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Evaluation on the Structural Indices Unveil Performance Variation among Dorper, Local and their F1 Crossbred Sheep Population in Ethiopia

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Abstract

The study was conducted at Sirinka Agriculture Research Center to assess the structural indices of local, local x pure Dorper 50% crossbreds and pure Dorper sheep. The study was performed based on body linear measurements and three hundred three (303) sheep were selected for this study. From the total samples 81, 128 and 94 sheep were local, 50% crosses and pure Dorper, respectively. The animals were grouped into three age groups based on pairs of Permanente incisor as (0 pairs of permanent incisor, 1 pairs of permanent incisor, and ≥ 2 pairs of permanent incisor). General linear model of SAS 2008 was used for statistical analysis of the collected data. Ten Structural indices were calculated for the three sheep populations separately. The average values of structural indices were compared within a breed while the correlation between structural indices was studied. Sex, age and sex by age interaction effect were the fixed effects considered for the analysis. Body index, weight index, thoracic development, body ration, height slop, length index, width slop, depth index, balance and pelvic index were used in the standard formula to calculate structural indices. Weight index (24.82 kg, 26.61 kg), height slop (2.95 cm, 1.71 cm), width slop (0.85 cm, 0.93 cm), body index (78.57 cm, 88.42 cm), thoracic development (1.14 cm, 1.28 cm) and pelvic index (77.61 cm, 85.08 cm) were the total mean value of local and crossbred sheep, respectively. As a conclusion, pure Dorper and crossbred sheep exhibit meat type traits. It was suggested to observe the performances of pure Dorper and crossbreds in farmers' management condition.

Keywords: Crossbred; Dorper sheep; Phenotype; Structural indices

Introduction

The index system for assessment of type and function in cattle was developed by Alderson [1], who suggested that the application can be used to other species of animals. Type and function are considered better indicators of the usefulness of the animal than weight. The larger animal also has implications for maintenance requirements, as well as for adaptation to local conditions which should be taken into consideration when examining the production system with respect to animal's body conformation [2].

The indices are considered an option for assessment of weight because they incorporate measures of desirable conformation, namely, length and balance [1]. Salako [3] suggested that indices that are produced from measurements that are more closely associated with bone growth such as foreleg length, height slope and length index (RBI) are more appropriate for assessment of type. production performances especially in function of meat production can be assessed from body measurements such as chest girth, body length, chest width, rump width and chest depth, which are more closely associated with bone or muscle growth. Structural indices are important for the prediction of milk and meat production performance and also indices are important to predict animal performance in terms of fitness, good respiratory system and in terms of animal's gravity center and balance [2].

Assessment of type by using body measurements is more objective than those obtained by visual appraisal, though both are still inferior to "function" as criteria for selecting breeding stock. Structural indices were combinations of several linear measurements or morphometric measurement, the results of which are expressed as a percentage and indicate the type and function of a particular breed [2-4].

Indices offer accurate estimation of an animal's conformation when compared to individual measurement alone. Structural indices also provide tested empirical values which are limited 19 in the use of single measurements. They are also used for the assessment of type, weight and function as well as enhance the ability of breeders to select potential breeding stock [3]. Structural indices are calculated from morphometric traits and provide evaluation of animals to buyers since the morphometric measurements are related with production characteristics [1-3].

Assessment of animal weight (due to its association with desirable conformation such as length and balance) are better done using indices [2-4].

This study aims to assess the importance of structural indices for evaluation of performances of local, pure Dorper and their crossbred sheep with the aim to support decisions related to management and future implementation of breeding system in that area; more comprehensive information on structural index of local, crossbred and pure Dorper sheep should be available. This paper revealed structural indices analysis to know production performance and body conformation variation with in a breed for the above mentioned sheep breeds at Sirinka Agricultural Research Center.

Materials and Methods

Study areas

The study was conducted at Sirinka Agricultural Research Center in Ethiopia, which is situated at an elevation of 1850 meters above sea level. It has a bi-modal type of rainfall receiving average annual rainfall at about 950 mm, in which the main rainy season "summer" occurs from June to September and the short rainy season "autumn" runs from February to April is erratic. The average maximum and minimum temperatures of the area are 26°C and 13°C, respectively.

Description of breeds: The local sheep kept at the Sirinka station locally named as "Tumelie". The community in the study area believes that the local sheep was a cross between Wollo and Afar sheep population [5] classified this sheep population as Afar sheep breed; however, Sisay Lemma [6] grouped it with the rift valley sheep. F1 Local × Dorper (50%) crossbred sheep were the cross of local and pure Dorper sheep which was developed from a Dorset Horn ram and a Blackhead Persian ewe in the harsh dry regions of South Africa [7].

Animals' management: The management system in the herd was that lambs born all year round were raised together with their parent dams until weaning (85-95 days). After weaning, lambs were managed as a flock separately from their dams grazed on natural pasture until they are distributed to the local farmers. During mating ewes kept together with their respective sire groups.

Concentrate supplementations were provided for each sheep based on their age and physiological status. Lactating ewes and rams supplemented 300 g/h/day of concentrate; consisting of 32% noug cake, 65.5% wheat bran, 1% limestone and 0.5% salt and none lactating ewes supplemented with 200 g/h/day of concentrate. Lambs had no access to concentrate feed other than grazing and their dam's milk before weaning. After weaning they are supplemented with 100-150 g/h/day of concentrate until they are able to graze actively. All animals received sprayed, vaccinated and appropriate treatment for common health problems as per the recommendations of the research center. There were pens and crash for vaccination and other treatments in the clinic that founds in research centers farm.

Data collection procedures

Seven separate measurements were used for all sheep in the sample population for the calculation of structural indices. The common measurements were body length, chest girth, chest depth, rump width, shoulder width, height at wither and height at rump. These all measurements were collected from 303 sheep which included 81 local, 94 Dorper and 128 crossbred sheep and also comprising 115 male and 188 female sheep. The ages of the sheep were grouped as 0 pairs of permanent incisor, 1 pairs of permanent incisor and ≥ 2 pairs of permanent incisor. The reason that 3 pairs of permanent incisors and 4 pairs of permanent incisors included in ≥ 2 pairs of permanent incisor was small number of observations in 3 pairs of permanent incisor and 4 pairs of permanent incisor age group.

Local and crossbreds were measured for the morphometric traits by using measuring tape and weighed using a spring balance whereas pure Dorper sheep were also measured by using measuring tape but were weighed by suspension balance since they were so heavy and difficult to weight them by spring balance. To construct indices; measurements anatomically related to each other were paired. The Most economically important calculated indices in this study were: Body index, weight, thoracic development, body ration, height slop, length index, width slop, depth index, balance and pelvic index. All the measurements were taken by one person/researcher in order to avoid any measuring error. The FAO, 2012 [8] quantitative sheep breed descriptor list and measuring techniques were followed to characterize the sheep types. Before measuring various parameters, the animals were restrained and calmed properly. All measurements were taken early in the morning prior to feeding to protect gut feeling and were taken to an up-right plane during measurement. Pregnant and lactating animals excluded in the sampling to avoid bias because of the effect can produce on parameters like thoracic measurements.

Statistical analysis

Data of the structural indices were derived from the linear measurements according to standard calculation as shown blow. G.L.M. analysis procedure of SAS, 2008 [9] was employed for the index and LSM ± SE, CV and R2 were generated. These all indices analyses were done for each population separately and computed for each age and sex groups.

From the linear measurements, the following ten conformation indices were calculated for each population and each sex and age group According to [1-4]. In order to assess the type and function of the three sheep breed. Morphology indices were calculated as follows:

Body index (BI)=Body length × 100 / Chest girth, [2,4].

Weight (W)=Body length × chest depth × (rump width + shoulder width)/2) /1050. Weight above 45 kg correspond to large or hypermetric animals, between 35 and 45 kg medium or eumetric animals and less than 35 kg, small or elipometric animals [2,4].

Thoracic Development (TD)=chest girth/ height at wither [2]

Body ratio (BR)=HW/HR [2,4,10]

Height slope (HS)=rump height-Wither height. If the withers are lower than the rump, the animal is low in front and vice versa [3,4,10,11]

Length index (LI)=Body length/wither height [3,4,10]

Width slope (WSI)=rump width/shoulder width [2-4]

Depth index (DI)=Chest depth/ wither height [3,10]

Balance (B)=(rump length*rump width)/ (chest depth*shoulder width) [2-4]

Pelvic index (PI)=rump width *100/ rump length [2,4,10]

Model to analyze body indices

Model 5

$Y_{ijkl}=\mu + A_j + S_l + (AS)_{jl} + (E)_{ijkl}$

Where:

Y_{ijkl}=Observation on response variables

μ=Population mean

A_j=the effect of jth age group (j=0PPI, 1PPI, ≥ 2PPI)

S_l=the effect of lth sex (l=male, female)

$(AS)_{jl}$=the effect of interaction of jth age group with ith of sex

E_{ijkl}=random residual error

Correlation of structural indices: Pearson's correlation coefficients for each breed were estimated between weight index and other body indices within sex. SAS version, 2008 [9] was used for the analysis. Body weight and other indices such as: Body index (BI), Thoracic Development (TD), Body ratio (BR), Height slope (HS), Length index (LI), Width slope (WSI), Depth index (DI), Balance (B) and Pelvic index (PI) were included for both males and females sheep for each breed.

Results and Discussion

The result of structural indices in this study indicated that; local sheep scored the mean value of width slop (0.85 cm), length index (0.89 cm), height slop (2.95 cm) and balance (0.67 cm). Width slop and height slop of local sheep in this study was lower than the previous report by Salako [3], which was 5.25 cm and 3.32 cm on Yankasa sheep in Nigeria. This study also indicated that width slop (0.93 cm), length index (1.07 cm), height slop (1.71 cm) and balance (0.81 cm) for crossbred. Height slop of crossbred sheep in this study was lower than the previous report of Handiwirawan et al. [12], which was 4.33 cm on Barbados Black Belly cross sheep in Indonesia.

However, length index of crossbred sheep was in agreement with the above similar report of Handiwirawan et al. [12] which was 1.09 cm on Barbados Black Belly sheep. Weight slop, length index, height slop, balance and depth index of Dorper sheep was 35.75 kg, 1.10 cm, 0.27 cm, 0.67 cm and 0.41 cm, respectively. Depth index of Dorper sheep was in agreement with the previous report which was 0.46 cm on Sumatra composite sheep breed in Indonesia [12].

Structural indices calculation for local, crossbred and Dorper sheep breeds

Sex effect: Structural indices such as; weight index, height slop, length index, width slop, depth index, body index, thoracic development, body ration, balance and pelvic index were analyzed for each breed and each sex separated by three age groups. It transpires weight had significant (p<0.01) effect on sex, age and sex-age interaction of local sheep breed. In addition to weight, width slop, depth index and pelvic index had significant effect on sex of local sheep and they had a mean value of 28 kg, 0.66 cm, 0.43 cm and 72.71 cm, respectively for males and 20 kg, 1.04 cm, 0.39 cm and 82.51 cm, respectively for female sheep. This denotes that local rams were larger in weight and width slop than local ewes while female sheep were larger in pelvic index. In this study the result of width slop, balance and depth index of local rams was smaller than the previous report of [3] which was 6.22 cm, 0.79 cm and 0.49 cm, respectively on 4 pairs of permanent incisors of Yankasa sheep in Nigeria.

Sex had significant (P<0.001) effect on Weight index, width slop, body ration and balance of crossbreds. The overall mean value of height slop, width slop, length index and balances of crossbred sheep was 1.71 cm, 0.93 cm, 1.07 cm and 0.81 cm, respectively. Height slop (1.66 cm), length index (0.93 cm) and width slop (0.77 cm) of WAD sheep in Nigeria as reported by Salako [3] was in agreement with the current study results of crossbred sheep. Weight index, width slop, body index and pelvic index of crossbred rams had the mean value of 29.48 kg, 0.83 cm, 82.88 cm and 82.30 cm, respectively. Similar indices keep their order scored 23.74 kg, 1.02 cm, 93.96 cm and 87.96 cm, respectively for crossbred ewes. Crossbred ewes were larger in width slop and balance while males were larger in weight and body ration. Depth index, height slop and width slop of crossbred rams scored 0.40 cm, 0.15 cm and 0.83 cm, respectively. This result was lower than the report of Handiwirawan et al. [12] which was depth index (0.52 cm), height slop (4.33 cm) and width slop (1.04 cm) on Barbados Black Belly crossbred sheep.

Sex had significant (P<0.05) effect on weight index and body index of Dorper sheep. Weight index, height slop, body index, length index, balance and width slop of pure Dorper rams had the mean values of 40.23 kg, 1.01 cm, 83.81 cm, 1.10 cm, 0.65 cm and 0.80 cm, respectively. The above similar indices in accordance order for Dorper ewes scored 31.27 kg, 0.47 cm, 81.31 cm, 0.70 cm and 0.84 cm, respectively. The values for weight index and body index of pure Dorper rams were higher (p<0.05) than pure Dorper ewes. Height slop of Dorper rams had similar values of height slop (1 cm) of Zambian indigenous fat tailed sheep reported by [11]. Width slop of Dorper rams in this study was in agreement with the report of [3] which was 0.77 cm on WAD sheep in Nigeria.

Age effect: Age group exerted had significant effect (p>0.05) on weight index, width index and balance of local and also it had a significant effect on weight index, height slop, width slop, thoracic development and balance of crossbred sheep. Whereas age exerted significant (P<0.01) effect on weight index, height slop, length index, body index and pelvic index of pure Dorper and also had significant (P<0.05) effect on thoracic development of pure Dorper sheep.

Height slop, length index, width slop, depth index and balance of local sheep of 0PPI age group were 2.12 cm, 0.90 cm, 0.86 cm, 0.41 cm and 0.66 cm, respectively. This result was in agreement with the report of [3] which was length index (0.93 cm), width slop (0.86 cm), depth index (0.44 cm) and balance (0.62 cm) on WAD sheep in Nigeria. The oldest age group of local sheep were significantly (P<0.05) larger in weight index, height slop and pelvic index which had the mean value of 31.46 kg, 2.95 cm and 78.59 cm, respectively.

The youngest age group of crossbred sheep had larger mean (0.95 cm and 101.97 cm) values of width slop and body index respectively. Similarly 1PPI age group of crossbred sheep had a largest mean value of height slop than 1PPI and ≥ 2PPI age group of the same breed. The result also indicated that the three age groups (0PPI, 1PPI and ≥ 2PPI) accounted similar mean value of balance (0.81 cm) for crossbred sheep. However the oldest age group of crossbred sheep scored lowest (0.39 cm) mean value for depth index (Table 1).

Effect and level	WI	HS	LI	WSI	DI	BI	TD	BR	B	PI

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	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE
Over all mean	81	24.08 ± 0.60	81	2.95 ± 0.31	81	0.89 ± 0.01	81	0.85 ± 0.02	81	0.41 ± 0.01	81	78.57 ± 0.79	81	1.14 ± 0.01	81	0.95 ± 0.01	81	0.67 ± 0.02	81	77.61 ± 0.87
CV%	81	19.1	81	23.12	81	7.13	81	15.43	81	9.34	81	6.93	81	4.73	81	3.49	81	19.12	81	7.54
R^2	81	0.67	81	0.09	81	0.03	81	0.57	81	0.26	81	0.15	81	0.21	81	0.1	81	0.6	81	0.41
Sex		**		NS		NS		**		**		**		NS		NS		NS		**
Male	20	28.06 ± 0.95^{a}	20	3.462 ± 0.50	20	0.88 ± 0.01	20	0.66 ± 0.03^{b}	20	0.43 ± 0.01^{a}	20	77.15 ± 1.25^{b}	20	1.15 ± 0.01	20	0.95 ± .01	20	0.48 ± 0.03	20	72.71 ± 1.38^{b}
Female	61	20.10 ± 0.73^{b}	61	2.441 ± 0.38	61	0.90 ± 0.01	61	1.04 ± 0.03^{a}	61	0.39 ± 0.01^{b}	61	79.98 ± 0.96^{a}	61	1.13 ± 0.01	61	0.96 ± 0.01	61	0.86 ± 0.03	61	82.51 ± 1.06^{a}
Age		**		NS		NS		**		NS		**		NS		NS		**		**
0 PPI	14	18.30 ± 1.15^{b}	14	2.12 ± 0.60	14	0.90 ± 0.02	14	0.86 ± 0.04^{b}	14	0.41 ± 0.01	14	80.84 ± 1.52^{a}	14	1.11 ± 0.01	14	0.96 ± 0.01	14	0.66 ± 0.04^{b}	14	75.24 ± 1.67^{c}
1 PPI	25	22.47 ± 0.96^{a}	25	3.79 ± 0.51	25	0.88 ± 0.01	25	0.85 ± 0.03^{a}	25	0.42 ± 0.01	25	76.27 ± 1.28^{c}	25	1.16 ± 0.01	25	0.94 ± 0.01	25	0.66 ± 0.03^{a}	25	79.01 ± 1.41^{a}
≥ 2 PPI	42	31.46 ± 0.98^{a}	42	2.95 ± 0.52	42	0.90 ± 0.01	42	0.84 ± 0.03^{a}	42	0.42 ± 0.01	42	78.59 ± 1.30^{b}	42	1.15 ± 0.01	42	0.96 ± 0.01	42	0.69 ± 0.03^{a}	42	78.59 ± 1.43^{b}
Sex by age		**		**		NS		NS		NS		*		NS		NS		NS		**
Male																				
0 PPI	9	16.62 ± 1.37^{bc}	9	2.13 ± 0.72^{bc}	9	0.89 ± 0.02	9	0.74 ± 0.05	9	0.41 ± 0.01	9	79.96 ± 1.82^{a}	9	1.11 ± 0.02	9	0.96 ± 0.01	9	0.54 ± 0.05	9	68.17 ± 2.00^{c}
1 PPI	6	25.12 ± 1.68^{b}	6	4.93 ± 0.88^{a}	6	0.86 ± 0.03	6	0.63 ± 0.06	6	0.44 ± 0.01	6	72.19 ± 2.22^{c}	6	1.20 ± 0.02	6	0.93 ± 0.01	6	0.44 ± 0.06	6	74.25 ± 2.45^{ab}
≥ 2 PPI	5	42.44 ± 1.84^{a}	5	3.32 ± 0.97^{b}	5	0.90 ± 0.03	5	0.62 ± 0.07	5	0.45 ± 0.02	5	79.31 ± 2.44^{ab}	5	1.13 ± 0.02	5	0.95 ± 0.01	5	0.47 ± 0.07	5	75.73 ± 2.68^{a}
Female																				
0 PPI	5	19.97 ± 1.84^{bc}	5	2.10 ± 0.97^{bc}	5	0.90 ± .03	5	0.98 ± 0.06	5	0.41 ± 0.02	5	81.73 ± 2.44^{a}	5	1.10 ± 0.02	5	0.97 ± 0.01	5	0.78 ± 0.07	5	82.32 ± 2.68^{ab}
1 PPI	19	19.83 ± 0.94^{ab}	19	2.64 ± 0.50^{a}	19	0.89 ± 0.01	19	1.07 ± 0.03	19	0.39 ± 0.01	19	80.35 ± 1.25^{ab}	19	1.12 ± 0.01	19	0.96 ± 0.01	19	0.89 ± 0.03	19	83.76 ± 1.38^{a}
≥ 2 PPI	37	20.50 ± 0.68^{a}	37	2.58 ± 0.36^{ab}	37	0.90 ± 0.01	37	1.05 ± 0.02	37	0.38 ± 0.01	37	77.87 ± 0.89^{c}	37	1.16 ± 0.01	37	0.96 ± 0.01	37	0.92 ± 0.02	37	81.44 ± 0.99^{bc}

Means with different superscripts within the same column and class are statistically different. Ns=Non significant; *significant at 0.05; **significant at 0.01. 0 PPI=0 pair of Permanent incisors; 1PPI=1 pair of permanent incisor and ≥ 2 PPI=2 or more pairs of permanent incisors. WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic Index.

Table 1: Least squares mean ± standard errors of structural indices for Local sheep.

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Sex by age interaction effect: The interaction between sex and age group significantly (p<0.01) affected weight index, height slop and pelvic index of the local sheep. Body index of local sheep was significantly (P<0.05) affected by this interaction effect. The oldest age group rams were significantly (P<0.05) larger than ewes in the same age group of local sheep by weight, height slop and body index which had the mean value of 23.44 kg, 3.32 cm and 79.31 cm, respectively. However, youngest age group of local ewes was larger in width slop and balance which accounted 1.05 cm and 81.44 cm, respectively.

This study also indicated that the interaction of sex and age group had significant (p<0.01) on weight index, body index, and pelvic index of crossbred sheep. It had also significant (P<0.05) effect on height slop of crossbred sheep. 0PPI age group of crossbred rams was larger in body index (86.12 cm) than ≥ 2PPI of the same breed. Whereas, ≥ 2PPI age group of crossbred rams were significantly (P<0.01) larger than ewes of the same breed and the same age group in body weight and pelvic index which have the mean value of 38.62 kg and 88.70 cm, respectively. Sex-age interaction of pure Dorper sheep had significant (P<0.01) effect on weight index, length index, body index and pelvic index.

In this study the matured age crossbreds rams and ewes were heavier than the local breeds rams in order that local breed weight was approximately 23.44 kg and crossbred 38.62 kg. In addition to weight crossbred rams were larger in length index, width slop, thoracic development, body ratio, balance and pelvic index with the mean value of 1.01 cm, 0.81 cm, 1.02 cm, 0.67 cm and 88.70 cm, respectively than matured age local rams. Length index, width slop and balance of matured crossbred ram sheep in this study was in agreements with the previous report of [3] on West African Dwarf (WAD) sheep which was 1.01 cm, 1.06 cm and 0.59 cm, respectively. Body index (78.52 cm) of ≥ 2PPI age group crossbred rams was lower than Zambian indigenous fat tailed rams (79.2 cm) sheep as reported by [11].

The weight index value of crossbred sheep indicated that they are medium weighted meat type sheep while the weight index value of local rams indicated that they were slightly light sheep. The result also indicated higher values of height slop (3.32 cm and 2.58 cm) of local rams and ewes respectively. This implies that that local sheep were slopes more to the posterior end than crossbreds at the back (point of withers to rump). Higher width slop of crossbred sheep showed that local sheep were a narrower animal.

Body index, pelvic index and depth index (0.42 cm) of Dorper rams were almost similar with the previous report by [11] which was 79.2 cm, 88.3 cm and 0.5 cm, respectively for Zambian indigenous fat tailed sheep. Crossbreds were larger in height slop 1.41 cm and 1.11 cm for rams and ewes respectively imply that crossbreds were sloppier than the pure breed Dorper sheep. Crossbreds and pure Dorpers were almost similar in balance index and width index (Table 2).

	WI		HS		LI		WSI		DI		BI		TD		BR		B		PI	
Effect and level	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**	**N**	**LSM ± SE**
Over all mean	128	26.61 ± 0.75	128	1.71 ± 0.53	128	1.07 ± 0.05	128	0.93 ± 0.01	128	0.42 ± 0.02	128	88.42 ± 6.74	128	1.28 ± 0.06	128	0.97 ± 0.01	128	0.81 ± 0.02	128	85.08 ± 1.19
CV%	128	19.41	128	1.28	128	20.14	128	16.95	128	23.15	128	24.39	128	22.12	128	8.78	128	23.26	128	14.44
R2	128	0.37	128	0.13	128	0.05	128	0.23	128	0.04	128	0.04	128	0.05	128	0.13	128	0.28	128	0.1
Sex		**		**		NS		**		NS		NS		NS		**		**		**
Male	51	29.48 ± 1.18^{a}	51	0.15 ± 0.84^{a}	51	1.00 ± 0.08	51	0.83 ± 0.02^{b}	51	0.40 ± 0.03	51	82.88 ± 10.61	51	1.22 ± 0.10	51	1.00 ± 0.01	51	0.69 ± 0.03	51	82.30 ± 1.87^{b}
Female	77	23.74 ± 0.93^{b}	77	3.26 ± 0.66^{b}	77	1.13 ± 0.06	77	1.02 ± 0.02^{a}	77	0.44 ± 0.03	77	93.96 ± 8.32	77	1.347 ± 0.08	77	0.95 ± 0.01	77	0.92 ± 0.02	77	87.86 ± 1.46^{a}
Age		**		**		NS		**		NS		NS		*		**		**		**
0 PPI	42	22.57 ± 1.25^{b}	42	1.81 ± 0.89^{ab}	42	1.00 ± 0.08	42	0.95 ± 0.02^{a}	42	0.44 ± 0.04	42	101.97 ± 11.24	42	1.14 ± 0.10^{b}	42	0.97 ± 0.01^{ab}	42	0.81 ± 0.03^{a}	42	81.41 ± 1.98^{c}
1 PPI	28	25.54 ± 1.55^{b}	28	3.17 ± 1.11^{a}	28	1.20 ± 0.10	28	0.91 ± 0.03^{a}	28	0.45 ± 0.05	28	83.60 ± 13.96	28	1.45 ± 0.13^{a}	28	0.95 ± 0.02^{b}	28	0.81 ± 0.04^{a}	28	85.65 ± 2.45^{b}
≥ 2 PPI	58	31.73 ± 1.04^{a}	58	0.15 ± . 74^{b}	58	1.00 ± 0.07	58	0.91 ± 0.02^{a}	58	0.39 ± 0.03	58	79.71 ± 9.38	58	1.26 ± 0.09^{ab}	58	1.00 ± 0.01^{a}	58	0.81 ± 0.03^{a}	58	88.18 ± 1.65^{a}
Sex by age		**		*		NS		NS		NS		**		NS		NS		NS		**

Citation: Mohammed J, Abegaz S, Lakew M, Tarekegn GM (2018) Evaluation on the Structural Indices Unveil Performance Variation among Dorper, Local and their F1 Crossbred Sheep Population in Ethiopia. J Genome 1: 102.

Male																				
0 PPI	16	23.10 ± 1.97^{bc}	16	1.35 ± 1.40^{ab}	16	0.94 ± 0.13	16	0.89 ± 0.04	16	0.44 ± 0.06	16	86.12 ± 17.69^{a}	16	1.11 ± 0.17	16	0.98 ± 0.02	16	0.73 ± 0.05	16	77.84 ± 3.11^{bc}
1 PPI	10	26.74 ± 2.49^{ab}	10	0.52 ± 1.77^{b}	10	1.05 ± 0.17	10	0.77 ± 0.05	10	0.37 ± 0.08	10	84.02 ± 22.38^{ab}	10	1.25 ± 0.21	10	0.99 ± 0.03	10	0.69 ± 0.06	10	80.35 ± 3.94^{b}
≥ 2 PPI	25	38.62 ± 1.58^{a}	25	1.41 ± 1.12^{a}	25	1.01 ± 0.11	25	0.81 ± 0.03	25	0.41 ± 0.05	25	78.52 ± 14.15^{c}	25	1.29 ± 0.13	25	1.02 ± 0.02	25	0.67 ± 0.04	25	88.70 ± 2.49^{a}
Female																				
0 PPI	26	22.05 ± 1.55^{bc}	26	2.27 ± 1.10^{ab}	26	1.06 ± 0.10	26	1.01 ± 0.03	26	0.43 ± 0.05	26	117.81 ± 13.88^{a}	26	1.17 ± 0.13	26	0.96 ± 0.02	26	0.88 ± 0.04	26	84.98 ± 2.44^{bc}
1 PPI	18	24.34 ± 1.86^{ab}	18	5.81 ± 1.32^{a}	18	1.35 ± 0.12	18	1.05 ± 0.04	18	0.53 ± 0.06	18	83.16 ± 16.68^{b}	18	1.64 ± 0.16	18	0.91 ± 0.02	18	0.93 ± 0.04	18	90.96 ± 2.93^{a}
≥ 2 PPI	33	26.85 ± 1.37^{a}	33	1.71 ± 0.97^{bc}	33	0.99 ± 0.09	33	1.01 ± 0.03	33	0.37 ± 0.04	33	80.89 ± 12.32^{bc}	33	1.23 ± 0.12	33	0.97 ± 0.01	33	0.95 ± 0.03	33	87.66 ± 2.17^{ab}

Means with different superscripts within the same column and class are statistically different. Ns=Non significant; *significant at 0.05; **significant at 0.01. 0 PPI=0 pair of Permanent incisors; 1PPI=1 pair of permanent incisor and ≥ 2 PPI=2 or more pairs of permanent incisors. WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic Index.

Table 2: Least squares mean ± standard errors of structural indices for Crossbred sheep.

The result related to length index showed differences among the genetic groups, the values assessed for Dorper was higher than the crossbred rams indicating that the carcass yield of the crossbred is expected to be lower than those of the Dorper but higher than local rams. This idea was in agreement with Chiemela et al. [4] on Bore, central highland goat and their crossbreds reared at Debre-Birhan Agricultural Research Center.

The thoracic development index value for the Dorper indicated heavy built animals while the crossbred indicated a medium but meat type. Length index showed that local sheep was longer bodied than crossbreds. This implies that the crossbred sheep were generally short legged and longer bodied; indicated that crossbreds have the proportions of beef animals. Body index of crossbred rams were higher than body index of local rams and pure Dorper implies that the body of crossbred rams was relatively closer to the ground which may correspond to its adaptations to mountainous topography.

The result for body ratio indicated that both Dorper and crossbred sheep were slightly larger at withers when compared to the rump implies that the sheep were large in front and vice versa. The result of pelvic index bespeaks that; rump of crossbred sheep was larger than local sheep breed. This result indicated that wider rump with animals having potential for good carcass traits [13]. As a result local sheep breed have narrow hips with low meat production potential. Higher thoracic development value observed in Dorper sheep indicated that Dorper sheep is a heavy meat animal while crossbred rams were intermediary meat type animals. Studies by Bravo and Sepulveda, [14] indicated that the value of the thoracic development is correlated with the muscular development and strength of the animal. This report agreed with the current finding from the thoracic development of Dorper and crossbreds that had the true traits of a meaty type animal. The total mean value of balance for local, crossbred and pure Dorper sheep scored 0.68 cm, 0.81 cm and 0.67 cm, respectively. This higher balance of crossbred enables to balance on rocky ground (Table 3) [2].

Effect and level	WI		HS		LI		WSI		DI		BI		TD		BR		B		PI	
	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE
Over all mean	94	35.75 ± 1.05	94	0.27 ± 0.39	94	1.10 ± 0.01	94	0.82 ± 0.02	94	0.41 ± 0.01	81	82.57 ± 0.58	81	1.34 ± 0.01	81	1.01 ± 0.01	81	0.67 ± 0.02	81	90.85 ± 1.47

CV%	94	23.87	94	25.91	94	5.44	94	17.59	94	10.78	81	6.17	81	6.58	81	5.26	81	25.37	81	13.7
R^2	94	0.44	94	0.08	94	0.16	94	0.06	94	0.13	81	0.34	81	0.15	81	0.08	81	0.04	81	0.16
Sex		**		NS		NS		NS		NS		**		NS		NS		NS		NS
Male	44	40.23 ± 1.51^{a}	44	1.01 ± 0.56	44	1.10 ± 0.01	44	0.80 ± 0.02	44	0.42 ± 0.01	20	83.83 ± 0.84^{a}	20	1.32 ± 0.01	20	1.016 ± 0.01	20	0.65 ± 0.03	20	91.58 ± 2.12
Female	50	31.27 ± 1.46^{b}	50	0.471 ± 0.54	50	1.10 ± 0.01	50	0.84 ± 0.02	50	0.41 ± 0.01	61	81.30 ± 0.81^{b}	61	1.36 ± 0.01	61	0.99 ± 0.01	61	0.70 ± 0.03	61	90.12 ± 2.04
Age		**		**		**		NS		NS		*		**		NS		NS		**
0 PPI	20	28.73 ± 2.02^{c}	20	0.50 ± 0.75^{b}	20	1.09 ± 0.01^{b}	20	0.78 ± 0.03	20	0.41 ± 0.01	20	82.80 ± 1.13^{a}	20	1.32 ± 0.02^{b}	20	0.99 ± 0.01	20	0.67 ± 0.04	20	83.10 ± 2.83^{b}
1PPI	19	35.81 ± 2.08^{b}	19	0.33 ± 0.77^{bc}	19	1.13 ± 0.01^{a}	19	0.82 ± 0.03	19	0.41 ± 0.01	19	84.99 ± 1.16^{a}	19	1.33 ± 0.02^{ab}	19	1.01 ± 0.01	19	0.67 ± 0.04	19	94.20 ± 2.91^{a}
≥ 2 PPI	55	42.72 ± 1.23^{a}	55	0.98 ± 0.45^{a}	55	1.09 ± 0.01^{b}	55	0.86 ± 0.02	55	0.43 ± 0.01	55	79.90 ± 0.68^{b}	55	1.37 ± 0.01^{a}	55	1.017 ± 0.01	55	0.68 ± 0.02	55	95.25 ± 1.72^{a}
Sex by age		**		NS		**		NS		NS		**		NS		NS		NS		**
Male																				
0PPI	10	31.30 ± 2.86^{c}	10	0.10 ± 1.06	10	1.12 ± 0.02^{a}	10	0.77 ± 0.04	10	0.42 ± 0.01	10	88.53 ± 1.59^{a}	10	1.27 ± 0.03	10	1.00 ± 0.02	10	0.61 ± 0.05	10	83.21 ± 4.01^{c}
1PPI	9	39.85 ± 3.02^{b}	9	1.83 ± 1.12	9	1.10 ± 0.02^{ab}	9	0.81 ± 0.05	9	0.39 ± 0.01	9	82.80 ± 1.68^{b}	9	1.33 ± 0.03	9	1.03 ± 0.02	9	0.67 ± 0.06	9	98.02 ± 4.22^{a}
≥ 2PPI	25	49.54 ± 1.81^{a}	25	1.11 ± 0.67	25	1.09 ± 0.01^{b}	25	0.83 ± 0.03	25	0.44 ± 0.01	25	80.17 ± 1.01^{bc}	25	1.36 ± 0.02	25	1.02 ± 0.01	25	0.65 ± 0.03	25	93.50 ± 2.53^{b}
Female																				
0PPI	10	26.16 ± 2.86^{c}	10	1.10 ± 1.06	10	1.05 ± 0.02^{ab}	10	0.80 ± 0.05	10	0.40 ± 0.01	10	77.08 ± 1.59^{bc}	10	1.37 ± 0.03	10	0.98 ± 0.02	10	0.73 ± 0.05	10	82.98 ± 4.01^{c}
1PPI	10	31.76 ± 2.86^{b}	10	1.17 ± 1.06	10	1.15 ± 0.02^{a}	10	0.83 ± 0.05	10	0.42 ± 0.01	10	87.18 ± 1.59^{a}	10	1.33 ± 0.03	10	0.98 ± 0.02	10	0.66 ± 0.05	10	90.37 ± 4.01^{b}
≥ 2PPI	30	35.89 ± 1.65^{a}	30	0.86 ± 0.61	30	1.10 ± 0.01^{b}	30	0.88 ± 0.03	30	0.41 ± 0.01	30	79.63 ± .92^{b}	30	1.39 ± 0.02	30	1.01 ± 0.01	30	0.71 ± 0.03	30	97.00 ± 2.31^{a}

Means with different superscripts within the same column and class are statistically different. Ns=Non significant; *significant at 0.05; **significant at 0.01. 0 PPI=0 pair of Permanent incisors; 1PPI=1 pair of permanent incisor and ≥ 2 PPI=2 or more pairs of permanent incisors. WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic Index.

Table 3: Least squares mean ± standard errors of structural indices for Dorper sheep.

Correlation of structural indices for local, crossbred and Dorper sheep

The correlations among weight and various body indices of local rams and ewes are presented in Table 4. The upper and lower part of the axis described male and female, respectively. The result indicates most of the structural indices for local rams and ewes had no significant correlation and other correlations among indices are, in general, low and frequently negative. Weight index had negative correlation with width slop, body index, body ratio, and balance for local rams. Whereas, weight index had significant (P<0.01) correlation with depth index (0.65 and 0.52) for rams ewes respectively.

Height slop had the highest negative correlation coefficient (-0.99) with body ration for both sexes of local sheep. However, pelvic index had negative correlation with thoracic development and height slop of local rams and body index, body ratio and balance of local female sheep. Thoracic development of rams had negatively highly correlated with body ration (-0.69) and balance (-0.58). The correlation between length index and height slop was negative (p<0.05). This result is disagreed with the previous report [3] on West African Dwarf Sheep.

	WI	HS	LI	WSI	DI	BI	TD	BR	B	PI
WI		0.14	0.09	-0.27	0.65^{**}	-0.04	0.14	-0.05	-0.19	0.51
HS	-0.16		0.02	-0.39	0.57^{**}	-0.43	0.71^{**}	-0.99^{**}	-0.43	-0.08
LI	0.11	0.32^{*}		0.32	-0.09	0.79^{**}	-0.22	-0.02	0.35	0.14

WSI	-0.31*	-0.01	-0.07		-0.4	0.57**	-0.56*	0.38	0.95**	0.2
DI	0.52**	0.04	-0.1	0.07		-0.44*	0.61**	-0.53*	-0.41	0.05
BI	0.03	0.05	0.74**	0.08	-0.08		-0.77**	0.42	0.60**	0.12
TD	0.1	0.37**	0.35**	-0.2	-0.02	-0.37**		-0.69**	-0.58**	-0.05
BR	0.19	-0.99**	-0.33**	0.02	-0.04	-0.06	-0.38**		0.42	0.16
B	-0.45**	0.07	0.12	0.73**	-0.52**	0.08	0.04	-0.06		0.11
PI	0.19	0.04	0	0.15	0.07	-0.02	0.02	-0.01	-0.01	

WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic Index.

Table 4: Phenotypic correlations between weight index and other structural indices for Local sheep.

The results pertaining to the correlation among structural indices for crossbred rams and ewes are presented in Table 5. The findings indicate that most of their indices are poorly correlated and some had negative association with each other. The results for rams indicated that the weight index (w) was correlated significantly ($p<0.05$) with depth index, thoracic development, body ratio and pelvic index; while negatively correlated with balance, height slop, width index and body index for crossbred rams. Width slop of crossbred rams was negatively correlated with weight index, height slop and length index. This is in agreement with the previous report of [3] on WAD sheep.

	WI	HS	LI	WSI	DI	BI	TD	BR	B	PI
WI		-0.39**	0.19	-0.19	0.31*	-0.18	0.29*	0.37**	-0.38**	0.29*
HS	0.14		0.14	-0.32*	0.06	0.32*	-0.18	-0.99**	-0.26	-0.32
LI	0.14	0.93**		-0.31*	-0.26	0.22	0.49**	-0.14	0.04	-0.07
WSI	0.11	0.03	-0.02		0.06	-0.06	-0.18	0.34*	0.69**	0.51**
DI	0.40**	0.87**	0.94**	-0.03		-0.09	-0.13	-0.05	-0.48**	-0.12
BI	-0.05	0.04	-0.01	-0.07	-0.01		-0.70**	-0.33*	0.04	-0.09
TD	0.15	0.93**	0.98**	-0.02	0.92**	-0.16		0.18	-0.06	0.09
BR	-0.13	-0.99**	-0.92**	-0.02	-0.87**	0.04	-0.92**		0.27*	0.32*
B	-0.14	0.03	-0.02	0.72**	-0.16	-0.05	-0.02	-0.03		0.14
PI	0.04	-0.02	-0.06	0.67**	-0.09	0.02	-0.06	0.03	0.23*	

*Correlation is significant at 0.05 levels (2 tailed), ** Correlation is significant at 0.01 levels (2 tailed). WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic index

Table 5: Phenotypic correlations between weight index and other structural indices for Crossbred sheep.

Body weight of crossbred ewes was significantly correlated with only depth index (0.40). This result is in agreement with [3] on WAD sheep. Height slop of crossbred ewes was positively highly correlated with length index, depth index and thoracic development. Similarly pelvic index and width slop of crossbred ewes was positively correlated.

The correlation between the structural indices for Pure Dorper rams and ewes were presented in Table 6. There was positive correlation ($p<0.01$) of weight index with depth index, thoracic development and pelvic index on both sexes of Dorper sheep. The significant correlation between weight index and depth index in this study was similar with the previous report of [3] on Yankasa sheep in Nigeria. Balance was negatively correlated with height slop and body ratio of Dorper rams. Similarly the correlation of weight index with width slop and balance was negative for Dorper ewes.

	WI	HS	LI	WSI	DI	BI	TD	BR	B	PI
WI		0.19	0.21	0.18	0.62**	-0.18	0.40**	0.19	-0.02	0.33*
HS	0.02		-0.24	-0.21	-0.02	0.06	-0.29	0.99**	-0.41**	0.03
LI	0.14	-0.33*		-0.11	0.12	0.56**	0.33*	-0.26	0.06	-0.08
WSI	-0.49**	0.27	-0.07		-0.09	0.01	-0.14	-0.21	0.89**	0.69**
DI	0.61**	-0.43**	0.36*	-0.38**		-0.45**	0.65**	-0.06	-0.34*	-0.07
BI	-0.35*	0.04	0.47**	0.27	-0.29*		-0.59**	0.04	0.14	-0.16
TD	0.50**	-0.32*	0.25	-0.35*	0.61**	-0.73**		-0.28	-0.14	0.06
BR	0.01	0.99**	-0.34*	0.28*	-0.43**	0.04	-0.32*		-0.41**	0.05
B	-0.62**	0.30*	-0.11	0.79**	-0.63**	0.23	-0.36*	0.31*		0.54**
PI	0.38**	0.17	-0.27	0.21	0.03	-0.26	0.1	0.16	-0.16	

*Correlation is significant at 0.05 levels (2 tailed), ** Correlation is significant at 0.01 levels (2 tailed) WI=weight index, HS=Height Slop, LI=Length Index, WSI=Width slop, DI=Depth index, BI=Body length, TD=Thoracic development, BR=Body ratio, B=Balance, PI=Pelvic index

Table 6: Phenotypic correlations between weight index and other structural indices for Dorper sheep.

Positive and highly significant correlations in the present investigation would be useful for predicting boy weight in local, crossbred and pure Dorper as reported by [3,10]. The high phenotypic correlations between weight index and other indices indicated that selection for indices will favor the selection for body weight.

Conclusions and Recommendations

From the current results obtained in this study the fixed effects sex, age and sex by age interaction effects were sources of variation for most of the response variables (indices). The structural indices result showed that body conformation of local sheep could be described as light in weight, long body size with long legs; they are longer at the rump than wither; so that they were sloppy to the posterior end, narrow body and small thoracic development. The general body conformation of local sheep was not corresponded to the meat type animal. This finding also reported that crossbreds were medium in weight, long body, short leg, sloppy to wither, their body was closer to the ground, wider body, large at the pelvic and also they had good thoracic development.

Generally structural indices for the local, crossbred and pure Dorper sheep indicated crossbreds were meat type animals. Results from current study on structural index analysis concluded that crossbred sheep were comprised the general conformation of meat type animals and also it had good adaptation ability to mountainous geographical conditions of the study area. To validate the significant of heterosis effect on crossbreds, it is important to undertake well planned genetic characterization.

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