Comparative Characteristics Of Black And Grey Chest And Selected Facial Hairs In Negroid Males

B Aboagye, J Ahenkorah, B Hottor, F Addai

Citation

Abstract
Aim/Objectives: To generate fundamental data on hairs from indigenous African Negroids for identification and diagnostic purposes, this work appraised and compared microscopic morphological characteristics of chest hairs, moustache, beard, soul patch and sideburns.

Method: Standard light microscopy techniques were employed to study a random sample of 1,055 black and 375 grey hair fibres obtained from 96 negroid male cadavers in Ghana. Structural features of hairs assessed were shaft and medulla diameters, type and index of medulla, scale count, interval between scale margins and scale margin characteristics.

Results: Both black and grey hair shaft diameters decreased in the order moustache, soul patch, beard, sideburns and chest. Medullary diameters were statistically greater in grey than black hairs from the same body region except in soul patch. Grey hairs had a higher occurrence (64.5%) of continuous type of medulla than black hair (19.1%). Interval between scale margins was significantly (p<0.05) bigger in black chest hairs and sideburns, which had lower mean scale counts than the other hairs. The three classical descriptive types of hair cuticular (scale) margin characteristics, namely crenate, rippled, and smooth were observed and illustrated. Crenate type of scale margin was commonest in all the hairs examined.

Conclusions: This study furnishes scarce literature on microscopic features of chest and selected facial hairs from indigenous African Negroid adult males. The data reported has reference value for researchers, and potential use in forensic anthropological identification and diagnosis.

INTRODUCTION
The use of morphological characteristics of human hair for personal identification in forensic investigations is well established.1 Easy availability of scalp hair, its likelihood of being shed at crime scenes, its persistence in fabric, possibility of being transferred from one individual to another or a place, and good chemical stability and resistance to decomposition has made it the choice of numerous forensic scientific studies.2 The naked eye appearance of scalp hair varies greatly to warrant its usage as differentiating characteristics of race.3 Human hair has been categorized into three racial groups: Negroid (African descent), Caucasoid (European descent) and Mongoloid (Asian descent).4 However, increasing artificial modification of scalp hair in recent years poses a challenge to identification; predicting that hairs from other parts of the body such as face and chest may be more useful in determination of age, sex, ancestry, and race by forensic scientists and anthropologists.

In cases of highly fragmented and commingled human remains resulting from mass fatalities such as the US World Trade Centre disaster, identification of victims with disparate ethnic and geographical origins requires forensic anthropological data.5,6 The increasing ease of international travel combines with unpredictable natural and human-made disasters to present catastrophe managers with the formidable task of identifying victims from body parts without the advantage of a manifest or other record(s) of the possible victims. Such situations demand detailed knowledge of anthropometric variants that distinguish people of different racial descent and gender. Human hairs survive fatal calamities7 and could give clues to individual racial origin.

The examination of hairs for investigative and associative information is typically conducted through use of the light microscope.8 The first step in the analysis is determining whether a sample is a hair rather than any other fibre. The legal concern is to ascertain whether the hair is of human or
animal origin; the part of the body that the hair came from (scalp, pubic, limb, or body hair); racial origin; whether the hair has been dyed; whether the hair was pulled or fell out as a result of natural causes or disease, and whether the hair was cut or crushed.9Microscopic characteristics that are considered for racial classification and forensic identification include variation in scale index, size of shaft, pigmentation, medullation, cortical appearance and surface cuticle features.2

Microscopically, hair structure consists of outer cuticle, middle cortex and inner medulla. The medulla may be present or absent in the hair fibre. Growth of pubic, axillary, facial and chest hairs is under the control of androgenic hormones.10,11 One unique feature about hair growth is the onset and progression of loss of pigment granules (greying) with increasing age of the individual, and the age at which greying occurs varies from one race to the other.12 An attempt has been made to characterize the morphology of all the hairs in a Caucasian male.13 Comparative studies of black and grey scalp hairs have been reported in Asian males.14 One of the authentic microscopic data on scalp, pubic, axillary and eyebrows in Ghanaian male and female adolescents were reported from our laboratory in 2008.15 The present study presents basic distinguishing microscopic features of black and grey hairs from chest, moustache, beard, soul patch, and sideburns in Negroid living in Ghana. Besides reasons given above, this study helps to address an apparent general paucity of scientific data on hairs in African Negroids, including those living in Ghana.

MATERIALS AND METHODS

Hair fibres were collected from 96 Negroid male cadavers in the Department of Anatomy, University of Ghana Medical School mortuary. A Ghana Anatomy Act, 1965 (Act 268) permits legal acquisition of unclaimed bodies from hospitals by the Department for use in teaching and research, and these are preserved by chemical embalmment and stored until needed. The study was approved by the Ethical and Protocol Review Committee of the University of Ghana Medical School. All male cadavers available in the Department’s teaching mortuary at the time of the study (January–December 2010) were sampled for hairs. For such bodies there were no records of age or residence, hence the only conclusive inferences regarding their being Negroid and Post-pubertal males. For every cadaver, depending on presence, 10 black and 10 grey hairs were removed randomly from each body region of interest (chest, moustache, beard, soul patch, and sideburns). Five hairs arbitrarily selected out of each sample of 10 were analysed under the microscope and included in this report. The total specimens studied comprised 1,055 black and 375 grey hair fibres.

Hair fibres were removed with a cosmetologist’s pair of tweezers, washed in 5% (v/v) alcohol, wiped with blotting paper, and air dried. A thin layer of clear nail varnish (Manicure Supernail Hardener, Bichun, Korea) was spread on a standard microscope glass slide (All Pro Processed Microscope Slide, Cat #7105, Surgifriend Medicals, Middlesex, England) and allowed to stand for 3 minutes to be partially dried. Using the pair of tweezers each hair fibre was individually placed in the middle of the semi-dry nail varnish and left to stand for 35 minutes to become well dried. During the waiting time, hair fibres were scanned along their length with 10X objective lens under an optical microscope (Leica, Galen III, Cat# 317505; Leica Microsystems, Wetzlar, Germany) to study their morphology with respect to medullation and shaft diameter. One eyepiece (lens) on the microscope used was replaced with a digital microscope eyepiece (Catalogue # MA 88; C & A Scientific Co Inc, Manassas, Virginia) connected to a laptop computer (Satellite L305-S5953) and digital images were saved. Thereafter, the hair fibre was gently pulled out and its impression in the nail varnish examined under the microscope (using 40X objective lens) for cuticular scale features and representative images recorded on the computer.

The diameter of each of three hair shaft images (and medulla if present) captured on the computer was measured randomly at different sites using Microsoft Publisher (Publisher software version 2007, Microsoft, Redmond, Wash). The Microsoft Publisher ruler was calibrated using a Micrometer Stage Graticule (Objective Micrometer, Nikon, Japan) so that all measurements in publisher units were converted to micrometers (µm). Medullary index was determined by dividing medullary diameter by hair shaft diameter.

Two photographs (40X objective lens) of the cuticle impressions of each hair shaft were examined for scale characteristics. The images of the hair cuticular impressions were evaluated for the patterns of scales based on three criteria first proposed by Ryder16 that are common to human hair, and more recently used by others.7,14 These are: (1) the form of the scale margin that may be (a) smooth or (b) crenate, (i.e. having shallow indentations) or (c) rippled, (i.e. having deep indentations); (2) the vertical distance between the scale margins that may be (a) close, (b)
distant or (c) near, (which is intermediate between close and distant); (3) the overall scale pattern that may be (a) mosaic, which may be regular, (in which visible parts of the scales are of similar size), or irregular, (in which they vary), or (b) waved, which may be either regular or irregular in shape, (waved patterns can occur with mosaic to give combinations such as irregular/regular-waved mosaic.

The intervals between the margins of two scales (ISM) were measured at 9 points parallel to the longitudinal axis of each cuticle impression and the average calculated. The number of scale edges was counted at three different sites across the width of each cuticle impression. The average of the 6 counts obtained per hair fibre represented the mean scale count (MSC), which is a reciprocal function of the linear size of the exposed cuticular scale. Descriptive and inferential statistics including means, standard deviation, ANOVA and Tukey-Kramer post hoc multiple comparison tests were performed, using GraphPad Prism (version 3.0; GraphPad, La Jolla, CA), at 95% confidence interval. A probability (P) value less than α = 0.05 was regarded as significant.

RESULTS

The five body-region-specific types of hairs studied and the numbers of cadavers from which they were obtained is shown in Table 1. Hair shaft and medullary diameters obtained in this work are respectively presented in Figures 1 and 2. ANOVA comparisons indicated significant difference in shaft diameters among the five hair types. Tukey-Kramer posthoc multiple comparison tests yielded the following results. The mean shaft diameter of black chest hair was significantly (p<0.05) smaller than black moustache, soul patch and beard. Black hair shafts from beard and soul patch had significantly (p<0.05) greater diameter than corresponding grey hairs (Fig. 1). Grey moustache had significantly (p<0.05) bigger shaft diameter than all the other grey hair types. Grey chest hair had a significantly bigger diameter than counterpart black hairs. Black sideburns and chest hairs had a significantly (p<0.05) smaller mean medullary diameter than the other three black hair types, and grey moustache showed a significantly (p<0.05) bigger mean medullary diameter than the other grey hair types (Fig. 2). Figure 2 also shows that with exception of soul patch, grey fibres had significantly (p<0.05) bigger medullary diameter than black hairs from the same body part.

Medullation of both black and grey hairs studied varied from being continuous, discontinuous, or altogether absent (Fig. 3a-f). Fifty-six to 83 per cent of studied black body hairs were devoid of medullation (Table 2). When present, the continuous type of medulla had higher occurrence in black hairs (Table 2). Eighty-eight to 100 per cent of studied grey hair fibres were medullated with the continuous type being predominant (Table 3). Data on medullary indices (MI) of studied hairs shown in Table 4 indicate that the general trend was bigger MI in grey than black hairs, albeit ANOVA failed to yield significant values.
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Table 1
Types of hair studied and the number of cadavers from who they were obtained.

<table>
<thead>
<tr>
<th>Hair Type</th>
<th>Number of Cadavers yielding samples</th>
<th>Number of black hairs</th>
<th>Number of grey hairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest</td>
<td>46</td>
<td>245</td>
<td>70</td>
</tr>
<tr>
<td>Moustache</td>
<td>55</td>
<td>255</td>
<td>95</td>
</tr>
<tr>
<td>Beard</td>
<td>47</td>
<td>210</td>
<td>55</td>
</tr>
<tr>
<td>Soul Patch</td>
<td>40</td>
<td>185</td>
<td>70</td>
</tr>
<tr>
<td>Sideburns</td>
<td>36</td>
<td>160</td>
<td>85</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1655</strong></td>
<td><strong>375</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Occurrence of descriptive types of medulla in studied black hairs.

<table>
<thead>
<tr>
<th>Medullary Type</th>
<th>Continuous</th>
<th>Discontinuous</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Chest</td>
<td>22</td>
<td>13.06</td>
<td>82</td>
<td>5.08</td>
</tr>
<tr>
<td>Moustache</td>
<td>35</td>
<td>33.33</td>
<td>25</td>
<td>9.00</td>
</tr>
<tr>
<td>Beard</td>
<td>37</td>
<td>32.66</td>
<td>12</td>
<td>5.71</td>
</tr>
<tr>
<td>Soul patch</td>
<td>39</td>
<td>21.08</td>
<td>26</td>
<td>14.05</td>
</tr>
<tr>
<td>Sideburns</td>
<td>18</td>
<td>11.25</td>
<td>5</td>
<td>3.63</td>
</tr>
</tbody>
</table>

No. stands for number, and % represents the percentage of the number of hairs for the specific region of body where they were obtained.

Table 3
Occurrence of descriptive types of medulla in studied grey hairs.

<table>
<thead>
<tr>
<th>Medullary Type</th>
<th>Continuous</th>
<th>Discontinuous</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Chest</td>
<td>44</td>
<td>62.86</td>
<td>26</td>
<td>37.14</td>
</tr>
<tr>
<td>Moustache</td>
<td>63</td>
<td>66.32</td>
<td>27</td>
<td>28.42</td>
</tr>
<tr>
<td>Beard</td>
<td>30</td>
<td>69.09</td>
<td>11</td>
<td>20.97</td>
</tr>
<tr>
<td>Soul patch</td>
<td>45</td>
<td>64.29</td>
<td>18</td>
<td>25.71</td>
</tr>
<tr>
<td>Sideburns</td>
<td>52</td>
<td>61.81</td>
<td>23</td>
<td>27.05</td>
</tr>
</tbody>
</table>

No. and % are defined as in Table 2.

Samples of the three descriptive scale margin characteristics 1 observed in this study are presented in Figures 4 and 5. Quantifiable features of cuticular scales permitted distinction of hair shafts. For instance black chest hair had a significantly (p<0.05) bigger interval between scale margins (10.22, SD 1.46) as well as lower mean scale count (2.50, SD 0.66) than the others (Table 5).

Table 4
Medullary index (MI) of studied body hairs.

<table>
<thead>
<tr>
<th>Hair Type</th>
<th>Black Hair</th>
<th>Grey Hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>SD</td>
<td>MI</td>
</tr>
<tr>
<td>Chest</td>
<td>0.230</td>
<td>0.071</td>
</tr>
<tr>
<td>Moustache</td>
<td>0.242</td>
<td>0.053</td>
</tr>
<tr>
<td>Beard</td>
<td>0.259</td>
<td>0.045</td>
</tr>
<tr>
<td>Soul Patch</td>
<td>0.246</td>
<td>0.066</td>
</tr>
<tr>
<td>Sideburns</td>
<td>0.233</td>
<td>0.098</td>
</tr>
</tbody>
</table>

SD stands for standard deviation.

Table 5
Mean scale count (MSC) and interval between scale margins (ISM) of studied black and grey body hairs.

<table>
<thead>
<tr>
<th>Hair Type</th>
<th>Black Hair</th>
<th>Grey Hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC</td>
<td>SD</td>
<td>ISM</td>
</tr>
<tr>
<td>Chest</td>
<td>2.50*</td>
<td>0.66</td>
</tr>
<tr>
<td>Moustache</td>
<td>3.17</td>
<td>0.67</td>
</tr>
<tr>
<td>Beard</td>
<td>3.05</td>
<td>0.51</td>
</tr>
<tr>
<td>Soul patch</td>
<td>3.04</td>
<td>0.62</td>
</tr>
<tr>
<td>Sideburns</td>
<td>2.50*</td>
<td>0.74</td>
</tr>
</tbody>
</table>

SD represents standard deviation. *Significant at p<0.05.

Table 6
Occurrence of classical descriptive scale margin characteristics among studied black body hairs.

<table>
<thead>
<tr>
<th>Scale Characteristics</th>
<th>Crenate</th>
<th>Smooth</th>
<th>Rippled</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Chest</td>
<td>191</td>
<td>77.96</td>
<td>14</td>
<td>5.71</td>
</tr>
<tr>
<td>Moustache</td>
<td>193</td>
<td>75.69</td>
<td>52</td>
<td>20.39</td>
</tr>
<tr>
<td>Beard</td>
<td>164</td>
<td>78.10</td>
<td>30</td>
<td>14.29</td>
</tr>
<tr>
<td>Soul patch</td>
<td>163</td>
<td>88.11</td>
<td>10</td>
<td>5.49</td>
</tr>
<tr>
<td>Sideburns</td>
<td>140</td>
<td>87.50</td>
<td>20</td>
<td>12.50</td>
</tr>
</tbody>
</table>

No. and % have the same definition as in Table 2.

Crenate type of scale margin had the highest occurrence in both black and grey hairs examined from all 5 body regions. No hairs with rippled margins were found among black.
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sideburns (Table 6) and grey beard (Table 7), whilst none of the hairs in grey moustache and soul patch had smooth scale margin (Table 7).

DISCUSSION

Both morphological and molecular (DNA) analyses are used to identify given hairs for exculpation of suspects in legal investigations.9 The confidence in the outcome of hair microscopy is dependent on the size of the sample of hairs, the length of the fibre and the experience of the person undertaking the microscopy.17 Hence forensic hair examination requires great experience in hair examination as well as in areas relevant to cosmetics, medicine and environmental effects in order to properly identify and compare hair by their microscopic characteristics.18 We present, apparently for the first time, features and micrographs of hairs from indigenous Negroid Africans to facilitate identification in situations of mass calamities.

Table 7

Presence of classical descriptive characteristics of scale margins in studied grey body hairs.

<table>
<thead>
<tr>
<th>Scale Characteristics</th>
<th>Crenate</th>
<th>Smooth</th>
<th>Rippled</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Chest</td>
<td>52</td>
<td>74.29</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Moustache</td>
<td>90</td>
<td>94.74</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Beard</td>
<td>40</td>
<td>72.73</td>
<td>15</td>
<td>27.27</td>
</tr>
<tr>
<td>Soul Patch</td>
<td>58</td>
<td>82.86</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Sideburns</td>
<td>61</td>
<td>71.76</td>
<td>29</td>
<td>38.24</td>
</tr>
</tbody>
</table>

No and % have the same definition as in Table 2.

Our finding that diameter of hair shaft (black and grey) had a decreasing size order moustache, soul patch, beard, sideburns and chest is notable. With the exception of sideburns, grey hair fibres had smaller diameter than black hairs from the same body location. Grey scalp hairs were reported to be smaller in size than black hairs 14, and similar observations were made by other authors.19,20 The diameter of medulla in black hair increased with increasing size of the hair fibre among the hairs in the present work. However, grey hair fibres that we studied had bigger medullary diameters than their black counterparts in agreement with previous finding of increasing medullary diameter and medullary index with ageing.14,21 The phenomenon has been attributed to empty spaces that appear in the grey hair on account of reduction in pigment granules in their cortices, which may increase medullary diameter and medullary index.22 Plausible as this explanation is, it is undermined by our finding that grey sideburns had bigger medullary and slightly bigger shaft diameter than their corresponding black hairs. A better explanation may be that the ageing follicle may reprogram the matrix keratinocyte to produce more medullary keratinocyte rather than cortical keratinocyte.23

The present study showed an entirely logical inverse association between MSC and ISM; such that hairs with smaller MSC (meaning larger size cuticles) had bigger ISM (meaning distance between cuticle margins) The MSC increased with increasing the size of the hair fibre while ISM decreased, meaning big hair shafts had bigger cuticular scales which were further spaced than smaller closely packed scales on smaller hairs. Similar observations have been reported in Caucasoid and Mongoloid races.24,25 Although not significant, grey fibres generally had bigger ISM than black hair fibres form the same body site, contrary to the assertion that reduction in cuticle scale size is associated with increasing age.14 As to why grey hairs have widely spaced scales, it has been postulated that the rate of budding of new cuticle-forming cell could be the same for all hairs, but the rate at which the linear length of some hairs increases proceed faster such that the exposed cuticle scale would appear long and wide.26 White beard hair is reported to grow at a rate of up to four times that of corresponding black hairs.27 Furthermore, it has been reported that melanin transfer promotes decrease in keratinocyte cell turn over, but rather increases keratinocyte terminal differentiation.23 With the advancement in ageing and greying, melanogenesis is impeded hence keratinocyte turnover is enhanced. The implication is that grey hairs increase in length at a faster rate and cuticle cell budding increases simultaneously compared with growth in black hairs. This could be the probable explanation for grey hair fibres having slightly bigger ISM than black hairs in the present study.

The present study revealed a higher incidence of medulla in grey hairs than black hairs. This may have been partly arisen from clearer distinction of medulla in grey hairs compared to their relative obscurity on account of heavy pigmentation in black hairs. Continuous type of medulla was common and medullary diamater followed the size of the shaft; in agreement with previous works.15,28. Non-medullation of black hair shafts may mean no medulla or melanosome density of medullary cells and cortical cells being similar such that the medulla would be...
inconspicuous. Crenate type of cuticle margin was more common in both black and grey hairs observed. This supports the claim that the hair retains the crenate type proximally for at least 24 years and that age related changes do not obliterate it. Notwithstanding this, progressive changes along the hair shaft occur such that whilst most hairs have crenate type of scales there is loss of pattern towards the tip of the hair.

Generally, chest and facial hairs in humans appear after puberty, whilst grey hairs appear in middle-to-advanced age people, so that their presence would serve to give an indication of possible sex and age bracket of victims of mass fatalities and graves. Our work has therefore produced data that must find use among many experts who may need to identify racial origin, sex, and age people involved in mass calamities.

**Figure 3a**
Micrograph of black moustache hair with continuous medulla. M=Medulla, C= Cortex

**Figure 3b**
Micrograph of grey beard hair showing continuous medulla. M=Medulla, C= Cortex

**Figure 3c**
Micrograph of black soul patch hair showing discontinuous (interrupted) medulla

**Figure 3d**
Micrograph of grey sideburns hair showing discontinuous medulla.

**Figure 3e**
Micrograph of black chest hair showing no conspicuous medulla

**Figure 3f**
Micrograph of black sideburns hair showing no conspicuous medulla

Fig. 3 (a-f) Photomicrographs of samples of shafts of hairs studied, showing variable presence of medulla or its absence.
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Figure 4a
Crenate, regular, near (grey Moustache)

Figure 4f
Crenate, regular, distant (grey chest)

Figure 4b
Smooth, regular, near (black Soul patch)

Figure 4g
Smooth, regular, distant (black chest)

Figure 4c
Smooth, regular mosaic, near (black Soul patch)

Figure 4h
Rippled, regular, close (black beard)

Figure 4d
Crenate, regular mosaic, distant (black beard)

Figure 4e
Crenate, regular mosaic, distant (black chest)

Fig. 4 (a-h). Photomicrographs of sample scale impressions made by the studied hairs illustrating the classical descriptive types of cuticular margins and the patterns of regular variety. False colour was added to enhance contrast.

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