Original Research

Journal of Advanced Veterinary Research
(2026) Volume 16, Issue 1, 16-19

Evaluating morphometric traits and body indices in Dorper sheep in Indonesia: A comparative analysis of four generations

Achiriah Febriana[1,2,3], Dela A. Lestari[1,3], Fatmawati Mustofa[1,3], Asep Setiaji[1,3], Sutopo Sutopo[1*]

[1]Department of Animal Science, Faculty of Animal and Agricultural Sciences Universitas Diponegoro, Semarang 50275, Central Java, Indonesia.
[2]Indonesian Center for Livestock Training Batu (ICLT), Ministry of Agriculture of Indonesia, Batu, 65301, Indonesia
[3]Tropic Research on Productivity, Genetic Enhancement, and Conservation of Local Livestock (TROPICAL), Indonesia

ARTICLE INFO

Received: 01 October 2025

Accepted: 09 December 2025

*Correspondence:

Corresponding author: Sutopo Sutopo
E-mail address: drsutopo36@gmail.com

Keywords:

Morphometric traits; Body indices; Across generations; Dorper sheep; Multivariate analysis

ABSTRACT

This research examined the morphometric characteristics of Dorper sheep over four generations (G0 to G3) in Indonesia. Most parameters exhibited significant differences between generations. The G0 generation had the longest body length (67.95±0.73 cm) and heaviest weight (56.58±1.60 kg), with a subsequent decline in G1 and partial recovery in G2 and G3, likely due to genetic or environmental influences. Chest depth and girth followed a similar trend, with G0 animals having the deepest chests (27.75±0.36 cm) and increased girth observed in G2 and G3. The height at the withers and rump rose from G0 to G1, then fell in G3, while chest and rump width were more pronounced in G2. The height index rose in G1 (104.46±0.99) compared to G0 (80.86±0.68), indicating a change in body shape. The compact index was highest in G0 (1.01±0.02) and decreased in later generations, especially in G1 (0.65±0.02), suggesting a more elongated body. The body weight index was highest in G0, with decreases noted in G2 and G3. Foreleg length was greater in G1 and G2. There was no significant variation in body index, body ratio, and over increase index across generations. Correlation analysis showed positive relationships among traits, with body weight most strongly correlated with chest depth. Principal component analysis identified body length, weight, chest depth, and girth as key distinguishing variables. These findings offer insights into the morphological evolution of IDS and highlight traits advantageous for selective breeding programs.

Introduction

Renowned for their resilience and meat production capabilities, Dorper sheep have attracted considerable interest in the livestock sector. Understanding growth characteristics is essential for assessing sheep productivity, and recognizing these traits across various generations is key to effective breeding programs (Hai *et al.*, 2023). Analyzing the variations between consecutive generations, from G0 to G3, in sheep provides valuable insights into the performance of each generation, primarily due to the heterosis effect. This genetic phenomenon, commonly known as hybrid vigor, can lead to offspring displaying superior traits compared to their parents (Erduran and Dag, 2022).

Pokhil *et al.* (2024) reported that crossbreeding programs have become an effective strategy for enhancing productivity across various agricultural and livestock sectors. Using morphometric measurements is an effective and unbiased approach to assess sheep performance and body structure. These measurements, along with calculated body indices, offer a thorough evaluation of an animal's physical traits and its potential for meat production (Oliveira *et al.*, 2021). . There is still a scarcity of research on the morphometric characteristics of sheep across various generations. Examining these traits and body indices in multiple generations of Dorper sheep is crucial for understanding the breed's development and identifying patterns in their physical features (Filho *et al.*, 2021). This research aimed to assess the morphometric characteristics of four generations of Dorper sheep using multivariate analysis.

Materials and methods

Experimental site

The study was conducted from March to June 2025 at the Farmer's Agricultural and Training Center (P4S) Mitra Ternak Utama in Malang, East Java Province, Indonesia. During the research, temperatures fluctuated between 22°C and 32°C. The animals were provided with meals twice a day, consisting of concentrate and silage.

Data collection

The current research focused on analyzing 230 Indonesian Dorper sheep (IDS), which were divided into four separate generational categories (G0-G3). G0 refers to animals that are purebred with a full blood lineage, whereas G1, G2, and G3 indicate subsequent generations resulting from crossbreeding or backcrossing between exotic and indigenous sheep breeds. Data on body measurements were gathered based on specific phenotypic characteristics of the IDS. A digital scale was used to determine body weight, while a flexible measuring tape (tailor tape) was employed to measure various body dimensions (Iqbal *et al.*, 2014). Each animal was evaluated for a total of twenty (20) morphometric traits. The body measurements taken included body length (BL), withers height (WH), live body weight (BW), Chest depth (CD); Chest width (CW); Chest girth (CG); Rump height (RH); Rump width (RW).

Based on these measurements, twelve zoometric indices were derived. These morphometric indices serve to illustrate the relationships between various animal body parts, highlighting their usefulness in forecasting body functionality and adaptation in tropical climates. Furthermore, the body indices in this study were calculated following the methods of Birteeb *et al.* (2014), Boujenane *et al.* (2015), and Khargharia *et al.* (2015) as follows: Body capacity index (BCI) = CW2/WH, Height index (HI) = (WH/BL)x100, Length index 1 (LI1) = BL/WH, Body Index (BI)= (BLx100) x CW, Body Ratio (BR) = WH/RH, Thoracic development index (TDI) = CW/WH, Compact Index (CI) = BW/WH, Over Increase Index (OII) = (RH/WH) x 100, Height Slope (HS) = RH-WH, Body Weight Index (BWI) = (BW/WH) x 100%, Length Index (LI2) = BL/CD, and Foreleg Length (FL) = WH-CD.

ISSN: 2090-6277/2090-6269/

Statistical analysis

The morphometric traits were statistically analyzed to determine the mean, range, standard deviation and coefficient of variation. Testing the influence of generation on each variable using ANOVA and Duncan's multiple range test was applied with a 5% probability level. Statistical analysis of the morphometric traits was conducted using SAS Studio. Multivariate analysis was conducted to identify discriminant variables, canonical structure, and Mahalanobis distance. The variance components represent the discrimination from the individual canonical structure and Mahalanobis distance. The T value, ranging from 0 to 1, was calculated to assess the correlation level among variables in the discriminant function. When a variable shows a high correlation with one or more others, the T value becomes very small, potentially leading to unstable estimates of the discriminant function coefficients.

Results

The morphometric traits of Dorper sheep are presented in Table 1. A significant difference (P<0.05) among generations for most linear body measurements, including body length (BL), withers height (WH), body weight (BW), Chest depth (CD), Chest width (CW), Chest girth (CG), Rump height (RH) and rump width (RW) was presented in Table 2.

Table 1. Body shape measurement of Dorper Sheep.

Variable (cm)*	N	Range	Mean	SD
BL	230	45.00-87.00	62.97	8.95
WH	230	40.00-70.00	56.12	5.68
BW	230	22.50-100.00	49.41	16.97
CD	230	13.00-37.00	26.18	4.2
CW	230	9.00-31.00	16.28	3.4
CG	230	0.00-109.00	79.26	14.93
RH	230	19.00-73.00	57.34	6.29
RW	230	10.00-62.00	16.89	4.39

*BL: Body Length; WH: Withers height; BW: Live body Weight; CD: Chest depth; CW: Chest width; CG: Chest girth; RH: Rump height; RW: Rump width

Table 2. Morphometric traits of Dorper Sheep in Indonesia.

Variable*	Generation (Mean±SE)				P value
	G0	G1	G2	G3	
BL	67.95±0.73[a]	55.56±0.56[c]	59.67±1.20[b]	60.00±2.09[b]	<.0001
WH	54.70±0.57[b]	57.78±0.44[ab]	58.56±0.92[a]	56.10±1.11[ab]	0.00
BW	56.58±1.60[a]	37.84±1.14[c]	46.04b±2.18[c]	47.54±3.36[b]	<.0001
CD	27.75±0.36[a]	23.72±0.40[b]	25.37±0.74[b]	25.40±0.81[b]	<.0001
CW	15.87±0.34[ab]	16.68±0.26[ab]	17.74±0.61[a]	14.80±0.90[b]	0.02
CG	83.86±1.45[a]	70.69±1.23	78.81±1.89[a]	81.20±3.18[a]	<.0001
RH	55.74±0.58[b]	59.78±0.42[a]	58.41±1.74[ab]	58.00±0.83[ab]	0.00
RW	16.43±0.31[bc]	17.25±0.32[ab]	19.00±1.76[a]	14.40±0.69[c]	0.01

Superscript in same row are significantly different (P<0.05).
*BL: Body Length; WH: Withers height; BW: Live body Weight; CD: Chest depth; CW: Chest width; CG: Chest girth; RH: Rump height; RW: Rump width

Body indices also varied across four generations, such as height index (HI), length index (LI1), thoracic development (TDI), compact index (CI), body weight index (BWI), foreleg length (FL), showing statistically significant differences (P<0.05), as summarized in Table 3. However, certain indices such as body capacity index (BCI), body index (BI), body ratio (BR), over increase index (OII), and length index (LI2) remained statistically non-significant (P>0.05). Table 4 reveals notable correlations among different parameters. BL was found to have a strong positive correlation with RW (r = 0.87, p < 0.05) and CD (r = 0.74, p < 0.05). In contrast, BL had weak correlations with CW (r = 0.24, p > 0.05) and RH (r = 0.18, p > 0.05). WH showed moderate correlations with CW (r = 0.53, p < 0.05) and RW (r = 0.39, p < 0.05). BW had a strong correlation with CD (r = 0.83, p < 0.05) but a weak one with RW (r = 0.24, p > 0.05). The correlation between CD and CW was weak (r = 0.10, p > 0.05).

Table 3. Body indices of Dorper Sheep in Indonesia.

Variable*	Generation (Mean±SE)				P value
	G0	G1	G2	G3	
BCI	4.79±0.20	4.88±0.15	5.54±0.37	3.99±0.44	0.14
HI	80.86±0.68[d]	104.46±0.99[a]	99.38±2.82[b]	94.36±3.24[c]	<.0001
LI1	1.25±0.01[a]	0.96±0.01[c]	1.03±0.03[b]	1.07±0.04[b]	<.0001
BI	80.19±0.50	83.19±5.24	76.02±0.96	74.22±1.77	0.48
BR	0.98±0.00	0.96±0.00	1.06±0.09	0.97±0.01	0.07
TDI	1.53±0.02[a]	1.22±0.02[c]	1.36±0.04[bc]	1.45±0.06[ab]	<.0001
CI	1.01±0.02[a]	0.65±0.02[c]	0.79±0.04[b]	0.85±0.06[b]	<.0001
OII	102.07±0.51	103.58±0.51	100.15±2.87	103.52±1.08	0.16
HS	1.04±0.26	2.00±0.29	0.15±1.82	1.90±0.57	0.12
BWI	101.12±2.41[a]	86.19±1.77	79.27±4.18[b]	84.71±5.88[b]	<.0001
LI2	2.48±0.03	2.38±0.04	2.38±0.06	2.37±0.06	0.24
FL	26±0.46[c]	34.06±0.39[a]	33.19±1.17[ab]	30.70±1.23[b]	<.0001

Superscript in same row are significantly different (P<0.05)
*BCI: Body capacity index; HI: Height index; LI1: Length index 1; BI: Body Index; BR: Body Ratio; TDI: Thoracic development; CI: Compact Index; OII: Over Increase Index; HS: Height Slope; BWI: Body Weight Index; LI2: Length Index 2; FL: Foreleg Length

Table 4. Associations among the morphometric traits of Dorper sheep in Indonesia.

	BL	WH	BW	CD	CW	CG	RH	RW
BL	1	0.25*	0.87*	0.74*	0.24*	0.68*	0.18*	0.17*
WH		1	0.42*	0.34*	0.53*	0.40*	0.76*	0.39*
BW			1	0.83*	0.35*	0.81*	0.33*	0.24*
CD				1	0.10*	0.70*	0.25*	0.22*
CW					1	0.28*	0.46*	0.54*
CG						1	0.30*	0.20*
RH							1	0.02*
RW								1

Superscript in same row are different significantly (P<0.05)
BL: Body Length; WH: Withers height; BW: Live body Weight; CD: Chest depth; CW: Chest width; CG: Chest girth; RH: Rump height; RW: Rump width

The findings of the principal component analysis conducted on Dorper sheep in Indonesia are detailed in Table 5. The first three canonical variables (CAN 1, CAN 2, and CAN 3) collectively accounted for 85% of the total variance observed in body measurements. Notably, CAN 1 contributed the largest share of variance (51%), with body length (BL), live body weight (BW), chest depth (CD), and chest girth (CG) exhibiting the most significant positive correlation. The Mahalanobis distances between the populations are presented in Table 6. The greatest distance is observed between G0 and G1. Fig. 1 confirmed that G1 is placed at the most distant location, whereas G3 is positioned nearest to G0.

Discussion

The present study examined morphometric traits and morphometric index traits across four generations (G0 to G3) of IDS, identifying significant intergenerational variation in most observed parameters. The G0 generation exhibited the greatest body length (BL) and body weight (BW), measuring 67.95±0.73 cm and 56.58±1.60 kg, respectively. This was followed by a notable decline in G1, with partial recovery observed in G2 and G3. Variations in body weight, body length, and other mor

Table 5. Component matrix of Dorper sheep in Indonesia.

Variable	Component		
	CAN 1	CAN 2	CAN 3
BL	0.8	-0.44	0.07
WH	0.68	0.58	-0.24
BW	0.92	-0.31	0.01
CD	0.81	-0.41	-0.02
CW	0.55	0.63	0.27
CG	0.83	-0.27	-0.03
RH	0.55	0.53	-0.6
RW	0.42	0.4	0.75
Eigenvalue	4.05	1.7	1.06
Proportion	0.51	0.21	0.13
Cumulative	0.51	0.72	0.85

BL: Body Length; WH: Withers height; BW: Live body Weight; CD: Chest depth; CW: Chest width; CG: Chest girth; RH: Rump height; RW: Rump width

Table 6. The Mahalanobis distance in relation to the morphometric traits of Dorper Sheep across various generations.

Generations	G0	G1	G2	G3
G0	1			
G1	7.99	1		
G2	4.86	0.96	1	
G3	2.95	2.89	2.00	1

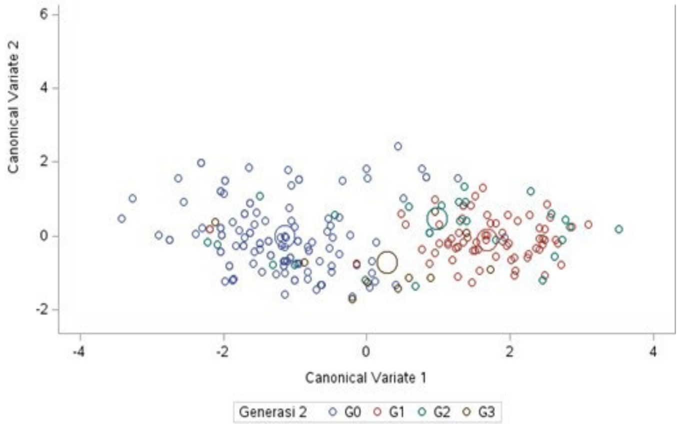

Fig. 1. A scattering diagram illustrating four generations is based on the canonical structure of morphometric traits.

phometric and morphometric index traits in sheep can be influenced by both genetic and environmental factors. Outcrossing, or the introduction of new genetic material into a population, can lead to genetic dilution. This might result in variations in these physical traits when new genetic combinations are formed. Such genetic mixing can initially lead to variability in body size and other characteristics due to the diverse genetic backgrounds being combined. A similar pattern was noted for chest depth (CD) and chest girth (CG), with G0 animals displaying greater depth (27.75±0.36 cm). An increase in chest girth was notably seen in G2 and G3, suggesting a possible compensatory mechanism or selective pressure that favors thoracic development. This growth is crucial for enhancing respiratory capacity and meat deposition, both advantageous traits in livestock production. Improved respiratory efficiency can facilitate better metabolic processes, while a larger thoracic size can result in more muscle mass, thereby enhancing meat quality. Nutritional strategies and environmental factors might indirectly affect traits like chest girth in livestock (Dakhlan *et al*., 2025). Research on small ruminants has similarly identified chest girth as an indicator of live weight and overall productivity (Adamu *et al*., 2020; Firdaus *et al*., 2025).

From generation G0 to G1, there was an increase in vertical skeletal traits such as withers height (WH) and rump height (RH), but a slight reduction was noted in G3. In contrast, chest width (CW) and rump width (RW) were significantly larger in G2, suggesting a sturdier skeletal build during this period. These larger chest and rump dimensions are considered advantageous for meat production, as they help predict the carcass compactness index (Maciel *et al*., 2015). The decrease observed in G3 might be due to inconsistent selection criteria or environmental factors affecting frame growth and uniformity. Ozgul *et al*. (2009) studied body weight dynamics in a wild population of Soay sheep by considering all factors contributing to change. Their research sheds light on why evolutionary responses to selection are not always evident, despite the heritability of body weight, and how environmental shifts have led to the observed reduction in body size among Soay sheep.

The examination of body indices provided additional insights. The height index (HI) showed a notable rise in G1 (104.46±0.99) compared to G0 (80.86±0.68), indicating that the animals were taller in relation to their length. These changes might suggest a modification in body shape, possibly due to selection for height or leg length. As noted by Liu *et al* (2020), sheep that have adapted to high altitudes, like the Tibetan sheep, are useful for studying adaptation and variations in body size. These sheep exhibit genetic differences associated with body size, implying that environmental adaptation plays a role in determining physical characteristics such as height and leg length.

The compact index (CI), which assesses body compactness, was at its peak in G0 (1.01±0.02) and showed a decline in the following generations, most notably in G1 (0.65±0.02), suggesting a shift towards a more elongated body structure. In meat-type sheep breeds such as Dorper sheep, a lower level of body compactness was unfavorable, as a sturdy and heavily muscled form was preferred. This preference for a strong and muscular physique is also apparent in Kilakarsal sheep (Ravimurugan *et al*., 2013).

Correlation analysis revealed significant associations among various morphometric traits in Dorper sheep. A strong positive correlation was observed between body length and wither height (r = 0.87), chest depth (r = 0.74), and chest girth (r = 0.68), indicating that sheep with longer bodies tend to be taller and possess larger chest dimensions (Atta *et al*., 2024). Furthermore, live body weight exhibited the strongest correlation with chest depth (r = 0.83), suggesting that chest depth may serve as a reliable indicator of overall body mass in Dorper sheep. As reported by Sabbioni *et al*. (2020), there is a correlation between the chest depth of Corniglìese sheep and their body weight (r = 0.852). As illustrated in Fig 1, a generational connection among Dorper Sheep was identified. The closest proximity between G0 and G3 exhibited the highest similarity in morphometric traits. Consistent with the current study, Getu *et al*. (2017) and Dai *et al*. (2024) reported that F3 demonstrates superior performance compared to the preceding generation, as the blood proportion stabilized at 87.5% or more of the dominant breed.

Conclusion

The study identified significant variations in morphometric traits and body indices across four generations of Indonesian Dorper sheep. Notably, generational differences in body measurements were observed, with the G0 generation exhibiting optimal meat production traits. Strong correlations were identified between various body measurements, with chest depth demonstrating the strongest correlation to live body weight. It is likely that both genetic and environmental factors contribute to these trait variations. While some traits exhibited changes, others remained consistent across generations. To maintain optimal body conformation and productivity in Cross Dorper sheep in Indonesia, consistent and focused breeding practices are necessary. Future research should aim to develop a program capable of determining the optimal generation among all cross-generations through a comprehensive analysis of morphometric traits, incorporating advanced statistical methods and genetic evaluation techniques to enhance the productivity of Indonesian Dorper sheep.

Acknowledgments

The authors express their sincere gratitude to the Laboratory of Genetics, Breeding and Reproduction, as well as the Balai Besar Pelatihan Peternakan Batu (Indonesian Center for Livestock Training Batu), for providing the facilities and support essential for this research. This study was funded by the Programme Postdoctoral by World Class University at Universitas Diponegoro, under grant number (215/UN7.A/HK/VII/2025).

Conflict of interest

The authors have no conflict of interest to declare.

References

Adamu, H., Ma'aruf, B.S., Shuaibu, A., Umar, H.A., Maigado, A.I., 2020. Morphometric characteristics of Red Sokoto and Sahel goats in Maigatari Local Government Area of Jigawa State. Niger. J. Anim. Prod. 47, 15–23.

Atta, M., Ali, A.B.S., Mohamed, M.B., Al-Dosari, H.M., Al-Shamari, H.S., 2024. Prediction of body weight using body measurements in some sheep and goats in Qatar. J. Appl. Anim. Res. 52, 2288917.

Birteeb, P.T., Peters, S.O., Ozoje, M.O., 2014. Analysis of the body structure of Djallonke sheep using a multideterminant approach. Anim. Genet. Resour. 54, 65–72.

Boujenane, I., El Aimani, J., By, K., 2015. Effects of clinical mastitis on reproductive and milk performance of Holstein cows in Morocco. Trop. Anim. Health Prod. 47, 207–211.

Dai, L., Chen, X., Huang, J., Xu, J., Xiao, M., Chen, J., Ruan, Y., 2024. Correlation of PGAM2 gene polymorphism with production performance in Boer × White goat hybrid. Pak. J. Zool. 56, 625.

Dakhlan, A., Santosa, P.E., Kurniawati, D., 2025. Int. J. Vet. Sci. 14, 876–881.

Erduran, H., Dag, B., 2022. Comparison of phenotypic and heterotic effects affecting milk yield, composition and udder morphometry of Hair and crossbred goats. Trop. Anim. Health Prod. 54, 59.

Filho da Silva, J.R.V., de Moura Neto, J.B., Arandas, J.K.G., Dos Santos, L.T.A., Queiroz, M.A.Á., de Nogueira Filho, P.A., Voltolini, T.V., de Mesquita, F.L.T., de Carvalho, F.F.G., Ribeiro, M.N., 2021. Does crossbreeding improve performance and carcass traits of Berganês sheep? Trop. Anim. Health Prod. 53, 451.

Firdaus, F., Atmoko, B.A., Adinata, Y., Panjaitan, T.S., Krishna, N.H., Widiyawati, R., Makmur, M., 2025. Meta-analysis of sheep body weight prediction for practical livestock management. Vet. Integr. Sci. 23, 1–10.

Getu, A., Guadu, T., Addisu, S., Assefa, A., Mogese, N., 2017. Gene segregations and body measurements in dairy cattle crossbreeding. Online J. Anim. Feed Res. 7, 86–90.

Hai, C., Bai, C., Yang, L., Wei, Z., Wang, H., Ma, H., Zhao, Y., Su, G., Li, G., 2023. Physiological and growth parameters of myostatin gene-edited crossbred cattle. Animals 13, 3216.

Iqbal, Z.M., Javed, K., Abdullah, M., Ahmad, N., Ali, A., Khalique, A., Aslam, N., Younas, U., 2014. Estimation of body weight from morphometric measurements in Kajli lambs. J. Anim. Plant Sci. 24, 700–703.

Khargharia, G., Kadirvel, G., Kumar, S., 2015. Principal component analysis of morphological traits of Assam hill sheep. J. Anim. Plant Sci. 25, 1251–1258.

Liu, J., Yang, B., Yuan, C., Xu, X., Sun, X., Yue, Y., Guo, T., Niu, C., Ding, X., Zhuoga, D., Lu, Z., Zhang, H., Wang, F., Renqing, D., Zeng, Y., 2020. High-altitude adaptation and distribution of Tibetan sheep. Sci. Rep. 10, 1–12.

Maciel, M.V., Carvalho, F.F.R., Batista, Â.M.V., Guim, A., Souza, E.J.O., Maciel, L.P.A.A., Neto, J.D.P., Junior, D.M.L., 2015. Carcass traits of sheep fed cassava. Chilean J. Agric. Res. 75, 307–312.

Oliveira, E.J., Savegnago, R.P., de Paula Freitas, A., de Freitas, L.A., de Paz, A.C.A.R., El Faro, L., Simili, F.F., Filho, A.E.V., Costa, R.L.D., de Paz, C.C.P., 2021. Genetic parameters of body weight and morphometric traits in Santa Ines sheep. Small Rumin. Res. 201, 106446.

Ozgul, A., Tuljapurkar, S., Benton, T.G., Pemberton, J.M., Clutton-Brock, T.H., Coulson, T., 2009. Dynamics of phenotypic change in shrinking St. Kilda sheep. Science 325, 464–467.

Pokhil, V., Pokhil, O., Mykolaichuk, L., Taran, D., 2024. Industrial crossbreeding for efficient sheep farming. Sci. Tech. Bull. Livest. Inst. NAAS.

Ravimurugan, T., Thiruvenkadan, A.K., Sudhakar, K., Panneerselvam, S., Elango, A., 2013. Estimation of body weight from measurements in Kilakarsal sheep. IJAS 3, 357–360.

Sabbioni, A., Beretti, V., Superchi, P., Ablondi, M., 2020. Body weight estimation from measurements in Cornigliese sheep. Ital. J. Anim. Sci. 19, 25–30.