Malaysian Applied Biology
https://doi.org/10.55230/mabjournal.v54i2.2803

Research Article

Morphometric Characterization, Scrotal and Udder Measurements of Dorper Sheep Reared in Setiu, Terengganu

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ABSTRACT

Dorper sheep are known for their adaptability, high fertility, and meat production capabilities making it a preferred choice among farmers. The Malaysian government has recognized the potential of Dorper sheep and provides support through breed improvement programs, technical assistance, and incentives. However, the lack of knowledge and expertise about Dorper sheep reared in Malaysia poses challenges and hinders their potential for success. Thus, the objectives of this study were to determine morphometric characterization, and testicular and udder measurements of Dorper sheep reared in Malaysia from age 1- to 13-months of age. The study had been conducted at a Dorper farm in Setiu, Terengganu. The data was collected from 49 rams and 49 ewes of Dorper sheep (total *n*=98) and categorized into five age groups; G1 (1–2-month-old), G2 (4-5-month-old), G3 (6-8-month-old), G4 (10-11-month-old), and G5 (12-13-month-old). The findings indicated that rams and ewes displayed their lowest measurements at G1, while G5 exhibited the highest measurements across all parameters. This observed pattern was primarily attributed to age-related factors, as animals typically experience ongoing physical transformations throughout their maturation and aging process. This study found that body weight (BW) has a positive correlation with body length (BL), wither height (WH), heart girth (HG), hip length (HL), scrotal length (SL), scrotal circumference (SC), teat length (TeL), teat diameter (TD), and distance between udder teat (DBUT). Instead, other variables did not influence the development of ear length (EL) and ear width (EW). The SL was highly correlated with SC (R=0.95), while TeL and TD positively correlated with DBUT (R=0.73 and 0.82, respectively). The description data of the morphometric measurements of the Dorper breed obtained in this study can further be utilized to enhance their management systems and inform breeding programs for the breed, promoting more effective practices.

Key words: Dorper sheep, morphometric characterization, testicular measurement, udder measurement

INTRODUCTION

The livestock industry is essential as it supplies beneficial animal protein food for the population, provides employment to citizens, and offers raw materials for agro-based industries (Zayadi, 2021; Abd Razak & Mohammad, 2022). In Malaysia, the ruminant sub-sector, which includes cows, goats, buffaloes, and sheep, is vital for providing a protein source alternative to fish and poultry (Abdullah *et al*., 2020). However, the Department of Veterinary Services (2023) stated that sheep production in 2022 is the lowest with 8.7% self-sufficiency compared to other livestock. This resulting higher importation from different countries to fulfill the demand. To address this issue, the government has implemented livestock rearing projects that involve the importation of a few breeds of small ruminants such as Dorper sheep in Malaysia. Farmers prefer Dorper sheep not only for their meat quality but also for their ease of management and adaptability to a variety of grazing environments. According to Norhayati *et al*. (2018), the Dorper breed is well-suited to Malaysia's environment due to its hardiness, adaptability, and rapid growth rate, making it ideal for meat production. Dorper ewes are also capable of early weaning, allowing them to return to breeding sooner and thus accelerating lambing programs. Additionally, Abd Majid *et al*. (2022) reported that Dorper sheep are resistant to parasitic gastroenteritis, thus reducing treatment costs for farmers. Therefore, breeding Dorper sheep is highly suitable for commercial development to boost the country's food supply production.

However, the information on Dorper sheep in Malaysia is still limited, and as an initial step of the breeding program, information was collected to know the prevailing sheep production systems and their genetic potential (Islam *et al*., 2018). The description and documentation of a breed's physical characteristics are known as morphological characterization (Putra *et al*., 2021) and are important for planning improvement, sustainable utilization, conservation strategies, and breeding programs (Markos *et al*., 2023). Moreover, morphometric characterization is also essential as a management tool to promote the productivity of the animals by predicting genetic improvement, growth rate, body condition score (BCS), conformation, and carcass traits (Yousuf

Article History
Accepted: 29 March 2025
First version online: 30 June 2025
Cite This Article:
Ahmad Nordin, N.S., Shaipudin, N.M.S.W.A., Saad, N.S.M., Komilus, C.F., Azid, A., Kari, A. & Kusumawati, E.D. 2025. Morphometric characterization, scrotal and udder measurements of dorper sheep reared in Setiu, Terengganu. Malaysian Applied Biology, 54(2): 92-103. https://doi.org/10.55230/mabjournal.v54i2.2803

et al., 2020).

In addition, testicular measurements are a crucial aspect of evaluating the reproductive health and potential fertility of ram in breeding programs. These measurements help assess the size, development, and functionality of the testes, which are directly related to sperm production and overall fertility. Faith *et al*. (2019) emphasized the importance of reproductive organ characteristics in breeding soundness evaluations to determine the fertility efficiency of breeding males. Testicular growth is essential for influencing the onset of puberty in rams and their sperm production capacity (Moulla *et al*., 2018; Faith *et al*., 2019; Prathibha *et al*., 2019). Strong genotype and phenotypic selection of rams is essential, making it necessary for farmers to know the reproductive status of each animal (Arbodela Marin *et al*., 2023).

Udder measurement is crucial for evaluating the health, productivity, and breeding potential of dairy animals. It is also a viable, practical, and low-cost method to assess and predict milk production (Iniguez *et al*., 2009; Arcos-Álvarez *et al*., 2020; Angeles-Hernandez *et al*., 2022). These measurements provide valuable insights into milk production capacity, udder health, and overall mammary system functionality. Udder size and type are crucial for machine milking, reducing udder damage, saving labor, and allowing the animal to stay productive longer. They also help lambs find and suckle the udder easily after birth. If the teats are positioned high and to the side, lambs may struggle to reach them, potentially leading to starvation, especially in smaller, multiple births. Teats that are too big or too small can make it difficult for lambs to suckle (Bakan & Demirhan, 2022). In addition, udder health is important not only for the productive longevity of animals but also for the hygienic quality of the milk produced (Vrdoljak *et al*., 2020). Quantifying milk production in sheep is vital because milk is the main nutrient source for the growth, development, and health of lambs (Arcos-Álvarez *et al*., 2020; Ibrahim *et al*., 2022). Insufficient milk can lead to stunted growth or mortality. Türkyılmaz *et al*. (2018) reported that ewes with larger udders had higher milk yields, and a positive correlation was found between udder circumference, the distance between teats, udder width, udder depth, and milk yield.

Thus, by analyzing key metrics such as body measurements (body weight, body length, wither height, heart girth, hip length, & chest width), udder measurement (teat length & diameter) and scrotal measurement (testes length, diameter & scrotal circumference) (Haque *et al*., 2020; Putra *et al*., 2021; Akbar *et al*., 2022; Markos *et al*., 2023) more straightforward and unbiased assessments of body conformation (Marković *et al*., 2019) can be achieved, thereby supporting the effective development of Dorper sheep breeding programs in Malaysia.

MATERIALS AND METHODS

Experimental animals

The study was conducted at a Dorper sheep farm located in Setiu, Terengganu (coordinated longitude and latitude at 5.4534ºN and 102.8846ºE, respectively). This study involved a total of 98 Dorper sheep (*n*=98), comprising 49 rams and 49 ewes, which were categorized into five different age groups; Group 1 (G1: 1–2-month-old), Group 2 (G2: 4–5-month-old), Group 3 (G3: 6–8-month-old), Group 4 (G4: 10–11-month-old), and Group 5 (G5: 12-13 month-old). Each age group consisted of 10 rams and 10 ewes (*n*=10), except for Group 3, which had 9 rams and 9 ewes (*n*=9). Different age groups will show distinct growth patterns enabling the identification of critical growth stages and how morphometric traits develop over time. Besides, establishing baseline data for each age group gives a reference for future studies and helps breeders compare their sheep to standard growth patterns. The Dorper sheep used in this study were housed and regularly fed with concentrates and forages (Napier grass) that were cut and carried to them, along with unlimited access to water.

Data collection

Body weight (BW)

Before obtaining any other measurements, the body weight (BW) of both Dorper rams and ewes across all age groups was assessed using a weighing scale, and the recorded weights were documented in kilograms (kg) (Khandoker *et al*., 2016; Markos *et al*., 2023).

Morphometric characterization

Before conducting the morphometric characterization as outlined below, the Dorper rams and ewes were appropriately restrained. Subsequently, the measurement was taken as explained in Table 1 and Figure 1 by using a measurement tape in centimeters (cm).

Scrotal measurements

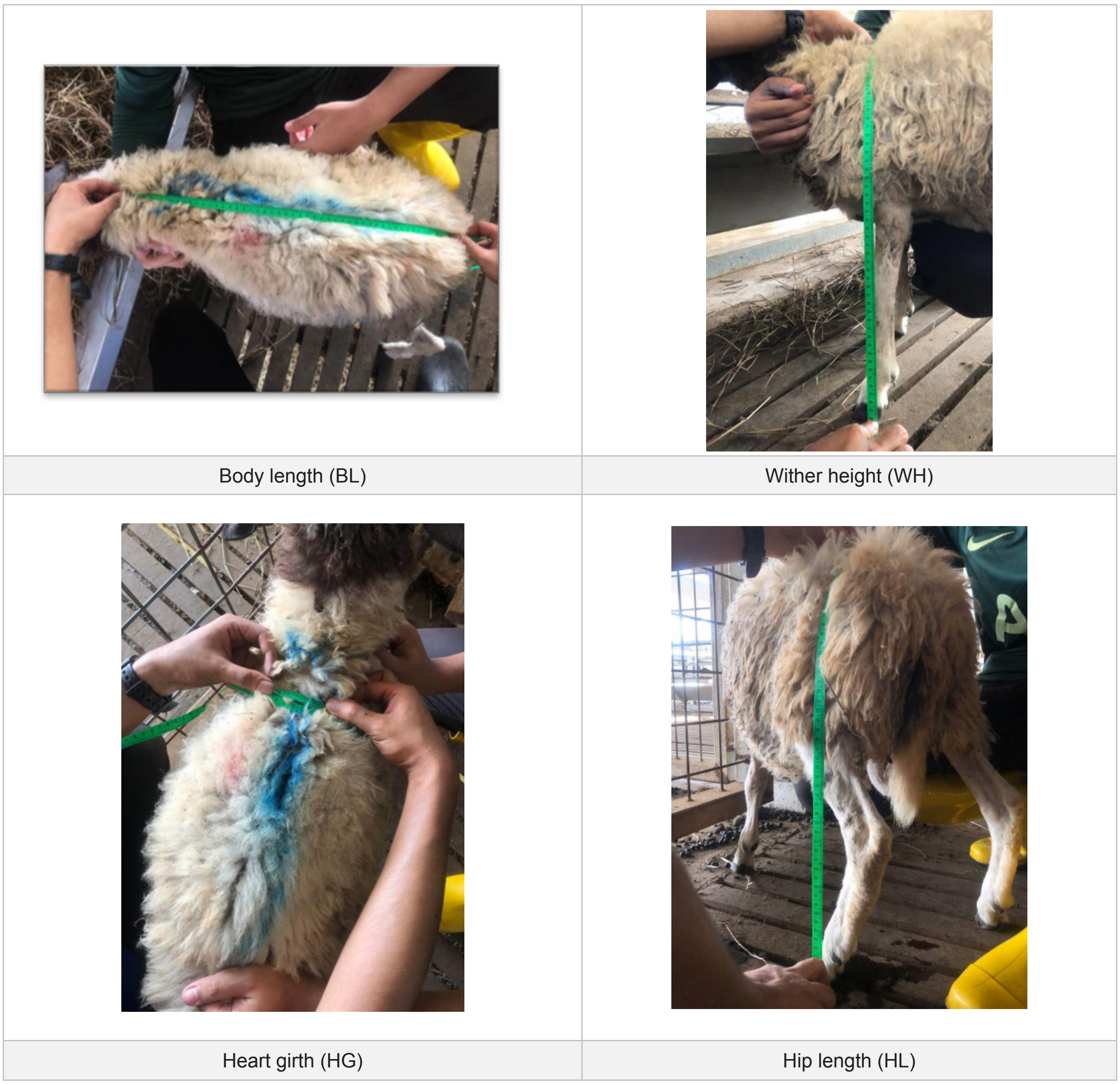
Scrotal measurements as detailed below were collected as explained in Table 2 and Figure 2 from a total of 49 Dorper rams (*n*=49) by using a measuring tape in centimeters (cm).

Udder measurements

The udder measurements of the 49 Dorper ewes (n=49) were collected in centimeters (cm), as specified in Table 3 and Figure 3.

Table 1. The morphometric measurements taken and their respective descriptions.

Measurement	Description	References
Body length (BL)	The measurement was taken from the base of the neck (where it joins the body) to the base of the tail.	Fourie *et al*. (2002); Stojiljkovic *et al*. (2015); Khandoker *et al*. (2016); Babale *et al*. (2018); Markos *et al*. (2023).
Wither height (WH)	The measurement was taken from the highest point of the withers to the ground.	Stojiljkovic *et al*. (2015); Babale *et al*. (2018); Markos *et al*. (2023).
Heart girth (HG)	The measurement was taken at the circumference of the chest just behind the front legs, where the heart is located.	Fourie *et al*. (2002); Carneiro *et al*. (2010); Babale *et al*. (2018); Markos *et al*. (2023).
Hip length (HL)	The measurement was taken from the base of the tail to the ground.	Carneiro *et al*. (2010); Khandoker *et al*. (2016).
Head length (HeL)	The measurement was taken from the base of the skull to the tip of the snout.	Carneiro *et al*. (2010); Khandoker *et al*. (2016).
Head width (HW)	The measurement was taken across the widest part of the animal's head.	Carneiro *et al*. (2010); Çilek, and Petkova (2016); Khandoker *et al*. (2016).
Ear length (EL)	The measurement was taken from the base of the ear (where it attaches to the head) to the tip of the ear.	Carneiro *et al*. (2010; Çilek, and Petkova (2016; Khandoker *et al*. (2016).
Ear width (EW)	The measurement was taken across the widest part of the animal's ear.	Çilek, and Petkova (2016; Khandoker *et al*. (2016).



Body length (BL) | Wither height (WH)

Heart girth (HG) | Hip length (HL)

Fig. 1. Morphometric measurements that were taken from Dorper sheep.

Head length (HeL)

Head width (HW)

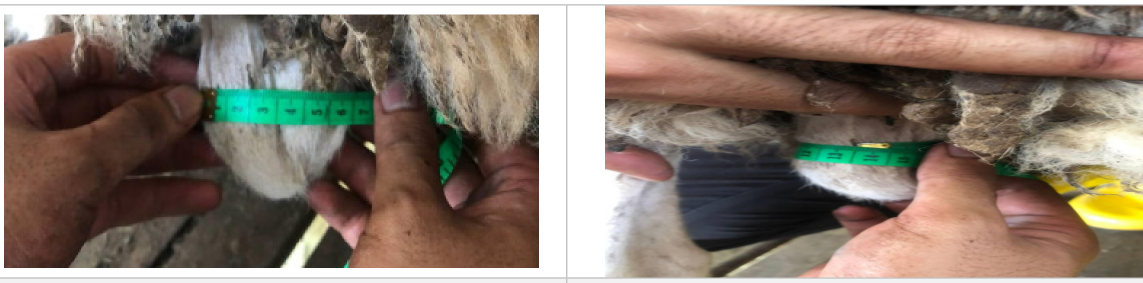
Ear length (EL)

Ear width (EW)

Fig. 1. (Continued) Morphometric measurements that were taken from Dorper sheep.

Table 2. The scrotal measurements taken and their respective descriptions.

Measurements	Description	References
Scrotal length (SL)	The measurement was taken across the widest part of the ram's scrotum.	Khandoker *et al*. (2016); Markos *et al*. (2023)
Scrotal circumference (SC)	The measurement was taken around the widest part of the scrotum.	Fourie *et al*. (2002; Khandoker *et al*. (2016).

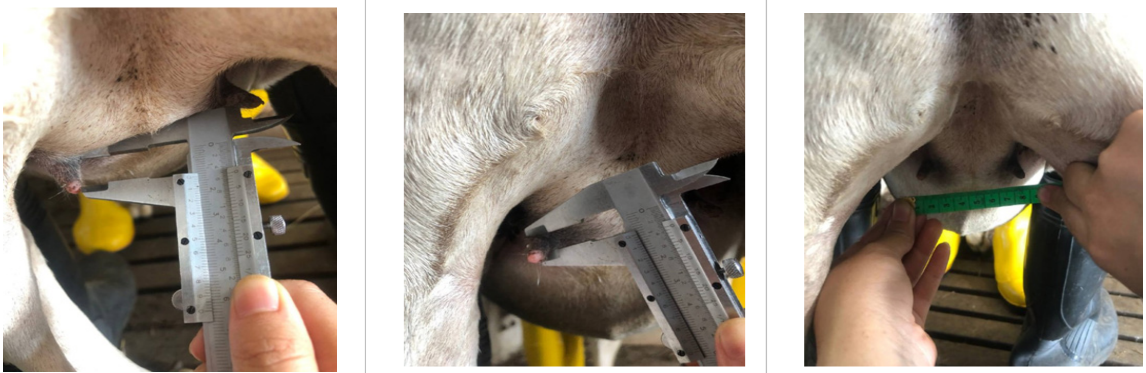


Scrotal length (SL) | Scrotal circumference (SC)

Fig. 2. The scrotal measurement that was taken from Dorper rams.

Table 3. The udder measurements taken and their respective descriptions.

Measurements	Description	References
Teat length (TeL)	The measurement was obtained with a caliper, starting at the teat's base (where it connects to the udder) and extending to the teat's tip.	Makovicky *et al*. (2013); Atigui *et al*. (2021); Wan-Azemin *et al*. (2021)
Teat diameter (TD)	The measurement was taken at the base of the teat where it connects to the udder by using a caliper.	Atigui *et al*. (2021)
Distance between udder teats (DBUT)	The measurement was taken between the two teats on the udder by using a measuring tape.	Atigui *et al*. (2021)



Teat length (TeL) | Teat diameter (TD) | Distance between udder teats (DBUT)

Fig. 3. The udder measurement that was taken from Dorper ewes.

Statistical analysis

The collected data of morphometric characterization (BW, BL, WH, HG, HL, HeL, HW, EL, & EW), scrotal measurements (SL & SC), and udder measurements (TL, TD & DBUT) from the Dorper rams and ewes were analyzed by using the Minitab software version 21. The descriptive statistics (mean ± standard error (SE)) of BW, morphometric characterization, and scrotal and udder measurements were determined by using the ANOVA, and the Turkey test was conducted to identify significant differences between these variables. Age was included in the analysis because it significantly contributes to variations in the traits of Dorper sheep, offering more accurate insights into how age affects these characteristics. These results were subsequently compared with previous findings to ensure accuracy and confirm the absence of errors or outliers. The association between age, BW, BL, WH, HG, HL, HeL, HW, EL, EW, SL, SC, TL, TD, and DBUT was determined using Pearson's correlation. (Ouchene-Khelifi & Ouchene, 2021; Selala & Tyasi 2022), And the scale of the r value was determined according to Selvanathan *et al*. (2020).

RESULTS

Body Weight (BW)

Figure 4 illustrated that the BW of both rams and ewes generally increased across the groups, with rams consistently weighing more than ewes. The body weights of both rams and ewes in G1 and G2 were statistically different (*P*<0.05) from those in G3 to G5.

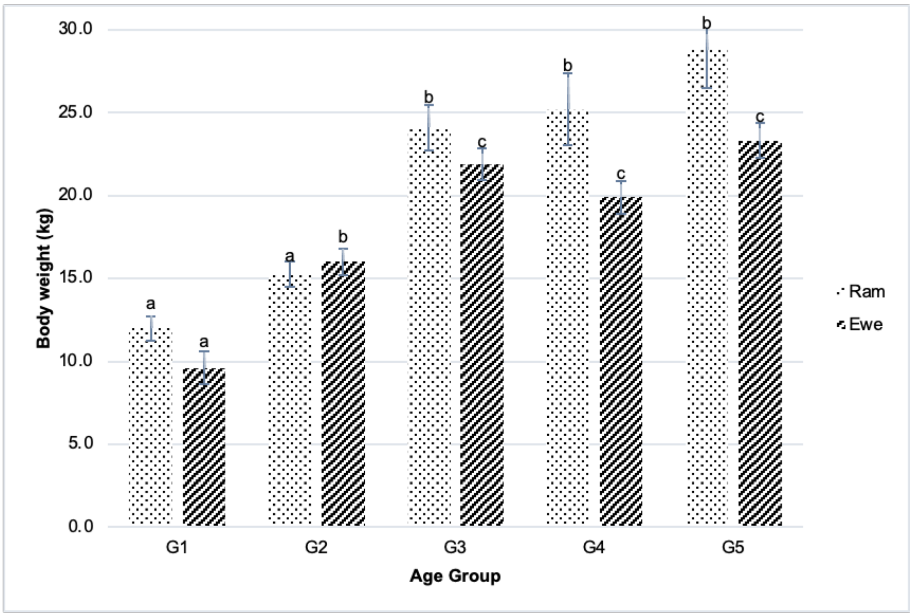


Fig. 4. The body weight (mean ± SEM) of Dorper rams and ewes for different age groups; Group 1 (G1: 1–2-month-old), Group 2 (G2: 4-5-month-old), Group 3 (G3: 6-8-month-old), Group 4 (G4: 10-11-month-old), and Group 5 (G5: 12-13-month-old). a, b, c, d: Mean in the same row and with different superscripts have significant differences (*p*<0.05).

Morphometric measurements

Table 4 presents the morphometric body measurements (mean ± SEM) for both sexes. As expected, these measurements increased as the animals aged. This trend was observed in the Dorper sheep in this study, with morphometric measurements rising from G1 to G5. Consistent with their natural characteristics, rams were generally larger and more muscular than ewes. However, in this study, the (HG) of the ewes was found to be greater than that of the rams. In G1, both rams and ewes did not show any statistically significant differences across the body parameters measured. In G2 and G3, the wither height (WH) of rams was significantly different (p < 0.05) from body length (BL), head width (HW), and ear length (EL). In both G4 and G5, the ear length (EL) of rams showed significant differences compared to other body parameters measured. For ewes in G2 and G3, hip length (HL) was significantly different from wither height (WH) and heart girth (HG), and head length (HeL) was significantly different from head width (HW), ear length (EL), and ear width (EW). In G4, the body length (BL) of ewes was significantly different from head width (HW) and ear width (EW).

Table 4. The morphometric body measurements (mean ± SEM) of Dorper rams and ewes for different age groups; 5 groups of age which were Group 1 (G1: 1–2-month-old), Group 2 (G2: 4-5-month-old), Group 3 (G3: 6-8-month-old), Group 4 (G4: 10-11-month-old), and Group 5 (G5: 12-13-month-old).

Age Group	Ram/Ewe	Body Parameter (cm)							
		BL	WH	HG	HL	HeL	HW	EL	EW
G1	Ram	41.8±0.80	45.6±0.59	54.7±1.34	47.6±0.44	16.4±0.42	11.4± 0.28	12.0±0.22	6.0± 0.22
	Ewe	41.5±1.13^{a}	43.7± 0.64^{a}	51.6±1.98^{a}	45.3± 1.04^{a}	16.5±0.50^{a}	11.5±0.29^{a}	12.2±0.52^{ab}	6.4±0.21^{a}
G2	Ram	46.6±1.47^{a}	50.7±1.02^{b}	58.7±1.15^{ab}	51.7±1.39^{ab}	18.5±0.49^{ab}	11.9±0.22^{a}	12.7± 0.37^{a}	6.2±0.17^{ab}
	Ewe	46.8± 1.15^{b}	48.4± 1.21^{b}	60.0± 1.94^{b}	50.0±0.93^{b}	18.4±0.37^{ab}	11.9±0.26^{ab}	12.5±0.30^{ab}	6.2±0.08^{a}
G3	Ram	55.6±1.52^{b}	56.9±1.01^{c}	66.1±1.42^{bc}	55.8±0.93^{bc}	20.4±0.69^{bc}	14.5±0.33^{b}	12.9± 0.46^{a}	6.9±0.10^{b}
	Ewe	50.6±1.41^{bc}	51.3± 1.31^{bc}	66.6±1.50^{bc}	52.1±1.38^{bc}	16.8±0.35^{b}	10.3±0.30^{a}	11.1±0.31^{a}	6.4±0.14^{a}
G4	Ram	59.9±2.32^{b}	57.0±1.20^{c}	71.8±2.65^{cd}	59.9±1.35^{c}	20.2± 0.64^{bc}	14.6±0.32^{b}	12.9±0.38^{a}	6.9± 0.25^{b}
	Ewe	53.4±1.48^{c}	51.3±1.17^{bc}	66.2±1.53^{bc}	52.2± 1.35^{bc}	18.1±0.61^{ab}	11.4±0.50^{a}	11.7±0.47^{ab}	6.6±0.10^{a}
G5	Ram	61.7±2.27^{b}	56.9±1.06^{c}	74.5±2.54^{d}	60.2±1.68^{c}	21.5± 0.43^{c}	14.6±0.50^{b}	13.0±0.43^{a}	6.8± 0.25^{b}
	Ewe	55.3±1.37^{c}	54.1±1.13^{c}	68.6±2.58^{a}	55.6± 0.83^{a}	20.1±0.57^{b}	13.2±0.45^{b}	12.9±0.40^{b}	6.6±0.16^{a}

a, b, c, d: Mean in the same row and with different superscripts have significant differences (*p*<0.05).
BL: Body length, WH: Wither height, HG: Heart girth, HL: Hip length, HeL: Head length, HW: Head width, EL: Ear length, EW: Ear width.

Scrotal measurements

Figure 5 displays the scrotal measurements (SL & SC) involved in this study. As previously mentioned, SL and SC also increase as the animals age. G5 demonstrated the highest values, with SL at 10.7±0.62 cm and SC at 24.7±1.46 cm, while G1 exhibited the lowest values, with SL at 4.9±0.24 cm and SC at 11.5±0.62 cm. Moreover, SL and SC in G1 and G2 were significantly different (P<0.05) from those in G3 to G5.

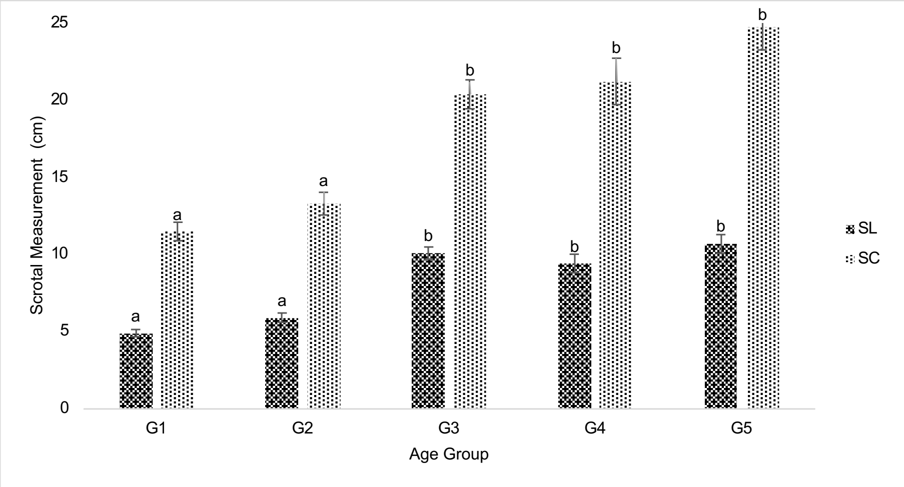


Fig. 5. The mean ± SEM of scrotal measurement (scrotal length (SL) & scrotal circumference (SC)) of Dorper rams for different age groups; Group 1 (G1: 1–2 month-old), Group 2 (G2: 4-5 month-old), Group 3 (G3: 6-8 month-old), Group 4 (G4: 10-11 month-old), and Group 5 (G5: 12-13 month-old). a, b, c, d: Mean in the same row and with different superscripts have significant differences (p<0.05).

Udder measurements

Figure 6 presents udder measurements (TeL, TD & DBUT). Naturally, the udder develops and enlarges as the animals age. Consequently, this study found that G1 had the lowest measurements, which gradually increased from G2 to G5. However, it was observed that G3 had exceptionally high measurements, which then decreased at G4 before increasing again at G5. TeL in G1 was significantly different (P<0.05) from the other age groups. Additionally, TD in G1 and G3 showed significant differences, while DBUT in G1, G3, and G4 were also significantly different.

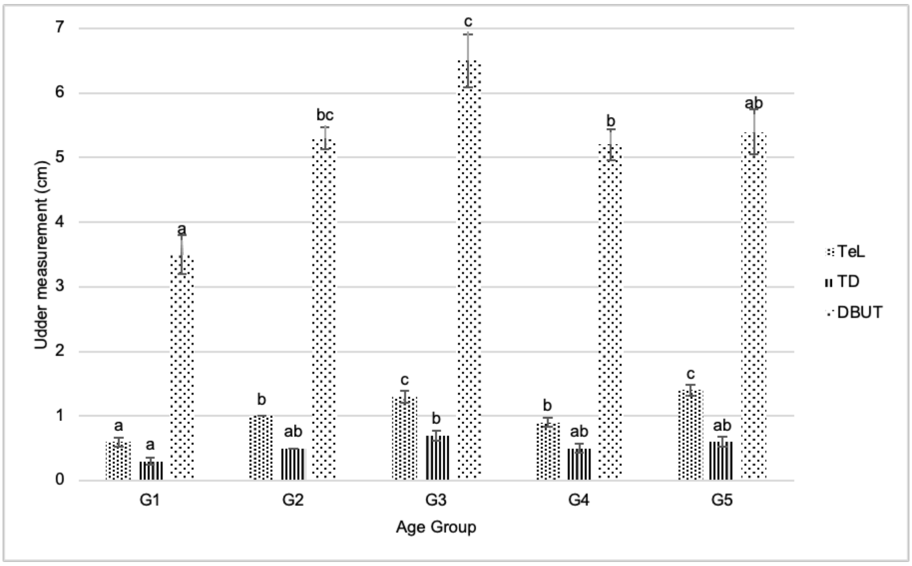


Fig. 6. The mean ± SEM of udder measurement (teat length (TL), teat diameter (TD), and distance between teat (DBUT)) of Dorper ewes for different age groups; Group 1 (G1: 1–2 month-old), Group 2 (G2: 4-5 month-old), Group 3 (G3: 6-8 month-old), Group 4 (G4: 10-11 month-old), and Group 5 (G5: 12-13 month-old). a, b, c, d: Mean in the same row and with different superscripts have significant differences (p<0.05).

Correlation analysis

Table 5 presents the correlation analysis of Dorper rams and ewes across various measurements. The data show that the age of Dorper sheep is highly correlated with BW, BL, WH, HG, and HL in both rams and ewes, with *R-values*≥ 0.6. BW, BL, and HeL in both rams and ewes have a strong correlation with WH, HG, and HL. In rams, HeL and HW are highly correlated with age, BW, and BL, but this is not the case for ewes. Generally, EL and EW exhibit moderate to low correlation with age, BW, BL, WH, HG, and HL in both genders, with *R-values*<0.6. However, EL in ewes and EW in rams are highly correlated with HW, with *R-values* of 0.689 and 0.603, respectively. SC is very highly correlated with SL, with an *R-value* of 0.953. Both SC and SL have a positive correlation with age, BW, BL, WH, HG, HL, HeL, and HW in both sexes, although they have a moderate correlation with EL. DBUT shows a high correlation with TeL and TD, with *R-values* of 0.726 and 0.823, respectively. However, DBUT has a negative correlation with HW and EL. TeL strongly correlates with age, BW, BL, and HG, while TD has a high correlation with BW and HG.

Table 5. Correlation analysis of Dorper ram and ewe measurements

	Gender	Group	BW	BL	WH	HG	HL	HeL	HW	EL	EW	SL	TeL	TD
BW	Ram	0.775												
	Ewe	0.782												
BL	Ram	0.808	0.923											
	Ewe	0.773	0.819											
WH	Ram	0.752	0.891	0.873										
	Ewe	0.697	0.783	0.636										
HG	Ram	0.787	0.949	0.925	0.837									
	Ewe	0.672	0.863	0.795	0.671									
HL	Ram	0.777	0.882	0.889	0.892	0.875								
	Ewe	0.683	0.783	0.721	0.841	0.751								
HeL	Ram	0.709	0.784	0.756	0.792	0.775	0.768							
	Ewe	0.51	0.524	0.525	0.608	0.601	0.672							
HW	Ram	0.734	0.872	0.861	0.837	0.83	0.79	0.787						
	Ewe	0.289	0.232	0.314	0.49	0.285	0.561	0.68						
EL	Ram	0.255	0.465	0.363	0.395	0.400	0.341	0.324	0.373					
	Ewe	0.068	0.192	0.257	0.305	0.195	0.429	0.572	0.689					
EW	Ram	0.465	0.661	0.579	0.591	0.567	0.501	0.508	0.603	0.585				
	Ewe	0.264	0.297	0.436	0.245	0.429	0.397	0.312	0.176	0.370				
SL	Ram	0.791	0.865	0.841	0.853	0.824	0.746	0.790	0.827	0.366	0.624			
SC		0.810	0.905	0.857	0.834	0.879	0.78	0.786	0.811	0.411	0.597	0.953		
TeL		0.616	0.720	0.650	0.504	0.674	0.522	0.414	0.112	0.047	0.237			
TD	Ewe	0.314	0.611	0.563	0.326	0.645	0.413	0.360	0.007	0.091	0.230			
DBUT		0.394	0.643	0.523	0.355	0.635	0.374	0.292	-0.175	-0.049	0.192		0.726	0.823

BW: Body weight, BL: Body length, WH: Wither height, HG: Heart girth, HL: Hip length, HeL: Head length, HW: Head width, EL: Ear length, EW: Ear width, SL: Scrotal length, SC: Scrotal circumference,

TeL: Teat length, TD: Teat diameter, DBUT: Distance between udder teat.

DISCUSSION

Body weight

The body weights observed in the current study were lower compared to the findings of Ayele *et al*. (2015), who reported that pure Dorper sheep weighed 16.18±0.35 kg at weaning, 24.30±0.59 kg at six months, and 34.43±0.79 kg at one year. Similarly, Santos *et al*. (2020) reported higher body weights for cross-bred Dorper and Santa Inês ewes, with an average weight of 29.94 kg at ages 2-9 months. Conversely, Selala and Tyasi (2022) found that newborn Dorper sheep had lower body weights, averaging 6.2±2.32 kg for males and 5.98±2.57 kg for females, compared to the current findings. The variations in body weight measurements across these studies may be influenced by several factors, including management practices such as environmental conditions and feed intake (Cho *et al*., 2020), lamb genotype, sex, birth type, and the year and season of birth (Ayele *et al*., 2015). For instance, animals reared under extensive systems may gain weight faster due to unlimited access to food resources, as observed by Santos *et al*. (2020), compared to those in intensive systems like in the current study. However, free-range systems may pose a higher risk of gastroenteritis parasites (Sirbu *et al*., 2020). Additionally, Ayele *et al*. (2015) noted that purebred animals tend to have higher body weights than crossbreeds. Overall, live weight is the most widely used indicator of animal performance because it not only provides a reliable and informative measure for animal selection, dietary needs, and health management but also price determination (Markos *et al*., 2023).

Morphometric measurements

BL, WH, and HG reported by Selala and Tyasi (2022) of below-month Dorper sheep was 37.92 ± 5.15 cm and 37.08 ± 6.57 cm, 34.41 ± 4.02 cm, and 35.44 ± 3.87 cm, and 42.30 ± 4.71 cm and 40.62 ± 5.98 cm respected to the male and female lamb which were lower compared to the current study. HL or rump height also recorded by Selala and Tyasi (2022) of 1-month Dorper sheep were 35.86 ± 3.38 cm and 33.68 ± 4.89 cm compared to males and females also lower than this study. Conversely, data reported by Santos *et al*. (2020) that the BL and WH of 2-9 months crossbreed Dorper and Santa Inês ewes were 62.46 cm and 59.37 cm respectively, which is higher than the current finding. Santos *et al*. (2020) also recorded their HL was higher compared to the present study. Compared to other breeds such as adult Thalli sheep (Akbar *et al*., 2022), BL showed 64.77±10.5 cm and 68.75±8.21 cm compared to males, and females were higher compared to the current finding. The WH of Thalli sheep also seems higher compared to this study with males 66.34±9.62 cm and females 68.56±7.28 cm. However, WH in Thalli ewes in this study is higher compared to Thalli rams, which is vice versa compared to the current finding. On the other hand, HG found in Thalli rams (70.49±11.3 cm) was lower compared to the current study while Thalli ewes (74.50±9.56 cm) showed vice versa. Barind sheep (Haque *et al*., 2020) yet showed lower BL (54.90±3.13 cm) and HG (67.80±4.46 cm) of ram compared to present data, while BL (55.69±3.06 cm) and HG (70.41±6.96 cm) were not. On the other hand, the WH of Barind sheep showed slightly lower (male: 54.78±1.88, female: 52.53±2.52) compared to this study. Costa *et al*. (2015) reported that the HL of male Dorper crossed F1 Santa Inês at a year old was 54.87 ± 3.15 cm which is lower compared to the current finding. HL measurement by Selala and Tyasi (2022) showed low compared to current findings in both genders. The Indigenous sheep in Bangladesh studied by Islam *et al*. (2018) seem to have lower results in BL, HeL, and EL compared to current findings. However, the WH of rams is slightly (58.47±0.75 cm) higher compared to the present data. HeL, HW, and EL in adult Barind sheep found by Haque *et al*. (2020) also showed lower compared to the present study in both sexes. According to Akbar *et al*. (2022), adult Thalli sheep presented higher measurements of HeL, EL, and EW compared to current findings in both genders. HW of the current finding seems higher compared to Thalli rams and ewes which were 09.70±2.08 cm and 10.15±1.40 cm, respectively.

The differences in data between these findings can be attributed to several factors, including breed, rearing location, climate, and management practices. Dorper sheep, a crossbreed between Dorset Horn and Blackhead Persian sheep (Pogodaev *et al*., 2023), was developed to provide desirable traits such as high growth and survivability rates, as well as quality meat, milk, and wool. They are known for their adaptability to a range of climates, including arid regions. Compared to indigenous sheep in Bangladesh, as studied by Islam *et al*. (2018) and Haque *et al*. (2020), the Dorper sheep in the current study showed higher performance. Santos *et al*. (2020) concluded that F1 Dorper × Santa Inês ewes have favorable conformation characteristics for meat production and reproduction. In this study, Dorper sheep were raised in the tropical climate of Malaysia. Despite their adaptability to harsh climate conditions, variations in temperature and humidity can influence their feed intake (Curtis *et al*., 2017; Mannuthy, 2017) and heat stress levels (Lewis Baida *et al*., 2021), which in turn affect their growth and reproduction. This explains the differences in data compared to the studies by Santos *et al*. (2020) and Selala and Tyasi (2022). Additionally, animals raised under extensive systems are at higher risk of parasitic gastroenteritis, leading to loss of appetite, stunted growth, and economic losses for farmers (Abubakar *et al*. 2015; Dey *et al*., 2020). This further explains the variations in data compared to the previous studies. Understanding these factors helps farmers identify animals with excellent body morphology, which tend to produce higher quality products, while those with poor morphology can be treated or culled. This practice aids in saving rearing time and operational costs for farmers.

Scrotal measurements

According to Akbar *et al*. (2022), the SC measurements of adult Thalli rams were slightly higher, recorded at 10.92±6.31 cm, compared to the present study. Conversely, the SC in the current study was higher compared to those reported by Akbar *et al*. (2022). Tabbaa *et al*. (2018) found that the SC of Awassi rams was 29.6±1.3 cm at yearling age and 33.5±0.8 cm in adulthood, which is higher than the measurements in the present study. On the other hand, indigenous rams in Bangladesh showed lower SC and SL measurements, with values of 16.33±0.18 cm and 10.23±0.2 cm, respectively (Islam *et al*., 2018), compared to the present findings. As animals reach puberty, SC and SL measurements develop in preparation for mating. The development of SC directly influences SL measurements. According to Tabbaa *et al*. (2018), SC development is affected by melatonin secretion, which increases gonadotropin secretion, particularly follicle-stimulating hormone. The development of SC is also due to the expansion of seminiferous tubules, which occupy a larger proportion of the testes. As animals age, scrotal measurements can vary between breeds (Perumal, 2014), explaining the differences observed in previous studies. Selecting animals with larger scrotums at an early age contributes to increased semen production (Siddiqui *et al*., 2008; Wahyudi *et al*., 2022). This is because scrotal circumference correlates with semen volume, sperm concentration, and the number of spermatozoa per ejaculate (Latif *et al*., 2009; Tabbaa *et al*., 2018). Ram fertility significantly influences flock performance and reproductive efficiency compared to the fertility of individual ewes. Therefore, selecting highly fertile males is essential for improving production (Faith *et al*., 2019).

Udder measurements

According to Akbar *et al*. (2022), adult Thalli ewes had lower teat length (TL) and teat diameter (TD) measurements, recorded at 2.25±1.64 cm and 2.85±1.78 cm, respectively, compared to the current findings. Wan-Azemin *et al*. (2021) found the teat length of Dorper ewes at 0-15, 16-30, and 31-45 days of lactation to be 35.0±1.3 mm, 35.6±1.7 mm, and 41.8±1.8 mm, respectively. Ayadi *et al*. (2011) reported that the teat diameter of Sicilo-Sarde dairy ewes at 45 days after lactation was 10.0±2.1 mm, with a distance between the teats (DBUT) of 7.5±1.1 mm. Margatho *et al*. (2020) noted that Serrana goats had TL, TD, and DBUT measurements of 9.5±3.1 mm, 31.3±9.1 mm, and 11.7±3.4 mm, respectively.

Udder size and type are critical for several reasons, including suitability for machine milking, minimizing udder damage, reducing labor during milking, maintaining the animal's productivity for a longer period, and helping lambs easily find and suckle the udder after birth. Additionally, teats that are too large or too small for the lamb's mouth can cause sucking problems. Udder type and teat placement also affect the milk flow rate and the amount of milk left in the udder after milking (Bakan & Demirhan, 2022).

Therefore, maintaining good udder morphology is important in this industry. Poor udder and teat conformations pose a management challenge for dairy producers. However, selecting against poor teat and udder conformations can increase profit potential by improving performance, longevity, and the overall ability of the animals (Saleh *et al*., 2023).

Correlation analysis

The findings of Pearson's correlation in this study align with Selala and Tyasi (2022), who found that body weight (BW) had a strong positive correlation with major traits such as heart girth (HG), rump height (RH), body length (BL), and wither height (WH). This study also supports the findings of Santos *et al*. (2020), indicating a high positive correlation between BW and both RH and WH.

Additionally, this study is consistent with Akbar *et al*. (2022), where both males and females exhibited a strong positive correlation among WH, BL, hip length (HL), and BW. In the current study, BW showed a low correlation with ear length (EL) for both genders, while Markos *et al*. (2023) reported moderate to low correlations between BW and EL, with *R-values* of 0.56 and 0.21 for males and females, respectively.

Akbar *et al*. (2022) found that head width (HW) had a moderate correlation with head length (HeL) for both male and female Thalli sheep (*R-values*: 0.573 & 0.516), whereas the current study indicated a high correlation between HW and HeL. Akbar *et al*. (2022) also reported that rams showed a moderate correlation between ear width (EW) and EL (*R-value*: 0.506), while ewes had a high correlation between these traits (*R-value*: 0.683), which differs from the findings of the current study.

Across all morphometric measurements, BW showed the strongest correlation with HG for both rams and ewes. This corresponds with Markos *et al*. (2023), who found that BW at one year old had the highest correlation with HG in both male and female sheep. HG is the simplest method for estimating live weight on farms, particularly for smallholder farmers. Including additional body measurements along with HG improves the accuracy of the prediction model (Worku, 2019). Thus, HG and BW can serve as initial indicators for selecting animals with desirable traits.

Scrotal measurements significantly contribute to semen production due to their association with semen quality (Latif *et al*., 2009; Tabbaa *et al*., 2018). Tabbaa *et al*. (2018) and Dasrul *et al*. (2020) stated that scrotal size is positively correlated with body weight and age, a finding that is consistent with the current study, which showed that scrotal circumference (SC) and scrotal length (SL) were positively correlated with age and BW. Therefore, selecting animals with optimal SC and SL provides farmers with a higher chance of breeding superior animals.

Udder measurements can predict milk production in ewes, with udder characteristics being influenced by genetic and environmental factors (Bakan & Demirhan, 2022). Arcos-Álvarez *et al*. (2020) reported that udder circumference and teat width are significantly correlated with total milk yield and are good predictors of performance in several sheep breeds. While there is limited research on the relationship among udder measurements, many studies have reported correlations between udder morphology and milk production. Saleh *et al*. (2023) found a linear relationship between teat distances and milk yield. Moreover, teat canal length significantly affects milk flow characteristics, such as daily milk yield, average milk flow, maximum milk flow, and somatic cell score, at different measurement times. Hence, favorable udder traits in ewes have a significant positive impact on both production and economic outcomes, particularly in dairy farming.

CONCLUSION

In this study, as animals age, their body measurements naturally increase. However, several factors can slow down the growth and other performance aspects of the animals. BW was found to have a strong positive correlation with BL, WH, and HL, with the highest correlation observed with HG. Therefore, BW and HG can be primary indicators of animal conformation. Scrotal measurements are crucial for farmers as they are associated with semen quality, leading to better offspring. Similarly, udder measurements are important not only for nursing lambs but also for dairy production. In this study, SL development was influenced by SC, as evidenced by an *R-value* of 0.953. Additionally, DBUT showed strong correlations with TeL and TD, with *R-values* of 0.73 and 0.82, respectively. Thus, both scrotal and udder measurements are significant for future offspring, production, and the farmers' economy. In conclusion, understanding morphometric, scrotal, and udder measurements in Dorper sheep helps farmers make informed breeding, selection, and management decisions, enhancing productivity and profitability. This will enable high-quality Dorper sheep to thrive in Malaysia.

ACKNOWLEDGEMENTS

The authors would like to extend heartfelt gratitude to the Ministry of Higher Education (MOHE) of Malaysia and Universiti Sultan Zainal Abidin (UniSZA) for providing funding for this project under the Fundamental Research Grant Scheme (FRGS) (FRGS/1/2022/STG01/UNISZA/02/3), and Dana Penyelidikan Universiti 2.0 (DPU 2.0 - UniSZA/2021/DPU2.0/03), respectively.

ETHICAL STATEMENT

This study was approved by the UniSZA Animal and Plant Research Ethics Committee, approval number UAPREC/07/019.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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