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Evaluation of Cephalic Index of the Henanigala Indigenous People in Sri Lanka

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ABSTRACT

Cephalic parameters are important in the studies of population variations, ethnic, racial and sexual identifications etc. The present study was aimed at evaluating the Cephalic Index (CI) of one group of indigenous people (Vedda community) living in Henanigala village in Sri Lanka. Despite their unique biological and cultural characteristics among other ethnic groups in the country, little attention was given to their cephalometric characteristics. A sample of one hundred and sixty-four (164) adult subjects comprising 106 females and 58 males were included in the study. They were divided into 5 age groups (19-29, 20-29, 30-39, 40-49, 50-59, 60yr+) and measured Cephalic Breadth (CB) and Cephalic Length (CL) individually. CI was calculated by dividing the CB by CL and multiplying by 100. Data were analyzed using SPSS data analyzing package and sexual differences were traced through t - test ($p<0.05$). CB, CL and CI of the females were 13.27 cm, 17.01 cm and 78.18 respectively. In males CB, CL and CI were reported as 13.51 cm, 17.48 cm and 77.30 respectively. Gender-based statistically significant differences were found in all principal cephalic dimensions. Among females and males most dominant cephalic types recorded were mesocephalic and brachycephalic which account for 45% and 26% among females and 43% and 29% among males respectively. The results of this study are significant for the anthropological, archaeological, forensic and clinical-oriented fields of studies where data are scarce.

KEYWORDS: *Cephalometry, Cephalic Index, Henanigala, Sri Lanka, Vedda People*

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1 INTRODUCTION

Veddas; the indigenous people of Sri Lanka are the descendants of pre-historic humans who inhabited the the Mesolithic Age of the country over 48,000 Years Before the Present (YBP) (Deraniyagala 1992; Perera et al. 2011; Wedage et al. 2019). They were the first anatomically modern human migrants to Sri Lanka dating to tens of thousands of years back when compared with the more recent migration of the contemporary ethnic groups namely Sinhalese, Tamils and Muslims etc.; the later arrivals (Wijayapala 1997; Kulathilake 2016; Wedage et al. 2019).

Presently, the Vedda community is experiencing marginalization due to development projects, resulting in their confinement to limited areas within the country. The impact of these development initiatives, coupled with resettlements, has led to their extensive assimilation with other major ethnic groups (Wijesekara 1982; Lund 2000; Ananda & Nahallage 2022). Consequently, the unique cultural and physical features of this distinctive group of people are diminishing and are at risk of disappearing rapidly, influenced by the swift socio-cultural changes that have similarly affected numerous indigenous and tribal groups worldwide (Ananda & Nahallage 2023).

Cephalometry is one of the four fields of Anthropometry and is a commonly used method for tracing population-based affinity and variation patterns. Cephalic index (CI) is the ratio of the maximum breadth of the head/cephalic (CB) region of an individual divided by its maximum length (CL) and multiplied by 100 (CI = CB/CL x 100). Based on the calculated cephalic indices data on various populations over the world, five cephalic types/shapes have been developed; hyper dolichocephalic (very long narrow headed - ≤ 69.9), dolichocephalic (long headed - 70 to 75.90), Mesocephalic (medium headed -76 to 80.9), brachycephalic (short broad headed 81 to 85.5), and hyper brachycephalic (very short broad headed ≥ 85.6) (Williams et al. 1995; Mostafa et al. 2013).

These cephalic indices and shape-based studies play a crucial role in anthropological studies, particularly when examining indigenous populations such as the Vedda people of Sri Lanka. These indices are instrumental in understanding human variation and evolution, providing insights into the morphological diversity within populations (Praveen et al. 2013; Salve et al 2013). By studying the head shape and size of indigenous groups, researchers can trace the evolution and adaptation of human populations over time. Migration patterns are another key aspect where cephalic indices prove valuable, especially for indigenous populations with unique genetic and morphological characteristics (Doni et al. 2013). In the case of the Vedda people, considered the first anatomically modern human migrants to Sri Lanka, cephalometric studies contribute to understanding their migratory history and interactions with other groups. Cephalometry allows for the identification of population-based affinities, as researchers analyze cephalic indices to discern similarities and differences between indigenous groups and other ethnic groups/populations (Jadav et al. 2011). The study of sexual differences through cephalic indices provides insights into the demographic structure of indigenous communities, contributing to a comprehensive understanding of population dynamics (Golalipour 2006; Mostafa 2013; Shah et al. 2015). Changes in cephalic indices over time can indicate socio-cultural factors, environmental influences, and interactions with other communities. Monitoring these variations helps researchers understand the ongoing evolution and adaptation of indigenous populations. By documenting and analyzing distinctive cephalometric features,

researchers help validate and preserve the unique characteristics defining a particular group.

Thus far only a handful of studies such as Sarasin & Sarasin (1886), Marret, (1937-1939) (Stoudt, 1961), Ilayperuma, (2011) and Chandimal et al. (2015) etc. have been conducted on the vedda people and other ethnic groups of the country to trace distinctive cephalometric features (Ananda & Nahallage 2019). The data on the cephalometry of the Vedda people is not only important to the Sri Lankan context but to the continental context too.

Considering the validity of Vedda peoples' cephalometry in human variation, evolution, migration pattern-based studies and in tracing sexual differences as mentioned above (Rabey 1971; Williams et al. 1995; Shah & Jadhav 2004; Umar et al. 2011; Kulathilake 2012) this research was carried out with the primary aim of evaluating the CI of the Vedda people living in Henanigala area, in the Eastern Province (Ananda 2019).

2 RESEARCH METHODOLOGY

In the present study, one hundred and sixty-four (164) Vedda people were purposively selected from the Henanigala indigenous village in the Eastern Province of Sri Lanka, ensuring their affinity to the indigenous people of the country; the Vedda people. These one hundred and sixty-four (164) adults comprised 106 females and 58 males (19 ≤ years). They were divided into 5 age groups as indicated in Table 1. Ethical clearance for the study was obtained from the Ethics Review Committee of the Faculty of Medical Sciences, University of Sri Jayewardenepura. Before taking the measurements, written consent was obtained from the participants after explaining the purpose of the study.

Before commencing the measurements, the head of the subject was allowed to rest in the eye-ear plane or Frankfurt plane [lower margins of the orbits, and the poria (ear canal upper margins) all lie in the same horizontal plane]. Subjects were made to sit on a low stool and given instructions to stay still in his/her position while taking measurements. All the measurements were taken twice, and the mean was calculated to ensure the accuracy of the measurements taken. Measurements taken using a spreading caliper were recorded to the nearest centimeter to an accuracy of 0.10 (Bass 1987; Anthropometry Procedures Manual 2009).

The measured cephalometric parameters are as follows (Bass 1987).

Cephalic Breadth (eu-eu: EURYON) distance between laterally placed points on the sides of the head.

Cephalic Length (g-op): distance between glabella (g); point above the nasal root between the eyebrows and intersected by mid-sagittal plane and opisthocranion (op); most posterior point on the posterior protuberance of the head in the mid-sagittal plane.

Cephalic Index was calculated dividing cephalic breadth by cephalic length and multiplying by 100 (Cephalic Index = Cephalic Breadth/Cephalic Length x 100). According to the cephalic index head shapes were classified as hyper dolichocephalic (≤69.9), dolichocephalic (70 to 75.9), mesocephalic (76 to 80.9), brachycephalic (81 to 85.5) and hyper brachycephalic (≥85.6) (Williams et al. 1995; Mostafa et al. 2013).

Descriptive statistics: mean, ranges, standard deviation and standard error were calculated using

SPSS *(Statistical Package for Social Sciences)* version 16.0. From the observations of the present study the parametric data were analyzed using student *t-test*. A P value of < 0.05 was considered statistically significant.

3 RESULTS & DISCUSSION

The mean, minimum (Min), maximum (Max.), standard deviation (SD) and standard error (SE), were calculated for cephalic breadth (CB), cephalic length (CL) and cephalic index (CI) of the Henanigala Vedda females and males and the data are presented in Table 1. Comparisons of cephalic indices between male and female groups are presented in Table 2.

Table 1. Age ranges, minimum (Min), maximum (Max), mean, standard deviation (SD) and standard error (SE) of Cephalic Breadth (CB) (cm), Cephalic Length (CL) (cm) and Cephalic Index (CI) of male and female Vedda people of Henanigala.

Age (years)	Parameter	Female						Male					
		N	Min.	Max.	Mean	SE	SD	N	Min.	Max.	Mean	SE	SD
19-29	CB	29	12.00	15	13.37	0.15	0.79	15	13.08	14.04	13.89	0.08	0.33
	CL	29	16.00	17.2	16.77	0.09	0.46	15	17.01	18.02	17.43	0.13	0.49
	CI	29	69.77	87.92	79.81	0.91	4.88	15	72.67	82.42	79.76	0.90	3.48
30-39	CB	37	13.00	14.02	13.34	0.08	0.47	12	13.05	14.06	13.69	0.14	0.48
	CL	37	16.00	18.01	17.03	0.13	0.79	12	17	18	17.20	0.11	0.38
	CI	37	72.22	87.5	78.52	0.76	4.64	12	76.58	82.71	79.65	0.82	2.83
40-49	CB	10	13.00	14	13.50	0.14	0.45	12	13.02	14.03	13.60	0.13	0.46
	CL	10	16.00	18	17.02	0.21	0.67	12	17.02	18.03	17.70	0.14	0.48
	CI	10	76.47	83.75	79.38	0.99	3.12	12	72.25	79.32	76.84	0.67	2.34
50-59	CB	14	12.07	14	13.04	0.14	0.54	8	13	14	13.25	0.16	0.46
	CL	14	16.05	18.03	17.60	0.20	0.74	8	17.02	18	17.76	0.16	0.45
	CI	14	66.94	81.18	74.20	1.19	4.45	8	72.22	82.26	74.75	1.64	4.64
60yr+	CB	16	12.25	14	13.00	0.12	0.50	11	12.05	14.02	12.87	0.22	0.72
	CL	16	16.01	18	16.88	0.19	0.75	11	17	18.03	17.44	0.15	0.49
	CI	16	69.60	81.51	77.17	1.08	4.33	11	69.6	77.76	73.75	0.96	3.18

Table 2. Age-based comparative Analysis of Cephalic Breadth (CB), Cephalic Length (CL) and Cephalic Index (CI) between Henanigala males and females

Age	Parameter	t	df	Sig. (2-tailed)
19-29	CB	-3.04	40.75	0.00*
	CL	-4.42	42	0.00*
	CI	0.03	42	0.97
30-39	CB	-2.25	47	0.03*
	CL	-0.99	40.00	0.33
	CI	-0.79	47	0.43
40-49	CB	-0.50	20	0.62

	CL	-2.78	20	0.01*
	CI	2.18	20	0.04*
50-59	CB	-0.96	20	0.35
	CL	-0.54	20	0.60
	CI	-0.27	20	0.79
60yr+	CB	0.58	25	0.57
	CL	-2.17	25	0.04*
	CI	2.23	25	0.04*

*Sexual difference is significant at P≤0.05

The mean CB of the females, and males of the entire study population was 13.27 ± 0.6 cm and 13.51 ± 0.6 cm, CL was 17.01 ± 0.72 cm, and 17.48 ± 0.49 cm, CI was 78.18 ± 4.78 and 77.3 ± 4.02 respectively.

According to the age group-based t-test, gender-based differences (sexually dimorphic) were significant in CB among the subjects that belong to the 19-29, and 30-39 age groups. Subjects that belong to 19-20, 40-49 and 60yr+ age groups showed significant gender differences in CL. However, only the subjects that fell into the 40-49 and 60yr+ age groups showed gender-based differences in CI ($p<0.05$) (Table 2). Intriguingly none of the measured parameters were sexually dimorphic in the subjects that belong to the 50-59 age group.

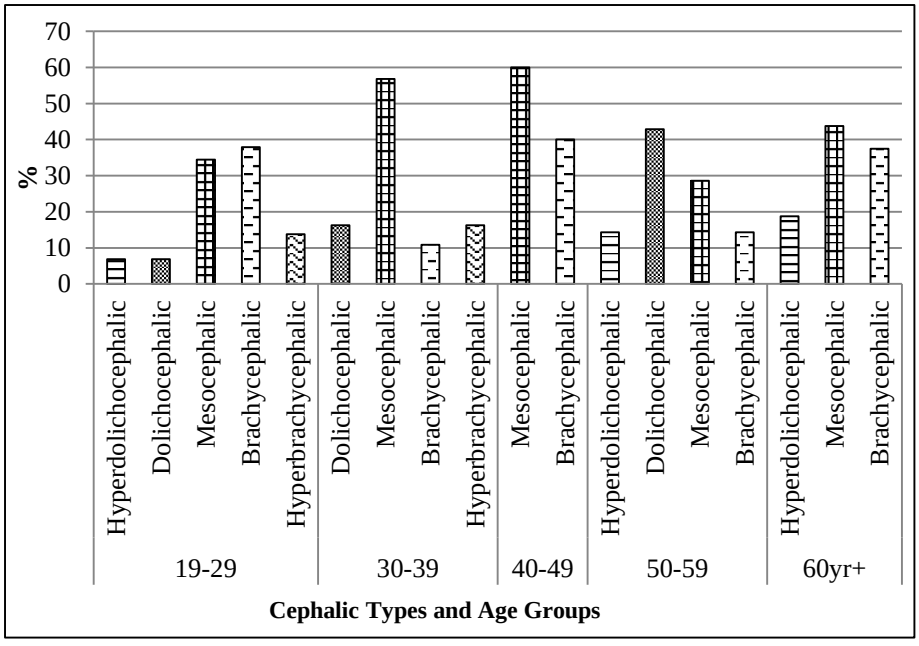

Figure 1. Cephalic types of Henanigala females according to cephalic index

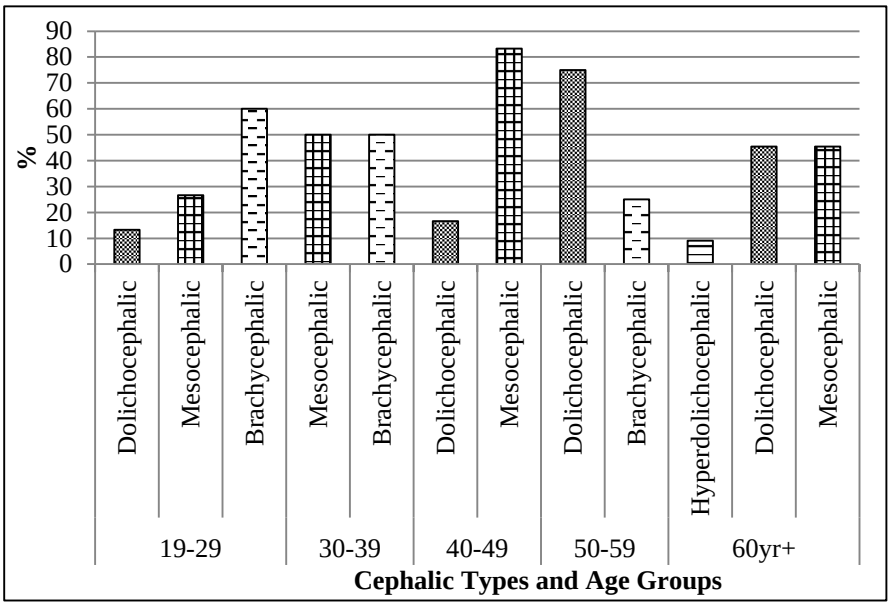

Figure 2. Cephalic types of Henanigala males according to cephalic index

The morphological classification of the cephalic types was carried out based on the calculated cephalic indices (Figure 1 & 2). The dominant cephalic type of the females (40%) and males (60%) in the19-29 age group was brachycephalic (short broad headed). The majority of the females of the 30-39 age group were mesocephalic (medium headed, 57%) and males of the same age group show both mesocephalic (50%) and brachycephalic (50%) types. The dominant cephalic type of both males (83%) and females (60%) of the 40-49 age group was mesocephalic. Dolichocephalic (long headed) was the dominant cephalic type of both males (75%) and females (43%) that belong to the 50-59 age groups. The most prominent cephalic type found among the females that belong to the oldest age group of 60yr+ was mesocephalic (44%). Among males of this age group prominent cephalic types found were dolichocephalic (46%) and mesocephalic (46%).

Sexual dimorphism was prominent among the subjects of the 19-29 age groups in CB and CL ($p<0.05$). It was also evident in CB among the subjects that belong to the 30-39 age group. Further, subjects that belonged to the 40-49, and 60+ year age groups were sexually dimorphic in CL and CI. Only the 50-59 age group which did not show sexual differences in measured parameters.

Previous literature on the cephalometry of the Sri Lankan populations including; Vedda people and main ethnic groups; Sinhalese and Tamils have been limited to one age group or one gender. Thus, there is a limitation in conducting in-depth age-based discussions using previous data with the current study.

According to the Merret's data on various ethnic groups of the country including the Vedda people from Anuradhapura (n = 24) and Badulla (n = 113) areas, mean CL of overall Vedda sample was 18.42 ± 0.7 cm (n = 137, r=16.4-20.5), (Anuradhapura: 18.54 ± 0.6 cm, r = 17.2 - 19.5 and Badulla Veddas: 18.39 ± 0.71 cm, r = 16.4 - 20.5) which were higher than the Henanigala adults CL (17.18 ± 0.69 cm) (Stoudt, 1961). In addition, Henanigala adult Vedda people had lower CL than that of the Marret's Sinhalese 18.16 ± 0.68 cm (n = 628, r=15.8 - 20.5) and Tamil sample 18.87 ± 0.72 cm (n= 587, r=16.4-20.5) (Stoudt, 1961). Ilayperuma (2011), based her study on a sample of 400 medical students (220

male and 180 female) and stated that Sri Lankan adults have a CL of 17.8 ± 1.1 cm. Henanigala Vedda people have a lower CL value than that of Ilayperuma's sample.

Though the present data on CB of Henanigala Vedda people (13.36 ± 0.61 cm) are comparable more to Marret's overall Vedda sample [13.49 ± 0.48 cm (R=12.4-15.1)] as well as Badulla [13.48 ± 0.48 cm (r=12.4 - 15.1)] and Anuradhapura Vedda communities [13.56 ± 0.52 cm (r=12.4-14.5)], Henanigala people recorded the lowest CB among the three communities (Stoudt, 1961). In addition, their mean CB was lower than that of Ilayperuma's Sri Lankan adults' mean CB of 14.46 ± 0.72 cm (Ilayperuma 2011).

The CI of Henanigala adults (77.87 ± 4.53) were higher than that of Sarasin's Vedda (n=19, Mean=70.5, r= 64.9-75.9) and Marret's Vedda (73.46 ± 3.72, r=67-89) populations, including both Anuradhapura (73.37 ± 3.81 (r=67-83) and Badulla Vedda communities (73.48 ± 3.70 (67-89). In addition, Henanigala adults recorded lower CI than that of Marret's Sinhalese (78.33 ± 4.50, r=67-91) and Ilayperuma's Sri Lankan adults (78.54 ± 6.35).

According to the classification of the cephalic types based on the calculated cephalic index, Henanigala adults were dominantly mesocephalic (medium-headed - 45%) followed by brachycephalic (short broad-headed - 27%) and dolichocephalic (Long headed - 18%). Concerning the head shape, Sarasin included Vedda people into the dolichocephalic type (long headed) (Sarasin & Sarasin 1886; Seligman & Seligman 1911; Seligman & Seligman 2011), which was also found among 18% of the Henanigala Vedda community during the present study. In Ilayperuma's study, both sexes together had the Brachycephalic (short and broad-headed, 33.07%) followed by the dolichocephalic type (29.04%) (Ilayperuma 2011) which was the second common type among Henanigala adults (27%). Chandimal et al.'s study on the Purana Inhabitants (belonging to Thalkote, Diyakepilla, Nagalawewa and Pidurangala purana villages, n = 312) resembled Henanigala adults in cephalic type as the majority of the individuals in both groups belong to the mecocephalic type (medium headed) (Chandimal et al. 2015). Differences in cephalic indices among these populations can be attributed to complex interactions between genetic, ethnic and environmental factors within and between populations. Most prominently it could also be due to rapid assimilation which constantly occurs among different ethnic groups as stated by the studies of Kasai *et al*., (1993) and Golalipour (2006).

4 CONCLUSION & RECOMMENDATIONS

Contiguity and discontiguity in cephalic characteristics within and between populations have also been demonstrated in various studies. In comparison with these studies it was evident that Henanigala Vedda People have a closer mean cephalic index to the Marret's Sinhalese (78.33 ± 4.5) (Stoudt 1961), Ilayperuma's Sri Lankan (78.54 ±6.35) (Ilayperuma 2011), South Indian (76.78) (Doni et al. 2013), Mumbai Indian (78.48) (Khair et al. 2013) and Andhra region Indian populations (76.94) (Salve et al. 2011). This study highlights the importance of a detailed knowledge of population-specific data on cephalic characteristics, with comparisons between and within populations amongst different ethnic and geographical backgrounds.

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