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Research Article

Osteometric Examination of Metapodial Bones in Sheep *(Ovis aries* L.) and Goat *(Capra hircus* L.) Unearthed from the Yenikapı Metro and Marmaray Excavations in Istanbul [1]

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Abstract

In this study, the metapodial bones of sheep and goats which were found out at Yenikapı Metro and Marmaray archaeological excavations in İstanbul were used. The variability of characteristic features of mentioned metapodia (CV values) were examined and calculations of shoulder heights were made with using metapodial evaluations. The results which were reached were compared with the data of modern and archaeological sheep and goats which belong to previous studies about this topic. Hereat, it is observed that the shoulder heights of Byzantine sheep are in same data range with Iron Age sheep and are in same size with one of the modern breeds Tuj sheep. It is confirmed that the shoulder heights of the Byzantine goats are higher than Iron Age goats and are in same size with one of the modern breeds Anatolian Black Goats.

Keywords: *Metapodial bones, Yenikapı Metro and Marmaray, Sheep, Goat*

Istanbul Yenikapı Metro ve Marmaray Kazılarında Ortaya Çıkan Koyun ve Keçi Metapodial Kemiklerinin Osteometrik İncelenmesi

Özet

Çalışmada, İstanbul Yenikapı Metro ve Marmaray bölgesi arkeolojik kazılarında ortaya çıkarılan koyun ve keçi metapodium'ları kullanıldı. Söz konusu metapodium'ların ana özelliklerinin değişkenlikleri (CV değerleri) incelendi ve metapodial ölçümler kullanılarak omuz yüksekliği hesaplamaları yapıldı. Elde edilen sonuçların bu konu üzerinde yapılmış çalışmalardaki modern ve arkeolojik koyun-keçi verileri ile karşılaştırılması yapıldı. Bunun sonucunda; Bizans dönemi koyunların omuz yüksekliğinin, Demirçağ koyunları ile aynı veri aralığında, modern ırklardan ise Tuj ırkı koyunlarının ebatında olduğu gözlendi. Bizans dönemi keçilerin omuz yüksekliği, Demirçağ keçilerinden daha yüksek, modern ırklardan ise Anadolu Kıl keçisi ebatlarında olduğu tespit edildi.

Anahtar sözcükler: *Metapodial kemikler, Yenikapı Metro ve Marmaray, Koyun, Keçi*

INTRODUCTION

Yenikapı Metro and Marmaray excavations has started with Marmaray sub-sea tunnel project in 2004 and is still going on. Excavation area is 58.000 m^2 wide and with many archaeological material, animal bones were also found [1]. The ongoing excavation confirmed that the region is ancient harbour of Theodosius [1-3]. Together with dating the archaeological material in the excavation area, animal bones were also radiocarbon dated and the mentioned skeletons belong to different ages between early (4-7th century) and late (15th century) Byzantine [4].

The excavation bones are not only giving information about only animal-human relations, but also the parameters such as visual morphological features, diseases of

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animal population and animal husbandry.

By examining the obtained ruins determination of many morphological parameters were provided (weight, shoulder height, age, sex, physical structure of animal) [5-10]. Information about visual morphology was obtained by using evaluation of metapodia specially [10,11]. For the enlightenment of history of domestication of sheep [10-12] and goats [10,13], metapodia were often used to determining morphological changes in this duration. In the studies, estimated shoulder heights were calculated by using evaluations of metapodia which obtained in archaeological excavations and classification of species was tried to be identified by comparing with archaeological data and actual breeds.

In this study, the metapodial slenderness index which classificates the individuals as ''slender" or ''thick" and playing a role for determining of visual features was used (SD/GL*100) [5,14,15]. Distribution of CV was examined for the osteometric evaluation of aforementioned metapodiums and the data which were used in identification of breed were obtained by using these values [11,16,17].

We believe that the metapodia data obtained will enlighten the definition of sheep and goat population of Byzantine age, socio-economic condition of region and ancient animal husbandry of Istanbul where is the heart of Byzatine.

MATERIAL and METHODS

In this study, the metapodial bones of adult sheep and goat, which were found in Yenikapı Metro and Marmaray excavations were used. For this purpose, sheep with maximum numbers of 148 metacarpus and 219 metatarsus bones were examined while maximum number of metapodial bones for goats were 65 and 92 respectively which were examined.

Measurements of metapodial bones were taken by digital calliper with precision of 0.01 mm. The measurements were made as described in Onar et al.[10], Berteaux and Guintard [14], Davis [16], Guintard and Lallemand [17], Daugnora [18], Driesch [19], Haak [20], Rowley-Conwy's [21] studies and taken from measuring points which stated below.

Morphometric measurements (Fig. 1)

GL: Greatest length
Bp: Width of proximal end
Dp: Depth of proximal end
SD: Smallest width of diaphysis in the medio-lateral axis
d: Mid-shaft width of diaphysis
e: Mid-shaft depth of diaphysis in the dorso-palmar axis
DD: Smallest depth of diaphysis in the dorso-palmar axis
Bd: Width of distal end
Be: Greatest width of metaphysis in the medio-lateral axis
De: Greatest depth of metaphysis in the dorso-palmar axis
Dd: Depth of distal end
DIM: Antero-posterior diameter of the internal trochlea of the medial condyle
DEM: Antero-posterior diameter of the external trochlea of the medial condyle
DIL: Antero-posterior diameter of the internal trochlea of the lateral condyle
DEL: Antero-posterior diameter of the external trochlea of the lateral condyle
WCM: Medio-lateral width of the medial condyle
WCL: Medio-lateral width of the lateral condyle

Calculation of mean values, SD values and CV values of above mentioned measurements were made for the two breeds. SPSS 8.0 and Excel programs were used for the calculation of statistical data. (SD/GL*100) metapodial slenderness index which was used for determining the

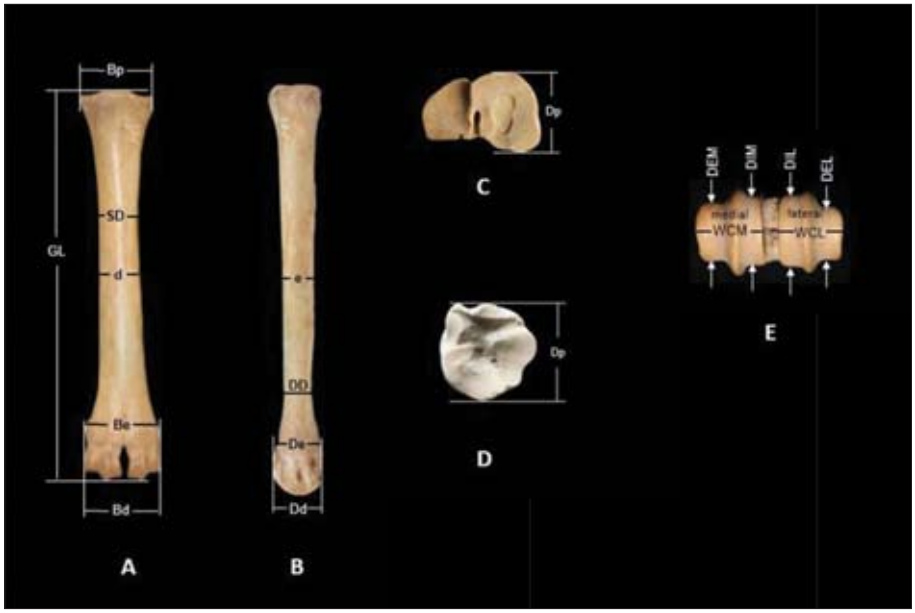

Fig 1. Measurements taken from the metapodial bones (sheep-goat), **A-** Dorsal view of metacarpus; **B-** Lateral view of metacarpus; **C-** Proximal view of metacarpus; **D-** Proximal view of metatarsus; **E-** Distal view of metatarsus

Şekil 1. Metapodium kemiklerinden alınan ölçümler (koyun-keçi), **A-** Metacarpus'un dorsal görünüşü; **B-** Metacarpus'un lateral görünüşü; **C-** Metacarpus'un proksimal görünüşü; **D-** Metatarsus'un proksimal görünüşü; **E-** Metatarsus'un distal görünüşü

thinness of skeleton were calculated by using metapodial calculation of bones of both species [5,14,15].

Shoulder height estimation which provides to estimate the visual morphology, has been calculated by using metapodial values taken from sheep and goats [20,22]. Visual morphology was tried to be estimated by comparing the data of shoulder heights of the two species with current data of goat and sheep [23,24].

RESULTS

Mean values, SD values and mean of CV values of osteometric values of metapodial bones of sheep and goats which were obtained from excavation for this study was given in *Table 1* and *Table 2*. Due to some of the metapodial bones have only distal or proximal fragments, material numbers which were used for each evaluation was subject to vary.

According to osteometrical evaluation results of sheep metacarpi, it was determined that the minimum variability was in Dp measurement (CV: 8.40%) while the maximum variability was observed in DD measurements (CV: 12.03%). When metatarsi were examined, it was determined that maximum variability was in DD (CV: 8.49%) and minimum variability was in Bd (CV: 5.91%) *(Table 1)*.

In the measurements of metapodium of goats for metacarpus, it was found that maximum variability was in Bd measurement (12.32%) and minimum variability was in WCM (7.24%) measurement. The maximum variability of goat metatarsi was in De measurements (%9.78) and minimum variability was observed in DIL measurements (6.79%) *(Table 2)*.

Metapodial slenderness index was calculated for metacarpi and metatarsi of both species seperately. While metapodial slenderness index for metacarpi of sheep was observed 11.70±1.12, index of metatarsi was determined 9.45±0.73 *(Table 3)*. Aforementioned index values for metacarpi and metatarsi were calculated 14.89±1.24 and 11.11±0.79 for goats respectively.

In this study, estimated shoulder heights of sheep and goats were calculated by using metacarpi and metatarsi which were obtained. Thus shoulder heights data were acquired for both species *(Table 3, Table 4)*. Mean value for the shoulder height of sheep was estimated as 60.79 cm while it was determined as 65.55 cm for goats. It was found that the value of CV (7.89%) lower in shoulder height results which were calculated with the values of metatarsi of sheep was lower. For goats, unlike the sheep CV value (8.18%) of estimated shoulder height was the lowest which were determined by using results of metacarpus measurements.

DISCUSSION

In this study, osteometric measurements were made on metapodial bones of sheep and goats which were found in İstanbul Yenikapı Metro and Marmaray excavations. The variabilities of main features of metapodia were researched and these features were compared with the

Table 1. *Morphometrical data of metapodial bones of sheep and calculation of CV %*
Tablo 1. *Koyunların metapodium kemiklerinin morfometrik verileri ve % CV hesaplanması*

Bone	Statistical Values	Measurements																
		GL	Bp	Dp	SD	d	e	DD	Bd	Be	De	Dd	DIM	DEM	DIL	DEL	WCM	WCL
Metacarpus	N	136	147	147	148	148	148	148	136	145	145	135	135	137	135	136	135	134
	Mean	124.91	24.51	17.51	14.56	14.71	10.98	9.98	26.74	27.00	14.10	16.42	14.24	11.98	14.32	11.06	12.66	12.14
	SD	11.04	2.45	1.47	1.74	1.52	1.13	1.20	2.49	2.41	1.41	1.43	1.29	1.26	1.35	1.18	1.21	1.20
	Min	105.85	20.36	14.74	10.79	10.82	8.70	7.83	22.63	22.38	11.61	13.10	11.73	9.26	11.68	8.70	10.72	10.25
	Max	180.31	47.31	28.03	25.73	25.64	19.09	18.49	48.85	45.12	24.04	25.15	23.86	21.82	24.99	20.40	23.27	22.52
	%CV	8.84	10.00	8.40	11.92	10.32	10.25	12.03	9.31	8.93	10.03	8.69	9.06	10.52	9.40	10.70	9.55	9.87
Metatarsus	N	203	219	217	219	219	219	217	208	216	216	207	209	210	207	208	207	207
	Mean	134.05	21.33	21.15	12.61	12.90	12.15	10.51	25.31	25.38	14.46	16.28	14.06	11.25	14.07	10.36	12.11	11.11
	SD	10.57	1.45	1.48	1.02	1.08	0.95	0.89	1.50	1.69	1.18	1.16	0.92	0.84	0.92	0.76	0.77	0.67
	Min	104.09	18.20	13.69	10.00	10.21	10.14	8.66	21.36	21.10	11.68	12.98	11.39	8.94	11.56	8.52	10.19	9.35
	Max	161.29	28.87	25.28	15.47	15.94	15.36	14.45	29.51	30.84	18.55	20.36	17.31	14.53	17.55	12.84	14.37	13.14
	%CV	7.89	6.78	6.98	8.05	8.33	7.86	8.49	5.91	6.64	8.20	7.10	6.57	7.47	6.57	7.38	6.33	6.05

GL: *Greatest length,* ***Bp:*** *Width of proximal end,* ***Dp:*** *Depth of proximal end,* ***SD:*** *Smallest width of diaphysis in the medio-lateral axis,* ***d:*** *Mid-shaft width of diaphysis,* ***e:*** *Mid-shaft depth of diaphysis in the dorso-palmar axis,* ***DD:*** *Smallest depth of diaphysis in the dorso-palmar axis,* ***Bd:*** *Width of distal end,* ***Be:*** *Greatest width of metaphysis in the medio-lateral axis,* ***De:*** *Greatest depth of metaphysis in the dorso-palmar axis,* ***Dd:*** *Depth of distal end,* ***DIM:*** *Antero-posterior diameter of the internal trochlea of the medial condyle,* ***DEM:*** *Antero-posterior diameter of the external trochlea of the medial condyle,* ***DIL:*** *Antero-posterior diameter of the internal trochlea of the lateral condyle,* ***DEL:*** *Antero-posterior diameter of the external trochlea of the lateral condyle,* ***WCM:*** *Medio-lateral width of the medial condyle,* ***WCL:*** *Medio-lateral width of the lateral condyle*

Table 2. *Morphometrical data of metapodial bones of goats and calculation of CV %*
Tablo 2. *Keçilerin metapodium kemiklerinin morfometrik verileri ve % CV hesaplanması*

Bone	Statistical Values	Measurements																
		GL	Bp	Dp	SD	d	e	DD	Bd	Be	De	Dd	DIM	DEM	DIL	DEL	WCM	WCL
Metacarpus	N	57	64	64	65	54	53	63	57	53	51	54	57	57	55	55	57	55
	Mean	115.52	26.04	17.81	17.30	17.95	11.42	11.31	28.66	28.77	14.54	17.19	14.75	11.07	14.85	10.51	13.44	13.01
	SD	9.44	2.15	1.47	1.80	1.85	1.09	1.19	3.53	3.08	1.40	1.33	1.40	0.89	1.40	0.82	0.97	1.08
	Min	99.57	21.77	14.82	13.34	14.05	9.56	9.36	15.86	18.64	11.69	14.12	12.00	9.66	12.10	8.76	11.59	10.94
	Max	142.92	30.51	21.15	22.10	22.92	15.88	15.03	35.50	34.15	17.14	19.70	19.79	13.33	19.49	12.55	15.48	15.71
	%CV	8.18	8.25	8.24	10.41	10.33	9.52	10.52	12.32	10.72	9.65	7.72	9.49	8.05	9.45	7.82	7.24	8.27
Metatarsus	N	78	90	88	92	76	76	87	75	69	69	76	77	77	77	78	76	75
	Mean	121.13	20.83	19.67	13.53	13.88	11.62	10.36	25.03	25.42	13.87	16.04	13.77	10.44	13.87	9.97	11.83	11.24
	SD	11.40	1.53	1.70	1.23	1.27	1.13	0.93	1.88	2.12	1.36	1.29	0.95	0.83	0.94	0.71	0.91	0.92
	Min	97.78	17.73	15.92	9.06	9.26	8.63	8.10	21.90	20.32	11.66	13.28	12.01	9.07	11.73	8.53	10.44	9.85
	Max	165.19	24.24	24.48	16.39	16.87	14.61	12.55	28.94	29.71	16.63	19.17	16.59	13.15	16.21	11.50	14.10	14.84
	%CV	9.41	7.36	8.64	9.12	9.12	9.70	8.97	7.49	8.32	9.78	8.04	6.90	7.91	6.79	7.11	7.70	8.19

GL: *Greatest length,* ***Bp:*** *Width of proximal end,* ***Dp:*** *Depth of proximal end,* ***SD:*** *Smallest width of diaphysis in the medio-lateral axis,* ***d:*** *Mid-shaft width of diaphysis,* ***e:*** *Mid-shaft depth of diaphysis in the dorso-palmar axis,* ***DD:*** *Smallest depth of diaphysis in the dorso-palmar axis,* ***Bd:*** *Width of distal end,* ***Be:*** *Greatest width of metaphysis in the medio-lateral axis,* ***De:*** *Greatest depth of metaphysis in the dorso-palmar axis,* ***Dd:*** *Depth of distal end,* ***DIM:*** *Antero-posterior diameter of the internal trochlea of the medial condyle,* ***DEM:*** *Antero-posterior diameter of the external trochlea of the medial condyle,* ***DIL:*** *Antero-posterior diameter of the internal trochlea of the lateral condyle,* ***DEL:*** *Antero-posterior diameter of the external trochlea of the lateral condyle,* ***WCM:*** *Medio-lateral width of the medial condyle,* ***WCL:*** *Medio-lateral width of the lateral condyle*

Table 3. *Metapodial slenderness index of sheep and calculation of estimated shoulder height*
Tablo 3. *Koyunların metapodial incelik indeksi ve tahmini omuz yüksekliğinin hesaplanması*

Animal	Statistical Values	Metacarpus		Metatarsus	
		MSI	SH (cm)	MSI	SH (cm)
Sheep	N	136	136	203	203
	Mean	11.70	60.58	9.45	60.99
	SD	1.12	5.36	0.73	4.81
	Min	9.80	51.34	7.65	47.36
	Max	19.66	87.45	11.80	73.39
	%CV	9.56	8.84	7.77	7.89

MSI: *Metapodial Slenderness Index,* ***SH:*** *Estimated Shoulder Height*

Table 4. *Metapodial slenderness index of goats and calculation of estimated shoulder height*
Tablo 4. *Keçilerin metapodial incelik indeksi ve tahmini omuz yüksekliğinin hesaplanması*

Animal	Statistical Values	Metacarpus		Metatarsus	
		MSI	SH (cm)	MSI	SH cm)
Goat	N	57	57	78	78
	Mean	14.89	66.42	11.11	64.68
	SD	1.24	5.43	0.79	6.09
	Min	11.73	57.25	8.79	52.21
	Max	17.06	82.18	12.75	88.21
	%CV	8.34	8.18	7.11	9.41

MSI: *Metapodial Slenderness Index,* ***SH:*** *Estimated Shoulder Height*

previous studies about modern and archaeological sheep-goat population.

CV values which were obtained from the measuring points of metapodia of sheep and goats were calculated *(Table 5)*. While CV values of metacarpus measurements of sheep varies between 12.03% (DD) and 8.40% (Dp), these values were between 8.49% (DD) and 5.91% (Bd) for metatarsus. The aforementioned values varies between 12.32% (Bd) and 7.24% (WCM) for metacarpi relating to goats, where as 9.78% (De) and 6.79% (DIL) for metatarsi. Obtained CV values were found as higher than the maximum values which Haak [20] and Davis [16] and lower than the maximum values that Guintard and Lallemand [17] defined. Because there is not any sampling method for data in archaeological excavations, homogeneous distribution may not be expected. In this study, variation in CV values suggests the bone samples probably belong to different breeds and genders. The CV values are not high as much as in modern breed studies [11,17] so that it supports the obtained sampling may be close to homogeneous.

Guintard and Lallemand [17] noted in their studies that GL is the main measurement for the assesment of slenderness of bone. They used this parameter for categorizing breeds as "tall" for higher and "short" for lower than 135 mm. Considering the GL values of metacarpus and metatarsus of sheep and goats which we used in our study, these values vary between 115.52 mm and 134.05 mm and therefore individuals belong to both species must be categorized as "short".

Table 5. *Comparison of the coefficient of variation (CV%) of osteometric measurements of sheep metapodial bones with the modern and archeological values*

Tablo 5. *Koyun metapodium kemiklerinin osteometrik ölçümlerinin varyasyon katsayısının modern ve arkeolojik veriler ile karşılaştırılması*

Bone	Sheep															Goat			
	Yenikapı Metro and Marmaray		Upper Anzaf Castle		Lallemand 2002				Guintard and Lallemand 2003				Davis 1996 (Cvall) Female		Davis 1996 (Cvav+good) Female		Yenikapı Metro and Marmaray		Upper Anzaf Castle	
					Female		Male		Female		Male									
Metacarpus	DD	12.03	De	7.84	d	15.04	d	19.61	d	15.04	d	19.61	DEM	5.8	DEM	5.8	Bd	12.32	GL	9.61
	SD	11.92	DD	7.34	SD	14.52	SD	18.85	SD	14.52	SD	18.85	DEL	5.4	DEL	5.4	Be	10.72	De	9.23
	DEL	10.70	SD	6.92	Bp	10.79	e	15.24	Bp	10.79	e	15.24	SD	5	SD	5	DD	10.52	e	8.09
	DEM	10.52	e	6.74	GL	9.56	DD	14.32	GL	9.56	DD	14.32	DIL	4.9	DIL	4.9	SD	10.41	Dp	7.59
	d	10.32	Dd	6.38	e	9.55	Bp	13.76	e	9.55	Bp	13.76	DIM	4.7	DIM	4.7	d	10.33	Bp	7.46
	e	10.25	GL	6.36	DD	9.37	Dp	13.32	DD	9.37	Dp	13.32	Bp	3.9	Bp	3.9	De	9.65	DD	7.04
	De	10.03	Be	5.64	Be	9.07	WCL	13.09	Be	9.07	WCL	13.09	GL	3.8	GL	3.8	e	9.52	SD	6.17
	Bp	10.00	Bp	5.61	Dp	8.56	Be	12.98	Dp	8.56	Be	12.98	WCM	3.6	WCM	3.6	DIM	9.49	Dd	5.94
	WCL	9.87	Dp	5.21	WCM	8.42	DEL	12.75	WCM	8.42	DEL	12.72	WCL	3.6	WCL	3.6	DIL	9.45	Be	5.91
	WCM	9.55	Bd	4.13	DEL	8.32	WCM	12.69	DEL	8.32	WCM	12.69	Bd	3	Bd	3	WCL	8.27	Bd	4.83
	DIL	9.40			De	8.21	DEM	12.32	De	8.21	DEM	12.32					Bp	8.25		
	Bd	9.31			DEM	8.14	Bd	11.96	DEM	8.14	Bd	11.96					Dp	8.24		
	DIM	9.06			WCL	8.04	DIM	11.75	WCL	8.04	DIM	11.75					GL	8.18		
	Be	8.93			Bd	7.79	DIL	11.74	Bd	7.97	DIL	11.74					DEM	8.05		
	GL	8.84			Dd	7.73	GL	11.58	Dd	7.73	GL	11.58					DEL	7.82		
	Dd	8.69			DIL	7.36	De	11.24	DIL	7.36	De	11.24					Dd	7.72		
	Dp	8.40			DIM	7.18	Dd	9.97	DIM	7.18	Dd	9.97					WCM	7.24		
Metatarsus	DD	8.49	DD	9.36	d	13.73	d	18.54	d	13.73	d	18.54	SD	5.1	SD	4.5	De	9.78	e	11.14
	d	8.33	SD	8.32	SD	12.66	SD	17.68	SD	12.66	SD	17.68	DIL	4.9	DIL	4.1	e	9.70	DD	10.01
	De	8.20	e	8.29	e	11.49	DEM	16.83	e	11.49	DEM	16.83	DIM	4.4	GL	3.7	GL	9.41	SD	9.71
	SD	8.05	Dp	8.04	GL	10.41	e	16.64	GL	10.41	e	16.64	GL	4.1	DIM	3.5	SD	9.12	Dp	8.67
	GL	7.89	De	7.86	DEM	10.2	DEL	16.3	DEL	10.20	DEL	16.30	Bd	3.2	Bd	2.9	d	9.12	De	8.55
	e	7.86	GL	7.71	DEL	10.2	DD	16.14	DEM	10.20	DD	16.14					DD	8.97	Bp	8.38
	DEM	7.47	Be	7.26	DD	10.18	Bp	15.3	DD	10.18	Bp	15.3					Dp	8.64	GL	7.87
	DEL	7.38	Bp	5.95	Dp	10.04	Dp	15.16	Dp	10.04	Dp	15.16					Be	8.32	Dd	7.14
	Dd	7.10	Dd	5.81	WCM	9.99	DIL	14.82	WCM	9.90	DIL	14.82					WCL	8.19	Be	6.68
	Dp	6.98	Bd	5.45	WCL	9.96	GL	14.55	WCL	9.96	GL	14.55					Dd	8.04	Bd	5.86
	Bp	6.78			Bp	9.95	WCL	14.47	Bp	9.95	WCL	14.47					DEM	7.91		
	Be	6.64			Be	9.52	DIM	14.45	Be	9.52	DIM	14.45					WCM	7.70		
	DIL	6.57			Dd	9.44	De	14.39	Dd	9.44	De	14.39					Bd	7.49		
	DIM	6.57			De	9.17	Be	14.23	De	9.17	Be	14.23					Bp	7.36		
	WCM	6.33			Bd	8.95	WCM	14.23	Bd	8.95	WCM	14.23					DEL	7.11		
	WCL	6.05			DIL	8.5	Bd	13.71	DIL	8.50	Bd	13.71					DIM	6.90		
	Bd	5.91			DIM	8.25	Dd	12.91	DIM	8.25	Dd	12.91					DIL	6.79		

GL: *Greatest length,* ***Bp:*** *Width of proximal end,* ***Dp:*** *Depth of proximal end,* ***SD:*** *Smallest width of diaphysis in the medio-lateral axis,* ***d:*** *Mid-shaft width of diaphysis,* ***e:*** *Mid-shaft depth of diaphysis in the dorso-palmar axis,* ***DD:*** *Smallest depth of diaphysis in the dorso-palmar axis,* ***Bd:*** *Width of distal end,* ***Be:*** *Greatest width of metaphysis in the medio-lateral axis,* ***De:*** *Greatest depth of metaphysis in the dorso-palmar axis,* ***Dd:*** *Depth of distal end,* ***DIM:*** *Antero-posterior diameter of the internal trochlea of the medial condyle,* ***DEM:*** *Antero-posterior diameter of the external trochlea of the medial condyle,* ***DIL:*** *Antero-posterior diameter of the internal trochlea of the lateral condyle,* ***DEL:*** *Antero-posterior diameter of the external trochlea of the lateral condyle,* ***WCM:*** *Medio-lateral width of the medial condyle,* ***WCL:*** *Medio-lateral width of the lateral condyle*

Table 6. *Comparison of the estimated shoulder heights of sheep and goats unearthed at the Yenikapı Metro and Marmaray excavations with the current breeds and archeological values*

Tablo 6. *Yenikapı Metro ve Marmaray kazılarından elde edilen koyun ve keçilerin tahmini omuz yüksekliğinin günümüz ırklar ve arkeolojik verilerle karşılaştırılması*

Breeds	Morphological Appearance and Pattern			
	Shoulder Height (cm)	Distribution	Phenotypic Description	Size
Yenikapı Metro ve Marmaray Sheep	**60.79**			
Upper Anzaf Castle Sheep	59.93			
White Karaman[1]	Male: 62-67; Female: 63-66	Eastern/Central Anatolia	Fat-tailed	Medium-size
Red Karaman[1]	Male: 65-71; Female: 66-68	Eastern/Central Anatolia	Fat-tailed	Medium-size
Awassi[1]	Male: 70-80; Female: 60-70	Eastern/Central Anatolia	Fat-tailed	Medium-size
Karakul[2]	65	Eastern/Central Anatolia	Fat-tailed	Medium-size
Tuj[2]	60	Eastern Anatolia	Fat-tailed	Medium-size
Dağlıç[2]	58	Central-west Anatolia	Fat-tailed	Small
Yenikapı Metro ve Marmaray Goat	**65.55**			
Upper Anzaf Castle Goat	56.97			
Angora Goat[1]	Male: 55-60; Female: 50-55	Central Anatolia		
Anatolian Black Goat[1]	Male: 65-70; Female: 65-73	All region in Turkey		
Kilis Goat[1]	Male: 65-75; Female: 60-70	South-Eastern Anatolia		

[1] Soysal et al.[23], [2] Yalcin [24]

Comparing with the literature that categorize the individuals as ''heavy'' and ''light'' according to metacarpus Bp values higher and lower than 27 mm, the values of individuals which belong to our study were evaluated lower than 27 mm thus small ruminants from Byzantine age defined as ''light''. The results of GL and Bp of sheep and goats in the zooarchaeological study of Onar et al.[10] are same with our results and show that same breeds of that age are also ''short'' and ''light''. The metapodial bones were also used in osteological researches on development of sheep in South England during post medieval period [12]. According to the results of metapodial data, authors indicated that the sheep of that region were ''light'' and ''short''.

The morphological image of the sheep breeds in that study have parallelism with the ones in our study. Metapodial slender index was used in this study (SD/GL*100) which classified the individuals as ''slender'' and ''thick''and effective for the evaluation of visual morphology [5,14,15]. While slenderness index varies between 9.45 and 11.70 for sheep, it was determined between 11.11 and 14.89 for goats. It is determined that results showed similarities with the results of animal bones which Onar et al.[10] stated as ''short'' and ''slender'' breeds and obtained from Upper Anzaf Castle excavations.

The comparison of modern and archaeological sheep goat data is given particularly in this study which shoulder heights of both species are evaluated *(Table 6)* [10,23,24]. The size of the sheep of Byzantine age appear to be similar according to modern Tuj sheep breeded in Eastern Anatolia and archaeological Iron Age sheep. However the goats are 10 cm higher than archaeological Iron Age goats and in the same data range with modern breed "Anatolian Black Goat". It is known that gender and breeding regions are importantly effective on the size of goats [13].

Considering the examined metapodium numbers, breeding and consumption of sheep are higher compared to goats, same as Upper Anzaf Castle excavation studies. Metapodial values obtained which enables to determine the position of the population of sheep and goat and the visual morphological structure of this population, are of nature to enlighten the history of livestock in Istanbul which is the heart of Byzantine.

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