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Association of Live Body Weight with Morphometric Traits in Three Poultry Breeds

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ABSTRACT

The present study was conducted during January to December, 2023 to investigate the body weight and morphometric traits of on 300 poultry birds belonging to Kadaknath, RIR and Punjab Brown chicken breeds and to also find out their functional associations. The traits were measured bi-weekly from the 12th to 26th week of age. Punjab Brown poultry birds had significantly higher (p≤0.01) body weight, beak length, wing length, keel length, and body girth in comparison to Rhode Island Red (RIR) and Kadaknath. Body length and shank width were found to be significantly (p≤0.01) higher in Punjab Brown from 12 to 16 weeks of age, while RIR birds exhibited higher values from 20 to 26 weeks of age. Shank length and comb length were consistently higher in RIR birds across all age groups except at 12 weeks, where Punjab Brown birds showed higher values. Significant (p≤0.01) and positive regression coefficients of body weight on SL from 14 to 26 weeks and on CL from 16th to 26th week of age were observed in RIR chicken. In Kadaknath poultry birds, positive, significant (p≤0.01) regression coefficients were observed for body weight on CL from 16 to 26 weeks of age and for WL from 18 to 26 weeks of age. Moreover, in Punjab, Brown poultry birds, a positive significant (p≤0.01) regression coefficient of body weight was observed on CL from 14 to 26 weeks of age, except 24th week of age, on KL from 16 to 26 weeks of age, except 20th week of age, and on WL from 14 to 20th week of age.

KEYWORDS: Kadaknath, RIR, Punjab brown, body weight, morphometric traits

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1. INTRODUCTION

Assessing growth performance and morphometric characteristics are vital factors in examining the anatomy, productivity and growth rates in poultry birds. Growth is a key trait in all living organisms which includes the gradual physiological changes that begin with zygote formation during fertilization and continue until the individual reaches maturity. Hristakieva et al. (2014) noted that growth in animals, while linked to the expansion of bodily cells and volume is a complex process influenced by both genetic and non-genetic elements. The growth of animals is affected by factors such as age, nutrition, breed, husbandry practices, and health management, among a multitude of other influences. Different animal breeds show varying live weights, which can provide essential insights during the selection process (Udeh et al., 2011). The body weight (BW) of animals is central to this analysis.

In developing countries like India, Indigenous chickens play a vital role in rural economies because of their adaptation to local climatic conditions, disease resistance, meat quality and scavenging ability (Wong et al., 2017). The genetic potential of indigenous chicken breeds is significantly hampered by a lack of genetic improvement and well-designed breeding programs. Indiscriminate crossbreeding is causing genetic erosion, severely threatening the genetic diversity of indigenous chickens, requiring urgent intervention (Gheyas et al., 2021; Chebo et al., 2022; Kebede et al., 2024). Due to their enormous variations in performance traits, Padhi (2016) described indigenous chickens as genetic reservoirs that could be used to develop genetic stocks with improved disease resistance, growth, reproductive, and morphological traits.

Growth in poultry birds is characterized as an organized process of developmental changes involving protein deposition and an increase in morphometric measurements. Variations in morphometric traits can be valuable yardsticks in designing selection experiments for genetic and phenotypic improvement in poultry birds, which primarily depend on the variations within and between breeds or populations. Traits of economic importance like body weight, egg production, and yield are quantitative, complex with continuous variability, whereas body morphometric parameters, viz. body length, shank length, keel length, chest circumference, etc., are variable based on some factors such as age, sex, nutrition, climate and status of the birds. Yakubu et al. (2009) reported that variations and associations among body weight and body morphometrics in chickens are important criteria in differentiating native from exotic breeds. Morphometric traits are the quantitative analyses of the structure, shape, and size of an organism. The derivation of body weight from body measurements (i.e., morphometric traits) has been reported to be a practical and easy technique, especially among rural poultry farmers with limited resources. Dalal et al. (2020) reported an effective and crucial correlation of morphometric traits with 40-week body weight, indicating the effectiveness of the use of morphometric traits in predicting body weight in the synthetic White Leghorn strain. Morphometric traits are correlated with body weight (Ajayi et al., 2012) and could be used as markers in body weight improvement programmes and as body weight predictors. Evaluation of interrelationships among morphometric traits is very useful as predictors of body weight, which in turn could speed up the assessment of traits through simple measurement that can predict body weight without necessitating bird slaughter, which is particularly desirable (Nosike et al., 2018). Estimation of bodyweight from important body measurements using regression models allows a true evaluation and early prediction of body weight, which is very useful in selection criteria (Ojedapo et al., 2012). Accordingly, the objective of this study was to evaluate the body weight and morphometric traits of three chicken breeds and to estimate the functional association among these traits.

2. MATERIALS AND METHODS

2.1. *Ethical approval*

Permission for conducting the study was obtained from Institutional Animal Ethics Committee (GADVASU/2023/IAEC/67/09 dated 14/01/2023).

2.2. *Collection of data*

The study was carried out during 2023 (January to December) at Poultry Research Farm under the Directorate of Livestock Farms, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. Three genetic groups of chickens, i.e., Kadaknath, Rhode Island Red (RIR), and one native chicken germplasm (Punjab brown) maintained under AICRP on Poultry breeding project, were included in the study. The data was collected on body weight and eight morphometric characteristics fortnightly during the 12^{th} to 26^{th} week of age. Body weight and various morphometric traits were measured using instruments as per Anonymous (2012) guidelines (Table 1).

2.3. *Statistical analysis*

The phenotypic $\{r_{p(xy)}\}$ correlations of body weight with different morphometric traits at various ages were calculated using the (Anonymous, 2016) IBM-SPSS 24.0 statistical package. The statistical significance of various fixed effects in the least squares model was determined by the F-test. For significant effects, the differences between pairs of levels of effects were tested by Duncan's Multiple Range Test (DMRT).

Table 1: Measurement of various morphometric traits and instruments used as per the guidelines of Anonymous (2012)

Sl. No.	Trait	Measurement	Instrument
1.	Body weight (BW)	Displayed in a weighing balance	Digital weight machine
2.	Body length (BL)	Birds are stretched in a lying position and measured from the tip of the beak to the tip of the tail (Excluding feathers).	Graduated flexible measuring tape
3.	Shank length (SL)	The distance between the hock joint and the metatarsal pad on the tarsal-metatarsus.	Graduated flexible measuring tape
4.	Shank width (SW)	Shank width (width of shank)	Graduated flexible measuring tape
5.	Beak length (BKL)	From widest point closer to the base of the beak to the end of beak	Graduated flexible measuring tape
6.	Comb length (CL)	Beak to the end of the combs.	Graduated flexible measuring tape
7.	Keel length (KL)	The sternum's length (distance between the vertices of the sternum)	Graduated flexible measuring tape
8.	Wing length (WL)	The distance between the tips of the phalanges and the shoulder joint	Graduated flexible measuring tape
9.	Breast girth (BG)	Circumference of the breast around the deepest part of the breast	Graduated flexible measuring tape

2.4. Regression coefficient

The regression coefficient of bodyweight on morphometric traits at different ages were calculated as:

$Y'_i=a+b_i \sum xi$

where,

Y'_i=Estimated body weight at the i^{th} week of age

x_i=Morphometric traits at i^{th} week of age

a= Intercept

b_i=Regression coefficient of body weight on morphometric traits at i^{th} week of age

3. RESULTS AND DISCUSSION

The least squares mean of body weight and morphometric traits at different ages in different poultry genetic groups during 12th to 26th week of age are given in Table 2. Punjab Brown poultry birds had significantly higher ($p\leq0.01$) body weight in comparison to Rhode Island Red (RIR) and Kadaknath. In morphometric traits, body length (BL) was found to be significantly ($p\leq0.01$) higher in Punjab Brown from 12 to 18 weeks of age, while RIR birds exhibited higher BL from 20 to 26 weeks of age. Shank length (SL) was consistently higher in RIR birds across all age groups except at 12 weeks, where Punjab Brown birds showed higher values. Shank width (SW) was initially higher in Punjab Brown (12th to 16th week), but RIR birds displayed higher SW measurements in subsequent ages. Beak length (BKL) was significantly ($p\leq0.01$) higher in Punjab Brown birds at all age groups, while comb length (CL) was higher in RIR birds from 14th to 26th week except at 12 weeks. Punjab Brown birds exhibited significantly ($p\leq0.01$) higher values for keel length (KL), wing length (WL), and body girth (BG) from 12th to 26th week of age. Variations in body weight and morphometric traits across genetic groups have been reported by many authors (Ahmad et al., 2019; Pawankar et al., 2022; Shafiq et al., 2022). Chebo et al. (2024) studied the body weight and morphometric traits in 1060 adult indigenous poultry birds from four districts in Ethiopia and reported the overall least squares mean of body weight, body length, breast circumference, shank length, shank circumference and comb length as 1.17 kg, 39.6 cm, 26.3 cm, 8.95 cm, 3.51 cm and 3.33 cm, respectively which are in line with our results.

The regression coefficients of body weight on different morphometric traits in the three breeds of poultry birds at different ages are given in Tables 3 to 5. In Kadaknath poultry birds, positive significant ($p\leq0.01$) regression coefficients are observed for body weight on CL (0.303 to 0.282) from 16 to 26 weeks of age and WL (0.377to 0.354) from 18 to 26th week of age. BL was negatively associated during 20th to 26th week of age. The association of BKL with body weight was mostly low or negative. The association of KL was significant ($p\leq0.01$) and negative during the 12–14th week of age and was positive afterwards. The association of BG was inconsistent throughout the study period. In RIR birds, significant ($p\leq0.01$) and positive regression coefficients of body weight on SL (0.441 to 0.432) from 14 to 26 weeks of age were observed, except at the 20th week of age. Significantly ($p\leq0.01$) higher regression coefficients of body weight on CL (0.279 to 0.361) were also found from 16 to 26th week of age. The association of other

Table 2: Least squares mean of body weight (g) and morphometric traits (cm) at different ages in Kadaknath, RIR and Punjab brown

N=100 (In each group)	Traits	12 wk	14 wk	16 wk	18 wk	20 wk	22 wk	24 wk	26 wk
Kadaknath	BW (g)	764.45^{c}	883.31^{c}	965.28^{c}	1076.01^{b}	1110.19^{c}	1139.29^{c}	1151.70^{c}	1169.20^{c}
RIR		866.43^{b}	1015.38^{b}	1240.59^{b}	1375.30^{a}	1576.18^{b}	1752.72^{b}	1903.58^{b}	1982.78^{b}
Punjab brown		912.56^{a}	1089.78^{a}	1283.79^{a}	1433.10^{a}	1625.80^{a}	1888.90^{a}	2240.90^{a}	2567.00^{a}
Kadaknath	BL (cm)	30.68^{b}	33.90^{b}	34.50^{b}	34.65^{b}	36.90^{c}	38.93^{c}	39.03^{c}	39.13^{b}
RIR		31.30^{b}	32.66^{c}	34.49^{b}	38.82^{a}	40.90^{a}	42.12^{a}	42.97^{a}	43.60^{a}
Punjab brown		36.64^{a}	37.69^{a}	38.14^{a}	38.69^{a}	39.86^{b}	40.31^{b}	40.91^{b}	42.16^{b}
Kadaknath	SL (cm)	6.27^{c}	7.14^{c}	7.58^{c}	7.97^{c}	8.35^{c}	8.59^{c}	8.79^{b}	8.81^{c}
RIR		7.19^{b}	8.69^{a}	8.96^{a}	9.17^{a}	9.33^{a}	9.67^{a}	9.75^{a}	9.99^{a}
Punjab brown		7.88^{a}	8.14^{b}	8.33^{b}	8.53^{b}	8.65^{b}	8.79^{b}	8.94^{b}	9.14^{b}
Kadaknath	SW (cm)	3.17^{c}	3.38^{c}	3.55^{c}	4.16^{b}	4.39^{b}	4.45^{b}	4.55^{b}	4.58^{b}
RIR		3.57^{b}	3.78^{b}	4.06^{b}	4.36^{a}	4.57^{a}	4.68^{a}	4.74^{a}	4.94^{a}
Punjab brown		3.79^{a}	4.00^{a}	4.16^{a}	4.16^{b}	4.19^{c}	4.39^{b}	4.53^{b}	4.56^{b}
Kadaknath	BKL (cm)	3.09^{b}	3.26^{b}	3.29^{c}	3.37^{c}	3.45^{c}	3.54^{c}	3.74^{c}	3.85^{c}
RIR		3.14^{b}	3.27^{b}	3.47^{b}	3.78^{b}	3.90^{b}	4.02^{b}	4.09^{b}	4.19^{b}
Punjab brown		3.65^{a}	3.84^{a}	4.41^{a}	4.42^{a}	4.45^{a}	4.49^{a}	4.51^{a}	4.52^{a}
Kadaknath	CL (cm)	3.16^{c}	3.24^{c}	3.52^{b}	3.66^{b}	4.07^{b}	4.32^{b}	4.47^{b}	4.59^{b}
RIR		3.36^{b}	3.72^{a}	3.91^{a}	4.55^{a}	5.01^{a}	5.39^{a}	5.60^{a}	5.70^{a}
Punjab brown		3.39^{a}	3.44^{b}	3.60^{b}	3.63^{b}	3.68^{c}	3.81^{c}	3.88^{c}	3.89^{c}
Kadaknath	WL (cm)	11.18^{b}	11.49^{b}	11.96^{b}	12.11^{b}	12.18^{b}	12.24^{b}	12.26^{b}	12.40^{c}
RIR		11.35^{b}	11.71b	11.94^{b}	12.03^{b}	12.24^{b}	12.38^{b}	12.50^{b}	12.80^{b}
Punjab brown		11.70^{a}	13.54^{a}	14.99^{a}	15.06^{a}	15.12^{a}	16.40^{a}	16.17^{a}	16.18^{a}
Kadaknath	KL (cm)	7.88^{c}	8.73^{c}	9.25^{c}	9.96^{b}	10.31^{c}	10.53^{c}	10.73^{c}	10.97^{c}
RIR		8.62^{b}	9.12^{b}	9.58^{b}	10.06^{b}	11.29^{b}	11.66^{b}	11.82^{b}	11.93^{b}
Punjab brown		10.16^{a}	10.90^{a}	11.96^{a}	13.18^{a}	14.00^{a}	14.49^{a}	15.38^{a}	16.38^{a}
Kadaknath	BG (cm)	20.95^{c}	22.18^{c}	23.40^{c}	24.15^{c}	25.72^{c}	27.87^{c}	28.21^{c}	30.53^{b}
RIR		24.67^{b}	27.46^{b}	27.86^{b}	28.48^{b}	30.15^{b}	31.08^{b}	31.45^{b}	31.66^{b}
Punjab brown		28.08^{a}	28.35^{a}	29.58^{a}	30.58^{a}	31.80^{a}	32.50^{a}	33.50^{a}	34.20^{a}

*Means with different superscripts within a trait/column differ significantly

morphometric traits with body weight was mostly low and non-significant. Moreover, in Punjab Brown poultry bird's, positive significantly ($p \leq 0.01$) regression coefficients of body weight was observed on CL (0.246 to 0.185) from 14 to 26 week of age except 24th week of age, on KL (0.311 to 0.588) from 16 to 26 week of age except 20th week of age and on WL (0.419 to 0.366) from 14 to 20th week of age. The association of BL, SL, BKL, and BG with body weight was mostly low and non-significant. SW was significantly ($p \leq 0.01$) associated (0.308 to 0.483) during the 12th, 16 to 20th weeks of age, whereas in the rest of the age groups, it was low and non-significant.

Worku et al. (2026) reported significant associations of body weight with linear body measurement traits in indigenous chickens of Ethiopia. Body weight was highly correlated ($p<0.05$) with wing span, keel length and body length of both sexes. Neck length, Shank length, comb height and chest circumference were also positively ($p<0.05$) correlated with body weight, particularly in male chickens. Contrary to this, comb height and comb length were negatively correlated ($p<0.05$) with body weight in female chickens. Moreover, there were positive correlations among most of the linear body measurement traits. Ajayi et al. (2008) studied on 100 of each Ross and Anak Titan broilers in span of 0 day to 9

Table 3: Regression coefficient of the explained variable (body weight) on explanatory variables (morphometric traits) at different age groups in Kadaknath poultry birds (N=100)

Week		BL	SL	SW	BKL	CL	KL	WL	BG
12th	BW	0.064	0.295*	0.002	0.024	0.124	-0.453**	-0.010	0.004
14th		0.115	0.754**	-0.018	-0.038	0.073	-0.188**	0.028	-0.063
16th		0.066	0.221	0.104	-0.031	0.303*	0.329**	-0.116	0.028
18th		0.406**	-0.718**	0.221*	-0.543**	0.468**	0.513**	0.377**	-0.039
20th		-0.260**	0.063	0.215**	-0.005	0.505**	0.215**	0.341**	0.003
22nd		-0.079	-0.040	0.085	0.018	0.469**	0.117	0.254*	0.179*
24th		-0.103	-0.043	0.142	-0.002	0.313**	0.161	0.303**	0.252**
26th		-0.055	-0.039	0.267*	-0.100	0.282**	0.186*	0.354**	-0.077

**: Regression is significant at the 0.01 level (2-tailed); *: Regression is significant at the 0.05 level (2-tailed)

Table 4: Regression coefficient of the explained variable (body weight) on explanatory variables (morphometric traits) at different age groups in RIR poultry birds (N=100)

Week		BL	SL	SW	BKL	CL	KL	WL	BG
12th	BW	0.027	0.230	0.274*	0.050	0.263*	-0.068	0.172	-0.120
14th		-0.044	0.441**	0.074	-0.056	0.187	0.033	0.118	0.087
16th		0.061	0.240**	0.027	0.280**	0.279**	-0.153*	0.079	0.218*
18th		0.057	0.377**	-0.127	0.068	0.562**	-0.072	0.186*	-0.131
20th		-0.106	0.075	-0.163	0.183	0.736**	-0.165	0.061	0.185*
22nd		0.020	0.284**	-0.047	0.097	0.635**	0.022	0.015	-0.017
24th		0.136	-0.225**	0.039	0.235**	0.546**	0.190	-0.117	0.019
26th		0.032	0.432**	0.006	0.080	0.361**	0.148	-0.177**	-0.038

**: Regression is significant at the 0.01 level (2-tailed); *: Regression is significant at the 0.05 level (2-tailed)

Table 5: Regression coefficient of the explained variable (body weight) on explanatory variables (morphometric traits) at different age groups in Punjab Brown poultry (N=100)

Week		BL	SL	SW	BKL	CL	KL	WL	BG
12th	BW	-0.171*	0.287**	0.483**	0.288**	-0.026	0.283	-0.161*	-0.113
14th		-0.028	0.018	0.059	-0.027	0.246**	0.257	0.419**	0.013
16th		0.110	0.062	0.327**	-0.098	0.145*	0.311*	0.288**	0.011
18th		-0.010	0.074	0.308**	-0.112	0.217**	0.331*	0.274**	0.007
20th		-0.048	0.011	0.386**	-0.132	0.211**	0.141	0.366**	-0.044
22nd		0.023	-0.087	0.210	-0.081	0.201**	0.536**	0.080	-0.057
24th		0.052	-0.073	0.029	-0.104	0.139	0.692**	-0.005	-0.155*
26th		0.047	-0.032	0.083	-0.097	0.185*	0.588**	0.087	-0.149

**: Regression is significant at the 0.01 level (2-tailed); *: Regression is significant at the 0.05 level (2-tailed)

week of age and correlated body measurement (body girth, keel length and thigh length) against body weight at 9 week of age and found significantly (p<0.001) higher regression coefficients of body weight on all body measurements (R^2 values: 82.07 to 99.25%, 61.57 to 98.21% and 80.78 to 98.67%) for body girth, keel length and thigh length respectively. Obike et al. (2019) studied on 300 birds of three strains, i.e., Arbor Acre broilers, Noiler hybrid and Yoruba ecotype cockerels, for 16 weeks. Linear measurements of body length, keel length, shank length, wing length, breast width, body depth and drumstick were regressed against body weight using linear models. The accuracy of body weight prediction based on the coefficient of determination (R^2%) ranged from low to moderate in all the strains. They concluded that body depth, breast width, body length, shank length and drumstick are the best regressors. Kumar et al. (2022) studied Aseel and Kadaknath at 24 weeks of age and found significantly ($p \leq 0.01$) higher correlation between body weight with different morphometric traits like BL (0.381), SL (0.247), CL (0.642), SC (0.468), KL (0.654) and BG (0.667). Lamido et al. (2024) studied performance data of body weight (BW), chest girth (CG), body length (BL), thigh length (TL), shank length (SL), shank circumference (SC), wing length (WL), and keel length (KL) in indigenous chicken of Nigeria. Simple linear regression used for predicting body weight from body measurements revealed that body weight could be predicted with a high degree of accuracy using chest girth and shank length at early and advanced ages. Matsambu et al. (2025) reported that chest girth (CG), body length (BL) and wing length (WL) are key predictors of body weight (BW) in White Leghorn chickens using a classification and regression trees (CART) model.

4. CONCLUSION

Brown native poultry birds had higher values for body weight and most of the morphometric traits as compared to RIR and Kadaknath birds at different studied age groups. Comb length, Keel length and wing length in Kadaknath; shank length and comb length in RIR and comb length, keel length, shank width as well as wing length in Punjab Brown native poultry are important predictors of body weight in the growing ages.

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