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Missing Shades: An Analysis of Perceived Skin Pigmentation in Scar-Related Images Within the American Society of Plastic Surgeons (ASPS) Resident Education Curriculum

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Abstract

Introduction

Scars may result from surgical procedures, trauma, burns, and other cutaneous injuries. Scar outcomes vary according to wound characteristics, anatomical location, genetic susceptibility, and skin pigmentation. Some studies report a higher burden of hypertrophic and keloid scarring in populations with more deeply pigmented skin. In plastic and reconstructive surgery, operative success includes safety, function, durability, patient-reported outcomes, and aesthetic acceptability. We assessed the distribution of perceived skin pigmentation of scar-related images within the American Society of Plastic Surgeons (ASPS) Residency Education Curriculum (REC).

Methods

We reviewed all REC images depicting human scars, including those featuring scar formation, post-operative healing, or surgical planning related to scar management. Non-human subjects and unrelated (non-scar) content were excluded. Each image was independently assessed by four of seven trained reviewers using visual reference derived from the Fitzpatrick categories. Images with substantial reviewer disagreement were reassessed after standardized retraining. We measured interrater reliability using Krippendorff's alpha; image diversity was analyzed by educational module, scar management category, type of image, and course material.

Results

Of 1,327 color images included in the pigmentation analysis, n = 1,288 (97.1%) were assigned to Fitzpatrick Types I-IV and n = 39 (2.9%) to Types V-VI. After retraining and reassessment, Krippendorff's alpha was 0.808, indicating strong interrater agreement. Skin tone Types V-VI were absent from gender affirmation and aesthetic surgery and infrequently represented across the remaining six modules (Breast, Head and Neck, Fundamentals of Surgery, Upper Extremity, Trunk, and Lower Extremity). Clinical case scenarios showed the highest representation for skin tone Types V-VI (13.8%, 4/29), while slide presentations (1.5%, 7/464) and supplemental articles (0%, 0/6) showed the least.

Conclusions

Highly pigmented skin tones are infrequently represented in the ASPS REC scar-related images, underscoring the need for more representative educational content. These findings may help prioritize the development of more visually inclusive educational materials.

Categories: Plastic Surgery, Medical Education, Quality Improvement
Keywords: diversity, fitzpatrick, plastic surgery, resident education, scars

Introduction

Scars develop as a normal part of the body's healing response following skin injury. These processes occur through overlapping inflammatory, proliferative, and remodeling phases [1]. This structural change leads to the characteristic texture and appearance of scars. Factors such as wound depth, location, size, and tension; genetic predisposition; and the presence of infection can all influence scar formation and severity [2]. Unfortunately, certain individuals are prone to pathologic scarring, including hypertrophic and keloid scars [3]. Genetic susceptibility and population-associated factors may influence pathological scarring; however, race, ethnicity, and skin pigmentation should not be treated as equivalent biological variables [1,4]. Prior research has shown that Asian patients have a threefold greater risk of hypertrophic scarring compared to

Caucasian patients undergoing cleft lip repair in the specific population studied [5]. Familial aggregation of keloids has also been reported in selected populations [6]. This disparate scar burden over disfigurement may influence patient concerns and decisions regarding surgical care [7].

Beyond physical appearance, scarring can have profound psychosocial consequences that impact overall well-being and quality of life [8-11]. In plastic and reconstructive surgery, operative success includes safety, function, durability, patient-reported outcomes, and aesthetic acceptability. This education is critical for surgical trainees and should include factors such as skin color, predispositions that may contribute to pathologic scarring, and scar treatment strategies. Surgeons often use the human body's natural contours to reduce scar visibility. Many strategies can help prevent hypertrophic or keloid scarring [2,12]. Given the complexity of both surgical planning and postsurgical scar management, residents and fellows should be well-educated on best approaches for various patient populations. Scar images across a broad spectrum of skin pigmentation may improve visual recognition and patient counseling, which can be a powerful tool in furthering trainee understanding and preparing them and their patients for the expected range of scar-related outcomes.

Due to a lack of representative patient images in the plastic surgery literature [13-16] and the importance of understanding scar care and outcomes in patients of different skin tones, we examined images in the Residency Education Curriculum (REC), an American Society of Plastic Surgeons (ASPS)-cultivated educational resource accessible to residents and fellows [17], to evaluate skin tone representation in scar education. While prior studies have assessed skin-tone representation broadly in plastic surgery education materials [13,14,16,18], scar-related images within the ASPS REC have not been separately characterized. Our goals were to (i) describe the distribution of perceived skin pigmentation across REC modules, (ii) identify modules and topics with limited inclusion of more deeply pigmented skin, and (iii) make recommendations regarding which modules would benefit from updating to be more representative of the United States population.

Materials And Methods

The ASPS REC [17] was accessed through the institutional subscription provided to plastic surgery residents. The REC is not publicly accessible, and study investigators accessed its content using their institutionally authorized resident credentials. Three study team members (WRS, LA, and AG) reviewed all nine REC modules: Aesthetic Surgery, Breast, Fundamentals of Surgery, Gender Affirmation Surgery, Head and Neck, Lower Extremity, Non-Clinical, Trunk, and Upper Extremity. This was done by assessing each module page-by-page, identifying images, and comprehensively analyzing the educational goal for that section. The key terms used to assist in identifying eligible images were "scar," "wound," "coverage," "excision," "healing," "postoperative result," "scar management," "operative planning," and "stitches," contextualized within areas of scar education (e.g., surgical planning and postoperative incision healing). Images eligible for inclusion were those featuring one or more scars on human skin, including recognizable portions of human skin. Drawings were included, as they represent an educational modality capable of reflecting intentional educational/curricular design choices. Both individual images and images that were part of an image series (e.g., preoperative and postoperative comparisons and photo series) were included. Images were excluded if they were duplicates, focused on aspects of care unrelated to scarring (e.g., wound management and surgical technique) without visible scar outcomes, or depicted nonhuman subjects (e.g., animal models and inanimate practice simulations). Black-and-white images were collected for descriptive categorization but were excluded from Fitzpatrick categorization analyses.

The same three study team members (WRS, LA, and AG) extracted and categorized all images that met inclusion and no exclusion criteria. Images were labeled according to two classification systems to further describe each image's purpose: (i) scar management, which included (a) surgical planning, (b) scar formation, and (c) closure; and (ii) type of Image, which included (a) drawing, (b) photograph, and (c) black-and-white image (whether the image was a drawing or photograph). Images were cataloged in a study-specific database to facilitate skin-tone assessment. The decision to add each image to the study database required a unanimous decision by the three study team members; any disagreements were resolved through group discussion.

Images were categorized using the Fitzpatrick Skin Phototype Classification [19]: Type I (very light pigmentation; always burns and does not tan), Type II (light pigmentation; usually burns and tans minimally), Type III (light-to-medium pigmentation; may burn and gradually tan), Type IV (moderate pigmentation; rarely burns and tans readily), Type V (deep pigmentation; very rarely burns and tans readily), and Type VI (the deepest pigmentation; does not burn). Because the study evaluated images rather than patients, reviewers could not assess participants' self-reported responses to sun exposure. Therefore, categorization was based on visually apparent skin pigmentation. Seven reviewers (WRS, LA, AG, AW, AP, JH, and CMC), representing a variety of racial and ethnic origins, were trained on how to apply the Fitzpatrick scale. All reviewers were provided with the same Fitzpatrick scale reference image [20], which they were instructed to use as they performed their image assessments. Each image was randomly assigned to four of the seven reviewers using a balanced allocation scheme. All reviewers scored images independently; scores were later compiled for analysis.

Statistical analysis

Statistical analyses were performed using R version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria) through RStudio version 2025.05.1 (Posit Software, PBC, Boston, MA, USA). We calculated Krippendorff's alpha to assess interrater reliability. A high level of agreement (alpha > 0.8) was expected to proceed with further analysis.

We used Fitzpatrick scale categorization based on similar published studies assessing image diversity [13,21,22]. Prevalence and percentages were calculated for each Fitzpatrick type (I-VI) in the study database and were stratified within five established subcategories: type of image, scar management, educational module, topic, and course material type (i.e., clinical case scenario, course article, video, slide presentation, or supplemental article).

Images were additionally grouped into broader classifications: "low-to-medium pigment" (Fitzpatrick Types I-IV) and "high pigment" (Types V-VI). This classification reflects the Fitzpatrick scale's original development, which included only Fitzpatrick Types I through IV, and its subsequent expansion to incorporate darker skin tones through Types V and VI [19]. Prevalence and percentage analyses were repeated using the binary "low-to-medium pigment" and "high pigment" categorizations, both overall and within the established subcategories.

Interrater reliability assessment and reviewer retraining

Initial reviewer scoring demonstrated poor interrater agreement (Krippendorff's alpha = 0.62). Therefore, we identified images for which three out of four reviewers' scores differed or for which the rating difference was >3 levels on the Fitzpatrick scale for one or more reviewers. These analyses identified a subset of images (n = 587, 44.2%) that were of low quality/resolution; had green, yellow, or red overtones that obscured patients' skin tones; were poorly lit; and/or appeared to be decades old. Krippendorff's alpha for this subset was -0.092. To address this group of images, we conducted structured reviewer retraining focused on aligning interpretations of hue variation, lighting artifacts, and scar texture across different skin tones and lower-quality/resolution images (photographs). This subgroup of images was then reassessed, with each image being assigned to four (of the seven) reviewers using the same balanced allocation scheme noted above. Following reassessment, Krippendorff's alpha increased to 0.893 for the reassessed subset and was 0.808 for the complete final dataset. Agreement among the remaining images (n = 740, 55.8%) that were not reassessed was 0.755.

Results

We identified n = 1,327 images pertaining to scar management education across the ASPS REC; this excluded n = 73 black-and-white images for which skin tone could not be assessed. Interrater agreement for skin tone classification yielded a high level of agreement (Krippendorff's alpha = 0.808), meeting our threshold for further analysis.

Lighter skin tones, identified as Fitzpatrick Scale Types I-IV, were most frequently represented (n = 1,288, 97.1%), with 21.8% (n = 289) classified as Type I, 44.1% (n = 585) as Type II, 22.6% (n = 300) as Type III, and 8.6% (n = 114) as Type IV. Darker skin tones, identified as Fitzpatrick Scale Types V-VI, were much less common (n = 39, 2.9%), with 2.1% (n = 28) classified as Type V and 0.8% (n = 11) as Type VI (Table *1*).

Fitzpatrick Scale	Number of Images (n, %)
Type I	289 (21.8%)
Type II	585 (44.1%)
Type III	300 (22.6%)
Type IV	114 (8.6%)
Type V	28 (2.1%)
Type VI	11 (0.8%)
Grouped	
Types I-IV ("Low-to-Medium Pigment" Skin Tones)	1,288 (97.1%)
Types V-VI ("High Pigment" Skin Tones)	39 (2.9%)

TABLE 1: Distribution of Fitzpatrick Scale Skin Types I-VI and the Grouped Types (I-IV = "Low-to-Medium Pigment" Skin Tones, V-VI = "High Pigment" Skin Tones) Across n = 1,327 ASPS Residency Education Curriculum (REC) Images Related to Scar Education.

Distribution by type of image and categorical scar management

Of n = 1,327 images, 97.7% (n = 1,296) were photographs, and 2.3% (n = 31) were drawings. Among photographs, 97% (n = 1,257) were characterized as Fitzpatrick Types I-IV, and 3% (n = 39) as Types V-VI. Among drawings, 100% (n = 31) were classified as Fitzpatrick Types I-IV (Table *2*).

Type of Image	Types I-IV (n, %)	Types V-VI (n, %)	Total (n, %)
Photographs	1,257 (97%)	39 (3%)	1,296 (97.7%)
Drawings	31 (100%)	0 (0%)	31 (2.3%)
Scar Management Category			
Scar Formation	1,130 (96.9%)	36 (3.1%)	1,166 (87.9%)
Surgical Planning	112 (97.4%)	3 (2.6%)	115 (8.7%)
Closure	46 (100%)	0 (0%)	46 (3.4%)

TABLE 2: Distribution of Fitzpatrick Scale Skin Types I-IV ("Low-to-Medium Pigment" Skin Tones) and Types V-VI ("High Pigment" Skin Tones) by Type of Image and Scar Management Category Across n=1,327 ASPS Residency Education Curriculum (REC) Images Related to Scar Education.

Of the three scar management educational categories, 87.9% (n = 1,166) of images were categorized into scar formation, 8.7% (n = 115) into surgical planning, and 3.4% (n = 46) into closure. Assessment for darker Fitzpatrick Scale Types (V-VI) in each category demonstrated 3.1% (n = 36) in the scar formation category and 2.6% (n = 3) in the surgical planning category. The closure category demonstrated no depictions of Fitzpatrick Scale Types V-VI (Table *2*).

Distribution by educational module

Among the REC's nine modules, most images meeting study criteria were identified in "Breast" (n = 340), followed by "Head and Neck" (n = 326), "Fundamentals of Surgery" (n = 175), "Upper Extremity" (n = 172), "Aesthetic Surgery" (n = 127), "Trunk" (n = 89), "Lower Extremity" (n = 82), and "Gender Affirmation" (n = 16); "Non-Clinical" did not contain any eligible images (n = 0) (Table *3*). Of the eight modules containing eligible images, only six contained images portraying individuals with Fitzpatrick Skin Types V-VI. The module with the highest proportion of images portraying individuals with Fitzpatrick Skin Types V-VI was "Trunk" (9.0%; 8/89 images), followed by "Fundamentals of Surgery" (6.9%, 12/175), "Lower Extremity" (4.9%, 4/82), "Upper Extremity" (2.3%, 4/172), "Breast" (1.8%, 6/340), and "Head and Neck" (1.5%, 5/326).

The two modules containing no images portraying individuals with Fitzpatrick Skin Types V-VI were "Aesthetic Surgery" (0/127) and "Gender Affirmation" (0/16).

Educational Module	Types I-IV (n, %)	Types V-VI (n, %)	Total (n, %)
Trunk	81 (91%)	8 (9%)	89 (6.7%)
Fundamentals of Surgery	163 (93.1%)	12 (6.9%)	175 (13.2%)
Lower Extremity	78 (95.1%)	4 (4.9%)	82 (6.2%)
Upper Extremity	168 (97.7%)	4 (2.3%)	172 (13%)
Breast	334 (98.2%)	6 (1.8%)	340 (25.6%)
Head and Neck	321 (98.5%)	5 (1.5%)	326 (24.6%)
Aesthetic Surgery	127 (100%)	0 (0%)	127 (9.6%)
Gender Affirmation	16 (100%)	0 (0%)	16 (1.2%)
Non-Clinical	0 (0%)	0 (0%)	0 (0%)

TABLE 3: Distribution of Fitzpatrick Scale Skin Types I-IV ("Low-to-Medium Pigment" Skin Tones) and Types V-VI ("High Pigment" Skin Tones) by ASPS Residency Education Curriculum (REC) Educational Module Across n=1,327 Images Related to Scar Education.

Distribution by topic

Across 105 topics within the REC modules, 69 included images related to scar management, with 23 (33.3%) topics containing one or more images depicting Fitzpatrick Skin Types V-VI (Table *4*). Six topics demonstrated higher proportions (between 15% and 100%) of "high pigment" representative images. These were "Anatomy, Physiology, and Embryology" (100%, 2/2), "Traumatic Injuries" (50%, 3/6), "Facial Fractures" (33.3%, 1/3), "Pelvic Reconstruction" (25%, 2/8), "Benign Skin Lesions" (22.2%, 2/9), and "Burns" (18.2%, 4/22). Three topics demonstrated moderate proportions (10% to <15%) of "high pigment" representative images: "Orthopedic Surgery" (13.6%, 3/22), "Congenital Breast Anomalies" (11.1%, 3/27), and "Abdominal Wall Reconstruction Surgery" (10%, 2/20). The remaining 14 topics contained between 0.7% and 8.3% "high pigment" images. The other two-thirds of all scar-related topics (46/69, comprising n=665 images) contained no images representing "high pigment" skin tones (Fitzpatrick Types V-VI).

Topics	Types I-IV (n, %)	Types V-VI (n, %)	Total (n, %)
Abdominal Wall Reconstruction Surgery	18 (90%)	2 (10%)	20 (1.5%)
Anatomy, Physiology, and Embryology	0 (0%)	2 (100%)	2 (0.2%)
Benign Skin Lesions	7 (77.8%)	2 (22.2%)	9 (0.7%)
Blepharoplasty	7 (100%)	0 (0%)	7 (0.5%)
Body Contouring	76 (100%)	0 (0%)	76 (5.7%)
Breast Augmentation	1 (100%)	0 (0%)	1 (0.1%)
Breast Cancer	1 (100%)	0 (0%)	1 (0.1%)
Breast Reconstruction (Ancillary Based)	68 (100%)	0 (0%)	68 (5.1%)
Breast Reconstruction (Autogenous Based)	144 (99.3%)	1 (0.7%)	145 (10.9%)
Breast Reconstruction (Implant Based)	51 (100%)	0 (0%)	51 (3.8%)
Breast Reduction and Hypertrophy	11 (100%)	0 (0%)	11 (0.8%)
Brow Lift	8 (100%)	0 (0%)	8 (0.6%)
Burns	18 (81.8%)	4 (18.2%)	22 (1.7%)
Chest Wall Reconstruction	22 (95.7%)	1 (4.3%)	23 (1.7%)

Cleft Lip	31 (100%)	0 (0%)	31 (2.3%)
Cleft Lip Nose	82 (97.6%)	2 (2.4%)	84 (6.3%)
Congenital Breast Anomalies	24 (88.9%)	3 (11.1%)	27 (2%)
Congenital Disorders	5 (100%)	0 (0%)	5 (0.4%)
Congenital Hand	29 (100%)	0 (0%)	29 (2.2%)
Congenital Head and Neck Anomalies	8 (100%)	0 (0%)	8 (0.6%)
Dupuytren's Disease	8 (100%)	0 (0%)	8 (0.6%)
Extensor Tendon	2 (100%)	0 (0%)	2 (0.2%)
Face and Neck Lift	3 (100%)	0 (0%)	3 (0.2%)
Facial Fractures	2 (66.7%)	1 (33.3%)	3 (0.2%)
Facial Nerve Injury	2 (100%)	0 (0%)	2 (0.2%)
Fasciocutaneous Flaps of the Lower Extremity	33 (100%)	0 (0%)	33 (2.5%)
Flaps and Grafts	18 (94.7%)	1 (5.3%)	19 (1.4%)
Flexor Tendon	7 (100%)	0 (0%)	7 (0.5%)
Foot Reconstruction	7 (100%)	0 (0%)	7 (0.5%)
Gender Affirmation Surgery	16 (100%)	0 (0%)	16 (1.2%)
Gynecomastia	11 (91.7%)	1 (8.3%)	12 (0.9%)
Hair Restoration	8 (100%)	0 (0%)	8 (0.6%)
Hand Infections	5 (100%)	0 (0%)	5 (0.4%)
Hand Tumors	2 (100%)	0 (0%)	2 (0.2%)
Head and Neck Cancer	14 (100%)	0 (0%)	14 (1.1%)
Implants and Biomaterial	13 (100%)	0 (0%)	13 (1%)
Lasers	9 (100%)	0 (0%)	9 (0.7%)
Liposuction	11 (100%)	0 (0%)	11 (0.8%)
Malignant Skin Lesions	20 (100%)	0 (0%)	20 (1.5%)
Microsurgery	19 (95%)	1 (5%)	20 (1.5%)
Microtia and Ear Reconstruction	35 (100%)	0 (0%)	35 (2.6%)
Muscle Flaps of the Lower Extremity	13 (100%)	0 (0%)	13 (1%)
Nasal Reconstruction	82 (100%)	0 (0%)	82 (6.2%)
Necrotizing Infections	6 (100%)	0 (0%)	6 (0.5%)
Nerve Compression	3 (100%)	0 (0%)	3 (0.2%)
Nerve Injury	2 (100%)	0 (0%)	2 (0.2%)
Neurosurgery	3 (100%)	0 (0%)	3 (0.2%)
Non-surgical Rejuvenation	5 (100%)	0 (0%)	5 (0.4%)
Orthopedic Surgery	19 (86.4%)	3 (13.6%)	22 (1.7%)
Pediatric Surgery	6 (100%)	0 (0%)	6 (0.5%)
Pelvic Reconstruction	6 (75%)	2 (25%)	8 (0.6%)
Pharmacology and Therapeutics	2 (100%)	0 (0%)	2 (0.2%)
Pressure Sores	13 (92.9%)	1 (7.1%)	14 (1.1%)

Ptosis and Mastopexy	23 (95.8%)	1 (4.2%)	24 (1.8%)
Reconstruction of Vascular Lesions	6 (100%)	0 (0%)	6 (0.5%)
Replantation, Revascularization	37 (97.4%)	1 (2.6%)	38 (2.9%)
Scalp, Forehead and Skull Reconstruction	24 (96%)	1 (4%)	25 (1.9%)
Soft Tissue Coverage of the Upper Extremity	69 (95.8%)	3 (4.2%)	72 (5.4%)
Soft-Tissue Injuries of the Face	5 (100%)	0 (0%)	5 (0.4%)
Special, Minimally Invasive and Non-invasive Techniques	17 (94.4%)	1 (5.6%)	18 (1.4%)
Spinal Reconstruction	17 (100%)	0 (0%)	17 (1.3%)
Targeted Muscle Reinnervation of the Lower Extremity	5 (100%)	0 (0%)	5 (0.4%)
Targeted Muscle Reinnervation of the Upper Extremity	4 (100%)	0 (0%)	4 (0.3%)
Transplantation and Immunology	9 (100%)	0 (0%)	9 (0.7%)
Trauma	1 (100%)	0 (0%)	1 (0.1%)
Traumatic Injuries	3 (50%)	3 (50%)	6 (0.5%)
Vascular Anomalies	36 (97.3%)	1 (2.7%)	37 (2.8%)
Venous Insufficiency of the Lower Extremity	11 (91.7%)	1 (8.3%)	12 (0.9%)
Wound Healing	5 (100%)	0 (0%)	5 (0.4%)

TABLE 4: Distribution of Fitzpatrick Scale Skin Types I-IV (“Low-to-Medium Pigment” Skin Tones) and Types V-VI (“High Pigment” Skin Tones) by Topics Across n=1,327 ASPS Residency Education Curriculum (REC) Images Related to Scar Education.

Topics are displayed in alphabetical order.

Distribution by course material type

Skin tone representation varied by course material type (Table *5*). Clinical case scenarios demonstrated the highest proportion of individuals with Fitzpatrick Skin Types V-VI (13.8%, 4/29), followed by course articles (3.7%, 24/642), videos (2.2%, 4/186), and slide presentations (1.5%, 7/464). Supplemental articles showed no (0%, 0/6) images depicting Fitzpatrick Skin Types V-VI.

Course Material	Types I-IV (n, %)	Types V-VI (n, %)	Total (n, %)
Clinical Case Scenario	25 (86.2%)	4 (13.8%)	29 (2.2%)
Course Article	618 (96.3%)	24 (3.7%)	642 (48.4%)
Video	182 (97.8%)	4 (2.2%)	186 (14%)
Slide Presentation	457 (98.5%)	7 (1.5%)	464 (35%)
Supplemental Article	6 (100%)	0 (0%)	6 (0.4%)

TABLE 5: Distribution of Fitzpatrick Scale Skin Types I-IV (“Low-to-Medium Pigment” Skin Tones) and Types V-VI (“High Pigment” Skin Tones) by Course Material Across n=1,327 ASPS Residency Education Curriculum (REC) Images Related to Scar Education.

Discussion

In this study, we comprehensively evaluated skin tone representation in scar-related educational images within the ASPS REC. This revealed that individuals with Fitzpatrick Skin Types V and VI, the two “high pigment” skin types, were represented in <3% of images. Additionally, Fitzpatrick Skin Type IV, the darkest

of the “low-to-medium pigment” skin tones, was represented in <9% of images, with the remaining 88.5% representing the lightest three skin tone types (I-III). This means the REC, an important resource for scar management education, is not representative of the US population, of which 20.5% identify as Hispanic/Latino, 13.5% as Black/African American, 6.9% as Asian, and 2.1% as either Native American/Alaska Native, Native Hawaiian/Pacific Islander, or Other [23].

While race and ethnicity may not directly equate to an individual’s skin tone, these census data can serve as helpful proxies for representation goals in educational photo libraries. Certainly, various studies have found that race/ethnicity and genetics can predispose certain individuals to pathologic scarring [1,4-6,24]. Asian patients have been found to have a threefold greater risk of hypertrophic scarring compared to Caucasian patients during cleft lip repairs [5]. Four single nucleotide polymorphism (SNP) loci in three chromosomal regions have been associated with keloid development in the Japanese population [24]. A study that evaluated numerous family pedigrees to assess the inheritance patterns of keloids observed that large keloids were exclusively found in African American populations [6]. Our study systematically audited visual representations of scars, an important component of plastic and reconstructive surgery education. Limited exposure to darker Fitzpatrick skin types may impair recognition of complications such as post-inflammatory hyperpigmentation or keloid formation, which is more prevalent in these populations [6]. These findings may help prioritize the development of more visually inclusive educational materials.

Our analysis revealed that most images were photos (97.7%) and most addressed the scar management category, “Scar Formation” (87.9%). Of the eight REC educational modules containing eligible images, only six included images representing the two darkest Fitzpatrick skin types; the two modules with no representation were aesthetic surgery and gender affirmation. This is concerning since 32% of patients seeking aesthetic surgery [7,21] and 45.3% of transgender/gender-diverse patients [22,25] identify as non-white. In addition to hypertrophic scarring and keloid formation, complications such as post-inflammatory hyperpigmentation are more prevalent in patients with darker skin tones and can significantly impact patients’ satisfaction with aesthetic results [2,3,7]. Having samples of scar images that are representative of patient populations is important to fields such as plastic surgery, wherein race-conscious surgical planning has been increasingly emphasized, particularly in facial, breast, and gluteal aesthetics [26,27]. A systematic review by Obiezu et al. (2025) emphasized the importance of understanding how various scar management approaches affect highly pigmented skin differently, and this knowledge should be used to select the best targeted therapies [7]. Other studies have shown racial and ethnic minorities face greater barriers in accessing gender-affirming procedures [28,29]. Improving image diversity in a nationally used education resource can be an important step towards improving these systemic disparities. Indeed, the Educational Modules “Trunk” and “Fundamentals of Surgery” contained the highest representation of Fitzpatrick Skin Types V-VI (9% and 6.9%, respectively), though these proportions were still below the US population percentage for African Americans.

In assessing the 69 REC module topics, six had "high" (15%-100%) and three had "moderate" (10% to <15%) representation of images with Fitzpatrick Skin Types V-VI. Of the six "high"-representation topics, “Burns” contained the most total images (n=22, 18.2% “high pigment” skin tones), with the other five topics containing nine images or fewer. Among the three topics with "moderate" representation, the total number of images ranged from 20 to 27. Fourteen additional topics had "some" (0.7%-8.3%) “high pigment” skin tone images, but the remaining 46 topics (comprising n=665 images) contained no images that represented “high pigment” skin tones. These data may provide guidance to individuals interested in updating various topics to improve infrequent representation of relevant skin tone types. The REC topic “Burns” may serve as a more representative example, which is educationally important since research has shown patients with darker skin tones are more likely to experience severe scarring and contracture post-burn injury, complicating both aesthetic and functional recovery [30]. Regardless, gaps in representation risk reinforcing educational blind spots; strategic updates of the REC’s visual content can better prepare trainees to care for a diverse US patient population.

Our assessment of course material also showed differences in representation, with “Clinical Case Scenario” having the greatest proportional diversity and “Supplemental Article” having none. This latter absence of diverse images is unsurprising, given the general deficiency of “high pigment” skin tone images in the plastic surgery literature [13-16] and the low number of “Supplemental Articles” included (total = 6). It is worth noting that these two Course Material types represented <3% of all Course Material types, whereas the other three types (“Course Article,” “Video,” and “Slide Presentation”), which contain 97% of scar education images, should be considered more closely to strategically improve REC image diversity. Suggestions include closer evaluation of images included in didactic materials and manuscripts intended for inclusion in the REC to determine whether they reflect current ranges of patient demographics.

Finally, image type and poor image quality may negatively impact the REC’s educational objectives. Accurate and detailed images are vital to understanding plastic and reconstructive surgery procedures and potential ranges of patient outcomes; poor image quality within an educational resource like the REC, which we identified as being as high as 44%, may contribute to misinterpretation and suboptimal clinical care. Many photographs were of low quality/resolution or appeared to be decades old and yielded lower levels of inter-rater agreement. With the potential exception of unique or rare cases, content contributors may consider following the guidance provided by the REC module teaching best practices in clinical photography to

ensure the inclusion of high-quality, well-lit photographs. Additionally, no drawn images represented “high pigment” skin tones. This represents an underutilization of this powerful medium, since drawings allow for greater editorial control and can reflect any skin tone. Artificial intelligence (AI)-based image generation may offer additional options for improving educational image diversity. This could enable the creation of standardized, high-quality depictions of scars and surgical scar outcomes across a spectrum of skin tones, particularly in scenarios where real-world image availability is limited. However, careful validation will be necessary to ensure clinical accuracy and avoid synthetic bias.

This study has limitations. First, our use of the Fitzpatrick Skin Tone Classification Scale does not directly correlate with patient race or ethnicity, as it is only an observer-assigned pigmentation category rather than confirmed Fitzpatrick phototypes; it was used as a proxy and therefore may not fully represent these demographic data. Second, our initial round of reviewer ratings demonstrated poor inter-rater agreement (Krippendorff’s alpha = 0.62). This necessitated identifying images with low inter-rater agreement and subsequent reviewer retraining to reduce measurement variability without influencing outcome directionality. Reviewers noted that many images in this subgroup were over 20 years old; different photographic technologies and techniques available when these photos were taken may contribute to hue distortions that obscured accurate skin tone assessment. Additionally, many subgroup images were low-resolution or poorly lit, making it difficult to distinguish natural pigmentation from surgical markings or postoperative changes/scars. Performing a second rating of this subgroup may impact the reproducibility of our findings; however, our analysis was similar to an analysis performed by Smith et al. (2022) of all images in the REC, which identified 6.6% of photographs and 0.6% of graphics (drawings) representing Fitzpatrick Skin Tone Types V and VI [13]. Finally, our findings may not be generalizable to other surgical curricula or international trainee education platforms.

Conclusions

Our study highlights a critical gap in the visual representation of diverse skin tones in scar education within the ASPS Resident Education Curriculum, wherein <3% of images portray Fitzpatrick Skin Tone Types V and VI. Our detailed evaluation provides a specific guide by which plastic surgery educators may efficiently address updating the REC by educational module, topic, and course material type to better reflect the US population. These findings may help prioritize the development of more visually inclusive educational materials.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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The source materials are publicly available to plastic surgery residents and organized into study-specific

folders available on reasonable request to Carisa M. Cooney (ccooney3@jhmi.edu). Carisa M. Cooney and Scott Lifchez are equally-contributing last-authors.

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