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DETERMINATION OF APPROPRIATE MODEL FOR THE ESTIMATION OF BODY WEIGHT IN GOATS

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ABSTRACT

A total of 194 kids' monthly body weight and body measurements (heart girth, height at wither and body length) records were analysed at the University of Maiduguri to determine the appropriate model for estimating body weight at both preweaning and postweaning ages. The average weights at birth were 1.8kg and 1.67kg for males and females, respectively. The corresponding values for heart girth (HGT), height at wither (HWT) and body length (BLT) was 25.14 and 30.26cm, 28.03cm and 27.28cm and 31.76 and 30.96cm, respectively. Heart girth, BLT and HWT at this age were 47.46 and 46.34cm, 66.99 and 65.51cm and 51.07 and 49.27cm, respectively for both sexes. The correlation coefficients between body weight and body measurements at all ages were high. Body weight predictions based on the coefficient of determination (R^2) of the regression equations varied among body measurements, sexes and ages. Heart girth had the highest followed by BLT and lastly, HWT. However, a combination of HGT with any of the other measurements (BLT and HWT) or both gave a better prediction than HGT alone. In addition, prediction of body weight using body measurement was better among the males while the efficiency improved with age. It could be concluded that HGT can be used to predict body weight in kids, though its combination with body length or height at wither would give a better prediction at postweaning.

Keywords: model, goats, bodyweight, regression.

INTRODUCTION

In Nigeria, goat production occupies an important place in the economy; with approximately 0.5 goat per head of the human populace [1] and, most of them are found in the more arid zone of Northern Nigeria [2]. They are veritable engines of meat and milk bearing an average of 1.5 kids per parturition and at least, 2.08 kids per year [1].

Assessing the performance of goats with the use of body weight is important for a number of reasons related to breeding (selection), feeding and health care [3]. However, body weights are not often available to those working with goats in the small scale farming sector due to the non-availability of scales. This has forced many farmers to rely on estimates of body weights using certain number of body characteristics which can be measured readily. Among these, body measurements have been used to predict body weight in cattle, horse and sheep [4, 5, 6, 7 and 8]. In goats, similar contributions have been made by [9, 10 and 11]. However, though several attempts [12, 13] have been made to identify heart girth as the most reliable measurements in goats, few [14, 15] are available on how to improve its efficiency. This paper therefore is aimed at establishing heart girth as a predictor of body weight and finding ways of improving its efficiency in multiple regressions with other body measurements.

MATERIALS AND METHODS

A total of 194 individual records of goats (male, 98; female 96) collected over a period of 3 1/2 years at the University of Maiduguri Teaching and Research Farm were used for the study. Maiduguri is located within the Sahelian region of West Africa on a longitude 11.38° North and latitude 32.77 ° East of the equator; 354m above sea level. Annual rainfall is estimated at 645mm with relative humidity ranging from 45% in wet season to 5-10% in dry season while the annual temperature range from 23°C to 40°C.

The animals were on semi intensive system; gazing on mixture of grasses (*Cyperus dactylon* and *Boerhara* diffusa) and browse plants (Balanite egyptica and Zizipus macronata).

The grazing was supplemented with a mixture of cowpea husk and wheat offal (10:1). Adequate veterinarian and sanitary measures were strictly practiced. Animals were weaned at 4 months of age.

The parameters traits studied were preweaning and postweaning weights and linear measurements. Body weights were taken with hanging balance. Heart girth (HGT, circumference round the chest) and Body length (BLT, from the head to the tail drop) were taken with a measuring tape while, height at withers (HWT, from the wither to the floor surface) was taken with graduated wooden tape.

The data was grouped on the basis of sex and age. Within each group, weight was regressed on body measurements using general linear model and regression analysis of [16]. Comparison of regression equations was based on coefficient of determination (R^2) of [17].

RESULTS AND DISCUSSIONS

The average values of body measurements (HGT, HWT and BLT) according to age and sex are shown in Table-1. All the traits increased with age and males had significantly higher values than the females. Body weights recorded are similar to those of [9] and [18], though; they are inferior to those of heavy breeds [19; 20]. Similar

values for the various body measurements were also reported by [21] and [22].

Table-1. Mean values of body measurements (cm) and body weight (kg).

Age	Sex	BLT	HGT	HWT	BWT
Pre-weaning birth	Male	31.76[a]	25.14[a]	28.03[a]	1.66[a]
	Female	30.96[a]	24.26[b]	27.28[b]	1.67[b]
	Pooled	31.36	24.70	27.65	1.77
1 month	Male	45.02[a]	31.90[a]	33.88[a]	4.13[a]
	Female	43.01[b]	30.41[b]	32.61[b]	3.56[b]
	Pooled	44.02	31.15	33.74	3.85
2 months	Male	50.31[a]	36.16[a]	36.16[a]	5.67[a]
	Female	48.29[b]	34.23[b]	36.23[b]	4.84[b]
	Pooled	49.30	35.25	36.23	5.26
3 months	Male	54.82[a]	39.59[a]	41.56[a]	7.34[a]
	Female	52.93[b]	37.27[b]	38.89[b]	6.08[b]
	Pooled	53.87	38.53	40.22	6.71
4 months	Male	57.99[a]	41.23[a]	43.67[a]	8.41[a]
	Female	55.28[b]	38.67[b]	40.90[b]	7.04[b]
	Pooled	56.68	39.95	42.29	7.73
Post-weaning 5 months	Male	59.39[a]	42.87[a]	45.73[a]	9.69[a]
	Female	57.12[b]	40.57[b]	43.15[b]	8.20[b]
	Pooled	58.37	41.72	44.44	8.95
6 months	Male	62.08[a]	44.31[a]	46.93[a]	9.88[a]
	Female	59.56[b]	42.37[b]	44.18[b]	8.40[b]
	Pooled	60.81	43.34	45.55	9.14
7 months	Male	65.21[a]	46.49[a]	49.58[a]	11.08[a]
	Female	62.89[b]	44.01[b]	47.04[b]	9.44[b]
	Pooled	64.05	45.25	48.31	10.26
8 months	Male	65.99[a]	47.86[a]	50.32[a]	11.65[a]
	Female	63.96[b]	45.92[b]	48.55[b]	10.29[b]
	Pooled	64.98	46.89	49.43	10.97
9 months	Male	66.99[a]	47.46[a]	51.07[a]	12.64[a]
	Female	65.51[a]	46.34[b]	49.27[b]	11.28[b]
	Pooled	66.25	47.40	50.17	11.96

BLT= Body length, HGT= Heart girth, HWT= Height at withers, BWT= Body weight. a,b= means of the same body measurement carrying different superscripts within the same age are not significantly different.

Correlation coefficient

The correlation coefficients between body weight and body measurements for males and females at various ages are shown in Table-2. They are comparable to reports of [23], [24] and [25]. High correlation coefficients obtained between body weight and body measurements at all ages and in both sexes suggest that any of the body measurements can provide a good estimate of body weight irrespective of age or sex. However, among the three body measurements, heart girth, generally had the highest correlation in males (92.2%) and females (93.9%) except at 5 and 6 months of age where body length had the highest (90.1 and 89.2 %, respectively) in females. Low

correlations observed for HWT in relation to the other body measurements contradict the reports of [26].
Among sexes, it appears higher correlations were observed for males than females. This disagrees with the reports of [27].
This result, which is supported by other researchers [29, 30] may be due to the fact that the HTW is a function of growth of bones which is not proportional to increase in general body weight [3]. The coefficient of determination was also, comparatively, higher at postweaning than at the preweaning, an observation similar to findings of [23] but contrary to that of [3]. Finally, it was observed that combination of HGT with BLT/HWT or BLT and HWT increased the coefficient of determination. Estimation of body weight can therefore be more accurate when heart girth is combined with one or two measurements [31, 32].

Table-2. Phenotypic correlations between body weight and body measurements (BM) at different ages.

Pre-weaning				Post-weaning		
BM	**Age**	**Male**	**Female**	**Age**	**Male**	**Female**
HG	Birth	90.4	80.2	5 months	90.6	87.6
HWT		82.5	70.9		85.1	86.2
BLT		80.6	81.1		85.8	90.1
HG	1 month	91.6	87.9	6 months	90.7	87.8
HWT		78.7	61.0		87.0	87.8
BLT		87.9	85.2		90.1	89.2
HG	2 months	88.7	93.9	7 months	94.0	93.0
HWT		85.9	76.8		82.5	70.4
BLT		80.2	92.1		86.6	84.7
HG	3 months	89.8	93.6	8 months	92.0	92.7
HWT		78.4	82.3		86.2	80.5
BLT		77.5	91.2		85.3	81.1
HG	4 months	91.1	91.9	9 months	90.5	85.4
HWT		84.5	87.3		84.4	70.7
BLT		86.0	87.7		82.4	75.5

BLT= Body length, HGT= Heart girth, HWT= Height at withers.

CONCLUSIONS

The results of this study identifies heart girth as the best measurement for predicting live weight, though its efficiency is more among the males and at the post weaning stages. Additionally, its combination with body length / height at withers or both gives a better estimate.

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Table-3. Regression equations of pre-weaning body weight with body measurements of goats.

Age	BM	Regression Equation	R^2 (%)	Regression Equation	R^2 (%)
Birth	HGT	-0.88+0.11HGT	81.60	-0.88+0.11HGT	81.60
	HWT	-0.55+0.09HWT	68.10	-0.55+0.09HWT	68.10
	BLT	-0.58+0.08BLT	64.90	-0.58+0.08BLT	64.90
	HGT+HWT	-0.90+0.10HGT+0.01HWT	81.70	-0.90+0.10HGT+0.01HWT	81.70
	HGT+BLT	-0.89+0.11HGT+0.03BLT	81.60	-0.89+0.11HGT+0.03BLT	81.60
	HWT+BLT	-0.66+0.06HWT+0.03BLT	69.60	-0.66+0.06HWT+0.03BLT	69.60
	HWT+BLT+HGT	-0.89+0.01HWT-0.01BLT+0.10HGT	81.81	-0.89+0.01HWT0.01BLT+0.10HGT	81.81
1 Mth	HGT	-3.19+0.22HGT	83.80	-4.14+0.11HGT	76.70
	HWT	-1.68+0.17HWT	61.90	-1.34+0.15HWT	37.20
	BLT	-3.00+0.16BLT	77.30	-3.63+0.16BLT	72.50
	HGT+HWT	-3.21+0.22HGT+0.01HWT	83.80	-3.99+0.26HGT-0.02HWT	77.20
	HGT+BLT	-3.42+0.16HGT+0.05BLT	85.20	-4.26+0.17HGT+0.20BLT	78.20
	HWT+BLT	-3.03+0.02HWT+0.14BLT	74.60	-0.36-0.05HWT+0.20BLT	74.40
	HWT+BLT+HGT	-3.42+0.17HWT-0.06BLT-0.02HGT	85.40	-3.98+0.17HWT+0.09BLT+0.06HGT	80.20
2Mths	HGT	-4.87+0.26HGT	78.80	-5.99+0.31HGT	88.20
	HWT	-4.51+0.27HWT	73.70	-2.01+0.19HWT	59.00
	BLT	-3.96+0.19BLT	64.40	-5.51+0.21BLT	84.80
	HGT+HWT	-5.09+0.21HGT+0.08HWT	79.70	-5.98+0.30HGT+0.01HWT	88.30
	HGT+BLT	-4.84+0.29HGT+0.05BLT	78.80	-6.01+0.24HGT+0.05BLT	88.50
	HWT+BLT	-4.71+0.02HWT+0.03BLT	74.10	-5.53+0.19HWT+0.03BLT	85.30
	HWT+BLT+HWT	-4.98+0.10HWT-0.03BLT+0.23HGT	79.90	-6.01+0.46HWT-0.01BLT+0.24HGT	88.60
3Mths	HGT	-7.48+0.37HGT	80.60	-6.77+0.34HGT	87.60
	HWT	-4.94+0.30HWT	61.40	-4.82+0.29HWT	67.80
	BLT	-4.94+0.22BLT	60.10	-5.94+0.23BLT	83.20
	HGT+HWT	-7.39+0.40HGT-0.04HWT	80.80	-6.65+0.39HG-0.05HWT	88.00
	HGT+BLT	-7.32+0.43HGT-0.05BLT	81.20	-6.80+0.26HGT+0.06BLT	83.20
	HWT+BLT	-5.75+0.17HWT+0.03BLT	69.60	-0.66+0.06HWT+0.03BLT	69.60
	HWT+BLT+HWT	-7.29-0.02HWT-0.04BLT+0.44HGT	81.20	-6.64+0.70HWT+0.30BLT+0.08HGT	88.80
4Mths	HGT	-10.00+0.43HGT	82.90	-7.54+0.37HGT	84.50
	HWT	-7.76+0.37HWT	71.40	-6.16+0.33HWT	76.10
	BLT	-9.74+0.31BLT	74.00	-6.57+0.25BLT	77.00
	HGT+HWT	-10.00+0.47HGT-0.03HWT	83.00	-7.57+0.34HGT+0.32HWT	84.70
	HGT+BLT	-9.94+0.12HGT+0.21BLT	83.00	-7.53+0.38HGT-0.01BLT	84.60
	HWT+BLT	-9.47+0.12HWT+0.21BLT	74.80	-6.78+0.13HWT+0.15BLT	78.80
	HWT+BLT+HWT	-10.00-0.28HWT-0.01BLT+0.47HGT	83.00	-7.54+0.36HWT+0.05BLT-0.03HGT	84.70

BLT = Body length, HGT = Heart girth, HWT = Height at withers, Mth = Month

Table-4. Regression equations of postweaning body weight with body measurements of goats.

Age	BM	Male Regression Equation	R^2 (%)	Female Regression Equation	R^2 (%)
5Mths	HGT	-11.80+0.43HGT	82.10	-7.82+0.39HGT	76.70
	HWT	-8.83+0.41HWT	72.40	-7.63+0.37HWT	74.20
	BLT	-12.70+0.37BLT	73.60	-9.21+0.30BLT	77.60
	HGT+HWT	-11.80+0.45HGT+0.01HWT	82.10	-8.42+0.24HGT+0.16HWT	78.80
	HGT+BLT	-11.80+0.49HGT-0.01BLT	82.10	-9.14+0.18HGT+0.17BLT	79.80
	HWT+BLT	-11.70+0.18HWT+0.22BLT	75.40	-9.10+0.07HWT+0.25BLT	77.80
	WT+BLT+HGT	-11.70+0.01HWT-0.01BLT+0.49HGT	82.10	-9.40+0.18HWT-0.03BLT+0.15HGT	79.80
6Mths	HGT	-11.80+0.43HGT	82.10	-7.82+0.39HGT	76.70
	HWT	-8.83+0.41HWT	72.40	-7.63+0.37HWT	74.20
	BLT	-12.70+0.37BLT	73.60	-9.21+0.30BLT	77.60
	HGT+HWT	-11.80+0.45HGT+0.01HWT	82.10	-8.42+0.24HGT+0.16HWT	78.80
	HGT+BLT	-11.80+0.49HGT-0.01BLT	82.10	-9.14+0.18HGT+0.17BLT	79.80
	HWT+BLT	-11.70+0.18HWT+0.22BLT	75.40	-9.10+0.07HWT+0.25BLT	77.80
	HWT+BLT+HGT	-11.70+0.01HWT-0.01BLT+0.49HGT	82.10	-9.40+0.18HWT0.03-BLT+0.15HGT7	9.80
7Mths	HGT	-14.30+0.54HGT	82.90	-11.60+0.48HGT	86.60
	HWT	-10.30+0.45HWT	69.70	-4.02+0.31HWT	49.60
	BLT	-16.00+0.43BLT	75.00	-10.20+0.32BLT	71.70
	HGT+HWT	-14.50+0.48HGT+0.08HWT	83.30	-11.50+0.50HGT-0.02HWT	86.60
	HGT+BLT	-15.20+0.45HGT+0.08BLT	83.30	-11.60+0.48HGT+0.01BLT	86.60
	HWT+BLT	-15.20+0.03HWT+0.32BLT	75.70	-10.20+0.02HWT+0.32BLT	71.80
	HWT+BLT+HWT	-15.00+0.12HWT+0.05BLT+0.45HGT	83.40	-11.60+0.02HWT-0.01BLT+0.49HGT	86.60
8Mths	HGT	-14.80+0.56HGT	85.00	-13.40+0.53HGT	85.90
	HWT	-9.89+0.45HWT	74.30	-8.10+0.41HWT	64.80
	BLT	-13.30+0.39BLT	72.80	-10.20+0.34BLT	65.70
	HGT+HWT	-14.80+0.54HGT-0.01HWT	85.00	-13.40+0.62HGT-0.09HWT	86.50
	HGT+BLT	-15.00+0.52HGT+0.03BLT	85.10	-13.00+0.61HGT-0.06BLT	86.30
	HWT+BLT	-11.60+0.29HWT+0.15BLT	75.10	-9.89+0.19HWT+0.19BLT	67.30
	HWT+BLT+HWT	-15.30+0.53HWT-0.04BLT+0.05HGT	85.10	-14.10+0.09HWT-0.03BLT+0.51HGT	82.20
9Mths	HGT	-14.50+0.56HGT	82.00	-14.20+0.56HGT	72.90
	HWT	-9.71+0.46HWT	71.20	-6.35+0.39HWT	50.00
	BLT	-13.10+0.40BLT	82.00	-9.70+0.34BLT	56.90
	HGT+HWT	-14.40+0.50HGT+0.06HWT	82.20	-14.50+0.73HGT-0.16HWT	74.60
	HGT+BLT	-14.70+0.53HGT+0.02BLT	82.00	-14.01+0.73HGT-0.13BLT	74.00
	HWT+BLT	-10.70+0.38HWT+0.09BLT	71.40	-9.70+0.01HWT+0.34BLT	56.90
	HWT+BLT+HWT	-14.10+0.09HWT-0.04BLT+0.51HGT	82.20	-14.40-0.41HWT-0.04BLT+0.76HGT	74.70

BLT = Body length, HGT = Heart girth, HWT = Height at withers, Mth = Month