

Prediction of body weight from linear body measurements in Japanese quail



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Abstract *Corresponding Author: dipodudu2000@yahoo.com; 08034069743

A total of 168 two-weeks-old Japanese quail chicks of mixed sex were used to study the relationship between Body weight and linear measurements in Japanese quail. Data were collected on body weight, body length, body girth, wing length, shank length and drumstick length fortnightly for eight weeks to predict body weight. Data were subjected to SAS for analysis. The mean body weights were 38.31, 81.12, 121.38 and 132.15g, respectively. Body weight gain increased as the birds advance in age and the highest body weight gain was between week 2 and week 4. Female birds were significantly ($P < 0.05$) heavier than male. Body weight had a positive correlation with all linear body measurements at week 2 except for drumstick length. The best correlation was obtained between body weight and body girth at the 2nd week of age (0.82) ($P < 0.05$). The estimates of coefficient of determination which ranged from 0.0043 to 0.68 and predictive equations show that body weight in Japanese quail is linearly related to body measurements especially with body girth and body length. The study showed that Body girth and Body length could be used as criteria for assessment and early selection of Japanese quail for body weight.

Keywords: Japanese quail; Body weight; linear measurements; Correlation, linear and multiple regressions.

Introduction

Japanese quail (*Coturnix coturnix japonica*) is the smallest farmed avian species for egg and meat (Minvielle, 1998) and it is becoming increasingly important in the Nigerian poultry industry. (Musa *et al.*, 2008). Some parameters of importance in Japanese quail include body weight, body conformation, the shank length and diameter, the body girth and length, wing length, drumstick length. These parameters are very useful and are important traits in poultry breeding and processing industry. Growth is a complex and highly dynamic physiological process that begins immediately after a zygote is formed and it continues until maturity. Components of growth, such as body weight and body measurements, are important factors to both poultry breeders and meat processors (Adeniji and Ayorinde, 1990). Body weight helps to determine several economic characteristics of farm animals. It is an

important trait as it forms the basis for assessing growth, feed efficiency and also in making economic and market decisions in farm animals (Momoh and Kershima, 2008). Body weight is an important feature, but seldomly adopted in rural areas due to lack of reasonable accurate scales. In an organized livestock marketing system, weight is normally taken to determine the market prices of animals. This is normally done with the use of weighing scales which is not always available to the rural livestock farmer/traders. Hence, farmers find it very difficult to estimate body weights of their birds, leading to inaccuracies in decision making. Indirect methods of assessing body weights in animals without the use of weighing scales do exist such as the use of body measurements (Semakula *et al.*, 2011).

The primary method of weighing animals without scale is to regress body weight to body characteristics, which can be

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measured readily (Mayaka *et al.*, 1995). Relationship existing among body traits provides useful information on the performance, productivity and carcass characteristics in animals. Most of the body linear measurements reflect primarily the length of the long bones of the animal and when taken sequentially over a period of time, they generally indicate the way in which the animal body is changing shape and have been useful as predictors of live weight and carcass composition (Oke *et al.*, 2004). Additionally, relationship between body weight and linear body measurements are important not only in predicting body weight but also useful in genetic improvement strategies. The objectives of this study were to determine the relationship between body weight and linear body measurements in Japanese quail, to determine the effect of sex on linear body measurements and to develop a regression equation for predicting body weight using linear body measurements in Japanese quail at different ages.

Materials and methods

This study was conducted at the Quail Unit, Obafemi Awolowo University Teaching and Research Farm, Ile- Ife, Nigeria. One hundred and sixty eight (168) one day-old Japanese quail of mixed sex were obtained from a random-bred population. The birds were brooded for four weeks and were fed on starter diet (24% crude protein and 2700 kcal kg⁻¹) from day old to 4 weeks and finisher diet (20% crude protein 2700 kcal kg⁻¹) from week 5 to week 8. Feed and water were given *ad libitum*. The sex of the birds was determined by their feather pattern after 28 days of age. Body weight and linear body measurements were taken fortnightly from week 2 to week 8.

Measuring procedure

Body weight (BL) was recorded using a sensitive weighing scale. Body Length

(BL) was taken in cm with a measuring tape stretched from bird's nasal opening, along its gently stretched neck and back, to the tip of its pygostyle. Body Girth (BG) was taken when a measuring tape is looped round the region of the breast under the wings. Wing Length (WL) was as the distance from the humerus- coracoid junction to the distal tip of the phalanges digits, using a measuring tape. Shank length (SL) was taken as the distance between the foot pad and the hock joint, measured using measuring tape. Drum stick length (DSL) was taken as the distance from the tip of hock to the ball joint of femur and measured using a measuring tape.

Statistical analysis

Data were subjected to SAS appropriate for a Completely Randomized Design and significantly different means ($P < 0.05$) were further separated by the use of Duncan's Multiple Range procedure option in statistical package. Correlation, linear and multiple regression analysis between body weight and the various body size parameters were also determined. The coefficient of determination (R^2) for each parameter in the regression equations was determined to show the relative contribution of each body measurement to the body weight of Japanese quail at different ages. The following regression equations were used to predict body weight from linear measurements.

$$Y = a + bx + e \dots \dots \dots 1$$

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + e \dots \dots \dots 2$$

Where Y = body weight or dependent variable, a = constant in the regression equation, b = regression coefficient, b_1, b_2, \dots, b_5 = regression parameters x = various body measurements, x_1, x_2, x_3, x_4 and x_5 are body length, body girth, wing length, shank length and drum stick length, respectively and e = random error.

Results and discussion

The mean (\pm SEM) and the coefficients of variation of body weight and linear measurements at different ages are presented in Table 1. There were progressive increases in body weight gain and linear measurements over the eight weeks period. Mean body weight increased from 38.31g at 2 weeks of age to 132.33g at 8 weeks of age. The highest body weight gain occurred between two and four weeks of age (42.95g). Body length increased from 12.41 cm at week two to 18.60 cm at week eight. Body girth increased from 9.11cm at week 2 to 14.43 cm at week 8. Wing length increased from 7.17g at week 2 to 8.32g at week 8. Shank length increased from 1.94g at week 2 to 2.52g at week 8 and Drum stick length increased from 4.24g at week 2 to 5.34g at week 8.

The Body Weight and linear measurements obtained in this study were however lower than values reported by other authors (Almeida *et al.*, 2002; Reddish *et al.*, 2003; Ojo *et al.*, 2014) which ranges from 35.23g to 143.78g. This is expected in morphometric traits assessments of birds belonging to different populations and environment (Alabi *et al.*, 2012).

Table 2 shows the correlation between body weight and body measurements in Japanese quail. Linear measurements that were significant means that they increase as body weight increase across the week and the negative values shows negative correlation with body weight. Body weight was positive and highly significantly ($P < 0.01$) correlated with all body measurements at week 2 except for Drum Stick length. Body Girth had the highest correlated value with body weight at week 2 (0.82) and week 4 (0.72). This agreed with Ojo *et al.*, (2014) who noticed a similar observation in their research. Estimates obtained for wing length, shank length and drum stick at weeks six and eight were between -0.19 and

0.28cm. Ibe and Nwakalor (1987) reported high and positive correlations between linear measurements and body weight in the Nigerian local chicken. Similar observation was reported by Adeniji and Ayorinde (1990) in their studies on broiler chicken. A zoometric study on Nigerian local Muscovy ducks by Raji *et al.* (2009) also showed highly significant positive correlations between BW and linear body measurements. Raji *et al.* (2009) observed that body girth had the strongest correlation with body weight followed by body length. The strong correlation between body girth and body weight may be due to the fact that the body girth consists of important bones, muscles and viscera.

The effect of sex on Body weight and linear body measurements of Japanese quail is shown in Table 3. There was no significant effect ($P > 0.05$) of sex on most body measurements except for shank length and body length (Table 2). Female chicks had significantly higher ($P < 0.05$) shank length at the 2nd (2cm) week and a higher body length at 4th (16.53cm) week of age, this agrees with the research of Ojo *et al.*, (2014) who indicated that female chicks had significant higher shank diameter at 2nd and 4th weeks of age and a higher body girth at the 6th week. Sex effect on bodyweight was not significant ($P > 0.05$) at the 2nd, 4th and 6th weeks of age and the female quails were numerically better in mean bodyweight at these ages. However, females were significantly higher ($P < 0.05$) than the males in body weight at 8th (136.13g vs. 128.53g) week of age. This agreed with the research reported by Ojo *et al.* (2014) who indicated that females were significantly higher ($P < 0.05$) than the males in body weight at 6th and 8th weeks of age. Sexual dimorphism has previously been reported in favor of the male in duck (Raji *et al.*, 2009) and in pigeon (Hassan *et al.*, 1997).

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Table 1: Body weight and linear measurements (\pm SE) of Japanese quail at different ages

Traits	Week 2	Week 4	Week 6	Week 8
	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE
BW (g)	38.31 \pm 1.11	81.26 \pm 1.60	121.38 \pm 1.85	132.33 \pm 1.78
BL (cm)	12.41 \pm 0.16	16.29 \pm 0.10	17.80 \pm 0.09	18.60 \pm 0.09
BG (cm)	9.11 \pm 0.09	12.24 \pm 0.10	14.08 \pm 2.31	14.43 \pm 0.10
WL(cm)	7.17 \pm 0.12	8.26 \pm 0.08	8.29 \pm 0.66	8.32 \pm 0.06
SL(cm)	1.94 \pm 0.03	2.44 \pm 0.03	2.44 \pm 0.02	2.52 \pm 0.02
DSL(cm)	4.24 \pm 0.06	4.95 \pm 0.05	5.42 \pm 0.06	5.44 \pm 0.06

BW- body weight; BL- body length; BG-body girth; WL-wing length; SL-shank length; SD- shank diameter; DSL-Drum Stick Length, SE- Standard error of mean

Table 2: Correlations between body weight and linear measurements in Japanese quail at different ages

Traits	2weeks	4weeks	6weeks	8weeks
Body Length (cm)	0.56**	0.61**	0.16	-0.16
Body Girth (cm)	0.82**	0.72**	0.18	0.05
Wing Length (cm) Shank Length (cm)	0.46**	-0.16	0.28	-0.07
Drumstick Length (cm)	0.47**	0.20	-0.19	-0.13
	0.23	-0.08	0.12	0.01

**significant at $P < 0.01$ and 0.05

Table 3: Effect of sex on body weight and linear measurement in Japanese quail at different ages

Traits	Week 2		Week 4		Week 6		Week 8	
	Male	Female	Male	Female	Male	Female	Male	Female
BW(g)	37.40	39.23	81.20	81.25	120.57	121.90	128.53 ^b	136.13 ^a
BL(cm)	12.25	12.63	16.05 ^b	16.53 ^a	17.63	17.99	18.46	18.74
BG(cm)	9.01	9.23	12.11	12.38	14.05	14.11	14.47	14.40
WL(cm)	7.05	7.29	8.25	8.27	8.22	8.36	8.26	8.38
SL (cm)	1.86 ^b	2.00 ^a	2.40	2.49	2.43	2.45	2.52	2.52
DSL(cm)	4.26	4.21	4.91	4.99	5.27 ^b	5.59 ^a	5.32	5.37

^{ab}Mean in the same column having different superscript within the same week differs significantly ($P < 0.05$). BW- body weight; BL- body length; BG-body girth; WL-wing length; SL-shank length; SD- shank diameter; DSL-Drum Stick Length

Table 4 showed the linear regression equations and Coefficient of determination (R^2) for predicting body weight at different ages in the Japanese quail. Live body weight had a significant ($P < 0.05$) linear relationship with body length at week 2 and 4, body girth at week 2 and 4, wing length at week 2 and shank length at week 2. This was in contrast to report by Ojo *et al.* (2014) that body weight had a significant ($P < 0.05$) linear relationship with all body measurements at all ages except with wing length and the shank diameter at the sixth week of age. R^2 was highest for body girth at week 2 (0.68) and lowest for drumstick length (0.0001) at week 8, this disagreed with Kaye *et al.* (2016) who reported a significant difference at different ages. The

R^2 values suggest that Body girth contributed 68 and 52 percent, body length contributed 38 and 31 percent to body weight at week 2 and 4 respectively. Conversely, drum stick length contributed 2 and 0.6 percent to body weight at 2nd and 4th week. This study showed that body length, wing length, body girth, shank length and drumstick length increased with age. This is possible because as bird's increases in body weight the body dimension, increases this is in accordance with finding Kozaczyrisk *et al.* (1999); Nsoso *et al.* (2008) and Akram *et al.* (2012). At week 6, wing length contributed more to body weight which disagrees with Ojo *et al.* (2014) who reported that body girth contributed more at week 6 and at week 8.

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Table 5 showed multiple linear regression equation for estimating body weight at different ages in Japanese quail. R^2 value increased when all body measurements were combined in a multiple regression with the Body Weight. R^2 values were 0.79, 0.64, 0.12 and 0.06 at 2nd, 4th, 6th and 8th

week, respectively. The increment in R^2 values when all body measurements were combined in a multiple regression with the body weight supported earlier observations (Ojo *et al.*, 2014; Raji *et al.*, 2009; Momoh and Kershima, 2008).

Table 4: Linear regression equation for predicting body weight of different ages in Japanese quail

Traits	Age	Intercept	Regression Coefficient (b)	Coefficient of determination (R^2)	Results
Body Length	2	-16.80	4.42	0.31	S
	4	-86.75	10.31	0.38	S
	6	67.68	3.01	0.02	NS
	8	194.57	-3.35	0.03	NS
Body Girth	2	-59.81	10.80	0.68	S
	4	-57.70	11.35	0.52	S
	6	66.21	3.91	0.03	NS
	8	118.74	0.94	0.003	NS
Wing Length	2	6.25	4.47	0.21	S
	4	108.82	-3.34	0.03	NS
	6	53.73	8.14	0.08	NS
	8	147.73	-1.85	0.0043	NS
Drum stick length	2	19.99	4.42	0.31	S
	4	93.29	10.31	0.38	S
	6	118.51	3.01	0.02	NS
	8	130.56	-3.35	0.03	NS
Shank length	2	0.74	19.36	0.22	S
	4	49.4	13	0.04	NS
	6	176.6	-22.6	0.03	NS
	8	158.8	10.54	0.02	NS

S- significant, NS-Not significant

Table 5: Multiple linear regression equation for estimating body weight at different ages in Japanese quail

Age (weeks)	Predicting equations	R^2	S	SE of estimates
2	$Y = -85.05 + 2.97BL + 6.60BG + 1.30WL - 0.19SL + 4.45DSL$	0.80	**	3.37
4	$Y = -105.85 + 6.57BL + 8.38BG - 0.30WL + 0.77SL - 4.41DSL$	0.64	**	6.53
6	$Y = 77.99 + 0.77BL + 1.27BG + 7.64WL - 17.11SL - 1.81DSL$	0.12	*	12.09
8	$Y = 193.59 - 3.65BL + 2.84BG + 1.92WL - 13.11SL + 2.74DSL$	0.06	*	11.65

BW- body weight; BL- body length; BG-body girth; WL-wing length; SL-shank length; SD- shank diameter; DS-drum stick **Coefficient of variation of R^2 is significant at 95% confidence level (i.e. $P < 0.05$) *Coefficient of variation of R^2 is not significant at 95% confidence level (i.e. $P < 0.05$).

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Conclusions

The results of this study show that body weight in Japanese quail is strongly related to body measurements, especially with Body Girth and Body Length. It can also be seen that sex does not affect body linear measurements in Japanese quail except Body Length at week 4 and Shank Length at week 2. The prediction of body weight from these measurements is therefore possible as early as 2 weeks of rearing. Therefore, a breeding programme to achieve an optimum combination of body weight and good conformation for maximum economic returns in the Japanese quail can be easily organized using easily measured parts like Body Girth and Body Length. In conclusion, body measurements had positive and high correlation with body weight indicating that body measurements can be used for estimation of body weight in the field where scales are not usually available.

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