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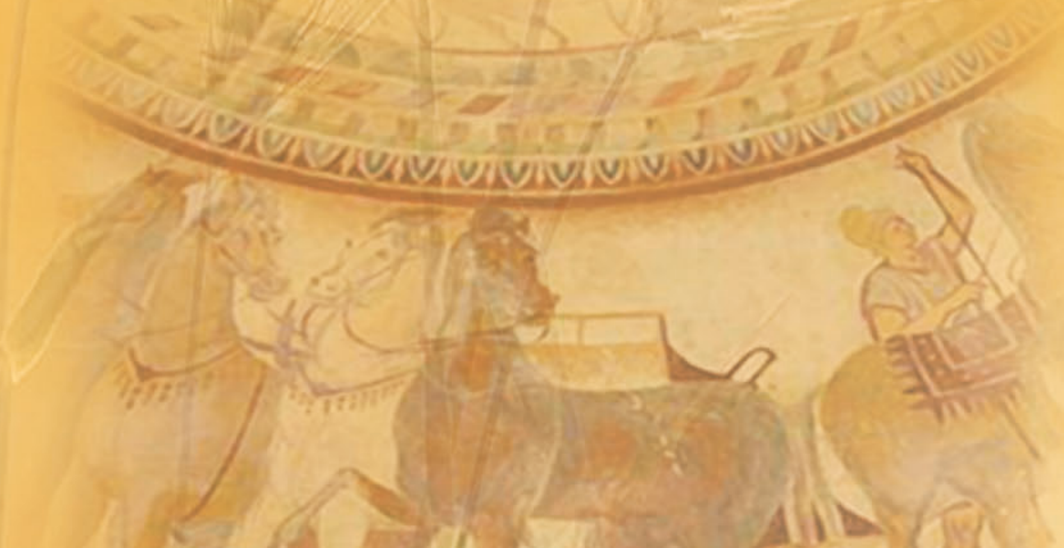

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Application of path coefficient analysis in assessing the relationship between growth-related traits in indigenous Nigerian sheep (*Ovis aries*) of Niger State, Nigeria

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Abstract. *Indigenous Nigerian sheep raised under extensive management were evaluated with the aim of assessing variability among body weight and body measurement traits thereby deducing components that best describe the relationship using path coefficient analysis. The parameters measured were body weight (BW), body length (BL), head length (HL), head width (HW), height at withers (HAW), chest depth (CD), chest girth (CG) and shin circumference (SC). Pair wise correlation between body weight and body measurements were positive and significant (r = 0.475 – 0.655 in males, 0.262 – 0.449 in females, and 0.336 – 0.509 in the combined population, P<0.01). Path analysis showed that shin circumference and chest depth had the greatest direct effect on body weight in male, female and the combined population (path coefficient = 0.250, 0.252 and 0.250, respectively) while the least direct effect was observed for head width (in male and female with path coefficient = 0.007 and -0.017, respectively), and height at withers in the combined population (path coefficient = -0.020). Percentage direct contribution to body weight was 6.25, 6.35 and 6.25% from shin circumference (male), chest depth (in female and the combined population respectively). The optimum linear regression models with coefficient of determination (R^2) value of 0.45, 0.31 and 0.37 included forecast indices such as chest depth and shin circumference in males, body length, head length and chest depth in females and the combined population, respectively.*

Keywords: correlation, direct and indirect effects, indigenous Nigerian sheep, path analysis, regression

Introduction

Sheep is kept by many rural farmers in Nigeria where they principally serve as sources of meat, income and manure. Buyers of sheep are keen on the body size of the animal at the point of purchase. This is usually accessed visually which is largely subjective and hence inaccurate. The development of any objective and therefore more accurate means of describing and or evaluating body size and conformation traits of the sheep and other farm animals for that matter will go a long way in overcoming the myriad of problems linked to visual assessment (Jimcy et al., 2011; Yakubuand Ibrahim, 2011). The prediction of body weight from a variety of body traits measured at different growth stages has been reported by many authors (Afolayan et al., 2006; Cam et al., 2010; Riva et al., 2004). The common methods used had been correlation between body weight and morphometric characters, or regression of body weight on body measurements (Kuzelovet al., 2011). One problem associated with these methods however, is their inability to properly explain the complexity associated with growth in farm animals. Growth in animals has both direct and indirect causal factors which mean that models that will take this into account will likely give a more accurate estimate of body weight.

Structural Equation Modelling (SEM) is one such model. It is a multivariate analysis technique that takes into consideration the effect of both observed and latent variables and their relationships (von Oertzenet al., 2013). According to the authors, SEM is a unification of several multivariate analysis techniques such as linear regression, ANOVA, correlation, path analysis, factor analysis, auto regression and growth modelling. Path coefficient is a partial regression coefficient obtained from regression equation where all variables have been expressed as deviation from the mean in unit of standard deviation (Sockal and Rholf, 1995). Path coefficient measures both the direct and indirect effect of one variable on another and also separates the correlation coefficient into components of direct, indirect and compound paths (Topaland Esenbuga, 2001). The model has been utilized to investigate the direct and indirect causal effects between traits in goat (Keskin et al., 2005; Ogah et al., 2009; Yakubuand Mohammed, 2012), turkey (Mendes et al., 2005), Yankasa lambs (Yakubu, 2010) and milking cows (Yakubu, 2011). Research using this method is scarce in adult sheep population and this ignited the need for the present study aimed at investigating the relationship between body weight and some conformation traits in adult indigenous Nigerian sheep.

Material and methods

Experimental animals and location of the study

Three hundred and seventy nine indigenous Nigerian sheep of both sexes (157 males and 222 females) were randomly selected in villages located within the three administrative zones of Niger State, North Central Nigeria. Niger State is located in the sub-humid savannah area of Nigeria around 30°2' North and 11°3' East. The State has a land area of 80,000 square kilometres with maximum altitude at its highest point of 1475 m above sea level. The state experiences distinct dry and wet seasons with annual rainfall varying from 1100 mm in the north to 1600 mm in the South. The dry season lasts for 6 to 7 months, October to April in the Northern part of the State, and 4 to 5 months from November to March in the Southern part. The maximum temperature (which does not exceed 39°C) is experienced between March and June, while minimal temperature (as low as 21°C) is usually experienced between December and January. The animals were managed extensively with little or no provision for shelter in the night and proper healthcare. Hence they scavenged on homestead wastes, straw and crop residues when available.

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Traits measured

The traits measured include body weight and seven body measurements. The measurements were taken on the animals in the morning before being released for grazing. The body parts measured were: body length (BL), measured as the distance from the nostril to the pin bone; head length (HL), measured as the distance from the nostril to the point of attachment of the horns; head width (HW), measured as the distance between the outer canthus of the right and left eye; height at withers (HAW), measured as the distance from point of withers to the floor; chest depth (CD), measured as the distance between the withers and chest floor; chest girth (CG), measured as the body circumference just behind the forelegs and shin circumference (SC), measured as the canon bone perimeter. Body weight (BW) was measured in kg using a hanging scale. The height and circumference measurements (cm) were done using a tape rule while the width measurement was done using a calibrated wooden calliper. The measurements were carried out by the same person in order to avoid between individual variations.

Statistical analysis

Means, standard deviation and coefficients of variation of the body weight and body measurements of sheep adjusted for sex effects were computed using Microsoft Excel 2007 version. The initial values of the parameters measured were transformed to generate the standardized version from the unstandardized variables using the means and standard deviations as described by Akintunde (2012). The standardized data was then subjected to regression and bivariate correlation analysis using SPSS (2001). The standardized partial regression coefficients called direct path coefficients were calculated thus:

$\sigma X_1/\sigma Y$= 'P_1', the path coefficient from X_1 to Y,
$\sigma X_2/\sigma Y$= 'P_2', the path coefficient from X_2 to Y,
$\sigma X_3/\sigma Y$= 'P_3', the path coefficient from X_3 to Y,
$\sigma X_4/\sigma Y$= 'P_4', the path coefficient from X_4 to Y,
$\sigma X_5/\sigma Y$= 'P_5', the path coefficient from X_5 to Y,
$\sigma X_6/\sigma Y$= 'P_6', the path coefficient from X_6 to Y,
$\sigma X_7/\sigma Y$= 'P_7', the path coefficient from X_7 to Y,

where Y is the effect and X_1, X_2, X_3, X_4, X_5, X_6 and X_7 are the causes.

The indirect contributions of X_1, X_2, X_3, X_4, X_5, X_6 and X_7 to Y were worked as follows:

$$Y_1 = P_1 + P_2RX_1X_2 + P_3RX_1X_3 + P_4RX_1X_4 + P_5RX_1X_5 + P_6X_1X_6 + P_7RX_1X_7$$
$$Y_2 = P_1RX_1X_2 + P_2 + P_3RX_2X_3 + P_4RX_2X_4 + P_5RX_2X_5 + P_6X_2X_6 + P_7RX_2X_7$$
$$Y_3 = P_1RX_1X_3 + P_2RX_2X_3 + P_3 + P_4RX_3X_4 + P_5RX_3X_5 + P_6X_3X_6 + P_7RX_3X_7$$
$$Y_4 = P_1RX_1X_4 + P_2RX_2X_4 + P_3RX_3X_4 + P_4 + P_5RX_4X_5 + P_6X_4X_6 + P_7RX_4X_7$$
$$Y_5 = P_1RX_1X_5 + P_2RX_2X_5 + P_3RX_3X_5 + P_4RX_4X_5 + P_5 + P_6X_5X_6 + P_7RX_5X_7$$
$$Y_6 = P_1X_1X_6 + P_2RX_2X_6 + P_3RX_3X_6 + P_4RX_4X_6 + P_5RX_5X_6 + P_6 + P_7RX_6X_7$$
$$Y_7 = P_1RX_1X_7 + P_2RX_2X_7 + P_3RX_3X_7 + P_4RX_4X_7 + P_5RX_5X_7 + P_6X_6X_7 + P_7$$

where R is correlation coefficient between the variables. The equations illustrate the splitting process for a 7 factor variables with one effect variable Y.

The multiple linearregression model adopted for the studies was

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \text{----------------} + bpXp$$

where Y is dependent or endogenous variable (body weight), a is intercept, b is regression coefficients and X is independent or exogenous variables (BL, HL, HW, HAW, CD, CG, SC).

Results and discussion

Morphometric traits

The result of the descriptive statistics of body weight and body measurement traits of indigenous Nigerian sheep is presented in Table 1. Male sheep had better values for all the traits measured except BW where the females were better than both the males and the combined population. The trend for all the other traits was in the order male sheep > combined population > female sheep. The greatest variation was observed for BW in male sheep, followed by CD and HAW. The least variation in the males was observed for BL.

Table 1. Descriptive statistics for all traits in male and female Yankasa sheep

Parameter	Male (n=157)			Female (n=222)			Total (n=379)		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
BW, kg	29.16^{c}	6.88	23.58	30.05^{a}	5.73	19.08	29.68^{b}	6.24	21.02
BL, cm	125.59^{a}	11.88	9.46	124.52^{c}	10.27	8.25	124.97^{b}	10.97	8.78
HL, cm	23.19^{a}	2.60	11.19	22.57^{c}	2.81	12.46	22.83^{b}	2.74	11.99
HW, cm	15.01^{a}	1.65	11.02	14.11^{c}	1.09	7.70	14.49^{b}	1.42	9.80
HAW, cm	77.70^{a}	9.79	12.59	74.58^{c}	9.69	12.99	75.87^{b}	9.84	12.97
CD, cm	17.72^{a}	3.65	20.59	16.63^{c}	2.69	16.18	17.08^{b}	3.17	18.53
CG, cm	81.94^{a}	9.56	11.67	79.07^{c}	9.30	11.76	80.26^{b}	9.50	11.84
SC, cm	7.98^{a}	0.90	11.33	7.43^{c}	0.96	12.88	7.66^{b}	0.97	12.72

^{a,b,c} – Means within the same row with different superscript differ (P<0.05) significantly, BW – body weight, BL – body length, HL – head length, HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC – shin circumference, BL – body length

In the females, BW had the greatest variation, followed by CD and HAW in that order while the least variation was observed for HW. Body weight varied most in the combined population. This was followed by CD and HAW with HW having the least variation. The high biometric values obtained for all the traits studied is an indication that the population of sheep studied apart from being adults, were probably strains of the Yankasa and Ouda sheep. These sheep breeds are known to be heavier than the West African Dwarf sheep found mostly in the southern parts of Nigeria. Their adult status probably explains the differences observed in the biometric values of this study when compared to that reported by Yakubu (2010). The high variation observed for BW and CD in the male, female and combined population of sheep means that these traits are candidates for selection and subsequent genetic improvement. The high variation observed especially for body weight is of economic importance to sheep farmers because of the likelihood of sheep having increase in their body weight when selection is properly done. The high variability in the traits might also mean that inbreeding depression have not yet set in the indigenous Nigerian sheep population.

Pair-wise correlation

The coefficient of correlation between body weight and body measurements of indigenous Nigerian sheep are presented in Tables 2a and 2b. The correlation between BW and the body measurements were all positive. The correlation between BW and the body measurements was highest between BW and SC in male sheep (r = 0.655), followed by correlation between BW and BL (r = 0.625). The lowest correlation in male sheep was observed between BW and HW (r = 0.451). In the females, BW and HL had the highest correlation (r = 0.449), followed by correlation between BW and BL (r = 0.439) while the lowest was observed between BW and SC (r = 0.262). In the combined population, the best correlation was between BW and HL (r = 0.509). This was closely followed by the correlation between BW and BL (r = 0.507) and BW and CG (r = 0.487). The least correlation was observed to be between BW and HW (r = 0.336). The positive and significant phenotypic correlation observed between body weight and the linear body measurements, suggests their control by the same genes. Since the relationship is positive, selecting one of the traits will lead to a corresponding increase in body weight. According to Lener and Donald (1996), the fact that majority of the genes controlling configuration traits in animals are of common action and not localized, signifies that formation of one part will lead to the formation of the other. This is clearly due to pleiotropic effect. The positive nature of the correlation portends that body weight could be estimated from body measurements to a large extent and the linear body measurements could be used as basis for selecting animals that will grow to heavy body weight and produce the next generation of sheep. Similar high correlation coefficients between body weight and body measurements have been reported in sheep (Aziz and Sharaby, 1993; Yakubu, 2010).

Direct and indirect effects

The direct and indirect effect of morphological measurements on BW in male, female and combined population of indigenous

Table 2a. Correlation coefficient between body weight and body measurements (male top of diagonal and female below the diagonal) of Yankasa sheep

	BW	BL	HL	HW	HAW	CD	CG	SC
BW	1	0.625**	0.623**	0.451**	0.602**	0.475**	0.609**	0.655**
BL	0.439**	1	0.816**	0.452**	0.812**	0.292**	0.760**	0.652**
HL	0.449**	0.635**	1	0.534**	0.803**	0.415**	0.721**	0.670**
HW	0.290**	0.389**	0.442**	1	0.274**	0.573**	0.275**	0.657**
HAW	0.413**	0.649**	0.844**	0.354**	1	0.251**	0.885**	0.566**
CD	0.333**	0.139*	0.143*	0.309**	0.090	1	0.258**	0.568**
CG	0.415**	0.608**	0.739**	0.393**	0.868**	0.218**	1	0.607**
SC	0.262**	0.293**	0.275**	0.359**	0.335**	0.215**	0.342**	1

BW – body weight, BL – body length, HL – head length, HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC – shin circumference, ** ($p<0.01$), *($p<0.05$).

Table 2b. Correlation coefficient between body weight and body measurements of Yankasa sheep (combined population)

	BW	BL	HL	HW	HAW	CD	CG	SC
BW	1							
BL	0.507**	1						
HL	0.509**	0.703**	1					
HW	0.336**	0.405**	0.481**	1				
HAW	0.480**	0.712**	0.829**	0.336**	1			
CD	0.389**	0.213**	0.279**	0.488**	0.190**	1		
CG	0.487**	0.667**	0.735**	0.351**	0.878**	0.255**	1	
SC	0.395**	0.427**	0.437**	0.539**	0.450**	0.404**	0.469**	1

BW – body weight, BL – body length, HL – head length, HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC – shin circumference, ** ($p<0.01$).

Table 3a. Direct and indirect effects of body measurements on body weight of Yankasa sheep, male

Traits	Indirect effects							
	BL	HL	HW	HAW	CD	CG	SC	Total
BL	**0.165**	0.027	0.0032	0.086	0.058	0.122	0.163	0.624
HL	0.135	**0.033**	0.0037	0.085	0.083	0.116	0.168	0.624
HW	0.075	0.018	**0.007**	0.029	0.114	0.044	0.164	0.451
HAW	0.134	0.027	0.0019	**0.106**	0.049	0.143	0.142	0.603
CD	0.048	0.014	0.004	0.027	**0.199***	0.042	0.142	0.476
CG	0.125	0.024	0.0019	0.094	0.051	**0.161**	0.152	0.609
SC	0.108	0.022	0.0046	0.060	0.113	0.098	**0.250***	0.656

Bold – direct effect, BL – body length, HL – head length; HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC– shin circumference, * ($p<0.05$)

Nigerian sheep is presented in Tables 3a, 3b and 3c respectively. Shin circumference had the greatest direct effect on body weight in male sheep followed by CD while the least direct effect was made by HL. When combined, the indirect effects acting on BW were observed to be greater than the direct effects and this was mostly via BL, CG and SC which had the best values. Path coefficient or direct effect of HW on body weight in female sheep (Table 3b) was negative. Chest depth had the highest positive direct influence on body weight in female sheep, followed by HL and BL respectively. The least was observed for HW. Path coefficient or direct effects of HW and HAW on body weight in sheep (combined population) were observed to be negative (Table 3c). Chest depth had the highest positive direct influence on body weight in the combined population, followed by BL and HL respectively. The least direct effect was observed for HAW. The insignificant nature of the direct effects of BL, HL, HW, HAW and CG (male sheep), HW, HAW, CG and SC (female sheep) and HW, HAW, CG and SC (combined population), and the large total indirect effects for the traits is an indication that the significant correlations observed between the traits and BW were due to indirect effects.

The indirect effects were realized through SC (for BL, HL, HW and CG) and CG (for HAW) in male sheep, all realized via HL in female sheep and via CD (in the case of HW) and BL (in the case of HAW, CG and SC) in the combined population. The direct effects of

Table 3b. Direct and indirect effects of body measurements on body weight of Yankasa sheep, female

Traits	Indirect effects							
	BL	HL	HW	HAW	CD	CG	SC	Total
BL	**0.218***	0.149	-0.0066	0.0039	0.035	0.019	0.021	0.439
HL	0.138	**0.234***	-0.0075	0.0051	0.036	0.023	0.020	0.449
HW	0.085	0.103	**-0.017**	0.0021	0.078	0.012	0.026	0.289
HAW	0.142	0.198	-0.006	**0.006**	0.023	0.027	0.025	0.413
CD	0.030	0.034	-0.0053	0.0005	**0.252***	0.0068	0.016	0.334
CG	0.133	0.173	-0.0067	0.0052	0.055	**0.031**	0.025	0.415
SC	0.064	0.064	-0.0061	0.002	0.054	0.011	**0.073**	0.262

Bold – direct effect, BL – body length, HL – head length; HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC– shin circumference, * ($p<0.05$)

Table 3c. Direct and indirect effects of body measurements on body weight of Yankasa sheep, combined population

Traits	Indirect effects							
	BL	HL	HW	HAW	CD	CG	SC	Total
BL	**0.243***	0.129	-0.024	-0.014	0.053	0.080	0.041	0.508
HL	0.171	**0.184***	-0.028	-0.017	0.069	0.088	0.042	0.509
HW	0.098	0.089	**-0.059**	-0.0067	0.122	0.042	0.051	0.337
HAW	0.173	0.153	-0.019	**-0.020**	0.048	0.105	0.043	0.481
CD	0.052	0.051	-0.029	-0.0038	**0.250***	0.031	0.038	0.389
CG	0.162	0.135	-0.021	-0.018	0.064	**0.120**	0.045	0.487
SC	0.104	0.080	-0.032	-0.009	0.101	0.056	**0.095**	0.396

Bold – direct effect, BL – body length, HL – head length; HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC– shin circumference, * ($p<0.05$)

CD and SC (male sheep), BL, HL and CD (female sheep) and BL, HL and CD (combined population) were however significant and hence, could be valuable in estimating body weight of indigenous Nigerian sheep. The results obtained from the present study shows that path analysis is a comprehensive way of determining the contributory factors leading to increase in BW in indigenous Nigerian sheep and in the process, it provides useful information which could be used in making correct selection decision during sheep improvement programmes. Path analysis is able to do this because of its ability to reveal both the direct and indirect effects of the independent variables or factors (BL, HL, HW, HAW, CD, CG and SC) on the dependent variable (BW). This is because correlation alone may perhaps not wholly provide the precise information on the contribution(s) made by the growth attributes to the overall body weight of the sheep. Yakubu (2010) reported that wrong conclusions leading to wrong selection could result if selection decision is based solely on phenotypic correlation.

Percentage contribution of parameters

The greatest percentage contribution to body weight in male sheep was made by SC (Table 4). This was followed by CD and BL while the least contribution was by HW. In the females, the best percentage contribution was by CD, followed by HL and BL, CD made the utmost percentage contribution in the combined population, followed by BL and HL. The least percentage contribution to BW in females, and the combined population was by HAW. The most combined percentage contribution in male sheep was by BL via SC and CD via SC while it was by BL via HL in female sheep and in the combined population. The least combined percentage contribution was by HL via HW (male and combine sheep population), and HW via HAW (female sheep). The greatest percentage contribution was made by SC in male sheep, CD in female and in the combined sheep population (Table 4). This implies that these traits made the greatest contribution to body weight in indigenous Nigerian sheep. This might be because body weight and its component traits are influenced by the same sets of genes whose effect is pleiotropic in nature. It may also be because the traits are strongly influenced by environmental factors. The high residual effect observed in the study might be accounted for by unexplained factors (probably some traits) which might have played key roles or have positive effects on body weight of indigenous Nigerian sheep had they being included in the study.

Establishment of preliminary and optimized regression equations

The following equations with their coefficients of determination (R^2) were obtained from simple regression between BW and the body measurements:

Y = -0.0000003 + 0.165BL + 0.033HL+ 0.007HW + 0.106HAW + 0.199CD + 0.161CG + 0.250SC…………i (male sheep, $R^2 = 0.55$).

Y = 0.009 + 0.218BL + 0.234HL - 0.017HW + 0.006HAW + 0.252CD + 0.031CG + 0.073SC …………………...ii (female sheep, $R^2 = 0.31$).

Y = 0.006 + 0.243BL + 0.184HL - 0.059HW - 0.020HAW + 0.250CD + 0.120CG + 0.095SC …………………...iii (combined population, $R^2 = 0.38$).

To optimize the models however, redundant (non-significant) variables were removed from the regression equations giving simplified versions with their coefficient of determination (R^2). The simplified equations are:

Table 4. Percent contribution of different body measurement attributes of Yankasa sheep to body weight (kg)

Body measurements	Contribution, %		
	Male	Female	Combined
	Direct contribution		
BL	2.72	4.75	5.91
HL	0.11	5.55	3.86
HW	0.05	0.03	0.35
HAW	2.12	0.004	0.04
CD	3.96	6.35	6.25
CG	2.59	0.10	1.44
SC	6.25	0.53	0.90
	Combined contribution		
BL via HL	0.004	0.03	0.03
BL via HW	0.001	-0.001	-0.01
BL via HAW	0.01	0.001	-0.004
BL via CD	0.01	0.01	0.01
BL via CG	0.02	0.004	0.02
BL via SC	0.03	0.005	0.01
HL via HW	0.0001	-0.002	-0.005
HL via HAW	0.003	0.001	-0.003
HL via CD	0.003	0.01	0.01
HL via CG	0.004	0.01	0.02
HL via SC	0.01	0.01	0.01
HW via HAW	0.0002	-0.00004	0.0004
HW via CD	0.001	-0.001	-0.01
HW via CG	0.0003	-0.0002	-0.003
HW via SC	0.001	-0.001	-0.003
HAW via CD	0.01	0.0001	-0.001
HAW via CG	0.02	0.0001	-0.002
HAW via SC	0.02	0.0002	-0.001
CD via CG	0.01	0.002	0.01
CD via SC	0.03	0.004	0.01
CG via SC	0.02	0.001	0.005
Residual effect	81.99	82.61	81.16
Total	100.00	100.00	100.00

BL – body length, HL – head length; HW – head width, HAW – height at withers, CD – chest depth, CG – chest girth, SC – shin circumference

Y = -0.000001 + 0.152CD + 0.569SC ……………………i (male sheep, $R^2 = 0.45$).

Y = 0.01 + 0.237BL + 0.261HL + 0.263CD ……………. .ii (female sheep, $R^2 = 0.31$).

Y = 0.007 + 0.288BL + 0.233HL + 0.263CD ..……………iii (combined population, $R^2 = 0.37$).

The extraction of the direct effects of BL, HL, HW, HAW and CG (male sheep), HW, HAW, CG and SC (female and the combined sheep population) from the regression equations is because their contribution to the overall body weight of the sheep might be negligible considering their non-significant nature, and in the case of HW and HAW; their negative nature. Similar procedures were carried out by Malau-Aduli et al. (2004) and Yakubu and Mohammed (2012). Removal of the redundant variables however led to decrease in the R^2 value of all the equations. The presence of BL and CD in the optimized equations is in agreement with earlier reports (Jawasrey and Khasawney, 2007; Kunene et al., 2009; Sowande et al.,2010; Yakubu, 2010), where particularly chest measurements were implicated as the traits having the most significant effect on body weight in sheep. Thys and Hardouin (1991) reported that heart girth (which is a chest measurement), explained 86.5% of the variation of the body weight of rams and 90.8% of that of the body weight of ewes in their study of sheep body weight in Cameroun. The presence of BL in the optimized equation however disagrees with the observation of Orji and Steinbach (1981) on the Nigerian Dwarf Sheep. They reported that the determination of HAW and BL do not improve significantly on formulae based on heart girth.

Conclusion

Results from the study showed that there were positive and significant phenotypic correlations between body weight and body measurement traits in the indigenous Nigerian sheep population studied. The results of path analysis also revealed that CD and SC (in males), BL, HL and CD (in females and in the combined population) contributed directly to the body weight of indigenous Nigerian sheep. The implication is that body weight of indigenous Nigerian sheep could be estimated accurately using body measurements such as BL, CD, HL and SC. Selecting and improving these traits will most likely lead to an improvement in the live body weight of indigenous Nigerian sheep.

References

Afolayan RA, Adeyinka IA and Lakpini C A M, 2006. The estimation of live weight from body measurements in Yankasa sheep. Czech Journal of Animal Science, 51, 343-348. http://www.agriculturejournals.cz/publicFiles/52310.pdf

Akintunde AS, 2012. Path analysis step by step using Excel. Journal of Technical Science and Technologies, 1, 9-15.

Aziz MA and Sharaby MA, 1993. Collinearity as a problem in predicting body weight from body dimensions of Najdi sheep in Saudi Arabia. Small Ruminant Research, 12, 117-124.

Cam MA, Olfaz M and Soydan E, 2010. Body measurements reflect body weights and carcass yields in Kerayaka sheep. Asian Journal of Animal and Veterinary Advances, 5, 120-127.

Jawasrey KIZ and Khasawney AZ, 2007. Studies of some economic characteristics on Awassi lambs in Jordan. Egyptian Journal of Sheep and Goat Science, 2, 101-110.

Jimcy J, Raghavan KCand Sujatha KS, 2011. Diversity of local goats in Kerala, India based on mopho-biometric traits. Livestock Research for Rural Development, 23, Article #5 http://www.lrrd.org/lrrd23/5/jimc23119.htm

Keskin S, Kor A and Mirtegioghi H, 2005. A study of relationship between milk yield and some udder traits by use of path analysis in Akkeci goat. Journal of Animal and Veterinary Advances, 4, 547-550.

Kunene NW, Nesamvuni AE and Nsahlai IV, 2009. Determination of prediction equations for estimating body weight of Zulu (Nguni) sheep. Small Ruminant Research, 84, 41-46.

Kuzelov A, Taskov N, Angelakova T, Atanasova E and Mladenov M, 2011. Impact of live weight on the quality of pig halves and meat of the large white breed. Biotechnology in Animal Husbandry, 27, 819-824.http://www.istocar.bg.ac.rs/images/V27_I3/V27_I3_49.pdf

Lener IM and Donald HP, 1996. Modern development in animal breeding.295pp, Academic Press. London, UK.

Malau-Aduli AEO, Aziz MA, Kojina T, Niibayashi T, Oshima K and Komatsu M, 2004. Fixing collinearity instability using principal components and ridge regression analyses in the relationship between body measurements and body weight in Japanese Black cattle. Journal of Animal and Veterinary Advances, 3, 856-863.http://medwelljournals.com/abstract/?doi=javaa.2004.856.863

Mendes M, Karabayir A and Pala A, 2005. Path analysis of the relationship between various body measures and live weight of American Bronze turkeys under three different lighting programs. Tarim Bilimleri Dergisis, 11, 184-188.

Orji BIand Steinbach J, 1981. Post-weaning growth and development of Nigerian Dwarf sheep. Tropical Animal Health and Production, 13, 101-106. http://www.ncbi.nlm.nih.gov/pubmed/7233557

Ogah MD, Hassan ID and Musa IS, 2009. Path analysis of the relationship between various body measurement and live weight in immature West African Dwarf goats.Annale IBNA, 25, 72-77.

Sowande O, Oyewale BandIyasere O, 2010. Age- and sex-dependent regression models for predicting the live weight of West African Dwarf goat from body measurements. Tropical Animal Health and Production, 42, 969-975. http://link.springer.com/article/10.1007%2Fs11250-009-9515-4/lookinside/000.png

Thys Eand Hardouin J, 1991. Prediction of sheep body weight in markets in the far north Cameroon. Livestock Research for Rural Development, 3, Article **#**1http://www.lrrd.org/lrrd3/1/hardouin.htm

Riva J, Rizzi R, Marelli SandCavalchini LG, 2004. Body measurements in Bergamasca sheep. Small Ruminant Research, 55, 221-227.DOI:10.1016/j.smallrumres.2003.12.010

SPSS, 2001.Statistical Package for Social Sciences.SPSS Inc., 444 Michigan Avenue, Chicago IL60611.

Topal M and Esenbuga N, 2001. A study of direct and indirect effects of some factors on weaning weight of Awassi lambs. Turkish Journal of Veterinary and Animal Science, 25, 377-382.

Ulukan H, Guler M and Keskin S, 2003. A path coefficient analysis of some yield and yield components in Faba Bean (*Viciafaba* L.) genotypes. Pakistan Journal of Biological Science, 6, 1951-1955.

Von Oertzen T, Brandmeir AM and Tsang S, 2013. Ωnyx user guide. P.1.

Yakubu A, 2010. Path coefficient and path analysis of body weight and biometric traits in Yankasa lambs. Slovak Journal of Animal Science, 43, 17-25. http://w3.cvzv.sk/slju/10_1/Yakubu.pdf

Yakubu A, 2011. Path analysis of conformation traits and milk yield of Bunaji cows in small holders herds in Nigeria. Agricultura Tropica Et Subtropica, 44, 152-157. http://www.projects.its.czu.cz/ats/pdf_files/vol_44_3_pdf/yakubu.pdf

Yakubu A and Ibrahim IA, 2011. Multivariate analysis of morphostructural characteristics in Nigerian indigenous sheep. Italian Journal of Animal Science, 10(2), 83-86.

Yakubu A and Mohammed GL, 2012. Application of path analysis methodology in assessing the relationship between body weight and biometric traits of Red Sokoto goats in northern Nigeria. Biotechnology in Animal Husbandry, 28, 107-117.

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows,IXth International Conference on Production Diseases in Farm Animals, September 11–14, Berlin, Germany.

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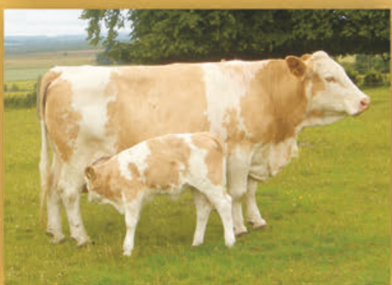

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