

SHORT COMMUNICATION

RELATIONSHIPS BETWEEN BODY WEIGHT AND SOME LINEAR MORPHOMETRIC TRAITS IN NIGERIAN NSUKKA ECOTYPE LOCAL HENS

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ABSTRACT

Body weight (BW) and linear body measurements of 120 Nigerian Nsukka ecotype local hens in terms of body length (BL), chest girth (CG), thigh circumference (TC), thigh length (TL), and shank length (SL) were taken and subjected to Pearson correlation analysis to obtain the relationship between these growth traits. Multiple Linear Stepwise Regression procedure was used to find the best linear combination of the linear body measurements that can best predict BW. The findings showed that linear body measurement traits of Nigerian heavy ecotype local hens were strongly ($p < 0.01$) and positively correlated ($0.5 < r$) except thigh length which recorded a moderate value ($0.3 < r > 0.5$). The regression equations of linear body measurement traits with BW were positive with coefficient of determination ranging from 60.5-74.6%. The stepwise analyses showed shank length as best single measurement with $R^2 = 0.605$, while inclusion of our five predictors in an equation resulted in $R^2 = 0.746$. Thus, the following equation was generated: $BW = -1485.70 + 82.06 SL + 58.34 BL + 38.70 TC + 8.39 CG + 3.85 TL$. This showed that they accounted for 74.6% of the variations in the BW of Nigerian heavy ecotype local hens. The prediction equations generated from linear body measurement traits are positive and strong, therefore can accurately be employed to predict the relative BW of Nigerian heavy ecotype local hens during selection programs as well as in the market with the use of measuring tape.

Key words: body measurements, body weight, Nsukka ecotype, correlation, regression

INTRODUCTION

The Nigerian Nsukka ecotype local chicken is one of the numerous indigenous genetic resources among poultry that can be found in almost every community in Nigeria. These indigenous poultry resources which have adapted to a wide range of ecological settings present viable alternatives to smallholder poultry production in developing countries (Daikwo *et al.*, 2015). This has led to efforts by researchers to employ scientific tools in improving the Nigerian heavy local chicken (Nwosu *et al.*, 1985; Momoh and Kershima, 2008; Ndofor-Foleng *et al.*, 2010; 2015, Oleforuh-Okoleh *et al.*, 2012; Agbo *et al.*, 2018; Ikeh *et al.*, 2020). Genetic improvements through breeding programmes have enabled breeders improve the performance of indigenous chicken (Agbo *et al.*, 2018) and body weight (BW) represents a vital economic trait breeders want to select (Tyasi *et al.*, 2017). BW is significant for any selection and breeding program, feeding, vaccination, and Drug dosage in animal production (Tyasi *et al.*, 2020).

The relationship between BW and other linear body measurements has been described to have important implications. Hence, the success of a breeding program relies on the ability to establish relationships that exist between identified traits (Tyasi *et al.*, 2020). BW is used in ascertaining the growth rate of an animal and its price during

marketing. Prospective customers and farmers often use visual appraisal which may not be accurate as the weighing scale is not always available. Multiple Linear Regression is an available tool for estimating relationships among variables, as well as predicting one variable from another. Researches have shown that linear body measurement traits are good predictor of BW in different chicken genotypes such as Senegal Indigenous chicken (Gueye *et al.*, 1998), Chinese indigenous Dagor chickens (Tyasi *et al.*, 2017), Ugandan indigenous chickens (Semakula *et al.*, 2011) and two commercial meat type (Ross and Anak Titan) chicken genotypes (Ajayi *et al.*, 2008). Because body conformation is different among breeds of chickens, different coefficients and exponents are needed for different breeds of chickens. Therefore, this study aimed at developing equations to estimate BW of Nigerian heavy ecotype local hens using linear body measurements taken.

MATERIALS AND METHODS

The study was carried out at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. The study lasted for twelve weeks. The experimental procedures complied with the provisions of the University of Nigeria, Nsukka Ethical Committee on the Use of Animals for Biometric Research.

Animals and Data Collection

In total, 120 individuals between 50 to 56 days of age were obtained randomly from the 8th generation population of Nigerian heavy local chicken ecotype, kept at the Department of Animal Science Local Chicken Research Unit, University of Nigeria Nsukka. The animals were housed individually on labeled metal cages and intensively managed. These birds were raised in the same chicken house and fed the same commercial growers mash with crude protein: 19.8%; fat: 3.6%; crude fiber: 4.2%; calcium: 4.2%; available phosphorus: 0.5%; methionine: 0.45%; lysine: 0.85% and metabolizable energy of 2880 kCal kg⁻¹.

The following traits were measured on weekly basis: BW was measured with a weighing scale in kilogrammes; body length (BL) was measured as the distance from the base of the neck to the cloaca using a measuring tape in centimeters; chest girth (CG) was taken when a measuring tape is looped around the region of the breast under the wing; shank length (SL) was recorded as the length of tarso-metatarsus from the hock joint to the metatarsal pad using a measuring tape; thigh length (TL) was recorded as the length from tibia-femur joint to the tibia-tarsus joint; thigh circumference (TC) was measured as the circumference of the middle thigh. All the measurements were collected with the same person to avoid individual variations on measuring.

Statistical Analysis

Pearson correlation and Stepwise regression procedure of SPSS statistical package was used to find the best linear combination of linear traits measured that can best predict the BW. The multiple linear regression model adopted was:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

where *Y* is dependent or endogenous variable (BW); *a* is intercept; *b*'s is regression coefficients; *X*'s is independent or exogenous variables (BL, CG, TL, TC, SL). Comparison of regression equations were based on the coefficient of determination. (*R*²).

RESULTS AND DISCUSSION

The Pearson correlation coefficients among BW and other linear body measurement traits of Nigerian Nsukka ecotype local hens are presented in Table 1.

The coefficients showed that BW had significant linear relationship with BL, CG, thigh circumference, thigh length, and shank length. The directions of the relationships were shown to be positive as shank length had the highest coefficient values while thigh length had the least coefficient values. The magnitude or strength of the association

between BW and other linear body measurement traits were strong ($0.5 < r$) except thigh length which recorded a moderate ($0.3 < r > 0.5$) relationship. Our results indicated that other linear body measurement traits were significantly associated with each other in a strong and positive direction with thigh length being the only trait with moderate association with other traits evaluated in this study. The results of this current study are similar to the early results reported in various studies of indigenous chickens (Gueye *et al.*, 1998; Yang *et al.*, 2006; Mancha *et al.*, 2008; Yakubu and Salako, 2009; Sri Rachma *et al.*, 2013; Egena *et al.*, 2014). These authors observed that BWs were highly related to all the other linear body measurements of the chickens with increases in any of the body measurements will definitely lead to a corresponding increase in the BW of the chickens. They all further concluded that the strong correlation between BW and other linear body measurements were useful as selection criterion.

Moreover, Momoh and Kershima (2008) confirmed the reports of Ige *et al.* (2006) that higher muscle deposition in breast and thigh created a strong relationship between breast circumference or shank length with live weight. Based on the fact that most linear measurements reflect primarily the length of the bones of animals. Oke *et al.* (2004) and Abdullah *et al.* (2010) explained that durable correlation was indicated between shank length and body length, and body girth and body length are also indications that shank length and body girth could be used as indicators of body length. And yet, clear relation between body girth and shank length could be used complementarily in selection (Momoh and Kershima, 2008). If the explicit phenotypic relation translates into positive genetic relation thus, selection for one will improve other as a correlated response (Apuno *et al.*, 2011). It is very important to consider the relationship between BW and body measurement traits as this could be useful as a selection criterion to improve the BW. Hence, regression analysis was performed to develop predictive equations for the estimation of BW using linear body measurement traits which had positively significant correlation with BW.

The stepwise regression analyses for the best linear combinations of linear body measurement traits for predicting BW of Nigerian heavy ecotype local hens are presented in Table 2. The results showed that the predictors significantly ($p < 0.01$) predicted BW of Nigerian heavy ecotype local hens with good efficiencies ($R^2 = 60.5-74.6\%$).

Table 1: Pearson correlations among body weight and other linear body measurement traits of Nigerian heavy ecotype local hens

Trait	BW	BL	CG	TC	TL	SL
BW	-					
BL	0.733**	-				
CG	0.736**	0.616**	-			
TC	0.746**	0.605**	0.728**	-		
TL	0.464**	0.368**	0.454**	0.420**	-	
SL	0.778**	0.630**	0.757**	0.735**	0.441**	-

BW - body weight; SL - shank length; BL - body length; TC - thigh circumference; CG - chest girth; TL - thigh length; ** - significant at $p < 0.01$

The analysis built a model with 5 steps, each of which adds a predictor to the equation. The best single measurement was shank length with an $R^2 = 0.605$. While more predictors are added, the adjusted r -square levels off; adding a second predictor to the first raises it with 0.097 (Table 2) but adding a fifth predictor to the previous four only results in a 0.008-point increase. Our final $R^2 = 0.746$, which means that our 5 predictors accounted for 74.6% of the variance in the BW of Nigerian heavy ecotype local hens. Our final model states that $BW = -1485.70 + 82.06 SL + 58.34 BL + 38.70 TC + 8.39 CG + 3.85 TL$ with our strongest predictor being SL ($b = 82.06$). SL is the body part that is commonly measured in poultry to relate to BW. A linear relationship between BW and SL in one breed of chicken was first reported by Lerner (1937). Because body conformation (especially chest girth) is different among breeds of chickens, different coefficients and exponents are needed for different breeds of chickens. For livestock, it is more common to estimate weight by measuring a part of the body trunk rather than an extremity. A good estimate of weight can be obtained by measuring the heart girth, the circumference of the animal posterior to the front legs. This estimate is routine for cattle, horses, and swine (Latshaw and Bishop, 2001). The significant positive correlations among the body measurements observed in the Nigerian heavy ecotype local hens indicate high predictability among the variables (Pundir *et al.*, 2011). This is in line with the work of Petrus *et al.* (2019) who showed a strong relationship between linear body measurements and BW in female Boschveld chicken. Also, for the Japanese quail, Ojo *et al.* (2014) reported estimates of coefficient of determination and predictive equations which showed that BW in this quail is linearly related to body measurements especially with body girth and body length. They concluded that breeders could use body girth and body length as criteria for assessment and early selection of Japanese quail the smallest farmed avian species for BW.

Furthermore, one of the purposes of assessing the interrelationship between performance parameters and BW and its associated traits like body dimensions, is predicting BW in indigenous chickens where scientific scales are not available. Momoh and Kershima (2008) developed both linear and multiple regression as predictors of BW in Nigerian local chickens, and found out that in both sexes the multiple regression equations when compared with the simple linear regression equations, multiple regression technique was better

in predicting BW from linear body measurements than simple linear regression technique. Multiple regression analysis has been used to interpret the complex relationship among BW and some linear body measurements (Yakubu *et al.*, 2012).

Ukwu *et al.* (2014) performed a statistical modeling of BW and linear body measurements in Nigerian indigenous chicken, the resultant predictive equations showed that there were significant relationships between BW and linear body measurements. The high R^2 values observed showed that the predictive equations could be used to predict BW accurately, with the multiple regression model being more efficient than the simple regression models. Wolanski *et al.* (2006) suggested that due to the positive and strong nature of the correlation between BW and linear body measurement traits in males of eight selected pure or commercial broiler breeder strains, it means that BW could be estimated from body measurements. From the results of Machebe and Ezekwe (2010), BW of pigs can be estimated using simple linear body measurement of heart girth, body length and flank-to-flank. This is because growth in animals could be evaluated from the component parts of the animal. This implies that improvements in the body measurements will invariably lead to a corresponding improvement in the BW of the indigenous Nigerian chickens especially if the correlation is positive (Egena *et al.*, 2014). Ogah (2011) suggested that prediction based on single linear body measurements is unreliable, therefore a crucial step in constructing a multiple regression model for predictive purposes is to determine those variables that contribute much to the response variable (BW) with elimination of non-significant variables. Using all possible selection approach will maximize the number of independent variables (BL, CG, TC, TL and SL) and their contribution in regression equation for predicting the dependent variable.

CONCLUSION

In conclusion, the findings suggest that there is a relationship between body weight (BW) and linear body morphometric traits. The BW had significant relationships with linear body measurement traits. Also, the BW of Nigerian heavy ecotype local hens could be predicted accurately from shank length, back length, thigh circumference and chest girth. Our findings might help the recognition of the association between BW and linear body measurement traits in these local hens, and this could selection to improve BW in breeding. Further studies in this regard are needed with larger sample of the same or closely related local chicken breeds.

Table 2: Stepwise regression for the combination of linear traits for predicting body weight of Nigerian heavy ecotype local hens

Predictor	Prediction equation	R^2	Adjusted R^2
SL	$BW = -454.93 + 221.60SL$	0.605**	0.604
SL, BL	$BW = -1689.96 + 149.25SL + 75.83BL$	0.702**	0.701
SL, BL, TC	$BW = -1535.15 + 103.30SL + 63.73BL + 48.84TC$	0.735**	0.733
SL, BL, TC, CG	$BW = -1515.55 + 85.12SL + 59.32BL + 40.00TC + 9.30CG$	0.743**	0.741
SL, BL, TC, CG, TL	$BW = -1485.70 + 82.06SL + 58.34BL + 38.70TC + 8.39CG + 3.85TL$	0.746**	0.744

BW - body weight, SL - shank length, BL - body length, TC - thigh circumference, CG - chest girth, TL - thigh length, R^2 - coefficient of regression, **Significant at $p < 0.01$

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