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ORIGINAL RESEARCH

Evaluation of Scalp Hair Density and Diameter in the Arab Population: Clinical Office-Based Phototrichogram Analysis

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Background: Knowing normal values of scalp hair thickness and density is beneficial for diagnosing hair disorders, monitoring responses to therapy, performing hair transplants, and conducting relevant research. Such normal values have not yet been studied for Arabs.

Objective: To assess the hair density and diameter of the Arab population at different scalp sites using phototrichogram.

Methods: A cross-sectional descriptive study was performed at King Saud University Medical City from December 2021 to August 2022. The study was conducted on Arab adults who were not suffering from any hair disorder. The study was conducted using a questionnaire and clinical examination by phototrichogram.

Results: A total of 120 participants were enrolled in this study. The mean hair density was 147.1± 7.8 hairs/cm2, and the mean hair diameter was 87±4.9 μm. There were significant differences between hair density (P=0.0001) and diameter (P=0.0001) in different regions of the scalp. Females had higher hair density than males at occiput (P=0.038).

Conclusion: Arab hair has a higher thickness and lower density than hair of other ethnicities. This needs to be considered when diagnosing and/or treating hair problems in Arabs.

Keywords: hair density, hair diameter, Arab population, phototrichogram

Introduction

Hair disorders are diseases primarily associated with the follicles of hair. It can be associated with various causes, from genetic, autoimmune, and infectious to environmental. Hair loss is considered one of the most common hair disorders.[1]

At present, the diagnosis of hair loss is usually based on patient history, hair loss pattern, and physical examinations, such as pull tests.[2] Therefore, an objective quantitative method to identify the disease is needed. The objective quantitative method includes two approaches: invasive approaches, such as scalp biopsy, and noninvasive techniques, such as trichoscopy and phototrichogram.[1,3,4] Scalp biopsy is an accurate diagnostic approach for hair disorders. However, due to the invasive nature of this procedure, it is sometimes not well tolerated by patients. Trichoscopy is a fast and noninvasive method for evaluating hair density that has been successfully used in various studies.[5] Phototrichogram is an automated technique for hair evaluation consisting of a digital video microscope and an image analysis system. Its advantages for the quantification of hair-associated parameters have been demonstrated.[6–8]

Studies determining normal values of hair density and diameter have been conducted in various ethnic groups.[9,10] The TrichoSciencePro © Software is designated for work with any optical visualization equipment, having at least two specific levels of magnification - lower (from x20 to x60) and higher (from x100 to x200). Very low (from x10 to x20) and very high (from x400 to x1000) levels of magnification have also been used for certain studies. However, one of the advantages of this software is that it may be used with optical equipment having only one lower level of magnification

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while still allowing the most important assessments and studies to be performed. Therefore, virtually any Trichoscope or Videodermatoscope with the option of taking and transmitting an image to a computer may be successfully used with it.

However, to date, less is known about the baseline values in Arab populations. Therefore, in this study, we aimed to assess the hair density and diameter of the Arab population at different scalp sites using TrichoSciencePro ©. This will aid in creating reference values for the hair of Arabs. This can help dermatologists diagnose hair disorders, monitor responses to therapy, assess before and after hair transplant procedures, and conduct hair-related research in these populations.

Subjects and Methods

Tools, Data Collection, and Assessment: Study Design and Subjects

This was a cross-sectional descriptive study that was conducted for 9 months from December 2021 to August 2022 at the dermatology clinics and blood bank waiting area at King Saud University Medical City, Riyadh, Saudi Arabia. The study was conducted on healthy Arabian adults aged 18–60 years old, including both sexes with normal scalp hair who did not have any hair disease. Individuals aged less than 18 years or older than 60 years, those with hair disorders, and nonconsenting participants were excluded. Confidentiality in regard to patient information was maintained. Information on patients' identities was secured and was not disclosed; all information was kept confidential for research purposes only. Additionally, verbal informed consent was obtained from all participants that were approved by the IRB of King Saud University.

This study complies with the Declaration of Helsinki and it was approved by the institutional review board (IRB) of King Saud University's research ethics committee.

Tools, Data Collection, and Assessment

First of all, we evaluated the participants with a preliminary assessment questionnaire. The questionnaire was designed to cover our inclusion and exclusion criteria. The questionnaire was structured into three parts: demographics, detailed hair history, and hair-shedding visual scale.[11] Demographics include age, gender, and nationality. A detailed hair history includes a history of any hair disorder, current or previous hair treatment, number of hairs that fall per day.

The hair-shedding visual scale is a scale that was developed for thick hair of short, medium, and long lengths by dividing a bundle of hairs of each length into nine piles of increasing hair amount that were then photographed and arranged in order of size. It is considered a quick tool to assess hair loss. The participants were asked to select the photographed hair bundle that best correlated with the amount of hair they shed on an average day. According to this preliminary assessment questionnaire, we can identify subjects with hair loss, then exclude them from the study. Participants were included in the study; those who fit the inclusion criteria and were without any hair diseases. Then, they were clinically examined for the assessment of hair diameter and density using a phototrichogram. Phototrichogram assessment was performed at three sites on the scalp and was measured at 12, 24, and 30 cm from the glabella exactly at midline, similar to Birnbaum and Leerunyakul's studies, which identified the frontal, vertex, and occipital areas.[9,10] The tricoscope lens was then put on it to make an image (magnified x25) proceeding evaluation with the TrichoSciencePro © computer program. We used the TrichoSciencePro© v1.7SE (Special Edition) version of a professional computer program that was developed and presented in Moscow, Russia in 2020. The program calculated the total number of hairs per square centimeter, as well as the number of terminal and Vellus-like, anagen and telogen hairs.

Statistical Analysis

The collected data were uploaded to the Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc, Armonk, NY, USA) for analysis. Categorical variables are reported as numbers and percentages, and continuous variables are reported as the means and standard deviations. Comparisons between categorical variables were performed using the chi-square test, and independent t-tests were performed for continuous variables. Comparisons within a group regarding one variable were performed using pairwise correlation analysis. Bivariate analysis using Pearson correlation was performed

to determine the association or correlation between two variables. A p value of <0.05 was considered statistically significant.

Results

A total of 120 participants were included in the current study; the most dominant age group included those aged 31–40 years 29 (24.2%). The male to female ratio was 1:1. The most common skin type was type III, with a frequency and proportion of 52 (43.3%). Straight hair was the most common hair texture at 43 (35.8%), and natural hairstyle was the most dominant hairstyle at 101 (84.2%). The demographics of the participants are shown in Table 1.

The description of hair density and diameters among participants and their comparisons are shown in Table 2. The mean± SD of hair density of the frontal, vertex, and occipital regions was 143.9±5.7, 147.1±7.8, and 153.6±6.5, respectively. There was a significant difference between the mean hair density in the three regions (P=0.0001).

Regarding the diameter of the hair, the mean± SD of hair diameter in the frontal, vertex, and occipital regions was 83.5 ±2.5, 87±4.9, and 90.7±5.8, respectively. There was a significant difference in hair diameter between the three regions (P=0.0001).

The comparison between hair density and hair diameter between males and females is shown in Table 3. There was no significant difference between males and females regarding hair density in the frontal and vertex regions, whereas there was a significant difference regarding the mean hair density in the occipital region (P=0.038); females showed a significantly higher mean± SD of hair density (154.8±7.6) than males (152.3±5). There was no significant difference between males and females regarding hair diameter in the three studied regions.

The comparison between different age groups regarding hair density and hair diameter in the three regions is shown in Table 4. There was a significant difference in the mean value of hair density in the frontal region regarding age groups

Table 1 Demographics of 120 Participants

	Frequency	Percentage
Age		
18–30	42	(35)
31–40	29	(24.2)
41–50	22	(18.3)
> 50	27	(22.5)
Gender		
Male	60	(50)
Female	60	(50)
Skin Type		
Type I	1	(0.8)
Type II	35	(29.2)
Type III	52	(43.3)
Type IV	31	(25.8)
Type V	1	(0.8)
Hair Texture		
Straight	43	(35.8)
Wavy	41	(34.2)
Curly	35	(29.2)
Coarse	1	(0.8)
Hair Style		
Natural	101	(84.2)
Dyed	9	(7.5)
Relaxer-treated	8	(6.7)
Keratin-treated	2	(1.7)

Table 2 Comparisons of Hair Density and Hair Diameter Among Different Scalp Sites

	Scalp Area			P value
	Frontal	**Vertex**	**Occipital**	
Hair density (hairs/cm^2)	143.9 ± 5.7	147.1 ± 7.8	153.6 ± 6.5	**0.000***
Hair diameter (μm)	83.5 ± 2.5	87 ± 4.9	90.7 ± 5.8	**0.000***
	Pairwise comparison			
	Frontal vs Vertex	**Frontal vs Occipital**	**Vertex vs Occipital**	
Hair density (hairs/cm^2)	P = 0.000	P = 0.000	P = 0.000	
Hair diameter (μm)	P = 0.000	P = 0.000	P = 0.000	

Notes: Data are the mean ± SD. *Analysis was performed using ANOVA. Bold numbers mean a statistically significant difference.

Table 3 Comparisons of Hair Density and Hair Diameter Between Males and Females

Scalp Area	Hair Density (hairs/cm^2)			Hair Diameter (μm)		
	Male	**Female**	**P value**	**Male**	**Female**	**P value**
Frontal	144.1 ± 5.7	143.7 ± 5.7	0.703$^{\#}$	83.2 ± 2.1	83.8 ± 2.9	0.222$^{\#}$
Vertex	147.2 ± 7.1	147 ± 8.5	0.889$^{\#}$	86.3 ± 4.2	87.7 ± 5.4	0.128$^{\#}$
Occipital	152.3 ± 5	154.8 ± 7.6	**0.038$^{\#}$**	90 ± 5.3	91.4 ± 6.2	0.202$^{\#}$

Notes: Data are the mean ± SD. $^{\#}$Analysis was performed using a *t*-test. Bold number means a statistically significant difference.

Table 4 Comparisons of Hair Density and Hair Diameter with Aging Among Different Scalp Site

Age Group	Frontal	Vertex	Occipital
Hair density (hairs/cm^2)			
18–30	147.9 ± 3.7	152.3 ± 6.3	158.1 ± 6.7
31–40	143.5 ± 6.2	145.2 ± 7.4	152.3 ± 4
41–50	142.2 ± 4.3	145 ± 6.9	152.7 ± 4.9
> 50	139.3 ± 4.6	142.9 ± 7	148.7 ± 5.2
Hair diameter (μm)			
18–30	85.3 ± 2.4	89 ± 5.1	93.3 ± 4.8
31–40	83.3 ± 1.6	87.3 ± 5.3	91.4 ± 6.5
41–50	82.8 ± 2	86.3 ± 4.3	89.6 ± 5.3
> 50	81.5 ± 2.1	84.1 ± 2.6	86.9 ± 4.6

(P=0.0001); those in the youngest age group had the highest density of hair in the frontal regions. Regarding the vertex regions, there was a significant difference in hair density between the different age groups (P=0.0001); those with the youngest age tended to have the highest density of hair at the vertex region. The comparison of age groups regarding hair at the occipital region showed a significant difference between the age groups (P=0.0001); those in the youngest age group showed the highest mean values of occipital density.

Regarding hair diameter, there was a significant difference in the mean values of hair diameter in the frontal region between different age groups (P=0.0001); those with the youngest age had the highest mean values of frontal hair diameter. The vertex hair diameter was significantly varied between different age groups (P=0.0001); those with the youngest age showed higher mean values of vertex hair diameter. The occipital hair diameter significantly varied among

Table 5 Pairwise Comparisons of Hair Density and Hair Diameter with Aging Among Different Scalp Sites

	Pairwise Comparison					
	18–30 vs 31–40	**18–30 vs 41–50**	**18–30 vs >50**	**31–40 vs 41–50**	**31–40VS >50**	**41–50 vs >50**
Hair density (hairs/cm^2)						
Frontal	**0.001**	**0.000**	**0.000**	0.783	**0.007**	0.140
Vertex	**0.000**	**0.001**	**0.000**	0.999	0.572	0.704
Occipital	**0.000**	**0.002**	**0.000**	0.994	0.071	0.057
	18–30 vs 31–40	**18–30 vs 41–50**	**18–30 vs >50**	**31–40 vs 41–50**	**31–40 vs >50**	**41–50 vs >50**
Hair diameter (μm)						
Frontal	**0.001**	**0.000**	**0.000**	0.769	**0.008**	0.164
Vertex	0.430	0.113	**0.000**	0.851	**0.043**	0.336
Occipital	0.474	0.051	**0.000**	0.636	**0.009**	0.264

Notes: Data with bold font mean P < 0.05, a statistically significant difference when compared different age groups.
Abbreviation: Vs, Versus.

different age groups (P=0.0001), and those in the younger age group had the highest mean values of occipital diameter Table 5.

Discussion

There was no previous study that assessed the density and diameter of hair among the Arabian population; therefore, we conducted this study using a phototrichogram. The density and diameter of hair in this study were evaluated in three regions, the frontal, vertex, and occipital regions of the scalp. Regarding densities, the means of the frontal, vertex, and occipital regions were 143.9, 147.1, and 153.6, respectively. There was a significant difference between the hair density in the three regions, where occipital regions contained the hair of the highest density.

A similar study was conducted on a Thai population, both our study and theirs showed that there were significant differences in hair density regarding the frontal, vertex, temporoparietal and occipital regions. In Thai's study, the vertex region of the scalp was the highest density. While in our study, the occipital region of the scalp was the highest density.

Similar findings to ours were reported in previous studies in which the diameter and density of hair varied at different sites of the scalp; however, these studies reported such findings by using scalp biopsy.[12,13] This may suggest that further studies are needed comparing the accuracy of tools used to assess hair diameter and density. These findings were also confirmed by other studies that used computer-assisted phototrichograms,[14–16] which were similar to our study regarding findings and the tool used.

Birnbaum et al evaluated hair density differences between different ethnicities using trichoscopy and found that the mean± density of hair ranged from 169±31 to 178±33 among American Hispanic individuals, from 148±25 to 160±27 among African American individuals, and from 214±28 to 230±33 in Caucasian individuals.[10] The mean density of hair in previous studies was higher than the density of hair in the Arab population in our study.

In our study, the mean diameter of hair in the frontal, vertex, and occipital regions was 83.5, 87, and 90.7, respectively. There was a significant difference in hair diameter between the three regions, and hair of the occipital region had the highest diameter value. In contrast to our study, the diameter of hair showed no significant difference regarding the different regions of the scalp in a previous study conducted on the Thai population.[9]

A study conducted on Chinese women showed that the reduction in hair diameter reached its peak in the 40s age range.[17] In our study, the highest reduction in hair diameter was found among individuals older than 50 years. However, a full comparison cannot be made, as the Chinese study was conducted on females only.

Table 6 Comparisons of Hair Density and Hair Diameter Among Different Ethnicities

	Hair Diameter (μm)	Hair Density (hairs/cm^2)	References
African	55	149 ± 23	[10,23]
Arab	87	147 ± 7.8	This study
Asian	80	175± 54	[23,24]
Caucasian	65	226 ± 20	[10,23]
Hispanic	75	178 ± 33	[10,23]

We found that the hair density in the three regions was significantly affected by age, where the youngest age was associated with the highest densities of hair in the three regions and vice versa. Regarding the diameter of hair in the current study, age was a determinant factor affecting the diameter of hair in the three studied regions; younger age was associated with a larger diameter of hair. Additionally, in our study, we found that the youngest age group showed significant variations compared to older age groups regarding hair density and diameter in the three studied regions. This indicates that the mean hair density and diameter decrease with increasing age. This was in agreement with a study on the Thai population, where hair density decreased with increasing age, but in contrast to our study, a study from Thailand showed that hair diameter was consistent.[9]

Similarly, previous studies using skin biopsies revealed that hair counts and the number of follicular units among subjects of older ages were decreased, revealing the impact of aging on hair density and diameter.[12,18,19] These findings were confirmed by a phototrichogram, where hair density and hair diameter were reduced with chronological aging.[6,14,20,21]

Our study showed that sex was a determining factor for hair density in the occipital region of the scalp only, whereas females had higher hair density in the occipital region than males. On the other hand, there was no significant difference in hair density at the frontal and vertex regions between males and females. Additionally, no sex differences were found regarding hair diameter in the three studied regions. The Thai study showed no significant impact of sex on hair density or hair diameter regarding the four assessed regions of the scalp.[9] Previous studies[2,6,12,19,22] showed variation in hair parameters between sexes; however, this variation was not significant.

In comparisons of hair density and hair diameter among different ethnicities, our results show that the Arab population has a larger hair diameter than their counterparts of other ethnicities but a lower density than individuals of African, Asian, Caucasian, and Hispanic descent (Table 6). [10,23,24]

This is the first study reporting hair density and diameter in Arabic. Larger sample size studies are recommended.

Conclusion

The findings of the present study agreed with those of previous studies that hair density and diameter varied at different sites of the scalp and decreased with increasing age. Arab population has a larger hair diameter and a lower hair density than their counterparts of other ethnicities. It is important to take this reference index into account for diagnosing hair disorders, monitoring response to therapy, and hair transplants, and by researchers who conduct hair-related research in this population.

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Disclosure

The authors report no conflicts of interest in this work.

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