

EFFECT OF BREED, AGE AND SEX ON BODY WEIGHT AND VARIOUS BODY MEASUREMENTS IN AZAD JAMMU AND KASHMIR GOAT BREEDS

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A survey was carried out in breeding tracts of five goat breeds of AJK viz. Jattal, Buchi, Kooti, Lambri and Bairli to study the effect of breed, age and sex on body weight and various body traits. Data of body measurements and weight were recorded by project staff under field conditions. AJK districts Kotly, Muzafrabad, Neelum Valley and Mirpur were surveyed. Body measurements i.e. heart girth, height, length, chest length, pubic bone length and live body weight were taken. Data were arranged according to age, sex and breed and analyzed using Mixed Procedure by REML methodology in SAS version 9.2. Overall breeds did not differ for live body weight ($P = 0.05$), heart girth, length, pubic bone and chest length. However, there was significant difference ($P < 0.05$) of height between Buchi and Kooti (69.28 ± 1.46 VS 75.67 ± 1.22) and Kooti and Bairli (75.67 ± 1.22 VS 70.12 ± 1.25). There significant difference between age for all the body measurement and body weight ($P < 0.05$) except for body length which varied significantly with age. Overall male goats showed higher values for all body traits than female with exception of pubic bone. Lambri goat showed highest body weight followed by Jattal, Bairli, Kooti and Buchi. The present study revealed for the first time variations in body measurements across age, sex and breed in AJK. The results from the present study have useful implications for launching any selection program in region to improve meat production.

Keywords: Goat farming, goat traits, small ruminants, genetic diversity, genetic factors, phenotypic variation

INTRODUCTION

Pakistan has diversified goat population having 36 goat breeds across the country in various ecological zones. There is an annual increment of more than 3% in goat population resulting in the third largest goat producing country in the world (GOP, 2015). According to 2015 economic survey of Pakistan current goat population is 68.4 million heads (GOP, 2015); the share of provinces is 37, 23, 22 and 18% for Punjab, Sindh, Baluchistan and KPK, respectively and goat population in AJK is 1.6 million heads (Azad Jammu & Kashmir, 2013). Goat is a small animal as compared to cow and owing to its ability to produce ample milk and less feed requirement it's known as poor man's cow in Pakistan.

Goat is comparatively small animal and easily manageable. Moreover, goats are excellent browsers and forage from the top down, which makes them efficient biological controls for weeds while substantially increasing vegetative cover by favorable grass and legume species (Singh-Knights and Knights, 2005). Goats are among the fastest growing ruminants in Pakistan. Goat meat is preferred over lamb, poultry and beef therefore; its demand is high. Goat flocks in Pakistan are maintained through traditional production system and their feeding requirement is met through grazing.

Main management in goat farming is climate, resource, vegetation, disease control and feed supplements. Small cash investment is needed for goat keeping and sometimes zero input is needed for goat keeping in villages. A large proportion of small farmers particularly women depend on goat keeping for their livelihood. Both live goat and its products have potential for export market. Therefore, meat appears to be primary breeding objective while milk is secondary. There exists diversity among and within goat breeds due to morphological, growth and fertility traits. Moreover, the diversity in performance of trait is due to genetic and non-genetic factors. It is necessary to take into account all factors in order to use genetic variation for effective breeding plans (Afzal *et al.*, 2004). Therefore, indigenous goat resources can be better utilized on sustainable basis if efforts of research and development address indigenous problems. However, at the moment, breed documentation both at phenotypic and genetic level is a priority research area (Khan *et al.*, 2008). Moreover, there is need to prioritize, monitor and manage the goat farming at scientific and farm operational levels (International Livestock Research, 2002). Breeding, genetics, socio economic are the neglected aspects of goat farming in our country.

The biometric measurements are used to assess several characteristics of animals. These measurements provide important evidences for the growth of the breed and the characteristics that change with genetic and environmental effects i.e. feeding factors. In addition, body measurements are important data sources in terms of reflecting the breed standards (Riva *et al.*, 2004). Unfortunately, some basic information is missing in case of many indigenous goat breeds of the country including that of AJK.

Keeping in view the scarcity of information regarding the indigenous goat breeds of Pakistan in general and that of AJK in particular the current study was designed to study the effects of age, sex and breed on body weight and body measurements of five goat breeds of AJK in their respective breeding tracts. Breeds included in study were Jattal, Buchi, Kooti, Lambri and Bairli. Moreover, this information might also prove useful for determining the relationship between body weight and body measurement in these five goat breeds.

MATERIALS AND METHODS

Present study was conducted in Kotli, Muzzafarabad, Neelum Valley, and Mirpur districts of AJK. These districts are native for these five breeds of AJK. AJK is mountainous, forests and fast running rivers area with total land of 13297 Square. Data were collected from above mentioned areas between February and June 2014.

Body measurements of 161 animals were taken in this study representing five breeds having at least 40 animals per breed randomly taken from 10 different farmers for each breed. Body measurements were taken during the study for heart girth, height, length, chest length, pubic bone length and live body weight. Weight was taken in Kg while body measurements were taken in cm. A brief methodology of all the recordings is as followed as described by Adeyinka and Mohammed (2006). Body weight was measured using Salter Hanging Spring weighing balance and was measured to accuracy of ± 0.5 kg. Body length was measured as the distance from the external occipital protuberance to the base of the tail in cm. A flat platform was used upon which the animal was placed. The height at wither was measured as the distance from the surface of the platform to the withers in cm. The heart girth was measured by taking the measurement of the circumference of the chest with a tape rule in cm. Chest length was measured as the distance between lobe the depth of brisket immediately behind forelegs in cm.

Animals were classified in age groups viz. class 1: 1 to 18 months; class 2: 19 to 36 months and class 3: 37 to 84 months. Data were arranged according to age, sex and breed and analyzed using Mixed Procedure by REML methodology in SAS (Version 9.2) to investigate the effect of breed, age, and sex on body weight and body

measurements. Estimates of regression coefficient and estimates of correlation coefficients were obtained using PROC REG of SAS (Version 9.2) and PRINCOMP of SAS (Version 9.2) respectively to predict body weight using body measurements.

RESULTS

Effect of breed, age class, and sex on body weight and measurements: Overall mean \pm SD for body weight (Kg), heart girth (cm), height (cm), length (cm), pubic bone (cm), and chest length (cm) were 33.77 \pm 12.81 Kg, 71.51 \pm 10.39, 70.89 \pm 9.04, 64.20 \pm 10.20, 10.46 \pm 3.06, and 16.28 \pm 2.70, respectively (Table 1).

Table 1. Overall Mean \pm SD of various body measurements and body weight in AJK goats.

Traits	No.	Mean \pm SD	Min	Max	CV
Weight (kg)	161	33.77 \pm 12.81	6	65	37.93
Heart girth (cm)	161	71.51 \pm 10.39	40	91	14.53
Height (cm)	161	70.89 \pm 9.04	40	87	12.75
Length (cm)	161	64.20 \pm 10.20	17	89	15.89
Pubic bone (cm)	161	10.46 \pm 3.06	6	40.50	29.22
Chest length (cm)	161	16.28 \pm 2.70	9.50	24	16.59

There were three classes of age (Table 2). There was an increasing trend in body measurements and body weight with the age. Overall age affected significantly for body measurements and weight. There was significant difference among age classes viz. age class 1 and 2 and age class 1 and 3; in term of body weight and body measurements except body length which differed significantly among all three age classes ($P < 0.001$; Table 2).

Table 2. Effect of age on various body measurements and body weight in AJK goats.

Traits	Age classes			Overall 1 P value
	Age Class 1	Age Class 2	Age Class 3	
	1-18 Months	19-36 Months	37-84 Months	
Weight (kg)	27.02 \pm 1.50 ^a	39.99 \pm 1.78 ^b	43.59 \pm 1.59 ^b	<.0001*
Heart girth (cm)	63.94 \pm 1.15 ^a	76.17 \pm 1.37 ^b	79.33 \pm 1.22 ^b	<.0001*
Height (cm)	64.77 \pm 1.00 ^a	74.43 \pm 1.19 ^b	76.79 \pm 1.06 ^b	<.0001*
Length (cm)	57.20 \pm 1.20 ^a	68.22 \pm 1.43 ^b	72.47 \pm 1.27 ^c	<.0001*
Pubic bone (cm)	8.96 \pm 0.43 ^a	11.48 \pm 0.51 ^b	11.30 \pm 0.46 ^b	<.0001*
Chest length (cm)	15.28 \pm 0.33 ^a	18.08 \pm 0.39 ^b	18.20 \pm 0.35 ^b	<.0001*

*Statistically significant ($P < 0.05$) and ^{NS} Statistically non-significant ($P \geq 0.05$)

Effect of breed on various body measurements and body weight are given in Table 3. Lambri had the highest body weight however; highest heart girths were in Jattal followed by Lambri breed. There was no difference among breeds in term of body measurements and body weight except height (Table 3). Kooti has the highest height (75.67 \pm 1.22 cm).

Table 3. Effect of breed on various body measurements and body weight in AJK goats.

Traits	Breed 1	Breed 2	Breed 3	Breed 4	Breed 5	Overall P value
	Jattal N=30	Buchi N=30	Kooti N=41	Lambri N=30	Bairli N=30	
Weight (kg)	36.82±1.90	33.73±2.18	35.59±1.82	41.44±2.06	36.75±1.87	0.0551 ^{NS}
Heart girth (cm)	74.75±1.46	70.85±1.67	72.27±1.39	74.19±1.58	73.67±1.43	0.3094 ^{NS}
Height (cm)	72.43±1.27 ^a	69.28±1.46 ^{ab}	75.67±1.22 ^{abc}	72.48±1.38 ^{a-d}	70.12±1.25 ^{a-e}	0.0015 [*]
Length (cm)	68.51±1.52	66.26±1.75	64.84±1.46	64.79±1.65	65.42±1.49	0.3251 ^{NS}
Pubic bone (cm)	10.70±0.55	10.19±0.63	10.69±0.52	11.03±0.59	10.27±0.53	0.8073 ^{NS}
Chest length (cm)	16.98±0.42	16.69±0.48	16.72±0.40	18.02±0.45	17.53±0.41	0.0812 ^{NS}

^{*}Statistically significant (P < 0.05) and ^{NS} Statistically non-significant (P ≥ 0.05)

However, there was significant difference (P<0.05) of height between Buchi and Kooti (69.28±1.46 VS 75.67±1.22) and Kooti and Bairli (75.67±1.22 VS 70.12±1.25) (Table 3). There were 137 female and 24 males in this study. There was significant difference of weight in both sexes viz. male have higher weight than female (Table 4). There was significant difference of body length and chest length in both sexes viz. male have more length as compared to female. However, pubic bone length was almost same in both sexes.

Table 4. Effect of sex on various body measurements and body weight in AJK goats.

Traits	Sex		Overall P value
	Male (N=24)	Female (N=137)	
Weight (kg)	41.35±2.11	32.38±0.87	0.0002 [*]
Heart girth (cm)	75.56±1.62	70.73±0.67	0.0071 [*]
Height (cm)	74.04±1.40	69.95±0.59	0.0091 [*]
Length (cm)	68.67±1.69	63.27±0.70	0.0040 [*]
Pubic bone (cm)	10.71±0.61	10.44±0.25	0.6925 ^{NS}
Chest length (cm)	18.41±0.47	15.97±0.19	<0.0001 [*]

^{*}Statistically significant (P < 0.05) and ^{NS} Statistically non-significant (P ≥ 0.05)

Weight prediction from body measurements: The equation derived for predicting live body weight from body measurements is as give under:

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 * \text{age} + \hat{\beta}_2 * \text{HG} + \hat{\beta}_3 * \text{CL} + \hat{\beta}_4 * \text{L} + \hat{\beta}_5 * \text{H} + \hat{\beta}_6 * \text{PB} \quad (\text{Eq.1})$$

Whereas \hat{Y} is predicted live weight of goat in AJK; $\hat{\beta}_0$ is constant; $\hat{\beta}_1$ is estimate of regression coefficient of regression of age (months) on live body weight (Kg); $\hat{\beta}_2$ is estimate of regression coefficient of regression of heart girth (cm) on live body weight; $\hat{\beta}_3$ is estimate of regression coefficient of regression of chest length (cm) on live body weight; $\hat{\beta}_4$ is estimate of regression coefficient of regression of body length (cm) on live body weight; $\hat{\beta}_5$ is estimate of regression coefficient of regression of height (cm) on height body weight and $\hat{\beta}_6$ is estimate of regression coefficient of regression of pubic bone length (cm) on live body weight.

The estimated values of $\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, $\hat{\beta}_4$, $\hat{\beta}_5$ and $\hat{\beta}_6$ were -44.59, 0.04, 0.43, 1.95, 0.16, 0.03 and 0.19, respectively.

The above model had mean square error (MSE) of 25.58 with R^2 and adjusted R^2 values of 0.85 and 0.84 respectively. However, it was observed that age, height, and length had a statistically non-significant effect (P < 0.05) on the body weight of goats. The results from principal component analysis in SAS indicated that three factors viz. live body weight, heart girth and chest length explained 93.5 % of the total variance. Therefore, other factors were dropped from the model. The final suggested model is given as under:

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 * \text{HG} + \hat{\beta}_2 * \text{CL} \quad (\text{Eq. 2})$$

Whereas \hat{Y} is predicted live weight of goat in AJK; $\hat{\beta}_0$ is constant; $\hat{\beta}_1$ is estimate of regression coefficient of regression of heart girth (cm) on live body weight (Kg); $\hat{\beta}_2$ is estimate of regression coefficient of regression of chest length (cm) on live body weight. The estimated values of $\hat{\beta}_0$, $\hat{\beta}_1$ and $\hat{\beta}_2$ were -46.27, 0.69 and 1.87, respectively.

This model had slightly higher MSE with (26.58) similar R^2 and adjusted R^2 (0.84) to that of previous model indicating that taking only two body measurements i.e. heart girth and chest length can effectively serve the purpose of accurate weight recording under field conditions in AJK goats.

DISCUSSION

Effect of breed, age class, and sex on body weight and measurements: The present study was conducted in AJK on five goat breeds, bodies measurements were taken, and live body weight were compared among them. Moreover, there has no earlier such report for AJK goat breeds.

There was effect of age group on body measurements and body weight (Table 2). Although it has already been established in Serrana Transmontano goat breed kids up to 60 days of age (n = 8930) that live body weight is influenced by age, sex and birth season (Jiménez-Badillo *et al.*, 2009). However, current study indicates that there was significant variation for body measurements and body weight between age class 1 and age class 2 or 3 except body length. This elucidate the main growth period in these breeds of goats

ranged between the ages of months 1 to 18. This information would have a practical implication for data recording and measurements of these breeds suggesting that if growth and body measurements are recorded to age of 18 months in these breeds; it would be enough as after that there is no significant change in weight or measurement.

Effect of breed on body weight and measurements among five goat breeds were non-significant. Although there was some variation observed among breeds as indicated in Table 3. Moreover, breed variation has already been observed for weight and measurements (Agga *et al.*, 2011). In the current study; highest body weight was observed in Lambri. However, heart girth measurements were similar among all five breeds but, there was significant difference of height in all five breeds with highest height in Kooti ($P < 0.0015$). Results showed no significance difference in pubic bone length among all five breeds of goat.

It has already been established that sex has effect on body weight as well as body measurements (Tsado and Adama, 2012). Probably the biological reason for this effect could be attributed to androgens differences in both sexes (Kakuma *et al.*, 2007). The current study also reports that sex has significant effect on body measurements and body weight. Effect of sex on body measurement has been reported in previous studies (Akpa *et al.*, 2010; Bazzi and Ghazaghi, 2011). Overall body measurements were greater for male as compared to female (Table 4). It was observed there is significant difference of body weight between male and female ($P = 0.0002$). Similarly, there was significant difference in heart girth between male and female ($P = 0.0071$). There were also height and length significant differences in male and female. However, there was no significant difference in pubic bone length in male and female. Chest length has significant difference between male and female ($P = 0.0001$). Our findings were similar to previous studies in term of variability in body measurement of Somali goat breed of Eastern Ethiopia (Gebreyesus *et al.*, 2014).

Weight prediction from body measurements: It has been noticed that from practical point of view; use of morphometric measurements for weight prediction is quite necessary. It's quite difficult to carryout weighing equipments in fields for weighing of live animals and situation is really aggravated when farmers for scattered in field. Keeping in view the importance of data recording in filed for breeds evaluation as well as genetic improvement programs; weight prediction from morphometric measurements is quite handy. In this context; our current study first time reports morphometric variation among goat breeds of AJK. Morphometric measurements have been used in prediction of live weight among different farm animal species i.e. cattle (Lukuyu *et al.*, 2016); in chicken (Malomane *et al.*, 2014); in equine (Martinson *et al.*, 2014); in sheep (Riva *et al.*, 2004) and in goat (Okpeku *et al.*,

2011). There has been some work on famous breeds of Pakistan i.e. Beetal and Teddi on these aspects however; most of the breeds are untouched. Therefore, equations are developed for prediction of live weight among AKJ goat breeds.

Equation 1 indicates all factors viz. age, heart girth, height, body length, chest length and pubic bone length. This model had mean square error (MSE) of 25.58 with R^2 and adjusted R^2 values of 0.85 and 0.84 respectively. Our results are comparable to other previous studies on the subject (Adeyinka and Mohammed, 2006; Khan *et al.*, 2006; Okpeku *et al.*, 2011; Tsegaye *et al.*, 2013). The results of current study showed no significant effect of age, height, and length ($P < 0.05$) on the body weight of goats. Moreover, the results from principal component analysis in SAS indicated that three factors viz. live body weight, heart girth and chest length explained 93.5% of the total variance. Therefore, Equation 2 is suggested to use for estimation of body weight in AJK breeds that has slightly higher MSE with (26.58) but, similar R^2 and adjusted R^2 (0.84) to that of Equation 1. Moreover, availability of more data is expected to improve MSE and R^2 .

Current study is first of its kind to explore this unique genetic resource of the region in terms of variation among goat breeds in morphometric measurements and body weight and could provide practical solution to the issue of measuring weight under field conditions.

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