Skin color

Could it be a new fingerprint?

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ABSTRACT

الأهداف: إثبات اختلاف الألوان بين التوائم المتشابهة وبين عامة الناس.

الطريقة: أجريت دراسة مقطعية وصفية في ولاية الخرطوم بالسودان خلال الفترة من يناير إلى يونيو 2010م في كلية الطب، جامعة الرباط الوطنية، الخرطوم، السودان. شملت الدراسة 139 شخصاً، 41 توأماً متشابهاً من السودان (82 شخصاً) و50 شخصاً من عامة الناس و7 من الصين، وسليمين جميعاً من الأمراض الجلدية. قيست درجة لون الجلد باستعمال جهاز قياس درجة اللون (ميديصن). قيس لون الجلد من داخل أعلى اليد. كان الحكم البصري على اختلاف الألوان مباشراً ومن خلال الصور بواسطة 3 أشخاص.

النتائج: وجد أن لون الجلد يختلف بين كل الأشخاص في الدراسة بالنظر والصور وقراءة الجهاز. أظهر لون الجلد كذلك اختلافاً بين مختلف الأجزاء بالجسم (خارطة لون الجلد). كانت درجة اللون في التوأم الأول (4.010±0.5) وفي التوأم الثاني (3.89±0.44) وأوضحت اختلافاً ذا أهمية إحصائية (قيمة الثقة الإحصائية p=0.001). أوضحت درجة الألوان أيضاً اختلافاً ذا أهمية إحصائية بين كل من في العينة من العامة والصينيين (قيمة الثقة الإحصائية p=0.002).

خاتمة: أن لون الجلد مختلف بين التوائم المتشابهة وجميع الناس ويعد وسيلة تعريف جديدة للشخصية تحتاج لمزيد من الدراسات العالمية.

Objectives: To prove that the difference in human skin color can be used as a new fingerprint.

Methods: A cross-sectional descriptive study was conducted in the Faculty of Medicine, The National Ribat University, Khartoum, Sudan between January and June 2010. The study consists of 139 subjects, which includes 41 Sudanese identical twins (82 subjects), 50 subjects from the general population, and 7 Chinese. All subjects were free of skin lesions. Based on reflectance spectrophotometry, the skin color has been read for all subjects from the inner upper arm using the Medisun skin check. Visual judgment on color differences was carried out directly with 3 normal observers, and through digital photos.

Results: Skin color was found to be different in all subjects under the study depending on visual judgment, digital photos, and skin color readings. Differences in skin color were also found between different parts of the body (color map). Color intensity reading in the first twin was 4.010 ± 0.5, and in the second twin was 3.89 ± 0.44 with a significant difference (p=0.001). The general population sample showed significant differences in skin color from each other, and from the Chinese group (p=0.002).

Conclusion: In this study, we found that skin color between identical twins is different, as well as in the whole population, and could be a new personal identification method, which needs further international studies.

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Biometric systems based on human characteristics for personal identification have attracted great attention in the last decade of forensic science.[1] The Holy Qur'anic verse 22 in Surat Alroom ("And among His signs is the creation of heavens and the earth and the variation in your tongues and colors, verify in that are signs for those who know") has drawn the attention

of principal investigator to notice that the skin colors of people around him are different. This observation has been extended to compare the skin color of 300 photos of different populations and 1000 university students visually, and proved that there are no identical colors. This raised the question: could skin color be a new identification method? If this is the case, then proving differences in skin color of identical twins will confirm this hypothesis. Monozygotic twins (identical twins) have nearly identical DNA (unless there has been a mutation during development), and they are almost always the same gender. Physical appearances are very similar but not exactly the same.[2] Different environmental influences throughout their lives affect some genes, which are switched on, or off. This is called epigenetic modification. As twins age, they diverge more and more, and in middle and old age will look more like non-identical twins.[3] Identical twins have the same DNA,[4] however, they have different phenotypes, meaning that the same DNA is expressed in different ways. They do not have identical fingerprints.[5] Voice as a finger print cannot easily identify the correct twin, and the voice pitch could possibly be reliable for identification.[6] However, the iris print is different in genetically identical twins as the iris sequence is phenotypic, instead of genotypic feature.[7,8] Human skin exists in a wide range of different colors and gradations.[9] The classification of skin type known as the Fitzpatrick skin type, or Fitzpatrick phototype scale has been used to determine skin sensitivity to ultraviolet light. This includes 6 types, from pale white (type 1) to dark brown, or black (type V1).[10] In this study, we compared the skin color intensity of different subjects and identical twins using the skin color meter.

Methods. The study design was a cross-sectional descriptive study carried out in the Faculty of Medicine, The National Ribat University, Khartoum, Sudan from January to June 2010. The study participants were from the different cities in Khartoum State (Khartoum, Omdurman , and Khartoum North). All procedure was subjected to ethical approval. Prior to commencement of the study, objectives, steps, and expected outcome of the research were explained to the respondents, and every volunteer has agreed to publish his/her photo, and parents consents were obtained for the children. The study population included identical twins and other individuals, males, and females of different ages. Twins were searched for by personal contact. One hundred and thirty-nine individuals were included, in which 41 were identical twins, 50 were general individuals, and 7 were Chinese. All subjects were apparently free of skin lesion. Equipments used include Medisun skin check apparatus (skin color meter supplied by Schulze & Bohm GmbH Company, Germany), computer, and digital camera. Using Medisun skin check device, skin color was read from different, but specific areas on the skin, and readings were taken to produce a map of skin color differences (**Figure 1**, **Table 1**). Visual judgment on color differences was performed with 3 normal subjects, and photos were obtained for twins, general population, and Chinese. The Medisun skin check apparatus devise is connected to the computer, in which the color reading software program has already been installed. Data sheet appears on the screen after starting the program, and the subject's name, skin characteristics, and any important comment regarding the volunteer are filled, the probe of the device is put on the targeted skin site for color reading, and then the start green button for color reading is clicked. The device determines digitally on the screen the skin color type within few seconds according to the method of Parish (A quantitative method based on reflectance spectrophotometry).[10] Medisun skin check system has 4 light emitting diodes (LEDs), the light emission of the LED will be reflected by the skin, measured, and analyzed by a sensor together with other skin, hair, and eye characteristics (sunburn/tan, hair color, eye color, and freckles). The result is displayed as a value between 1 and 6. To improve reliability, a small line was drawn to demarcate the upper edge of the probe for the second move, the probe was placed in a non-hairy skin, and females should wash their faces out of cosmetics. Technical errors include calibration, which can be affected by cold air and wrong site on the skin, from which the reading is taken. The capacity of the device has limitation, as it cannot read more than 600 values of skin type. The accuracy is adjusted by the company (can only read 2 decimals). As an advantage, the device is quick and easy, testing large groups with minimal costs, and the LED analyzer is being used globally.

Data were collected using the Medisun skin check sheet, photos, visual judgment on skin color. Analysis was performed using the Statistical Package for Social Sciences version 2011 (SPSS Inc, Chicago, IL, USA). Paired test, independent T-test, Spearman correlation was also used. A $p \leq 0.05$ was considered significant.

Results. The total number of subjects was 139, of different ages and gender. The study groups include Sudanese from Khartoum state, their ages range from 6 month-60 years, 41 identical twins were included in the study (19 were females and 22 twins were males), 50 subjects from general population were randomly chosen (26 were females and 24 were males), and 7 male Chinese workers were included as a pilot from a homogeneous population. Measurement of skin color intensity by skin color meter from the inside surface

of the arm has shown significant difference between all twins' skin color. The skin color intensity was 4.01 ± 0.5 in the first set of twins, and 3.89 ± 0.44 in the second set (p=0.001) (**Figure 2**). All the 41 twins have visually different colors, as judged by 3 normal subjects. Photos from the twins (**Figures 3-7**) confirmed the visual differences. General population sample showed significant differences in skin color from each other, and from the Chinese group (p=0.002). Skin color map was carried out for them. The higher intensity of skin color is located in the neck (**Figure 8**). Skin color was different between Sudanese and Chinese, and even different between the Chinese themselves.

Discussion. Over the past decade, with an increasing emphasis on security, and the need for identity verification for normal life activities and in forensic medicine, attention had been offered to the field of

Table 1 - Main areas for measuring skin color intensity by Medisun skin check.

Area	Description
Left upper arm	Inner side immediately above the cubital fossa (reference area in each person), using the crease line as demarcation line
Lower arm	Immediately below the demarcation line of the cubital fossa
Hand	Base of the big finger
Forehead	Above and between the eyebrows
Neck	Anteriorly, immediately above the suprasternal notch
Back	Above the first thoracic vertebra
Chest	At sternal angle
Leg	At lateral malleolus
Hair	Immediately above the ear pinna

Figure 1 - The procedure of skin color reading using Medisun skin check device.

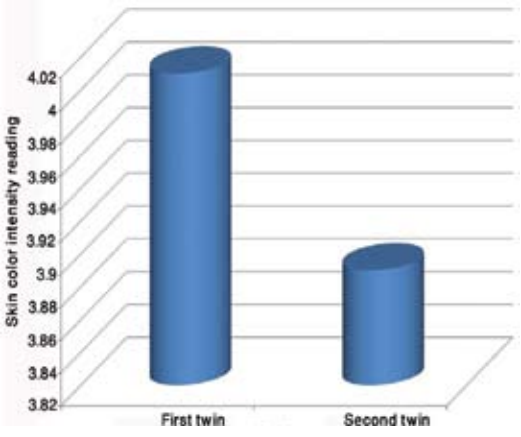

Figure 2 - Skin color intensity difference in a set of first and second twin.

Figure 3 - Differences in skin color between the identical twins as seen visually and by photos, and confirmed by skin typing (skin color type: left - 3.62, and right - 3.81

Figure 4 - Differences in skin color between identical twins as seen visually and by photos as confirmed by skin color typing (skin color type: left - 4.49, and right - 4.35).

Figure 5 - Differences in skin color between identical twins as seen visually and by photos as confirmed by skin color typing (skin color type: left - 4.68, and right - 4.36).

Figure 6 - Differences in skin color between identical twins as seen visually and by photos as confirmed by skin color typing (skin color type: left - 4.73, and right - 4.47).

Figure 7 - Differences in skin color between the identical twins as seen visually and by photos, and confirmed by skin typing (skin color type: left - 3.74, and right - 3.56).

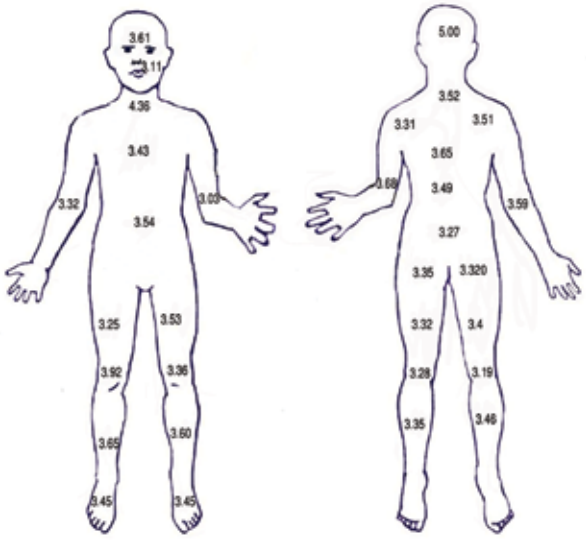

Figure 8 - Body map of skin color intensity in a 3 year-old child.

individual identification based on "biometrics," which became an active topic in both research and practical application.[1] Among the various biometric technologies being considered are: facial features, fingerprint, voice, iris, retina, palm prints, DNA, signature, and so forth, however, each biometric parameter separately has problems in its accuracy.[6-8] Therefore, a search for new identification methods is definitely needed in the lack of proven personality.

Could skin color be used as an identification method? If skin color is going to be an identification method, then all the population, 6 billion or more, should have different degree of color intensities. This statement is difficult to imagine, but definitely, it has been asked when dealing with the different biometric identification methods; could there be 6 billion different finger prints? The answer is yes, and the answer again for skin color could be yes. Skin color is variable and subjected to significant differences based on age, episodic or chronic diseases, sun rays, creams, medications, regions, and race. These factors should all be considered when thinking of skin color as a print. This does not make the skin color unspecific or unaccepted, as other biometric measures have their problems. Retinal scan is affected by severe astigmatism and cataract,[11] voice is affected by sickness and extreme emotional states, and phrases can be misspoken,[12] finger prints can be eroded, and changed during years of heavy labor and can be altered by surgery,[13] and DNA can be fabricated. Despite all these factors interfering with the accuracy of these mentioned biometrics, still they are used, and so it could be in the case of skin color.

Iris features remain constant over an individual's lifetime, and are not subject to changes produced by the effects of aging as skin color, and other biometric features may be. For these reasons, the human iris is an ideal feature for highly accurate and efficient identification systems,[14,15] however, unlike other biometric devices, iris recognition systems act primarily as a screening tool to allow, or deny access to a particular place, rather than as a law enforcement tool as DNA and fingerprints to track down suspected criminals. The uses of skin color in personal identification could be as that of the iris, but with more forensic application. To prove that skin color can vary between all humans, the logical approach is to compare skin color of identical twins. This study was designed to prove that skin color differs between identical twins, and hence, in all humans. The need for a scientific instrumental investigation has lead to the use of Medisun skin check, which will give a larger range than the 6 known categories of skin color.

Initially, it is clear that skin color has different intensities, making a map in all individuals, where exposed areas will have darker color than the covered ones. This lead us to choose, and stick to one same anatomical area in each person for comparison between individuals. Comparisons between different Sudanese and Chinese individuals have shown that there is skin color difference visually and digitally using the Medisun skin check. This has verified the general observation

that there are skin color differences in all individuals. In this study, the difference in skin color between identical twins has been proven visually, and by Medisun skin check (**Figures 3-7**). Although twin identification is difficult even in DNA, skin color identification has proved to be a scientifically valid approach.

The level of melanin has not yet been measured for ethical and technical reasons, but definitely needed to further verify this observation. Even more, the skin color measurement by Medisun skin check has its limitations as it reads color intensity to certain limits (600 different readings). This indicates that this instrument should be developed to read billions of different colors like other identification methods instruments.

In conclusion, this study has shown skin color differences between identical twins, and hence, expectedly in the whole population worldwide. This indicates that this study should be carried in multiple international centers to verify this observation, and to help in developing a new identification tool. Even more, melanin level in identical twins should be measured in the near future for definite confirmation. The definite conclusion is that the previous classification of skin colors is no longer valid.

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Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.