ORIGINAL RESEARCH

A Descriptive Study on the Orbital Morphology and Morphometry in a Sri Lankan Sample: A Guide for Surgical Procedures and Forensic Verifications

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Abstract

Objective: Gender-specific normative measurements and morphological classifications of the bony orbit in the Sri Lankan population are essential for accurate craniofacial surgical planning and reliable forensic and anthropological verification of identity.

Materials and methods: We analyzed 148 orbital cavities from 74 dry adult Sri Lankan skulls (41 male, 33 female). Seven orbital measurements were taken, including orbital width, orbital height, superior orbital depth (SOD), inferior orbital depth (IOD), and margino-fissural distance (MFD). The orbital index was calculated to classify the orbital morphology. Statistical analyses were performed to determine sex-based differences and bilateral symmetry.

Results: Significant sexual dimorphism was noticed in both the Orbital Width and the Orbital Index ($p < 0.005$ for both). Males exhibited wider orbits (mean width: 41.14 mm) orbital Index - 60.09 to 95.08. Females had higher orbital Index (mean 86.76) range - 66.47 -108.56). SOD-ranged from 34.85 to 55.03 mm; IOD ranged from 37.47 to 54.99 mm; MFD-ranged from 14.21 to 28.24 mm from the inferior rim. No statistically significant difference was found between the right and left orbits in either gender.

Conclusion: This research provides population-specific orbital standards for the Sri Lankan population, including definitive data ranges for critical landmarks.

Keywords: Anthropometry; Anatomy of Orbit: Sex Characteristics; Sri Lanka

DOI: https://doi.org/10.4038/slaj.v10i2.334

Sri Lanka Anatomy Journal 2026; 10(II): 66–79

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Received 21/07/2026 *Revised version accepted 20/10/2026* *Published 11/11/2026*

Introduction

The orbital cavities are located anterosuperiorly on either side of the sagittal plane of the skull. Each orbit is pyramidal with its base facing anterolaterally, while its apices project posteromedially (1). Each orbital cavity accommodates the eyeball and associated muscles, nerves, vessels, and lacrimal glands, and it allows the accurate positioning of the visual axis, which is essential for binocular vision in humans (2). The orbit contains the eyeball, extraocular muscles, lacrimal apparatus, connective tissue fat pad, and neurovascular structures. The orbital dimensions are crucial in neurosurgery, maxillofacial surgery, and ophthalmology, and they aid in the diagnosis, surgical planning, and postoperative follow-up for craniofacial and orbital complications such as extraocular muscle tumors, infections, trauma, and Grave's disease (3).

Orbital measurements vary among individuals concerning age, sex, and ethnicity. The racial variation in orbital dimensions is due to evolutionary processes and inheritable mutations acted upon by natural selection with subsequent selective adaptation of humans to their environment (4). These variations have led to individualization, a major aspect of forensic anthropometry. Craniofacial morphologies are considered major anthropometric tools in the identification of individuals in forensic medicine. Therefore, orbital features within it may offer additional insight into the determination of intraspecies human variations in craniofacial anthropometry (5).

The basic anthropometric measurements of the orbit, including orbital width, orbital height, inferior and superior orbital depths, interorbital and bi-orbital distances, and the marginofisural distance, are commonly taken in assessing orbital variations. In addition to these measurements, one well-utilized measure in orbital morphology is the orbital index (OI). It is the ratio between orbital height and its width multiplied by 100 (6). According to previous data, three categories of OI have been described as a population in the world. Megaseme describes an OI of ≥89, and this type is usually seen in Mongoloid races. Mesoseme describes an OI between 89, to 83 and it is typically seen in Caucasians. Microseme describes an OI of ≤83, and it is typically seen in African races (7, 8).

There were limited reported studies conducted in assessing orbital morphometry in Sri Lankans, and a small number of morphometrical parameters were assessed. The sample represented in theSri Lankan population included in such studies was small and limited to small locations in the country (9,10,11). According to the reported literature on the orbital index of Sri Lankans, one study reported that there were significant variations in OI between males and females, in which males were classified as Microseme while females were classified as mesoseme, and the microseme type is dominant among Sri Lankans (9). Another study showed that the mean orbital index (MOI) with half of the sample belonged to the microsome category, while 27.7% of the sample belonged to the megasome category and further highlighted that each category had equal gender distribution (11). Therefore, the results of the reported orbital indices of Sri Lankans would not give a clear understanding of the orbital morphologies and other important orbital morphometric parameters of Sri Lankans, which were not included in such studies.

Specific morphometric data on orbit morphometry are also required for

comprehensive assessment and preoperative planning in areas of neurosurgery and craniofacial surgery. Moreover, it is required to assess the craniofacial database based on the anthropometric measurements by the surgeon to treat congenital disfigurement and trauma for the safety and efficacy of clinical treatment (12,13). Superior Orbital Depth is typically measured from a point on the supraorbital margin (brow ridge) to the orbital opening of the optic canal at the orbital apex. The optic canal transmits the optic nerve (Cranial Nerve II), which is essential for vision. The superior orbital depth indicates the posterior limit of a safe superior surgical dissection. Exceeding this depth risks injury to the optic nerve, which can lead to blindness. Roof procedures are a key consideration in surgeries involving the orbital roof, such as those accessing the frontal lobe or repairing orbital roof fractures. A commonly suggested safe depth for superior orbital dissection is around 53 mm (though this varies by sex and population).

The inferior orbital depth of the orbit measurement taken from a point on the inferior orbital margin (lower rim) to the orbital opening of the optic canal facilitates communication between the orbit and the infratemporal and pterygopalatine fossae (10). Similar to the superior depth, the inferior depth defines the safe posterior limit for dissection and reconstruction of the orbital floor. This is crucial during the repair of "blowout" fractures of the orbital floor, which are common. A suggested safe depth into the orbital cavity on the floor is around 55 mm to avoid the optic nerve (10).

The margin-facial distance (MFD) is the distance from the inferior orbital margin to the anterior extent of the inferior orbital fissure (IOF). During inferior orbital wall reconstruction, the surgeon must consider the distance between the anterior extent of the inferior orbital fissure and the inferior orbital margin. During surgical procedures, care should be taken not to damage the structures passing through the fissure, such as the infraorbital nerve and the inferior ophthalmic vein. Moreover, during deep orbit surgical procedures, it is important to have a clear idea about the superior and inferior orbital depths to prevent damage to the optic nerve (10).

Standardizing data of orbital indices, interorbital distances, and bi-orbital distances are important measurements in the diagnosis of craniofacial syndromes and post-traumatic deformities. Prior knowledge of the normal values and their ranges among genders and even the left and right sides of each gender for a particular orbital morphometry is essential to designing and treating maxillofacial abnormalities and to make the best surgical outcome and functional outcome. For these purposes, standards based on local data are preferable because these standards reflect the various patterns of craniofacial growth resulting from racial, ethnic, social, behavioral, and dietary habits (14).

Thus, this study aimed to describe the orbital measurements in Sri Lankans, including important bony distances and orbital indices that are primarily applicable for evaluating cardinal structures of the eye orbit in surgery and anthropometric assessments. The study also contributes to updating the knowledge of orbital morphometry among genders and develops gender-specific Sri Lankan standard values for orbital measurements to be used in forensic identifications.

Materials and Methods

18 dry adult skulls from the Department of Anatomy, Faculty of Medicine, Wayamba

University of Sri Lanka which is located in the Northwestern province of Sri Lanka, 29 dry adult skulls from the Department of Anatomy, Faculty of Medicine, University of Peradeniya which is located in Central province of Sri Lanka and 27 dry adult skulls from Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura which is located in the western province were included in the study. The total of 148 orbital cavities in the 74 adult skulls were studied in detail. Skulls with maxillary tooth sockets for third molar teeth, free of orbital deformities, were included in the study. Skulls with pathological abnormalities were also excluded from the study. The sex of each skull was estimated using established morphological characteristics of the cranium, including the supraorbital margin, glabella and frontal eminences, following the criteria described by Bass (2005) and White *et al.,* (2011). These features were assessed to classify the skulls as male or female for the analysis of orbital measurements. However, sex was estimated from cranial morphology rather than confirmed using an independent reference standard. Therefore, the possibility of misclassification cannot be excluded. The age of the skulls was determined by tooth eruption and wear patterns on the maxillary teeth as described in Bass, 2005. The authors hereby confirm that every effort was made to comply with all local and international ethical guidelines and laws concerning the use of human cadaveric donors in anatomical research (15, 16).

The following seven orbital measurements described in table 1 were measured with reference to bony landmarks highlighted in figure 1 for both sides of the eye orbit separately with 0.1 mm accuracy by using a digital Vernier caliper. The inferior orbital depth, superior orbital depth, and margino-fissural distance were measured to locate the important neurovascular bundle in the orbital foramen and the neurovascular bundle in the inferior orbital fissure, highlighted in Figure 2. The orbital with and length, interorbital distances, and bi-orbital distances were measured to determine the norms of mean and ranges of male and female Sri Lankans for designing and treating maxillofacial abnormalities and to achieve the best surgical outcome and functional outcome. The present measurements are important in the identification of the neurovascular bundle and maxillofacial surgeries

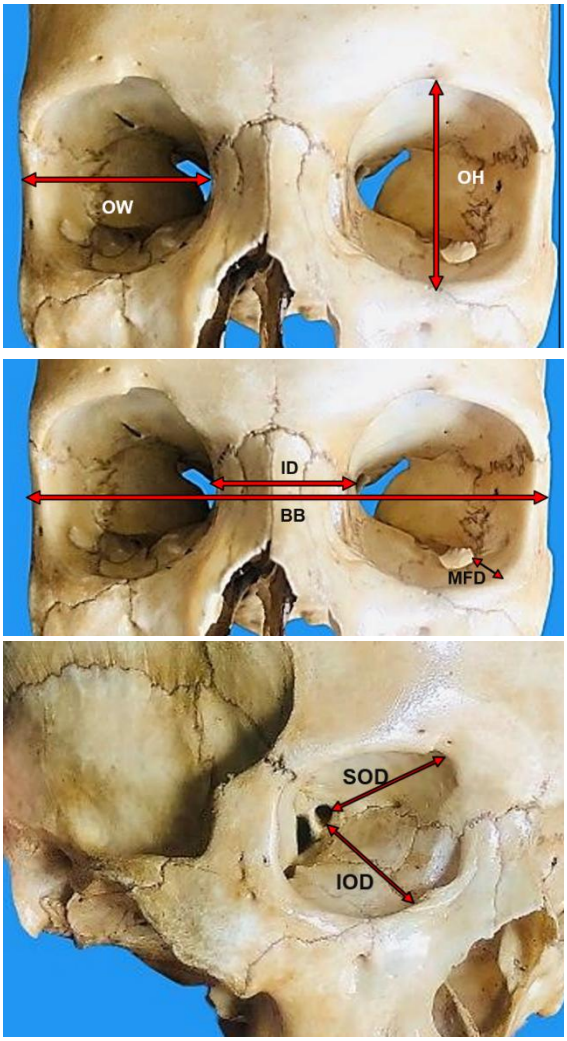


Figure 1: Landmarks for the orbital measurements. OW- Orbital width, OH- Orbital height, BB- Bi orbital distance
ID- Inter orbital Distance, MFD-Margino fissural Distance, SOD- Superior Orbital Distance, IOD- Inferior Orbital Distance

Table 1: Orbital measurements and their anatomical landmarks

Orbital measurements	Importance in application	Anatomical landmarks
Orbital height OH)	Maxillofacial surgery/ Gender determination	The distance between the midpoints of the upper and lower margins of the orbital cavity.
Orbital width (OW)	Maxillofacial surgery/ Gender determination	The distance between the midpoint of the medial and lateral margins of the orbit.
Biorbital distance (BOD)	Maxillofacial surgery/ Gender determination	The distance between the left and right ectoconchion (intersection of the most anterior surface of the lateral wall of the orbit and a line bisecting the orbit along its long axis).
Interorbital distance (ID)	Maxillofacial surgery/ Gender determination	The distance between the left and right dacryon (the point on the medial wall of the orbit at which the frontal, lacrimal, and maxilla bones intersect).
Superior orbital depth (SOD)	Identification of neurovascular bundle/ Gender determination	The distance between the supraorbital notch to the superior aspect of the orbital opening of the optic canal.
Inferior orbital depth (IOD)	Identification of neurovascular bundle/ Gender determination	The distance between the inferior orbital margin directly above the infraorbital foramen to the inferior aspect of the orbital opening of the optic canal.
Margino-fissural distance (MFD)	Identification of neurovascular bundle/ Gender determination	The distance between the inferior orbital margin to the anterior extent of the inferior orbital fissure, the point directly above the infraorbital foramen on the inferior orbital margin

A single observer did all measurements, every measurement was taken thrice, and the mean was taken for analysis. The mean value of each measurement of right and left eye orbit was taken for male and female orbits and was calculated separately by using SPSS 23.0 version. A comparison of the orbital measurements was done using an independent sample t-test and a paired samples t-test. The mean values of the measurements of male and female eye orbits were compared using the independent sample t-test. The measurements of the right and left sides of male and female eye orbits were compared separately using the paired samples t-test.

The orbital index (OI) was calculated as (orbital height/orbital width) *100 (17). Using the OI, the orbits were classified as either megaseme (OI ≥ 89), mesoseme (OI = 83-89), or microseme (OI ≤ 83) (18) The Chi-square test was used to determine the prevalence of the orbital morphologies with the side of orbit and gender. Statistical significance was considered at $p < 0.05$.

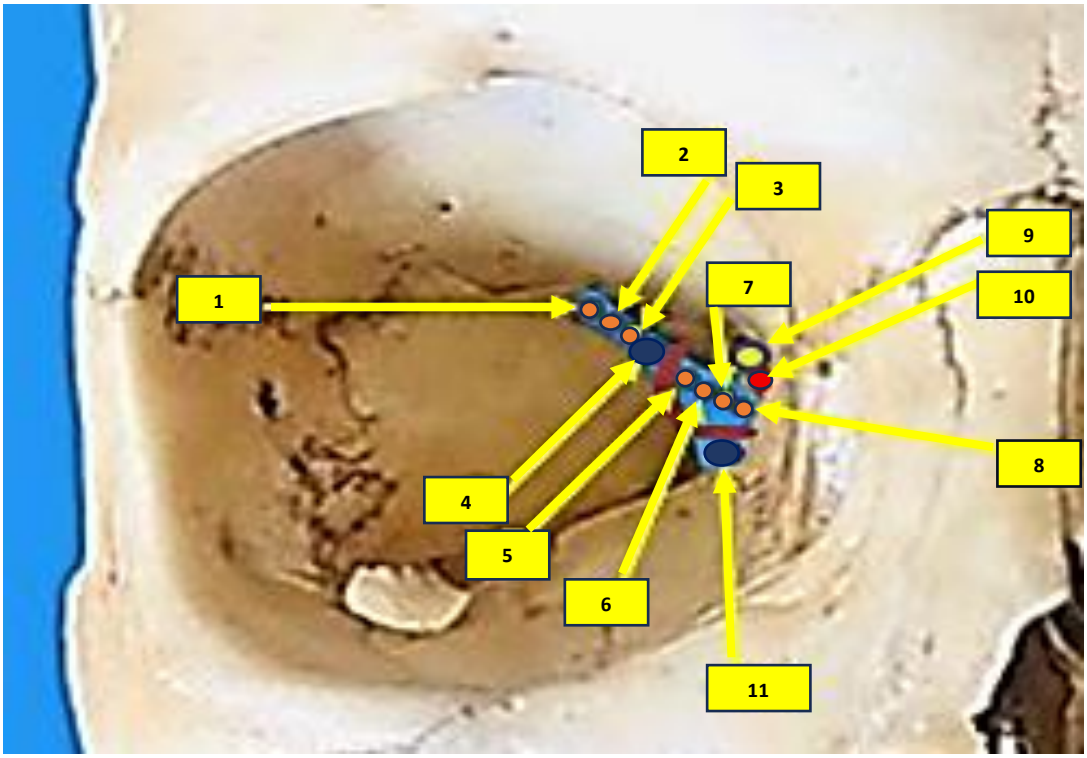


Figure 2: Structures pass through Inferior orbital fissure, Superior orbital fissure and Orbital canal. 1-Lacrimal nerve, 2-Frontal nerve, 3-Trochlear nerve, 4-Superior ophthalmic vein, 5-Superior division of oculomotor nerve, 6-Nasocilliary nerve, 7-Abducent nerve, 8-Inferior division of oculomotor nerve, 9- Optic nerve, 10-Ophthalmic artery, 11-Inferior ophthalmic vein.

Results

Orbital measurements were taken from 74 skulls in this study, and 41 male skulls and 33 female skulls were identified among them. The age of the skull studied ranged from 60 to 80 years according to the molar attrition patterns. The mean of each right and left measurement of males and females were compared using the independent samples t-test to find the differences among the genders. According to the results, the mean orbital width was higher in males than females bilaterally (left (L) and right (R)) with a significant difference of $P<0.005$. The mean orbital index for L and R was higher in females than in males in both the right and left sides, with a significant difference ($p<0.005$).

Mean orbital height was higher in females than in males bilaterally. The mean bi-orbital distance was higher in males, while the mean inter-orbital distance was higher in females. The mean superior orbital depth (R), the mean inferior orbital depth (R), the mean inferior orbital depth (L), and the mean margino-fissural distance (R) were higher in females while the mean superior orbital depth (L) and the mean margino-fissural depth (L) were higher in males. There wasn't any significant difference in these measurements between males and females.

The dimensions presented in Table 2 are critical anatomical reference data for navigating the bony orbit in the Sri Lankan population. The table establishes precise

ranges for these measurements, as no statistically significant sex differences were observed ($P > 0.05$ for all comparisons). The Superior Orbital Depth (SOD) shows a combined range spanning from 34.85 mm (Female Left) to 55.03 mm (Male Right). Similarly, the Inferior Orbital Depth (IOD) ranges from 37.47 mm (Female Left) to 54.99 mm (Female Left). Furthermore, the Margino-Fissural Distance (MFD) ranges from as close as 14.21 mm (Female Left) to 28.24 mm (Female Right) from the inferior orbital rim. The mean values of orbital dimensions are more valuable in the identification of the neurovascular bundle in the orbit.

Table 3 presents dimensions essential for craniofacial reconstruction and anthropological sex determination. Significant sexual dimorphism was observed in Orbital Width (OW) and Orbital Index (OI) ($P < 0.001$), with males having significantly wider orbits (OW ranges from 34.60 mm to 47.57 mm) and a lower OI (ranging from 60.09 to 95.08). Females showed a higher OI (ranging from 66.47 to 108.56), indicating a rounder orbital shape. Measurements crucial for facial symmetry correction, such as Bi-orbital Distance (BOD) and Interorbital Distance (IOD), did not show significant sex differences ($P > 0.05$). The BOD ranged from 87.20 mm to 104.60 mm, providing a baseline for facial width, while the IOD ranged from 14.90 mm to 31.08 mm.

The analysis presented in Table 4 confirms significant bilateral symmetry in the Sri Lankan population, as all measured orbital parameters showed no statistically significant difference ($P > 0.05$ for all comparisons) between the right and left sides for both males and females. This finding encompasses all linear dimensions Orbital Width (OW), Orbital Height (OH), Superior Orbital Depth (SOD), Inferior Orbital Depth (IOD), and Margino-Fissural Distance (MFD)as well as the calculated Orbital Index (OI). This symmetrical architecture is a highly valuable asset in craniofacial reconstruction

Microseme orbital morphology has the highest prevalence among Sri Lankan males for both orbits, R and L, whereas megaseme orbital morphology has a lower prevalence for both orbits, right and left. While mesoseme morphology is highly prevalent in the left orbit among female Sri Lankans, microseme and megaseme orbital morphologies are equally prevalent in the right orbit in a higher percentage of female Sri Lankans (Table 5).

Discussion

Evaluation of the orbit dimensions appears to be important for ophthalmic surgeons to

Identify surgical margins and nearby susceptible neurovascular structures in ophthalmic surgeries (19). A complex set of biological interactions and bidirectional crosstalk among a group of cellular components, including developing optic vesicles, neuro ectoderm, cranial neural crest cells (CNCC), and mesoderm, determines the development of orbits. However, biological, ethnic, regional, and ecological factors, gender, age, etc., play a critical role in the determination of human morphology and morphometry (20)

Research on changes in gender, age, and ethnicity within and between populations has long been conducted to reveal the morphological and morphometrical variation of orbit. Accordingly, anthropometric assessments were tailored to determine population-specific norms for morphometrical and morphological parameters for a particular population (19).

Table 2: The mean and ranges of orbital measurements among male and female Sri Lankans that determine the neurovascular bundle in the orbit

Orbital measurements	Sex	Mean (mm)	STD	Range (mm)	P value
SOD (R)	Male	47.20	4.09	39.86-55.03	P=0.422
	Female	44.40	3.65	37.47-50.47	
SOD (L)	Male	46.62	4.99	38.20-53.79	P=0.814
	Female	44.12	4.20	34.85-49.21	
IOD (R)	Male	46.50	4.15	37.83-54.07	P=0.216
	Female	47.94	3.81	41.49-53.55	
IOD (L)	Male	46.16	3.07	42.11-51.73	P=0.945
	Female	46.75	4.37	37.47-54.99	
MFD (R)	Male	21.70	2.96	17.14-28.12	P=0.627
	Female	22.35	3.15	14.66-28.24	
MFD (L)	Male	20.60	3.06	16.58-28.23	P=0.678
	Female	20.89	3.12	14.21-25.77	

Table 3: The mean and ranges of orbital measurements among male and female Sri Lankans that determine the craniofacial reconstruction

Orbital measurements	Sex	Mean (mm)	Std. Deviation	Range (mm)	P value
OW (R)	Male	41.24	2.59	35.7- 46.96	P=0.000
	Female	38.43	2.58	33.20-42.79	
OW (L)	Male	41.03	3.25	34.6-47.57	P=0.000
	Female	38.23	3.23	32.50-46.44	
OH (R)	Male	33.08	1.80	29.2-37.58	P=0.747
	Female	33.25	2.80	28.80-42.61	
OH (L)	Male	32.77	1.77	28.29-38.05	P=0.669
	Female	32.94	1.46	30.20-35.90	
OI (R)	Male	80.47	6.24	69.7-92.72	P=0.001
	Female	86.85	8.85	71.03-108.56	
OI (L)	Male	80.37	7.72	60.09-95.08	P=0.001
	Female	86.68	7.52	66.47-104.66	
BOD	Male	96.90	4.35	89.20-104.60	P=0.066
	Female	95.04	4.15	87.20-104.59	
IOD	Male	22.37	3.66	14.9-31.08	P=0.170
	Female	23.45	2.80	16.50-29.85	

Table 4: Comparison of orbital measurements of right-side orbit with left side orbit of each gender separately

Orbital measurement	Male Sex			Female Sex		
	Side	Mean	P value	Side	Mean	P value
OW	Right	41.24	P=0.596	Right	38.43	P=0.700
	Left	41.03		Left	38.23	
OH	Right	33.07	P=0.210	Right	33.25	P=0.447
	Left	32.77		Left	32.93	
OI	Right	80.47	P=0.922	Right	86.84	P=0.914
	Left	80.37		Left	86.68	
SOD	Right	47.20	P=0.061	Right	44.40	P=0.776
	Left	46.16		Left	44.12	
IOD	Right	46.50	P=0.066	Right	47.94	P=0.114
	Left	46.16		Left	46.75	
MFD	Right	21.70	P=0.215	Right	22.35	P=0.085
	Left	20.60		Left	20.89	

Table 5:Prevalence of specific orbital morphologies among male and female Sri Lankans

Type	Right side			Left side		
	Male	Female	Total	Male	Female	Total
Microseme	68.3%	36.4%	54.6%	63.4%	30.3%	49.3%
Mesoseme	22.0%	27.3%	24.0%	22.0%	36.4%	28.0%
Megaseme	9.8%	36.4%	21.4%	14.6%	33.3%	22.7%

In this sense, the various orbital parameters such as orbital height, width, bi-orbital distance, inter-orbital distance, superior orbital depth, inferior orbital depth, margiofissural distance, orbital index, and orbital morphologies were evaluated to determine the population-specific orbital morphometrical and morphological parameters of Sri Lankans concerning gender.

The results of this study showed that morphological and morphometrical parameters, including orbital height, width, bi-orbital distance, inter-orbital distance, superior orbital depth, inferior orbital depth, and margiofissural distance, are not significantly different among genders except for orbital width and the OI. For all examined orbital metrics, no significant variations of orbital measurements were found between the right and left sides of the orbits of individuals of either gender. The present findings compare with those of Ukoha *et al.,* (5), in which no significant differences were found between the right and left sides of orbital parameters.

The results of the present research were compared to the previously published studies. In this study, the orbital width of males is significantly higher than that of females for

both sides, and the mean orbital length of females is higher than that of males for both sides. These findings are compared with the study results of Weaver *et al.,* (12). Weaver *et al.,* reported that the orbital width and height in males were higher than in females, and no significant difference. This is in contrast with the present study, the orbital width of males in this study is higher than that of the females.

The mean orbital width in this study for both males (left - 41.03, right - 41.24) and females (left - 38.23, right - 38.43) was greater than that of the height of both males (left - 32.77, right – 33.08) and females (left - 32.94, right – 33.25) Sri Lankans. These findings are in contrast with the Nigerian study. The orbital height (37.69) of Nigeria was higher than that of the orbital width (35.77) for both R and L orbits, excluding the gender (20). Another Sri Lankan study targeted the Sinhalese population living in the Central province of Sri Lanka and showed that the orbital width of males (left - 40.63±1.92 mm, right - 41.47±1.94 mm) and females (left 38.27±2.1 mm, right 38.91±2.39 mm) showed different figures than those of our study (35). Previous studies done in Nigeria, India, Ghana, and Iran documented a larger orbital width than height for both genders, which is compared with Sri Lankans in this study (23, 3, 25).

A previous study done on Nigerians showed that the studied orbital measurements, such as orbital width, height, orbital index, bi-orbital distance, and inter-orbital distance of males were significantly higher than Nigerian females (22). These findings have disagreed with our findings as a few of the studied orbital measurements of males are higher than those of female Sri Lankans. There are no significant differences between the studied measurements that were identified among genders in this study, except orbital width and orbital index.

The present study revealed that the mean OI in females of the left 86.68 and right 86.85 sides was significantly higher than that of the right 80.47 and left side 80.37 males, and no significant differences in OI were determined between the left and right orbit of each gender. Microseme orbital morphology is the dominant orbital type for both R and L in Sri Lankan males (OI ≤ 83), and mesoseme orbital morphology is the most dominant orbital type for both R and L in Sri Lankan females (OI = 83-89), concerning the mean value of OI of both genders. In general, Sri Lankans show a prevalence of microseme (54.6% in the right, 49.3% in the left), mesoseme (24.0% in the right, 28.0% in the left), and megaseme (21.4% in the right, 22.7% in the left) orbital morphologies without considering the gender.

When the prevalence of orbital morphology of males and females was calculated by using their values, microseme orbital morphology was more dominant (68.3% in the right side, 63.4% in the left side), and megaseme was less dominant (9.8% in the Right side and 14.6% in the left side) in male Sri Lankans. Microseme and megaseme orbital morphologies are equally dominant, and mesoseme is less abundant in the right orbit in females. In the left orbit of females, mesoseme and megaseme are more dominant compared to microseme. In general, Sri Lankans show a prevalence of microseme (54.6% in the right, 49.3% in the left), mesoseme (24.0% in the right, 28.0% in the left), and megaseme (21.4% in the right, 22.7% in the left) orbital morphologies without considering the gender.

This study's findings are in contrast with a study of the OI in Brazilian skulls conducted by Fernandez *et al.,* (25), which found no significant differences in OI in both genders. Furthermore, Husmann *et al.,* found that the OI was higher in females (26). This also agrees

with our results, which highlight females' OI is higher than that of males.

The reported dominant microseme OI type of North Indians and Western Indians reported in several studies are compared with our study results of dominant microsome orbital morphology without considering the gender (27, 10). Most dominant mesoseme orbital morphology is the same as the results of the dominant orbital morphology from various states of South India such as Mekala D *et al.,* (Tamil Nadu), Divya C *et al.,* and Sanjaykumar BR (Karnataka), Nagaraj S *et al.,* (Telengana), Shaikh M (Kerala), which is contrasted with our result findings, which is the second most prevalent type in this study of Sri Lankans (26, 8). Our study findings on orbital morphologies are different from the study conducted on Nigerians. It was reported that the male and female Nigerians had megaseme type in both genders (OI male =106.6 ± 7.665) and (OI = females 105.4 ± 8.004), while microsome orbital types were least prevalent among them, which is the most predominant type of Sri Lankan male and females (14). The present study describes differences among the findings of the research in the central region of Iran by Khademi *et al.,* representing that the OI of this group of Iranian people was mesosomes which is the female dominant orbital type in Sri Lankans (24).

The mean OI findings of males and females in a previous Sri Lankan study targeting a small sample (34 male and 16 female) of the Sinhalese population represented by a small part of a country–Central province showed that the adult Sri Lankan male and female population had 79.29 and 84.39 without considering the side of the orbit respectively (9), These findings were contrast with the findings of this study which shows OI in females of left 86.68 and right 86.85 sides and OI in males of right 80.47 and left 80.37 side.

Orbital measures are important considerations during orbit reconstruction surgeries and when delivering periorbital anesthesia. In addition to the orbital height, width, and OI, superior and inferior orbital depths and margino-fissural distance are essential for the safety of intra-orbital neurovascular structures during surgical procedures deep into the orbit. Although the male and female orbital dimensions of superior and inferior orbital depths and margino-fissural distance, in this study, the findings are not significantly different. Females show the higher mean values for inferior orbital depths (Female R: 47.94, L: 46.75, Male R: 46.50, L: 46.16) and margino-fissural distance (Female R: 22.35, L: 20.89, Male R: 21.70, L: 20.89) for both the left and right of the orbits than that of males. Males show higher mean values for superior orbital depths (47.94mm for R) (46.62mm for L) than females (44.40mm for R, 44.12mm for L) for both sides of the orbits. In safeguard of neurovascular structures in the inferior orbital fissure in orbital surgery is facilitated by the male and female mean values and the ranges of the margino-fissural distance obtained by this study (female- R: 14.66-28.24, L:14.21-25.77, Male- R: 17.14-28.12,L: 16.58-28.23)and the safeguard of optic nerve is facilitated by the mean values and the ranges of the superior (Female- R: 37.47-50.47, L: 34.85-49.21, Male-R:39.86-55.03,L: 38.20-53.79)and inferior orbital depths (Female- R: 41.49-53.55 , L:37.47-54.99, Male-R: 37.83-54.07,L: 42.11-51.73) obtained in this study for Sri Lankans. In contrast, A Kenyan study conducted on 113 adult crania from the National Museum of Kenya reported consistently larger mean orbital dimensions in males compared to females. The superior orbital depth measured 53.38 mm in males and

52.03 mm in females, while the inferior orbital depth was 55.17 mm in males and 53.76 mm in females. The margino-fissural distance was 23.79 mm in males and 22.30 mm in females. These findings demonstrate a clearer pattern of sexual dimorphism in the Kenyan population, whereas the Sri Lankan sample displayed a relatively narrower range of variation between sexes. (13).

The orbital measurements, such as bi-orbital breadth and interorbital distance, are crucial for preserving facial symmetry during reconstructive and cosmetic procedures. The orbital measurements of bi-orbital breadth and interorbital distance of Sri Lankan males and females do not show significant differences among genders. The bi-orbital distance of the male (96.90 mm) is higher than the female (95.04 mm) Sri Lankans. Whereas the interorbital distance in females (23.45 mm) is higher than that of males (22.37 mm), Sri Lankans. The study done in Kenya reported that the bi-orbital distance in males (99.49mm) was higher than that of females (96.43mm) in Kenya, which is higher than the findings of this study (6). The same study showed that males (18.91 mm) showed higher interorbital breadth than females (18.26 mm), which is in contrast with this study's findings. The facial reconstruction of Sri Lankans in the region is facilitated by the male and female mean values and their ranges of the bi-orbital breadth and interorbital distance of Sri Lankans obtained by this study.

Orbital index norms and norms of basic measurements are used in the evaluation and diagnosis of craniofacial disorders and posttraumatic abnormalities. OI variation in the population was caused by environmental and genetic factors, as well as unique craniofacial growth patterns brought about by ethnic variations (4). Additionally, it was shown that the orbital parameters and OI indicated a respectable accuracy percentage for estimating age (89.9%) and sex (79.5%), respectively. Our results showed that estimating the gender of a deceased in Sri Lanka would be achieved by OI and orbital width as mean OI and orbital width are both significantly different among genders in this study. This is also in agreement with the study conducted by Fernandez *et al.,* which also reported that OI was significantly different among genders and OI is to be used to determine the gender of a deceased individual, and this is very important in anthropometric assessments (25).

Standardizing data of orbital measurements and indices is an important measurement in the diagnosis of craniofacial syndromes and post-traumatic deformities, too. Prior knowledge of the normal values for a particular region in orbit is essential to treat abnormalities and to achieve the best aesthetic and functional outcome. For these purposes, standards based on local data of Sri Lankans reported in this study are preferable, because these standards reflect the various patterns of craniofacial growth resulting from racial, ethnic, social, behavioral, and dietary habits (28).

A major drawback of this study is that sex was estimated based on the morphological features of the skull rather than being confirmed by means of an independent reference. Even though the supraorbital margin, the glabella and the frontal eminences are well-known features employed in estimating cranial sex, the expression of these characteristics can differ from one individual to another, and their interpretation may vary depending on the observer. It therefore cannot be ruled out that some sex misclassification has taken place. This kind of misclassification might affect the apparent differences between the male and

female groups and must therefore be considered when interpreting the sex-related variations in orbital width and orbital index. The results should thus be seen as indicating sex-associated differences within the sample that has been classified, not as proof of sexual dimorphism in the entire Sri Lankan population. Future research which includes independently established sex and makes use of larger, more representative samples would help to verify these findings.

Acknowledgements

The authors sincerely thank those who donated their bodies to science so that anatomical research could be performed. Therefore, these donors and their families deserve our highest gratitude. The authors sincerely thank the staff of the Departments of Anatomy at the University of Peradeniya, University of Sri Jayewardenepura, and Wayamba University of Sri Lanka for their support during this study.

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