RESEARCH ARTICLES

Morphological Evaluation of Cephalic Phenotypes in Purana (old) Inhabitants at Sigiriya Suburbs, Sri Lanka

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Abstract

This study was designed to determine the cephalic phenotypes of adult *Purana* (ancient) inhabitants living in the suburbs of Sigiriya, Sri Lanka, whose ancestry goes back to, the times of Sinhalese Kings, 5th century A.D. (1,450 YBP). One hundred and seven adult male and 206 female individuals belonging to *Purana* pedigree without craniofacial deformity were used as primary samples for the study. The head length and breadth were measured accordingly to the standard procedures as described in the literature and cephalic index and cephalic phenotype were determined for each individual. The study revealed that mean head length (18.2 cm) and mean head breadth (14.4 cm) of male were significantly higher than mean head length (17.5 cm) and mean head breadth (13.9 cm) of female, respectively ($P < 0.05$). The mean cephalic index was 79.40 in male and 81.00 in female. The dominant type of cephalic phenotype in male was mesocephalic (41%) followed by brachycephalic (29%), dolicocephalic (20%) and hyperbrachycephalic (10%). In females, dominant type of cephalic phenotype was mesocephalic (34%) followed by brachycephalic (32%), dolicocephalic (17%) and hyperbrachycephalic (17%). The common cephalic phenotype of the *Purana* population, irrespective of gender, was mesocephalic (35%). The data of the study will be useful to anthropologists, anatomists and forensic experts etc.

Keywords

Anthropometry, Cephalic Index, Cephalic Phenotypes, *Purana* Population, Sigiriya

Introduction

Geographical variation in anthropological traits, both quantitative and qualitative, of the populations is analyzed in current studies. Racial and ethnic affiliation, climatic, socio-economic, nutritional and genetic influences are known determiners of the craniofacial morphologies found in *Homo sapiens* (Bass 2005). The craniofacial anthropometry is an important branch of anthropometry used to describe phenotypic variations of humans. Cephalometry is one of the

important subfield in craniofacial anthropometry in which dimensions of head and face are measured. The cephalic index was introduced by the Swedish anatomist Retzius over a century ago to measure skull shape (Kelso 1974). The cephalic index is the percentage ratio of head breadth and head length (Williams et al. 1995). Cephalic index in human population varies from 70 % - 90 % (Harrison et al. 1990). The cephalic phenotypes of human population were described as dolicocephalic (71.0-75.9%), mesocephalic (76.0 - 80.9%), brachycephalic (81.0 - 85.9%) and hyperbrachycephalic (>86.0 %) according to the percentage value of cephalic indices (Rexhepi and Meka 2008). This is an important parameter that is useful in anthropological studies for assessing the variation between different genders as well as in ethnic groups. Comparative study on cephalic index between parents and their offsprings and siblings can give evidence to genetic transmission of inherited characters as well (Williamset al. 1995). Morphometry and morphology of head is also useful in pediatrics, forensic medicine, plastic surgery, diagnostic comprehension between patient and ordinary individuals.

Literature suggests that Sigiriya which is situated in the intermediate climatic zone in Matale district in Sri Lanka may have been occupied by *Homo sapiens* as far back as Mesolithic period of Sri Lanka (Adikari 1998). There is evidence to suggest that Sigiriya had been continuously occupied by *Homo sapiens* during the prehistoric, protohistoric and historic eras (Adikari 2008). Presently, the *Purana* population whose ancestry runs back to the times of the Sinhalese Kings of the 5th century A.D. (1,450 YBP) is mostly genetically and biologically isolated from the rest of the modern Sinhalese population living in the surroundings (Bandaranayake et al. (1990). Thus, Sigiriya is considered to be a site of anthropological importance where anthropological materials are available for investigations. Today, they face an imminent threat of extinction because of the isolation and inbreeding thus a detailed study of morphology, morphometry and genetics of the *Purana* population living at Sigiriya is a timely need. Thus, this study was designed to determine the cephalic phenotypes including morphology and morphometry in adult male and female *Purana* population at Sigiriya suburbs in Sri Lanka.

Materials and Methods

The *Purana* villages: *Talkote, Pidurangala, Diyakepilla* and *Nagalaweva* at Sigiriya suburbs were selected as study sites. With their consent 107 male and 206 female adult *Purana* inhabitants living in four *Purana* villages were included in this study and those who showed any craniofacial deformity or injury were excluded from the study. The age range of the subjects was from 20 - 37 years.

The selection of the individuals was based on the recorded *Purana* pedigree from the survey conducted at *Purana* villages in Sigiriya suburbs in 1981 (Bandaranayaka and Mogren 1994). The

survey launched in 1981 on population density, clans and castes of *Purana* villages of Sigiriya suburbs revealed that *Talkote, Pidurangala* and *Diyakepilla Purana* population had *Gamagedara, Aluthgedara, Undiyagedara, Beddegedara* as their surnames and *Nagalaweva* population was represented by their surnames such as *Millagahagedara, Kongahagedara* and *Aluthgedara* (Bandaranayaka and Mogren 1994). These surnames were identified as *Purana* surnames. The selected pedigrees such as *Gamagedara, Aluthgedara, Undiyagedara, Liyanagedara, Beddedar* are can be found in the *Purana* population at *Talkote, Pidurangala* and *Diyakepilla* and their traces can be traced back to at least three generations. Surnames such as *Millagahagedara, Kongahagedara* and *Aluthgedara* in *Nagalaweva* also can be traced back to three generations.

The ethical clearance to study cephalic indices and cephalic phenotypes was granted by the Ethics Review Committee of Faculty of Medical Sciences, University Sri Jayewardenepura, Sri Lanka (Ref No: 491/10).

Anthropometric Measurements

The selected persons were asked to remove any hair ornaments, jewellery, hair buns or braids. The maximum cranial length was taken from gabella, the bony prominence between the eyebrows and above the nasal depression, to the most posterior point of the occiput (inion) by spreading calliper as shown in Figure 1. The maximum length in between the two parietal eminences and right angle to the sagittal plane was measured as cranial breadth by spreading calliper (Fig. 2).

The cephalic index of each individual was calculated by using measured maximum cranial length and maximum cranial breadth of each individual adopting the following equation reported in Harrison et al. (1990).

$$\text{Horizontal cephalic index} = \frac{\text{Maximum cranial breadth} \times 100}{\text{Maximum cranial length}}$$

Maximum cranial length and maximum cranial breadth were measured after careful superficial palpation of anatomical landmarks and measurements were taken to the nearest 1 mm. All measurements were taken between 9:00 - 12:00 hours in the morning to eliminate discrepancies due to diurnal variation. All measurements were taken three times and the mean was taken for further analysis. All measurements were taken by the same individual to minimize the errors in data collection.

The measured and calculated quantitative cephalic parameters of male and female adult Purana populations residing in *Purana* villages:- *Piduranagala, Diyakepilla, Nagalaweva* and *Talkote* were statistically analyzed separately by applying Turkey's pair wise tests after one-way ANOVA (Minitab version 15) to determine the mean ±SD, range in parenthesis and the significant differences among gender. P value of < 0.05 was considered statistically significant.

The cephalic phenotype of each individual was categorized as Dolicocephalic (71.0 –75.9) Mesocephalic (76.0 - 80.9) Brachycephalic (81.0- 85.9) and Hyperbrachycephalic (>86.0) accordingly to percentage value of cephalic index (Williams et al. 1995).

Results and Analysis

The calculated mean horizontal cephalic index of male and female *Purana* population was (79.40 ± 4.95) and (81.00 ± 6.04) respectively. The mean cephalic index of female was higher than of male's significantly ($P<0.05$) (Table 1 and Table 2). Gender differences with respect to the mean cranial length, cranial breadth were found to be significantly higher in males compared to females ($P<0.05$). The common cephalic phenotype of the *Purana* population was mesocephalic 80.00 ± 3.95 represented by 35% in the population irrespective of gender. The mesocephalic cephalic phenotype was the most common cephalic phenotype seen in both male (41%) and female (34%) *Purana* populations in Sigiriya suburbs. (Table 3). The rare type of cephalic phenotype was Hyperbrachycephalic (15%).

Discussion

The variations of cephalic dimensions, indices and cephalic phenotypes of Homo sapiens in different parts of the world have been reported. (Thomas et al. 1980; Ricklan and Tobias 1986; Bhatia et al. 1994; Hwang et al. 1995; Manjunath 2002; Del Sol 2005; Golalipour 2006; Golalipour et al. 2007; Acer et al. 2007; Kumar and Gopichand 2013). The mean cephalic indices of the *Purana* male (79.43 ± 4.95) and female (81.04 ± 6.04) individuals in this study were higher than the mean value of present Sri Lankans (male as 78.04 and female as 79.32) (Illayperuma 2011). The mean cephalic index (80.00) of *Purana* population irrespective of gender which falls into mesocephalic head phenotype is higher than of the Indian population (76.06) that falls into mesocephalic head phenotypes (Bhasin 2006).

In the present study, the mean cephalic indices of the *Purana* males (79.43 ± 4.95) and females (81.04 ± 6.04) were close to of north Indian males (79.14), Igbo males (79.14) and north Indian females (80.74) respectively (Oladipo and Olotu 2006; Anitha et al. 2011).This finding was higher than of West African males (77.67), Haryanvi males in India (66.72), Andra males in India (76.28) (Odokumar et al. 2010; Gujaria and Salve 2012; Kumar and Gopichand 2013) and This finding was lower than Ijaw males (80.98), Ogonis males (111.18) and Gujarati males in India (80.42) (Oladipo and Olotu 2006; Oladipo and Olotu 2009; Gujaria and Salve 2012).

Mean cephalic index of females was 81.04 ± 6.04. This finding was higher than of Ijaw females (78.24), Igbo females (76.83), Ogonis females (75.09), Haryanvi females (72.25), Andra females (78.16) (Oladipo and Olotu, 2006; Oladipo and Olotu 2009; Gujaria and Salve 2012; Kumar and Gopichand 2013) and the finding was lower than of Gujarati females (81.20) (Gujaria and Salve 2012).

The dominant type of mesocephalic cephalic phenotype (medium wide-long head) of the *Purana* population (41% in males, 34% in females) was different from dolicocephalic cephalic phenotype (long head) of Sri Lankan males (35%) and brachycephalic phenotype of Sri Lankan females (46.15%) (Illayperuma 2011). The dominant phenotype of head in Purana males -mesocephalic (41%) was similar to Gujarati males in which 41% of male population mesocephalic and Mapuche males in Chile (Shah and Jadhav 2004; Del sol 2005) in which 66% of male population was mesocephalic. The second dominant cephalic phenotype in *Purana* males was brachycephalic (29%) which is predominant in Turkman males (42.4%) in North Iran and Tehran – Iran (36.6%) (Abolhasanzadeh and Farahani 2003; Gololipour et al. 2007). The third dominant cephalic phenotype in *Purana* males was Dolicocephalic (20%) which is predominant in Indian student males (33%) and Indian males (58.5%) (Bhatia et al. 1995; Yagain et al. 2012). The least common cephalic phenotype of Purana males was Hyperbrachycephalic (10%) which is predominant in Fars males in North Iran (52%) and South Iran (34. 3%) (Golalipour 2006; Vojdani et al. 2009).

In Purana females, mesocephalic (34%) cephalic phenotype was more common. It is similar to Indian females in Mahrasta (40%) (Nemade and Nemade 2014). The second dominant cephalic phenotype of *Purana* female was brachycephalic. Brachycephalic phenotype was dominant in females in Tehran -Iran (42.7 %), Southern Iran (42.5%) and Indian females (49%) (Abolhasanzadeh & Farahani 2003; Saha and and Jadhav 2004; Vojdani et al. 2009). The least common cephalic phenotypes of *Purana* female were hyperbrachycephalic (17%) and dolicocephalic (17%). The hyperbrachycephalic phenotype was dominant in Fars females in northern Iran (53.6%) (Golalipour 2006).

The most common cephalic phenotype identified through in this study Regardless of gender is mesocephalic (35%), which is similar to Mapuche individuals (66 %) and Gujaratees in India (41 %), Turkmans (42.4%) and Iranians (36.6%) (Abolhasanzadeh and Farahani, 2003; Shah and Jadhav 2004; Del sol 2005) and different from most of the other populations in the world such as Albanian Kosov populations (50.4 %) Albanians (79.5 %) and Greeks (48.97%) showed predominantly brachicephalic cephalic phenotype and Indians (58.5%) (Bhatia et al. 1955), Bulgarians (34 %) and Serbs (39.2 %) showed predominantly dolicocepahalics cephalic phenotype (Rexhepi and Meka 2008).

Comparing previous records of cephalic phenotypes of different races with present results indicates that Purana population living in Sigiriya suburbs in Sri Lanka is different from most other races in the world and present day Sri Lankans as well. Accordingly, it can be concluded that the Purana population living in Sigiriya suburbs is different from present Sri Lankans and most others in the world in terms of cephalic dimensions and cephalic phenotypes.

The variations in cephalic dimensions, indices and cephalic phenotypes between and within the population are attributed to a complex interaction between genetic and environment factors (Okupe et al. 1984; Kasai et al. 1993; Golalipour et al. 2003). The climatic conditions where they live play a major role in determining cephalic phenotypes (Bhasin et al. 1994). Climatic condition of monsoon activity with short dry season and cold winters along with short summer results in producing dolichocephalic head phenotypes as compared to other climatic regions. The variations of cephalic phenotypes have been identified among occupational groups, ethnic groups and language groups in India (Bhasin et al. 1994).

The proposition or the assumptions that the present-day *Purana* inhabitants at villagesin Sigiriya suburbs are descendants of the contemporary or near contemporary *Vedda* community in Sigiriya region or that they are in any way connected with the prehistoric hunter gatherers of the distant past is debatable (Bandaranayake et al. 1990). The *Purana* populations in Sigiriya do have *Purana* surnames such as *Aluthgedara, Gamagedara, Undiyagedara, Beddegedara, Millagahagedara, Kongahagedara* etc, and they their caste system exist by strictly practicing their marriages among themselves (Bandaranayak and Mogren 1994). They trace their ancestry to the times of the Sinhalese Kings of the 5th century A.D. (1,450 YBP) (Bandaranayake et al. 1990). Therefore, it can be hypothesized that this community continues to persist as an isolated population keeping genetic signature of ancient settlers. This may affect the cephalic phenotypic variations seen in *Purana* population.

Most of *Purana* population at Sigiriya suburbs presently speak Sinhala and are Buddhists just like modern day Sri Lankans. The subsistence economy of the *Purana* population was hunting and gathering of berries, tubers and edible wild plants. This is common to many traditional pre - modern Sri Lanka as *Vedda*. Themost distinctive specialization in this area in the past had been the extensive practice of honey-gathering which indicates reminiscence *Vedda* community way of life, especially the wet mountain *Vedda* (Bandaranayak and Mogren 1994). Today, they practice wet rice cultivation, *chena* cultivations, and livestock raring, hunting and fishing using traditional methods. The traditional occupational patterns in *Purana* population specific to them may affect the cephalic phenotypic variations seen in *Purana* population as discussed in the Bhasin et al. (1994).

Genetic factors, traditional occupational patterns may affect the cephalic phenotypic variations seen in *Purana* population more than other determiners of cephalic phenotypes such as ethnic groups, language groups, climatic factors, altitude etc.

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Tables

Table 1 - Head measurements and cephalic indices of the *Purana* male population (n=107)

	Mean	S. D	P value	Range Minimum	Maximum
Head length	18.2	0.95	0.000	13.5	18.9
Head breadth	14.4	0.99	0.000	10.40	18.50
Cephalic Index	79.4	4.95	0.019	69.44	82.35

Table 2 - Head measurements and cephalic indices of the *Purana* female population (n=206)

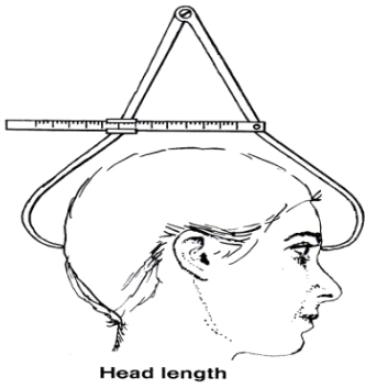
	Mean	S. D	P value	Range Minimum	Maximum
Head length	17.5	1.08	0.000	12.0	18.5
Head breadth	13.9	0.88	0.000	11.00	17.02
Cephalic Index	81.0	6.04	0.019	64.86	84.41

Table 3 - Frequency of cephalic phenotypes among Purana male and female population (n=213)

Head phenotype	Male	Female	Both male and female
Dolicocephalic (71.0 -75.9)	20%	17%	18%
Mesocephalic (76.0 - 80.9)	41%	34%	35%
Brachycephalic (81.0- 85.9)	29%	32%	32%
Hyperbrachycephalic (>86.0)	10%	17%	15%

Figures

Fig. 1. Spreading caliper position for maximum cranial length



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