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Gait Score, Latency-to-Lie and their Association with Body Weight and Morphometric Measurements in Light and Heavy Genotypes of Domestic Turkey

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Abstract

Locomotion problems limit access to drinkers and feeders with a resultant effect on birds' survival and productivity. In this study, gait score (GS), latency-to-lie (LTL) and their association with body weight (BWT) and morphometric traits in light weight (Nigerian Local, NL) and heavy weight (Nicholas White, NW) strains of turkeys were evaluated. A total of two hundred day-old Nigerian local and Nicholas white poults were used for the study. Gait of poults were scored at 4, 8, 12 and 16 weeks of age using Kestin gait scoring system. Other parameters measured include latency-to-lie, body weight and morphometric traits at 4, 8, 12 and 16 weeks of age. The results showed that poults with normal walking ability (GS=0) in the light strain Nigerian local declined slightly from 88.4 percent at week 4 to 85.0 percent at week 16, while poults with normal walking ability (GS=0) in Nicholas white declined from 81.1 at week 4 to 16.4 percent at week 16, respectively. The GS of Nicholas White was higher ($p<0.05$) than that of NL at 8 and 16 weeks of age. The LTL values decreased (1310.1- 555.7 seconds) with the age of birds and were higher ($p<0.05$) in NL at 8, 12 and 16 weeks of age. Correlation (r =-0.256 to 0.278) between BWT and GS was significant ($p<0.05$) at weeks 8 and 12 in NW and at weeks 12 and 16 in NL. BWT was correlated ($p<0.05$) with body girth, keel length, femur length, shank diameter and Tibia Metatarsus in both genotypes. There was significant correlation ($p<0.05$) between LTL and GS (r= -0.36 to -0.87), BWT and LTL (r= -0.24 to 0.31), BWT and LM traits (r= 0.56 to 0.96) in both genotypes. It was concluded that GS and LTL are influenced by genotype and age of poults.

Key words: correlation, linear measurement, Nicholas White, Nigerian local, walking ability

Introduction

The use of intensive production methods and new breeds has brought about rapid changes in global poultry production since 1940 (Permin and Pedersen, 2000). Modern production system is however, associated with a high incidence of leg problems; reduce access to feeder and drinker, thereby limiting birds' survival and productivity. A survey conducted in the United Kingdom showed that about 30% of broilers have substantial gait abnormalities (Knowles *et al*., 2008). Corr *et al*. (2003c) observed that compensatory gait adaptations to minimise energy required for movement may occur in birds that have experienced an interruption of the normal gait cycle. Interruption of the 'normal' gait cycle if associated with increase in energy expenditure often affects the bird's tendons, joints, ligaments, and bones (Bradshow *et al*., 2002, Mench *et al*., 2004) resulting into lameness in the affected animal (Muir *et al*., 1998, Waters *et al*., 1999). It may further results into poor animal welfare, poor performance of birds and slaughterhouse losses (Almeida Paz *et al*., 2010). According to Dawkins *et al*. (2003), leg weakness in birds is associated with hock and foot pad burns as well as breast blisters due to prolonged sitting or lying in the litter. A number of studies also associated leg weakness with the strains and age of birds (Reiter and Bessei, 1997, Ayorinde *et al*., 2004). A Report by Bizeray *et al*. (2000) and another report by Bokkers and Koene (2004) showed that selection against leg abnormality was 9th out of 12th traits considered. Gait score is a measure of musculoskeletal fitness and (to an extent) physiological well-being of the animal. The most widely used methodology for on-farm welfare assessment of lameness within commercial broiler flocks is the six-point gait scoring scale (Kestin *et al*, 1992). According to Talaty *et al.* (2010), broilers with poor walking ability (i.e. with GS scores of 4 and 5 on a scale of 0 to 5) had decreased mobility and trouble accessing feeders and water fountains, resulting in reduced feed intake and lower body weights. Behavioural responses such as Latency-to-lie have been employed to assess bird's leg health and overall well-being in broiler chicken (Weeks *et al*., 2003). Rapid growth rate in meat-type birds has been suggested to be a major cause of poor bone quality (Williams *et al*., 2004). However, only a few studies have attempted to address and quantify the relationships between gait and skeletal structure characteristics (Cara *et al.,* 2015). There is no known work on the comparison between the gait characteristics and latency-to-lie of Nigerian light strain of domestic turkey and their exotic meat types. Information on wellbeing of turkey (as measured by GS and LTL tests) is important to commercial turkey breeders in Nigeria. Thus, the aim of this study was to compare gait score, latency-to-lie and their relationship with bird's body weight and morphometric measurements in Nigerian local and Nicholas white turkeys.

Materials and Methods

Location of Study

The experiment was carried out at the breeding unit of the Teaching and Research Farm, Faculty of Agriculture, University of Ilorin, Ilorin. Ilorin lies between rainforest of the South West and Savannah grassland of Northern Nigeria. It has a co-ordinate of 8˚ 30' 0" North, 4˚ 33' 0" East. Ilorin has an altitude of 305m, 1001' above sea level; with annual rainfall, relative humidity and day temperature of Ilorin of 600-1200 mm, 65-80% and 33-370 C, respectively.

Experimental birds and management

Nigerian local turkey used in this study was a slow growing turkey, while Nicholas white turkey is the most popular fast growing exotic turkey in Nigeria. A total of two hundred day-old poults (100 per genetic group) were obtained from Tolvic farm in Ibadan, Oyo State. The poults from each genotype were divided into four replicates of twenty-five poults per replicate. The birds were then transferred into deep litter brooder pens. Good quality water, starter mash (28% crude protein, 0-6 weeks), grower mash (24% crude protein, 7-16 weeks) and finisher mash (20% crude protein, 17-20 weeks) were supplied *ad libitum*. Routine sanitation and vaccination programs were observed to prevent the occurrence of diseases.

Methods of data collection

Gait scoring was evaluated on the birds at 4, 8, 12 and 16 weeks of age. Each bird was observed and scored separately; recumbent birds were gently prodded to determine their ability to walk independently. Kestin gait scoring system marking from 0 to 5 was used; the birds were allowed to walk over a distance in the test pen to assess their walking ability. Each bird was observed while walking by two observers and then scored on a scale of 0-5 as described by

Kestin *et al.* *(*1992) with 0 and 5 scores assigned to sound bird and bird which could barely moves, respectively. The score of 1, 2, 3, and 4 were assigned to birds with a slight walking deficiency; bird with significant walking deficiency; bird with obvious gait defects that affected their ability to move (i.e. moderately lame), and birds with serious difficulty in walking, respectively. Turkeys with gait scores of 3 to 5 were classified as clinically lame.

Birds were transferred and allowed to stay in test pen for 30 minutes. Tepid water was poured into the test pen to stimulate the birds undergoing the test to stand simultaneously as described by Berg and Sanotra (2003b). The length of time in which the birds stood before they sat was recorded (in seconds) as the Latency-to-lie (LTL). Birds that were able to stand for at least 15 minutes were classified as sound, while those that lied within five minutes were grouped as lame. The birds were evaluated for LTL at 4, 8, 12 and 16 weeks of age.

The body weight and some morphometric traits were measured as objective indicators of poults' walkability at 4, 8, 12 and 16 weeks of age. Body Weight (W) was taken with the aid of a weighing balance. Each of the poults was then grouped according to its body weight to one of the three weight groups (A, B, C for high, medium and low weight groups, respectively). **Femur (F)** was taken as the distance from the ball joint of the femur (hip joint) to the thigh joint. Shank Length (SL) was the distance between the shank joint to the extremity of the *Digitus pedis*. Body Girth (BG) was determined as the distance beneath the wing and around the region of the breast. Shank Diameter (SD) was measured at the middle of the left shank of each bird with the aid of a pair of vernier caliper. Keel Length (KL) was measured as the distance between the cranial and the caudal terminals of the keel bone using a tape rule.

Statistical analysis

Data collected were subjected to the General Linear Model procedure of Statistical Analysis System program (SAS, 2002) to test the effects of initial weight group and genotype on weekly body weight, and to test the effects of genotype on GS and LTL values. Tukey-Krammer HSD multiple comparison test (Tukey, 1953; Kramer, 1956) was used to separate significant means. The correlation procedure of SAS software was used to determine the phenotypic correlations among traits. The mathematical model used to test the effect of genotype and weight group on weekly body weight of poults was as follow:

$$Y_{ijk} = \mu + G_i + W_j + GW_{ij} + e_{ijk}$$

Where;

Y_{ijk} = i^{th} observation on the bird of the j^{th} genotype and the k^{th} weight group;

μ = overall mean;

G_i equals the effect of the i^{th} genotype;

W_j equals the effect of the j^{th} weight group;

GW_{ij} equals the interaction between genotype and weight group; and

e_{ijk} = random error with expectation equals 0.

Results and discussion

The results of body weights measured at different ages in the two genotypes are presented in Table 1. The results showed significant effect ($p<0.05$) of initial weight group on subsequent body weights up to 12 and 16 weeks of age in Nigerian local and Nicholas white poults, respectively. Nicholas white poults of weight groups A, B, C were significantly ($p<0.05$) heavier than Nigerian local poults (of corresponding weight groups) at 4, 8, 12 and 16, weeks of age. Interaction between genotype and initial weight group was not significant ($p>0.05$) at all ages.

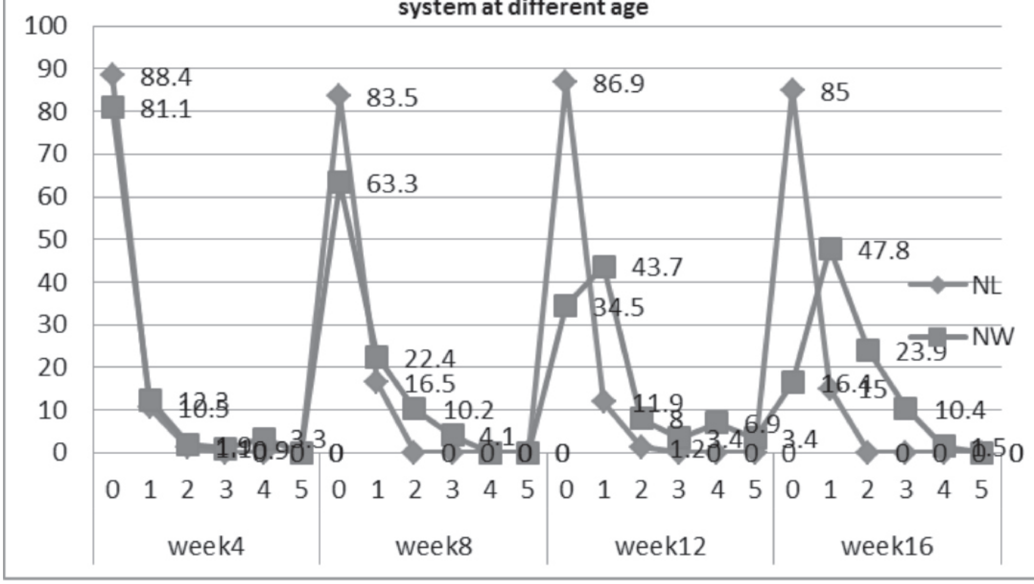
Table 1: Body weight (Kg) of Nicholas white and Nigerian Local poults at 4, 8, 12 and 16 weeks of age

	Nicholas white			Nigerian Local			
WEEKS	A	B	C	A	B	C	S.E.M
4	0.593^{d}	0.449^{c}	0.313^{b}	0.443^{c}	0.340^{b}	0.238^{a}	0.728
8	1.982^{d}	1.741^{c}	1.291^{b}	1.130^{b}	0.926^{a}	0.863^{a}	0.501
12	3.659^{e}	3.272^{d}	2.700^{c}	1.943^{b}	1.598^{a}	1.588^{a}	0.951
16	5.020^{c}	4.786^{c}	3.850^{b}	2.661^{a}	2.146^{a}	2.250^{a}	0.375

Means in the same row with different superscripts are significantly different ($p < 0.05$). A, B, C represent high, medium and low weight groups, respectively

Poults with normal walking ability (GS=0) in the light strain Nigerian local declined slightly from 88.4 percent at week 4 to 85.0 percent at week 16, while poults with normal walking ability (GS=0) in Nicholas white declined from 81.1 at week 4 to 16.4 percent at week 16, respectively (Figure 1).

Figure 1: Percentage gait scores of NL and NW poults on Kestin gait scoring system at different age



Gait score values remained fairly constant (0.1279 – 0.1667) with increasing age in Nigerian Local poults, while the gait score value increased with age in Nicholas white poults. The gait score was significantly ($p<0.05$) higher in Nicholas white than Nigerian local poults at 8 and 16 weeks of the experiment (Table 2). The proportion of lame (GS 3-5) birds was higher in Nicholas White poults at weeks 4, 8, 12 and 16. The Latency-to-lie decreased with the age of Nigerian Local and Nicholas white turkeys (Table 2). Nigerian local turkey had higher ($p<0.05$) Latency-to-lie values at 8, 12 and 16 weeks of age than Nicholas white turkeys.

Table 2: Mean value (±SEM) for gait score and latency-to-lie in Nicholas white and Nigerian Local poults at different ages

	Age (weeks)	Nigerian Local	Nicholas White	S.E.M
Gait score	4	0.1279	0.3023	0.4780
	8	0.1667	0.5128*	0.4430
	12	0.1429	1.1640*	0.8930
	16	0.1500	1.240*	0.4470
Latency-to-lie (seconds)	4	1310.198*	638.267	0.643
	8	815.869*	363.623	0.596
	12	667.702*	276.582	0.495
	16	555.725*	223.620	0.856

Significant ($p<0.05$) correlation was obtained between body weight and gait score at weeks 8 and 12 in Nicholas white (r= -0.236 and -0.256, respectively), and at weeks 12 and 16 in Nigerian local poults (r= 0.261 to 0.278, respectively) (Table 3). The relationship between body weight and LTL was not significant ($p>0.05$) beyond week 4 in both genotypes (Table 3).

Table 3: Correlation between body weight and gait score, and correlation between body weight and latency-to-lie in Nicholas white and Nigerian Local poults

	Age (weeks)	Nigerian Local	Nicholas White
Gait score	4	-0.039(0.720)	-0.016(0.867)
	8	0.109(0.324)	-0.236*(0.020)
	12	0.278*(0.010)	-0.256*(0.017)
	16	0.261*(0.019)	-0.080(0.520)
Latency-to-lie (seconds)	4	-0.310**(0.004)	0.221*(0.023)
	8	-0.187(0.089)	-0.011(0.914)
	12	0.068(0.539)	0.129(0.235)
	16	-0.133(0.239)	0.028(0.825)

*p values in parenthesis, *significant correlation at p<0.05, **significant correlation at p<0.01*

The correlation values obtained at different ages between gait score and latency-to-lie (LTL) in Nicholas white and Nigerian local poults were significant ($p<0.05$; Table 4). Most of the estimates of correlation between gait score and LTL were negative (r= -0.127 to -0.866).

Table 4: Correlation between gait score and latency-to-lie in Nicholas white and Nigerian Local poults at 4, 8, 12 and 16 weeks of age

Age (weeks)	Nigerian Local	Nicholas White
4	-0.363**(0.001)	-0.721**(0.000)
8	-0.127(0.249)	-0.714**(0.000)
12	0.055(0.619)	-0.866**(0.000)
16	0.265*(0.018)	-0.807**(0.000)

*p values in parenthesis, *significant correlation at p<0.05, **significant correlation at p<0.01*

The correlation between gait score and linear measurements in Nicholas white and Nigerian Local poults is presented in Table 5. The results showed that BG, KL, F and TM were positively correlated ($p<0.05$) with body weight at weeks 8 and 12 in Nicholas White. Body weight was significantly correlated ($p<0.05$) with BG, F and SD in 12 weeks old Nigeria local poults. Body weight was highly correlated (p<0.01) with the linear measurements at week 8, 12 and 16 in both Nigerian local and Nicholas White poults, except SD at week 12.

Table 5: Correlation between gait score and linear measurements and the correlation between body weight and linear body measurement in Nicholas white and Nigerian Local poults

		8 WEEKS		12 WEEKS		16 WEEKS	
		NL	**NW**	**NL**	**NW**	**NL**	**NW**
Gait Score and LM	HW	0.175	0.219*	0.189	-0.13	0.169	-0.084
	SL	0.05	0.215*	0.139	-0.209	0.155	-0.043
	BG	0.143	0.236*	0.238*	-0.237*	0.290**	-0.04
	KL	0.128	0.252*	0.232*	0.308**	0.146	-0.121
	F	0.003	0.218*	0.139	0.291**	0.236*	-0.093
	TT	0.243*	0.243*	0.258*	-0.053	0.158	-0.199
	TM	0.039	0.206*	0.124	0.238*	0.179	-0.099
	SD	0.065	0.33**	-0.023	-0.061	0.305**	-0.023
Body weight and LM	HW	0.752**	0.904**	0.617**	0.880**	0.467**	0.945**
	SL	0.823**	0.910**	0.807**	0.938**	0.665**	0.880**
	BG	0.754**	0.891**	0.943**	0.900**	0.888**	0.843**
	KL	0.799**	0.823**	0.794**	0.934**	0.671**	0.933**
	F	0.561**	0.964**	0.722**	0.937**	0.785**	0.890**
	TT	0.621**	0.899**	0.753**	0.675**	0.766**	0.863**
	TM	0.621**	0.917**	0.791**	0.918**	0.739**	0.952**
	SD	0.563**	0.735**	-0.028	0.792**	0.786**	0.799**

HW, SL, BG, KL, F, TT, TM, SD, represent Hip Width, Shank Length, Body Girth, Keel Length, Femur, Tibia Tarsus, Tibia Metatarsus, Shank Diameter, respectively. NL and NW represent Nigerian Local and Nicholas White poults, respectively.
*** Correlation is significant at the level of 0.01 (2- tailed)*
** Correlation is significant at the level of 0.05 (2- tailed)*

The Kestin gait score pattern of 4-8 weeks old Nicholas white broiler turkey in this study were comparable to gait score patterns obtained for Ross 708 and Cobb 500 broiler chicken by Webster *et al* (2008), however the 12-16 weeks old Nicholas white broiler turkey had different Kestin gait score patterns with more than 5 percent of poults given gait score of 3 or more. The higher gait score of Nicholas White suggests that heavy birds are more likely to have locomotion disorders than light genotypes like Nigerian local turkey. According to Cara *et al* (2015), a relationship likely exists between skeletal changes and duck mobility. Previous report (Skinner-Noble and Teeter, 2009) have shown that varying a bird's physical proportions results in a change in its gait to maintain the centre of gravity during locomotion. Corr *et al.* (2003b) noted that the low level of activity and the morphological changes seen in the modern broiler are likely consequences which help to increase stability during walking. In another study, Corr *et al.* (2003a) observed that broiler birds had bigger bodyweights, body girths and breast muscle which probably displaced their centre of gravity. These fast growing birds were also characterised by shorter legs, greater thigh-muscle masses, broader *tarso metatarsi* and weak bones which were lower in calcium and phosphorus.

The poorer gait score with increased in birds age in the fast growing Nicholas white may be due to weaker skeletal integrity. Cara *et al.,* (2015) observed significant increase right and left hip angle as the ducks aged. The results of gait assessment agree with LTL score which also suggests that older birds of both genotypes have lower leg stability than younger birds. The present results agrees with the report of Sorensen *et al*. (2000) who observed that movement disorders is not a major problem in young birds of less than 4 weeks old. The significant correlation between gait score and body weight in 8-12 weeks old Nicholas white poults agrees with the results of an earlier study conducted in commercial Pekin ducks which showed that body weight increased with age, but within an age, body weight decreased as walking ability or gait score became worse (Cara *et al.,* 2015).

The observed negative association between gait score and LTL agrees with earlier reports in broiler chickens that negative correlation exists between the two assessment methods (Weeks *et al*. 2003, Ayorinde *et al*., 2004, Webster *et al*., 2008). Caplen *et al.* (2014) reported that mobility impairments are closely related to lameness assessed using GS. Therefore selection of poults at specific age for high LTL may help to reduce chronic leg discomfort in turkey. Berg and Sanotra (2003a) obtained a high negative correlation (r = - 0.86) between LTL and gait score in a survey involving 14 farms. The non-linear correlation between gait score, LTL and body weight suggests that other factors apart from body weight contributes to the results of poults' leg health tests like gait score and LTL. A similar observation was made by Ayorinde *et al*. (2004) in broiler chicken. The present results agrees with Skinner-Noble and Teeter (2009) who observed variation in correlation values in their measurement of the time taken to rise among broiler birds that differs in field gait score. The increase in zoometric measurements with age is expected in animals in the growing phase, similar observation was made by Cara *et al.,* (2015) who reported linear increases in tibia and femur bone width and length as age of the ducks increased. The observed low correlation between gait score and zoometric measurements in 16 weeks old Nicholas white poults suggest that most of the bone parameters considered were poor direct indicators of bird walking ability. Cara *et al* (2015) examined the relationship among gait score, bone parameters, and hip angle in commercial Pekin ducks at ages 14 days, 21 days, and 32 days. Their report showed significant relationship between gait score and hip angles, and bone density increased linearly with both age and gait score.

Conclusion

It is therefore concluded that gait score and latency-to-lie were influenced by genotype and age of poults. The study further revealed a significant correlation between body weight, gait score, latency-to-lie and linear body measurement in both genotypes.

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