (1.18-3.66)**	-	**1.70 (1.98-2.68)**	-	**0.38 (0.21-0.71)**	-
Image is Free to Access						
Free to Access	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Not Free To Access	1.58 (0.90-2.77)	-	1.37 (0.88-2.12)	-	**0.22 (0.11-0.47)**	-
Database						
Adobe Stock Images	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Canva	1.29 (0.60-2.77)	1.31 (0.59-2.89)	0.75 (0.40-1.40)	0.78 (0.41-1.48)	0.71 (0.34-1.48)	0.66 (0.30-1.45)
Getty	**2.80 (1.37-5.73)**	**2.69 (1.30-5.58)**	**2.04 (1.18-3.50)**	**2.01 (1.14-3.50)**	**0.15 (0.05-0.48)**	**0.13 (0.04-0.45)**

Microsoft Office Image Library	1.95 (0.53-7.13)	1.79 (0.46-6.99)	0.73 (0.25-2.12)	0.65 (0.21-2.00)	1.36 (0.47-3.91)	0.59 (0.19-1.83)
Pixabay	0.53 (0.16-1.74)	0.52 (0.15-1.77)	**0.25 (0.07-0.89)**	**0.26 (0.07-0.93)**	1.13 (0.45-2.86)	0.85 (0.31-2.31)
Topic						
Healthier Diet	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Physical Activity	1.28 (0.60-2.74)	1.34 (0.60-2.99)	1.26 (0.65-2.44)	1.37 (0.68-2.76)	1.41 (0.69-2.86)	1.42 (0.67-3.01)
Pregnancy	0.83 (0.37-1.89)	0.86 (0.36-2.03)	0.88 (0.44-1.76)	0.99 (0.48-2.02)	**0.29 (0.11-0.77)**	**0.28 (0.10-0.75)**
Quitting Smoking	0.57 (0.18-1.86)	0.60 (0.18-2.00)	0.64 (0.29-1.41)	0.60 (0.26-1.39)	**0.09 (0.02-0.50)**	**0.09 (0.02-0.51)**
Vaccination	**2.88 (1.09-7.64)**	2.02 (0.68-5.02)	**2.58 (1.25-5.29)**	**2.35 (1.09-5.09)**	**0.03 (0.001-0.55)**	**0.03 (0.002-0.59)**

Note: Number of cases in each outcome variable varies as not all images could be coded for each outcome (e.g., people presented in silhouette or images without people). Logistic regression models used penalized likelihood (i.e., Firth) methods to reduce small-sample bias in maximum likelihood estimation. Skin color is modeled in an ordinal logistic regression model. Paywall presence means the database has a paywall but not all images are necessarily behind the paywall (e.g., a database has some images behind the paywall).

For the study, a total of 525 stock images were identified from the five databases. Of these images, 495 were relevant to the topic. Table 1 shows the proportion of relevant images and images with visible faces by topic and database. Of these relevant images, 121 (19.0%) came from the topic of healthier diet, 121 (19.0%) came from the topic of physical activity, 102 (16.0%) came from the topic of pregnancy, 72 (11.3%) came from the topic of quitting smoking category, and 79 (12.4%) came from the topic of vaccination. When analyzed by database, the percentage of images containing a visible face ranged from 38.1% (Pixabay) to 63.2% (Adobe Stock Images). When analyzed by search topic, the percentage of images containing a visible face ranged from 20.0% (vaccination) to 76.6% (physical activity). In total, 49.8% of images contained a visible face and 50.2% did not.

Regarding diversity of communities, which was operationalized as gender, age, perceived racial/ethnic representation, skin color, and indicators of high socioeconomic status. When analyzed by database, male gender presentation was featured in a range of 13.9% (Pixabay) to 54.9% (Canva) of images, while female gender presentation was featured in a range of 58.8 (Microsoft Office Image Library) to 93.9% (Getty Images) of images (Table 2). When analyzed by search term, male gender presentation was featured in a range of 2.1% (pregnancy) to 68.8% (vaccination) of images, while female gender presentation was featured in a range of 63.2% (quitting smoking) to 100% (pregnancy) of images (Table 3). Overall, 37.6% of images depicted at least one person presenting as male and 89.5% of images at least one person presenting as female.

When analyzed by database, both images with one person and images with multiple people had very low representation of neonates-toddlers, children-adolescents, and older adults (Table 2). A substantial majority of the photos analyzed represented young and middle-aged

adults. These trends continued to be evident when photos were analyzed by search topic (Table 3).

Variability was seen in the perceived racial/ethnic representation in stock photos when analyzed by database. Values ranged from 26.7% (Pixabay) to 67.7% (Getty Images) of photos featuring representation of a perceived racial/ethnic minority (Table 2). Variability continued to be present when analyzed by search topic, as values ranged from 33.3% (quitting smoking) to 73.3% (vaccination) of photos featuring representation of a perceived racial/ethnic minority (Table 3). Overall, 51.5% of images portrayed one or more people with a perceived minoritized racial/ethnic identity (Table 2 & 3).

Lighter skin tones were represented substantially more than darker skin tones in both images with one and multiple people. By database, Getty Images had the highest proportion of images representing darker skin tones, while Pixabay had the lowest proportion of images representing darker skin tones (Table 2). By search topic, vaccination had the highest proportion of images representing darker skin tones, while quitting smoking and healthy eating featured the least representation of darker skin tones (Table 3).

Across databases, Getty Images had the lowest proportion of images containing perceived indicators of high socioeconomic status (2.5%) and Microsoft Office Image Library had the highest proportion of images containing perceived indicators of high socioeconomic status (20.0%) (Table 2). Perceived indicators of high socioeconomic status were more prevalent in the healthy eating and physical activity categories. Perceived indicators of high socioeconomic status were absent in the vaccination category and minimally present in the quitting smoking and pregnancy categories (Table 3). Overall, perceived indicators of high socioeconomic status were present in 11.5% of images.

Table 4 presents regression models examining the association between stock photo characteristics, topics, and databases and three outcomes: perception as representing a minoritized racial/ethnic group, skin color, and having a marker of high SES present. These were predicted by the presence of faces, cost barriers to image use, and the database and topics.

Having one or more faces visible in the image was significantly associated with lower likelihood of the photo representing a perceived minoritized group (OR 0.47, 95% CI: 0.23-0.96). Visible faces were not associated with skin color or having a marker of high SES shown.

Regarding cost barriers to use, having a paywall for the database was significantly associated with each outcome: Images in databases with paywalls were significantly more likely to have representation of a perceived minoritized racial group (OR 2.08, 95% CI: 1.18-3.66), to have higher likelihood of a darker skin color represented (OR 1.70, 95% CI: 1.98-2.68), and, in contrast, were less likely to have a marker of high SES included (0.38, 95% CI: 0.21-0.71). The same pattern of results, albeit without reaching traditional thresholds of statistical significance for minoritized representation and skin tone, was present based on if the image was free to access or not.

Regarding databases, there were differences in outcome by database. Comparing to Adobe Stock Images, Getty was more likely to have representation of minoritized groups (OR

2.80, 95% CI: 1.37-5.73), increasing likelihood of the presence of darker skin tones (OR 2.04, 95% CI: 1.18-3.50), and less likelihood of images having a marker of high SES represented (OR 0.15, 95% CI: 0.05-0.48). Pixabay was significantly less likely than Adobe to include images with darker skin color (OR 0.25, 95% CI: 0.07-0.89). Finally, there were differences in these three outcomes by topic. Compared to images about a healthier diet, images about vaccination had a pattern of being more likely to show a perceived minoritized racial/ethnic group, darker skin color, and were less likely to show a marker of SES. Markers of high SES were also less likely for pregnancy and quitting smoking compared to a healthier diet. Physical activity had a general pattern, albeit not significant, of being more likely to show minoritized groups, darker skin color, and high SES.

Discussion

Principal Findings

The findings from our study suggest that the cost to develop high quality health education materials is higher for materials representing minoritized populations and populations not of high socioeconomic status. They also suggest that free stock images poorly represent the diversity of communities at risk of preventable diseases. For our first research question, we found that Getty Images best included minoritized racial/ethnic communities, and that Pixabay had the weakest representation. Getty Images also best included individuals of darker skin colors. While Pixabay had the weakest representation of darker skin colors, Adobe Stock Images, Canva and Microsoft Office Image library also had limited representation of darker skin colors. Getty Images also had the strongest representation of populations not of high socioeconomic status, while Microsoft Office Image Library had the weakest representation. Perceived female representation was greater than perceived male representation across all topics and databases. There was also a lack of representation of children and older adults when compared to the representation of young adults/adults. For our second research question, we found that photos with cost barriers are more likely to portray minoritized populations, suggesting that there is a correlation between the portrayal of minoritized groups and the presence of barriers to access the imagery. We also found that photos with cost barriers are less likely to portray indicators of high socioeconomic status.

Results in Context

Stock imagery is important for the development of effective health education materials. Stock imagery that does not properly represent the topic can cause patients to be misinformed, putting them at risk (Goodstein 2018). Tailored messaging can improve health outcomes (Campbell 2006), and diverse stock imagery is needed to create tailored health education materials. Previous studies have shown a lack of diversity and representation in online images depicting pregnancy, similar to the results of our study (Bogers 2020). Lack of diversity and representation has also been shown in stock imagery depicting other health-related search topics, such as search topics involving dermatology (Kurtti 2022). This concerning trend has also been exhibited in rheumatology clinical image banks (Strait 2021), hospital social media and online platforms (Myers 2019) and dermatology teaching images (Ebede 2006). In order to achieve

optimal health outcomes, high-quality, highly diverse stock images need to be available to the creators of health education media.

Although racial diversity and representation in stock imagery is important for creating tailored patient education materials, cultural diversity should also be taken into consideration as well. Focusing on these deep structures instead of surface-level demographics is recommended (Institute of Medicine 2002). Such approaches can be used for personalization through "cultural tailoring" that allows interventionists to personalize based on "how individuals perceive their own culture, the extent to which they identify with it, and the specific cultural values that are important to them" (Kreuter 2003, p.137). Deep messaging improves the effectiveness of tailored messages (Huang 2016; Noar 2007). Future research should investigate the cultural diversity and representation in stock photo libraries.

It is also important to note that there are some risks to representation. For example, there is a risk that cultural targeting around health disparities messaging can backfire (Niederdeppe 2013) by promoting fatalistic views among the intended audience and reducing risk perceptions among populations who are not represented. Researchers have documented some of these challenges in the context of messaging with cancer-disparities messaging (Landrine 2014), HIV/STI disparities (Friedman 2014; Lee 2017), and with COVID disparities . Developers of materials should work to balance representation with avoiding stereotypes and perceptions that a problem is faced by just a single group.

Strengths and Limitations

Strengths of this study include the use of ranges for age and skin tone to increase the range of confidence and to decrease variability in answers. This study also established intercoder reliability before coding was performed. A limitation of this study was that despite the establishment of intercoder reliability, perception of what qualifies as an indicator of high socioeconomic status can be highly subjective. Also, determining whether a photo portrays a person of minoritized racial/ethnic identity can be difficult by definition given that identity can come from within. We also coded using photos from only five databases, when there are several more databases that could potentially be used by creators of health education materials. Additionally, although we established inter-coder reliability, this study only utilized one coder, thus it is subject to the coder's perceptions from their own identity.

Conclusion

Health disparities faced by minoritized populations can be exacerbated by poor health communication. Creators of health communication materials are reliant on stock photo libraries to create materials for diverse populations. The findings from this study reveal that there is substantial room for producers of free stock photos to improve their representation of minoritized populations.

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