

# Estimation of Live Body Weight from the Linear Body Measurements of Begait Goats in Western Tigray, Ethiopia

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## Abstract

The present study was conducted in Western Zone of Tigray, Ethiopia on-farm measurements. Data was collected on 615 (78 males and 537 females) Begait goats of different age group. The mean average body weight of female Begait goat in four age group (1-2, 2-3, 3-4 and above years old) were revealed  $23.47 \pm 0.62$ ,  $29.95 \pm 0.54$ ,  $34.54 \pm 0.44$  and  $37.80 \pm 0.40$  kg respectively while that of male Begait goat in the same group age revealed  $28.00 \pm 1.17$ ,  $37.05 \pm 1.19$ ,  $46.03 \pm 1.03$  and  $53.46 \pm 1.38$  kg respectively and the average body weight of Begait goat is  $34.05 \pm 0.32$  kg. The heart girth of female Begait goat was recorded as  $65.67 \pm 0.49$ ,  $70.56 \pm 0.42$ ,  $74.35 \pm 0.35$  and  $77.46 \pm 0.31$  cm, while that of male Begait goat  $69.05 \pm 0.92$ ,  $76.15 \pm 0.93$ ,  $82.04 \pm 0.81$  and  $87.46 \pm 1.09$  cm respectively. The mean height at withers in female Begait goat is showed as  $62.64 \pm 0.52$ ,  $67.53 \pm 0.45$ ,  $70.19 \pm 0.37$  and  $72.15 \pm 0.33$  cm while that of male Begait goat  $66.36 \pm 0.99$ ,  $70.52 \pm 1.00$ ,  $77.08 \pm 0.87$ ,  $81.19 \pm 1.17$  cm respectively. The mean body length in female Begait goat is measured as  $55.63 \pm 0.52$ ,  $61.41 \pm 0.45$ ,  $64.56 \pm 0.37$  and  $66.60 \pm 0.33$  cm while the mean body length of male Begait goat measured as  $59.56 \pm 0.98$ ,  $66.40 \pm 0.99$ , and  $70.82 \pm 0.86$  and  $74.40 \pm 1.15$  cm respectively. Bodyweight of female Begait goat was correlated with heart girth, body length and height at wither (0.89, 0.85 and 0.83) and bodyweight of male Begait goats respectively. These breeds are easily adaptable to different agro ecological condition but now a day they are dominated in low land agro-ecological environment. Sex and age of the Begait goats had significant effect in all body measurements. Correlation coefficient was consistently highest between body weight and heart girth in male 0.96 and in female 0.89 among the Begait goat population. Generally male Begait goats have higher body measurements than female Begait goats in all linear body measurements.

**Keywords:** Estimation, Heart Girth, Body Length, Height at Wither, Linear Body measurement

## 1. INTRODUCTION

Goat plays a significant economic role for the farming communities living in lowland, midland as well as highland agro ecologic zones of Ethiopia. Goats being smaller sized animal and more prolific, have lower requirements in terms of capital and maintenance costs (Jørgen, et al., 2007). Goats have the ability to produce milk and meat under harsh environmental conditions that might limit productivity of sheep and cattle (Getachew, et al., 2000). Ethiopia is home for 24.06 million heads of goats (CSA, 2013). There is a pressing to know the weight of animal to make decisions for breeding, feeding and veterinary service provision under farmers' settings. Body weight of animals varied as a function of breed, feed, health, gender, yield type, age and general husbandry situation under which the animals kept (Pesmen and Yardimci, 2008 and Dupe, 2013.).

Estimating the live weight using body measurements is practical, faster, easier and cheaper in the rural areas where the resources are insufficient for the breeder (Nsoso, 2003). Therefore, there is a need to estimate weight using simple methods where weighbridge is not available and its use is not practically feasible. Live body weight of goats increased with increasing rate until the eruption of the first pairs of incisors (IPPI) which is at the age of about 16 months and then gradually decrease at late maturity (Dereje, et al., 2013 and Semakula, 2010).

Body measurements are considered as quantitative growth indicators which reflect the conformational changes occurring during the life span of animals. Although live body weight is an important growth and economic trait, it is not always possible to measure it due to mainly the lack of weighing scales, particularly in rural areas. To maintain good animal husbandry, the measurement of live body weight is absolutely essential for breeding, nutrition and health management. Live weight may be estimated through several measurements such as heart girth, body length, height at wither and soon, but those are the most important traits used to determine body weight. And they are simplest and most accurate techniques (Khan et al., 2006).

Body size is found to be a key classifying physical characteristic of Ethiopian goat families and breeds. For instance, Western Highland goats can be classified as a large breed and Afar goats as a small breed. Body size refers to the height, length and width of the animal. Such measures of body size are called linear body measurements and include height at withers and chest girth. Linear body measurements are taken using a measuring tape (Solomon, 2009).

The classical description of breeds is based upon phenotype because an organism's phenotype is principally a manifestation of its genotype, and that it lends itself to direct measurement on the organism (Workneh, et al., 2004). However; estimation of live body weight from linear body measurement has not been done so far particularly for Begait goat. The resources found in western zone of Tigray are not much described.

There is no recent study on linear body measurements of *Begait* goat. Beside this fact breed characterization is the prerequisite for conservation, documentation and utilization. Therefore estimation of body weight from linear body measurements of *Begait* goat is a basis to describe *Begait* goat performance.

The present study was carried out to establish the relationship between live weight and linear body measurements in *Begait* goat as a step towards employing such in body weight estimation for selection and other purpose. Results obtained in present study would also be useful and helpful to farmers and animal scientists who are involved in small ruminant's research on *Begait* Goats with the objective:

#### Objectives

- To estimate body weight from linear body measurements of the *Begait* goat breed in western zone of Tigray.
- To compare the relationship between body weight and linear body measurements.

## 2. MATERIAL AND METHODS

### 2.1. Description of the Study Area

Tigray National Regional State is found in the North part of Ethiopia. It is bordered in the east by Afar and in the south by the Amhara regional states, in the north by Eritrea and in the west by Sudan. The survey was carried out in two districts of western zone of Tigray National Regional State known as Kafta Humera and Setit Humera.

Generally both districts have semi-arid environmental condition with a temperature level that falls between 25 and 42°C, with an average temperature of 35°C. The altitude of the study area is about 530-1831 meters above sea level. Both districts receive an average annual rainfall of 400 - 650 mm per year (Tigray livelihood zone report, 2006). The study area is located 560Km from Mekelle west direction and 991Km from Addis Ababa to north western direction. Sesame and sorghum are widely grown in the study area. The total number of livestock species (cattle, sheep and goat) is estimated about 912536 out of those 40.5% (369945) is goats (CSA, 2013).

### 2.2. Selection of the Study Sites

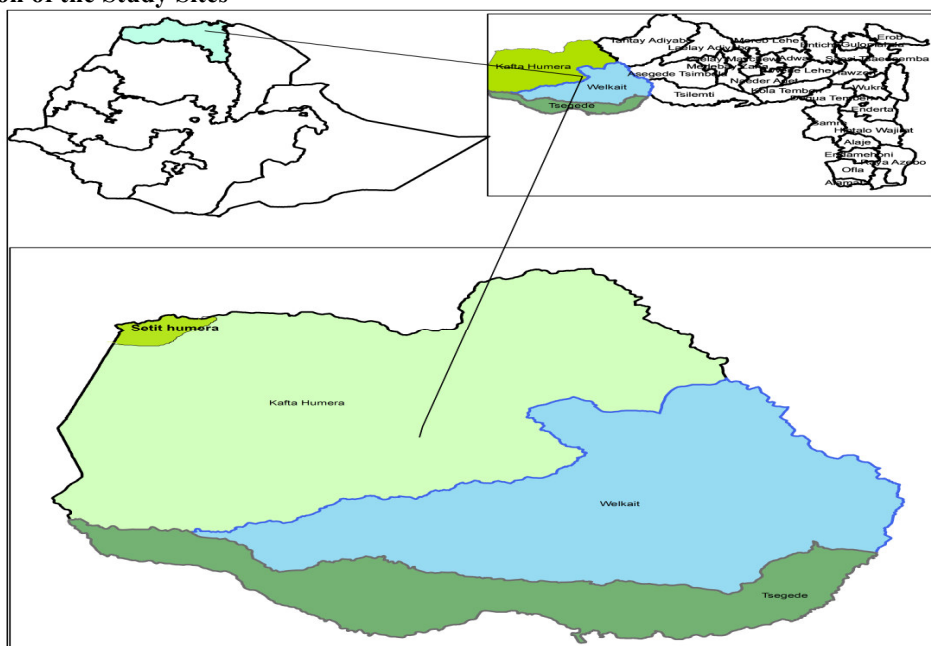


Figure 1. Map of the study area

### 2.3. Data collection Methods

A total of 615 *Begait* goats (537 females and 78 males) were sampled for their linear body measurements such as heart girth (HG), body length (BL), height at wither (HW), head length (HL), ear length (EL), and tail length. They were also measured for their live body weight (BW). Age and sex were considered as independent variable that could substantially determine these traits. The animals were categorized in to two sexes groups as males and females and four age groups as 1PPI, 2PPI, 3PPI, and 4PP which refer one pair of permanent incisors (1-2 years), two pair of permanent incisors (2-3 years), three pair of permanent incisors (3-4 years), four pair of permanent incisors (4 and above years) respectively. The age category was determined according their permanent incisors dentition as outline in the ESGPIP (2009). The animals were measured in their standing position under field conditions using plastic measuring tape and measuring stick and at the same time the body weight was taken

using 100kg size spring balance early in the morning before allowing the animals for grazing in their site. All male and female animals were measured separately. The following linear body measurements were taken as per procedures of ESGPIP (2009).

- ❖ Body length: the distance from the base of the tails to the base of neck (first thoracic vertebrae)
- ❖ Heart girth: the circumferential measure taken around the chest just behind the front legs and withers
- ❖ Withers height: the distance from the surface of a platform on which the animal stands to the wither
- ❖ Head length: the distance from the base of the horn to the tip of mouth
- ❖ Ear length: the distance from the base of the ear to the tip of the ear
- ❖ Tail length: the distance from the base of the tails to the tip of tail

## 2.4. Data Managements and Analysis

The General Linear Model (GLM) procedure of SAS version 9.2 (SAS, 2008) was employed to analyze quantitative variables to determine effects of class variables (district, sex, age and sex by age interaction). Analysis was done for both sexes to estimate the variation.

Correlations between body weight and linear body measurements were computed for the population within group of sex. SAS version 9.2 (SAS, 2008) procedure was used to determine the best measurement for the estimation of body weight from linear body measurements. For *Begait* goat body weight and linear body measurements were considered to estimate correlation between body weight and linear body measurements.

Using this formula  $BW = GH^2 BL/300$  in pound, then it is simple to convert in to kilo gram to estimate body weight from linear body weight.

Model to analyze adult body weight and other linear body measurements were:

$$Y_{ijk} = \mu + S_i + B_j + A_k + S_i * B_j + e_{ijk}$$

Where:  $Y_{ijk}$  = the observation of body weight and body measurements in the  $i^{\text{th}}$  age group,  $j^{\text{th}}$  sex and  $k^{\text{th}}$  district

$\mu$  = overall mean

$S_i$  = the effect of  $i^{\text{th}}$  age group ( $i = 1, 2, 3$  and  $4$ )

$B_j$  = the effect of  $j^{\text{th}}$  sex ( $j =$  female and male)

$A_k$  = the effect of  $K^{\text{th}}$  district ( $K =$  Kafta and Setit Humera)

$S_i * B_j$  = interaction of sex by age group

$e_{ijk}$  = random residual error

## 3. RESULT AND DISCUSSION

### 3.1 Body measurements

Body size is found to be a key classifying physical characteristic of Ethiopian goat families and breeds. For instance, Western Highland goats can be classified as a large breed and Afar goats as a small breed. Body size refers to the height, length and width of the animal. Such measures of body size are called linear body measurements and include height at withers and chest girth. Linear body measurements are taken using a measuring tape (Solomon, 2009). According Nigatu, (1994) reported male and female *Begait* goats weighted 45.3kg and 33.8kg respectively.

**Sex effects:** The least squares means and standard errors for the effect of sex, on body weight, body condition and other body measurements are presented in Tables 1. Variation between male and female *Begait* goats is obvious due to sex. Sex of the *Begait* goats significantly influenced ( $p < 0.05$ ). The influence of sex on the body weight and quantitative traits were clearly observed. The reason might be due to difference hormonal sex which is revealed variation in body size.

**Age effect:** Age is observed to have effect on body linear measurements parameters in *Begait* goat breed as indicated in Table 1. Live body weight of *Begait* goats increased with increasing rate of eruption. The increasing in body weight was high between 1PPI to 2PPI whereas the increasing rate was at decreasing rate from 2PPI and above. The rate of increasing in body weight was minimal as the *Begait* goat advances in age and attributed to the attainment of mature weight at later age.

**Sex by age group:** The interaction between sex and age group significantly ( $p < 0.05$ ) influenced. The value of linear body measurements for both male and female *Begait* goats increased as dentition class increased from age group 1PPI to age group 4PPI. Sex by age interaction for HG, BL, HW, HL, BW, TL and EL are indicating that the fact males and females have different measurement even though they have the same age. This happened due to production of different sex hormones to determine their growth.

**District effect:** Least squares means standard errors of body weight (kg), body condition score and linear body measurements (cm) for agro ecology are presented in Table 1. There is no variation between districts except for HG and HL. This may be due to proximate location of the districts.

Table 1. Least Square Means  $\pm$ SE of body weight (kg) and LBMs (cm) for the effect of sex, district, age and sex by age interaction

Effects Levels	N	HG	BL	HW	HL	BW	TL	EL
		LSM $\pm$ SE	LSM $\pm$ SE	LSM $\pm$ SE	LSM $\pm$ SE	LSM $\pm$ SE	LSM $\pm$ SE	LSM $\pm$ SE
Overall	615	73.95 $\pm$ 0.25	64.08 $\pm$ 0.24	69.73 $\pm$ 0.023	19.52 $\pm$ 0.08	34.05 $\pm$ 0.32	14.06 $\pm$ 0.08	23.63 $\pm$ 0.11
CV%	615	5.49	6.72	6.26	7.96	15.15	14.30	10.59
R <sup>2</sup>	615	0.56	0.47	0.42	0.34	0.57	0.09	0.06
<b>Sex</b>		*	*	*	*	*	*	*
Male	78	78.68 <sup>a</sup> $\pm$ 0.48	67.79 <sup>a</sup> $\pm$ 0.51	73.79 <sup>a</sup> $\pm$ 0.52	20.77 <sup>a</sup> $\pm$ 0.18	41.14 <sup>a</sup> $\pm$ 0.61	14.73 <sup>a</sup> $\pm$ 0.23	24.05 <sup>a</sup> $\pm$ 0.29
Female	537	72.01 <sup>b</sup> $\pm$ 0.23	62.05 <sup>b</sup> $\pm$ 0.24	68.13 <sup>b</sup> $\pm$ 0.24	18.80 <sup>b</sup> $\pm$ 0.08	31.44 <sup>b</sup> $\pm$ 0.29	13.84 <sup>b</sup> $\pm$ 0.11	23.36 <sup>b</sup> $\pm$ 0.14
<b>District</b>		*	NS	NS	*	NS	NS	NS
Kafta Humera	500	74.90 <sup>b</sup> $\pm$ 0.26	64.97 $\pm$ 0.28	70.62 $\pm$ 0.28	20.07 <sup>a</sup> $\pm$ 0.10	35.84 $\pm$ 0.53	14.13 $\pm$ 0.13	23.66 $\pm$ 0.16
Setit Humera	115	75.79 <sup>a</sup> $\pm$ 0.42	64.88 $\pm$ 0.44	71.29 $\pm$ 0.45	19.50 <sup>b</sup> $\pm$ 0.16	36.73 $\pm$ 0.34	14.44 $\pm$ 0.20	23.74 $\pm$ 0.25
<b>Age group</b>		*	*	*	*	*	*	*
1PPI	90	67.36 <sup>d</sup> $\pm$ 0.53	57.60 <sup>d</sup> $\pm$ 0.56	64.50 <sup>d</sup> $\pm$ 0.57	17.64 <sup>d</sup> $\pm$ 0.20	25.74 <sup>d</sup> $\pm$ 0.67	13.88 <sup>b</sup> $\pm$ 0.26	22.60 <sup>c</sup> $\pm$ 0.32
2PPI	123	73.36 <sup>c</sup> $\pm$ 0.52	63.91 <sup>c</sup> $\pm$ 0.55	69.03 <sup>c</sup> $\pm$ 0.56	19.69 <sup>c</sup> $\pm$ 0.20	33.50 <sup>c</sup> $\pm$ 0.66	13.80 <sup>b</sup> $\pm$ 0.25	23.52 <sup>b</sup> $\pm$ 0.32
3PPI	187	78.19 <sup>b</sup> $\pm$ 0.45	67.69 <sup>b</sup> $\pm$ 0.47	73.63 <sup>b</sup> $\pm$ 0.48	20.61 <sup>b</sup> $\pm$ 0.17	40.29 <sup>b</sup> $\pm$ 0.57	14.67 <sup>a</sup> $\pm$ 0.22	24.53 <sup>a</sup> $\pm$ 0.27
$\geq$ 4PPI	215	82.46 <sup>a</sup> $\pm$ 0.57	70.50 <sup>a</sup> $\pm$ 0.61	76.67 <sup>a</sup> $\pm$ 0.61	21.21 <sup>a</sup> $\pm$ 0.22	45.63 <sup>a</sup> $\pm$ 0.73	14.79 <sup>a</sup> $\pm$ 0.28	24.16 <sup>ab</sup> $\pm$ 0.35
<b>Sex*age</b>		*	*	*	*	*	*	*
Male, 1PPI	20	69.05 <sup>d</sup> $\pm$ 0.92	59.56 <sup>c</sup> $\pm$ 0.98	66.36 <sup>c</sup> $\pm$ 0.99	18.06 <sup>c</sup> $\pm$ 0.35	28.00 <sup>c</sup> $\pm$ 1.17	15.02 <sup>a</sup> $\pm$ 0.45	22.78 <sup>cde</sup> $\pm$ 0.56
Male, 2PPI	19	76.15 <sup>cd</sup> $\pm$ 0.93	66.40 <sup>cd</sup> $\pm$ 0.99	70.52 <sup>cd</sup> $\pm$ 1.00	20.59 <sup>b</sup> $\pm$ 0.35	37.05 <sup>c</sup> $\pm$ 1.19	13.59 <sup>bc</sup> $\pm$ 0.46	23.91 <sup>abc</sup> $\pm$ 0.57
Male, 3PPI	25	82.04 <sup>b</sup> $\pm$ 0.81	70.82 <sup>b</sup> $\pm$ 0.86	77.08 <sup>b</sup> $\pm$ 0.87	21.81 <sup>a</sup> $\pm$ 0.31	46.03 <sup>b</sup> $\pm$ 1.03	15.37 <sup>a</sup> $\pm$ 0.40	25.21 <sup>a</sup> $\pm$ 0.50
$\geq$ Male, 4PPI	14	87.46 <sup>a</sup> $\pm$ 1.09	74.40 <sup>a</sup> $\pm$ 1.15	81.19 <sup>a</sup> $\pm$ 1.17	22.62 <sup>a</sup> $\pm$ 0.41	53.46 <sup>a</sup> $\pm$ 1.38	14.94 <sup>ab</sup> $\pm$ 0.54	24.30 <sup>ab</sup> $\pm$ 0.67
Female, 1PPI	70	65.67 <sup>e</sup> $\pm$ 0.49	55.63 <sup>e</sup> $\pm$ 0.52	62.64 <sup>e</sup> $\pm$ 0.52	17.21 <sup>e</sup> $\pm$ 0.18	23.47 <sup>e</sup> $\pm$ 0.62	12.74 <sup>c</sup> $\pm$ 0.24	22.43 <sup>c</sup> $\pm$ 0.30
Female, 2PPI	104	70.56 <sup>d</sup> $\pm$ 0.42	61.41 <sup>d</sup> $\pm$ 0.45	67.53 <sup>d</sup> $\pm$ 0.45	18.79 <sup>d</sup> $\pm$ 0.16	29.95 <sup>d</sup> $\pm$ 0.54	14.01 <sup>b</sup> $\pm$ 0.21	23.14 <sup>bc</sup> $\pm$ 0.26
Female, 3PPI	162	74.35 <sup>d</sup> $\pm$ 0.35	64.56 <sup>d</sup> $\pm$ 0.37	70.19 <sup>d</sup> $\pm$ 0.37	19.40 <sup>d</sup> $\pm$ 0.13	34.54 <sup>d</sup> $\pm$ 0.44	13.97 <sup>b</sup> $\pm$ 0.17	23.84 <sup>bd</sup> $\pm$ 0.21
$\geq$ Female, 4PPI	201	77.46 <sup>c</sup> $\pm$ 0.31	66.60 <sup>c</sup> $\pm$ 0.33	72.15 <sup>c</sup> $\pm$ 0.33	19.79 <sup>d</sup> $\pm$ 0.12	37.80 <sup>c</sup> $\pm$ 0.40	14.64 <sup>a</sup> $\pm$ 0.15	24.03 <sup>b</sup> $\pm$ 0.19

a,b,c,d,e,f means on the same column with different superscripts within the specified dentition group are significantly different (P<0.05); Ns = No significant (P>0.05); \*significant at 0.05; HG = Heart girth; BL= Body length; HW= Height at wither; HL = Head length; BW= Body weight; TL= Tail length; EL=Ear length; 1PPI=1Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI =3 pair of permanent incisors; 4PPI=4pair of permanent Incisors. 3.2 Correlation between Body Weight and Linear Body Measurements

The Pearson's correlation coefficient among the quantitative measurement of *Begait* goat within all sex groups is summarized in the Table 2. Body weight was highly correlated with all continuous traits of both female and male *Begait* goats considered in this study area except tail length. The quantitative traits in both male and female *Begait* goat population, body weight was indicated that highly correlated with HG, BL, HW and HL (0.96, 0.92, 0.90 and 0.74 in male *Begait* goats) and (0.89, 0.85, 0.83 and 0.54 in female *Begait* goats) respectively. Heart girth had strong positive correlation followed by body length, height at wither and head length. So this result indicates HG, BL, HW and HL have higher correlation to body weight respectively, so that it is possible to estimate body weight from linear body measurements.

Correlation Coefficient among body measurement and body weight of *Begait* goats in the study area (values above the diagonal are for females and below the diagonal are for males). Number of sample *Begait* goats male =78 and number of females= 537.

Table 2. Correlation among LBMs and BW of female and male *Begait* goats

	BW	HG	BL	HW	HL	TL	EL
BW		0.89*	0.85*	0.83*	0.54*	0.26*	0.30*
HG	0.96*		0.74*	0.79*	0.52*	0.24*	0.24*
BL	0.92*	0.88*		0.80*	0.52*	0.22*	0.26*
HW	0.90*	0.91*	0.90*		0.50*	0.24*	0.32*
HL	0.74*	0.75*	0.77*	0.45*		0.27*	0.27*
TL	0.18 <sup>ns</sup>	0.22 <sup>ns</sup>	0.27*	0.17 <sup>ns</sup>	0.34*		0.13*
EL	0.34*	0.35*	0.28*	0.28*	0.30*	0.22 <sup>ns</sup>	

LBM= Linear body measurements, HG= Heart girth; BL= Body length; HW= Height at wither; HL= Head length; BW= Body weight; TL= Tail length; EL= Ear length, ns =not significant, \* = significant (P<0.05).

#### 4. CONCLUSION AND SAMMURY

From the result, it is possible to estimate live body weights from linear body measurements using heart girth, body length and height wither are most correlated to live body weight. Body measurements were significant affected by age and sex. Sex and age of the animals had significant effect (p<0.05) on body weight and on all linear body measurements (HG, BL, HW, HL, BW, TL and EL). District had not significant effect (p>0.05). Dentition classes contributed significant effect on body weight and linear body measurements. Heart girth revealed the highest value in determining body weight. The interaction of sex and age revealed that higher value of body weight and linear body measurements in male *Begait* goats and also in advancing age there is increasing

in body measurements. Generally from the present finding body measurements of male *Begait* goats is higher than female *Begait* goats. The correlation between body weight and linear body measurements are core stones to estimate live body weight from linear body measurements in absence of weighing scale in farmer level. *Begait* goats have relatively higher body measurements comparing with other Ethiopian goat breeds, so it is possible to conclude that *Begait* goats have higher performance, even though they are rearing in low input of feed in low land environmental condition. So it is easy to calculate body weight from linear body measurements, especially heart girth and body length is more accurate from this findings. Male *Beagit* goats have higher body measurement than female *Begait* goats.

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