How to cite: Hakan, S., A. Ö. Demir & A. Öner, 2026. Some phenotypical characteristics of Norduz sheep raised in Norduz region within scope of the 'Protecting gen resources in situ' program. Ege Univ. Ziraat Fak. Derg., 63 (1): 95-111, https://doi.org/10.20289/zfdergi.1699717

Research Article
(Araştırma Makalesi)

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Keywords: Case study, descriptive qualitative field study, native sheep gene source, Norduz sheep

Anahtar sözcükler: Vaka çalışması, tanımlayıcı nitel saha çalışması, yerli koyun gen kaynağı, Norduz koyunu

Ege Üniv. Ziraat Fak. Derg., 2026, 63 (1):95-111
https://doi.org/10.20289/zfdergi.1699717

Some phenotypical characteristics of Norduz sheep raised in Norduz region within scope of the 'Protecting gen resources in situ' program

'Gen kaynaklarının yerinde korunması' programı kapsamında Norduz bölgesinde yetiştirilen Norduz koyunlarının bazı fenotipik özellikleri

Received (Alınış): **15.05.2025** **Accepted** (Kabul Tarihi)**13.03.2026**

ABSTRACT

Objective: This study aims to document the phenotypic diversity, morphometric characteristics and conservation status of the Norduz sheep breed in order to provide essential data for future genetic conservation and breeding strategies.

Material and Method: The study sample consisted of Norduz sheep raised in the Norduz region of Gürpınar, Van province. Field studies conducted in 2024 identified morphological traits suitable for purebred breeding and phenotypic traits were generated using standard forms. Furthermore, the current conservation status was assessed through observation and breeder information.

Results: The data obtained demonstrate that Norduz sheep are exceptionally well adapted to regional conditions. However, observations and breeder data have shown a significant decline in the purebred Norduz sheep population in recent years. Despite this decline, concrete steps have been taken to prevent genetic erosion as part of the "In-Situ Conservation" program launched by the Ministry of Agriculture and Forestry.

Conclusion: The Norduz sheep represents a valuable local genetic resource with high adaptive and productive potential. The documentation of its phenotypic and morphometric characteristics is crucial for informing future breeding and conservation programs.

ÖZ

Amaç: Bu çalışma, Doğu Anadolu'ya özgü yerli bir genotip olan Norduz koyununun fenotipik çeşitliliğini, morfometrik özelliklerini ve mevcut koruma durumunu ortaya koyarak, ırkın sürdürülebilirliği için gerekli olan gen koruma ve yetiştirme stratejilerine bilimsel altyapı sağlamayı amaçlamaktadır.

Materyal ve Metod: Çalışmanın materyalini Van ili Gürpınar ilçesi Norduz yöresinde yetiştirilen Norduz koyunları oluşturmuştur. 2024 yılında yapılan arazi çalışmaları ile safkan yetiştiriciliğine uygun morfolojik özellikler belirlenmiş ve fenotipik özellikler standart formlar kullanılarak oluşturulmuştur. Ayrıca, mevcut koruma durumu gözlem ve yetiştirici bilgileri kullanılarak değerlendirilmiştir.

Bulgular: Elde edilen veriler, Norduz koyununun bölge koşullarına son derece iyi uyum sağladığını ortaya koymuştur. Bununla birlikte, yapılan gözlemler ve yetiştirici verileri, son yıllarda safkan Norduz koyunu popülasyonunda belirgin bir düşüş yaşandığını göstermiştir. Bu düşüşe karşın, Tarım ve Orman Bakanlığı tarafından başlatılan "Yerinde Koruma" programı kapsamında, gen erozyonun önlenmesine yönelik somut adımlar atılmıştır.

Sonuç: Çalışma bulguları, Norduz koyununun bölgeye özgü üstün verim özelliklerine sahip önemli bir yerli genetik kaynak olduğunu ve korunması gerektiğini ortaya koymaktadır. Irkın fenotipik ve morfometrik olarak ayrıntılı şekilde tanımlanması, gelecekteki ıslah ve koruma çalışmalarına yön verecek niteliktedir.

INTRODUCTION

The Norduz Region (37°52′42″N, 43°27′2″E) within the borders of the Gürpınar district of the province of Van (Ünal & Özgökçe, 2009) has been the stronghold of small ruminant breeding for centuries. Norduz sheep are concentrated in 27 highland villages in the region: (Yalınca, Oğuldamı, Çatakdibi, Kırkgeçit, Dikbıyık, Arındı, Örmeli, Topyıldız, Topçudeğirmeni, Dağseven, Üçdoğan, Sıcaksu, Dolaylı, Akdoğdu, Doluçıkın, Çepkenli, Taşlıyazı, Kılıçtutan, Örmeli-Karakaş Mahallesi, Bükeç, Geçerli, Beşbudak, Geziyurt, Kalkanlı, Tutak, Kapçık, Özlüce) Breeding is carried out here with traditional systems suitable for the mountainous terrain and harsh climate conditions of the Norduz region. Norduz sheep were registered as a local genetic resource in Notification Regarding the Registration of Native Animal Breeds and Lines Notification No: 2004/39 In the Official Gazette dated 12 December 2004 and numbered 25668 (Anonymous, 2025a).

Extensive research has been conducted on the current status and future of sheep breeds in Türkiye (Kaymakçı et al., 2006; Taşkın & Kandemir, 2022). However, despite the cultural and ecological importance of Norduz sheep, data on their phenotypic structure, breeding practices and conservation status are still limited. One reason for this is that purebred Norduz sheep are raised on small family farms in the rugged and difficult geography of the Norduz Region (Aysan Dayan & Bingöl, 2008).

Norduz sheep are a high-bodied and fat-tailed breed. Their body color is usually white, but ash colored ones are also found. The tail hangs down and is divided into three parts, with the middle part being longer (Kara Uzun, 2008). However, comprehensive studies are still needed to define breed characteristics. Considering the increasing concerns about the erosion of local gen resources, this study aims to characterize the morphometry and visual phenotypes of Norduz sheep in their natural habitat. The study also aims to contribute to the ‘In situ conservation’ efforts at the national level by providing a scientific basis for breed recognition and strategic genetic protection.

In-situ protection and development of sheep gen resources in Türkiye

The registration of breeds and lines of farm animals was decided by the "Animal Breeds Registration Committee" established in accordance with the "Regulation on Registration of Animal Breeds". The regulation on the 'Protection and Sustainable Use of Gen Resources of Domestic Animals' was published in the Official Gazette dated 22 December 2011 and numbered 28150 (Anonymous, 2025b). The sheep breeds and distribution areas within the scope of support were published Ministry of Agriculture and Forestry, Communiqué No: 2006/9 In the Official Gazette dated 8 March 2006 and numbered 26102 (Anonymous, 2025c) (Table 1).

Table 1. Breeds and distribution areas within the scope of support (Ministry of Agriculture and Forestry, Communiqué No: 2006/9)

Çizelge 1. *Destek kapsamındaki ırklar ve dağılım alanları (Tarım ve Orman Bakanlığı, Tebliğ No: 2006/9)*

Local Gene Source Sheep Breeds	Spreading Areas
Çine Çaparı Sheep	Aydın
Dağlıç Sheep	Afyon
Gökçeada Sheep	Çanakkale
Güney Karaman Sheep	Konya
Hemşin Sheep	Artvin
Herik Sheep	Amasya
Kangal Akkaraman Sheep	Sivas
Karagül Sheep	Black Sea and Gateway Regions
Kıvırcık Sheep	Kırklareli
Norduz Sheep	Van
Sakız Sheep	İzmir
Tuj Sheep	Kars and Ardahan

Registration of domestic animal gen resources

With the Livestock Support Implementation Communiqué (Communiqué No: 2024/23) published in the Official Gazette, dated August 17, 2024 and numbered 32635 (Anonymous, 2025d), a total of 1.126.300 sheep were supported under the ''Protection of Gen Resources of Domestic Animals'' to protect sheep breeds with declining numbers in various regions of our country, where breeding was intensively carried out by the Ministry of Agriculture and Forestry (Table 2).

Table 2. 2024 Livestock Supports (Ministry of Agriculture and Forestry, Communiqué No: 2024/23)

Çizelge 2. *2024 Hayvancılık Destekleri (Tarım ve Orman Bakanlığı, Tebliğ No: 2024/23)*

Project Name	Number of Sheep Supported (Head)
Small Ruminant Breeding in Rural Conditions	1.108.800
Protection of Gen Resources in Situ	15.500
Protection of Sensitive Herds	2.000
Total	1.126.300

Small ruminant breeding in rural conditions

Each sub-project of the National Small Animal Breeding Project in the Public Sector will consist of a maximum of 6.000 breeding females and 300 males; additionally, enough elite breeding sheep can be kept and mated in a controlled manner. In sub-projects for breeds that are difficult to obtain sufficient animals, the project can be initiated provided that there are 5.000 breeding and 250 male animals. It is essential that the number of animals in the project is sourced from as few farms as possible and that all suitable animals in the farms are included in the project (Ministry of Agriculture and Forestry, Communiqué No: 2024/23) (Anonymous, 2025d). Data on sheep breeding support in the public sector were presented (Table 3).

Table 3. Supports for 'Small Ruminant Raised in Rural Condition' (Ministry of Agriculture and Forestry, Communiqué No: 2024/23)

Çizelge 3. *'Kırsal Alanda Yetiştirilen Küçükbaş Hayvanlara' Yönelik Destekler (Tarım ve Orman Bakanlığı, Tebliğ No: 2024/23)*

Breed	Province (Number of Projects)	Number of Animals Supported (Head)
Akkaraman Sheep	Adana (1), Aksaray (2), Ankara (1), Bingöl (2), Çankırı (2), Çorum (3), Kahramanmaraş (2), Kayseri (3), Karaman (2), Kırşehir (2), Konya (4), Niğde (6), Osmaniye (1), Malatya (3), Tokat (2), Yozgat (2)	239.400
Morkaraman Sheep	Ağrı (4), Bingöl (7), Erzurum (4), Elazığ (2), Muş (1)	113.400
İvesi Sheep	Adana (1), Antalya (1), Gaziantep (2), Kahramanmaraş (1), Kilis (2), Mersin (4), Osmaniye (2), Şanlıurfa (3)	100.800
Şavak Akkaraman Sheep	Elazığ (6), Erzincan (6), Tunceli (4)	100.800
Karayaka Sheep	Amasya (2), Giresun (1), Ordu (3), Sinop (1), Tokat (2), Trabzon (2)	69.300
Kangal Akkaraman Sheep	Sivas (9)	56.700
Karacabey Merinos Sheep	Balıkesir (4), Çanakkale (1), Edirne (1), Manisa (1)	44.100
Orta Anadolu Merinos Sheep	Ankara (2), Eskişehir (2), Karaman (2), Konya (1)	44.100
Kıvırcık Sheep	Balıkesir (1), Aydın (1), İzmir (1), Manisa (2), Kırklareli (2)	44.100
Hemşin Sheep	Ardahan (1), Artvin (5)	37.800
Zom Sheep	Diyarbakır (4), Şanlıurfa (2)	37.800
Koçeri Sheep	Batman (5)	31.500
Güney Karaman Sheep	Mersin (4)	25.200
Karakaş Sheep	Diyarbakır (4)	25.200
Pırlak Sheep	Afyonkarahisar (2), Antalya, (1) Kütahya (1)	25.200

Table 3. Continued

Çizelge 3. *Devamı*

Breed	Province (Number of Projects)	Number of Animals Supported (Head)
Ramlıç Sheep	Afyonkarahisar (2), Eskişehir (2),	25.200
Karya Sheep	Aydın (1), Denizli (2)	18.900
Pırıt Sheep	Isparta (2)	12.600
Sakız Sheep	Çanakkale (1), İzmir (1)	12.600
Artlı Sheep	Trabzon (1)	6.300
Bafra Sheep	Amasya (2)	6.300
Dağlıç Sheep	Afyonkarahisar (1)	6.300
Eşme Sheep	Uşak (1)	6.300
Hamdani Sheep	Siirt (2), Muş (1), Şırnak (1)	6.300
Kıvırcık (Yalova Kıvırcığı) Sheep	Yalova (1)	6.300
Tahirova Sheep	Çanakkale (1)	6.300
Total		1.108.800

The minimum number of one-year-old and older breeding sheep that must be in the herd of each breeder who will be included in the project for the first time is 40 head for Eşme, Sakız and Tahirova sheep and 100 head for other breeds (Ministry of Agriculture and Forestry, Communiqué No: 2024/23) (Anonymous, 2025c).

In-situ protection of gen resources

The breeder who will benefit from on-site conservation support must reside at the conservation site and may not keep male material belonging to different breeds of the species for which support is received. Among livestock breeders, preference is given to those who have at least one child living with them, who are not engaged in any occupation other than breeding, who have received agricultural training, and who do not engage in both large and small livestock breeding. Within the scope of protection, the breeds and numbers of animals shown opposite in Table 4 are supported in the provinces listed (Ministry of Agriculture and Forestry, notification no: 2024/23) (Anonymous 2025d). Data on animal assets included in on-site protection projects were presented (Table 4).

Table 4. 'In-Situ Protection of Gen Resources' Supports (Ministry of Agriculture and Forestry, Communiqué No: 2024/23)

Çizelge 4. *Gen Kaynakların Yerinde Korunması Destekleri (Tarım ve Orman Bakanlığı, Tebliğ No: 2024/23)*

Breed	Province	Number of Animals Supported (Head)
Of Sheep	Trabzon, Rize	2.500
Artlı Sheep	Trabzon	2.000
Çepni Sheep	Giresun, Trabzon	2.000
Norduz Sheep	Van	2.000
Dağlıç Sheep	Afyonkarahisar, Konya	1.500
Gökçeada Sheep	Çanakkale	1.500
Hemşin Sheep	Artvin, Erzurum	1.000
Kıvırcık Sheep	Kırklareli	1.000
Sakız Sheep	İzmir	1.000
Suruç Sheep	Şanlıurfa	1.000
Total		15.500

Sensitive herd protection

In the 'Sensitive Herd Protection' support, provided that the project requirements are met, in line with the decisions of the Domestic Animal Gen Resources Advisory Board and as a result of the evaluation of the field screening data with the Ministry registration system (TURKVET), Çine Çaparı,

Kaçeli, Karagül and Tuj sheep breeds whose breed population fell below 500 head were supported (Ministry of Agriculture and Forestry, Communiqué No: 2024/23) (Anonymous, 2025d). Data on animals supported in Sensitive Herd Protection projects were presented (Table 5).

Table 5. 'Sensitive Herd Protection' Supports (Ministry of Agriculture and Forestry, Communiqué No: 2024/23)

Çizelge 5. *'Hassas Sürü Koruma' Destekleri (Tarım ve Orman Bakanlığı, Tebliğ No: 2024/23)*

Breed	Province	Number of Animals Supported (Head)
Çine Çaparı Sheep	Aydın	500
Kaçeli Sheep	İzmir	500
Karagül Sheep	Tokat	500
Tuj Sheep	Ardahan, Kars	500
Total		2.000

Van province sheep presence

In Van Province, which ranks first in small ruminant breeding in Türkiye, a greater number of small ruminant breeding activities occur due to the abundance of pastures and rugged areas. According to TUIK data, as of December 2024, the largest breeding geography in the province is Gürpınar District with 546.693 sheep. While Norduz sheep and Akkaraman breeds are raised in Gürpınar, purebred Norduz sheep are raised only in the Norduz region. The distribution of sheep numbers according to the districts of Van Province was presented (Table 6). And the data on the December 2024 sheep population of 27 neighborhoods in the Norduz Region were presented (Table 7).

The decreasing numbers of Norduz sheep are preserved as a genetic resource in the Norduz Region through the "In Situ Protection" program implemented by the General Directorate of Agricultural Research Policies, Ministry of Agriculture and Forestry. The breed was protected for the first time in 2021 with the In Situ Protection project of the Ministry of Agriculture and Forestry (Communiqué No: 2021/43) (Anonymous, 2025e).

There were studies on our local sheep gen resources (Sönmez et al., 1975; Kaymakçı et al., 2002, 2006). Unfortunately, the studies on Norduz sheep are not sufficient. In this study, the phenotypic and character traits of Norduz sheep were examined.

Table 6. Sheep presence in the districts of Van Province (TUIK, 2024)*

Çizelge 6. *Van ili ilçelerinde koyun varlığı (TUİK, 2024)*

District	Presence of Sheep (Head)		+ / - Change % (Head)
	June 2024	December 2024	
Bahçesaray	47.590	47.980	390 (+ 0,820%)
Başkale	514.437	497.990	16.447 (+ 3,197%)
Çaldıran	236.294	262.779	26.485 (- 11,208%)
Çatak	182.494	173.427	9.067 (- 4,968%)
Edremit	49.659	50.156	497 (- 1,001%)
Erciş	415.570	419.725	4.155 (- 0,100%)
Gevaş	90.976	89.795	1181 (- 1,298%)
Gürpınar	591.481	546.693	44.788 (- 7,572%)
İpekyolu	150.989	165.714	14.725 (9,752%)
Muradiye	200.577	202.337	1.760 (+0,877%)
Özalp	305.303	308.356	3.053 (+ 1,000)
Saray	144.217	145.164	947 (+ 0,657%)
Tuşba	129.290	130.030	740 (+ 0,572%)
Total	3.058.877	3.040.146	18.731 (-0,612)

* % Calculations were made on a per-row basis.

Table 7. Sheep population raised in neighborhoods of the Norduz Region (TURKVET, 2025)

Çizelge 7. *Norduz Bölgesi mahallelerinde yetiştirilen koyun popülasyonu (TURKVET, 2025)*

Neighbourhood	Ewe (%)	Ram (%)	Total (%)
Akdoğdu	7.319 (4.18%)	394 (1.83%)	7.713 (3.92%)
Arındı	9.741 (5.56%)	1.780 (8.25%)	11.521 (5.85%)
Beşbudak	2.615 (1.49%)	395 (1.83%)	3.010 (1.53%)
Bükeç	3.026 (1.73%)	653 (3.03%)	3.679 (1.87%)
Çatakdibi	11.415 (6.51%)	1.593 (7.39%)	13.008 (6.61%)
Çepkenli	5.194 (2.96%)	351 (1.63%)	5.545 (2.82%)
Dağseven	8.304 (4.74%)	643 (2.98%)	8.947 (4.55%)
Dikbıyık	10.438 (5.96%)	1.178 (5.46%)	11.616 (5.90%)
Dolaylı	6.844 (3.91%)	1.141 (5.29%)	7.985 (4.06%)
Doluçıkın	5.824 (3.32%)	1.060 (4.92%)	6.884 (3.50%)
Geçerli	2.950 (1.68%)	225 (1.04%)	3.175 (1.61%)
Geziyurt	2.102 (1.20%)	181 (0.84%)	2.283 (1.16%)
Kalkanlı	1.928 (1.10%)	274 (1.27%)	2.202 (1.12%)
Kapçık	1.361 (0.78%)	278 (1.29%)	1.639 (0.83%)
Kılıçtutan	4.280 (2.44%)	377 (1.75%)	4.657 (2.37%)
Kırkgeçit	10.685 (6.10%)	1.162 (5.39%)	11.847 (6.02%)
Oğuldamı	12.312 (7.03%)	1.552 (7.20%)	13.864 (7.05%)
Örmeli	10.333 (5.90%)	1.221 (5.66%)	11.554 (5.87%)
Örmeli-Karakaş Mezrası	3.817 (2.18%)	798 (3.70%)	4.615 (2.35%)
Özlüce	975 (0.56%)	189 (0.88%)	1.164 (0.59%)
Sıcaksu	7.401 (4.22%)	872 (4.04%)	8.273 (4.20%)
Taşlıyazı	4.425 (2.53%)	823 (3.82%)	5.248 (2.67%)
Topçudeğirmeni	8.765 (5.00%)	582 (2.70%)	9.347 (4.75%)
Topyıldız	10.260 (5.86%)	1.014 (4.70%)	11.274 (5.73%)
Tutak	1.791 (1.02%)	291 (1.35%)	2.082 (1.06%)
Üçdoğan	7.953 (4.54%)	458 (2.12%)	8.411 (4.27%)
Yalınca	13.164 (7.51%)	2.079 (9.64%)	15.243 (7.75%)
Total	175.222 (100.00%)	21.564 (100.00%)	196.786 (100.00%)

The total may not be an exact number due to rounding.

MATERIALS and METHOD

This study was designed as a descriptive qualitative field study based on detailed observations of Norduz sheep in their natural habitats (Mwacharo & Drucker, 2005; Uzunoz & Akcay, 2009; FAO, 2012; Anonymous, 2025f). Yin (2018) says that the 'case study' method can be used for in-depth observation studies not only in social sciences but also in fields such as agriculture and health. In a study conducted by Anderson (2016), the discussion revolved around the use of descriptive qualitative observations, especially in cases where numerical data were limited and the condition of animals was evaluated with observation-based analyses instead of numerical measurements.

Table 8. Literature list suitable for the 'Qualitative field study based on detailed observations' method

Tablo 8. *'Detaylı gözlemlere dayalı nitel saha çalışması' yöntemine uygun literatür listesi*

Study Type	Topic	Relationship	Literatures
Field + Genetics	Observational + DNA	Farmer observation, morphological characteristics	Mwacharo & Drucker, 2005
Phenotypic Characterization	Observational field data	Zootechnics compatibility	FAO, 2012
Case Study	General research methodology	Social sciences compatibility	Yin, 2018

In this study, the phenotypic and character traits of the flocks from which purebred Norduz sheep were selected were discussed. For this purpose, a scientific framework was created with the 'observation-based, descriptive qualitative data analysis and case study (qualitative observational study)' approach. The observed traits were thematically coded with the descriptive coding method and qualitative categories were created. Finally, photographs taken in the field were presented with observation-based visual mapping.

In 2021, a field survey was conducted in 27 neighborhoods in the Norduz Region to find purebred Norduz sheep by looking at their phenotypic characteristics. In 2014, it was determined that animals with purebred Norduz sheep characteristics were raised in a total of 18 farms located in the Dağseven, Taşlıyazı, Dikbıyık, Yalınca and Geçerli neighborhoods in the Norduz Region. A total of 1.000 purebred Norduz sheep (778 ewes and 222 rams) were selected and registered in the official "In-Situ Protection" program. Detailed information on the phenotypic characteristics of purebred Norduz sheep is available in the Ministry's archives (Anonymous 2025a). All animals had to be kept in participating herds for at least five years. There was also the obligation to remove male animals other than the Norduz ram from the herd.

The study covers two clusters: purebred Norduz ewes and rams included in the 'In-Situ Protection' program (S) and the main herds from which they were selected (G). The mathematical expression of animals selected from the main herds was presented below.

$$G = 44.229 \{ \text{All sheep} \}$$
$$S = 1.000 \{ \text{Selected sheep} \}$$
$$|A| = 39.281 \{ \text{Total number of ewes} \}$$
$$|B| = 4.948 \{ \text{Total number of rams} \}$$
$$\text{Selected ewe subset SAI } |SA| = 778$$
$$\text{Selected ram subset SBI } |SB| = 222$$
$$S = SA \cup SB,\ SA \subset G,\ SB \subset G,\ |S| = |SA| + |SB|$$

Variations of some phenotypic characteristics of animals in the main herds were as follows:

Variation of body color:

Norduz sheep were observed in two variants, White and White-Pied.

$$G = \{ \text{All sheep} \}$$
$$R \in \{ \text{White (W), White-Pied (P)} \}$$
$$G = W \cup P \text{ and } W \cap P = \emptyset \text{ and } C = G - P$$
$$f(G) = (R)$$

Variation of head color:

The heads of Norduz sheep were observed in three different colors.

$$G = \{ \text{All sheep} \}$$
$$R \in \{ \text{Brown (B), Dark Brown (D), Gray (G)} \}$$
$$G = B \cup D \cup G \text{ and } B \cap D \cap G = \emptyset$$
$$f(G) = (R)$$

Variation of head color distribution:

Norduz sheep were observed in two variations: "Single color" and "Varied".

$$G = \{ \text{All sheep} \}$$
$$C \in \{ \text{Single color (S), Pied (P)} \}$$
$$G = S \cup P \text{ and } S \cap P = \emptyset \text{ and } S = G - P$$
$$f(G) = (C)$$

Variation of forelock presence:

Norduz sheep were observed in two variations: with a forelock and without a forelock.

$G = \{ All\ sheep \}$

$C \in \{ Forelock\ (F), Without\ forelock\ (W) \}$

$G = F \cup W$ and $F \cap W = \emptyset$ and $F = G - W$

$f(G) = (C)$

Variation of horns presence:

Norduz sheep were observed to occur in two varieties as horned and hornless.

$G = \{ All\ sheep \}$

$C \in \{ Horned\ (H), Hornless\ (W) \}$

$G = H \cup W$ and $H \cap W = \emptyset$ and $H = G - W$

$f(G) = (C)$

Variation of horn length of horned sheep:

The horn length of the Horned Norduz sheep was observed to vary in three different lengths.

Horn length: $L \in \{ Short, Medium, Long \}$

Variation of ear presence:

Norduz sheep were observed in two forms as eared and earless.

$G = \{ All\ sheep \}$

$C \in \{ Eared\ (E), Earless\ (W) \}$

$G = E \cup W$ and $E \cap W = \emptyset$ and $E = G - W$

$f(G) = (C)$

Variation of ear length of eared sheep:

No variation was observed in the ear structure of eared sheep. All sheared sheep had medium-length ears.

Phenotypic characteristics
- Body color, head color and forelock presence
- Horn structure
- Ear structure

Character characteristics

IBM SPSS v27 software package was used in calculations related to numerical data on the animal population.

RESULT and DISCUSSION

The numerical data and percentages of purebred Norduz sheep determined in 18 farms in 2021-2022 were presented (Tables 9 & 10).

Table 9. *Data on animals under the 'In-Situ Protection' program in 2021-2022 (TAGEM, Van Provincial Directorate of Agriculture, Erzurum Eastern Anatolia Agricultural Research Institute)*

Çizelge 9. 2021-2022 yıllarında 'Yerinde Koruma' programı kapsamındaki hayvanlara ait veriler (TAGEM, Van İl Tarım Müdürlüğü, Erzurum Doğu Anadolu Tarımsal Araştırma Enstitüsü)

Neighbourhood	Number of Farms Where Purebred Sheep were Selected / Number of Total Farms	Number of Selected Animals (heads) / Total Number of Animals in Herds from Which Purebred Animals were Selected		
		Ewe	Ram	Total
Dağseven	1 / 44	48 / 8.092	14 / 2.070	62 / 10.162
Taşlıyazı	1 / 21	83 / 3.023	24 / 733	107 / 3.756
Dikbıyık	1 / 58	78 / 8.564	22 / 2.080	100 / 10.644
Geçerli	1 / 18	53 / 3.823	15 / 927	68 / 4.750
Yalınca	14 / 57	516 / 12.928	147 / 3.134	663 / 16.062
Total	18 / 198	778 / 36.430	222 / 8.944	1.000 / 45.374

Table 10. *Number of Norduz sheep under the 'In-Situ Protection' program in 2021-2022 (TAGEM, Van Provincial Directorate of Agriculture, Erzurum Eastern Anatolia Agricultural Research Institute)**

Çizelge 10. 2021-2022 yıllarında 'Yerinde Koruma' programı kapsamındaki Norduz koyunu sayıları (TAGEM, Van İl Tarım Müdürlüğü, Erzurum Doğu Anadolu Tarımsal Araştırma Enstitüsü)

Neighbourhood	Animal (head)		
	Ewe (%)	Ram (%)	Total (%)
Dağseven	48 (6,17%)	14 (6,31%)	62 (6,20%)
Taşlıyazı	83 (10,67%)	24 (10,81%)	107 (10,70%)
Dikbıyık	78 (10,03%)	22 (9,91%)	100 (10,00%)
Geçerli	53 (6,812%)	15 (6,76%)	68 (6,80%)
Yalınca I	48 (6,17%)	14 (6,31%)	62 (6,20%)
Yalınca II	39 (5,01%)	11 (4,95%)	50 (5,00%)
Yalınca III	28 (3,60%)	8 (3,60%)	36 (3,60%)
Yalınca IV	10 (1,29%)	3 (1,35%)	13 (1,30%)
Yalınca V	42 (5,40%)	12 (5,41%)	54 (5,40%)
Yalınca VI	38 (4,88%)	11 (4,95%)	49 (4,90%)
Yalınca VII	32 (4,11%)	9 (4,05%)	41 (4,10%)
Yalınca VIII	31 (3,98%)	9 (4,05%)	40 (4,00%)
Yalınca IX	10 (1,29%)	3 (1,35%)	13 (1,30%)
Yalınca X	111 (14,27%)	31 (13,96%)	142 (14,20%)
Yalınca XI	43 (5,53%)	12 (5,41%)	55 (5,50%)
Yalınca XII	41 (5,27%)	12 (5,41%)	53 (5,30%)
Yalınca XII	16 (2,06%)	5 (2,25%)	21 (2,10%)
Yalınca XIV	27 (3,47%)	7 (3,15%)	34 (3,40%)
Total	778 (100.00%)	222 (100.00%)	1.000 (100.00%)

*Due to rounding, the total may not equal the exact number.

Purebred Norduz sheep breeders had committed not to sell their sheep for 5 years and to expand the herd every year. However, during the field inspection conducted in 2023, it was determined that some enterprises were selling Purebred Norduz sheep and the breeders were removed from the project. In place of the removed enterprises, a total of 10 enterprises were determined in the Dağseven, Kırkgeçit, Oğuldamı and Örmeli neighborhoods of the Norduz Region and the enterprises were included in the project in 2024. A total of 484 purebred Norduz sheep (ewes; n:379 and rams; n:105) in these enterprises were reported in the official gazette (Anonymous, 2025d) to be included in the program. However, some of the breeders selected in 2024 were removed from the program because they could not continue to meet the eligibility requirements in 2025. Currently, animals registered in the program receive support during the 2024-2026 period. During this period, male animals other than Norduz rams must also be removed from the herd. Relevant animal data were presented (Tables 11 & 12).

Table 11. Data on herds under the 'In-Situ Conservation' program planned in 2024 (TAGEM, Van Provincial Directorate of Agriculture, Van Agricultural Research Institute)*

Çizelge 11. *2024 yılında planlanan 'Yerinde Koruma' programı kapsamındaki sürülere ilişkin veriler (TAGEM, Van İl Tarım Müdürlüğü, Van Tarımsal Araştırma Enstitüsü)*

Neighbourhood	Number of farms where Purebred Sheep were Selected / Number of Total farms	Number of Selected Animals (heads) / Total Number of Animals in Herds from which Purebred Animals were Selected		
		Ewe	Ram	Total
Dağseven	1 / 44	64 / 8.304	18 / 643	82 / 8.947
Kırkırkgeçit	1 / 61	46 / 10.685	13 / 1.162	59 / 1.1847
Örmeli	1 / 83	33 / 14.150	12 / 2.019	45 / 16.169
Oğuldamı	7 / 79	236 / 12.312	62 / 1.552	298 / 13.864
Total	10 / 267	379 / 45.451	105 / 5.376	484 / 50.827

*Ewes were included in the support program in 2024.

Table 12. Number of Norduz sheep under the 'In-Situ Protection' program planned in 2024 and realized in 2025 (TAGEM, Van Provincial Directorate of Agriculture, Van Agricultural Research Institute)*

Çizelge 12. *2024 yılında planlanan ve 2025 yılında gerçekleştirilen 'Yerinde Koruma' programı kapsamındaki Norduz koyunu sayıları (TAGEM, Van İl Tarım Müdürlüğü, Van Tarımsal Araştırma Enstitüsü)*

Neighbourhood	Animal (Head)					
	Planned in 2024**			Realized in 2025***		
	Ewe (%)	Ram (%)	Total (%)	Ewe (%)	Ram (%)	Total (%)
Dağseven	64 (16,89%)	18 (17,14%)	82 (16,94%)	77 (19,74%)	5 (20%)	79 (19,04%)
Kırkgeçit	46 (12,14%)	13 (12,38%)	59 (12,19%)	59 (15,13%)	4 (16%)	63 (15,18%)
Örmeli	33 (8,71%)	12 (11,43%)	55 (11,36%)	55 (14,10%)	4 (16%)	59 (14,22%)
Oğuldamı I	35 (9,23%)	10 (9,52%)	45 (9,30%)	34 (8,72%)	2 (8%)	36 (8,67%)
Oğuldamı II	34 (8,97%)	10 (9,52%)	44 (9,09%)	-	-	-
Oğuldamı III	52 (13,72%)	15 (14,29%)	67 (13,84%)	-	-	-
Oğuldamı IV	24 (6,33%)	6 (5,71%)	30 (6,20%)	67 (17,18%)	4 (16%)	71 (17,11%)
Oğuldamı V	30 (7,92%)	8 (7,62%)	38 (7,85%)	30 (7,69%)	2 (8%)	32 (7,71%)
Oğuldamı VI	24 (6,33%)	6 (5,71%)	30 (6,20%)	38 (9,74%)	2 (8%)	40 (0,96%)
Oğuldamı VII	33 (8,71%)	12 (11,43%)	55 (11,36%)	30 (7,69%)	2 (8%)	32 (7,711%)
Total	379 (100.%)	105 (100%)	484 (100%)	390 (100%)	25 (100%)	415 (100%)

*Due to rounding, the 'total' may not give the exact number. **Supports paid ***Supports to be paid

In TAGEM's Domestic Animal Gen Resources introduction catalogue, Norduz sheep are described as follows. A considerable portion of the sheep is earless. Although the color is primarily white, ash-colored is the next most common and a small amount of gray-white and brown-white colors are also encountered. Black spots are seen in various parts of the body, especially on the head. The skin is white. Males have horns; approximately half of the females have horns. They have fat tails. The tail consists of three parts, with the third part being longer than the first part and hanging down (Anonymous, 2025g).

In this study, variables were evaluated in sex-independent variables (body color, head color) and sex-dependent variables (presence of frontal hair, presence of horns and presence of earless). This categorization was based on the fact that the alleles for the presence of ear and frontal hair were dominant in Norduz sheep (Table 12). Phenotypic characteristics of selected Norduz sheep were presented (Table 13).

In terms of body color, the animals in the farms were observed in two colors: white and white-pied. While white ewes and rams were observed in all herds, white-pied sheep were observed in farms in Oğuldamı I, Oğuldamı II, Oğuldamı III, Oğuldamı IV, Oğuldamı V, Oğuldamı VI and Oğuldamı VII. In terms of head color, the animals in the farms were observed in three colors: brown, dark brown and gray. Sheep with brown head color were observed in herds in Oğuldamı I, Oğuldamı II, Oğuldamı III, Oğuldamı IV, Oğuldamı V, Oğuldamı VI, Oğuldamı VII and Kırkgeçit. The dark brown head color was present in all farms except for the farms in Oğuldamı I, Oğuldamı VII I to Oğuldamı VII. The gray head color was seen only in the herd in Dağseven. There were ewes with forelocks on all farms. However, the presence of forelocks in rams was observed in the herds in Örmeli, Yalınca II, Yalınca IV, Yalınca VIII, Yalınca X, Yalınca XIII and Yalınca XIV. All rams in the farms had horns. However, the presence of horns in ewes was seen in the herds only in Oğuldamı I and Örmeli. There were a few earless ewes on all farms. Earless rams were present only in the herd in Yalınca II.

Table 13. Phenotypic characteristics of selected purebred Norduz sheep

Çizelge 13. *Seçilmiş safkan Norduz koyunlarının fenotipik özellikleri*

Farm			Gender-independent variables					Gender-dependent variables					
	Animal (Head)		Body color		Head color			An animal with forelock		Horned animal		Earless animal	
	Ewe	Ram	White	White-Pied	Brown	Dark brown	Gray	Ewe	Ram	Ewe	Ram	Ewe	Ram
Dağseven	48	14	+	-	-	+	+	+	-	-	+	+	-
Taşlıyazı	83	24	+	-	-	+	-	+	-	-	+	+	-
Dikbıyık	78	22	+	-	-	+	-	+	-	-	+	+	-
Geçerli	53	15	+	-	-	+	-	+	-	-	+	+	-
Oğuldamı I	35	10	+	+	+	-	-	+	-	+	+	+	-
Oğuldamı II	34	10	+	+	+	-	-	+	-	-	+	+	-
Oğuldamı III	52	15	+	+	+	-	-	+	-	-	+	+	-
Oğuldamı IV	24	6	+	+	+	-	-	+	-	-	+	+	-
Oğuldamı V	30	8	+	+	+	-	-	+	-	-	+	+	-
Oğuldamı VI	24	6	+	+	+	-	-	+	-	-	+	+	-
Oğuldamı VII	33	12	+	+	+	-	-	+	-	-	+	+	-
Örmeli	33	12	+	-	-	+	-	+	+	+	+	+	-
Kırkgeçit	64	18	+	-	+	+	-	+	-	-	+	+	-
Yalınca I	48	14	+	-	-	+	-	+	-	-	+	+	-
Yalınca II	39	11	+	-	-	+	-	+	+	-	+	+	+
Yalınca III	28	8	+	-	-	+	-	+	-	-	+	+	-
Yalınca IV	10	3	+	-	-	+	-	+	+	-	+	+	-
Yalınca V	42	12	+	-	-	+	-	+	-	-	+	+	-
Yalınca VI	38	11	+	-	-	+	-	+	-	-	+	+	-
Yalınca VII	32	9	+	-	-	+	-	+	-	-	+	+	-
Yalınca VIII	31	9	+	-	-	+	-	+	+	-	+	+	-
Yalınca IX	10	3	+	-	-	+	-	+	-	-	+	+	-
Yalınca X	111	31	+	-	-	+	-	+	+	-	+	+	-
Yalınca XI	43	12	+	-	-	+	-	+	-	-	+	+	-
Yalınca XII	41	12	+	-	-	+	-	+	-	-	+	+	-
Yalınca XIII	16	5	+	-	-	+	-	+	+	-	+	+	-
Yalınca XIV	27	7	+	-	-	+	-	+	+	-	+	+	-

While genotype refers to the hereditary structure of an organism, phenotype refers to the physical characteristics that develop as a result of its genotype. Even when two individuals have different genotypes, the same phenotypic features can be observed. In cases where research on determining the genotype is not possible, a genotypic estimate can be made by looking at the phenotype of the organism. For this reason, the phenotypic features of the main herd, from which the purebred Norduz sheep were selected within the scope of the 'In-Situ Conservation' program, are as important as the phenotypic features of the supported purebred Norduz sheep. Recessive features may appear in subsequent generations because there is a possibility of their expression. This possibility can be determined with Gregor Mendel's Laws. As shown, the Punnett square representing the allele distribution of possible female and male offspring genotypes was shown (Table 14).

B = Dominant allele that causes horns
b = Recessive allele that causes hornlessness

Table 14 illustrated the potential genetic combinations resulting from the mating of Norduz sheep with various genotypes. It depicts the inheritance of horned and hornless traits by considering the genotypic combinations of the male (BB, Bb) and female (BB, Bb, bb) sheep. The cells showed the possible genotypes of offspring, with BB and Bb representing horned individuals, while bb represents recessive hornless individuals. Since all male sheep were horned (either BB or Bb), the offspring will inherit a horned trait from the male, but hornlessness can only be passed by a homozygous recessive female (bb).

Table 14. Punnett square for horn presence in sheep

Çizelge 14. *Koyunlarda boynuz varlığına ilişkin Punnett karesi*

Male x Female*	BB rate	Bb rate	bb rate	Female kid		Male kid**
				Horned kid (%)	Hornless kid (%)	Horned kid (%)
BB x BB	100 %	0 %	0 %	100 %	0 %	100 %
BB x Bb	50 %	50 %	0 %	100 %	0 %	100 %
BB x bb	0 %	100 %	0 %	100 %	0 %	100 %
Bb x BB	50 %	50 %	0 %	100 %	0 %	100 %
Bb x Bb	25 %	50 %	25 %	75 %	25 %	75 %
Bb x bb	0 %	50 %	50 %	50 %	50 %	50 %

* Since all males have horns, the ‘bb x BB, bb X Bb and bb x bb’ lines were not included in the table
** Since all males have horns, the 'hornless kid' column was not included in the table.

In this scenario, the probability of producing a hornless offspring from the mating of two horned sheep is 25%, contingent upon both parents being heterozygous (Bb) for the horned locus. This outcome exemplifies the applicability of Mendel’s Law of Segregation, wherein alleles segregate independently during gametogenesis, leading to predictable phenotypic ratios among the offspring.

In an imaginary population at genetic equilibrium, where evolutionary mechanisms are not effective, allele frequencies in a population remain unchanged throughout generations. In other words, the p and q values in the initial population remain the same even after thousands of generations. This stability is called the *Hardy-Weinberg Equilibrium* (Demir, 2014).

According to the Hardy-Weinberg equation for a female individual:

$p^2 + 2pq + q^2 = 1$

Accordingly, in the horned genetic assumptions;

p = Frequency of B allele

q = Frequency of b allele

p^2 *= Proportion of homozygous dominant (BB) individuals*

2pq = Proportion of heterozygous (Bb) individuals

q^2 *= Proportion of homozygous recessive (bb) individuals (percentage of hornless sheep)*

Sample calculation:

Suppose that the proportion of hornless sheep (bb) in the population is 9% ($q^2 = 0.09$*),*

The q value is calculated as follows:

$q^2 = \sqrt{0.09} = 0.3$

In this case, p-value:

$p = 1 - q = 1 - 0.3 = 0.7$

Genotype frequencies:

$p^2 = (0.7)\ 2 = 0.49 \rightarrow$ *49% BB (horned)*

$2pq = 2\ (0.7)\ (0.3) = 0.42 \rightarrow$ *42% Bb (horned carrier)*

$q^2 = (0.3)\ 2 = 0.09 \rightarrow$ *9% bb (hornless)*

According to the Hardy-Weinberg equation for a male individual:

The p and q values in male individuals are identical to those calculated in the general Hardy-Weinberg equilibrium for the population. However, q^2 (homozygous recessive, bb) is not observed among males. Thus, male genotype frequencies are normalized to include only BB and Bb genotypes.

Accordingly, under the assumptions of horned inheritance:

p = Frequency of B allele

q = Frequency of b allele

p^2 = Proportion of homozygous dominant (BB) individuals

2pq = Proportion of heterozygous (Bb) individuals

q^2= Proportion of homozygous recessive (bb) individuals (not observed in male individuals)

$(p^2) / (p^2 + 2pq) + (2pq) / (p^2 + 2pq) = 1$

Sample calculation for a male individual:

Suppose if the proportion of hornless sheep (bb) among male is 9% ($q^2 = 0.09$) but not observed

Thus:

$q = \sqrt{0.09} = 0.3$

$p = 1 - 0.3 = 0.7$

$p^2 = (0.7)\ 2 = 0.49$

$2pq = 2\ (0.7)\ (0.3) = 0.42$

BB (horned) Male rate:
$(p^2) / (p^2 + 2pq) = 0.49 / 0.91 = 0.538$
Bb (ressesive horned) Male rate:
$(2pq) / (p^2 + 2pq) = 0.42 / 0.91 = 0.462$

Genotype frequencies:
53.8 % BB
46.2 % Bb

As long as the Hardy-Weinberg equilibrium is maintained, these ratios remain unchanged over generations. However, factors such as natural selection, selective mating, or genetic drift can disrupt this balance. Since detailed genetic studies on the genotypic characteristics of the selected animals have not yet been conducted, the phenotypic characteristics of the Norduz sheep in the main herd were also considered in this study.

Phenotypic characteristics of the Norduz sheep in the main herd

Norduz sheep's heads were proportional to their bodies. The animals had a dynamic appearance and proper body conformation. The eyes of the Norduz sheep were lateral and small. The gaze of the animals was sharp. The leg structures were thin and the hoof structures were of medium size. The sample pair selected as best carrying the phenotypic characteristics of the purebred Norduz ewe (on the left) and the Norduz ram (on the right) was presented (Figure 1).

Figure 1. Norduz sheep pair*.

Şekil 1. *Norduz koyun çifti**.

Body color, head color and forelock presence

Figure 2. Light-toned wool (a)*, medium-toned wool (b)*, medium-dark wool (c)*.

Şekil 2. *Açık tonlu yapağı (a)*, orta tonlu yapağı (b)*, orta-koyu yapağı (c)*.*

Body color in Norduz sheep did not show a large variation. Body color was white, in tones of (milk white, ivory, cream, etc.) and high variation was not observed belonging to the same herd. However, differences in tones were observed between herds. Body cover of different herds was presented below, from light to dark tones (Figures 2a, b, c). In some herds, there were animals with white-pied body cover (Figures 3a, b). The head color of Norduz sheep showed three variations (Figure 3c). These were dark brown (on the right, with horns), brown (on the back, without horns) and gray (on the left, without horns). Raven brown tones that looked black were dominant and prioritized in the selection of purebred Norduz sheep.

Figure 3. White-brown (a)* and white black (b) Norduz sheep* and Different head colors in Norduz sheep (c)*.

Şekil 3. *Beyaz kahverengi (a)* ve beyaz siyah (b) Norduz koyunu* ve Norduz koyunlarında farklı baş renkleri (c)*.*

In some herds, the head color did not cover the entire head but only part of it. In animals, the head color ended at the atlas and axis vertebrae or continued until the end of the cervical vertebrae. A uniformity was observed in the head and foot colors of the animals. A positive phenotypic association was observed between head pigmentation intensity and foot pigmentation. Although in some animals the color ended at the part of the head close to the body, it was seen that the lower hairs of the fleece, which passed into the white body cover, were dark in color harmonizing with the head color (Figure 4a). Although the presence of forelocks in Norduz sheep was not as pronounced as in Norduz goats, some Norduz sheep have short forelocks at the front of the horns or in the horn area of hornless animals (Figure 4b, c). Although these forelocks rarely reach eye level, the eyes were not covered.

Figure 4. Dark underhairs in Norduz ram that match the head hair (a)*, Norduz ewe (b)*, Norduz ram (c)*.

Şekil 4. *Norduz koçunda baş kıllarıyla eşleşen koyu renkli alt kıllar (a)*, Norduz koyun (b)*, Norduz koç (c)*.*

Horn structure

A horn is formed by the modification of the epidermis. In sheep, the horn is located on the horn protrusion (*processus cornualis*) in the os frontale. It forms a mold that fits the shape of the os frontale and encases it like a sheath. Horns do not contain hair or sweat glands. The shape and structure of the cornu, which develops as a protective organ in sheep, vary according to the breed. According to the horn structure, Norduz sheep were divided into two groups, as horned and hornless, by the breeder. All male animals had horns (Figure 5a). The horns were long, thick and strong. Some of the females had horns (Figure 5b). The horns of male animals were long, thick and curved. The horns of females were smaller and less developed. Horned animals were classified as short, medium and long-horned. Hornless female animals constituted the majority of the herd (Figure 5c).

Figure 5. Norduz ram (a)*, Norduz ewe with horn (b)*. Norduz ram and hornless Norduz ewes (c)*.

Şekil 5. *Norduz koçu (a)*, boynuzlu Norduz koyunu (b)*. Norduz koçu ve boynuzsuz Norduz koyunları (c) *.*

Ear structure

The breeder divided Norduz sheep into two groups according to ear structure: eared and earless (Figure 6). In the eared animals studied, the ear was of medium length. No short-eared animals were observed.

Şekil 6. Genetik olarak orta uzunlukta kulak yapısına sahip Norduz koyunu*.

Figure 6. *Norduz sheep with genetically medium-length ear structure*.*

Character traits of Norduz sheep

When Norduz sheep were examined in terms of character traits, the following characteristics were noted. They were calm and compatible with herd management. They behave docilely in their relationships with people. They have the instinct to be with their herds in open areas. They adapt to being cared for and fed together with goats on farms. Horn size indicates power in Norduz sheep. No difference was observed between horned Norduz sheep and the hornless ones in terms of character traits. The ram with the largest age and size and the most magnificent horns, is regarded as the herd leader. Although horns were important in the hierarchy, hornless Norduz sheep were not excluded from the herd. Norduz sheep were attentive to their lambs. Lambs were dynamic and friendly. They were animals adapted to cold climates. The heavy snow cover and adverse weather conditions in the Norduz Region do not affect their health.

CONCLUSION

It was observed that the animals identified as purebred Norduz sheep in the herds well reflected the phenotypic characteristics of the breed. Although most female animals in the herd were hornless, no instances of fighting or beheaded sheep were observed. Horn populations were observed in the horned Norduz sheep in 54 variations. International researchers analyzed ancient genomes from Türkiye, Iran, Russia, Sweden, France and Spain to reveal the history of domestic sheep and show that sheep were most likely domesticated in Anatolia. The research team also examined ancient sheep genomes from Türkiye, Iran, Russia, Sweden, France and Spain, dating back 9,000 to 4,000 years ago. “The results confirm that the first sheep in Europe were brought there by farmers originating from Anatolia approximately 7,000 years ago. At the same time, sheep were also brought to Asia via Iran,” said Eva-Maria Geigl, a senior researcher at the Paris CNRS. Knowing the current genotypic and phenotypic characteristics of sheep is as important as knowing their ancestors. Therefore, comprehensive studies are needed.

ACKNOWLEDGEMENTS

We would like to thank Agric. Eng. Mehmet Salih Hasar for his valuable contributions during the data collection phase of this study.

Data Availability

Data will be made available upon reasonable request.

Authors’ Contributions

Conception and design of the study: AÖD, SH; data collection and obtaining data: SH; statistical analysis: AÖD; preparation of draft: AÖD, SH, AÖ; visualization: AÖD, SH; critical review and revision of the article: AÖD, SH; writing manuscript: AÖD, SH, AÖ.

Conflict of Interest

There is no conflict of interest between the authors in this study.

Ethical Statement

We declare that there is no need for an ethics committee for this research.

Financial Support

This study was not financially supported.

Article Description

This article was edited by Section Editor Prof. Dr. Zümrüt AÇIKGÖZ

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