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INTER-RELATIONSHIP OF BODY WEIGHT WITH LINEAR BODY MEASUREMENTS IN HISSARDALE SHEEP AT DIFFERENT STAGES OF LIFE

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ABSTRACT

Determining animal live body weight (BW), linear body measurements, and their inter-relationship and correlation is imperative for determining genetic potential, breed standards, and improved breeding programs for higher meat production. Hissardale is the only fine wool sheep breed maintained in Pakistan and developed by crossing exotic Merino with a local carpet wool sheep Bikaneri. Data from 314 Hissardale sheep for body weight and linear body measurements including heart girth (HG), height at withers (HAW), body length (BL), ear length (EL), ear width (EW), neck length (NL), neck width (NW), tail length (TL), and tail width (TW) was obtained after random selection at the Livestock Experiment Station, Jahangirabad, Khanewal, Pakistan. The data was then analyzed to determine the appropriate model for estimating BW at different ages of life cycle including pre-weaned and post-weaned sheep. Animals were categorized according to their age (≤6, 7 to 12, 13 to 18, 19 to 24, and >24 mo). The BW (mean ± SD) of animals was found to be 10.87 ± 1.82, 16.40 ± 1.40, 21.04 ± 1.44, 25.57 ± 2.94 and 47.10 ± 4.41 kg in all age groups (≤6, 7 to 12, 13 to 18, 19 to 24, and >24 mo, respectively). Body weight was found to be significantly ($P < 0.001$) and positively correlated with HAW for all 5 age groups (0.79, 0.85, 0.67, 0.73, and 0.54, respectively), BL (0.69, 0.83, 0.53, 0.82, and 0.46, respectively) and HG (0.58, 0.85, 0.70, 0.76, and 0.42, respectively). However, the relationship between BW and other linear body measurement like EL, EW, NL, NW, TL, and TW were found significant ($P < 0.05$) but comparatively less correlated except for neck width in 0 to 6- and 7 to 12-mo age groups. The recorded body measurements had a strong positive correlation with BW, indicating that they can be used to estimate BW in Hissardale sheep of varying ages under field conditions.

Key words: Hissardale sheep, live body weight, linear body measurements.

INTRODUCTION

Hissardale sheep is a medium fine wool breed developed in Hissar, India during 1930s by crossing Merino with a local carpet wool sheep known as Bikaneri. The animals of this breed are large and have a white body coat (Akhtar *et al.,* 2008). In Pakistan, Hissardale sheep is raised for mutton and wool production and is maintained at Livestock Experiment Station Jahangirabad, district Khanewal.

Animal live body weight is an important feature, but can seldom be measured in rural areas due to lack of reasonable accurate scales. Hence, farmers have to rely on questionable estimates of the body weights of their sheep, leading to inaccuracies in decision making. The primary method of weighing animals without scale is to regress body weight to body characteristics, which can be measured readily (Mayaka *et al*., 1995). Body measurements have been used to predict body weight by several authors in many breeds of sheep (Aziz and Sharaby, 1993; Enevoldsen and Kristensen, 1997; Atta and El Khidir, 2004; Riva *et al*., 2004; Afolayan *et al*., 2006; Sowande and Sobola, 2007; Iqbal 2010). They reported that different models might be needed to predict body weight in different environmental conditions and breeds.

The objectives of present study were to establish the relationship between live body weight and linear body measurements in Hissardale sheep and to study the phenotypic characterization of Hissardale sheep for body length, height at withers, heart girth, neck length, neck width, ear length, ear width, tail length and tail width at different stages of life as a step toward employing such in body weight estimation for selection and other purposes. Results obtained in present study would also be useful and helpful to farmers and animals scientists who are involved in small ruminants' research.

MATERIALS AND METHODS

Hissardale sheep (n=314) were used and divided in to five different age groups A (0-6 mo), B (7-12 mo), C (13-18 mo), D (19-24 mo) and E (>24 mo). Each group consisted minimum of 50 animals. Distribution of animals according to the age for the measurements is summarized in Table-1.

The animals were released daily for grazing at 8.00 am and they remained outside until 4.00 pm.

Drinking water was provide ad lib. Animals received routine inspection and dipping; drenching and vaccination were done for herd health maintenance. The animals were having permanent identification in the form of ear tags in right ear and dates of birth were taken from birth register. Live weight of individual animal was determined in the early morning prior to supply of food to avoid error, the weight of the animals were taken with the help of weighing scale. The animals were placed squarely on four legs on even surface before they had an access to food and water in the morning when the measurements were taken with the help of measuring tape calibrated (cm) after restraining and holding the animals in an unforced position.

The body length of the animals was taken by using measuring tape from the point of shoulder to the pin bone. Height at withers was measured as the distance from the surface of the platform to the withers of the animal. Heart girth was measured by taking the measurement of the circumference of the chest. Neck length was taken as length of cervical region, from neck attachment with head, to the neck attachment with body from lateral side. Neck width was measured from dorsal border to ventral border in the center of neck. Ear length was taken from the base to the tip of ear. Ear width was measured as the widest part in the center of ear. Tail length was measured from the base to the tip of tail and width as the widest part in the center of tail.

Data thus collected were classified on the basis of age groups (0-6, 7-12, 13-18, 19-24 and > 24 months). Mean ± S.D for the body weight and linear body measurements (HAW, BL, HG, NL, NW, EL, EW, TL and TW) were calculated.

Statistical analysis: Statistical analysis was carried out by using SPSS software, Version 13.0 (SPSS 2008) for linear and nonlinear regression.

RESULTS AND DISCUSSION

The average measurements obtained for the studied traits are summarized in Table-2. The mean body weight and height at withers of Hissardale sheep was found to increase significantly with age. Animals ranging from day 1st to 18th months of age have more potential to grow physically. Therefore, it was seen that major body measurements like body length, height at withers and heart girth have profound role in early stages of animal's life cycle i.e. first 3 age groups (A, B and C) with higher growth compared to the rest of period. Whereas, other measured traits like ear width, neck length, neck width, and tail width did not show a very high relationship with the age of animals, although these bear positive correlation coefficient values. Strong association of mean heart girth (cm) and body weight in Hissardale sheep was noted in all five age groups (A, B, C, D and E group). More variation was seen in age group E that might be probably due to broad range of age of animal in this group i.e. >24 months of age.

Average measurements obtained for the six traits studied are given in Table-3. The mean ear length and ear width of Hissardale sheep with age was also seen to be increasing in all five age groups (A, B, C, D and E group), although this increase in size was not as profound as that of major body measurements i.e. HAW, BL and HG. The mean neck length and neck width of Hissardale sheep was also prospectively more in older age groups. Long tail is a characteristic feature of Hissardale sheep. The mean tail length and tail width of Hissardale sheep was found to be increasing with age, apparent from the data for all five age groups (A, B, C, D and E group). Tail width did not show a significant increase with age, however, mean tail width of Hissardale sheep in five age groups (A, B, C, D and E group) was found to be 1.98 ± 0.38, 2.60 ± 0.30, 2.95 ± 0.30, 3.54 ± 0.46, 4.32 ± 0.61cm, respectively implicating that this trait along with some other studied parameters can be used to assess the body weight of Hissardale sheep.

Table-4 describes the correlation of body weight and other body measurements. The findings of the present study are in line with those of Iqbal (2010) who reported the coinciding results of more growth rate during early stages of life cycle for 0-3 month's age group compared to 4-6 months age group in Kajli sheep. Similarly, the results obtained from 7-12 month age group, coincide with Aziz and Sharaby (1993) who considered height at withers (HAW) a best predictor of body weight than heart girth. Correlation values were seen positive and significant in major studied parameters (HAW, BL and HG) similar to the results of Atta and Khidir, 2004; Topal and Macit, 2004; Abdel – Moneim, 2009 and Cam *et al*., 2010. In first two age groups (A and B), ear width is found to be negatively correlated as ear width was not increasing as much parallel to the weight of animal. Results obtained from 13-18 months age group are in line with Benyi and Karbo,1998; Badi *et al*., 2002; Fourie *et al*., 2002; Bassano *et al*., 2003; Atta and Khidir, 2004; Topal and Macit, 2004; Fasae *et al*., 2005; Thiruvenkadan, 2005; Afolayan *et al*., 2006; Moaeen-ud-Din *et al*., 2006; Alade *et al*., 2008; Abdel – Moneim, 2009 and Cam *et al*., 2010 and Tariq *et al*., 2012), as they have reported the high phenotypic correlation between heart girth (cm) and body weight (Kg) that strongly entails the importance of relationship between hearth girth and body weight as body weight predictor. In table-4, correlation coefficient values go down in 3rd age group because studied animals were a group mixture male and female and most of sheep got pregnant in this age group (13-18th) due to which a massive increase in size (cm's) of major body parameters (BL and HG) were recorded that ultimately lead to negative correlation.

Statistical Regression Model: Linear regression models were estimated for different age groups of Hissardale animal. These regression models were determined using step wise multiple regression analysis. All nine body measurements were fitted into the model and through stepwise elimination procedure, six of the body measurements (ear length, ear width, neck length, neck width, tail length and tail width) were observed flabby for the model among different age groups A (0-6 mo), B (7-12 mo), C (13-18 mo), D (19-24 mo) and E (>24 mo) as compared to three major body measurements that were best fit for the model were height at wither (HAW), body length (BL) and heart girth (HG) with coefficient of determination (R^2) value in range of 34-63.6% of the live weight in Hissardale sheep in group A (0-6 mo). However, height at withers (HAW) and body length (BL) confirmed more promising role in term of coefficient of determination (R^2) value i.e. 63.6% and 48.4%, respectively in first age group (0-6 mo). The regression model for group A (0-6 mo) is as follow;

$$\mathbf{Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2}$$

$$Y_i = -21.19 + 0.46\ x_1 + 0.197\ x_2$$

Whereas;

Yi = Body weight in kg.

β_0 = Intercept of the best fit straight line.

β_1, β_2 = Partial regression co-efficient of body weight on height at wither (HAW) and body length (BL), respectively.

X_1, X_2 = Height at withers (HAW) and body length (BL), respectively.

Similarly, two body measurements that were best fit for the model were height at wither (HAW) and heart girth (HG) accounting for high coefficient of determination (R^2) value i.e. 73.1% and 72.3 %, respectively of the live weight in Hissardale sheep of group B (0-6 mo). The regression model for group B (7-12 mo) is as follow;

$$\mathbf{Y_i = \beta_0 + \beta_1 x_1 + \beta_3 x_3}$$

$$Y_i = -22.30 + 0.36\ x_1 + 0.34\ x_2$$

Whereas;

X_1, X_3 = Height at withers (HAW) and heart girth (HG), respectively.

Group C (13-18 mo) showed height at withers (HAW) and heart girth (HG) as two body measurements that were best fit for the model and accounting for high coefficient of determination (R^2) value i.e. 65.7 % and 50.1%, respectively of the live weight in Hissardale sheep. The regression model for group C (13-18 mo) is as follow;

$$\mathbf{Y_i = \beta_0 + \beta_1 x_1 + \beta_3 x_3}$$

$$Y_i = -26.85 + 0.38 \text{ (height at withers)} + 0.39 \text{ (heart girth)}$$

Group D (19-24 mo) showed body length (BL) and heart girth (HG) as two body measurements that were best fit for the model and accounting for high coefficient of determination (R2) value i.e. 68.6 % and 59.1%, respectively of the live weight in Hissardale sheep. The regression model for group D (19-24 mo) is as follow;

$$\mathbf{Y_i = \beta_0 + \beta_2 x_2 + \beta_3 x_3}$$

$$Y_i = -65.75 + 0.82 \text{ (body length)} + 0.60 \text{ (heart girth)}$$

In last, group E (>24 mo), height at withers (HAW) and heart girth (HG) showed high coefficient of determination (R^2) value i.e. 35.3 % and 21.7% , respectively of the live weight in Hissardale sheep. The regression model for group E (>24 mo.) is as follow;

$$\mathbf{Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2}$$

$$Y_i = -32.89 + 0.76 \text{ (height at withers)} + 0.41 \text{ (body length)}$$

In conclusion, since the body measurements had positive and high correlation with body weight indicating that body measurements can be used for estimation of body weight in the field where scales are not usually available. These may also be used as selection criteria. However, further research is needed to investigate the relationship between the body weight and linear body measurements in other breeds of sheep and goats in Pakistan.

Table-1. Distribution of animals according to the age to various groups.

Group	Age (Month)	No. of observations
A	0 – 6	74
B	7 – 12	53
C	13 – 18	62
D	19 – 24	51
E	Above 24 months	74
	Total	**314**

Table-2. Mean ± S.D for body weight and linear body measurements

Age (Months)	Body weight (kg)	Height at withers (cm)	Body length (cm)	Heart girth (cm)	Ear length (cm)
0-6	10.87 ±1.82	48.85 ±2.35	47.45 ±2.69	48.17 ±2.83	12.41 ± 0.93
7-12	16.40 ± 1.40	55.50 ± 1.85	54.27 ± 1.80	55.64 ± 1.95	12.50 ± 0.59
13-18	21.04 ± 1.44	61.91 ± 1.79	60.66 ± 1.78	60.83 ± 1.95	12.68 ± 0.63
19-24	25.57 ± 2.94	63.59 ± 1.53	63.91 ± 2.02	64.94 ± 1.90	13.53 ± 0.72
Above 24	47.10 ± 4.41	66.35 ± 3.22	70.69 ± 3.51	80.67 ± 3.65	14.21 ± 1.71

Table-3. Mean ± S.D for body weight and linear body measurements

Body weight (kg)	Ear width (cm)	Neck length (cm)	Neck width (cm)	Tail length (cm)	Tail width (cm)
10.87 ±1.82	6.31 ± 0.65	14.85 ± 1.70	12.22 ± 1.16	22.25 ± 2.59	1.98 ± 0.38
16.40 ± 1.40	6.31 ± 0.63	15.23 ± 0.90	13.90 ± 0.72	22.30 ± 0.97	2.60 ± 0.30
21.04 ± 1.44	6.70 ± 0.65	15.14 ± 0.63	13.68 ± 0.67	22.24 ± 1.85	2.95 ± 0.30
25.57 ± 2.94	6.35 ± 0.53	15.93 ± 0.68	14.42 ± 0.80	25.97 ± 2.67	3.54 ± 0.46
47.10 ± 4.41	7.15 ± 0.60	19.36 ± 1.57	16.30 ± 1.69	27.64 ± 4.22	4.32 ± 0.61

Table-4: Coefficient of correlation between body weight (Kg) and other linear body measurements

Age (Mon)	HAW (cm)	BL (cm)	HG (cm)	EL (cm)	EW (cm)	NL (cm)	NW (cm)	TL (cm)	TW (cm)
0-6	0.798	0.696	0.586	0.467	-0.18	-0.039	0.458	0.253	0.153
7-12	0.855	0.835	0.850	0.461	-0.137	0.316	0.599	0.320	0.443
13-18	0.676	0.536	0.708	0.455	0.350	0.666	0.597	0.397	0.643
19-24	0.737	0.828	0.769	0.275	0.508	0.600	0.575	0.617	0.537
Above 24	0.549	0.466	0.425	0.116	0.253	0.437	0.463	0.327	0.077

Height at withers (**HAW**), Body length (**BL**), Heart girth (**HG**), Ear length (**EL**), Ear width (**EW**), Neck length (**NL**), Neck width (**NW**), Tail length (**TL**) and Tail width (**TW**).

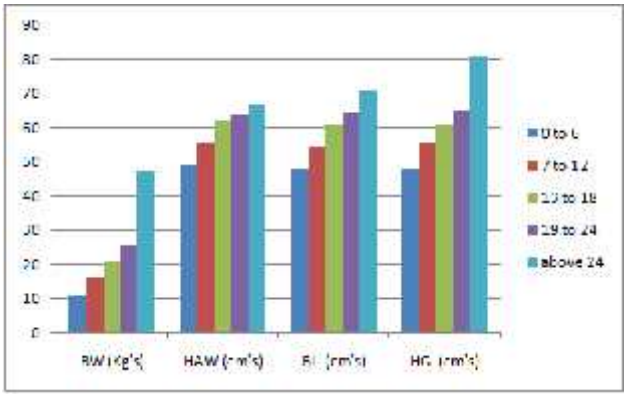

Figure -1: Mean ± S.D of body parameters of different age groups in Hissardale sheep

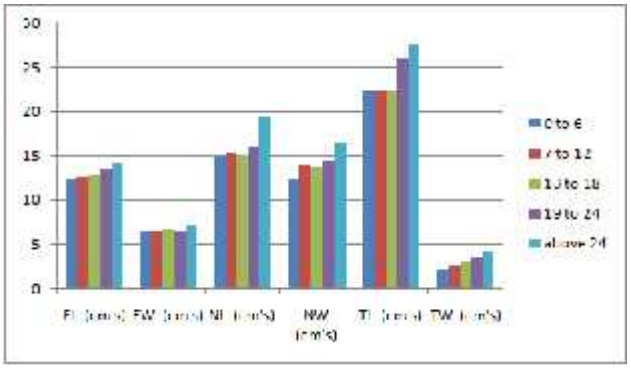

Figure-2: Mean ± S.D of body measurements of different age groups in Hissardale sheep

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