Digital Photographic RGB Scores used for the Evaluation of Skin Color

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ABSTRACT

Background: *The photograph is one method that has been used for the evaluation of skin color. The numeric values extracted from the photographs could be of value for statistical assessment.*

Objective: *To assess the correlation between skin color evaluation using a narrowband reflectance spectrophotometer (Mexameter MX18) and digital photographic RGB scores.*

Methods: *The participants were evaluated for skin color by a narrowband reflectance spectrophotometer (Mexameter MX18) and had taken the photographs for RGB scores assessment from the photography computer program (Adobe® Photoshop CS2 version 9). Skin color was measured on four different anatomical skin sites of each participant. These sites were on the medial aspect of the volar and the dorsal regions of both forearms.*

Statistical analysis used: *Pearson correlation*

Results: *A total of 208 records from 52 participants were established. The average of R, G, B and sum of the RGB scores from photographs were 162.4±11.9, 147.5±17.6, 135.4±24.8 and 445.3±51.9 respectively. The correlation coefficient of the digital photographic RGB scores and each index; M, E and M plus E indices were at -0.85, -0.81 and -0.85 respectively with a statistical significance of $P < 0.001$.*

Conclusions: *Skin color evaluation using a narrowband reflectance spectrophotometer has shown an inverse correlation with a digital photographic RGB scores.*

Key Words: *Digital photographic RGB scores, mexameter MX18, narrowband reflectance spectrophotometer*

Key Messages: What was known? *Photographs can have a role in skin color evaluation. Nevertheless, the photograph is a subjective assessment.*

INTRODUCTION

Skin color evaluation is a key for assessing the therapeutic efficacy when treating skin problems. So far, many objective and subjective tools were developed for evaluating the skin color. However, visual assessment remains one of the gold standards.[1] Several objective tools express the skin color in numeric values for statistical analysis. So far, two types of skin reflectance spectrophotometers have been used to determine skin color: a tristimulus reflectance colorimeter such as the Minolta Chromameter (using the Commission International d'Eclairage (CIE) lab system) and a narrow band reflectance spectrophotometers such as the Mexameter (using erythematic and melanin indices).[1] Of these, the role of the photograph is not only for visual assessment but also increases its value by analyzing it in numeric values. Many clinical studies have used the color analysis from the photographs for clinical assessment. Some of these uses are the color of dentition, scars and port-wine stains.[2-4]

Basically, there are many color models used in a color system. These are such as the CIELAB (***L*, a*, b****), RGB and CMYK color models. Theoretically, the RGB color model uses three main colors; red, green and blue. The different colors are composed of the three main colors. Photography computer programs such Adobe® Photoshop can analyze the colors of the photograph in numeric values. The encoding of numeric values in the RGB color model is 0-255 for each color. The white color's numeric value is encoded as R=255, G=255 and B=255. The black color is encoded in the numeric values of R=0, G=0 and B=0. Therefore, the summation of the R, G and B scores demonstrate the level of each color's differences and has been used for statistical analysis.

The purpose of this study is to assess a correlation between the skin colors' evaluation by using digital photographic RGB scores with the narrowband reflectance spectrophotometer (Mexameter MX18).

SUBJECTS AND METHODS

Participants: Fifty two volunteers, working at Her Royal Highness (HRH) Princess Maha Chakri Sirindhorn Medical Center, were enrolled in this study. All participants who had tattoos, any known skin diseases, or pigment skin disorders in the evaluated areas were excluded. The ages, gender and Fitzpatrick skin photo types of each participant were recorded. This study was reviewed and approved by the appropriate institutional review boards and ethics committee of the HRH Princess Maha Chakri Sirindhorn Medical Center. Informed consent was provided and obtained from all participants prior to engaging in this study.

Skin Color Assessment: The narrowband reflectance spectrophotometer (Mexameter MX18) readings and the RGB scores from digital photographs were used for skin color evaluation. The skin color of each participant was measured by a well-trained investigator on four anatomical areas of skin. These areas were at the midpoint between the elbow and the wrist on the medial aspect of the volar regions and the medial aspect of the dorsal regions of both forearms (Fig. 1).

The Mexameter MX18 (Courage & Khazaka Electronic, Cologne, Germany) has been used to assess the skin color based on the content of melanin and hemoglobin in the skin, which is expressed as Erythema (E) and Melanin (M) indices. This instrument uses the absorption and reflection principles from light emission (green; 568 nm, red; 660 nm, infrared; 880 nm) and a receiver to measure the light reflected from the skin. Regarding the measurement of melanin, the wavelengths of 660 nm and 880 nm were used. The erythematic index is measured by two different wavelengths: 568 nm and 660 nm. The results of a measurement of the E and M indices range from 0 to 999 (0 corresponds to white skin, 999 corresponds to black skin). The values of M, E, and M plus E indices from the Mexameter MX18 were used for analysis. The measurement of the skin color with the Mexameter MX18 was taken by the same trained dermatologist under similar controlled conditions, probe pressure, and shielded against the ambient light. The average indices taken from the Mexameter MX18 were carried out with four repeated measurements on the indicated reference points.

The second tool used to assess the skin color was photographs obtained from a high-resolution camera (4288x2828 pixels, JPEG digital photographic images). The camera used was the Nikon D90 with Nikko 50mm 1:1.8D. The photographs were taken without the use of a flash under control protocols. These protocols were set so the photographs were done in a room with 6, 36 Watt fluorescent light bulbs without any interference from outdoor sunlight for a period of 20-30 minutes. The distance between the objects and camera was set at 120 cm. The camera was shot in a manual mode. The setting of the camera's speed shutter, aperture and white balance adjustment was balanced with a gray card. This calibrated setting was used for all participants for the study. Each photograph was processed in the Samsung N148 plus (10.1" RGB monitor, Intel Atom N 450 1.66GHz) with Adobe® Photoshop CS2 version 9 (Adobe systems, Inc, San Jose, CA, USA). In the Adobe® Photoshop program, the eyedropper tool (the icon in the Toolbar) was used for sample a color from a photograph and analyze skin color to the R, G and B scores (encoding of numeric values for the R, G and B were 0-255 for each color, Fig. 1). The average values were carried out with four repeated measurements on the indicated reference points**.**

A different trained investigator also classified the skin phototypes of all participants using the Fitzpatrick skin phototype criteria (skin phototype I: pale white skin, blue/hazel eyes, blond/red hair, always burns, does not tan; skin phototype II: fair skin, blue eyes, burn easily, tans poorly; skin phototype III: darker white skin, tans after initial burn; skin phototype IV: light brown skin, burns minimally, tans easily; skin phototype V: brown skin, rarely burns, tans darker easily; skin phototype VI: dark brown or black, never burns, always tans).[5] The method to evaluate the skin color was determined by the control protocols.

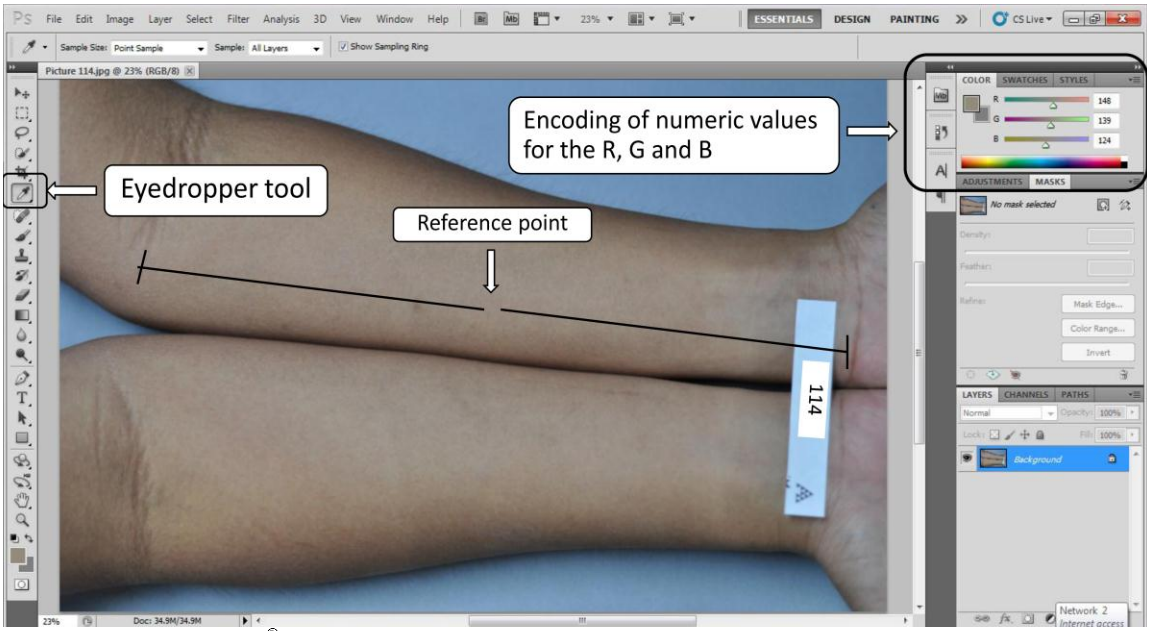

Fig. 1: Screenshot of Adobe® Photoshop show the eyedropper tool, the reference point and the numeric values for the R, G and B

Statistical Analysis

All data were analyzed with SPSS version 11.5. The correlation between the two methods was analyzed with Pearson's Rank and was considered statistically significant at the value of $P < 0.05$.

RESULTS

Fifty two participants were enrolled in the study and a total of 208 records were established. The average age was at 23.7±5.7 years. Most of the participants were female (51.9%). Skin photo types of the participants, using the Fitzpatrick skin photo type criteria, was III (71.2%), IV (23.1%), and V (5.8%). The mean M, E, and M plus E indices were at 230.4±74.4, 268.5±73.2 and 498.9±143.9 respectively. The average scores of R, G, B and sum of RGB scores from photographs were 162.4 ± 11.9, 147.5 ± 17.6, 135.4 ± 24.8 and 445.3 ± 51.9, respectively.

The evaluation of the skin color using the digital photographic RGB scores was inversely correlated with the results of the testing that was done with the Mexameter, MX18. The correlation coefficient of the digital, photographic RGB scores and each index (M, E and M plus E indices) were -0.85, -0.81 and -0.85 respectively with a statistical significance of $P<0.001$ (Table 1). The increment of the digital photographic RGB scores inversely correlated with a subsequent decrease in each mean index (mean M, mean E, and mean M plus E indices).

The relationships of the Fitzpatrick skin photo type, the digital photographic RGB scores and the mean indices from the Mexameter MX18 are shown in Table 2. The skin photo types had been measured for III, IV and V had M plus E indices at 431.5 ± 85.1, 635.0 ± 109.4 and 784.9 ± 103.9, respectively. Contrarily, the skin photo types for types III, IV and V had the RGB scores as 466.7 ± 37.3, 399.1 ±44.0 and 366.5 ± 41.9 respectively.

Table 1: Correlation analysis (R, *P*) for skin color evaluation by the photographic RGB scores and the Mexameter MX18

Mexameter MX18 measurements	Mean ± SD	Correlation between two methods	
		Correlation coefficient (R)	*P* value
M plus E indices	498.9 ± 143.9	-0.85	<0.001
M indices	230.4 ± 74.4	-0.85	<0.001
E indices	268.5 ± 73.2	-0.81	<0.001

Table 2: The relation of the Fitzpatrick skin photo types, the photographic RGB scores and the Mexameter MX18

Fitzpatrick skin phototypes	III	IV	V
M plus E indices (mean ± sd)	431.5 ± 85.1	635.0 ± 109.4	784.9 ± 103.9
M indices (mean ± sd)	193.9 ± 38.6	303.7 ±55.2	386.4 ± 57.4
E indices (mean ± sd)	237.5 ± 51.3	331.3 ± 58.6	398.6 ± 47.7
R score	166.5 ± 9.9	152.9 ± 10.2	149.8 ± 11.3
G score	154.7 ± 12.3	132.1 ± 15.2	119.4 ± 16.7
B score	145.4 ± 17.3	114.4 ± 17.3	97.3 ± 22.5
Sum RGB score	466.7 ± 37.3	399.1 ± 44.0	366.5 ± 41.9

DISCUSSION

Digital photographs have been used in many medical aspects. The analysis from digital images has established yields for many purposes.[2-4] Although, digital photographs are a common tool that has been used in the assessment of skin diseases and the outcomes of treatments; its subjective method is difficult for use in statistical comparisons. This study shows the inverse correlation of skin color when evaluated by a narrow band reflectance spectrophotometer and with the use of digital photographic RGB scores. Similarly, the increments of the skin phototype classification numbers scored values inverse to the digital photographic RGB scores. The numeric values from the digital photographs are better compared following pigmentation treatments. The digital photographs offer an opportunity for skin color analysis when a sophisticated method, such as a narrowband reflectance spectrophotometer, is not available.

Regarding the assessments of skin color, there has not been a 'best tool' established to measure pigmentation. Each method has both, advantages and disadvantages that make them suitable for certain situations and unsuitable for others.[6] The visual assessment is still considered to be the gold standard for the evaluation of skin color.[1] The results from this study confirm that the digital photographic RGB scores may be used for application in clinical practice; especially when used meticulously by trained evaluators. Taking the photograph under controlled confounding factors could reduce the error of the diagnoses that relates to skin pigmentation. Sommers, M et al. have demonstrated the reliability of the assessment of data from digital image color analysis between expert and novice analysts.[7] Both methods have achieved high levels of agreement.

There are many color models that have been used in color systems such as CIELAB (***L*, a*, b****), RGB and CMYK color models. The CIELAB color system has been used for many purposes in medical research.[3,4]

CIELAB indicates that these values contain three axes: L* (light and dark), a* (red and green), and b* (blue and yellow). The L* axis represents lightness (ranging from 0; black to 100; white). On each color axis, the values run from positive to negative; a* (red is positive and green is negative) and b* (yellow is positive and blue is negative). For both axes, neutral gray is a value of zero. The differences in the colors are described in different values. Thus, the CIELAB color system is used for printing industries. Regarding the differences of the RGB color system, there were positive values in each color. The values in the RGB color model ranges from 0 to 255 for each color. The sum of the RGB scores; taken from digital photographic analysis; was found to be more practical in comparing the differences of each skin color. However, a trained evaluator is the important factor that is responsible for improving the validity and reducing the errors for this method.

LIMITATIONS

The other objective instrument such as chromameter was not included in this study because of the low-resources setting. Additional future studies are recommended for assess a correlation and intra class correlation should be analysis.

CONCLUSIONS

Skin color evaluation using a narrowband reflectance spectrophotometer has shown an inverse correlation with digital photographic RGB scores which possibility for skin color analysis in a limited resource setting.

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WHAT IS NEW?

The digital photograph offers the opportunity for skin color analysis when more sophisticated methods are not available.

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