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Ruminants

Sexual Dimorphism of Foetal Sheep Skulls During the Second and Third Periods of Pregnancy

Barış Can Güzel | Fatma Işbilir

Department of Anatomy, Faculty of Veterinary Medicine, Siirt University, Siirt, Turkey

Correspondence: Fatma Işbilir (fatmaisbilir42@gmail.com)

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ABSTRACT

The skull is a very important structure, and it is the centre of many vital functions. There have been many studies on the skulls of mammals, but not many studies on the prenatal period. The aim of this study is to examine developmental sheep foetal skulls from the last two trimesters of pregnancy. A total of 40 sheep foetuses, 20 in the 2nd trimester (10 females and 10 males) and 20 in the 3rd trimester (10 females and 10 males), were examined. On the basis of CT scans of foetal skulls, morphometric measurements were performed by creating a three-dimensional (3D) model. Total skull length was statistically significant between males and females in the third trimester ($p < 0.01$). In the second trimester, the tooth length parameter was statistically significant between males and females ($p < 0.01$). In the second trimester, M3 was found to be statistically significant in the sheep foetus mandible ($p < 0.01$). It was determined that there was developmental sexual dimorphism between males and females.

1 | Introduction

The mammalian lineage evolved from reptilian ancestors approximately 178 million years ago (Kemp 2005). Divided into monotremes, marsupials and placentals, modern mammals encompass more than 6000 species that occupy a wide variety of ecological niches (Feldhamer 2007). Many evolutionary changes in living things, especially changes in the skull, have enabled living things to adapt to life (Higashiyama et al. 2021). The skull is a highly plastic region of the mammalian skeleton, housing the organs of special sense and facilitating many vital functions. The skull protects the brain, and special sensory organs (vision, smell, hearing, balance and taste) provide openings for air and food passage and house teeth in the jaws for chewing (Dyce et al. 2010). Morphological innovations and skull shape variability in mammals are reflections of changes in embryonic development (Green et al. 2015). Foetal development is an important research area of animal biology, and in this process, skull morphometry plays a critical role in understanding the evolutionary and developmental biology of organisms (Buss et al. 2012). Skull structure reflects many biological factors, such as brain growth, feeding habits and environmental adaptations (Succu et al. 2023). Developmental analyses of foetal skulls are performed using biometric measurements and advanced imaging techniques. These analyses reveal growth rates of different parts of the skull, changes in shape and differences between females and males (Szara et al. 2024). Mammalian skulls help us understand the relationship between foetal developmental patterns and brain development, and these data allow us to examine the effects of genetic and environmental factors on skull development (Koyabu 2023).

With the developing technology, three-dimensional (3D) modelling techniques have begun to be used in the fields of industry and health (Demircioglu and Gezer Ince 2020). 3D modelling also contributes to studies used in clinical cases, complex pathological cases and anthropological and sexual dimorphism (Güzel et al.

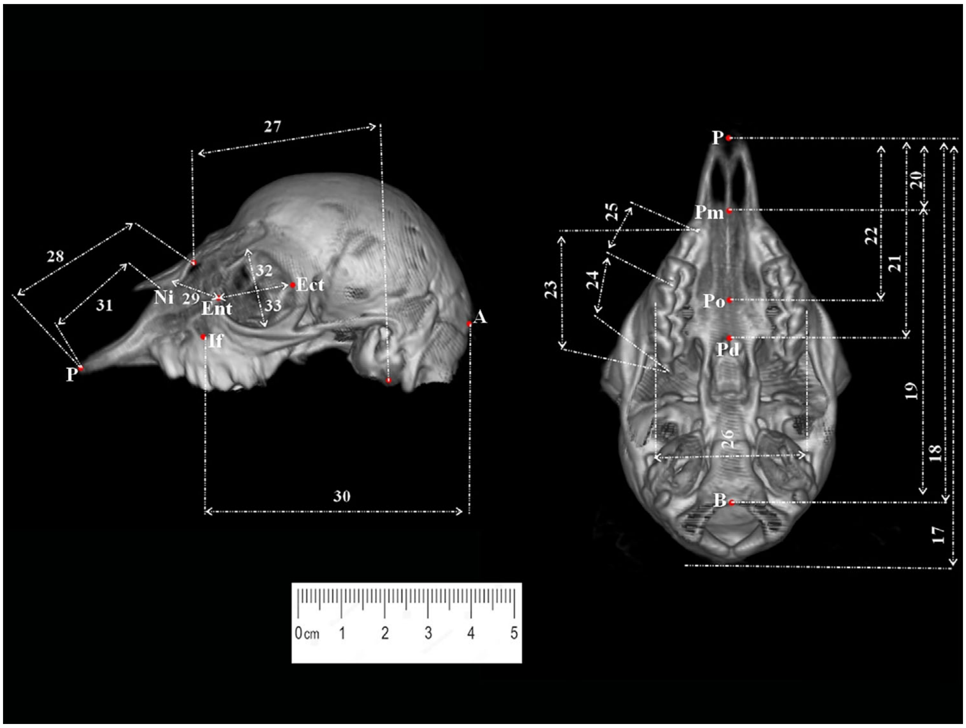

FIGURE 1 | Lateral and ventral measurement points of the skull taken from sheep foetuses (third trimester). **B,** Basion; **P,** Prosthion; **Pd,** Postdentale; **Ect,** Ectorbitale; **If,** Infraorbitale; **Ni,** Nasointermaxillare; **Pm,** Premolare; **Po,** Palatinoorale.

2022; Demircioglu et al. 2021; Gündemir 2023; Gündemir et al. 2023).

This study aims to investigate the developmental characteristics of sheep foetal skulls in the last two periods of pregnancy and the differences between males and females by revealing sexual dimorphism comparatively.

2 | Materials and Methods

2.1 | Animals

In our study on skull and mandible measurements of 2nd- and 3rd-trimester sheep, a total of 40 foetuses from the 2nd trimester (10 females and 10 males) and the 3rd trimester (10 females and 10 males) were used. Fetuses were collected from private slaughterhouses in the Southeastern Anatolia region. Foetuses are between 89 and 95 days in the second-trimester group and 112 and 130 days in the third-trimester group. In confirming the gestational days, a formulation appropriate to the literature was applied (İşbilir et al., 2024; Kandil et al., 2025). Computerized tomography of the collected foetuses was taken at Hayat Hospital in Siirt Province.

2.2 | CT Imaging and 3D Model Generation

The skull and mandible of the 2nd- and 3rd-trimester sheep were scanned with a multi-slice Siemens computed tomography device with 64 detectors at 80 kV, 200 MA, 639 mGY and 0.625 mm section thickness. The resulting images were saved in DICOM format. Then, images in DICOM format were written and loaded with 3D-Slicer 5.6.2 software. Skulls were segmented using the threshold segmentation module, with a threshold set at a minimum of 230.38 and a maximum of 5372.09. The resulting skull models were saved in STL format. Measurements were made on the resulting 3D models. Images of the head are shown in Figures 1 and 2, and images of the mandible are shown in Figure 3.

2.3 | Statistical Analysis

The mean values, standard deviations, coefficient of variations and craniofacial indices were calculated with SPSS (version 22). Independent samples *t*-test was used for *p* values. Statistical significance level was defined as $p < 0.05$.

2.4 | Obtaining Craniometric Parameters

In the article, measurements taken from the skull and mandible were taken from similar articles (Güzel and İşbilir 2024; Gündemir et al. 2020; Güzel et al. 2023: İşbilir and Güzel 2023). Linear measurement points taken from the skull and mandible are given as follows:

Craniometric parameters:

- C1. The total skull length
- C2. The greatest breadth of the skull
- C3. Akrokranion-bregma
- C4. Frontal length greatest length of nasals bone
- C5. Upper neurocranium length

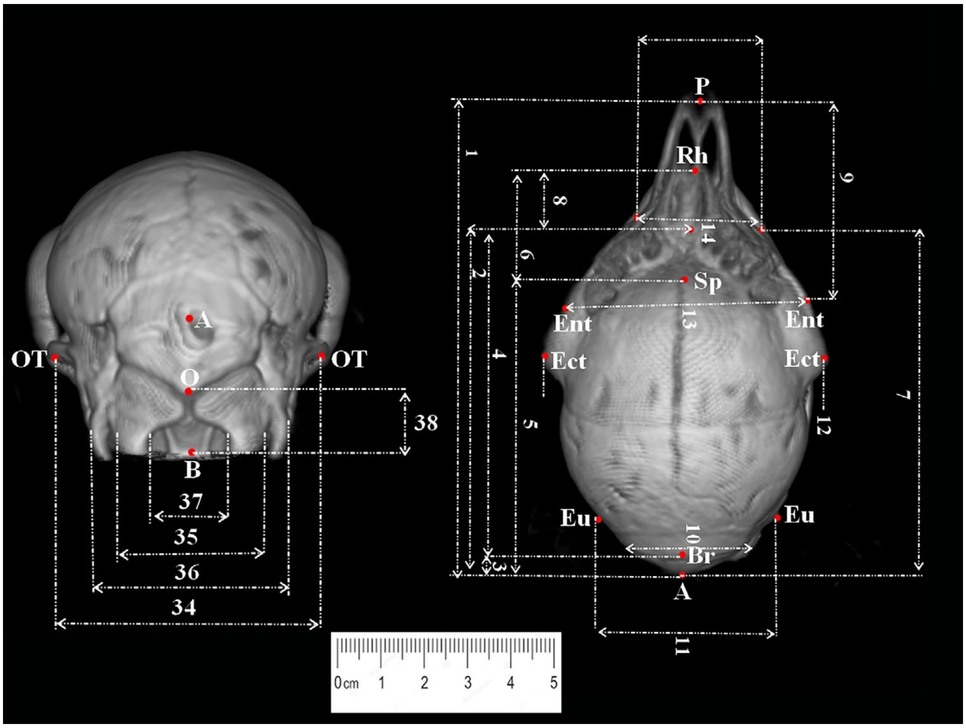

FIGURE 2 | Dorsal and caudal measurement points of the head taken from sheep foetuses (third trimester). **A,** Akrokranion; **B,** Basion; **O,** Opisthion; **Ot,** Otion; **Br,** Bregma; **Ect,** Ectorbitale; **Ent,** Entorbitale; **If,** Infraorbitale; **Rh,** Rhinion; **Sp,** Supraorbitale.

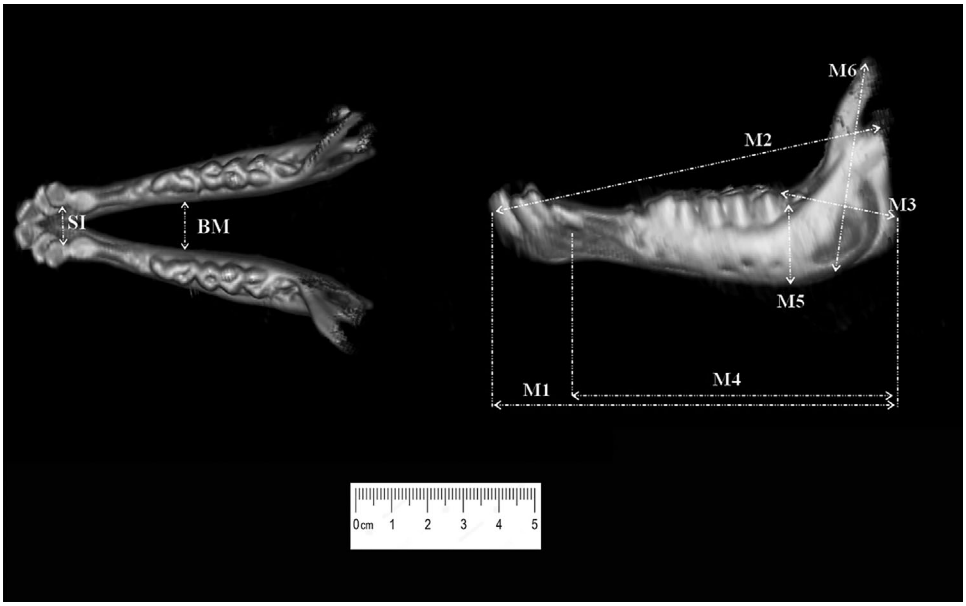

FIGURE 3 | Measurement points of mandible taken from sheep foetuses (third trimester).

C6. Facial length (Sopraorbitale-Prosthion)

C7. Akrokranion-infraorbitale of one side

C8. The Greatest length of nasals bone

C9. Short lateral facial length

C10. Least breadth of the parietal bone

C11. Greatest neurocranium breadth

C12. Greatest breadth across the orbits

C13. Least breadth between the orbits

C14. Facial breadth

C15. Greatest breadth across the nasals

C16. Greatest breadth across the premaxillae

C17. The condylobasal length—from incisive bone to the occipital condyles

C18. Basal length (Basion-Prosthion)

C19. Short skull length (Basion-Premolare)

C20. Premolare-prosthion

C21. Dental length (Postdentale-Prosthion)

C22. Oral palatal length

C23. Length of the cheek tooth row

C24. Length of the molar row

C25. Length of the premolar row

C26. Greatest palatal breadth

C27. Neurocranium length

C28. Viscerocranium length

C29. The greatest length of the lacrimal bone

C30. From the aboral (Between the foramen infraorbital and the upper point of the foramen magnum)

C31. The lateral length of the premaxilla

C32. The greatest inner length of the orbit

C33. The greatest inner height of the orbit

C34. The greatest mastoid breadth of the paraoccipital processes

C35. The greatest breadth of the occipital condyles

C36. The greatest breadth at the breadth of the paraoccipital processes

C37. The greatest breadth of the foramen magnum

C38. Height of the foramen magnum (Basion-Opisthion)

In this study, craniofacial indices were calculated as follows (Aslan Kanmaz et al. 2024; Dayan et al. 2023):

Skull index: Greatest breadth of the skull (2)/Total length (1)×100
Facial index 1: Facial breadth (14)/Viscerocranium length (28)×100
Facial index 2: Greatest breadth of the skull (2) /viscerocranium length (28)×100
Basal index: Greatest breadth of the skull (2)/basal length (18)×100
Palatal index: Greatest palatal breadth (26)/dental length (21)×100
Orbital index: Greatest inner height of the orbit (33)/greatest inner length of the orbit (32)×100
Foramen magnum index: Height of the foramen magnum (38)/greatest breadth of the foramen magnum (37)×100

Mandible parameters:

M1 (GOC-ID): Length between GOC-ID
M2 (PC-ID): Length between the aboral edge of proc. condylar-ID
M3 (GOC-MTR): Length between GOC- aboral alveolar edge of M3
M4 (GOC-FMN): Length between GOC—aboral edge of for. Mental
M5 (MTR-MH): Height of mandible in the plane of posterior alveolar edge of M3
M6 (GOV-CR): Length between GOC-CR
M7 (SI): Mandible width at last incisive tooth level
M8 (BM): Width of the mandible at the level of the first molar

3 | Results

In our study, craniometric measurements of the skulls of second- and third-trimester ewes belonging to the last two periods of pregnancy were made, and cranial indices were calculated. In addition, mandible measurements were made, and the measurements were completed. The measurements of the skull and mandible are given in Tables 1–6. In second- and third-trimester sheep, C1 values of sheep were found to be larger in males than females. When the skull measurements of two-trimester sheep are analysed in Table 1, it is seen that C1, C4, C5, C7, C15, C16, C29, C32, C36 and FMI measurement parameters are statistically highly significant ($p < 0.001$). C18, C25 and PI measurement parameters were found to be statistically significant ($p < 0.05$). When third-trimester sheep skulls were analysed, C21, C26, C27, C29 and OI measurement parameters were found to be statistically highly significant ($p < 0.01$). C12, C16 and PI measurement parameters were statistically significant ($p < 0.05$). In the second- and third-trimester mandibles, the C1 parameter was found to be larger in males than females. When the second-trimester sheep mandible was analysed, it was found that the M3 parameter was highly significant ($p < 0.01$). When the third trimester was analysed, the M8 measurement parameter was statistically significant ($p < 0.05$).

4 | Discussion

Bone remains recovered from zooarchaeological excavations from the past to the present can give information about past civilizations. To obtain this information, it is very important to know the osteological and osteometric characteristics of common sheep breeds in the world. Craniometric features are frequently used to determine the differences among species, breeds and even sexes. It is possible to come across craniometric studies in many sheep breeds. However, it is advantageous to have information about foetal development to understand the craniometric differences among sheep breeds. In the present study, it was aimed to determine the developmental differences between male and female foetuses in Hamdani crossbred sheep breed by examining the skull and mandible bones in the last two periods of pregnancy using the 3D modelling method. Due to the lack of studies in the foetal period, comparisons were made with different animal species and breeds.

The mean length of the skull was measured as 183.7 ± 6.5 mm and 200.8 ± 2.9 mm in Akkaraman and Kangal Akkaraman sheep, respectively (Baş et al. 2023). The skull length parameter was reported as 246.5 ± 21.6 mm in Barbados Black Belly sheep (Mohamed et al. 2016). In our study, the skull length parameter showed a statistically significant difference in 2nd-trimester foetuses in males compared to females ($p < 0.01$). In third-trimester foetuses, there was no such difference.

TABLE 1 | Measurement parameters of sheep skulls from the second trimester.

	Gender	*N*	Mean	Std. Deviation	*P*
1	Male	10	68.93	0.59	**
	Female	10	67.06	0.25	
2	Male	10	27.90	1.16	NS
	Female	10	25.44	0.35	
3	Male	10	6.24	0.41	NS
	Female	10	4.87	0.19	
4	Male	10	38.67	0.80	**
	Female	10	36.44	0.29	
5	Male	10	31.46	0.64	**
	Female	10	30.10	0.08	
6	Male	10	64.58	1.10	NS
	Female	10	61.80	0.70	
7	Male	10	37.88	0.72	**
	Female	10	36.12	0.10	
8	Male	10	27.52	0.72	NS
	Female	10	25.99	0.86	
9	Male	10	31.64	0.78	NS
	Female	10	30.40	0.47	
10	Male	10	14.21	0.80	NS
	Female	10	12.89	0.55	
11	Male	10	23.93	0.69	NS
	Female	10	22.43	0.26	
12	Male	10	26.08	0.57	NS
	Female	10	24.91	0.41	
13	Male	10	25.30	0.30	NS
	Female	10	24.59	0.25	
14	Male	10	18.53	0.46	NS
	Female	10	17.31	0.20	
15	Male	10	12.35	0.14	**
	Female	10	11.48	0.37	
16	Male	10	11.27	0.21	**
	Female	10	10.25	0.07	
17	Male	10	67.30	0.39	NS
	Female	10	66.52	0.21	
18	Male	10	65.47	0.64	*
	Female	10	64.15	0.12	
19	Male	10	35.49	0.49	NS
	Female	10	33.79	0.45	
20	Male	10	12.62	0.26	NS
	Female	10	11.13	0.44	
21	Male	10	23.54	0.23	NS
	Female	10	21.97	0.48	
22	Male	10	19.58	0.19	NS
	Female	10	17.72	0.52	
23	Male	10	13.52	0.24	NS
	Female	10	11.81	0.16	
24	Male	10	9.27	0.35	NS
	Female	10	8.63	0.52	
25	Male	10	2.76	0.19	*
	Female	10	2.15	0.06	
26	Male	10	19.50	0.18	NS
	Female	10	18.22	0.31	
27	Male	10	36.55	0.28	NS
	Female	10	35.18	0.25	
28	Male	10	32.41	0.28	NS
	Female	10	30.81	0.36	
29	Male	10	13.48	0.21	**
	Female	10	13.76	0.94	
30	Male	10	16.73	0.38	NS
	Female	10	15.34	0.24	
31	Male	10	20.53	0.69	NS
	Female	10	19.21	1.99	
32	Male	10	12.11	0.60	**
	Female	10	10.36	0.16	
33	Male	10	12.52	0.21	NS
	Female	10	11.57	0.19	
34	Male	10	29.03	0.71	NS
	Female	10	27.37	0.48	
35	Male	10	22.09	0.83	NS
	Female	10	19.67	1.10	
36	Male	10	19.52	1.29	**
	Female	10	17.73	0.46	
37	Male	10	8.68	1.06	NS
	Female	10	7.40	0.89	
38	Male	10	13.43	0.81	NS
	Female	10	12.00	0.47	

(Continues)

TABLE 1 | (Continued)

Abbreviation: NS, non-significant.
*$p < 0.05$.
**$p < 0.01$.

Neurocranium length was determined as 36.25 ± 0.28 mm and 35.18 ± 0.25 mm in male and female foetuses in the second trimester, respectively. In the third trimester, it was found to be 68.53 ± 0.54 mm and 64.09 ± 1.22 mm in the same order, and the neurocranium length was statistically greater in male foetuses than in female foetuses. Neurocranium length was

TABLE 2 | Index of sheep skulls from the second trimester.

	Gender	*N*	Mean	Std. Deviation	*p*
SI	Male	10	40.47	1.53	NS
	Female	10	37.94	0.59	
FI1	Male	10	57.16	1.40	NS
	Female	10	56.19	0.66	
FI2	Male	10	86.07	3.50	NS
	Female	10	82.58	1.25	
BI	Male	10	42.61	1.42	NS
	Female	10	39.66	0.48	
PI	Male	10	82.83	0.63	*
	Female	10	82.95	1.69	
OI	Male	10	103.84	5.15	NS
	Female	10	110.72	4.40	
FMI	Male	10	65.10	11.21	**
	Female	10	62.34	8.76	

Abbreviation: NS, non-significant.
*$p < 0.05$.
**$p < 0.01$.

reported as 110.82 ± 3.42 mm in adult Morkaraman sheep and 107.20 ± 3.69 mm in Tuj sheep (Özcan et al. 2010). In the Bardhoka sheep breed, the statistical difference in terms of neurocranium length in male and female animals was found to be compatible with the third-trimester group of our study (Gündemir et al. 2020).

In many studies, craniofacial index parameters were determined in sheep breeds. These parameters were considered important in terms of understanding craniofacial deformities and examining brain development (Kanchan et al. 2014). The skull index value in adult Hamdani sheep was reported as 49.64 ± 0.62 in females and 49.04 ± 1.49 in males (Dayan et al. 2023). The Hamdani breed was found to have higher values than Hasak, Hashmer (Can et al. 2022) and Sharri (Jashari et al. 2022) sheep and lower values than Hemshin (Dalga et al. 2018), Mehraban (Karimi et al. 2011) and Romanov (Güzel and İşbilir 2024) sheep in terms of this parameter (Dayan et al. 2023). In the sheep breeds mentioned above, except for the Romanov sheep breed, skull index value did not show a statistical difference between male and female sheep, whereas the difference between sexes was reported in Romanov sheep (Güzel and İşbilir 2024). In our study, in accordance with the literature, skull index values did not show statistical differences between the sexes during pregnancy.

In our study, PI value showed a statistical difference between genders in both second- and third-trimester foetuses. Female foetuses had a higher value than males. This study contrasts with the studies conducted on adult Hamdani sheep (Dayan et al. 2023) and Romanov sheep (Güzel and İşbilir 2024). No statistical difference was reported for PI parameters in adult Hamdani (Dayan et al. 2023) and Romanov (Güzel and İşbilir 2024) sheep.

TABLE 3 | Measurement parameters of sheep skulls from the third trimester.

	Gender	*N*	Mean	Std. Deviation	*p*
1	Male	10	100.36	1.22	NS
	Female	10	95.62	1.05	
2	Male	10	46.61	0.95	NS
	Female	10	43.59	0.83	
3	Male	10	12.06	0.64	NS
	Female	10	10.59	0.39	
4	Male	10	67.37	1.08	NS
	Female	10	62.65	1.15	
5	Male	10	53.30	1.11	NS
	Female	10	55.59	1.15	
6	Male	10	95.23	1.05	NS
	Female	10	92.23	0.86	
7	Male	10	72.24	0.62	NS
	Female	10	69.09	1.73	
8	Male	10	51.74	0.94	NS
	Female	10	47.72	0.48	
9	Male	10	64.34	0.53	NS
	Female	10	60.50	0.37	
10	Male	10	26.42	0.59	NS
	Female	10	23.38	0.740	
11	Male	10	41.37	0.71	NS
	Female	10	38.14	0.72	
12	Male	10	52.87	0.68	*
	Female	10	49.94	0.32	
13	Male	10	44.33	0.87	NS
	Female	10	41.59	0.58	
14	Male	10	37.77	0.66	NS
	Female	10	34.94	0.74	
15	Male	10	25.30	1.38	NS
	Female	10	23.64	1.18	
16	Male	10	22.43	0.29	*
	Female	10	20.28	0.87	
17	Male	10	96.53	0.95	NS
	Female	10	92.56	0.73	
18	Male	10	85.60	0.71	NS
	Female	10	81.05	0.63	
19	Male	10	69.44	0.33	NS
	Female	10	66.16	0.59	
20	Male	10	17.55	0.78	NS
	Female	10	14.83	0.56	

(Continues)

TABLE 3 | (Continued)

	Gender	*N*	Mean	Std. Deviation	*p*
21	Male	10	39.97	0.560	**
	Female	10	35.93	1.20	
22	Male	10	35.78	0.43	NS
	Female	10	32.26	0.54	
23	Male	10	21.82	0.51	NS
	Female	10	19.94	0.33	
24	Male	10	18.68	0.74	NS
	Female	10	15.75	0.69	
25	Male	10	4.01	0.59	NS
	Female	10	2.78	0.28	
26	Male	10	35.54	0.36	**
	Female	10	32.63	0.81	
27	Male	10	68.53	0.54	**
	Female	10	64.09	1.22	
28	Male	10	61.36	0.63	NS
	Female	10	57.83	0.93	
29	Male	10	22.30	0.67	**
	Female	10	20.06	0.23	
30	Male	10	31.96	0.79	NS
	Female	10	28.67	0.66	
31	Male	10	32.71	0.51	NS
	Female	10	30.28	0.36	
32	Male	10	24.78	0.70	NS
	Female	10	21.27	0.61	
33	Male	10	22.12	0.54	NS
	Female	10	20.41	0.49	
34	Male	10	49.95	0.84	NS
	Female	10	45.73	0.48	
35	Male	10	34.86	0.72	NS
	Female	10	32.55	0.40	
36	Male	10	32.03	0.53	NS
	Female	10	29.58	0.54	
37	Male	10	16.27	0.55	NS
	Female	10	14.24	0.55	
38	Male	10	18.70	0.49	NS
	Female	10	16.45	0.39	

Abbreviation: NS, non-significant.
*$p < 0.05$.
**$p < 0.01$.

C16, C29 and PI values were determined as the skull regions in which sexual dimorphism was prominent in both periods of foetal life. It was detected that many parameters differed in terms of sexual dimorphism in the early period. In addition, it was observed that the parameters showing sexual dimorphism decreased with foetal development in third-trimester sheep skulls. Our findings suggest that sheep skulls show less sexual dimorphism during late foetal development compared to the early period of foetal life.

TABLE 4 | Index of sheep skulls from the third trimester.

	Gender	*N*	Mean	Std. Deviation	*p*
SI	Male	10	46.46	1.34	NS
	Female	10	45.59	0.95	
FI1	Male	10	61.55	0.88	NS
	Female	10	60.42	1.15	
FI2	Male	10	75.97	1.13	NS
	Female	10	75.39	1.76	
BI	Male	10	54.46	1.24	NS
	Female	10	53.78	1.05	
PI	Male	10	88.93	1.38	*
	Female	10	90.90	3.10	
OI	Male	10	89.27	2.07	**
	Female	10	96.05	4.42	
FMI	Male	10	114.99	4.14	NS
	Female	10	115.68	5.17	

Abbreviation: NS, non-significant.
*$p < 0.05$.
**$p < 0.01$.

Considering the osteometric data of skull and mandible in humans and animals, it has been stated that males have statistically larger values than females for most parameters (Gezer Ince and Pazvant 2010; Onar et al. 1997; Pitakarnnop et al. 2017; Rooppakhun et al. 2010; Yılmaz and Demircioğlu, 2021). In the osteometric measurements performed in our study, a statistical difference was determined between sexes in the parameters M3 in second-trimester foetuses and M8 in third-trimester foetuses. Both values were higher in male animals following the literature. The M3 parameter was found to be 54.63 ± 0.91 mm in Hamdani rams and 50.79 ± 0.47 mm in sheep (Guzel, Demircioğlu and Gezer İnce 2023), and no statistical difference was reported between genders. In our study, the M3 parameter in second-trimester foetuses was statistically higher in male foetuses than female foetuses following the Romanov sheep breed (İşbilir and Güzel 2023). In the Awassi sheep breed (Yılmaz 2020), this parameter was statistically higher in ewes than in rams.

In our study, the M8 parameter was determined as 1.08 ± 0.03 mm in male and 1.00 ± 0.03 mm in female foetuses in the second trimester and 1.32 ± 0.06 mm and 1.21 ± 0.35 mm in the third-trimester foetuses, respectively. Second-trimester foetuses did not have statistical differences between sexes as in Hamdani breed sheep (Güzel et al. 2023) and Awassi breed sheep (Yılmaz 2020). In the M8 parameter, no statistical difference was observed between genders in third-trimester foetuses.

In conclusion, in this study, the osteometric properties of the skull and mandibular bones of the foetuses collected at different gestation periods in the Hamdani crossbred sheep breed were determined, and a developmental study was carried out in the

TABLE 5 | Measurement point of sheep mandibles of the 2nd trimester.

	Gender	*N*	Mean	Std. Deviation	*p*
M1	Male	10	5.5740	0.33374	NS
	Female	10	4.6070	0.27653	
M2	Male	10	5.4890	0.24830	NS
	Female	10	4.6310	0.21921	
M3	Male	10	4.4470	0.21899	**
	Female	10	3.8740	0.08003	
M4	Male	10	5.2930	0.11748	NS
	Female	10	4.4310	0.25133	
M5	Male	10	1.4850	0.07706	NS
	Female	10	1.0351	0.04045	
M6	Male	10	2.5680	0.13990	NS
	Female	10	1.8400	0.11547	
M7	Male	10	1.1680	0.08574	NS
	Female	10	1.0580	0.04211	
M8	Male	10	1.0830	0.03268	NS
	Female	10	1.0012	0.03784	

Abbreviation: NS, non-significant.
**$p < 0.01$.

TABLE 6 | Measurement point of sheep mandibles of the third trimester.

	Gender	*N*	Mean	Std. Deviation	*p*
M1	Male	10	8.33	0.20	NS
	Female	10	7.40	0.22	
M2	Male	10	7.56	0.18	NS
	Female	10	6.96	0.12	
M3	Male	10	7.31	0.08	NS
	Female	10	6.80	0.07	
M4	Male	10	6.31	0.14	NS
	Female	10	5.69	0.22	
M5	Male	10	1.83	0.09	NS
	Female	10	1.50	0.11	
M6	Male	10	3.77	0.08	NS
	Female	10	3.25	0.07	
M7	Male	10	1.45	0.08	NS
	Female	10	1.25	0.07	
M8	Male	10	1.32	0.064	*
	Female	10	1.21	0.035	

Abbreviation: NS, non-significant.
*$p < 0.05$.

foetal period. As reported in many studies, some osteometric parameters were found to be higher in males than females in the foetal period. According to the results of the study, it is thought that the use of craniometric parameters in sex discrimination in the foetal period will be more reliable than the morphometric parameters of the mandible due to the higher differences between sexes. The obtained data contain basic anatomical information that will be useful in taxonomic studies, diagnostic imaging, radiologically determined pathological disorders and treatment applications and evaluation of cranial facial and dental deformities. In addition, the data obtained can be used to determine whether sheep craniums found in zooarchaeological excavations belong to the foetal period and to differentiate the sexes. The parameters showing sexual dimorphism obtained from our study can be used in sex determination by measuring with ultrasonographic imaging in sheep foetuses. It will also contribute to future craniometric and osteometric studies in the foetal stages of mammals.

Author Contributions

Barış Can Güzel: project administration, conceptualization, investigation, original draft, writing–review and editing, methodology, validation, software, data curation. **Fatma Işbilir**: investigation, original draft, writing–review and editing.

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Ethics Statement

With the ethics committee report numbered 2024/05/28, the Siirt University Experimental Animals Application and Research Center approved the procedures used in our investigation.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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