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Variation of facial features among three African populations: Body height match analyses

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ABSTRACT

Body height is one of the variables that show a correlation with facial craniometry. Here we seek to discriminate the three populations (Nigerians, Ugandans and Kenyans) using facial craniometry based on different categories of body height of adult males. A total of 513 individuals comprising 234 Nigerians, 169 Ugandans and 110 Kenyans with mean age of 25.27, $s = 5.13$ (18–40 years) participated. Paired and unpaired facial features were measured using direct craniometry. Multivariate and stepwise discriminate function analyses were used for differentiation of the three populations. The result showed significant overall facial differences among the three populations in all the body height categories. Skull height, total facial height, outer canthal distance, exophthalmometry, right ear width and nasal length were significantly different among the three different populations irrespective of body height categories. Other variables were sensitive to body height. Stepwise discriminant function analyses included maximum of six variables for better discrimination between the three populations. The single best discriminator of the groups was total facial height, however, for body height >1.70 m the single best discriminator was nasal length. Most of the variables were better used with function 1, hence, better discrimination than function 2. In conclusion, adult body height in addition to other factors such as age, sex, and ethnicity should be considered in making decision on facial craniometry. However, not all the facial linear dimensions were sensitive to body height.

Introduction

Population studies contain a quantitative record of the average facial characteristics that exist for different ethnic groups (Fang et al., 2011; Farkas, 1994). This type of information makes possible analysis of the differences in facial proportions amongst the ethnic groups. It was hypothesized that certain facial features have more inter-ethnic variability than others (Fang et al., 2011). It is well known that a single facial esthetics is not appropriate for application to diverse ethnic groups (Moyers, 1988; Profit, 1999; Wuerpel, 1936).

Facial traits are largely influenced by factors such as age, sex, ethnicity, culture and environment among others (Mandall et al., 2000). Therefore, the precise prediction of biological sex, age and ancestry is a necessity for the recognition of unknown human remains in forensic investigations (Kranioti et al., 2014). Understanding the variation of facial features of different ethnic populations is critical in preserving the ethnic identity of individuals while pursuing the ideal facial characteristics.

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The main idea of discriminating different populations assumes importance particularly in mass disasters when fatalities occur simultaneously involving persons of different nationalities, ethnicities and other factors (Vij, 2005).

Metric and morphological analyses of the human face are considered one of the most promising methods for personal identification. However, the face among other parts of the body is found to be correlated with body height (İşcan, 2005; Krishan, 2008a,b). The data on the correlation of body height and facial variables were documented from the studies among Italian population (Introna et al., 1993), Japanese (Chiba and Terazawa, 1998), central Indian (Patil and Mody, 2005), north Indian (Krishan and Kumar, 2007; Krishan, 2008a) and South Africans (Ryan and Bidmos, 2007). It was documented that body height estimation in forensic context can supplement other personal identification data like age, sex, ethnicity, and individualistic features (Krishan, 2008a,b). Despite numerous available evidence on the correlation of facial variables with body height, researchers tend to neglect the influence of body height on the cephalometry as individuals within the same age, sex and ethnic group with different body height may have different values of facial features. In this context body height may be considered as a confounding variable that may need more attention than other variables such as age, sex and ethnicity. Hence, forensic scientists will be equipped with additional confounder that may need careful consideration while establishing identity.

Discriminant analysis is a form of multivariate analysis usually performed to categorize individuals into two or more different groups with reference to measurements, in order to recognize the variables responsible for making the categorization (Badam et al., 2011). The aim of this study was to use discriminant function analysis to discriminate the three African population groups (Nigerians, Ugandans and Kenyans) using cephalometry based on different categories of height of adult males. This will further highlight the role of adult body height in the ethnic differentiation using facial features.

Materials and methods

Study site

The study was conducted among citizens of three African countries; Nigeria, Uganda and Kenya. The geographical location of the Federal Republic of Nigeria is on the Gulf of Guinea in West Africa. It is between Benin in the West and Cameroon in the East (E). In the North (N) it has borders with Chad (NE) and Niger (NW). The study participants came from the Kano state of the north-western part of the country (Phillips, 2004). Uganda and Kenya belong to the eastern part of Africa. The Republic of Uganda to the west, the Sudan and Ethiopia in the north, Tanzania to the south and Somalia in the east (Ojany and Ogendo, 1988) (Fig. 1). Kenya is located at the eastern part of Africa and west of Somalia and Indian Ocean. It has borders with Tanzania to the south, Ethiopia and South Sudan to the north and Uganda to the west.

Participants

A total of 513 participants comprising 234 Nigerians, 169 Ugandans and 110 Kenyans with mean age of 25.27, $s = 5.13$ (18–40 years) participated. Informed consent was obtained from the participants. The inclusion criteria allowed all the participants who were reportedly healthy, non-syndromic and without history of facial surgeries and/or injuries, limb and vertebral deformities. To eliminate confounding influence of age on the facial variables (Farkas, 1994) only participants within the age range of 18–40 years were considered.

Landmarks and their anatomical descriptions

Seventeen anatomical landmarks (Table 1) were used in this study to measure the facial distances (Kelly et al., 1999; Porter, 2004).

Cephalometry and anthropometry

To avoid inter-observer error, all the participants were measured by one investigator. Three paired and 10 unpaired facial dimensions were measured using facial landmarks and distances as proposed by earlier workers (Lohman et al., 1988; Martin and Saller, 1957; Porter, 2004; Weiner and Lourie, 1981) (Table 2).

The body heights of the participants were categorized into groups that generate a statistically significant difference. The three groups were; less than 1.61 m (H1), between 1.61 m and 1.70 m (H2) and greater than 1.70 m (H3) (Table 3).

Statistical analysis

The data obtained were expressed as maximum (max), minimum (min), mean and standard deviation (SD). Multivariate and univariate analyses (followed by Benferoni post hoc test) were employed to determine the facial variation among the three different population groups. Stepwise discriminant function test was used to generate a mode for differentiation of the three population groups based on facial features. SPSS (IBM Corporation, Armonk, NY) version 20 was used to analyze the data and $P < 0.05$ set as level of significance.