

Morphometric and Macroanatomic Examination of Cavum Nasi in Kivircik Sheep: A Statistical Comparison by Gender

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Abstract— The nasal cavity of sheep exhibits complex anatomical structures that are important for respiratory function and breed-specific adaptations. Understanding its macroanatomical and morphometric characteristics can provide insights into species-specific traits. This study aims to determine the macroanatomical and morphometric values of certain structures within the nasal cavity of Kivircik sheep. Ten Kivircik sheep heads (5 males, 5 females) were used. Eighteen tissues of the cavum nasi (nasal cavity) and nasus externus were evaluated for length and thickness using a digital caliper. Data were analyzed using multi-factor and interactive analysis of variance (Two-Way ANOVA), the Mann-Whitney U test, and the Pearson correlation test. A positive and significant correlation was found between the length of the widest part of the concha nasalis dorsalis and the length of the plica basalis ($r = 0.661$, $p < 0.01$). Additionally, a positive and significant correlation was observed between the cranio-caudal length of the concha nasalis media and the width of its caudal end ($r = 0.510$, $p < 0.05$). The morphometric characteristics of the concha nasalis sections are largely symmetrical and independent of sex, with only minor biological variation in certain measurements.

Keywords— Sheep, Nasal Cavity, Anatomical Structures, Morphometric.

I. INTRODUCTION

Sheep, from which people benefit for their meat, milk, skin, and wool, are among the first domesticated animal species. Sheep breeding has an important share in agricultural activities in most countries. In addition to the fact that most countries's climatic characteristics, land structure, and natural pastures are suitable for sheep breeding, sheep breeding is widely practiced due to its versatile productivity [1]. Kivircik sheep is one of the sheep breeds raised in Turkey, Bulgaria, and Greece. Kivircik sheep are mostly used for their meat yield. Their bodies are covered with white, coarse-mixed wool. Black and brown ones are also seen and are bred in Bulgaria. Males have white spiral horns, females have no horns. Head, neck, underbelly, and legs are naked. The head is long, the ears are short, the neck is long and narrow, the body is long and narrow, the rump is low and narrow, legs are long. The tail is long and thin and extends to the tarsus joint. The body is medium-sized. The fleece is carpet-like fleece and one of higher quality than the fleece of other local breeds. The Kivircik sheep ranks first among Turkish sheep breeds in terms of meat quality. The cranium in the axial skeleton system is located at the front of the skeletal system. It is a solid structure consisting mostly of double bones. The skull bones are divided into sections and examined separately according to the spaces they surround and the structures they form the basis of. These sections are called ossa cranii and ossa faciei. The facial part of the cranium forms the wall of the nasal cavity, called the cavum nasi, and the bony roof of the oral cavity. The cavum nasi (nasal cavity) forms the facial part of the respiratory system. The nasal cavity is a cavity divided into two halves by a partition called the septum nasi. It opens into the nares in the front and the choana in the back and the pars nasali pharyngis. It has a roof, a floor, and two lateral walls, one inner and one outer. The nasal cavity is divided into the airways called the meatus nasi dorsalis, meatus nasi medius, meatus nasi ventralis and meatus nasi communis through the conchae [2,3]. The cranial bones encase and protect the brain and are meticulously categorized into the calvaria and the skull base. The calvaria, or skullcap, consists of the frontal, parietal, and occipital bones, each contributing to the overall shape and integrity of the cranial vault. In contrast, the base of the skull encompasses the sphenoid, temporal, and ethmoid bones, which articulate to form the complex floor that supports vital neurovascular structures [4].

In addition to their protective roles, these bones provide crucial attachment points for muscles involved in mastication and head movement. The intricate sutures that connect them allow for flexibility during growth and development, while also serving as landmarks for both anatomical study and surgical intervention [5]. Meanwhile, the facial bones contribute to the structural framework of the face, housing the nasal cavity, orbits, and dental arches. Comprising the maxillae, zygomatic bones, nasal bones, and mandible, these elements support the overlying soft tissues and play a pivotal role in functions such as respiration, mastication, and articulation [6,7]. Each bone's unique morphology is tailored to its function, with foramina facilitating the passage of nerves vessels, and sinuses providing resonance to the voice while reducing overall skull weight. The intricate interplay between these elements underscores the skeleton's dual role as both a protective encasement and a dynamic framework for the human body. Thus, a comprehensive understanding of skull anatomy is essential for both anatomical knowledge and clinical practice [8]. The aim of this study is to reveal the macro-anatomical and morphometric characteristics of certain structures of the nasal cavity in Kivircik sheep. In addition, statistical evaluations of the morphometric and macro-anatomical features of the cavum nasi were conducted.

II. MATERIAL AND METHODS

Ethics approval was not required for this study because all materials used were obtained from slaughterhouse by-products. A priori power analysis was conducted to evaluate the adequacy of the sample size for two-way ANOVA and correlation tests. With a total sample size of 10 sheep (5 males, 5 females), the achieved power was sufficient only to detect large effect sizes (Cohen's $f > 0.40$ for ANOVA; $r > 0.80$ for correlation) at $\alpha = 0.05$. Therefore, the study was adequately powered for large effects, but underpowered for detecting small-to-moderate effects. In this study, the formations in the nose and nasal cavity of 10 Kivircik sheep (5 males, 5 females) were examined macroanatomically and morphometrically. For this purpose, Kivircik sheep brought to the Meat Integrated Facility for slaughter were used in Turkey, Balikesir province. The heads were brought to Balikesir University, Faculty of Veterinary Medicine, Anatomy Laboratory. After the heads were weighed as a whole, measurements were taken of the external noses of the heads. Then, using a hand saw, these heads were separated into two equal halves in the sagittal direction from the right median line in order not to damage the nasal septum. Measurements of each head-half and measurements of the septum nasi were made. A total of 18 measurement points were determined. Measurements were made with the aid of a digital caliper. The other two heads were photographed transversely, first from the rostral third level of the dental pad, then from the level of the caudal edge of the first premolars, then from the level of the caudal edge of the third premolars, and finally from the level of the caudal edge of the first molars.

All measured points are named and coded with letters as follows:

Measurement points of the external nose

A. Nostril length

B. Distance between two nostrils

C. Distance from the nostril to the upper lip

Measurement points of concha nasalis dorsalis

D. Cranio-caudal length of concha nasalis dorsalis

E. Distance of cranial tip to palatum durum

F. Distance of caudal tip to palatum durum

G. Widest point of concha nasalis dorsalis

Measurement points of concha nasalis media

H. Cranio-caudal length of concha nasalis media

I. Distance of cranial tip to palatum durum

J. Width of caudal tip

K. Widest point of concha nasalis dorsalis

Measurement points of concha nasalis ventralis

L. Cranio-caudal length of concha nasalis ventralis

M. Distance of cranial tip to palatum durum

N. Widest point of concha nasalis ventralis

O. Length of Plica alaris

P. Length of Plica basalis

Measurement points of septum nasi

R. Septum nasi length

S. Septum nasi thickness

2.1 Statistical analyses

Analyses were performed using the IBM®SPSS 22 package program. Whether there was a statistical difference between the data of the measurements of the right and left sides of the anatomical structure with gender and whether gender and organs being right or left affected each other and whether there was an interaction between them was examined using the multi-factor and interactive analysis of variance (Two-Way ANOVA) test. At the same time, effect sizes related to gender and organs being right or left were also calculated. The existence of a statistically significant relationship between all examined features (lengths and thicknesses) was examined using the Pearson correlation test. Distance between two nostrils, Septum nasi thickness, and Septum nasi length was compared only on gender basis with Mann Whitney U test because data was not distributed normally. Statistical significance was accepted when $p \leq 0.05$ [9].

III. RESULT AND DISCUSSION

Examination of the parameters of the concha nasalis dorsalis is presented in Table 1. The measurements of the concha nasalis dorsalis did not show significant differences between sexes or sides. Although slight variations were observed between males and females and between the right and left sides for all measured traits, these differences were not statistically significant ($p > 0.05$). Additionally, the interaction between gender and side had no significant effect on the measured values. Effect sizes were very small, indicating minimal practical impact of gender, side, or their interaction on the anatomical dimensions of the concha nasalis dorsalis.

TABLE 1
EXAMINATION OF THE PARAMETERS OF THE CONCHA NASALIS DORSALIS USING MULTI-FACTOR AND INTERACTIVE ANALYSIS OF VARIANCE

		Concha nasalis dorsalis			
		D	E	F	G
Gender	Male	112.69±2.24	28.80±1.05	54.21±1.21	13.63±0.75
	Female	112.09±0.97	27.91±0.68	54.47±1.11	12.61±0.29
Side	Right	111.99±2.97	28.62±0.82	53.83±0.84	13.02±0.69
	Left	112.79±3.78	28.08±0.63	54.85±1.38	13.22±0.54
Gender*Side	Male-Right	111.98±1.60	29.27±1.36	53.85±1.34	13.65±0.81
	Male-Left	113.40±1.84	28.32±0.83	54.57±2.23	13.62±0.80
	Female-Right	112.00±1.79	27.97±1.03	53.82±2.23	12.40±1.15
	Female-Left	112.18±1.08	27.85±1.06	55.12±1.99	12.82±0.79
P-values	Gender	0.823	0.429	0.883	0.28
	Side	0.766	0.629	0.574	0.829
	Gender*Side	0.816	0.711	0.872	0.808
Effect size	Gender	0.004	0.053	0.002	0.096
	Side	0.008	0.02	0.027	0.004
	Gender*Side	0.005	0.012	0.002	0.005

Data are presented as Mean±Standard error. D: Cranio caudal length (mm) E: Distance of cranial tip to palatum durum (mm). F: Distance of caudal tip to palatum durum (mm). G: Widest point (mm)

The results of the multifactorial analysis of variance for the concha nasalis media are presented in Table 2. No statistically significant differences were observed between males and females for any of the evaluated parameters ($p > 0.05$). Similarly, no significant asymmetry was detected between the right and left sides ($p > 0.05$). Although the interaction between gender and

side was also not significant ($p > 0.05$), effect size values indicated relatively higher variation for cranio-caudal length and caudal tip width.

TABLE 2
EXAMINATION OF THE PARAMETERS OF THE CONCHA NASALIS MEDIA USING MULTI-FACTOR AND INTERACTIVE ANALYSIS OF VARIANCE

		Concha nasalis media			
		H	I	J	K
Gender	Male	54.51±0.93	33.33±0.97	24.68±0.37	27.80±0.60
	Female	52.58±0.91	32.85±0.67	24.93±0.22	27.23±0.26
Side	Right	53.32±0.58	33.37±0.79	24.57±0.27	27.48±0.53
	Left	53.77±1.27	32.81±0.87	25.05±0.32	27.55±0.41
Gender*Side	Male-Right	53.42±0.35	33.87±1.28	24.17±0.28	27.60±1.03
	Male-Left	55.60±1.77	32.80±1.61	25.20±0.64	28.00±0.79
	Female-Right	53.22±1.20	32.87±1.06	24.97±0.41	27.37±0.52
	Female-Left	51.95±1.48	32.82±0.97	24.90±0.24	27.10±0.20
P-values	Gender	0.169	0.706	0.569	0.444
	Side	0.738	0.663	0.287	0.931
	Gender*Side	0.214	0.692	0.222	0.644
Effect size	Gender	0.151	0.012	0.028	0.05
	Side	0.01	0.016	0.094	0.001
	Gender*Side	0.125	0.014	0.122	0.018

Data are presented as Mean±Standard error. H: Cranio caudal length (mm). I: Distance of cranial tip to palatum durum (mm). J: Width of caudal tip (mm). K: Widest point (mm)

The results of the multifactorial analysis of variance for the concha nasalis ventralis are shown in Table 3. No statistically significant differences were observed between sexes for cranio-caudal length and widest point ($p > 0.05$). However, distance of the cranial tip to the palatum durum showed a near-significant difference between males and females ($p > 0.05$), with females presenting slightly higher values. Regarding the side factor, no significant differences were found ($p > 0.05$), although the effect size for widest point was relatively higher, suggesting a tendency for larger values on the left side. The interaction between gender and side was not significant ($p > 0.05$); nevertheless, moderate effect sizes were noted for widest point, mainly due to higher values observed in the female–left combination. The effects of gender, side, and their interaction on nostril length, the distance from the nostril to the upper lip, and the lengths of plica alaris and plica basalis were analyzed.

TABLE 3
EXAMINATION OF THE PARAMETERS OF THE CONCHA NASALIS VENTRALIS USING MULTI-FACTOR AND INTERACTIVE ANALYSIS OF VARIANCE

		Concha nasalis ventralis		
		L	M	N
Gender	Male	71.82±0.74	12.08±0.27	30.36±0.56
	Female	69.68±1.06	12.85±0.19	30.96±0.78
Side	Right	71.35±1.01	12.51±0.29	30.01±0.50
	Left	70.16±0.93	12.42±0.26	31.31±0.75
Gender*Side	Male-Right	72.90±0.64	12.00±0.40	30.25±0.79
	Male-Left	70.75±1.17	12.17±0.42	30.47±0.90
	Female-Right	69.80±1.67	13.02±0.23	29.77±0.70
	Female-Left	69.57±1.57	12.67±0.31	32.15±1.18
P-values	Gender	0.134	0.053	0.524
	Side	0.389	0.809	0.181
	Gender*Side	0.483	0.474	0.263
Effect size	Gender	0.177	0.278	0.035
	Side	0.062	0.005	0.144
	Gender*Side	0.042	0.044	0.103

Data are presented as Mean±Standard error. L: Cranio caudal length (mm). M: Distance of cranial tip to palatum durum (mm). N: Widest point (mm)

The mean values, standard errors, p-values, and effect sizes are summarized in Table 4. The comparison of morphometric parameters of the nasus externus and cavum nasi according to gender, side, and their interaction revealed that there were no statistically significant differences in any of the examined traits ($p > 0.05$). Although not significant, males tended to have a slightly longer plica alaris and plica basalis compared to females, while females showed marginally greater nostril length values. The effect size values indicated that gender had a small to moderate effect particularly on the length of the plica basalis, whereas all other parameters were influenced only minimally by gender or side. Side (right vs. left) and the interaction of gender*side showed negligible effects on all measured traits.

TABLE 4
INVESTIGATION OF SOME PARAMETERS OF NASUS EXTERNUS AND CAVUM NASI USING MULTI-FACTOR AND INTERACTIVE ANALYSIS OF VARIANCE

		Nostril length (mm)	The distance from the nostril to the upper lip (mm)	The length of Plica alaris (mm)	The length of Plica basalis (mm)
Gender	Male	21.93±0.67	15.43±0.42	104.63±1.95	95.18±1.50
	Female	22.78±0.84	15.52±0.31	101.72±0.76	91.53±0.81
Side	Right	22.55±0.84	15.65±0.43	102.72±1.37	93.46±1.37
	Left	22.17±0.70	15.31±0.32	103.63±1.75	93.26±1.40
Gender*Side	Male-Right	22.27±1.09	15.70±0.76	104.30±2.32	95.42±2.14
	Male-Left	21.60±0.89	15.17±0.47	104.97±3.50	94.95±2.41
	Female-Right	22.82±1.44	15.60±0.53	101.15±1.30	91.50±1.30
	Female-Left	22.75±1.12	15.45±0.52	102.30±0.90	91.57±1.18
P-values	Gender	0.477	0.883	0.219	0.071
	Side	0.751	0.574	0.692	0.915
	Gender*Side	0.88	0.754	0.918	0.884
Effect size	Gender	0.043	0.002	0.123	0.247
	Side	0.009	0.027	0.014	0.001
	Gender*Side	0.006	0.009	0.001	0.002

Data are presented as Mean±Standard error

The measurements of the nasus externus and cavum nasi, including the distance between two nostrils, septum nasi thickness, and septum nasi length, are summarized in Table 5. The comparison of the distance between two nostrils, septum nasi thickness, and septum nasi length according to gender revealed no statistically significant differences between males and females ($p > 0.05$). Although not significant, females exhibited slightly higher mean values for all measured parameters compared to males. The greatest numerical difference was observed in the distance between the two nostrils, while septum nasi thickness and length showed minimal variation between genders.

TABLE 5
EXAMINATION OF SOME PARAMETERS OF NASUS EXTERNUS AND CAVUM NASI

		Distance between two nostrils (mm)	Septum nasi thickness (mm)	Septum nasi length (mm)
Gender	Male	7.73±0.51	6.40±0.44	130.03±4.67
	Female	8.38±0.06	6.53±0.18	131.63±1.19
	P-values	0.102	0.663	0.564

Data are presented as Mean±Standard error

Correlation coefficients for the examined features are presented in Table 6. A positive and statistically significant correlation was determined between the cranio-caudal length of the concha nasalis dorsalis and the distance of the cranial end of the concha nasalis dorsalis to the palatum, and between the distance of the caudal end of the concha nasalis dorsalis to the palatum and the cranio-caudal length of the concha nasalis ventralis ($r = 0.696$, $p < 0.01$). A significant and positive correlation was found between the cranio-caudal length of the concha nasalis dorsalis and the length of the plica alaris ($r = 0.568$) and plica basalis ($r = 0.536$, $p < 0.05$). A positive and significant correlation was found between the distance of the cranial end of the concha nasalis dorsalis to the palatum durum and the length of the widest part of the concha nasalis dorsalis ($r = 0.502$, $p < 0.05$), the distance of the nostrils to the upper lip ($r = 0.650$, $p < 0.01$) and the length of the plica basalis ($r = 0.760$, $p < 0.01$); between

the distance of the caudal end of the concha nasalis dorsalis to the palatum durum and the length of the nostril ($r = 0.648$, $p < 0.01$) and the length of the nasal septum ($r = 0.712$, $p < 0.05$). A positive and significant correlation was found between the length of the widest part of the dorsalis concha and the length of the basal plica ($r = 0.661$, $p < 0.01$). A positive and significant correlation was also found between the cranio-caudal length of the nasal concha and the width of the caudal end of the nasal concha ($r = 0.510$, $p < 0.05$). A high level of correlation was found between the thickness of the nasal septum and the distance from the cranial end of the nasal concha to the palatum ($r = 0.806$, $p < 0.05$). A positive and significant correlation was observed between the width of the caudal end of the nasal concha and the length of the widest part of the nasal concha ($r=0.640$) and the distance from the ventral concha to the palatum ($r = 0.658$, $p < 0.01$). A positive and significant relationship was found between the length of the widest part of the concha nasalis media and the distance between the two nostrils ($r = 0.763$, $p < 0.05$), plica alaris ($r = 0.572$, $p < 0.05$) and basalis length ($r = 0.638$, $p < 0.01$). Similarly, a positive and significant correlation was determined between the cranio-caudal length of the ventral concha nasalis and the length of the plica basalis ($r = 0.517$, $p < 0.05$). A positive and significant correlation was determined between the distance of the ventral concha nasalis to the palatum and the distances of the nostrils to the upper lip ($r = 0.555$, $p < 0.05$). The relationship between the length of the plica alaris and the length of the plica basalis was observed to be highly and statistically significant ($r = 0.849$, $p < 0.001$). A negative significant correlation was observed between the length of the nasal septum and the distance of the cranial end of the nasal concha to the palatum ($r = -0.710$) and the thickness of the nasal septum ($r = -0.748$, $p < 0.05$). A negative significant correlation was also found between the cranio-caudal length of the concha nasalis dorsalis and the distance of the cranial end of the concha nasalis media to the palatum durum ($p < 0.05$). No statistically significant correlation was observed for the remaining characteristics ($p > 0.05$).

The measurement points determined on the concha nasalis dorsalis and their distances are presented in Figure 1. The measurement points determined on the concha nasalis media and the measured distances are presented in Figure 2. The measurement points defined on the concha nasalis ventralis and their distances are presented in Figure 3. The measurement points and locations of the plica alaris and plica basalis are shown in Figure 4. The nostril length measurement point is shown in Figure 5. The distance between the nostril and the upper lip and the distance between the two nostrils are presented in Figure 6. The cavum nasi section taken from the third level of the dental pad and the location of the septum nasi, nasal cavity floor and dental pad are presented in Figure 7. The anatomical structures related to the section of the nasal cavity taken at the level of the caudal edge of the first premolar teeth are presented in Figure 8. The nasal cavity section taken from the level of the caudal edge of the third premolar teeth and the anatomical structures seen at this level are presented in Figure 9. The anatomical structures related to the nasal cavity section taken from the level of the caudal edge of the first molar teeth are presented in Figure 10.

TABLE 6
PEARSON CORRELATION COEFFICIENTS OF DATA FROM NASUS EXTERNUS AND CAVUM NASI

	E	F	G	H	I	J	K	L	M	N	A	B	C	S	R	O	P
D	0.43	0.696**	0.314	0.191	-0.549*	0.205	0.145	0.049	0.294	0.149	0.303	-0.034	0.064	-0.535	0.579	0.568*	0.536*
E		0.394	0.502*	0.378	0.123	0.393	0.510*	0.696**	0.489	0.072	0.25	0.426	0.650**	-0.028	0.329	0.476	0.760**
F			0.303	0.055	-0.547	-0.128	-0.106	0.243	0.241	-0.12	0.648**	-0.046	-0.247	-0.367	0.712*	0.424	0.418
G				-0.25	0.042	-0.005	0.286	0.301	-0.229	-0.04	-0.187	0.171	-0.04	-0.204	0.312	0.422	0.661**
H					0.048	0.510*	0.303	0.468	0.411	-0.04	0.11	-0.046	0.478	0.17	-0.206	0.269	0.272
I						0.344	0.244	0.392	0.01	0.011	-0.32	-0.083	-0.08	0.806*	-0.710*	0.058	0.087
J							0.640**	0.093	0.658**	0.469	-0.237	0.686	0.251	0.171	0.09	0.362	0.325
K								0.212	0.26	0.47	-0.495	0.763*	0.371	-0.259	0.27	0.572*	0.638**
L									0.154	-0.34	0.335	-0.071	0.483	0.156	-0.085	0.404	0.517*
M										0.227	0.37	0.531	0.555*	0.134	0.402	0.117	0.111
N											-0.301	0.548	0.226	0.055	0.026	0.103	0.131
A												-0.15	0.35	0.142	0.234	-0.085	-0.081
B													0.591	-0.235	0.391	0.153	0.306
C														0.079	0.163	-0.009	0.251
S															-0.748*	-0.621	-0.305
R																0.534	0.382
O																	0.849***

*: Statistical significance at $P < 0.05$ level, **: Statistical significance at $P < 0.01$, ***: Statistical significance at $P < 0.001$.

All letters are defined at Materials and Methods section

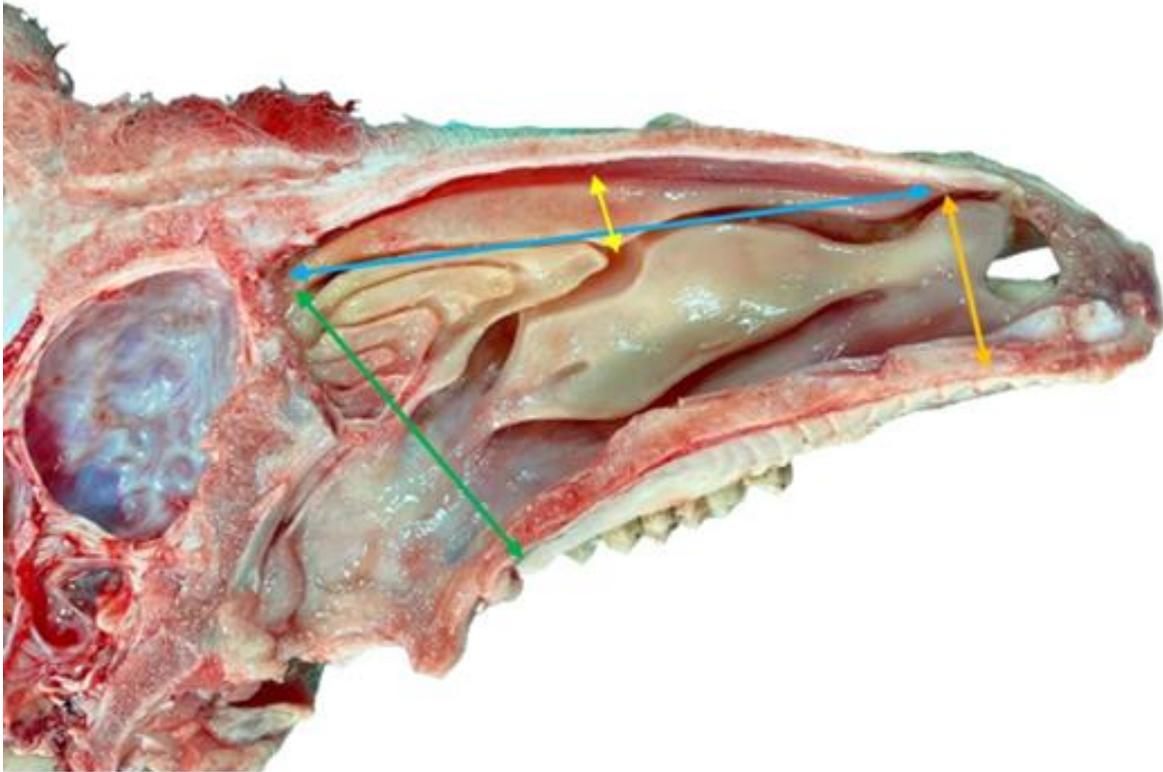


FIGURE 1. Measurement points of concha nasalis dorsalis (Original). Blue arrow: Cranio-caudal length of concha nasalis dorsalis (D), Orange arrow: Distance of cranial tip to palatum durum (E), Green arrow: Distance of caudal tip to palatum durum (F), Yellow arrow: Widest point of concha nasalis dorsalis (G)

In this study, the nasal and nasal cavum structures of Kivircik sheep were evaluated macroanatomically and morphometrically, and the obtained data were compared with those of other species and breeds. The nasal planum was found to be black, keratinized, and hairless, a finding consistent with results reported in Bengal goats and Garole sheep [10]. It was determined that the nasal cavity is divided into two equal halves by the nasal septum, and that this space contains three conchae (dorsalis, ventralis, and medialis) and four meati (dorsalis, medius, ventralis, and communis). This structure is consistent with the morphological order previously reported in the literature in different species [10–12]. Regarding nostril lengths, the values measured in Kivircik sheep (21.93 ± 0.67 mm in males and 22.78 ± 0.84 mm in females) were lower than those reported in Gaddi sheep and Egyptian goats [13,14]. This difference may reflect morphological diversity and environmental adaptations among the breeds. Similarly, the internostril distance was observed to be shorter in Kivircik sheep than in Egyptian goats and closer than in Egyptian Baladi dogs. The length of the nasal concha dorsalis was found to be longer in both males and females of Kivircik sheep compared to Egyptian goats and similar to the values reported in Gaddi sheep. Width measurements were also found to be shorter than in Gaddi sheep. The length of the nasal concha media in Kivircik sheep is quite consistent with the values reported in Egyptian goats and Gaddi sheep. The ventral concha nasalis is divided into plica alaris and plica basalis, similar to those in Yankasa sheep, Gaddi sheep, and camels. However, length values showed significant differences among species [13–15]. These variations are thought to be related to adaptation to different climatic conditions, respiratory functions, and the ecological niche of the species. Statistical analyses conducted in the study determined that gender and right-left lateralization factors did not influence each other in organ measurements. However, correlation analyses revealed significant relationships between some morphometric parameters. This suggests that the nose and navicular structures are developmentally and functionally interconnected. The morphometric data obtained from Kivircik sheep show both similarities to other small ruminants reported in the literature and also contain significant differences. These observed differences may represent the breed's unique morphological characteristics and its adaptations to environmental conditions. The morphometric characteristics of the concha nasalis sections are largely symmetrical and independent of sex, with only minor biological variation in certain measurements.

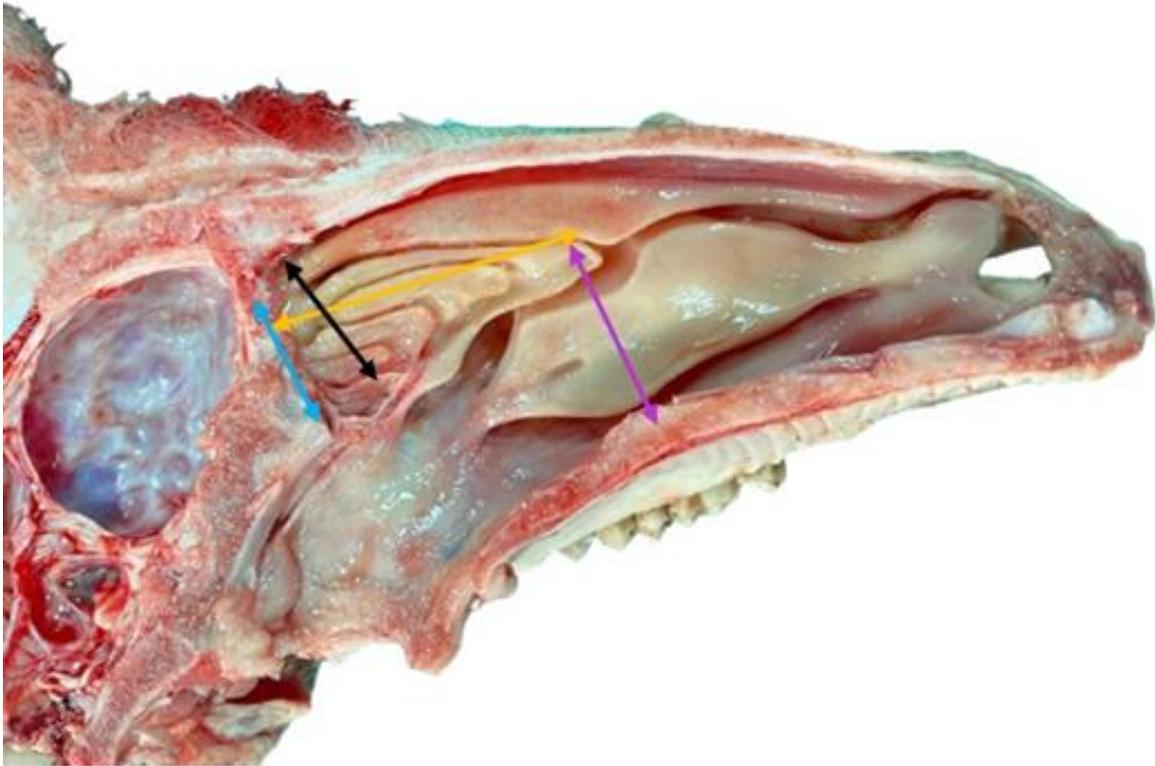


FIGURE 2: Measurement points of concha nasalis media (Original). Orange arrow: Cranio-caudal length of concha nasalis media (H), Purple arrow: Distance of cranial tip to palatum durum (I), Blue arrow: Width of caudal tip (J), Black arrow: Widest point of concha nasalis media (K)

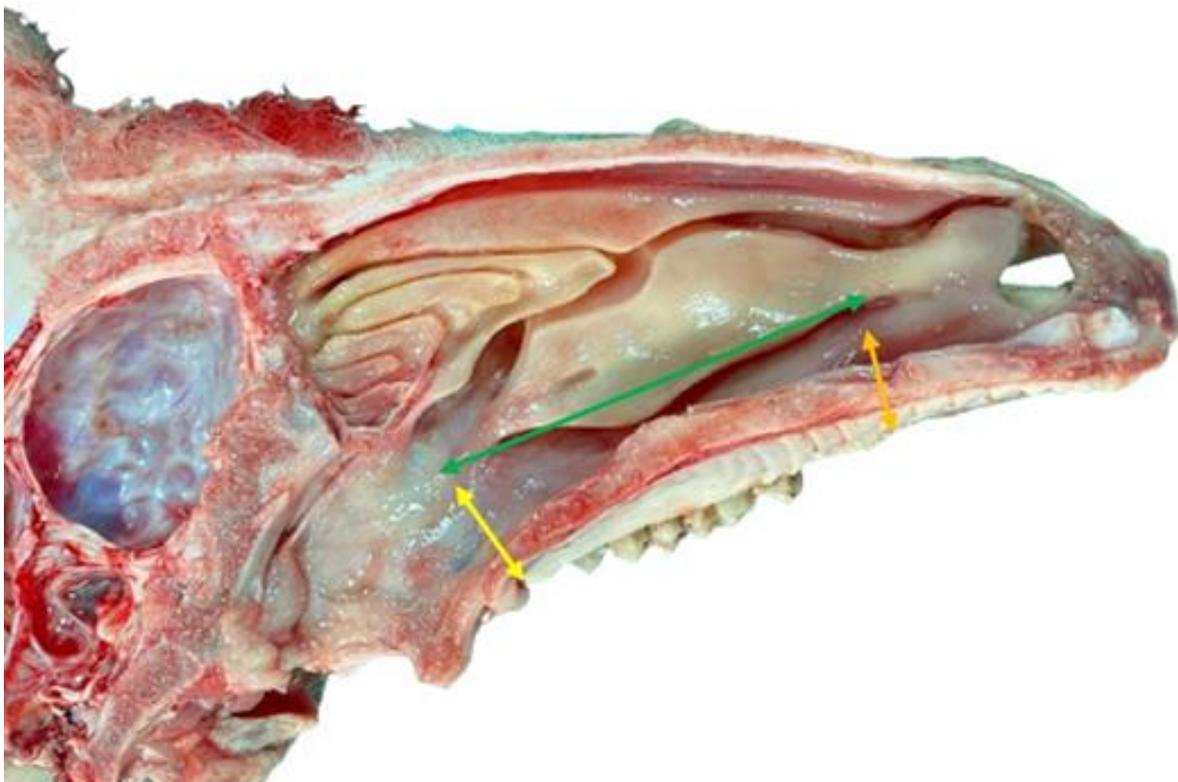


FIGURE 3: Measurement points of concha nasalis ventralis (Original). Green arrow: Cranio-caudal length of concha nasalis ventralis (L), Orange arrow: Distance of cranial tip to palatum durum (M), Yellow arrow: Widest point of concha nasalis ventralis (N)



FIGURE 4: Measurement points of plica alaris and basalis (Original). Black arrow: Length of plica alaris, Red arrow: Plica basalis

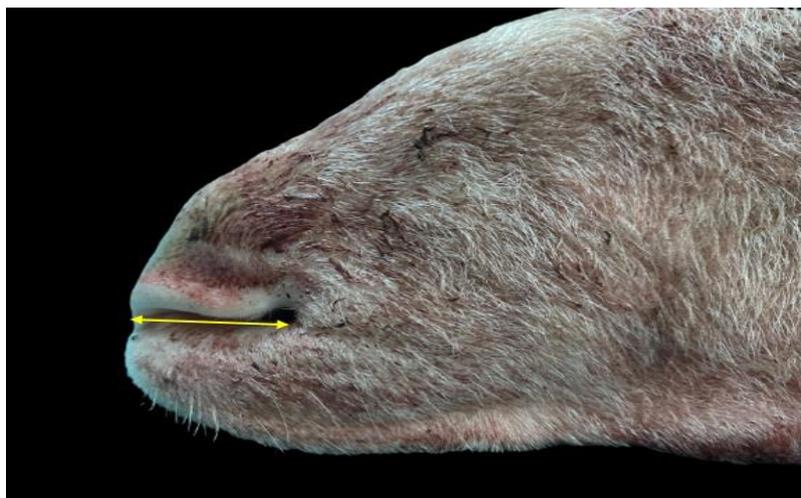


FIGURE 5: Yellow arrow: Nostril length (Original)

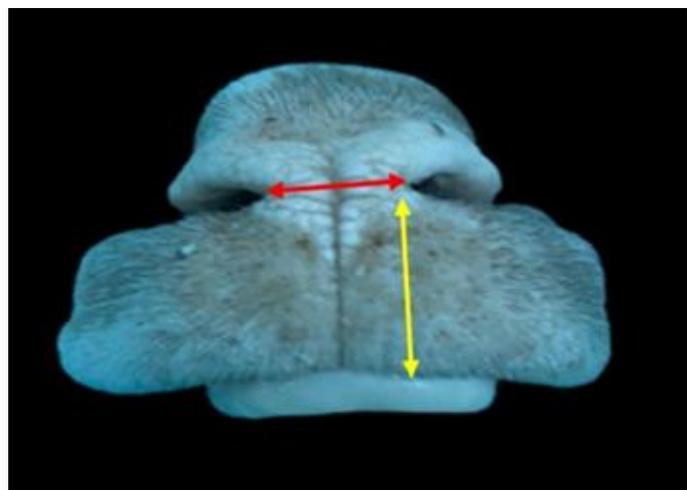


FIGURE 6: Yellow arrow: Distance from the nostril to the upper lip, Red arrow: Distance between two nostrils (Original)



FIGURE 7: The section of the cavum nasi cut from the third level of the dental cushion in the rostral (Original) 1. Septum nasi, 2. Floor of the nasal cavity, 3. Dental pad



FIGURE 8: The section of the nasal cavity cut at the level of the caudal margin of the first premolar teeth (Original) 1. Meatus nasi communis 2. Meatus nasi dorsalis, 3. Basal lamella of concha nasalis dorsalis, 4.

Spiral lamella of concha nasalis ventralis, 5. Meatus nasi ventralis, 6. Meatus nasi medius, 7. Basal lamella of concha nasalis ventralis

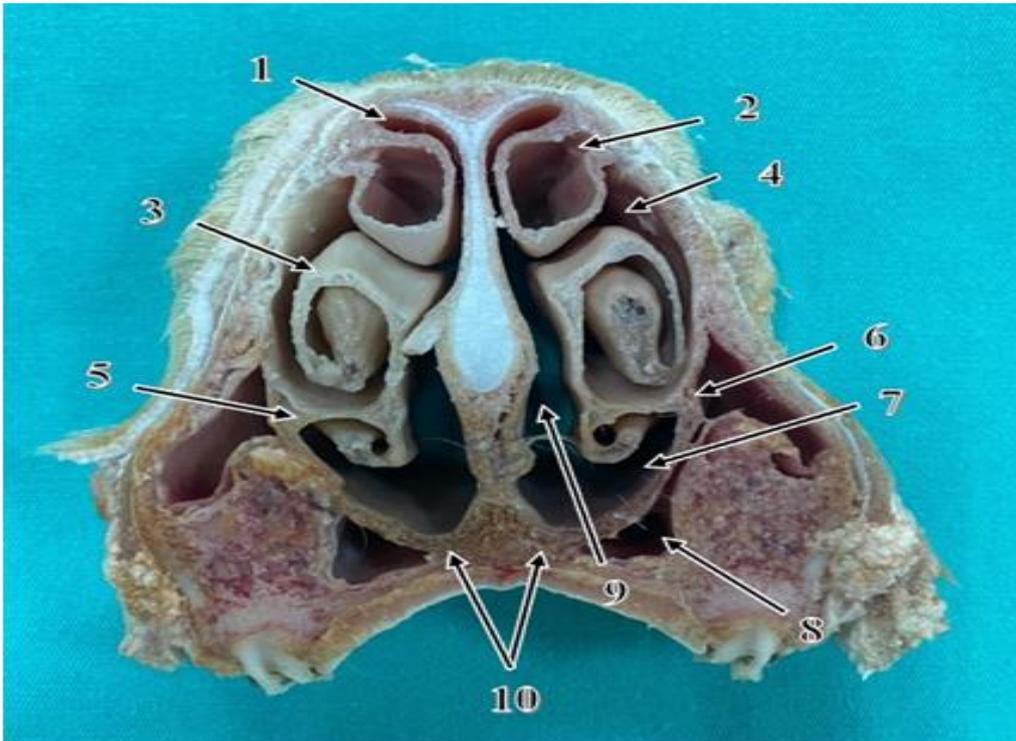


FIGURE 9: The section of the nasal cavity cut at the level of the caudal margin of the third premolar teeth (Original) 1. Meatus nasi dorsalis, 2. Sinus conchae dorsalis, 3. Dorsal spiral lamella belonging to the recess formed by the concha nasalis ventralis, 4. Meatus nasi medius, 5. Dorsal spiral lamella of the bulla formed by the concha nasalis ventralis, 6. Basal lamella of concha nasalis dorsalis, 7. Basal lamella of concha nasalis ventralis, 8. Sinus palatinus, 9. Meatus nasi communis, 10. Vomer nasal organ

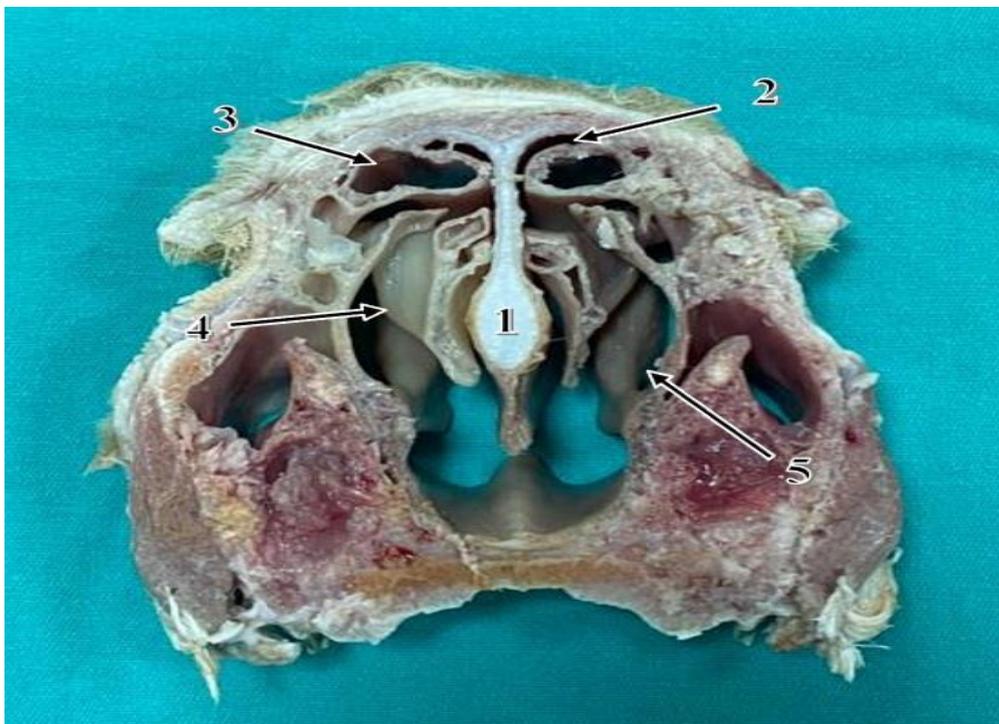


FIGURE 10: The section of the nasal cavity cut at the level of the caudal margin of the first molar teeth (Original) 1. Septum nasi, 2. Meatus nasi dorsalis, 3. Sinus conchae dorsalis, 4. Sinus conchae media, 5. Concha nasalis ventralis

IV. CONCLUSION

The morphometric data obtained from Kivircik sheep show both similarities to other small ruminants reported in the literature and also contain significant differences. These observed differences may represent the breed's unique morphological characteristics and its adaptations to environmental conditions. The morphometric characteristics of the concha nasalis sections are largely symmetrical and independent of sex, with only minor biological variation in certain measurements.

CONFLICT OF INTEREST

The authors declare that they have no competing interest.

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