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Morphological Characterization of Indigenous Highland Sheep Population of Tigray, Northern Ethiopia

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Abstract
The study was conducted to phenotypically characterize in local sheep in the highlands of Atsbi-Womberta district in northern Ethiopia. Two hundred fifty seven randomly selected sheep (121 males and 136 females) were grouped into four age groups based on PPI (in full) as (0 PPI, 1 PPI, 2 PPI, and 3 PPI. Lateral ear orientation (93.5%), uniform coat pattern (49 %) with beige color, medium hair length with course hair (61%), curved (50%) horn shape with lateral orientation (58%), In-between the lanky and compacted body shape (82%) and flat face (62%) are among the major physical characteristic of the highland sheep flock found in the study area. The mean (±SE) live body weight for male and female sheep was 23.3±0.5 kg and 20.9±0.3 kg, respectively. The mean (±SE) value of body weight at age group 0 PPI, 1 PPI, 2 PPI, and ≥3 PPI was recorded as 19.3±0.3 kg, 23.0±0.6 kg, 25.7±0.8 kg and 28.9±0.8 kg, respectively for male and 17.1±0.1 kg, 20.1±0.6 kg, 22.3±0.4 kg and 23.4±0.2 kg for female in the respective age categories. The mean (±SE) values of heart girth, body length, and height at wither was 71.6±0.6 cm, 57.6±0.8 cm and 62.2±0.7 cm, respectively for male and 68.4±0.4 cm, 54.9±0.5 cm, and 58.5±0.5 cm, respectively for female. The study concluded that the highland sheep found in Atsbiwonberta district is small sheep breed adapted in the dry highland area, reproduced, and contributed to the socioeconomic life of the local community.
Keywords: Highland sheep, phenotypic characterization, body measurement and prediction equation

1. Introduction

The increased human population and recurrent uncertainty of weather conditions and the crop failures bring about the increase demand for livestock products. Hence, the contribution of livestock for food production is increasing at a higher rate than that of cereals in developing countries (FAO, 1997). The total population of cattle, sheep, and goat in Ethiopia is estimated as 53.4 million, 25.5 million, and 22.78 million, respectively (CSA, 2011). The Institute of Biodiversity Conservation (IBC) tried to document the general overview of the indigenous small ruminant breeds inhabited in Ethiopia. About 14 breeds of sheep and 15 breeds of goat inhabited in the low land, midland, and highland agro ecologies of the country (IBC, 2004). Abergelle, Begait, Ille and highland sheep are the four sheep breeds inhabited the regional government of Tigray under varied agro ecological zones including lowland, midland and highland. The highland sheep breed found in Atsbie district is characterized as small breed with an average live body weight of 28 kg and 23 kg for the adult (≥3 years and above) male and female sheep, respectively. Breed improvement through selection under smallholder farmer is important for ensuring sustainable improvement of the indigenous sheep breeds. Indirect estimation of body weight to an acceptable degree of accuracy using a prediction equation based on linear body measurements is of considerable practical use. Body measurements especially body length; heart girth and height at withers are used to describe the population of the sheep breed and are prerequisites for further genetic gain improvements (Alemayehu and Tikab, 2010). The three linear body measurements mentioned above are the most important criteria for selection of individual animals. Live body weight is also used as criteria for performance evaluation of the individual animals (Seifemichael *et al.,* 2014). Despite the importance of sheep to the local economy, there are limited attempts for phenotypically characterize the highland sheep dominating a unique ecological niche neighboring a lowland Afar pastoral system. The aim of this study was to evaluate morphological characteristics of highland sheep using physical body characteristics and linear body measurements. The objective of the study was to conduct phenotypic characterization in the highland sheep population.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out in Atsbiwonberta district located between 390 30’ E - 390 45’ E and 130 30’ N- 130 45’ N and about 75 km northeast of Mekelle. Annual rainfall and temperature are more than 600 mm and 18 ºC, respectively (Mulata, 2013). About 75% of the woreda is upper highlands (2600 meter above sea level or above) and only 25% is found in midlands (between 1500 and 2600 meter above sea level) and lowlands (below 1500 meter above sea level) (Alembirhan; personal communication held on August 26, 2014). The dominant agricultural production system is mixed crop-livestock production with barley/wheat/pulses small ruminant dominant sheep production (Solomon *et al.,* 2013).

2.2. Sampling procedure and Data Collection

Two hundred fifty seven sheep (121 males and 136 females) were randomly selected for phenotypic characterization of the highland sheep found in Atsbiwonberta. Three representative PAs (Peasant Association) namely, Habes, Golgolnaele and Gebrekidan were selected. The animals were divided into four age groups of male and female sheep as: 0 PPI (Pairs of Permanent Incisors), 1 PPI, 2 PPI and 3 PPI consisted of 90, 45, 38 and 84 animals, respectively. They were managed under the traditional management, which is free grazing with little or no supplementation after returning to home. The descriptor lists are adopted from FAO (2012).

2.3. Data collection

The variables measured included live weight recorded using Salter scale with capacity of 50 kg (accuracy nearest 200 g) and linear body measurements using meter tape (1.5 meter and accuracy 0.5 cm) were recorded early in the morning, with the animals standing on a flat surface with head held up. About 12 linear body measurements namely, Heart girth (HG), Height at Withers (HW), HW (Height at Wither), Height at Rump (HR), Shoulder Width (SW), Body length (BL), Chest Depth (CD), Ear length (EL), and Ear width (EW), Horn Length (HL), Tail Length (TL), Head Width (HeW) and Head Length (HeL) were recorded for all of the sampled animals. The anatomical reference points (ESGPIP, 2009) were as follows:

1. HG was measured by taking the circumference of the chest using a tailor's tape calibrated in cm, taken as the circumference of the body immediately behind the shoulder blades in a vertical plane, perpendicular to the long axis of the body.
2. HW was measured as the distance from the ground to the withers
3. BL was the distance from the head of humerus to the distal end of the pubic bone.
4. SW was measured as a distance between the shoulders.
5. CD was measured as the distance between the top behind the scapular and the flow of the sternum (taken to be the depth of brisket) immediately behind forelegs.

2.4. Statistical analysis

Live body weight and Linear body measurements were subjected to List-square analysis of variance using the General Linear Model (GLM) procedure of SPSS version 16.0 with sex and age as fixed effects. The Tukey's simultaneous test was used to separate significance of least-square means.

$Y_{ijk} = \mu + S_i + Tj + (ST)ij + e_{ijk}$ ……GLM analysis of variance

Where:

Y_{ijk} = The observation on body weight and other linear body measurements;
W = The observation on live body weight of the animal
μ = Overall mean;
S_i = Fixed effect of sex (i = Female, Male);
T_j = Fixed effect of age (j = 0 PPI, 1PPI, 2PPI, ≥3 PPI);
$(ST)_{ij}$ = the interaction effect of sex with age;
e_{ijk} = effect of random error

3. Results and Discussions

3.1. Physical body characteristic of the highland sheep

The morphological descriptions of the highland sheep are presented in table 1. The study observed for coat pattern in highland sheep population. Majority of the highland male sheep had uniform (52.4%) and shaded (26.8%) while the frequently observed coat pattern in the female sheep was spotty 45.5% (white on beige) followed by shaded 36.8%. Majority of the male (58.9%) and female (62.3%) sheep characterized as medium hair length (1-2 mm). Lateral ear orientation (93.5%), uniform coat pattern (49 %) with beige color (light brown), medium hair length with course hair (61%), curved (50%) horn shape with lateral orientation (58%), In-between the lanky and compacted body shape (82%) and flat face (62%) are among the major physical characteristic of the highland sheep flock found in the study area. Mulata *et al*., (2014) reported that the sheep population found in Atsbiwonberta is characterized as dominant coat color of red brown, flat face profile, long hair length, curled hair type and horn is absent in majority of the sampled sheep. According to the ESGPIP (2009), body shape is the relative contribution of body length; heart girth and height at wither. Coat color and presence of horn are among the qualitative body traits used as a criterion to select individual sheep for breeding purpose (Bosenu *et al*., 2014). Another author reported similar findings that coat color is among the qualitative body characteristics, the local community selects breeding rams and ewes based on the coat color (Dhaba *et al*., 2012).

Table 7. Observed morphological characteristics of the highland sheep

Physical body character	Variables	Male	%	Female	%	Total	%
	Uniform	121	52.4	105	45.5	226	**49%**
Coat patter	Pied	23	10	16	6.9	39	8%
	Spotty	25	10.8	25	10.8	50	11%
	Shaded	62	26.8	85	36.8	147	**32%**
	Total	**231**	**100**	**231**	**100**	**462**	**100%**
	Short(<1 mm)	29	12.6	39	16.9	68	15%
Hair length	Medium(1-2 mm)	136	58.9	144	62.3	280	**61%**
	Long(>2 mm)	66	28.6	48	20.8	114	**25%**
	Total	**231**	**100**	**231**	**100**	**462**	**100%**
	Straight	9	3.9	0	0	9	2%
Hair type	Curly	83	35.9	83	35.9	166	**36%**
	Smooth	35	15.2	28	12.1	63	14%
	Glossy	102	44.2	117	50.6	219	**47%**
	Dull	2	0.9	3	1.3	5	1%
	Total	**231**	**100**	**231**	**100**	**462**	**100%**
Ear orientation	Upright	22	9.5	6	2.6	28	6.1%
	Lateral	207	89.6	223	96.5	430	93.5%
	Dropping	2	0.9	0	0	2	0.4%
	Total	**231**	**100**	**229**	**99.1**	**460**	**100.0%**
Horn presence	Present	180	79%	51	23%	231	52%
	Absent	49	21%	168	77%	217	48%
	Total	**229**	**100%**	**219**	**100%**	**448**	**100%**
Horn shape	Straight	60	26	21	9.1	81	31%
	Curved	114	49.4	16	6.9	130	50%
	Spiral	15	6.5	8	3.5	23	9%
	Corkscrew	16	6.9	9	3.9	25	10%
	Total	**205**	**88.7**	**54**	**23.4**	**259**	**100%**
Horn orientation	Upright	53	22.9	10	4.3	63	33%
	Forward	24	10.4	11	4.8	35	18%
	Lateral	95	41.1	16	6.9	111	58%
	Dropping	19	8.2	13	5.6	32	17%
	Polled	1	0.4	0	0	1	1%
	Total	**192**	**83.1**	**50**	**21.6**	**192**	**100%**
Body shaped	Compact	7	3	7	3	14	3%
	Lanky/leggy	25	10.8	44	19	69	15%
	In between	194	84	178	77.1	372	82%
	Total	**226**	**97.8**	**229**	**99.1**	**455**	**100%**
Face profile	Flat	138	59.7	148	64.1	286	62%
	Concave	76	32.9	73	31.6	149	32%
	Convex	17	7.4	10	4.3	27	6%
	Total	**231**	**100**	**231**	**100**	**462**	**100%**

The course hair type of the highland sheep is among the indictor for evaluating the adaptability of the sheep population (Fig 1). This report of the current finding is in line to the previous finding of Mulata *et al*., (2014) reported that the sheep population found in the same study district is classified as short fat tailed sheep type. According to the ESGPIP**, (2009),** there are four sheep groups in Ethiopia. These sheep groups are classified based on physical body characteristics.

Figure 1. Adult female (left image) and male (right image) of the highland sheep

The highland sheep flock composed of lambs, rams, and ewe that survived and reproduced in the highland dry agro ecology of Atsbiwonberta. The highland sheep developed an adaptive mechanism to the cool and dry weather condition through its hair type. It owned attractive body color and body shape, which are the base for community based sheep breed improvement (Fig 2).

Figure 2. Flock of the highland sheep adapted in the dry area of the Atsbiewonberta district

Figure 2 illustrated that most of the highland sheep owned light to dark brown coat color, medium hair length, short ear length with lateral ear orientation, short fat tailed face, and body profile, and horn length and shape. Horn is mostly absent in female highland sheep (Fig. 2). The indigenous sheep population found in Atsbiwonberta is characterized as short fat tailed.

3.2. Body weight and linear body measurements

The main source of variation on live body weight and linear body measurement were sex, age and the interaction of both sex and age. Table 4 summarized the least squares means for live body weight and body measurement in different age groups and sex for the highland sheep breed.

3.2.1. Effect of sex on live body weight and linear body measurement of the highland sheep: The differences in body weight and body conformation (size of height, length, and girth) phenotypically expressed as the sexual morphological variation (Seifemichael *et al.,* (2014). Sex of the sheep exerted significant ($p<0.05$) effects on body weight and other linear body measurements except shoulder width, Chest depth, Ear length, Ear width, Head length

and Head width. The finding of the current report is in line to the previous findings of Mengistie *et al.,* (2010) reported that a significant effect of sex on body weight, heart girth, body length and height at wither in Washera sheep. However; previous findings of Mulata *et al*., (2014) reported that sex has no significantly (p>0.05) effect on body weight, heart girth, body length and height at wither in highland sheep found in Atsbiwonberta.

3.2.2. Effect of age on live body weight and linear measurement of the highland sheep

In the highland sheep found in Atsbiwonberta, age has an effect on live body and linear body measurements. As age of the individual animal advanced, the average values of live body weight, heart girth, body length, and height at wither are significantly (P<0.05) increased in the highland sheep population. Mulata *et al*., (2014) reported that age is found to significantly (P<0.0001) affect body weight, heart girth, body length and height at withers in the Elle sheep breed. The report of the current finding is in line to the previous reports of Seifemichael *et al.,* (2014) who found that age has a significantly (P<0.05) effect on body weight, body length, chest girth; wither height, pelvic width, horn length, ear length, and rump height in the Afar goat breed type. The current study observed that growth rate from 0 PPI to 1PPI was higher than as compared to that from 1PPI to 2 PPI and 2 PPI ≥ 3PPI in live body weight of the highland sheep population (Fig .3). This result of the current finding is in line to the previous reports of (Seifemichael *et al.,* (2014) who stated, "as the age of the animals increased, there was wide variability for body measurements".

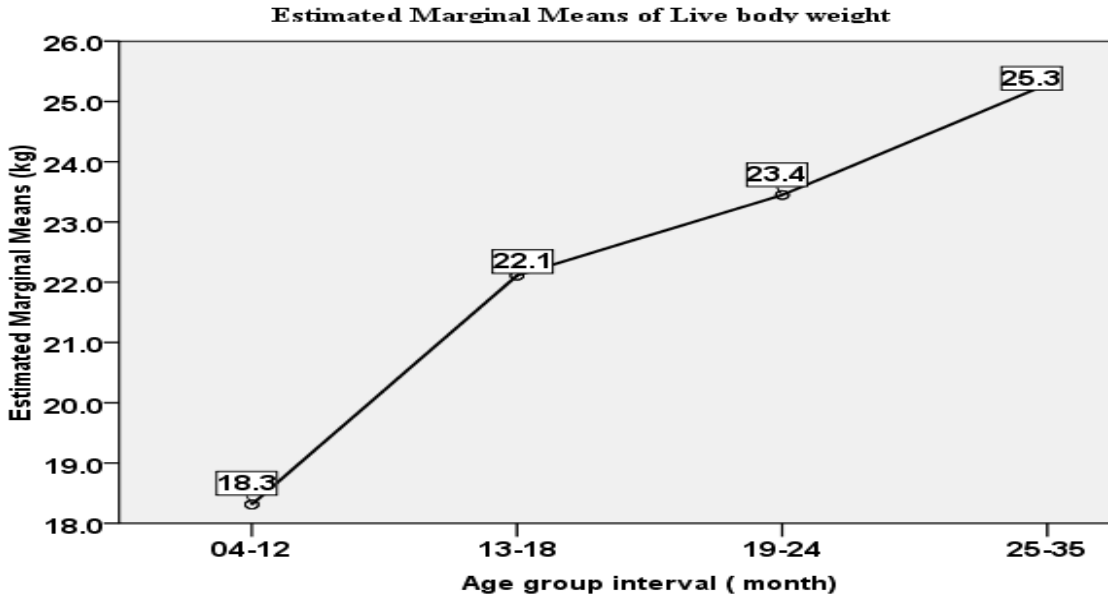

Figure 3. Effect of age on live body weight in relation to growth rate in the highland sheep

3.2.3. Sex by age interaction:

The hormone difference between male and female sheep induces faster growth in male than in female sheep. As the age of the male and female sheep advanced, their body size also increased resulted male are heavier than female sheep. It is obvious that both sex and age have a synergetic effect of body size of the animal. The interaction between sex and age significantly (p<0.05) affected body weight, heart girth, height at wither, body length, and height at rump while shoulder width, ear width, ear length, head width, head length and horn length were not affected significantly (P>0.05). The current finding in the interaction effect of sex and age on body weight, heart girth and at height wither is in line to the previous findings of (Seifemichael *et al.,* (2014).

3.3. Live body weight

The overall mean (±SE) live body weight for male and female sheep was 23.3±0.5 kg and 20.9±0.3 kg, respectively. The mean (±SE) live body weight for male and female highland sheep at matured age (≥3 PPI) was 28.9±0.8 kg and 23.4±0.2 kg, respectively. This report of the current finding is within the range of the previous findings reported as minimum and maximum average matured weights 21.6±9.3 and 41.5±2.0 kg, respectively in Ethiopia sheep (Abebe, 2010). The current finding observed a significant (P<0.05) difference on live body weight between male and female sheep under studied. Similar findings were reported in the highland sheep found in the regional government of Tigray (Mulata *et al*., 2014) and Alemayehu and Tikab, (2010). The regardless of the sex, the least squares mean of the live body weight at age groups of 0 PPI, 1 PPI, 2 PPI, and ≥3 PPI was 18.3±0.2 kg, 22.1±0.5 kg, 23.5±0.5 kg and 25.3±0.4 kg, respectively. Live body weight is significantly (P<0.05) increased while the individual animal steadily grow (Table 4). Regardless of the sex, the least squares mean of the live body weight at adult age (≥3 PPI) was 25.3±0.4 kg, which is higher than the previous report of Alemayehu and Tikab, (2010) who reported as 20.46± 2.98 kg in the highland sheep found in the regional government of the Tigray. This report of

the current finding closely related to the previous finding reported as 26.7±0.45 kg for Washera sheep (Mengistie *et al*., 2010) and 23.8± 0.9 kg for Abergelle sheep Seare *et al.,* (2011). The mean live body weight of the highland male sheep at age groups of 0 PPI, 1 PPI, 2 PPI, and 3 PPI was recorded as 19.3±0.3 kg, 23.0±0.6 kg, 25.7±0.8 kg and 28.9±0.8 kg, respectively. For highland female sheep in the four-age category was 17.1±0.1 kg, 20.1±0.6 kg, 22.3±0.4 kg and 23.4±0.2 kg, respectively. A significant (P<0.05) difference was observed between the live body weight of the male and female sheep in all age categories, which indicated that male are heavier than female (Table 4). This report of the current finding is in line to the previous findings of Seare *et al.,* (2011) who reported that male sheep are outgrow female sheep across age categories in the Abergelle sheep. Afolayan, *et al*., (2006) found that male lambs were heavier at birth (2.92±0.07 vs 2.64±0.07) than the female counterparts in Yankasa sheep of Nigeria. During growth phase male lambs were 8% longer and had 17% more muscles than female lambs (Afolayan, *et al*., 2006).

3.4. Heart girth

The mean value of heart girth for male and female highland sheep was 71.6±0.6 cm and 68.4±0.4 cm, respectively. The study observed a significant (P<0.05) difference in heart girth between male and female of the highland sheep, which indicated that male have deep heart girth than female. This report of the current finding is similar with the previous finding of Mengistie *et al*., (2010) who observed that a significant (P<0.01) difference in heart girth between male and female of the Washera sheep. The heart girth of the highland sheep is smaller than from heart girth of Washera sheep reported as 75.7 cm and 73.1 cm for male and female, respectively. For the age categories of 0 PPI, 1 PPI, 2 PPI, and 3 PPI, the mean value of heart girth was 64.6±0.4 cm, 70.2±0.7, 72.3±0.7 cm and 74.4±0.9 cm, respectively. Significant (P<0.05) difference in mean value of heart girth was observed within the age groups. As the animal grow, the mean value of heart girth also advanced with age of the individual animal (Alemayehu and Tikabo, 2010). There was a significant (P<0.5) difference observed between male and female of the corresponding age categories in which male are larger than female in heart girth (Table 4).

3.5. Body length

The mean value of body length for male and female highland sheep was 57.6 cm ± 0.8 cm and 54.9 ± 0.5 cm, respectively. This report of the current finding is higher than from the previous findings reported as 49.59 ± 3.11 cm and 47.94 ± 3.12 cm for female and male highland sheep found in Tigray (Alemayehu and Tikabo, 2010). The value obtained in the current finding is comparable with the value reported as 58.3 cm and 57.0 cm for male and female, respectively for Washera sheep (Mengistie *et al*., 2010) and 56.7 cm and 59.7 cm for male and female highland sheep found in the same study area of the current study (Mulata *et al*., 2014). For the age categories of 0 PPI, 1 PPI, 2 PPI, and 3 PPI, the mean value of body length was 51.7±0.5 cm, 55.4±1.0 cm, 57.2±1.1 cm and 60.9±0.8 cm, respectively. Significant (P<0.05) difference in mean value of body length was observed between male and female. Significant (P<0.05) difference in mean value of body length was also observed among the age groups except between 1PPI and 2 PPI. There was a significant (P<0.5) difference observed between male and female of the corresponding age categories in which male are larger than female in body length (Table 4).

3.6. Height at wither

The mean values of height at wither for male and female of the highland sheep was 62.2 ± 0.7 cm and 58.5 ± 0.5 cm, respectively. The mean values of height at wither for the highland sheep observed in the current finding is in line to the previous findings reported as 56.7 cm and 59.7 cm (Mulata *et al*., 2014) and 57.9±0.8 cm and 59.0±0.5 cm (Zelealem *et al*., 2012), for male and female sheep, respectively. The height at wither for highland sheep reported in the current study is smaller than from the Washera sheep reported as 70.8 cm and 67.1 cm for male and female, respectively (Mengistie *et al*., 2010). For the age categories of 0 PPI, 1 PPI, 2 PPI, and 3 PPI, the mean value of height at wither was 55.8±0.5 cm, 60.6±0.8 cm, 61.2±1.0 cm and 64.4±0.8 cm, respectively. Significant (P<0.05) difference in mean value of height at wither was observed between male and female indicated that male have large height at wither than female. Significant (P<0.05) difference of height at wither was also observed among the age groups except between 1PPI and 2 PPI. There was a significant (P<0.5) difference observed between male and female of the corresponding age categories in which male are higher than female in height at wither (Table 4).

3.7. Ear length and Width

The highland sheep found in Atsbiwonberta district is characterized as small ear size with mean ear length of 10.0 ± 0.2 cm and 9.8 ± 0.2 cm for male and female, respectively (Table 4). It also observed that the ear width of the highland sheep is narrow with 5.8 ± 0.2 cm and 5.5 ± 0.1 cm for male and female, respectively. The study found that no significant (P>0.05) difference in the ear length and width between male and female of the highland sheep under study.

3.8. Tail and horn length

The mean tail length for male and female highland sheep was 17.0±0.3 cm and 15.3±0.3 cm, respectively. The mean horn length of male and female highland sheep was 6.4±0.4 cm and 3.12 ± 0.2 cm, respectively.

3.9. Head width and length

The mean head width for male and female highland sheep was 10.3±0.2 cm and 10.0 ± 0.2 cm, respectively. The mean head length of male and female highland sheep was 16.6 ± 0.3 cm and 17.3 ± 0.3 cm, respectively. The highland sheep is characterized as medium face appearance.

Table 8. Least square means (±SE) of body weight (kg) and linear body measurements (cm) for the effect of sex, age and sex by age interaction on LBW and LBM

Effect and level	BW	HG	HW	RH	SW	BL	CD	E L	Ew	HL	TL	HeW	HeL
Sex	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Male	23.3±0.5^{a}	71.6±0.6^{a}	62.2±0.7^{a}	61.9±0.6^{a}	7.9±0.2^{a}	57.6±0.8^{a}	6.9±0.2^{a}	10.0±0.2^{a}	5.8±0.2^{a}	6.4±0.4^{a}	17.0±0.3^{a}	10.3±0.2^{a}	16.6±0.3^{a}
Female	20.9±0.3^{b}	68.4±0.4^{b}	58.5±0.5^{b}	60.1±0.5^{b}	7.3±0.1^{a}	54.9±0.5^{b}	6.8±0.2^{a}	9.8±0.2^{a}	5.5±0.1^{a}	3.12±0.2^{b}	15.3±0.3^{b}	10.0±0.2^{a}	17.3±0.3^{a}
Age													
0 PPI	18.3±0.2^{d}	64.6±0.4^{d}	55.8±0.5^{c}	56.8±0.7^{c}	6.91±0.1^{b}	51.7±0.5^{c}	6.0±0.1^{b}	9.3±0.2^{b}	5.3±0.1^{b}	6.03±0.4^{b}	14.8±0.3^{b}	9.4±0.3^{b}	16.7±0.3^{b}
1 PPI	22.1±0.5^{c}	70.2±0.7^{c}	60.6±0.8^{b}	61.7±0.8^{b}	8.1±0.2^{a}	55.4±1.0^{b}	7.4±0.4^{b}	9.9±0.2^{b}	6.1±0.4^{ab}	5.93±0.7^{b}	16.6±0.6^{a}	9.7±0.4^{b}	14.5±0.4^{c}
2 PPI	23.5±0.5^{b}	72.3±0.7^{b}	61.2±1.0^{b}	64.0±0.6^{a}	7.7±0.3^{a}	57.2±1.1^{b}	6.4±0.2^{a}	9.8±0.3^{ab}	5.6±0.1^{ab}	3.71±0.5^{a}	16.2±0.6^{a}	11.4±0.3^{a}	17.7±0.5^{ab}
≥3 PPI	25.3±0.4^{a}	74.4±0.9^{a}	64.4±0.8^{a}	63.6±0.5^{a}	8.1±0.2^{a}	60.9±0.8^{a}	7.7±0.2^{a}	10.5±0.2^{a}	5.8±0.1^{a}	2.96±0.3^{a}	17.1±0.3^{a}	10.6±0.3^{ab}	18.4±0.8^{a}
Sex and Age													
Male 0 PPI	19.3±0.3^{f}	66.3±0.5^{e}	57.6±0.7^{e}	59.0±0.8^{d}	7.2±0.2^{a}	52.2±0.7^{cf}	6.4±0.2^{b}	9.5±0.3^{a}	5.4±0.2^{a}	7.8±0.5^{a}	16.0±0.5^{b}	9.7±0.4^{a}	16.8±0.4^{a}
Male 1 PPI	23.0±0.6^{c}	71.5±0.9^{d}	61.5±0.9^{c}	61.4±0.9^{c}	8.2±0.3^{a}	56.3±1.1^{cd}	7.1±0.4^{ab}	9.7±0.3^{a}	6.3±0.5^{a}	7.1±0.8^{a}	17.0±0.7^{a}	9.6±0.4^{a}	14.4±0.6^{b}
Male 2 PPI	25.7±0.8^{b}	75.3±1.2^{b}	64.3±1.5^{b}	65.3±1.6^{a}	8.5±0.4^{a}	60.6±1.7^{b}	6.1±0.3^{b}	10.5±0.4^{a}	5.4±0.2^{a}	5.5±1.1^{b}	17.5±1.0^{a}	11.3±0.3^{a}	17.1±0.8^{a}
Male ≥3 PPI	28.9±.8^{a}	79.1±1.1^{a}	69.6±1.3^{a}	65.7±1.0^{a}	8.7±0.4^{a}	66.5±1.5^{a}	7.9±0.3^{ab}	10.8±0.3^{a}	6.1±0.0^{a}	3.9±0.7^{c}	18.6±0.6^{a}	11.7±0.1^{a}	18.2±0.7^{a}
Female 0 PPI	17.1±0.1^{a}	62.6±0.3^{f}	53.8±0.7^{f}	54.3±1.0^{e}	6.6±0.2^{b}	51.1±0.6^{f}	5.6±0.2^{c}	9.0±0.3^{a}	5.1±0.1^{a}	4.0±0.5^{bc}	13.6±0.4^{c}	8.9±0.3^{b}	16.5±0.4^{b}
Female 1 PPI	20.1±0.6^{e}	67.4±0.7^{e}	58.4±1.3^{de}	62.3±1.4^{bc}	7.7±0.3^{a}	53.29±2.0^{e}	8.0±1.0^{a}	10.4±0.4^{a}	5.6±0.2^{a}	3.4±0.9^{c}	15.8±0.9^{ab}	9.9±1.0^{a}	14.6±0.8^{b}
Female 2 PPI	22.3±0.4^{d}	70.8±0.8^{cd}	59.5±1.2^{d}	63.4±0.5^{b}	7.4±0.3^{a}	55.4±1.3^{d}	6.5±0.2^{b}	9.4±0.4^{a}	5.6±0.1^{a}	2.8±0.5^{d}	15.5±0.7^{ab}	11.4±0.5^{a}	18.0±0.6^{a}
Female ≥3 PPI	23.4±0.2^{c}	72.0±0.4^{c}	61.6±0.7^{c}	62.5±0.5^{bc}	7.8±0.2^{a}	57.9 ±0.7^{c}	7.6±0.3^{ab}	10.3±0.2^{a}	5.6±0.1^{a}	2.5±0.2^{d}	16.3±0.4^{b}	10.1±0.3^{a}	18.4±0.4^{a}

Means with different superscripts within the same column and class are statistically different at significant at 0.05.

Conclusion

The highland sheep mainly characterized as lateral ear orientation, uniform coat pattern with beige color, medium hair length with course hair, curved horn shape with lateral orientation, In-between the lanky and compacted body shape, and flat. It is classified as short fat tailed sheep breed adapted to the highland agro ecology. The live body weight and major linear body measurements of the males are higher than those of females are and the difference in these measurements between males and females increased with age. At the adult age (≥3 PPI), the highland ram and ewe sheep had an average live body weight of 28.9±0.8 kg and 23.4±0.2 kg, respectively. The study observed that the highland sheep found in Atsbiewonberta is a small sheep breed with an adult average live body weight of 25.3±0.4 kg. Further research is needed to investigate the relation between the body weight and linear body measurements. Therefore To increase the validity of this on farm preliminary study, it is important to undertake well planned on station study for phonotypic and genetic characterization of sheep within breeds and then to improve their genetic potential.

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