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# The relationship between skin color and keloid

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## ABSTRACT

**Introduction:** Keloid is a fibroproliferative tumor with excessive growth caused by an abnormality in the wound healing process. Several factors are contributing to the development of keloid, such as genetics, local and systemic factors. Keloid can happen in any skin color, but more common in darker skin colors related to melanocytes, melanin, or α-MSH. Color bar tool is an objective and economical tool used to determine each skin color. This study aimed to evaluate the relationship between skin color and keloid.
**Methods:** This is an analytic observational study with a cross-sectional method that includes 44 keloid subjects and 44 controls according to inclusion and exclusion criteria. Sex, age, education, job, family history were documented. Diagnosis of keloid was made by history taking and clinical examination. The skin color is measured with the color bar tool. Kruskal Wallis test was used to determine the relationship between skin color and keloid. The result was significant, with a p-value <0.05.
**Results:** Keloids were found primarily in females (58.8%), 18-25 years old age group (40.9%), and unemployed (40.9%). The majority of the subjects have high education (47.7%) and no family history of keloid (63.6%). The most common location was the sternum (18.9%), followed by the abdominal (15.0%). This study found that the most documented skin color was color bar 2 (54.5%), followed by color bar 3 (29.5%). We found that there was a significant relationship between skin color and keloid (p=0.026).
**Conclusion:** There was a relationship between skin color and keloid.

**Keywords:** Color bar tool, keloid, melanin, skin color.
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## INTRODUCTION

Keloid is a fibroproliferative tumor with excessive overgrowth caused by an abnormality in the wound healing process.[1] According to epidemiology, keloid happens at the peak of 10-30 years old and 15-20% in African, Hispanic, and Asian.[2,3] This scar is closely associated with pain, hyperesthesia, pruritus, functional and cosmetic disorders, and physiological stress that can interfere with the patient's quality of life.[2] Several factors such as genetics, systemic and local factors are associated with keloid.[4] Those factors can cause persistent inflammation in the wound and pathological scar and lead to chronic fibroblast activity and disorder in pathological scar maturation.[5,6]

Skin color such as black, brown, and white is associated with several components, which consist of melanin (yellow-orange), oxidized hemoglobin (red), deoxyhemoglobin (purple-blue), bilirubin (yellow), and carotenoid (yellow). The combination of those chromophores causes a difference in absorption and light reflection, as the final result is a different type of skin color. Melanin is one of the essential pigments in differentiating variation of skin color among races worldwide.[7,8]

Keloid occurs mainly in African, Hispanic, and East Asian descendants associated with melanocyte, melanin content, or α-melanocyte stimulating hormone (α-MSH).[9] When trauma occurs, the damage in the epidermis layer causes a change in the microenvironment of local skin, induces melanocytes proliferation and melanin production. This cell then migrated to the wound location because of the influence of several cytokines. In this process, fibroblasts interact with melanocytes that migrate from the basal membrane to the edge of the wound and begin proliferation as they have a role in the development of pathological scar.[10]

Color bar tool is an objective, economic and simple tool used to determine skin color. To determine an individual's skin color, select the most closely matched skin tone of the inner part in the upper arm.[11] The study showing the relationship between skin color and keloid is sparse. So that, this study aimed to evaluate the relationship between skin color and keloid.

## METHODS

### Study Design

This study was an analytic observational study with a cross-sectional design consist of 44 keloid subjects and 44 controls with age ≥ 18 years old that came to the outpatient clinic of Dermatology and Venerology in Universitas Sumatera Utara Hospital. The research was conducted from November 2020 to January 2021.

### Data Collection

Each subject had signed the informed consent. The exclusion criteria were subjects with tattoos, psoriasis, or burn scars covering the brachii anterior dextra and sinistra. Subjects with vitiligo and albino were excluded as well. History taking and clinical examination were conducted, and a color bar tool was used to determine skin color.

**Table 1. Demographic characteristics of keloid subjects**

| Characteristics | Keloid | |
|---|---|---|
| | Total (n) | Percentage (%) |
| Gender | | |
| Male | 19 | 43.2 |
| Female | 25 | 56.8 |
| Age (years old) | | |
| 18 – 25 | 18 | 40.9 |
| 26 – 35 | 13 | 29.5 |
| 36 – 45 | 8 | 18.2 |
| 46 – 55 | 3 | 6.8 |
| 56 – 65 | 2 | 4.5 |
| Education | | |
| Primary Education | 6 | 13.6 |
| Secondary Education | 17 | 38.6 |
| Tertiary Education | 21 | 47.7 |
| Occupation | | |
| Professional | 10 | 22.7 |
| Technician and professional assistant | 1 | 2.3 |
| Administration | 3 | 6.8 |
| Entrepreneur | 9 | 20.5 |
| Handcrafter | 1 | 2.3 |
| Manual labor | 2 | 4.5 |
| Unemployment | 18 | 40.9 |
| Family history of keloid | | |
| Father | 2 | 4.5 |
| Mother | 8 | 18.2 |
| Sibling | 6 | 13.6 |
| None | 28 | 63.6 |

**Table 2. Distribution of keloid locations**

| Keloid Locations | Total (n) | Percentage (%) |
|---|---|---|
| Auricularis | 2 | 3.8 |
| Facialis | 1 | 1.9 |
| Brachii | 6 | 11.3 |
| Antebrachii | 7 | 13.2 |
| Dorsum manus | 1 | 1.9 |
| Scapularis | 4 | 7.5 |
| Deltoid | 3 | 5.7 |
| Sternum | 10 | 18.9 |
| Mammae | 1 | 1.9 |
| Abdominal | 8 | 15.0 |
| Femoralis | 3 | 5.7 |
| Genu | 1 | 1.9 |
| Cruris | 2 | 3.8 |
| Dorsalis pedis | 4 | 7.5 |
| Total | 53 | 100 |

### Data Analysis

The results were analyzed in descriptive analysis and Kruskal Wallis test to determine the relationship between skin color and keloid, with $p<0.05$ was considered significant.

## RESULTS

In this study, the demographic characteristics of keloid subjects were highest in female (58.8%), age of 18-25 years old (40.9%), tertiary education (47.7%), and unemployed (47.7%). Most of the subjects (63.6%) did not have a family history of keloid. The demographic characteristics of the subjects were shown in Table 1. From 44 subjects with keloid, we found 53 keloids distributed in several predilections, and most were found in the sternum (18.9%) and abdominal (15.0%) (Table 2).

In the keloid group, we found that the majority skin color was color bar 2 (54.5%) followed by color bar 3 (29.5%), as shown in Table 3 and Table 4. In the control group, the highest skin color was color bar 2 (75.0%) and followed by color bar 3 (13.6%). In this study, color bar 5 and color bar 6 were not found. Brighter skin color was found in the control group, and darker skin color was shown in the keloid group. Because of these differences in the proportion of skin color, we then analyzed them with the Kruskal Wallis test and found that there was a significant relationship between skin color dan keloid ($p=0.026$).

## DISCUSSION

Keloid is a benign pathological scar that grows beyond the wound margin.[1,2] This scar is closely associated with pain, hyperesthesia, pruritus, cosmetic and functional disorders, as well as psychological stress that can dramatically influence a patient's quality of life.[2] The incidence of keloid was equal in males and females, but most of the keloid patients who came to seek treatments were females due to cosmetic concerns compared to males.[12–14] In this study, we found that keloid occurred in females (56.8%). This study result was relevant with Noishiki et al., shown from 1290 keloid patients who came to the polyclinic; most were female

**Table 3. Distribution of skin color in keloid subjects**

| Skin color | Total (n) | Percentage (%) |
|---|---|---|
| Color bar 1 | 1 | 2.3 |
| Color bar 2 | 24 | 54.5 |
| Color bar 3 | 13 | 29.5 |
| Color bar 4 | 6 | 13.6 |
| Color bar 5 | 0 | 0 |
| Color bar 6 | 0 | 0 |
| Total | 44 | 100 |

**Table 4. Relationship between skin color and keloid**

| Skin color | Keloid n (%) | Control n (%) | P-value |
|---|---|---|---|
| Color bar 1 | 1(2.3) | 2(4.5) | |
| Color bar 2 | 24(54.5) | 33(75.0) | |
| Color bar 3 | 13(29.5) | 6(13.6) | 0.026 |
| Color bar 4 | 6(13.6) | 3(6.8) | |
| Color bar 5 | 0(0) | 0(0) | |
| Color bar 6 | 0(0) | 0(0) | |
| Total | 44(100) | 44(100) | |

n = number of samples; % = percentage

(68.8%).[12] Study by Putra and Jusuf also shown that keloid subjects were primarily females.[15]

Table 1 showed that keloid was found highest in 18-25 years old age group,18 subjects (40.9%), and followed by 26-35 years old age group about 13 subjects (29.5%). This study is consistent with the study by Andisi et al., who found that most of the keloid cases were found in 15-24 years old age group, 34 people (36.56%), followed by 25-44 years old age group, 33 people (35.48%).[16] Lu et al. in their study also found that the peak of keloid happens in 10-30 years old in both male and females.[17] Although keloid can occur at any age, the highest incidences were found in the second and third decades of life.[2,3] This can happen because both skin tension and trauma frequencies were higher in younger individuals than the old individuals.

There is an association between education and health, such as (1) reverse causality, bad health can cause lower education level, (2) education generally increases health. Evidence showed that a person with higher education was most likely to seek preventive treatment because of access to healthcare.[18] In line with this study that found most of the subjects that came to the polyclinic were those with tertiary education levels (47.7%). The majority occupation of this study subjects was unemployment. This study was in line with Damanik et al. found that most keloid subjects were unemployed (60%).[19] Study by Putra and Jusuf showed that keloid patients who came to the polyclinic were unemployed.[15] This study showed that occupation was not entirely associated with keloid.

Based on Table 1, we found that from 44 subjects with keloid, 63.6% did not have a family history of keloid. This study is consistent with Lu et al., 516 (72.2%) of 715 keloid subjects had no family history of keloid.[17] However, a study by Narayana et al. showed different results as 54.55% of the keloid subjects had a family history of keloid.[20] Family history of keloid supports that genetics play a role in the development of keloid and was proved by autosomal dominant inheritance in keloid, related locus (chromosome 2q23 and 7p11), and several HLA alleles (HLA-DRB1*15, HLA-DQA1*0104, DQ-B1*0501 and DQB1*0503), and dysregulation of 25 genes in the main pathway that associated to the development of keloid including apoptosis, mitogen-activated protein kinase, TGF-ß, IL-6, and plasminogen activator inhibitor-1.[21]

In this study, from 44 subjects with keloids, we found 53 keloids distributed in several locations. The most found location of keloid was sternum (18.9%) followed by abdominal (15.0%). This result is consistent with a study by Rachmantyo et al., which found that the most common keloid locations were the chest region (23.1%) and arms (23.1%).[22] In the study conducted by Ogawa et al., from 483 keloid subjects with 1500 keloid lesions, they found that keloid was more prone in the anterior chest region (48.9%), scapular region (26.9%), and chin or neck region (12.1%).[25] One of several local factors that play a role in the development and progression of keloid is mechanical force, such as skin tension induced by stretching.[5] This fact was proven by evidence that shown strong predisposition of keloid was found in the area with strong tension and repetitive actions of the skin, particularly in the anterior chest, shoulder, deltoid, chin, and ear. On the contrary, keloid was hardly found in the rarely stretched area, such as scalp and tibia anterior.[23]

Fitzpatrick's Skin Type (FST) has limited relevance and reliability for an individual with colored skin because several ethnicities or races were clusters in one category of Fitzpatrick. Therefore, Ho et al. developed the color bar tool to determine skin color. In their study, the mean index of melanin had a linear correlation with color bar, skin tone description, and skin color category, according to Fitzpatrick.[11] Based on table 4, it is shown that in the keloid subjects group, the proportion of skin color was dominated by color bar 2 (54.5) and followed by color bar 3 (29.5%). In the control group, we found that color bar 2 and color bar 3 were the majority. In the non-keloid group, we found that the skin color is lighter compared to the keloid group. Because of differences in each group proportion, the result was then analyzed by the Kruskal Wallis test and showed a significant relationship between skin color and keloid ($p = 0.026$).

A higher incidence of keloid was found in darker skin color about 10-15 times more frequent than in white skin and scarcely in albino. This proof was associated with melanocyte, melanin content, or α-MSH.[9,10] Melanin is the pigment in the skin. Darker skin had more melanin content because of the increasing activity of enzymes and the production of melanin. A study by Luo

et al. reported that keloid, especially in keloid fibroblast, showed a decrease in expression of melanocortin-1 receptor (MC1R). The decrease in this expression leads to decreased suppression mediated by α-MSH in collagen synthesis and myofibroblast formation, leading to keloid development.[24] Taylor et al. also found that α-MSH produced by skin melanocytes can increase the secretion of TGF-β and inhibit the production of interferon (IFN)-g by activating T-cell, which then stimulates the multiplication of fibroblasts.[25]

## CONCLUSION

There was a relationship between skin color and keloid. Also, further research with different study designs and larger samples need to be done to identify the relationship between skin color and keloids in a wider scope.

## DISCLOSURE

### Author Contribution

All authors have contributed to this research process, including preparation, data gathering, analysis, drafting, and approval to publish this manuscript.


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The authors are responsible for all of the study funding without a grant or any external funding source.


### Conflict of Interest

The authors declare no conflict of interest regarding the publication of this article.

### Ethical Consideration

This research was approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Sumatera Utara, and Universitas Sumatera Utara Hospital Medan. Letter of exemption Ref. No. 537/KEP/USU/2020.


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