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Research Article

Evaluation of the Relationship between Body Weight and Linear Measurements in West African Dwarf Goat as Influenced by Sex and Agro-vegetational Zone

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Abstract

Background: In the present study, body weight and body linear measurements of West African Dwarf (WAD) goats were evaluated as influenced by gender and agro-vegetational zone. **Materials and Methods:** Two hundred animals comprising 100 goats each of both sexes were randomly selected and measured in two different zones where they were reared extensively and kept as security against crop failure and for animal proteins supply. **Results:** Results revealed significant phenotypic correlations between body weight and morphometric traits and this cut across the sexes and zones. The studies also revealed high positive correlations between and among morphometric traits regardless of sex and the zone where the animals are found. Of all body linear measurements, heart girth was closely related to body weight, that is recorded highest correlation coefficient value with body weight, while height at withers has the least relationship, that is lowest correlations with body weight. The study also indicated sexual dimorphism as regards relationship between body weight and linear measurements. In addition, it was discovered that relationship between body weight and morphometric traits in WAD goats differed from one zone to another. **Conclusion:** Therefore, it is suggested that measurements on animals to be used for breeding or commercial purposes should be sex and zone restricted. Measurements obtained in one locality should not be applied to other zones.

Key words: West African Dward goats, phenotypic correlations, heart girth, height at withers

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Goats are multi-functional animals and play a significant role in the economy and nutrition of landless, small and marginal farmers[1]. In Nigeria goat rearing is practiced by a large section of people living in rural and semi-urban areas. Goats can survive with or without industrial by-products and be profitably reared on less nutritious forages such as shrubs and trees in a land where most minerals and plant nutrients have been depleted due to continuous cropping. They contribute to livestock industry in terms of meat, milk, wool and skin[2]. Khan *et al.*[1] posited that when compared to other domestic animals, goats are the victims of prejudice and neglect because less attention was paid to their housing and feeding by their owners. Nevertheless, they are still performing an important role of supplying human race with meat, milk, wool, leather and other animal products.

According to De Villiers *et al.*[3], income derived from goat rearing is a major contributor to the livelihoods of rural populace. And for profitable rearing, the animals have to be properly managed and efficiently assessed when taken to market. Due to the inability of these poor rural farmers to have weighing scales of their own, they resort to visual estimation to determine market price of their animals which may not be good enough to earn them commensurate income for their efforts and sweat. Reliance on visual estimation also affects other management practices such as feeding, breeding time, medication and vaccination dosages. However, the danger of using visual estimation lies with applying the same method for more than one breed of a particular species[2]. Otoikhian *et al.*[4] documented that body structure employed in rural markets to estimate body weights of animals is very deceptive and subjective too. The net result of reliance on estimated live weights according to Matsebula *et al.*[2] is inefficiencies in goat production and inconsistencies in market pricing resulting to reduced profit and loss of revenue to farmers.

Since farmers have no access to weighing scales, the use of weight band to estimate the weight of their animals becomes imperative. A weight band is a measuring tape whose graduation has a correlation between live weight (kg) and linear measurement (cm). This weight band has been successfully used in dairy cows[5], beef cattle[6,7], pigs[8,9], sheep[10] and goats[3,11]. The weight band is a simple tool, less stressful, practical and can easily be understood by farmers with little education and minimum supervision.

Linear measurements such as body length, heart girth, height at withers and rump height are measured to assess the relationship between these parameters and live weight. It can also be used to assess growth rate, feed utilization and carcass characteristics in farm animals[12]. Birteeb and Ozoje[10] asserted that optimum production and value-based trading systems will be achieved when producers and buyers of livestock are able to relate animal measurements to growth characteristics. This will ensure that farmers are well compensated for their sweat and get value for their stock rather than the middlemen and livestock processors making a lot of profit more than the impoverished rural farmers.

Although, there are many published studies on linear body measurements as predictors of live weight in goats, none dealt with the influence of gender and rearing location under Nigerian climatic conditions. It will be misleading therefore, to apply prediction formulae derived for a different breed or strain of goats under different conditions for West African Dwarf (WAD) goat which are found in Nigeria and some regions in West Africa. It is common knowledge that growth, final body weight and body conformation vary between goat breeds. Based on these assumptions, this study was designed to investigate the relationship between body weight and linear measurements of WAD goats reared in different agro-vegetation zones. The study also aimed at assessing the effect of sex on the relationship between all the growth traits under investigation. The study eventually accomplished the above-stated objectives.

MATERIALS AND METHODS

This study was carried out in two agro-vegetational zones of Southwestern region of Nigeria. These are Ekiti and Osun states which have different rainfall pattern and land resources. A total number of 200 West African Dwarf goats comprising 100 animals each of both sexes were captured in the evaluation of morphometric traits. The animals are reared extensively in free range and subsist on available uncultivated grasses and browse plants, cassava peels, yam peels and other domestic waste. Medical attention is provided only when the need arises and are exposed to cold weather and other hazards in the night.

Traits measured: Body weight and linear body characteristics evaluated included body length, heart girth, height at withers and rump height. Each of the animals selected for measurement was restrained and gently handled to prevent injury to both the animals and handlers. Calibrated hanging scale was used to measure body weight, while other linear measurements were done with the aid of a measuring tape. Pregnant does and sick ones were excluded from this study.

Body length: This is the distance from occipital protuberance to the base of the tail.

Height at withers: This is the distance from the surface of a platform to the withers.

Heart girth: This is circumferential measure taken around the chest.

Rump height: This is the distance from the surface of a platform to the rump.

Data analysis: Data collected on body weight, body length, heart girth (upper abdominal-shoulder part), height at withers and rump height were analyzed with Pearson correlation analysis of SAS[13].

The appropriate statistical model is:

$$Y_{ijk} = \mu + S_j + R_i + \varepsilon_{ijk}$$

Where:

Y_{ijk} = Observation of kth population, j^{th} sex and i^{th} region
μ = Common mean
S_j = Fixed effect of sex (j = 2)
R_i = Fixed effect of region (i = 2)
ε_{ijk} = Error term

RESULTS

Table 1 represented the descriptive statistics for the body weight and linear measurements evaluated on the WAD goats as influenced by sex and agro-vegetational zones.

The results in Table 2 showed the correlation coefficients between body weight and morphometric traits in WAD male goats as affected by agro-vegetational zone. There was a significant (p<0.01) high positive correlation coefficient between body weight and body length in the two zones, with males in Ekiti zone recording higher values than those measured in Osun zone. Between body weight and height at withers and rump height, WAD males from Osun zone recorded higher positive values than those measured in Ekiti zone. However, pertaining to relationship between body weight and heart girth, WAD males from Ekiti zone had higher positive correlation coefficient than those from Osun zone.

In Table 3, high and positive significant (p<0.01) phenotypic correlations were reported for WAD female goats in both Ekiti and Osun zones. Similar to what was reported for WAD male goats, high correlations were recorded between body weight and morphometric traits. However,

Table 1: Descriptive statistics showing Means±SD of body weight and linear measurements of West African Dwarf goat in Ekiti and Osun states

Sex	Traits	No.	Minimum	Maximum	Mean	SD
Male	BWT	50	5.0 (5.0)	22.0 (23.0)	12.3 (13.6)	3.8 (4.1)
	BDL	50	59.0 (64.4)	85.0 (96.6)	76.3 (79.4)	5.7 (7.9)
	HTW	50	31.0 (36.2)	50.60 (61.5)	41.6 (42.3)	3.8 (4.4)
	HTG	50	38.5 (0.2)	59.0 (62.5)	49.3 (48.6)	4.2 (8.7)
	RPH	50	29.6 (35.5)	49.1 (52.0)	40.3 (41.1)	3.8 (3.8)
Female	BWT	50	10.0 (8.0)	43.8 (43.8)	26.7 (24.2)	6.8 (8.9)
	BDL	50	36.8 (69.5)	107.4 (111.6)	88.4 (89.0)	12.4 (10.8)
	HTW	50	36.0 (32.7)	66.5 (57.2)	51.1 (47.1)	6.2 (6.1)
	HTG	50	45.5 (42.5)	72.5 (87.5)	61.8 (60.0)	6.5 (10.2)
	RPH	50	35.0 (31.5)	64.3 (55.5)	49.5 (46.1)	6.1 (6.1)

Values in parenthesis represent Osun state, BWT: Body weight, BDL: Body length, HTW: Height at withers, HTG: Heart girth, RPH: Rump height

Table 2: Phenotypic correlations between body weight and linear measurements in male WAD goats as affected by agro-vegetational zone

Traits	BWT	BDL	HTW	HTG	RPH
BWT	1.00	0.7169***	0.3096*	0.7586***	0.3047*
BDL	0.5662***	1.00	0.5156***	0.7210***	0.5046***
HTW	0.4353**	0.7129***	1.00	0.4482**	0.9872***
HTG	0.3808*	0.4359**	0.3077*	1.00	0.4508***
RPH	0.4519***	0.6753***	0.7707***	0.4391**	1.00

*p<0.05, **p<0.01, ***p<0.001, above diagonal represent values for Ekiti state, below diagonal represent values for Osun state, BWT: Body weight, BDL: Body length, HTW: Height at withers, HTG: Heart girth, RPH: Rump height

Table 3: Phenotypic correlations between body weight and linear measurements in female WAD goats as affected by agro-vegetational zone

Traits	BWT	BDL	HTW	HTG	RPH
BWT	1.00	0.4754***	0.4747***	0.7619***	0.4882***
BDL	0.8025***	1.00	0.5002***	0.5144***	0.5131***
HTW	0.8397***	0.8603***	1.00	0.6316***	0.9588***
HTG	0.8980***	0.8296***	0.8482	1.00	0.6199***
RPH	0.8447***	0.8692***	0.9861***	0.8608***	1.00

***p<0.001, above diagonal represent values for Ekiti state, below diagonal represent values for Osun state, BWT: Body weight, BDL: Body length, HTW: Height at withers, HTG: Heart girth, RPH: Rump height

values between body weight and heart girth appeared to be the highest when compared to other linear traits.

DISCUSSION

Body weight measurement is essential for any breeding and selection programme, feeding, vaccination and drug dosage in livestock industry. Bello and Adama[14] asserted that the presence of muscle and bone around the heart region was responsible for the relatively higher and positive relationship between body weight and heart girth when compared to other linear traits. Cam *et al.*[15] and Lavvaf *et al.*[16] reported comparable findings in Turkish hair goats and Afshari and Zandi rams, respectively. The researchers found high phenotypic correlations between body weight and chest girth in the afore-mentioned animals.

The obtained results suggested that any one among morphometric traits or their combinations could be used to predict live weight in WAD male goats, though variations existed in values obtained in the two zones. In addition, higher positive correlations were recorded between and among all morphometric traits in WAD male goats reared in the two zones. Of particular interest was the very high values recorded between rump height and height at withers. This implies that the two traits are linked and controlled by a gene and an improvement in one will result to corresponding increase in value of the other.

The results obtained in different zones for body weight and morphometric traits showed that there are differences in body conformation of these animals being reared in different zones though they belong to the same breeding group. Therefore, it is suggested that for any successful breeding programme, data obtained on body weight and linear measurements be analyzed and applied for the animals in that particular zone and not using values obtained from a zone different from where the breeding project is being carried out.

In agreement with this study are the observations of De Villiers *et al.*[3] and Yakubu *et al.*[11] who reported that heart girth was a better predictor of live weight. Also, variations in correlations existed for each trait between the two zones with WAD females reared in Osun zone having higher correlations between body weight and linear traits than those from Ekiti zone. It also confirm earlier assertion that correlation values obtained between body weight and morphometric traits in a particular region cannot be applied for animals in another region since they differ in body conformation due probably to differences in genetic make-up, health status, feeds and feeding and management practices. Musa *et al.*[17] reported similar results. The researchers observed high correlations between body weight and linear traits in Sudanese Kenana cattle. The high correlations obtained between body weight and morphometric traits in this study suggest that anyone of them or combination will provide a good estimate for predicting body weight in WAD female goats, though differences exist in values from one zone to another.

It was equally seen from analyzed data that high and positive correlations existed between and among linear traits in the two zones covered. The highest correlations were reported between height at withers and rump height and this means that once the value of one is given the value of the other could be predicted. The obtained results showed a very strong relationship between the various traits that are connected with animal growth. According to El-Labban[18], positive correlation among traits could be as a result of pleiotrophic effects of genes and linkage effects which operate on these traits. Therefore, any attempt to perform phenotypic selection for one trait will consequently result in improvement of the other.

CONCLUSION

The findings of this study revealed that heart girth was the best predictor of body weight regardless of sex and zone where the animals are reared. And the least predictor was height at withers. Among the linear traits, rump height and height at withers had strong relationship than with other traits. In addition, the study established positive influence of gender and zone on body weight and morphometric traits.

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