



The Sudanese female face: Normative craniofacial measurements and comparison with African–American and North American White females



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ABSTRACT

Background: Ethnic differences in craniofacial dimensions and proportional relationships means that ethnicity-specific data is required for both diagnosis and treatment planning. This investigation establishes normative craniofacial anthropometric values for the Sudanese female (SF) population, compares with North American White (NAW) and African–American females (AA), and analyses the occurrence of neoclassical norms within the study sample.

Methods: Standardized frontal and profile facial photographs were taken of 100 female participants. Five vertical and five horizontal anthropometric measurements were determined.

Results: Significant differences were found between the 3 populations. The sample showed very poor compliance with the neoclassical norms. The upper face height of the SF was ~20-mm taller than the AA faces ($p < 0.001$). Midface, nasal and lower face heights were also significantly taller, by 15-mm, 10-mm and 10-mm respectively ($p < 0.001$). SF showed significant reduction in bizygomatic width (~30-mm), compared to NAW and AA ($p < 0.001$). Eye width was ~5-mm less than the AA sample and 3-mm less than the NAW sample ($p < 0.001$). Mouth width was ~5-mm less in SF than the other two groups ($p < 0.001$). The SF exhibited a reduced interalar width compared with AA ($p < 0.001$), but wider than the NAW ($p < 0.001$).

Conclusions: The average SF face is significantly taller and narrower than the AA or NAW female face. The neoclassical proportional norms appear to be unreliable guides in relation to the SF face, and should not be used in comparative diagnosis and treatment planning. Use of the normative anthropometric data presented in this article, both linear and proportional values, should be considered in the diagnosis and treatment planning of young adult female patients of Sudanese descent.

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1. Introduction

To treat congenital or post-traumatic facial disfigurements in patients from different ethnic backgrounds successfully, surgeons may require access to craniofacial databases based on accurate anthropometric measurements (Farkas et al., 2005). A variety of developmental craniofacial conditions, traumatic facial injuries, facial aesthetic, reconstructive and orthognathic surgery, and even orthodontic treatment, may produce significant changes in facial

appearance (Farkas et al., 2005; Savastano and Craca, 1992). An understanding of facial aesthetics, craniofacial proportions and age-, gender- and ethnicity-specific craniofacial measurements is thereby beneficial in clinical practice, providing guidance for both clinical diagnosis and treatment planning (Naini, 2011).

The exploration of facial beauty by artists has a long history. Anthropometric measurements for the purpose of art and sculpture began with the early Egyptians, approximately 700 BC, with facial measurements being pioneered by classical Greek sculptors around 500 BC, the most famous being Polycleitos of Argos (Naini, 2011).

By the early 16th century, the historical period known as the Renaissance led to an intellectual movement that employed

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humanistic methods in studying art and sculpture (Haughton, 2004; Jose, 2001). Leonardo da Vinci, the most famous artist of the period, worked extensively on finding 'ideal' facial and body proportions for art and sculpture. His proportional drawings, the most famous of which is the Vitruvian man (*Homo Vitruvianus*), demonstrate his ideas about facial and body proportions, and are often termed 'norms' of proportions (Naini, 2011).

Leading up to the 19th century, the neoclassical movement in art and sculpture appeared, which coincided with the European Enlightenment. Neoclassicism re-emphasized the use of the classical Greek proportional norms and the norms of the Renaissance period. The depiction of human figures with the ideal aesthetic measurements and proportions constituted the basis of these neoclassical norms (Naini, 2011).

Many of the facial aesthetic analyses used in craniofacial surgery are based on the artistic attempts to find 'ideal' proportions for art and sculpture (Naini, 2011). For a great part of the 20th century, the plastic surgeon Leslie Farkas, leading a team of international investigators, was responsible for introducing anthropometric techniques into clinical practice (Farkas et al., 2005). This allowed the quantification of variations in craniofacial morphology, which led to findings in relation to features distinguishing various ethnic groups (Farkas et al., 2005; Naini, 2011). Such normative data of facial measurements are indispensable for precise determination of the degree of deviation from the average, or 'norm', for any ethnic group. The normal range in each resultant database, once established, provides potentially valuable information about major facial characteristics in different ethnic groups. Unfortunately, normative craniofacial soft tissue data for the Sudanese population is very limited in the available literature. One cross-sectional study undertook three-dimensional measurements from facial laser scans of Sudanese subjects (326 male; 327 female) between the ages of 4 and 30 years (Sforza et al., 2013a). Overall, they found differences between their measurements and previous data from other African and Caucasian subjects, and thereby recommended further investigation in order to find ethnic-specific data (Sforza et al., 2013a). The same team also described normative anthropometric values for the orbital region in Sudanese subjects (Sforza et al., 2013b). Data has also been provided for the morphometry of the ear (Sforza et al., 2011a) and nasolabial regions of Sudanese individuals with Down syndrome (Sforza et al., 2011b). However, to date, normative anthropometric data and proportional data that may be used for treatment planning in craniofacial and orthognathic surgery has been unavailable for the Sudanese female population.

The aims of this study were:

- 1 To establish normative craniofacial anthropometric values for the Sudanese female population.
- 2 To compare the measurements with North American White (NAW) female faces and African-American (AA) female faces (Farkas et al., 1984, 1985, 2000).
- 3 To detect the occurrence of four horizontal and one vertical neoclassical proportional norms within the study sample.

The null hypotheses being tested were:

- 1 There is no difference in the average facial measurements and proportional relationships of the young adult Sudanese female compared with the African-American and North American White female.
- 2 There is no difference between the neoclassical proportional norms and the proportional relationships of the young adult Sudanese female face.

2. Materials and methods

Ethical approval was obtained from the Postgraduate Medical Board of the University of Khartoum. A cross-sectional investigation was undertaken. One hundred female participants were chosen from the students at the University of Khartoum, using a systematic random sampling technique. The list of the students enrolled within the Faculty of Dentistry was obtained from the admissions office and every third students who complied with the following inclusion criteria was included in the study:

- being of Sudanese descent (each participant was questioned regarding their family background, and both sets of grandparents were to be of Sudanese descent);
- age range 17–23 years;
- having average/normal facial appearance (as visually assessed by the lead investigator);
- no history of facial surgical intervention or orthodontic therapy;
- all verbally agreed and consented (written) to participate in the study.

A frontal and profile photograph of each female participant was taken using a standardized technique (participant in natural head position, the same camera to participant distance, the same background and similar lighting conditions), using a digital camera (Panasonic Lumix DMC-ZS3) (Fig. 1). Facial measurements were undertaken using UTHSCSA Image Tool analysis software (version 3, Microsoft Windows®). To facilitate using the software, one horizontal facial measurement (mouth width) and one facial vertical measurement (bilabial vermilion height, in the facial midline) were taken directly from the participants using a digital calliper and then used to calibrate for the other photographic facial measurements. The measurements were all undertaken by the same investigator (MS). Intra-examiner reliability was assessed using the Dahlberg method. The reliability varied between the different measurements ranging from 0.32 to 0.57, which is considered to be acceptable.

Ten facial soft tissue anthropometric landmarks were identified on the frontal and profile views of the participants' photographs (Table 1). Ten standard anthropometric measurements were obtained for each participant (Farkas et al., 1984, 1985, 2000):

- Horizontal measurements:
 - 1 Inter-canthal distance (en-en).
 - 2 Nose width (al-al).
 - 3 Eye width (ex-en).
 - 4 Mouth width (ch-ch).
 - 5 Facial width (zy-zy).
- Vertical measurements:
 - 6 Forehead height I (tr-n').
 - 7 Forehead height II (tr-g').
 - 8 Nasal height (n'-sn).
 - 9 Midface height (g'-sn).
 - 10 Lower face height (sn-me').

The measurements were obtained in millimetres and compared with the North American White adult female measurements and the African-American adult female measurements. These measurements were also compared with five neoclassical norms, as described by Farkas et al. (1985):

- 1 Vertical facial trisection (tr-n' = n'-sn = sn-me')
- 2 The orbito-nasal proportion norm – i.e. the intercanthal distance being equal to the interalar width of the nose (en-en = al-al).

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