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REPRESENTING DIFFERENT SHADES: A PREDICTION FOR THE PRESENTATION OF VARIOUS SKIN DISEASES IN DARKER COMPLEXIONS

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REPRESENTING DIFFERENT SHADES: A PREDICTION FOR THE PRESENTATION OF VARIOUS SKIN DISEASES IN DARKER COMPLEXIONS

by

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ABSTRACT

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Medical literature in the area of skin disease largely relies on images of patients with lighter skin tones while containing minimal references to the way disease states of the skin present on patients with more pigmented skin. In fields such as dermatology, where these image references are repeatedly critical for diagnosis, these disparities can hinder proper treatment and/or increase misdiagnosis for patients presenting with darker skin tones. The goal of the following project is to ultimately guide discussion and build awareness of these evident disparities while introducing to medical professionals the possibility of digitally enhancing symptoms as a means to broaden the number of images depicting skin disease in darker skin. The project took images of various skin diseases as they present in lighter skin tones and utilized Adobe Photoshop software to adjust for factors such as saturation, hue, vibrance, etc. to make predictions for how these disease

states would present in individuals of color. Results show digital manipulation of selected skin diseases provided a unique possibility for modeling skin disease and could provide great advantages to medical professionals notwithstanding its limitations.

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CHAPTER 1

INTRODUCTION

Medical images have played a pivotal role in the field of medicine since the advent of photography. In the specialty of dermatology, which is largely visual based, these clinical images have even heightened importance. Clinicians not only utilize these images to guide their diagnosis but depend on them as an educational tool in their continued training and the teaching of medical students. The presentation of the skin conditions which these clinicians are tasked with treating can vary depending on our individual skin tones, a factor of the amount of melanin found in our skin. Melanin is the pigment responsible for giving color to our skin and is produced from cells called melanocytes, located within the outermost layer of our skin known as the epidermis. The amount of melanin an individual carries influences many factors of skin disease, namely, the way the disease will present on our bodies. Lyme disease, an infectious disease caused by a tick bite, provides a visual understanding of the significant differences with which a rash may present contingent on skin tone. The characteristic 'bulls-eye' patterned rash resulting from Lyme disease is simple to identify in patients of lighter skin tones due to its striking red color and shape as seen in the image to the left in Figure 1.1 (CDC). However, in patients of darker skin tones this same rash is much harder to detect as seen in the image to right in Figure 1.1 (Brown Skin Matters).

Figure 1.1: Presentation of Lyme Disease

Illnesses such as Lyme disease, highlight the importance for including clinical presentations of skin conditions for a variety of skin tones. Unfortunately, medical literature contains limited images depicting disease for people of color (Ebede & Papier, 2006). These facts raise concerns for medical professionals who are expected to use those same images and literature to properly diagnose skin conditions on darker skinned patients. Such disparities in representation within the literature can lead to a lack of proper treatment and/or misdiagnosis for many patients. In addition to highlighting these evident disparities in the literature, our research hoped to explore and expose medical professionals to the possibilities of digitally manipulating symptoms to predict their presentation on darker skin tones. These digital models serve to aid in the endeavor of broadening the number of images available to physicians and medical students from which skin conditions in colored populations can be studied. Images of various skin diseases, as they present in lighter skin tones, were manipulated using adobe digital software, the results and discussion of these manipulations are included here.

CHAPTER 2

LITERATURE REVIEW

Research regarding the representation for patients of color within educational medical literature has been well documented, concluding resources to be limited (Ebede & Papier, 2006). More recent studies have shown identical findings, one such study concluding that less than 5% of images represented dark skin tones after investigating 4 medical textbooks assigned at top medical schools (Louie & Wilkes, 2018). The latest publication in the Journal of the American Academy of Dermatology, aimed at updating any changes in the medical literature and concluded representation of skin disease in dark skin to have not changed compared to prior years, with only one textbook noted as having greater than 1% increase in presentations of dark skin (Lipoff et al., 2021). That same study also noted syphilis as being the only condition which presented consistently across textbooks for all skin tones, possibly alluding to a bias for the diseases that colored populations are chosen to represent and/or overrepresentation of dark skin types in material involving sexually transmitted diseases. The research thus concludes that these disparities still exist despite the well-documented rapid growth of minority populations that will occur in the United States over the following decades (Colby & Ortman, 2014). These factors greatly increase the importance of broadening the literature to be more representative of the country's population. Several groups have arisen in response to these disparities in representation, with the goal of contributing images that highlight how various skin conditions present in darker skin. The St. Georges University of London recently

published a clinical handbook titled ‘Mind The Gap,’ co-authored by a senior medical student who recognized the gaps in medical literature that existed for colored patients in his own medical school education (Mukwende et al., 2020). The handbook serves to both guide clinicians tasked with treating patients of darker skin tones and advocate for the incorporation of such materials into medical curriculum. In addition, several online pages have been formed to serve as platforms on which medical professionals and patients themselves are able to contribute images of lesser represented conditions of the skin in colored populations (Black & Brown Skin; Brown Skin Matters). Until the medical school literature is broadened to become more representative of patient demographics, physicians have utilized these online sources in addition to texts that focus specifically on clinical presentations for patients of color (*Dermatology for Skin of Color, 2nd edition*).

CHAPTER 3

METHODOLOGY

Images depicting various skin diseases as they present in lighter skin tones were accumulated in preparation for edits. Each image was then inserted into Adobe Photoshop 2021 for digital manipulation in the categories detailed below by following manuals and guides (*Adobe Photoshop User Guide: Image adjustments, 2020)*.

3.1 Manipulation of Luminosity

Once in Photoshop, copies of the skin layer were made in order for digital manipulations to only affect selected areas such that backgrounds were not altered. A black and white adjustment layer was then added. Within the adjustment layer, luminosity blending mode was utilized to darken skin by adjusting sliders such that reds and yellows were darkened from initial settings.

3.2 Hue, Saturation, Lightness

Copies of the skin layer were again made to not alter background and an additional adjustment layer, Hue/Saturation adjustment layer, was added. Within the adjustment layer the option to colorize was first selected which converted the image to a red hue. Hue was then manipulated by rotating the color wheel in a counterclockwise rotation from the original color of the pixel landing the slider in the red-orange-yellow range. Saturation was increased from the original saturation level utilizing sliders. Lightness was then decreased from its original level in order to increase the percentage of black in the color.

Once proper adjustments in hue, saturation, and lightness were made, a brush tool was used to add color. Brush was set to soft round at 50% opacity and air-brush style effect was enabled. Color was added to the image in the proper areas to create a darker skin tone with adjustments to opacity and brush size made as needed.

3.3 Curves

An additional Curves adjustment layer was added to images which allowed for manipulation of the image's tonal range. Tonality of the image, which was initially depicted as a straight diagonal line on a graph was lowered at each point to affect highlight and shadow. Points were lowered along the upper portion of the graph resulting in darkening of highlights in the image. Additionally, points were lowered in the bottom portion of the graph resulting in the darkening of shadows.

CHAPTER 4

RESULTS

Figure 4.1: Molluscum Contagiosum Digital Manipulation Result

Molluscum contagiosum is a skin disease of viral origin, resulting from the family of viruses known as the poxvirus. Patients present with small pink like lesions which can be found anywhere on the body. Lesions may be raised, or flat with pitted centers. These lesions can be significantly harder to recognize in patients with darker skin tones as shown in Figure 4.1.

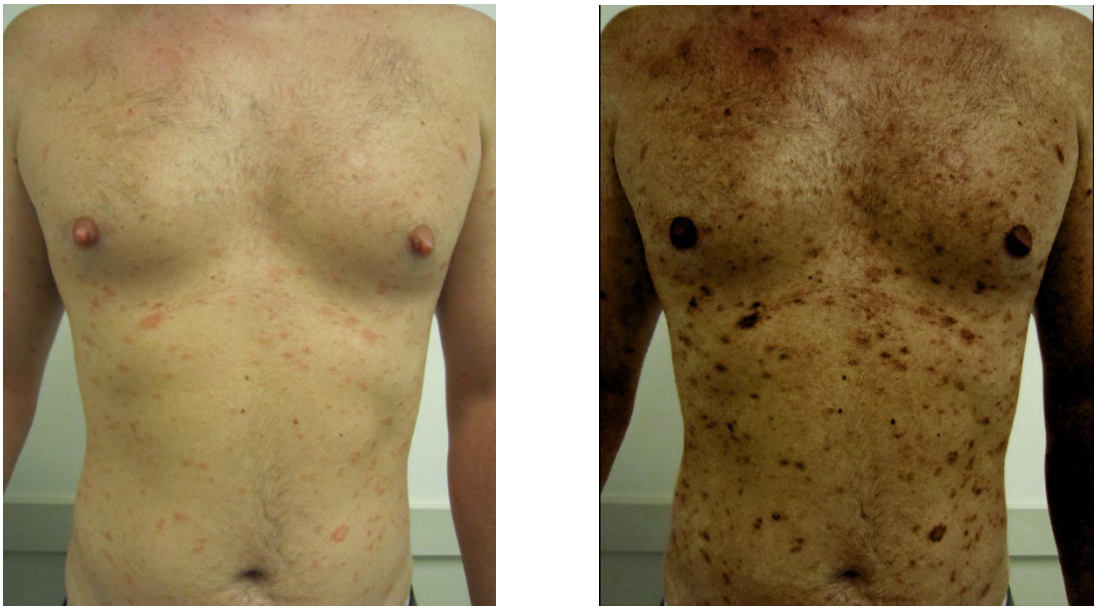

Figure 4.2: Pityriasis Rosea Digital Manipulation Result

The origin of Pityriasis rosea is largely unknown but thought to be viral. Pityriasis rosea typically begins as a large circular spot on the torso or back. Smaller spots then follow that can branch out and span a larger area. This rash can cause itching that could become severe. The rash often appears as pink or red in those individuals with lighter skin tones as show in the left image of Figure 4.2 (Blum et al., 2019). The same rash can present as a variety of colors in those individuals with darker skin as shown in the right image of Figure 4.2.

Figure 4.3: Necrobiosis Lipoidica Diabeticorum (NLD) Digital Manipulation Result

The rash resulting from NLD typically is found in the lower legs and presents as raised, reddish-yellow patches as shown in the left image of Figure 4.3 (Salazar et al., 2020). NLD is shown to be prevalent in women and those with any personal or family history of diabetes. These patches may not present as red or have slightly darker outer edges in patients of darker skin as shown in the right image of Figure 4.3.

CHAPTER 5

DISCUSSION

The use of digital software such as Adobe Photoshop provides a unique possibility for modeling skin disease in those individuals with darker skin tones, given the evident disparities within current educational literature. Digital manipulations of color have proven to be able to produce skin tones on which skin disease presentations can be modeled and studied. These methods have the capability of providing medical professionals with great advantages in the areas of dermatology and beyond. Where possible, the comparison of our manipulations with actual clinical presentations of the selected skin diseases show that the products of our edits due resemble actual presentations. Despite these results, digital manipulations do have limitations. An example limitation arises in select skin conditions which result in the development of necrotic tissue, presumably resulting in loss of the epidermal layer which carries melanocytes. In these skin conditions, necrotic areas could show constancy in presentation across all skin types due to melanin no longer serving as a factor. Digital manipulations may therefore not consistently be able to account for such variables. Furthermore, in the creation of our digital models and referencing of available images in medical literature, an additional limitation was observed in the fact that skin conditions can show significant differences even within individuals of comparatively similar skin tones. These observations could possibly be explained by secondary factors which affect the skin such as exposure to sun, smoking or air pollution (Vierkötter & Krutmann, 2012). Limitations such as these lead to the conclusion that although digital

manipulations produced consistent models; digital software should not be expected to encompass all possible clinical presentations.

The ultimate solution to bettering the representation of colored patients in medical literature lies in the continued contributions of images that depict how these skin conditions present in those with darker skin tones. Although contributions from physicians from across the world will broaden our medical literature, contributions from patients themselves that live with these illnesses are equally as important given many individuals do not seek or have access to care (Riley, 2012). Platforms such as Black & Brown Skin and the social media page Brown Skin Matters currently exist in serving to create a space in which these images can be compiled. These platforms and the organizations that have created them are in need of increased awareness in order for the contribution of high-quality images of dark skin to expand. Future medical school textbooks should include the side-by-side comparisons of clinical presentations in patients of varying skin tones and other additions aimed at diversifying curriculum in order to ensure physicians are trained to serve the needs of a diverse patient population. It is in these steps that we hope to see the diversification of medical curriculum and literature.

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BIOGRAPHICAL INFORMATION

William Teddy began his undergraduate degree at the University of Texas at Arlington in 2017 and will be graduating with an Honors Bachelor of Biology and minor in Biochemistry. This research project was a continuation of his research regarding the differences with which skin diseases present in individuals of differing skin tones, a research he began when contracting his human anatomy course for honors credit. With the aid of his faculty mentor, Dr. Wilk, William extended his research to cover the possibility of digitally manipulating symptoms of skin disease. After graduation, he will take part in biomedical research as a participant in the UNT Health Science Center SMART program. William is pursuing a future career in medicine and will therefore be seeking acceptance into medical school following graduation.