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Inter-institutional Analysis of Skin of Color Representation in Dermatological Lecture Content at MD and DO Medical Schools

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Abstract

The purpose of this study was to analyze the lecture materials provided in medical schools through a diversity lens. Skin pathologies manifest distinctively on various shades of skin and physicians must be equipped with the proper knowledge to identify and diagnose these conditions accurately and promptly. For medical students, images in prominent textbooks and lecture slides are often their first encounter with disease presentations. Therefore, it is important to analyze the diversity of skin tones in the content that is being delivered. Specifically, the use of images featuring darker skin tones compared to those depicting lighter skin tones. This study analyzed lecture materials from two allopathic and two osteopathic medical schools. The analysis was limited to lectures given during the skin/musculoskeletal block or dermatology block. The skin pathologies were organized into five categories: Inflammatory Disorders, Infectious Skin Disorders, Pigmented Disorders, Non-Pigmented Disorders, and Blistering Disorders. Images were classified as dark skin tones, light skin tones, and indeterminate based on the Fitzpatrick Scale. The results showed that of the 560 images analyzed, 96 images, or 17.1%, were representative of dark skin tones. 78.0% represented light skin-tone subjects and 4.8% were classified as indeterminate.

Keywords: SoC, skin of color, ethnic skin, dark skin tones, light skin tones, under representation of SoC, Fitzpatrick scale, Fitzpatrick skin type, health disparities, racial disparities, SoC representation, skin disorders, inflammatory disorders, blistering disorders, pigmented disorders, non-pigmented disorders, infectious skin disorders, skin infections, call to action, inter-institutional analysis of SoC, dermatology lecture content, resident confidence, medical student confidence, diagnosing SoC

Abbreviations

1. Pigmented malignant melanoma (PMM)
2. Amelanotic malignant melanoma (AMM)
3. Cutaneous melanomas (CM)
4. Skin of Color (SoC)
5. Non-Skin of Color (Non-SoC)
6. Basal cell carcinoma (BCC)
7. Squamous cell carcinoma (SCC)
8. Acral lentiginous melanoma (ALM)

Introduction

Dermatology is a field of medicine concerned with the diagnosis of diseases of the skin, hair, and nails. Accurate diagnosis is dependent upon the recognition of the pathological changes associated with a disease, as well as the knowledge of how those patterns may be altered depending on the skin tone of a patient. An example of the former, is the diagnosis of pigmented malignant melanoma (PMM) vs. the diagnosis of amelanotic malignant melanoma (AMM). In a study that analyzed 591 patients with PMM and 342 patients with AMM, the patients with AMM were 13% more likely to obtain a clinical misdiagnosis and 5% more likely to obtain a pathology misdiagnosis when compared to their PMM counterparts.[1] As the incidence of cutaneous melanomas (CM) continues to steadily rise, and as CM remains one of the most aggressive skin malignancies, accurate diagnosis of melanoma regardless of whether it is a melanotic or an amelanotic lesion is of the utmost importance.[2]

In addition to the color of a skin lesion itself, the underlying skin tone of a patient can alter the patterns of manifestations that may be characteristic of a disease. This speaks to the importance of including patients with a wide variety of skin tones in aspects such as clinical trials and academic material. To illustrate the importance of this inclusivity, the 2020 US Census reported that 71% of the United States population identified as white, including 61.6% identifying as "white alone.[3] Despite a large portion of the country's population having light skin tones, there are important ramifications that must be considered when dark skin toned subjects are not covered adequately in modern medical education. By 2045 it is projected that more than 50% of the U.S. population will be an ethnicity other than non-Hispanic white, further demonstrating the importance and urgency of increasing the representation of subjects' skin tones in medical student resources.[4] A systematic review of 626 dermatological clinical trials

showed that from studies that reported racial/ethnic data, 74.4% of study participants were reported to be white.[5] In regard to the microscopic characteristics of pigmented malignancies on Skin of Color (SoC) such as CM, pigmented basal cell carcinoma (BCC), pigmented squamous cell carcinoma (SCC), and acral lentiginous melanoma (ALM) the lack of published data of these pigmented skin malignancies in regard to SoC contributes towards the later diagnosis of these cancers in this patient population.[6] A literature review of 41 studies found that CM, pigmented BCC, pigmented SCC, and ALM on SoC was mentioned in approximately 19 of them.[6] Moreover, a meta-analysis of 454 full text articles regarding UV exposure and the risk of Keratinocyte Carcinoma in SoC found that of these studies performed in the United States, none of them included black individuals, and only one study included the Hispanic population.[7] Failing to study and understand the macroscopic and microscopic differences of skin lesions on dark skin tones compared to that of light skin tones fails to uphold an equitable standard of care by virtue of omission.

In addition to the lack of SoC included in published literature and clinical trials, there is also a lack of SoC image representation in academic learning material. This shortcoming may create a cascade effect in which an early lack of exposure to SoC images of medical students, leads to a lack of confidence in identifying skin lesions on SoC patients. This may further contribute to the late diagnosis and misdiagnosis of skin pathologies as already seen in SoC patients. A study that analyzed 1,123 images from six popular medical school resources, such as *Pathoma* (pathoma.com) and *First Aid* (McGraw Hill) found that only 167 images were considered to be SoC.[8] Another study that analyzed 424 images of determinable skin tone from the *New England Journal of Medicine Image Challenge* (nejm.org/image-challenge*)* identified just 44 images to be SoC.[9] A complete mastery of skin pathologies on SoC simply cannot be

accomplished without adequate resources. When assessing medical student confidence in diagnosing dermatological diseases in SoC patients, a study that analyzed 77 medical students who completed a pre-test, learning module, and a post-test observed a significant increase in student confidence in the post-test results compared to the pre-test results.[10] Another study that assessed the confidence level of 125 dermatology residents in diagnosing SoC patients, found that resident confidence was significantly lower in all categories in regard to treating SoC patients compared to their confidence in treating non-SoC patients.[11] There are many implications for a failure to integrate SoC or dark skin toned images and patients into medical resources and training. As discussed above, misdiagnosis, late diagnosis, and lack of medical student/resident confidence in diagnosing patients with dark skin tones are all potential consequences of this defect. Classically in the literature, darker skin tones are referred to as SoC and lighter skin tones are referred to as Non-SoC per the Fitzpatrick scale. The scale was developed in 1972 by Harvard Medical School Dermatologist Thomas B. Fitzpatrick based on an outdoor photosensitivity study he was conducting in Australia. The classification system is based on an individual's susceptibility to sunburn and/or tan based in non-Hispanic white populations[12]. This study refrains from using SoC and non-SoC language and instead uses a modified version of the Fitzpatrick scale. Therefore, the aim of this study was to investigate the data trends related to the number of dark skin toned and light skin toned images included in medical school lecture materials across four academic institutions.

Methods

Five overarching categories of skin disorders with 69 total individual skin conditions were analyzed for the number of dark skin tones, light skin tones, and indeterminate images in each category at 2 allopathic (MD degree-granting) and 2 osteopathic (DO degree-granting) U.S. medical institutions. These four institutions are each located in distinct locations throughout the country, each being in a different state with no specific region. The categories and distribution of analyzed diseases are as follows: 12 inflammatory disorders, 12 infectious skin disorders, 17 pigmented disorders, 20 non-pigmented disorders, and 8 blistering disorders (Table 1). Image analysis was confined to images obtained from professor-generated lecture material, such as PowerPoint slides and PDF note documents, that were used within the skin or dermatology instructional blocks at each institution. These lecture materials were unique to each institution and were provided to the students as study tools alongside virtual or in-person lectures. All lectures were delivered between 2022 and 2023. If an institution did not have a designated skin or dermatology block, analysis was instead confined to dermatology-specific lecture material generated during the first 2 years at that institution. One institution's data was gathered from relevant courses such as Musculoskeletal System (MSK), Principles of Clinical Medicine (PCM), Immunology, Hematology, and Lymphatic Systems (IHL), and Microbes and Infectious Diseases (MID).

A modified version of the Fitzpatrick scale was created by the authors for this study and was used to standardize image analysis between the medical institutions. Skin types I-IV, on the Fitzpatrick scale were considered to be light skin tones and were further classified as: type I light white, type II white, type IIIA medium white, and type IIIB olive. Skin types IV-VI, on the Fitzpatrick scale were considered to be dark skin tones and were further classified as: type IV

light brown, type V brown, and type VI dark brown. Some clinicians may consider darker Fitzpatrick type III skin and lighter Fitzpatrick type IV skin to be either light skin tones, an intermediate category of Asian or Hispanic type skin, or dark skin tones. For the purposes of this study, medium white and olive skin tones were categorized as light skin tones (Table 2). Images confined to the palms and soles without easily discernible skin from the back of the hand or the top of the foot respectively, were categorized as “indeterminate”. Images of lesions in body cavities without discernible skin were also categorized as “indeterminate”. The decision was made to incorporate the indeterminate images into analysis in order to accurately reflect the total number of dermatological images presented at each medical institution for each unique skin pathology. Image analysis was performed by visually inspecting the images and comparing the shade of skin on the images to one standardized image of the Fitzpatrick Scale to establish a skin tone range for each category. A single review was done for each individual image.

Results

The purpose of the present study was to determine the degree of representation of subjects of darker skin tones in dermatological lecture content. A total of 560 images were analyzed between the four medical institutions, of which 96 were representative of dark skin tones, equal to 17.4% of the total sample size. 78.0% of the total samples were light skin toned subjects, and 4.8% of the samples were categorized as indeterminate (Table 3).

Two MD and two DO schools were included in the study. Images from MD1 had 8.6% dark skin toned subjects, while 88.2% were light skin tones. Images from MD2 had 19.6% dark skin toned subjects and 73.9% light skin toned subjects. Images from DO1 showed 18.8% of subjects with dark skin tones and 77.2% with light skin tones. Images from DO2 had 23.1% dark skin toned subjects and 73.6% light skin toned subjects. The average proportion of dark skin toned subjects at osteopathic medical schools was 21% and the average at allopathic medical schools was 14% (Table 3).

Across all medical schools the proportion of dark skin toned subjects for each category of disease is as follows: inflammatory 18.8%, infectious 19.4%, pigmented 13.0%, non-pigmented 14.7%, and blistering 24.4% (Table 3). The category of disorder with the highest amount of dark skin toned images represented was blistering disorders.

Discussion

The results of the analysis indicate that there is a discrepancy between the implementation of different skin types between the sampled institutions. When comparing the institutional breakdown of skin tone inclusivity (17.1% representing darker skin tones and 78.0% representing lighter skin tones) versus the 2020 US Census identification results (71% self-identifying as lighter skin tones and 17.1% self-identifying as darker skin tones) the results were consistent when viewed as proportional representation[3].

The choice to use a modified Fitzpatrick scale was predicated on ensuring a consistent way of comparing and quantifying the images into light skin toned and dark skin toned groups. Instead of using the traditional Fitzpatrick scale, this study further subdivided traditional Fitzpatrick Type III/Type IV into Type IIIA and Type IIIB and Type IV. There have been several modifications of the Fitzpatrick scale since its inception, with more of an emphasis placed on different skin tones having varying levels of reactivity to sunlight based on darker eumelanin and lighter pheomelanin compositions. The eumelanin is more prevalent in darker-skinned individuals and exerts a greater photoprotective effect than pheomelanin, thereby creating a proxy which the team modified in order to have consistent categorization between light skin toned and dark skin toned individuals. This led to the findings of 17.1% of the images representing skin tones in the Type IV-VI categories and 78.0% of the images representing skin tones in the Type I-III categories. The use of this scale allowed the research team to designate a hard cutoff between two different sample types.

Differences between curriculum structure are paramount to consider when analyzing the data from this project. Certain institutions have a dedicated dermatology block, and it is therefore expected that these institutions will cover the pertinent disease entities in greater detail.

Additionally, the conditions which the research team decided to focus on for consistent cross-institutional data collection could have produced certain limitations to the study, as conditions deemed important by one institution, and therefore given to its students, might not be included in the curriculum of another institution. Different levels of integration of dermatological topics existed across the schools analyzed, such as how the physiology, pathology, and pharmacology could be either integrated into one course or separated into multiple courses. This could potentially allow for some skin conditions to be covered multiple times whereas others to be covered only once depending on the institution.

Although the researchers searched the lecture materials available to them, the search was not infallible. Immediately relevant lecture materials were requested and provided through the duration, which allowed for access to information that would have otherwise been unavailable. It is possible that not having access to all lecture materials may have led to unintentional exclusions. In this event, it is unlikely that a larger sample size would significantly affect the proportion of dark skin toned to light skin toned subjects. Mismatching in curriculum schedules and depth of curriculum is likely to exist in a similar magnitude regardless of the number of medical institutions analyzed. There were likely instances in the data collection process where minor semantic differences between campuses led to the exclusion of certain materials. Additionally, it is probable that different institutions covered or excluded conditions that may or may not have been included in the standardized lists used for data collection. Some skin conditions are easier to visualize in dark skin toned individuals, even though they are not exclusive to them (Figure 4). Therefore, conditions such as albinism and vitiligo may be presented in lecture materials on dark skin toned patients more frequently to help students more easily visualize these conditions.

Conclusion

This study was conducted in order to help improve the state of medical education in the United States by analyzing the proportion of representation of subjects with dark skin tones in lecture materials provided by medical schools pertaining to dermatologic lesions. The aim is that by performing an in-depth, quantitative study of the images provided by instructors during lectures, bias in representation may be uncovered and corrected, if found to exist. It was determined that the majority of lecture materials represented light skin toned subjects where 78% of all presented lecture materials were of subjects determined as light skinned. Darker skinned subjects represented 17.1% of the sample.

This research shows the need to bolster medical education in the United States by exposing medical students to a more diverse set of exemplary images during their didactic education. Instructors are encouraged to provide photographs of pathology on light skin and on dark skin whenever reasonably possible. In doing so, medical students will be better prepared to provide high quality healthcare to all patients regardless of ethnicity. Areas of further research include similar studies analyzing medical education beyond lecture materials. Possible areas of investigation include standardized patients, clinical rotations, community service opportunities, and more. These resources can be analyzed in a similar manner to assess the quality and diversity of patient populations medical students are exposed to outside of the classroom. The color of a patient's skin should never affect the quality of healthcare that they can receive.

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Figures and Tables:

Table 1. The Categories of the Analyzed Skin Disorders and the Specific Conditions Associated with Each Category

Inflammatory Disorders:	Urticaria, Eczema, Atopic Dermatitis, Contact Dermatitis, Stevens-Johnson Syndrome, Toxic Epidermal Necrolysis, Seborrheic Dermatitis, Psoriasis, Lichen Planus. Rosacea, Lupus, Erythema Nodosum.
Infectious Skin Disorders:	Verruca Vulgaris, Molluscum Contagiosum Tinea Capitis, Tinea Corporis, Tinea Cruris, Onychomycosis, Tinea Versicolor, Cellulitis, Necrotizing Fasciculitis, Impetigo, Erysipelas, Staph Scalded Skin Syndrome.
Pigmented Disorders:	Vitiligo, Albinism, Ephelides, Lentigo Simplex, Lentigo Solar, Melanotic macule, Melasma, Melanocytic Nevus, Halo Nevus, Congenital Nevus, Malignant Melanoma, Lentigo Maligna, Lentigo Maligna Melanoma, Superficial Spreading Melanoma, Nodular Melanoma, Acral Lentiginous Melanoma, Dysplastic Nevus.
Non-Pigmented Disorders:	Seborrheic Keratosis, Acanthosis Nigricans, Skin Tag, Cutaneous Cyst, Actinic Keratosis, Squamous Cell Carcinoma in Situ, Squamous Cell Carcinoma, Keratoacanthoma, Basal

	Cell Carcinoma, Benign Fibrous Histiocytoma (dermatofibroma), Dermatofibrosarcoma Protuberans (DSFP), Mycosis Fungoides, Langerhans Cell Histiocytosis Cell, Mastocytosis, Eruptive Xanthoma, Tuberous Xanthoma, Xanthelasma, Amelanotic Melanoma.
Blistering Disorders:	Pemphigus Vulgaris, Bullous Pemphigoid, Dermatitis Herpetiformis, Epidermolysis Bullosa, Epidermolysis Bullosa Acquisita, Pemphigus Foliaceus, Varicella vesicle, Trauma burns.

Table 1. Depicts the overarching categories of disorders analyzed as well as the specific conditions associated with each category. The categories analyzed were inflammatory disorders, infectious skin disorders, pigmented disorders, non-pigmented disorders, and blistering disorders with 12, 12, 17, 20, and 8 specific skin conditions in each category respectively.

Table 2: Shade Inclusion of the Original and Modified Fitzpatrick Scales

Shades	**Original Fitzpatrick Scale**	**Modified Fitzpatrick Scale**
Light White (Ivory)	Skin Type I	Skin Type I
White	Skin Type II	Skin Type II
Medium White (Beige)	Skin Type III	Skin Type IIIA
Olive	Skin Type III/IV	Skin Type IIIB
Light Brown	Skin Type IV	Skin Type IV
Brown	Skin Type V	Skin Type V
Dark Brown to Black	Skin Type VI	Skin Type VI

Table 2. Depicts the shade range of the original and the modified Fitzpatrick scales. The authors' modified scale distinctly separates olive shades into a Type IIIB category and light brown shades into a Type IV category rather than having the two shades overlap such as suggested with the original Fitzpatrick skin typing based on skin photosensitivity.

Table 3: Data from independent entities

MD1				
Type of Disorder	**Dark Skin Tones (%)**	**Light Skin Tones (%)**	**Indeterminate (%)**	**Total**
Inflammatory	4 (9.3)	38 (88.4)	1 (2.3)	43
Infectious	1 (7.1)	12 (85.7)	1 (7.1)	14
Pigmented	2 (6.3)	29 (90.6)	1 (3.1)	32
Non-Pigmented	6 (11.5)	45 (86.5)	1 (1.9)	52
Blistering	0 (0)	10 (90.9)	1 (9.1)	11
Total	13 (8.6)	134 (88.2)	5 (3.3)	152
MD2				
Type of Disorder	**Dark Skin Tones (%)**	**Light Skin Tones (%)**	**Indeterminate (%)**	**Total**
Inflammatory	7 (12.1)	48 (82.8)	3 (5.2)	58
Infectious	15 (26.3)	39 (68.4)	3 (5.3)	57
Pigmented	5 (13.9)	27 (75.0)	4 (11.1)	36
Non-Pigmented	4 (18.2)	18 (81.8)	0 (0)	22
Blistering	5 (45.5)	4 (36.4)	2 (18.2)	11
Total	36 (19.6)	136 (73.9)	12 (6.5)	184
DO1				

Type of Disorder	**Dark Skin Tones (%)**	**Light Skin Tones (%)**	**Indeterminate (%)**	**Total**
Inflammatory	7 (29.2)	16 (66.7)	1 (4.2)	24
Infectious	3 (15.8)	15 (78.9)	1 (5.3)	19
Pigmented	2 (8.7)	19 (82.6)	2 (8.7)	23
Non-Pigmented	5 (16.1)	25 (80.6)	1 (3.2)	31
Blistering	2 (50.0)	3 (75.0)	1 (25.0)	4
Total	19 (18.8)	78 (77.2)	6 (5.9)	101
DO2				
Type of Disorder	**Dark Skin Tones (%)**	**Light Skin Tones (%)**	**Indeterminate (%)**	**Total**
Inflammatory	12 (34.3)	23 (65.7)	0 (0)	35
Infectious	2 (11.1)	15 (83.3)	1 (5.6)	18
Pigmented	5 (29.4)	12 (70.6)	0 (0)	17
Non-Pigmented	6 (15.8)	29 (76.3)	3 (7.9)	38
Blistering	3 (23.1)	10 (76.9)	0 (0)	13
Total	28 (23.1)	89 (73.6)	4 (3.3)	121
Total	**Dark Skin Tones (%)**	**Light Skin Tones (%)**	**Indeterminate (%)**	**Total**
Inflammatory	30 (18.8)	125 (78.1)	5 (3.1)	160

Infectious	21 (19.4)	81 (75.0)	6 (5.6)	108
Pigmented	14 (13.0)	87 (80.6)	7 (6.5)	108
Non-Pigmented	21 (14.7)	117 (81.8)	5 (3.5)	143
Blistering	10 (24.4)	27 (65.9)	4 (9.8)	41
Total	96 (17.1)	437 (78.0)	27 (4.8)	560

Table 3. Display of the raw data from each medical school. MD1 (n = 152), MD2 (n = 184), DO1 (n = 101), and DO2 (n = 121) total (n = 560)

Figure 1. Skin Disorders and the Distribution of Dark Skin Tones, Light Skin Tones, and Indeterminate Image

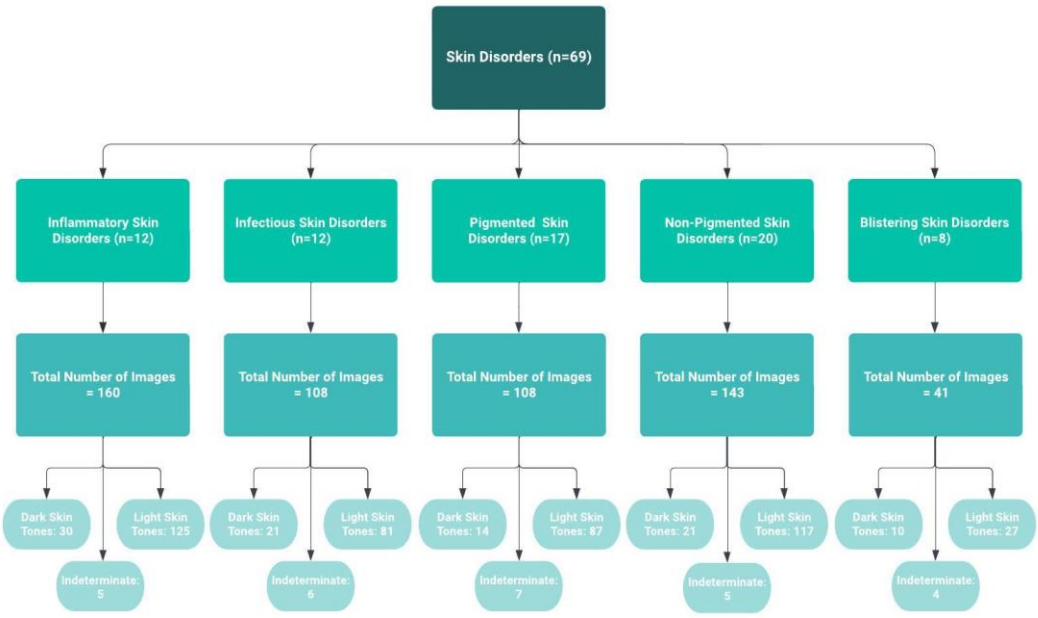


Figure 1. Depicts the flow of the overall number of Skin Disorders, to the number of Skin Disorders in each category, to the number of total images analyzed for each category, and finally to the breakdown of dark skin tones, light skin tones and indeterminate images for each category respectively. Of the 12

Inflammatory Skin Disorders, 160 total images were analyzed with 30 images being identified as dark skin tones, 125 images being identified as light skin tones, and 5 images being identified as indeterminate. Of the 12 Infectious Skin Disorders, 108 total images were analyzed with 21 images being identified as dark skin tones, 81 images being identified as light skin tones, and 6 images being identified as indeterminate. Of the 17 Pigmented Skin Disorders, 108 total images were analyzed with 14 images being identified as dark skin tones 87 images being identified as light skin tones, and 7 images being identified as indeterminate. Of the 20 Non-Pigmented Skin Disorders, 143 total images were analyzed with 21 images being identified as dark skin tones, 117 images being identified as light skin tones. Of the Blistering Skin Disorders, 41 total images were analyzed with 10 images being identified as dark skin tones, 27 images being identified as light skin tones, and 4 images being identified as indeterminate.

Figure 2: Total Skin of Color Representation at Four US Medical Schools

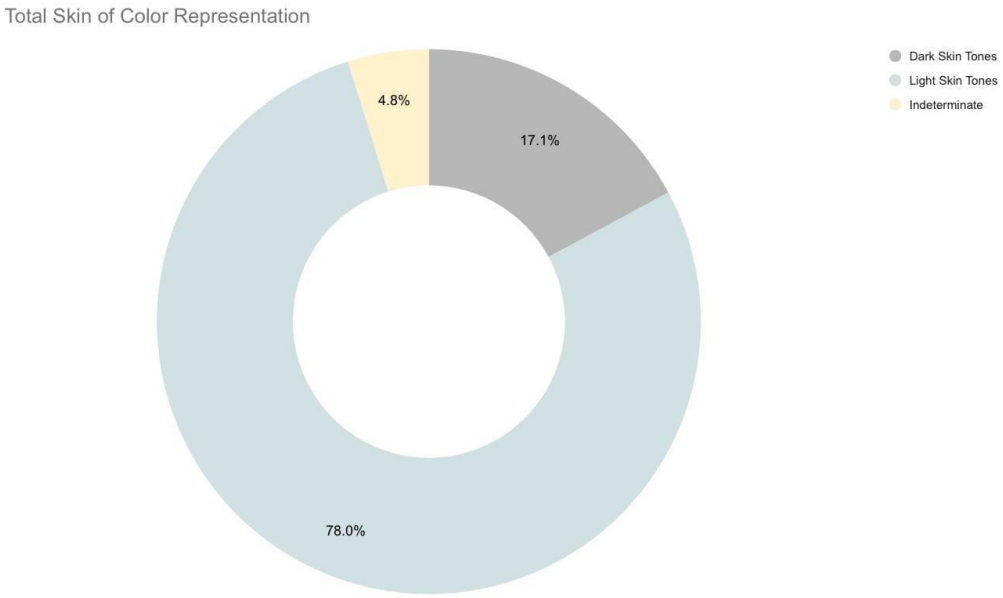


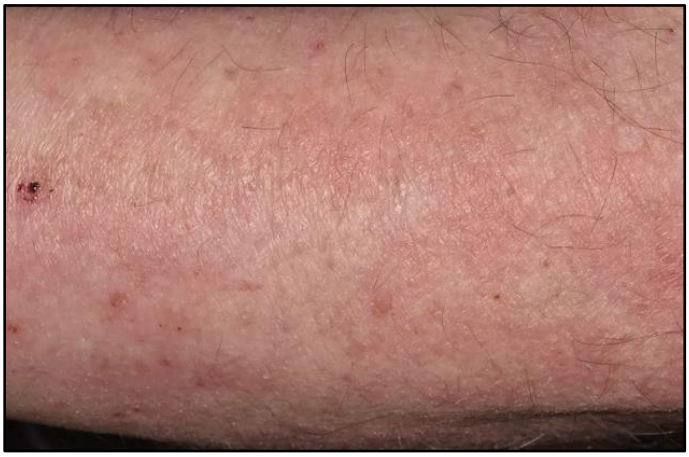
Figure 2. Total samples across four medical schools (n = 560) of which 78.04% had light skin subjects, 17.14% had dark skin subjects, and 4.82% were indeterminate.

Figure 3: Skin of Color Representation at Each Medical School

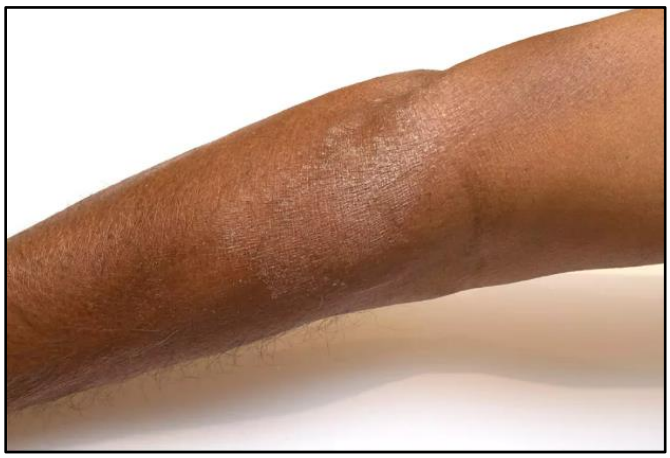
Figure 3. Pictographic representation of the data from each medical school, MD1 (n = 152), MD2 (n = 184), DO1 (n = 101), and DO2 (n = 121).

Figure 4. Variation in common skin pathologies on SoC vs non-SoC:

Eczema:

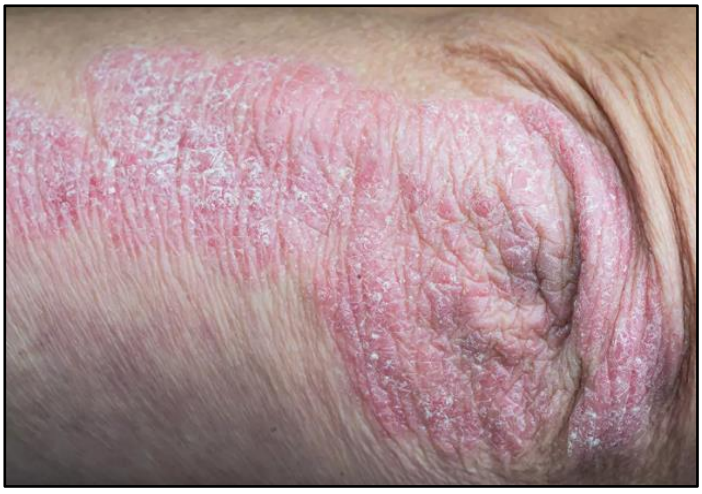


The classic characteristics of eczema, such as dry, flaking skin and erythema, easily recognizable in Fitzpatrick skin type II.

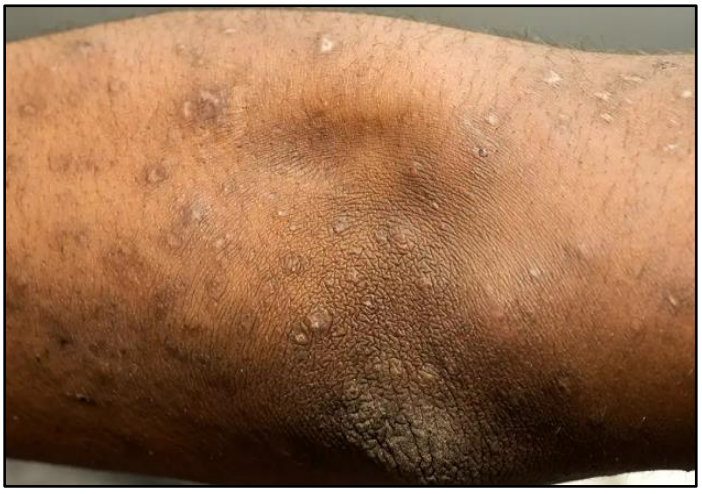


Eczema on Fitzpatrick skin type V: white scaly skin with skin thickening and hyperpigmentation. Note the lack of erythema.

Psoriasis:



Fitzpatrick skin type I: scaling with well demarcated erythematous plaques.



Fitzpatrick skin type V: red, scaly patches, papules, and plaques that are itchy.