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Research Article

Influence of Sex on Some Body Measurement Traits of South African Non-Descript Goat Kids at Birth

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Abstract | Body measurement traits have been used as a management tool to predict live body weight, feedstuff consumptions and carcass parameters in farm animals at lesser costs with a high relative accuracy and consistency. This research was performed at the University of Limpopo experimental farm (Syferkuil) to examine the effect of sex on the interrelationship between body weight and linear body measurements in South African non-descript goat kids. A total of 46 new-born South African non-descript goat kids (30 females and 16 males) were used for the study. Analysis of variance and Pearson's correlation were used for data analysis. Results showed that the mean live body weight of females and males was 2.11±0.05 and 2.76±0.12 respectively. Correlation analysis revealed that body weight (BW) was positively correlated with heart girth (HG) and rump height (RH) in males, while in females, BW was positively correlated with RH, body length (BL), withers height (WH) and shoulder height (SH). The findings of the study suggest that rump height can be used as an accurate indicator/good management tool for goat selection and breeding programs in improvement of BW. The findings of the current study might also help goat farmers to have a better understanding of monitoring the growth development, and further assist in selecting replacement males and females using morphological traits.

Keywords | Body weight, Heart girth, Rump weight, Sternum height, Withers height

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INTRODUCTION

Goat farming plays a vital role in the South African (SA) economy through job creation and is of cultural importance in many rural communities (Webb et al., 1999). The South African non-descript goat is an indigenous goat breed which is commonly found in many communal parts of SA (Tyasi and Putra, 2021). Body weights of goats at distinct phases of their life cycle are important parameters for judging performance adaptability to current environmental conditions (Rather et al., 2021). Verma et al. (2016) reported that body measurements of animals are essential for establishing breed standards. Moreover, these measurements provide useful evidence about the morphological structure of the animal, as well as its physiological position (Rather et al., 2021). Under traditional farming systems in most developing countries, animals are visually assessed, using a subjective method of judgement (Abanikannda et al., 2002; Yakubu et al., 2005). Body measurements are beneficial in animal improvement, are used for developing suitable selection criteria and for providing information about the developmental ability of the animals (Jafari and Hashemi, 2014). The body measurements are often used for prediction of live body weight of animals (Kumar et al., 2018; Rather et al., 2021). Norris et al. (2015) reported that prediction of body weight in small ruminants such as goats is a valuable tool for farmers to understand medicine dosages, adjust feed supply, monitor growth and select superior females and males for breeding purposes. Rather et al. (2021) showed that body weights and body measurements traits are highly positively correlated traits that could be used as selection criteria for the body weight. Tyasi et al. (2020) assessed the association between body weight and morphological traits of South African non-descript indigenous goats with the use of correlation and simple regression analyses. However, to the best of our knowledge, there is no literature documented on the effect of sex on birth weight and linear body measurement traits on new-born South African non-descript indigenous goat kids. Thus, the objective of this study was to evaluate the effect of sex on birth weight and biometric traits of South African non-descript indigenous goat kids. This study might assist indigenous goat farmers to identify sex effect on birth weight and morphological parameters.

MATERIALS AND METHODS

Study area

This research was performed at the University of Limpopo investigational farm (Syferkuil), Limpopo province, South Africa. The farm is located 10 km in the north-west of the University of Limpopo. The University lies at latitude 27.55 °S and longitude 24.77 °E. The temperature around the area is above 32 °C during summer and between 5 and 25 °C during the winter seasons. The mean annual rainfall ranges between 446.8 and 468.4 mm during the rainy season between November and March. The dry season occurs between April and October, and the rainy season occurs between November and March (Kutu and Asiwe, 2010).

Ethical approval

This research was carried out in accordance with the standard operation procedures of the Animal Research and Ethics Committee (AREC) at the University of Limpopo, South Africa.

Experimental animals and management

A total of 46 new-born South African non-descript goat kids (30 females and 16 males) were used as the experimental animals. Farm workers walked close to the kraal at least once hourly, looking for visual signs of kidding, and upon notice, moved does to the maternity pens. After kidding, farm workers performed a physical examination of the kids and does. All the kids were allowed to suckle colostrum before commencing with data collection. The kids were weighed and their linear body measurement traits recorded. The lactating does were fed lucerne hay and supplemented with lactating pellets in the morning and evening during the first month of lactation. Vitamins and minerals for nursing does were included in the lactation pellets. Lactating does were released to grazing camp during the day and allowed to feed on natural pastures and shrubs. The lactating goats had access to water *ad libitum* both in the maternity pen and grazing camp. The maternity pens had a shelter to protect both kids and goats during extreme weather conditions.

Data collection

Body weight (BW) was measured in kilogram (kg) using a weighing scale (Mavule, 2012). The linear body measurement traits were taken using a measuring tape calibrated in centimeters (cm). To maintain accuracy when taking measurements, the animal handler ensured that the animal stood still on a level ground to prevent anatomical distortions which can give false results (Okpeku et al., 2011). Linear body measurement traits were measured following the procedures described by Yakubu (2010). The body weight and all linear body measurements were taken once off by the same person in order to avoid individual variations in measurements.

Statistical analysis

The statistical Package for Social Sciences (IBM SPSS, 2019) version 26.0 was used for analysis. Pearson's correlation was used to determine the relationship between body measurement traits. Analysis of Variance (ANOVA) was used to examine the influence of sex on body measurement traits. The following formula was used for ANOVA.

$$Yij= \mu+Ai+eij$$

Where; Yij = j^{th} observation in the i^{th} body measurement traits (body weight and linear body measurement traits), μ = overall mean, Ai = effect of the i^{th} sex (i = male and female) and eij = residual error.

RESULTS AND DISCUSSION

Descriptive statistics of measured traits

Boxplot (Figure 1) depicts the summary distribution of BW of new-born South African female and male non-descript indigenous goat kids. The findings displayed that there was a remarkably difference at ($p < 0.001$) probability level across both new-born South African female and male non-descript indigenous goat kids. The male animals had

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higher BW than the females. Moreover, the boxplot shows the minimum, 25th per-centile (first quartile), median, 75th percentile (third quartile), and maximum values of BW for both sexes. In the boxplot, female BW showed minimum values of 2.0 kg, first quartile, and median of greater than 2.0 kg, whereas the third quartile had a maximum of less than 2.5 kg, respectively. Meanwhile, the boxplot of male BW displayed minimum values of 2.0 kg, first quartile greater than 2.0 kg, median greater than 2.5 kg, third quartile greater than 3.0 kg, and the maximum less than 4.0 kg. The boxplot summary suggests that the data regarding BW in new-born South African female and male non-descript indigenous goat kids was not well distributed, it had three outliers in South African female non-descript indigenous goat kids.

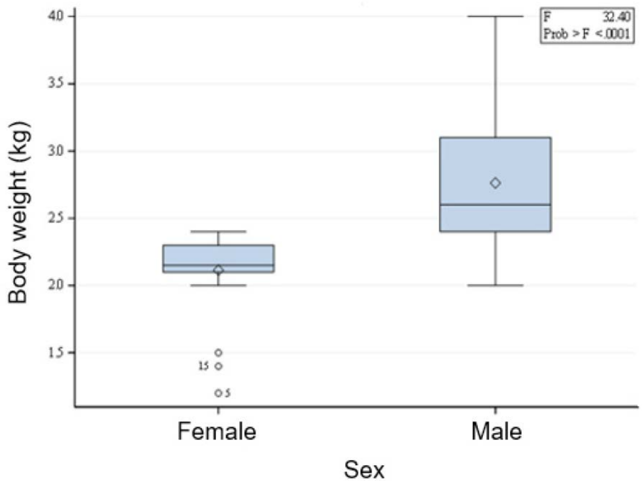

Figure 1: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of BW of South African female and male non-descript indigenous goat kids.

Boxplot (Figure 2) shows the summary distribution of hearth girth (HG) of new-born South African female and male non-descript indigenous goat kids. Findings showed that there was a remarkable difference at ($p < 0.001$) probability level across both the female and male non-descript indigenous goat kids. Females had higher HG compared with the males. Furthermore, the boxplot revealed the minimum, 25th per-centile (first quartile), median, 75th percentile (third quartile), and maximum values of HG for both sexes. In the boxplot, female HG showed minimum values of 30 cm, first quartile, and median of greater than 35 cm, whereas the third quartile had a maximum of greater than 50 cm, respectively. Meanwhile, boxplot of male HG revealed minimum values of 30 cm, first quartile greater than 30 cm, median less than 35 cm, third quartile greater than 35 cm, and the maximum less than 40 cm. The summary of boxplot suggests that the data concerning HG in new-born South African female and male non-descript indigenous goat kids was well distributed with no outliers.

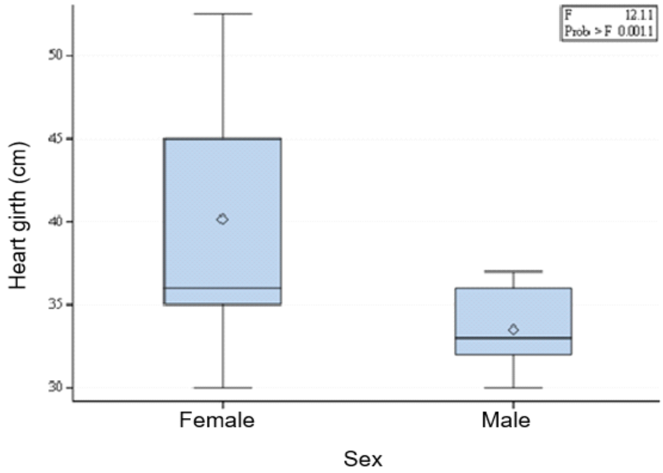

Figure 2: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of HG of South African female and male non-descript indigenous goat kids.

Boxplot (Figure 3) shows the summary distribution of rump height (RH) of new-born South African female and male non-descript indigenous goat kids. Results showed that there was a remarkable difference at ($p < 0.001$) probability level across both female and male non-descript indigenous goat kids. The male had a higher RH than the female. Furthermore, the boxplot showed the minimum, first quartile, median, third quartile, and maximum values of RH for both sexes. Female RH showed lowest values of less than 18 cm, first quartile, and median of greater than 20 cm, whereas the third quartile had a highest of greater than 24 cm, respectively. Meanwhile, the boxplot of male RH displayed first quartile values greater than 22 cm, median less than 24 cm, third quartile greater than 24 cm, and the maximum greater than 24 cm. The summary of boxplot suggests that the data concerning RH in new-born South African female and male non-descript indigenous goat kids was well distributed with no outliers.

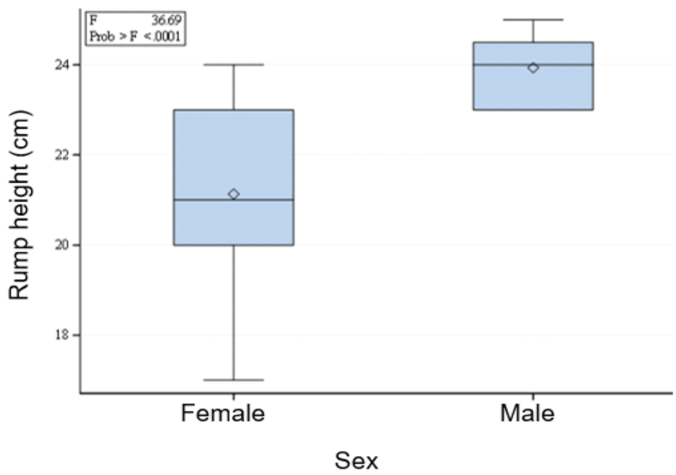

Figure 3: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of RH of South African female and male non-descript indigenous goat kids.

Boxplot (Figure 4) shows the summary distribution of body length (BL) of new-born South African female and male non-descript indigenous goat kids. Results indicate that there was a remarkable difference at ($p < 0.001$) probability level across both female and male non-descript indigenous goat kids. The male had a higher BL than the female. Moreover, the boxplot revealed the minimum, first quartile, median, third quartile, and maximum values of BL for both sexes. In the boxplot, female RH showed lowest values of less than 30 cm, first quartile, and median of greater than 30 cm, whereas the third quartile had a highest of greater than 32 cm, respectively. Meanwhile, the male boxplot of BL revealed minimum values greater than 30 cm, first quartile greater than 32 cm, median less than 34 cm, third quartile greater than 32 cm, and the maximum greater than 36 cm. The summary of boxplot suggests that the data regarding BL in new-born South African female and male non-descript indigenous goat kids was not well distributed, as it had three outliers in the female goat kids.

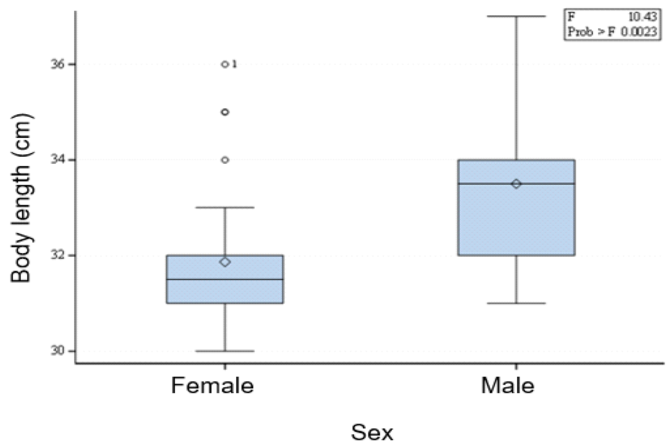

Figure 4: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of BL of South African female and male non-descript indigenous goat kids.

Boxplot (Figure 5) shows the summary distribution of withers height (WH) of new-born South African female and male non-descript indigenous goat kids. Results displayed that there was a remarkable difference at ($p < 0.001$) probability level across both female and male goat kids. Females were found to have higher WH than the males. Furthermore, the boxplot displayed the minimum, first quartile, median, third quartile, and maximum values of WH for both sexes. In the boxplot, female WH showed lowest values of less than 16 cm, first quartile, and median of greater than 20 cm, whereas the third quartile had a highest of less than 24 cm, respectively. Meanwhile, boxplot of male WH revealed first quartile values greater than 20 cm, median of 22 cm and third quartile greater than 22 cm. The summary of boxplot suggests that the data regarding WH in new-born South African female and male non-descript indigenous goat kids was well distributed without outliers.

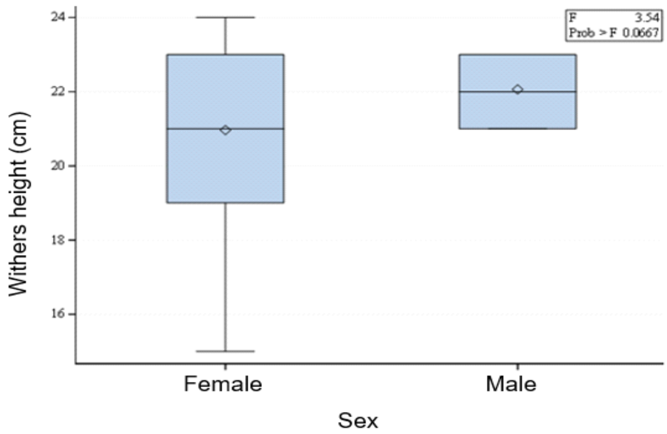

Figure 5: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of WH of South African female and male non-descript indigenous goat kids.

Boxplot (Figure 6) shows the summary distribution of sternum height (SH) of new-born South African female and male non-descript indigenous goat kids. Results indicate that there was a remarkable difference at ($p < 0.001$) probability level across both new-born female and male non-descript indigenous goat kids. Males were found to have higher SH when compared with the female. Furthermore, the boxplot showed the minimum, first quartile, median, third quartile, and maximum values of SH for both sexes. In the boxplot, female SH showed lowest values of less than 10 cm, first quartile, and median of greater than 11 cm, whereas the third quartile had a highest of greater than 13 cm, respectively. Meanwhile, the boxplot of male SH revealed the lowest values of less than 10 cm, first quartile greater than 11 cm, median less than 13 cm, third quartile greater than 12 cm, and the highest less than 14 cm. The summary of boxplot suggests that the data regarding SH in new-born South African female and male non-descript indigenous goat kids was well distributed without outliers.

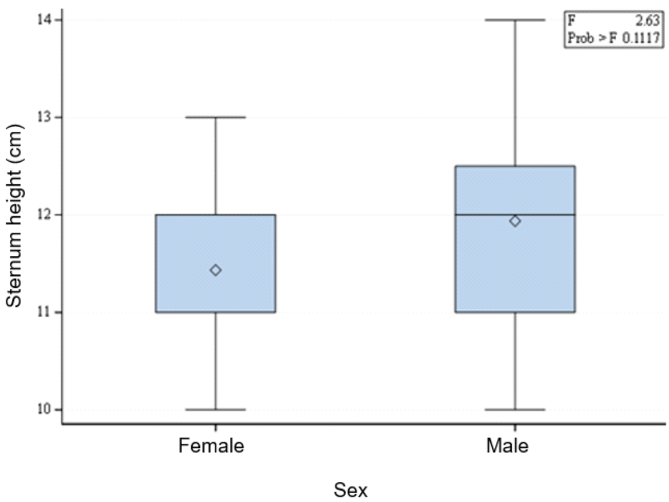

Figure 6: Boxplot depicting median, minimum, maximum, 25th, and 75th percentile values of SH of South African female and male non-descript indigenous goat kids.

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Descriptive statistics of the body weight (BW) and morphological traits of new-born South African non-descript indigenous goat kids are denoted in Table 1. The BW of average numerical values of new-born male goat kids (2.76 kg ± 0.12) was higher than those of new-born female goat kids. However, new-born female goat kids had higher mean numerical values in all traits (HG, RH, BL, WH and SH) than the new-born male goat kids. The coefficient of variation (CV) (%) was calculated by dividing the mean with the standard deviation. The findings displayed a range of 3.22%–18.02% in new born male goat kids, and 4.64–18.50% in new-born female goat kids.

Table 1: Descriptive statistics of measured traits.

	Male (n = 08)		Female (n = 30)	
Traits	**Mean ± SE**	**CV (%)**	**Mean ± SE**	**CV (%)**
BW	2.76±0.12	28.02	2.11±0.05	13.19
HG	33.50±0.56	6.72	40.15±1.36	18.50
RH	23.94±0.19	3.22	21.13±0.32	8.31
BL	33.50±0.47	5.66	31.87±0.27	4.64
WH	22.06±0.23	4.21	20.97±0.41	10.59
SH	11.94±0.28	9.41	11.43±0.17	8.18

BW: Body Weight; HG: Heart Girth; RH: Rump Height; BL: Body Length; WH: Withers Height; SH: Sternum Height; SE: Standard Error; CV: Coefficient of Variance.

Phenotypic associations between measured parameters

The Pearson correlation between birth weight and linear body measures trait for both male and female is shown in Table 2. The lowest and highest correlation was observed between heart girth and rump height in males, while in females the lowest and highest correlation was observed between birth weight and rump height. Heart girth was negatively correlated with birth weight ($r = -0.353$) in females, while in males, heart girth ($r = 0.124$) was positively correlated. For both sexes, rump height was positively correlated with birth weight (M: $r = 0.132$; F: $r = 0.376$) and heart girth (M: $r = 0.019$; F: $r = 0.042$). As shown in Table 2, body length had a positive correlation with birth weight ($r = 0.163$) in females. However, heart girth ($r = -0.282$) and rump height ($r = -0.019$) were negatively correlated with body length in females while in males, body length was negatively correlated with birth weight ($r= -0.021$), heart girth ($r= -0.015$) and rump height ($r= -0.432$). Withers' height was positively correlated with birth weight in females. It was also observed that in both sexes, withers height was positively correlated with rump height (M: $r = 0.037$; F: $r= 0.531$).

Table 2: Phenotypic association between parameters male above diagonal and female below diagonal measures parameters.

Traits	BW	HG	RH	BL	WH	SH
BW		0.124	0.132	-0.021	-0.109	-0.481
HG	-0.353		0.019	-0.015	-0.462	-0.092
RH	0.376	0.042		-0.432	0.037	-0.004
BL	0.163	-0.282	-0.019		-0.132	-0.140
WH	0.045	-0.178	0.531	-0.106		-0.059
SH	0.109	-0.290	0.152	-0.056	0.389	

BW: Body weight, HG: Heart girth, RH: Rump height, BL: Body length, WH: Withers height, SH: Sternum height.

Effect of sex on body weight and morphological parameters

It was observed from Table 3 that the means of birth weight for South African non-descript indigenous goat kids for females and male sex were 2.11±0.05 and 2.76±0.12 respectively. There were non-significant differences ($p > 0.05$) in WH and SH traits for both males and females. However, significant differences ($p < 0.05$) existed in BW, HG, RH and BL in both sexes.

The descriptive statistics of BW and morphological traits for male and female revealed a significant difference in all measured parameters, except WH and SH. Male South African non-descript indigenous goat kids displayed a higher BW than female goat kids. Our results are in line with the findings of Yakubu (2010) and Rather et al. (2021) in White Fulani cows and Kashmir Merino sheep, respectively. Gebreyowhens and Kumar (2017) reported similar findings from research in indigenous Maefur goats where males were found to be heavier than females (42.8±6.6 kg versus 37.2±4.1kg). Because body weight is an economically significant feature, differences in body weight between males and females could be essential for

Table 3: Effect of sex on birth weight and morphological parameters of South African non-descript indigenous goat kids.

	Measured traits					
Sex	**BW**	**HG**	**RH**	**BL**	**WH**	**SH**
Female	2.11^b±0.05	40.15^a±1.36	21.13^b±0.32	31.87^b±0.27	20.97^a±0.41	11.43^a±0.17
Male	2.76^a±0.12	33.50^b±0.56	23.94^a±0.19	33.50^a±0.47	22.06^a±0.23	11.94^a±0.28
P-values	<0.0001	0.0001	<0.0001	0.0023	0.0667	0.1117

Means in the same row with different superscripts are significantly different. Data expressed as mean ± Standard error of means. BW: Body weight, HG: Heart girth, RH: Rump height, BL: Body length, WH: Withers height, SH: Sternum height.

genetic improvement. According to Moela (2014), phenotypic variation may not be directly translated into genetic variance due to environmental influences in different study locations. The female South African non-descript indigenous goat kids showed high mean numerical values as compared to the males in all the measured morphological traits. This trend revealed the manifestation of sexual differentiations amongst South African non-descript indigenous goat kids. These observations are similar to those made by Ogah et al. (2009), whose reports showed that female West African Dwarf goats had higher mean numeric values in comparison with the male except for rump height. However, Okpeku et al. (2011) made contrary observations. Their findings indicated that male indigenous Southern Nigerian goats had higher mean numerical values in all linear body measurements taken. Furthermore, the results also revealed that a non-significant difference existed between both sexes in WH and SH traits. The objective of this research remained to assess the effect of gender on birth weight and morphological traits of male and female South African non-descript indigenous goat kids. In males, birth weight was positively connected with all body measurement traits except HG, but it was negatively correlated with HG in females. Interestingly, our results showed that the RH in both genders was positively correlated with birth weight. It was obvious that an increase in the RH of both sexes resulted in a concomitant increase in their birth weight. These findings are similar to the reports in goat breeds by Norris et al. (2015) and by Thiruvenkanden (2005) in Kanni Adu goat kids in South India. Gul et al. (2019) also made similar observations in Awassi lambs.

The phenotypic correlation coefficients between the sexes could indicate that the goats' genetic architecture differs due to sexual differences. The positive relationships discovered in this study suggest that body weight may be determined using body measures, which is particularly beneficial in communities where scales are scarce. The relationship could be utilized as a selection criterion if it is established that the correlations are genetically regulated, suggesting that they are controlled by the same gene.

CONCLUSIONS AND RECOMMENDATIONS

Pearson correlation findings suggest that rump height can be used as a complementary marker to improve the birth weight of South African non-descript indigenous goat kids. The implication is that rump height could be useful for goat selection and breeding programs in improvement of body weight. Additionally, more studies need to be done to determine the influence of sex on morphological traits of South African non-descript goat kids at birth with the aim of improving body weight in more goat breeds or larger sample size.

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NOVELTY STATEMENT

Based to our knowledge, this is the first report on the effect of sex at birth on body measurements of South African non-descript goats.

AUTHOR'S CONTRIBUTION

Thobela Louis Tyasi designed the study, analysed the data and approved the final manuscript. Lubabalo Bila, Mthi Siza and Nkgaugelo Kgasago wrote the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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