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Facial indices and morphology: A study among Bono and Ewe adult population in the Bono region, Ghana

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ABSTRACT

Facial parameters are of utmost importance in identification and racial morphological classification. Facial indices serve as identification tools when used alongside hand print patterns for forensic and biometric purposes such as health insurance, voters' identity card, driver's license and passports among others. There is paucity of information on facial types and their distribution patterns with respect to ethnicity, age and sex in Ghana. Therefore, the aim of this study was to generate baseline data on facial dimensions among the Bonos and Ewes living in the Bono Region of Ghana. A total of 291 healthy individuals (152 Bonos and 139 Ewes), aged 18–60 years were recruited for the study. The results of the present study showed that male facial parameters were numerically higher than those of the female participants. The predominant facialtype was hyperleptoprosopic (98.96%) and the least was leptoprosopic (1.03%). There were more Bono participants (51.89%) that were hyperleptoprosopic compared to the Ewes (47.07%). Also, among the hyperleptoprosopic participants, there were more males (55.32%) than females (43.29%). Very few males (0.003%) and females (0.006%) were leptoprosopic.

The Bono participants recorded significantly greater morphological facial height and facial breadth than the Ewes. The results of the present study affirm population variation in facial anthropometry and reinforce the need to establish specific facial standards for each tribe of the Ghanaian population. This study has provided data for facial morphology for biometric and forensic purposes as well as facial reconstruction in Ghana.

Introduction

Variation is a phenomena occurring in humans and has been attributed to a number of factors such as mutation and natural selection [1]. Anthropometric studies are essential to humans and an important tool in forensic science and crime investigation [2]. Identification of an unknown person when some dismembered body parts of the victim are available is one of the main goals of forensic medicine [3,4].

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The size of soft tissues in the face can be estimated by direct measurements [5]. Anthropometric studies in various populations have detailed the relationships between the landmarks of the face [5,6]. Facial index bears direct relationship with morphological facial height and indirectly with maximum facial width. Morphological facial height has positive correlation with age. It is one of the facial parameters with the fastest growth rate [7,8]. There is a positive correlation between maximum facial width and age [9]. Changes in facial index between parents, offspring and siblings can give a clue to genetic transmission of such characters [10–12].

The Facial Index (FI) is one of the commonest and reliable indices used in identification of the five types of faces namely; Hypereuryprosopic (FI: $\leq$ 79.9), Euryprosopic(FI: 80.0–84.9), Mesoprosopic (FI: 85.0–89.9), Leptoprosopic (FI: 90.0–94.9) and Hyperleptoprosopic (FI: $\geq$ 95.0) [13–16]. The knowledge acquired from the study of facial morphology is useful in several areas such as facial aesthetics, forensic medicine, medico-legal disputes as well as reconstructive surgeries [17]. However, in Ghana, although emphasis is placed on the face in photographic recognition systems used in the issuance of identity cards, very little information is available on metric facial data, face types, distribution patterns and their association with ethnicity, age and sex. Therefore in a bid to contribute to the Science and Technology component of the Africa Development Agenda 2063 [18], this study sought to establish the distinction between the Bono and Ewe tribes with respect to their facial anthropometry.

Materials and methods

Study population and location

This cross-sectional study span from February 2018 to December 2018 in the Bono Region of Ghana. A purposive sampling technique was employed to sample a total of 291 healthy individuals 152 Bonos (87 males, 65 females) and 139 Ewes (75 males and 64 females) for the study.

It included 162 males and 129 females aged 18–60 years who were Bonos and Ewes living in the Bono Region of Ghana.The study and its protocols were explained to the participants to their comprehension.

Ethical approval

The study adhered to the Helsinki declaration and was approved by the Committee on Human Research,Publication and Ethics at the Kwame Nkrumah University of Science and Technology with approval number: CHRE/AP/131/20.

Measurement of facial parameters

All anthropometric measurements of the face were performed with the participants in a sitting position, body in erect position and head in the Frankfurt plane and arms at the side. Using Shahe Vernier Calipers, two facial anthropometric indices were measured (to the nearest 0.1 mm).

The measurements taken from the participants included:

i Morphological face height (n-gn): It was taken as the straight distance from the nasal root (nasion) to the lowest point on the lower border of mandible in the mid-sagittal plane (gnathion).
ii Face breadth (zy-zy): It was taken as the maximum distance between the most lateral points on the zygomatic arches (left zygion to right zygion) [19].

The facial index was estimated from the formula: Facial index (FI) = (Morphological face height (n-gn)/ Face breadth (zy-zy) $\times$ 100. Where Morphological face height = nasion-gnathion, Face breadth = bizygomatic breadth (zygion – zygion). Banisters classification was then used to determine the facial types from the facial index [19].

1 Hypereuryprosopic (very broad face): Facial index below 80%.
2 Euryprosopic (broad face): Facial index between 80 and 85%.
3 Mesoprosopic (round face): Facial index between 85 and 90%.
4 Leptoprosopic (long face): Facial index between 90 and 95%.
5 Hyperleptoprosopic (very long face): Facial index above 95%.

Inclusion and exclusion criteria

Individuals with physical impairment, scarring of face, craniofacial trauma, amputated lower limb, visible tumors, facial edema and pregnant women were excluded from the study. Participants with physical signs of endocrine disorders such as dwarfism and gigantism were also excluded from the study since morphological changes in the individual will not give accurate measurements of the bony landmarks of the face. Consented healthy participants without any of the aforementioned defects and with both parents and grandparents being Bono or Ewe and living in the Bono region were included in the study.

Table 1
Descriptive statistics and comparison of morphological facial dimensions between Bono and Ewe tribes.

Parameter	Tribe		*p*-value
	Bono (n = 152)	Ewe (n = 139)	
Morphological facial height (n-gn) (mm)	115.96 ± 22.35	111.29 ± 16.16	0.043
Facial breadth (zy-zy) (mm)	103.22 ± 10.70	100.46 ± 9.30	0.020

Data recorded in mean ± standard deviation and range; n = Number of participants; n-gn = nasion to gnathion; zy – zy = zygion to zygion; p = Significance level at p < 0.05;mm = millimeter.

Data analysis

Statistical analyses were carried out using IBM statistical Package for Social Sciences software (SPSS 24.00 version, Inc. Chicago, IL, U.S.A). Normal distribution was tested with the one-sample Kolmogorov–Smirnov test and Shapiro-Wilk normality test. Differences among age groups were tested with the Analysis of Variance test (ANOVA), followed by Tukey's Multiple Comparison (TMC) Test.Differences among sex and tribes mean of facial dimensions were tested with ANOVA and followed by the TMCTest. The association between the facial dimensions with the age and height was assessed using Pearson's correlation analysis. Linear regression (step-wise) analysis was applied to determine model fit between the facial dimensions, age and height. The level of statistical significance was determined at $p< 0.05$.

Results

The morphological facial height (n-gn) of the Bono participants, (115.96 ± 22.3 mm) was numerically higher than that of the Ewe participants (111.29 ± 16.16 mm). The mean facial breadth (zy-zy) of the Bono and the Ewe participants was 103.22 ± 10.70 mm and 100.46 ± 9.30mmrespectively. Moreover, the differences between the morphological facial height (n-gn) and facial breadth (zy-zy) of Bono and Ewe participants showed statistical significance ($p < 0.05$) (Table 1)

Table 2a and b show comparison of the mean facial indices of the males and females of both Bono and Ewe participants with other published studies using one sample *t*-test.This aspect was part of advances made in the study to make it outstanding from earlier studies carried out in Ghana. The facial indices for the males and females of both tribes of the present study were statistically different ($p < 0.05$) from all the published facial indices except the Ewe males of the present study and Akan males [20].

Inter-population comparison of study and published values

Although numerically higher, the mean value of the morphological facial height of the Bono tribe of the study was not significantly different from that of the Bini tribe of a South-South Nigeria [24], Central Serbians [27] and Lithuanians [28]. Meanwhile, comparison with Andhra region in India [26] showed lower numerical values but statistically significant difference with the present study. However, the morphological facial height of this study was significantly lower than that of Dagaabas and Sisaalas in Ghana [21], North Eastern Nigerians [29] and Sri Lanka population [30].

Moreover, the differences between the means of the morphological facial height of Ewe tribe of the present study compared to the Dagaabas and Sisaalas in Ghana [21], a North-Eastern Nigerian population [29], Sri Lanka population [30], female population of the Andhra region in India [26], male population of Central Serbia [27] and male population of Lithuanians [28] showed statistically significance.

The mean values of the facial breadth of the Bono tribe of the present study showed statistical difference with Dagaabas and Sisaalas in Ghana [21], Bini tribe of South-South Nigeria [24], Andhra region of India [26], Central Serbians [27], Malaysians and Indians [23] ($p < 0.05$).

The facial breadth of the Ewe tribe of this study was significantly different from the male Dagaabas, male and female Sisaala population in Ghana [21], the Bini tribe of South-South Nigeria [24], Andhra region of India [26], Central Serbians [27], Malaysians and Indians [23] ($p < 0.05$).

Descriptive statistics of facial parameters

Fig. 1 is a bar chart showing the distribution of facial types based on prosopic index by sex within the two tribes. Majority of the participants, 98.96% (288 out of 291) had hyperleptoprosopic facial type whereas very few 1.03% (3 out of 291) were of the leptoprosopic type. There were more Bono participants 51.89% (151 out of 291) that were hyperleptoprosopic compared to the Ewes 47.07% (137 out of 291).

Also, among the hyperleptoprosopic participants, there were more males; 55.32% (161 out of 291) than females 43.29% (126 out of 291). There were no mesoprosopic, hypereuryprosopic or euryprosopic facial type among the two tribes.

Table 2a
Means of facial (prosopic) indices of the present study compared with selected published values.

Study	Sex	Tribe	t	p	Tribe	t	p
Present Study (Ghanaians)	M	Bono			Bono		
	F	113.27			113.27		
		109.14			109.14		
Ghanaians - Akans and Ewes [20]	M	Akan	4.176	<0.001*	Ewe	8.895	<0.001*
	F	109.12	7.017	<0.001*	104.43	4.082	<0.001*
		99.41			103.48		
Ghanaians - Dagaabas and Sisaalas [21]	M	Dagaaba	12.94	<0.001*	Sisaala	10.827	<0.001*
	F	100.41	7.154	<0.001*	102.51	5.221	<0.001*
		99.22			101.90		
Fars and Turkman [22]	M	Fars	41.626	<0.001*	Turkman	35.33	<0.001*
		71.9			78.15		
Malaysians and Indians[23]	M	Malaysia	27.721	<0.001*	India	26.242	<0.001*
	F	85.72	15.454	<0.001*	87.19	16.146	<0.001*
		87.71			86.75		
Bini tribe in South – South region	M	87.78	25.648	<0.001*	87.78	25.648	<0.001*
(Nigerians) [24]	F	85.88	19.406	<0.001*	85.88	19.406	<0.001*
Malaysians [25]	M	75.29	38.215	<0.001*	75.29	38.215	<0.001*
Andhra Region of Indians [26]	M	89.50	23.917	<0.001*	89.50	23.917	<0.001*
	F	86.72	16.168	<0.001*	86.72	16.168	<0.001*

b: Means of facial (prosopic) indices of the present study compared with selected published values

Study	Sex	Tribe	t	p	Tribe	t	p
Present Study (Ghanaians)	M	Ewe			Ewe		
	F	110.26			110.26		
		111.67			111.67		
Ghanaians - Akans and Ewes [20]	M	Akan	1.262	0.210	Ewe	6.456	<0.001*
	F	109.12	11.20	<0.001*	104.43	7.152	<0.001*
		99.41			103.48		
Ghanaians - Dagaabas and Sisaalas [21]	M	Dagaaba	10.908	<0.001*	Sisaala	8.583	<0.001*
	F	100.41	11.471	<0.001*	102.51	8.791	<0.001*
		99.22			101.90		
Fars and Turkman [22]	M	Fars	42.482	<0.001*	Turkman	35.56	<0.001*
		71.90			78.15		
Malaysians and Indians[23]	M	Malaysia	27.212	<0.001*	India	27.212	<0.001*
	F	85.72	22.837	<0.001*	87.19	25.515	<0.001*
		87.71			86.75		
Bini tribe in South – South Region	M	87.78	25.895	<0.001*	87.78	25.895	<0.001*
Nigerians [24]	F	85.88	24.657	<0.001*	85.88	24.657	<0.001*
Malaysians [25]	M	75.29	38.215	<0.001*	75.29	38.215	<0.001*
Andhra Region of Indians [26]	M	89.50	22.990	<0.001*	89.50	22.990	<0.001*
	F	86.72	23.822	<0.001*	86.72	23.822	<0.001*

* = Statistical significance level ($p < 0.05$) using Analysis of Variance followed by Dunnett's Multiple Comparison Test; M = Males; F = Female.

Discussion

The morphological facial height of the Bono tribe of the study was not significantly different from that of the Bini tribe of a South-South Nigeria [24], Central Serbians [27] and Lithuanians [28]. This could be attributed to pubertal testosterone which causes increase in lower facial height and size and mass of muscles resulting in changes in facial shapes between the sexes [31,32]. Morphological facial height has a positive correlation with age. It is sexually dimorphic with males having higher values than females [8].

There were no significant differences between the facial breadth of the present study and that of the values of the Bini ethnic group in South-South region of Nigeria [24] and Turkish adults (12.91 ± 0.71 cm for males and 12.72 ± 0.65 cm for females) [33]. Males have broader zygomatic region, stronger and wider bones compared to females, but it is influenced by race, ethnicity, climate, socioeconomic, nutritional and genetic factors [27,34]. Unlike this study, most research done in this area did not do population comparison of the facial indices. Population comparison is essential to establish if significant differences exist between facial parameters of people living in these different geographical locations.

The Bono and Ewe participants had relatively longer faces in comparison with other tribes in Sub-Saharan Africa. This could be attributed to the genetics and difference in nutrition which brings about the significant growth in the bony structures of the head and face of most Bono and Ewe individuals than the other tribes even though they live in the same climatic setting. This is similar to what Cheetham [20] reported on the Akan (82%) and Ewe (88%) participants where hyperleptoprosopic face type was the commonest. The hypereuryprosopic and the euryprosopic facial types recorded the lowest frequencies in each tribe. The leptoprosopic facial type occurred in 8% Akans and 6% Ewes while the mesoprosopic face type

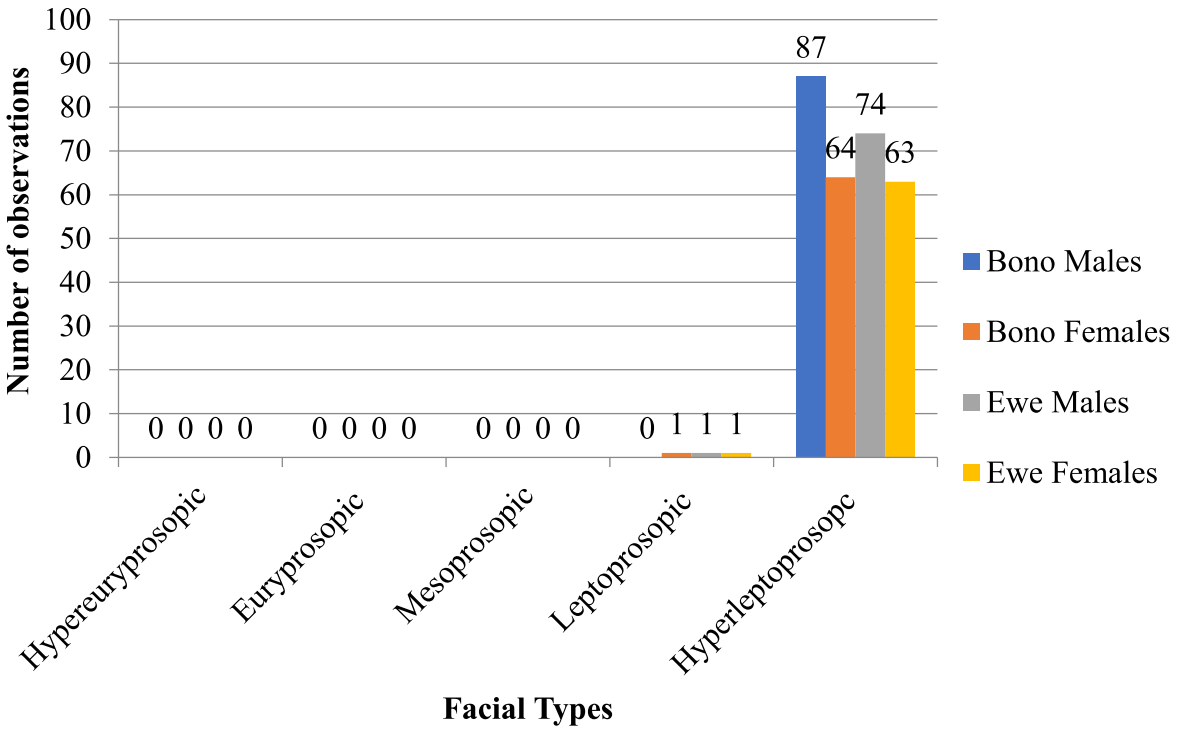

Fig. 1.. A bar chart showing the distribution of facial types by sex within the tribes.

occurred in 10% Akans and 2% Ewes. Changes in facial index between parents, offsprings and siblings can give a clue to genetic transmission of characters as asserted by Yesmin et al. [12].

According to Kyei et al. [35], the dominant face type of the Akans in the Assin District of the Central region of Ghana was hyperleptoprosopic with 46% in males and 40% in females. The least facial type was mesoprosopic with 2% in males and 4% in females. The situation was not different in Utter Bastar Kankar in India as reported by Ranjana [36], where the predominant type of face was hyperleptoprosopic, with the rarest being hypereuryprosopic (1%) in both sexes.

Oladipo et al. [37] reported that, 45% and 46% of the Igbo people of Abakaliki in Nigeria were hyperleptoprosopic and leptoprosopic respectively with a facial index of 90.02. This could be due to the varying mechanism of facial growth from tribe to tribe. Salve et al. [26] showed that, the dominant type of face in males was mesoprosopic (57.5%) and mesoprosopic (25%) in females in the Andhra Region of India. The least common type of face was hyperleptoprosopic (1.25%) in males and hypereuryprosopic (0.625%) in females. These varying facial types have strong connection with the environment, diet, geographical distribution, race among others.

Ogah et al. [19] stated that, leptoprosopic facial type was found in 38.75% male and 20.63% female participants. Euryprosopic was the commonest with 72% in both males and females, hyperleptoprosopic was absent in the facial index at University of Ilorin Teaching Hospital in Nigeria. However, the predominant facial type among three dominant ethnic groups of Gombe State, Nigeria was the leptoprosopic [29]. Kanan et al. [38] found that, euryprosopic was dominant (96%) and leptoprosopic (64%) was the least facial type among Gujarati males. In Central Serbia, leptoprosopic face type was dominant (81.7%) and hyperleptoprosopic was the rarest (5.56%) [27].

In a study by Shetti et al. [23] in India, the predominant face type was mesoprosopic with facial index for males and females being 87.19 and 86.75 respectively. In another related study by Ewunonu and Anibeze [39] in a South-Eastern Nigerian population, leptoprosopic facial type was the most dominant. Euryprosopic face was predominant among the Fars (37.7%) and Turkman (51.7%) ethnic groups in Northern Iran [22]. Mansur et al. [40] reported that, the commonest type of face was hyperleptoprosopic with a total prevalence of 75.68% (sex specifically, females contributing 70.43% with males having 81.31%), which was followed by leptoprosopic with a total prevalence of 19.37% (specifically, females contributing 20.87% and males having 17.76%) among the population of Dhulikhel, Nepal. Knowledge of the facial types especially in the Ghanaian population would be useful in the production of face masks, helmets, spectacles using bio-data of facial indices to create employment and help reduce poverty which is another challenge for Africa's Agenda 2063 [18]. This research seems to be the first among the Bonos and Ewes living in the Bono Region, making the results of this study essential for the wider research community by serving as a baseline data.

Conclusion

Male facial parameters were numerically greater than those of the female participants. The Bono participants recorded significantly greater morphological facial height and facial breadth than the Ewes. The dominant facial type was hyperleptoprosopic (very long face) and the least was leptoprosopic (long face). The results of the present study affirm population variation in facial anthropometry and reinforce the need to establish tribe-specific facial standards for Ghanaians. This study has also provided additional data of facial morphology for biometric and forensic purposes and facial reconstruction in Ghana.

Ethics approval and consent to participate

This work was approved by the Committee on Human Research, Publication and Ethics of the School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology and the Komfo Anokye Teaching Hospital with reference number: CHRE/AP/131/20. Participants read and signed the consent forms after the purpose of the research was explained to them.

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Declaration of Competing Interest

There are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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