2025 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 15, Issue 3: 175-185; May 30, 2025

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2025.21

ESTIMATION OF BODY WEIGHT FROM BIOMETRIC TRAITS OF CHICKENS USING REGRESSION STATISTICAL METHOD: A SYSTEMATIC REVIEW

Joas Albino TSENANE, Thobela Louis TYASI, and Obert TADA

Department of Agricultural Economics and Animal Production, University of Limpopo, Private Bag X1106, Sovenga, 0727, Limpopo, South Africa

Email: louis.tyasi@ul.ac.za

Supporting Information

RESEARCH ARTICLE
PII: S222877012500021-15
Received: March 02, 2025
Revised: May 28, 2025
Accepted: May 29, 2025

ABSTRACT: Live body weight is a vital tool when placing price on the chickens for profit and to assess decisions to be made in selection of animals and other husbandry practices. However, the chicken farmers, especially the resource limited farmers, lack weighing scales to perform these animal husbandry practices. The objective of this study was to systematically review the articles published on the estimation of live body weight from biometric traits of chickens using regression statistical methods. Databases such as Google Scholar, ScienceDirect, PubMed, and Web of Science, with the combination of the following keywords: "Body weight" or "body mass", "biometric traits" "zoometric measurements" or "Morphological traits" or "linear body measurements" or "Morphometric traits" or "body parameters" or "growth traits" or "growth performance traits", chicken or poultry or "*Gallus gallus domesticus*" or fowl, regression. There were limited articles that aimed to predict live body weight using regression statistical method across the world. A total of fourteen articles were published between the years 2009 and 2024. The results indicated that stepwise linear regression method was mostly used by 39% of the articles included, followed by multiple regression method and simple linear regression method by 22% of the included articles each. The results indicated that the highest coefficient of determination (R2 = 0.970) was recorded on the model of combination of body length (BL) and breast length (BRL) using multiple linear regression method on chickens. The limitation is that some articles did not include either sex or age of the animals that can make it difficult to make conclusion for different sexes and ages. This systematic review concludes that multiple linear regression statistical method is the best in estimating live body weight in chickens with combination of BL and BRL. As a practical suggestion, it would be best for breeders to select chickens with the highest measurements of BL and BRL to improve live body weight of the chickens.

Keywords: Biometric traits, Body weight, Chicken, Linear body measurements, Regression.

INTRODUCTION

Live body weight is an important tool to use when pricing chickens for sale and assessing the choices to be made in animals husbandry practices (Semakula et al., 2011; Adenaike et al., 2015). Body measurements' components such as live body weight and biometric traits of an animal can be used to evaluate growth of that animal (Yakubu and Salako, 2009; Sadick et al., 2020). Farmers use body weight to price their reared chicken when selling them for profit and to generate income (Udeh et al., 2021).

However, one of the challenges that most farmers experience is that they lack access to weighing scales which make it difficult to estimate their chickens live body weight and growth rate (Semakula et al., 2011; Tyasi et al., 2024). The live body weight of animals such as chickens can be predicted from biometric traits using a variety of regression methods (Yunusa and Adeoti, 2014; Bila et al., 2021).

Several studies have been conducted on the estimation of live body weight from biometric traits of chickens (Adenaike et al., 2015; Yakubu and Ari, 2018; Bila and Tyasi, 2022). Although, according to the authors' knowledge, there has been no systematic review on the estimation of live body weight from biometric traits of chicken using regression statistical methods. Thus, the objective of this study was to systematically review the articles published on the estimation of live body weight from biometric traits of chickens using regression methods. The results from this study will help researchers to find the best biometric traits that they will guide farmers to use when estimating their chickens' live body weight to easily fulfil their farm husbandry practices.

MATERIALS AND METHODS

Eligibility criteria

Identification of Population, Exposure, and Outcomes (PEO) elements of the research questions were done for this systematic review. The "chickens" were identified as the population of this study, with "regression statistical methods" as

Citation: Tsenane JA, Tyasi TL, and Tada O (2025). Estimation of body weight from biometric traits of chickens using regression statistical method: a systematic review. *Online J. Anim. Feed Res.*, 15(3): 175-185. DOI: https://dx.doi.org/10.51227/ojafr.2025.21

exposure and "regression models for estimation of live body weight from biometric traits of chickens" as the outcomes. Before it was decided to pursue with this study, the first search of the PEO components on Google Scholar, PubMed, ScienceDirect, and Web of Science were performed.

Search strategy

The two investigators conducted a systematic review of articles in the databases such as Google Scholar, ScienceDirect, PubMed, and Web of Science, with the combination of the following keywords: "Body weight" or "body mass", "biometric traits" or "Morphological traits" or "linear body measurements" or "Morphometric traits" or "body parameters" or "morphobiometric traits" or "zoometric measurements" or "growth traits" or "growth performance traits", chicken or poultry or fowl or "*Gallus gallus domesticus*", regression. Only English articles were considered in this review. The keywords were combined in different combinations.

Inclusion criteria

The articles that were available from more than one database were removed prior screening for eligibility. The criteria for inclusion were articles that estimated the live body weight of chicken using regression method, articles written in English, and articles that are published using regression methods like simple linear, stepwise linear, multiple linear regression, power non-linear regression, exponential non-linear regression and polynomial non-linear regression methods were included. Articles that deal with the estimation of live body weight of chicken using biometric traits, regression models for estimation of live body weight of chicken from biometric traits were included in this review.

Exclusion criteria

Articles were removed from the included articles due to that they did not meet requirements such as duplicate records, studied different species, used different methods of estimating live body weight such as machine learning algorithms, and not written in English.

Data extraction

The data of this study was independently extracted by two investigators and a general agreement concerning all the materials was reached. The articles that have met inclusion criteria had an author, publication year, type of breed, and the model type.

Ethical considerations

Misconduct, Plagiarism, informed consent and manipulation of data were termed ethical criteria by all authors when conducting this systematic review.

RESULTS

Searched Literature

Figure 1 shows the flow chart of the identification and selection of articles for systematic review. In the initial search, a total of 452 articles were extracted. A number of 23 duplicate articles were excluded, and 429 articles remained. Articles were screened for title; 395 articles were excluded. A number of 34 articles were screened, and 18 articles were removed. About 16 articles were screened for eligibility and 2 articles were removed. A total number of 14 articles were included in this review.

Characterization of included articles

Table 1 shows the characterization of 14 articles that are included in this review. The results showed that Adenaike et al. (2015) and Akporhuarho and Omoikhoje (2017) both predicted body weight of chicken breeds' crosses. The findings showed that out of 14 articles included in this review, Yunusa and Adeoti (2014) used the highest sample size (n = 2641) of chickens. The results indicated that from the 14 articles included in this review, 2 articles (Yakubu and Salako, 2009; Yakubu et al., 2009) used the same sample size (n = 238) of chickens and 2 articles (Bila and Tyasi, 2022; Tyasi et al., 2024) used the same sample size (n = 100) of chickens. The results showed that most of the breeds that were used across the 14 articles included in this review were indigenous chicken breeds (n = 16). The results indicated that the most used production system across the 14 articles was intensive production system (n = 9).

Publication by year

Figure 2 shows the year of publications of the included 14 articles. The results indicated that out of the 14 articles included, only 10 different years that the articles were published. The results indicated that year 2021 (Ikeh and Okwesili, 2021; Bila et al 2021; Udeh et al., 2021) had the highest published articles (n = 3) and 2009 (Yakubu and Salako, 2009; Yakubu et al., 2009) and 2024 (Christophe et al., 2024; Tyasi et al., 2024) had the second highest published articles (n = 2) out of the 14 included articles. The results showed that year 2011 (Semakula et al., 2011), 2014 (Yunusa and Adeoti, 2014), 2015 (Adenaike et al., 2015), 2017 (Akporhuarho and Omoikhoje, 2017), 2018 (Yakubu and Ari, 2018), 2020 (Sadick et al., 2020) and 2022 (Bila and Tyasi, 2022) had the least number of articles published (n = 1).

Table 1 - Characterisation of included articles

Author	Year	Country	Age (weeks)	Breed	Sample Size	Production system	Biometric traits	Regression method
Yakubu and Salako	2009	Nigeria	_	Nigerian indigenous Autochthonous chicken	238	Extensive	CH, CL, BKL, BL, NL, SL, CC, TC	Multiple linear
Yakubu et al.	2009	Nigeria	_	Nigerian Normal feathered, Naked neck, Frizzled chickens	238	Extensive	CH, CL, BKL, BL, NL, SL, CC, TC	Stepwise linear
Yunusa and Adeoti	2014	Nigeria	_	Nigerian Yoruba chickens, Nigerian Fulani chickens	2641	Semi-intensive	KL, TL, WL, BL, DS, SL, CC, BRL	Multiple linear
Akporhuarho and Omoikhoje	2017	Nigeria	22	Exotic Broilers * Nigerian local chickens (main), Nigerian local * exotic broiler chickens (reciprocal)	228	Intensive	BL, WS, WL, TL, SL, KL, BRG	Stepwise linear
Adenaike et al.	2015	Nigeria	8	Normal-feathered, Marshal, Naked-neck, Marshal*naked-neck, Marshal*normal feathered	265	Intensive	BL, BRG, WL, WS, TL, SL, KL	Stepwise linear
Bila and Tyasi	2022	South Africa	5	Ross 308 broiler chicken	100	Intensive	WL, BKL, SL, BG, BL, SC	Stepwise linear
Yakubu and Ari	2018	Nigeria	6	Sasso, Kuroiler, Fulani	150	Intensive	BRG, NC, BL, WL, TL, TC, SL, SC	Stepwise linear
Ikeh and Okwesili	2021	Nigeria	7, 8	Nigerian Nsuka heavy chicken	120	Intensive	BL, CG, TC, TL, SL	Stepwise linear
Udeh et al.	2021	Nigeria	8, 14, 20	Nigeria Nsuka heavy chicken	240	Intensive	BL, SL, CC, TC, TL	Simple linear, Multiple linear
Tyasi et al.	2024	South Africa	40	White leghorn	100	Intensive	BL, WL, SL, SG, CG, BKL, BCL, CNH, TBL	Stepwise linear
Semakula et al.	2011	Uganda	8, 24, 36, 80	Ugandan indigenous chicken	493	Semi-intensive	CPL, CC, FL, FC, SL, KL	Exponential non-linear, Polynomial non-linear, Power non-linear, Simple linear
Bila et al.	2021	South Africa	5	Ross 308 broiler chicken	130	Intensive	WL, BKL, SL, BG, BL, SC	Multiple linear
Sadick et al.	2020	Ghana	15	Cobb broiler chicken	50	Intensive	HL, BKL, BL, BL, SL, SC, CNH	Simple linear
Christophe et al.	2024	Benin	_	Goliath chicken	342	Extensive	SL, SD, BL, DS, CC, WS, STL,	Simple linear

_ = not indicated, CH = comb height, CL = comb length, BKL = beak length, BL = body length, NL = neck length, CC = chest circumference, TC = thigh circumference, SL = shank length, KL = keel length, TL = thigh length, WL = wing length, BRL = breast length, DS = drum stick, WS = wing span, BRG = breast girth, BG = body girth, SC = shank circumference, CG = chest girth, NC = neck circumference, BCL = beak-to-comb length, TBL = toe-to-back length, BC = body circumference, CNH = chicken height, CPL = corpus length, FL = femur length, FC = femur circumference, HL = head length, SD = shank diameter, STL = sternum length.

Citation: Tsenane JA, Tyasi TL, and Tada O (2025). Estimation of body weight from biometric traits of chickens using regression statistical method: a systematic review. *Online J. Anim. Feed Res.*, 15(2): ---. DOI: https://dx.doi.org/10.51227/ojafr.2025.00

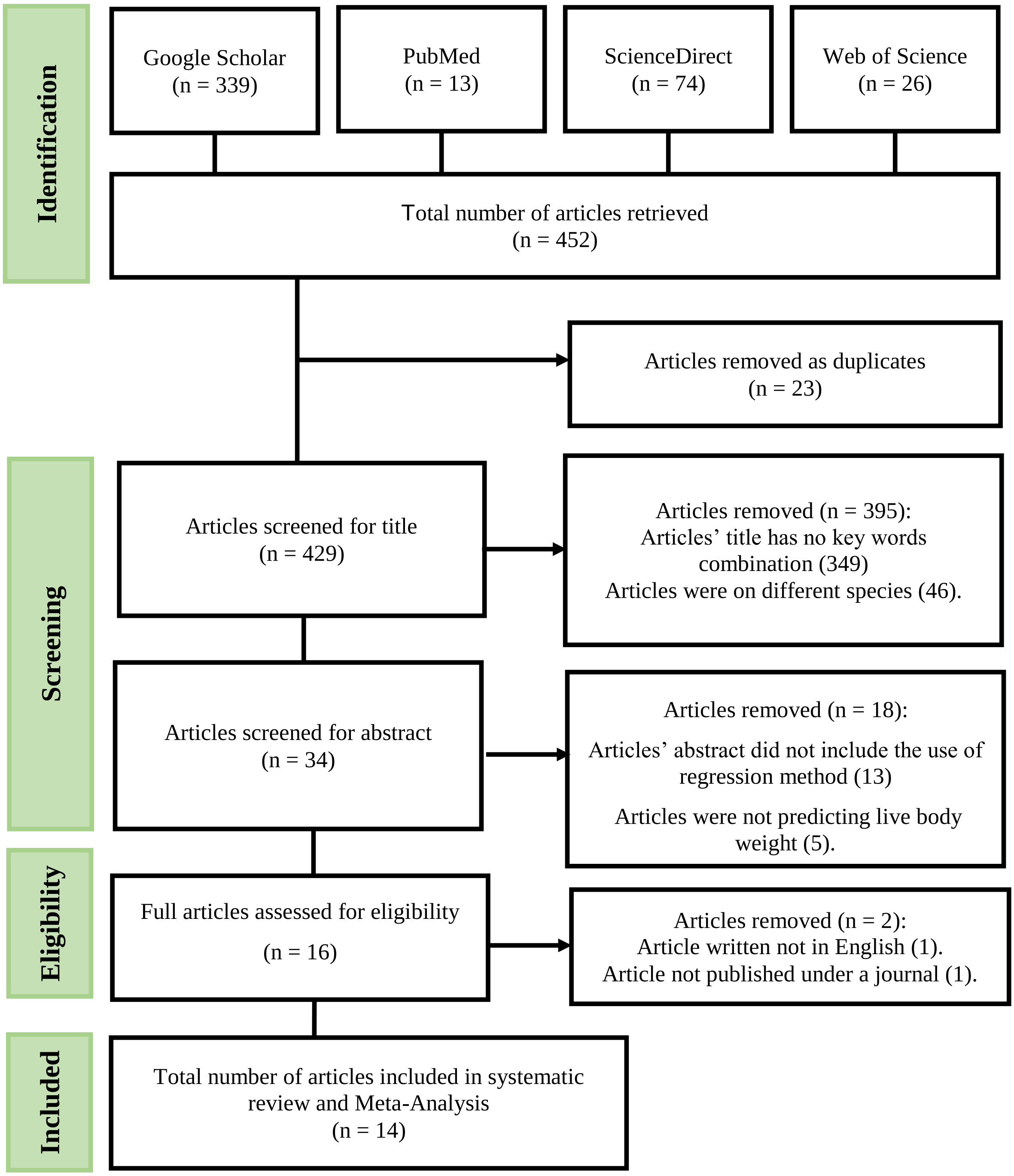

Figure 1 - Flow chart of identification and selection of studies used in the systematic review and Meta analysis

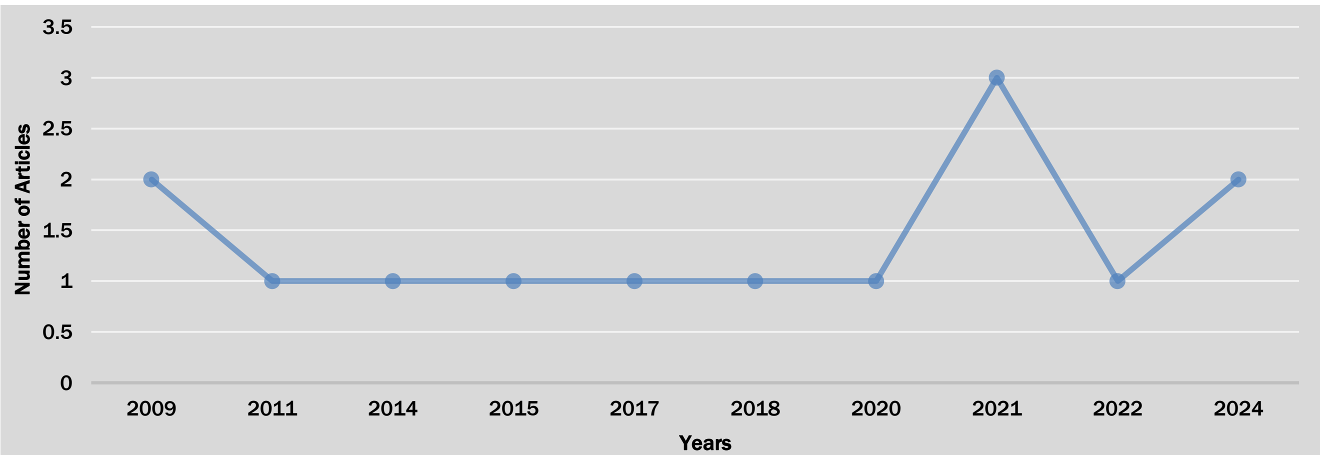

Figure 2 - Publication of the articles included by year

Citation: Tsenane JA, Tyasi TL, and Tada O (2025). Estimation of body weight from biometric traits of chickens using regression statistical method: a systematic review. *Online J. Anim. Feed Res.*, 15(2): ---. DOI: https://dx.doi.org/10.51227/ojafr.2025.00

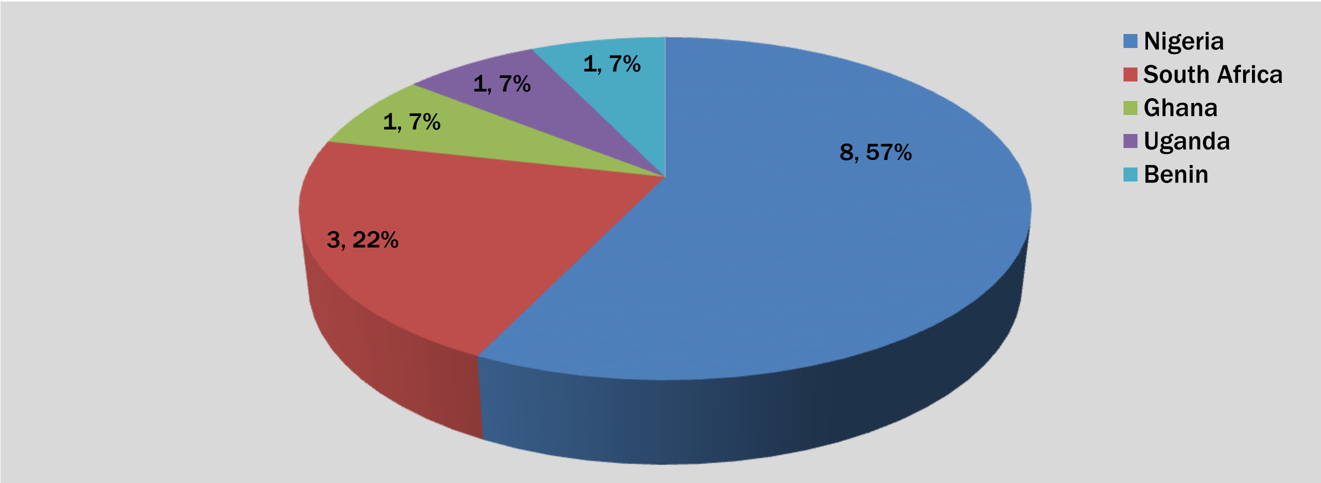

Figure 3 - Publication by country.

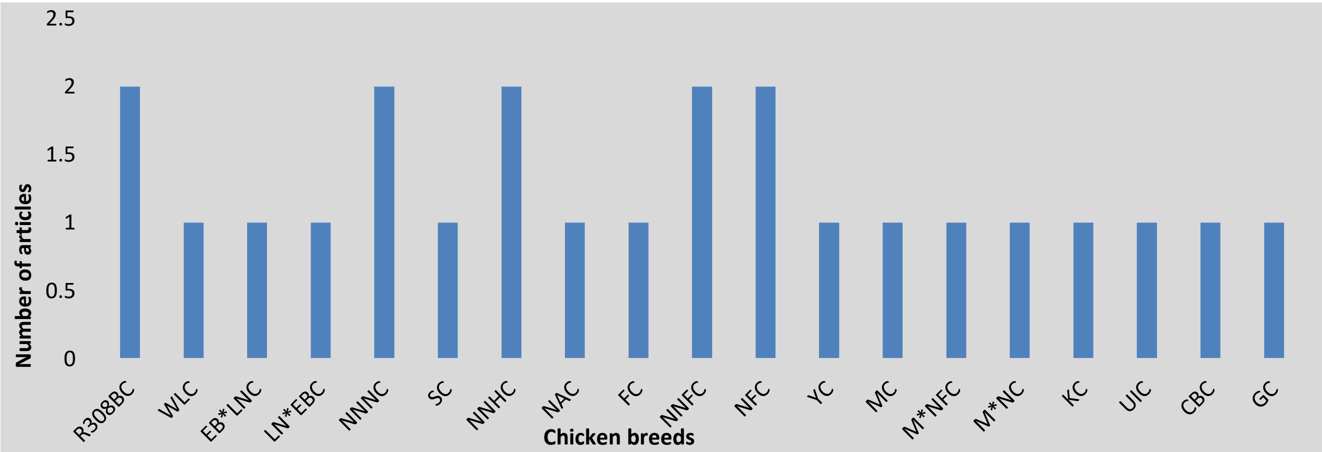

Figure 4 - Publication by chicken breed.

R308BC = Ross 308 broiler chicken, WLC = White leghorn chicken, EB*LNC = Exotic broiler*local Nigerian chicken, LN*EBC = Local Nigerian*exotic broiler chicken, SC = Sasso chicken, NNHLC = Nigerian Nsuka heavy local chicken, NAC = Nigerian autochthonous chicken, FC = Fulani chicken, NNFC = Nigerian Normal feather chicken, NNNC = Nigerian Naked neck chicken, NFC = Nigerian Frizzled chicken, YC = Yoruba chicken, MC = Marshal chicken, M*NFC = Marshal*normal feather chicken, M*NC = Marshal*naked neck chicken, KC = Kuroiler chicken, UIC = Ugandan indigenous chicken, CBC = Cobb broiler chicken, GC = Goliath chickens.

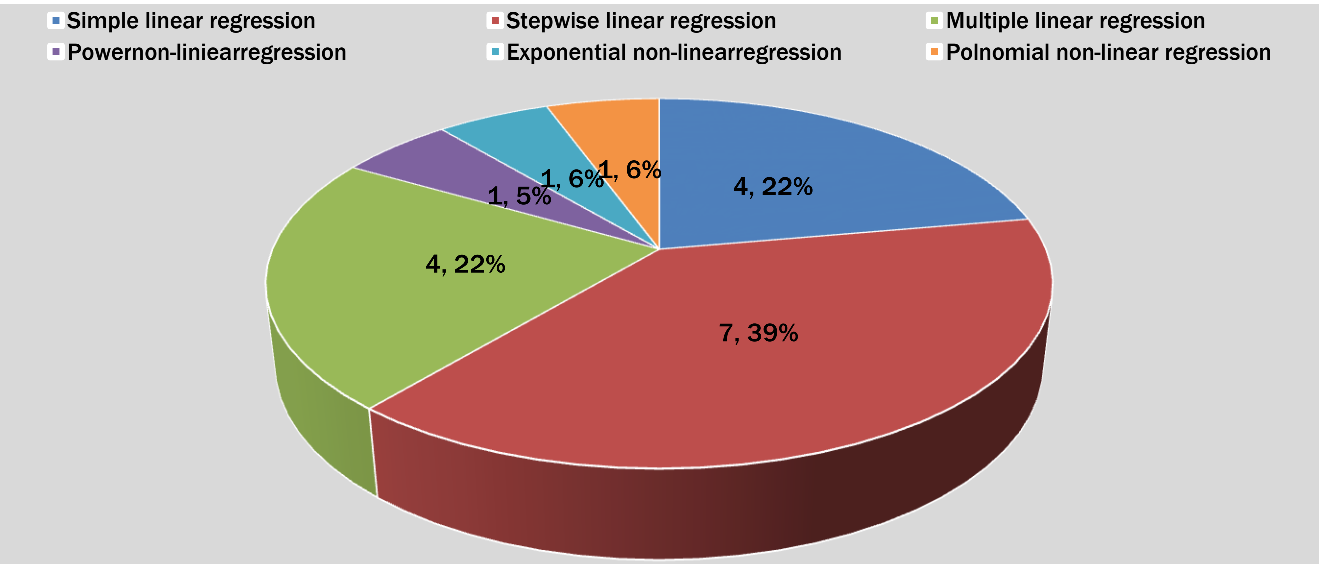

Figure 5 - Publications by regression statistical method

Publication by country

Publications by country of the 14 articles included are presented in Figure 3. The results showed that across the 14 articles included only 5 countries that the articles were published. The results showed that out of the 14 articles, Nigeria had the highest published articles (n = 8), and South Africa (Bila and Tyasi, 2022; Bila et al., 2021; Tyasi et al., 2024) had the second highest published articles (n = 3).

Publication by chicken breed

Publications by breed of the 14 articles included are displayed in Figure 4. The results indicated that 19 breeds were used in this review. The results showed that the breed of Nigerian Naked neck chicken (Yakubu et al., 2009; Adenaike et al., 2015), Nigerian Normal feathered chicken (Yakubu et al., 2009; Adenaike et al., 2015), Ross 308 broiler chicken (Bila et al., 2021; Bila and Tyasi, 2022), Nigerian Nsuka heavy chicken (Ikeh and Okwesili, 2021; Udeh et al., 2021) and Nigerian Fulani chicken (Yunusa and Adeoti, 2014; Yakubu and Ari, 2018) were the mostly used chicken breeds (n = 2).

Publications by regression statistical methods

Figure 5 demonstrates the publications by regression methods. The results indicated that there were only 6 regression methods (simple linear, stepwise linear, multiple linear, power non-linear, exponential non-linear and polynomial non-linear) used in this review. The results showed that stepwise linear regression method was mostly used (n = 7) across the 14 articles included. The results showed that multiple linear regression (Yakubu and Salako, 2009; Yunusa and Adeoti, 2014; Bila et al., 2021; Udeh et al., 2021) and simple linear regression method (Semakula et al., 2011; Sadick et al., 2020; Udeh et al., 2021; Christophe et al., 2024) were second most used regression methods (n = 4) across the 14 included articles.

Estimation of live body weight using simple linear regression method

Table 2 shows the estimation of live body weight from biometric traits using simple linear regression. The results showed that only 4 articles (Semakula et al., 2011; Sadick et al., 2020; Udeh et al., 2021; Christophe et al., 2024) out of the 14 articles included predicted live body weight using simple linear regression method. The results indicated that the highest coefficient of determination (R^2 = 0.760) was reported by Semakula et al. (2011) on model of CC in Ugandan indigenous chickens and was followed by the model of BL with R^2 = 0.750 on Cobb broiler chickens. The least coefficient of determination (R^2 = 0.074) was reported by Chrysostome et al. (2024) on the model of WS on Goliath chickens.

Estimation of body weight using stepwise linear regression method

Estimation of live body weight from biometric traits of chicken using stepwise linear regression is shown in Table 3. The results mentioned that 7 articles out of the 14 articles included in this review were predicting live body weight of chickens using stepwise linear regression method. The results indicated that Yakubu et al. (2009) reported the highest coefficient of determination (R2 = 0.960) on the model of the combination of TC, CC, CH and BL on the Nigerian Frizzled chickens. The results indicated that the second highest coefficient of determination (R2 = 0.950) was recorded by Yakubu et al. (2009) on the model of combination of TC, CC, and CH on Nigerian Frizzled chickens, and by Akporhuarho and Omoikhoje (2017) on the model of combination of BL, WS, WL, and TL on reciprocal male LN*EBC crossbreed chickens. The results showed that the least coefficient of determination (R2 = 0.002) on the model of BL was reported by Akporhuarho and Omoikhoje (2017) on main female EB*LNC crossbreed chickens.

Estimation of body weight using multiple linear regression method

Table 4 indicates the estimation of live body weight from biometric traits of chickens using multiple linear regression method. The results showed that 4 articles out of the 14 articles included estimated body weight of chickens using multiple linear regression method. The results indicated that the highest coefficient of determination (R2 = 0.970) was recorded by Yunusa and Adeoti (2014) on the model of combination of BL and BRL using Nigerian Yoruba chickens. The results showed that Yakubu and Salako (2009) reported the second highest coefficient of determination (R2 = 0.952) on male Nigerian Autochthonus chickens from the combination of TC, CH and BL. The least coefficient of determination (R2 = 0.140) was recorded by Yunusa and Adeoti (2014) on the Nigerian Fulani chickens from a model of combination of BRL, CC, and WL.

Estimation of body weight using power non-linear regression method

Estimation of live body weight from biometric traits of chickens using power non-linear regression method is shown on Table 5. The results indicated that only 1 article across the 14 articles included (Semakula et al., 2011), estimated live body weight using power non-linear regression. The results showed that model of CC had coefficient of determination of R^2 = 0.830 on Ugandan indigenous chickens.

Estimation of body weight using exponential non-linear regression method

Table 6 indicates the estimation of live body weight from biometric traits of chickens using exponential non-linear regression method. The results indicated that 1 article (Semakula et al., 2011) estimated live body weight using exponential non-linear regression across 14 articles included. The results showed that model of CC had coefficient of determination of R^2 = 0.800 on Ugandan indigenous chickens.

Estimation of body weight using polynomial non-linear regression method

Estimation of live body weight of chickens from biometric traits using polynomial non-linear regression method is shown on Table 7. The results indicated that only 1 article (Semakula et al., 2011) estimated live body weight using

polynomial non-linear regression across 14 articles included. The results showed that model of CC had coefficient of determination of R^2 = 0.770 on Ugandan indigenous chickens.

Table 2 - Estimation of live body weight using simple linear regression

Author and year	Breed	Sex	Model	Goodness of fit		
				R²	RMSE	P value
Udeh et al. (2021)	Nigerian Nsuka heavy local chicken	_	LBW = -909.52 + 83.67BL	0.370	4.330	P < 0.01
			LBW = -1159.38 + 316.42SL	0.580	10.99	P < 0.01
			LBW = -904.80 + 59.68CC	0.720	1.490	P < 0.01
			LBW = -317.43 + 143.38TC	0.460	6.260	P < 0.01
			LBW = -620.55 + 125.38TL	0.710	3.170	P < 0.01
Sadick et al. (2020)	Cobb broiler chicken	_	LBW = - 95.287 + 186.27SL	0.710	_	P < 0.01
			LBW = 478.55 + 386.88BKL	0.410	_	P < 0.01
			LBW = -111.33 + 189.05HL	0.630	_	P < 0.01
			LBW = -2.33 + 42.919BL	0.590	_	P < 0.01
			LBW = -119.29 + 59.08WL	0.660	_	P < 0.01
			LBW = -187.47 + 62.151CNH	0.720	_	P < 0.01
			LBW = -132.10 + 395.07SC	0.750	_	P < 0.01
Semakula et al. (2011)	Ugandan Indigenous chicken	_	LBW = -1.60 + 0.123CC	0.760	_	P < 0.01
Chrysostome et al. (2024)	Goliath chicken	_	LBW = 1.23 + 0.12SL	0.102	_	P < 0.01
			LBW = 0.41 + 1.52SD	0.327	_	P < 0.01
			LBW = 1.22 + 0.03WS	0.074	_	P < 0.01
			LBW = 0.829 + 0.10STL	0.223	_	P < 0.01
			LBW = 0.35 + 0.05BL	0.120	_	P < 0.01
			LBW = 1.27 + 0.09DS	0.119	_	P < 0.01

_= not indicated, P < 0.05 = significant, RSME: residual square mean of error, LBW: live body weight, BKL: beak length, BL: body length, CNH: chicken height, CC: chest circumference, TC: thigh circumference, SL: shank length, TL: thigh length, HL: head length, SC: sternum circumference, WL: wing length, SD = shank diameter, STL = sternum length.

Table 3 - Estimation of body weight using stepwise linear regression.

Author and year	Breed	Sex	Model	Goodness of fit		
				R²	RMSE	P value
Yakubu et al. (2009)	Nigerian normal-feathered chicken	–	LBW = - 1.02 + 0.3BL	0.830	_	_
			LBW = - 0.43 + 0.05BL + 0.06TC	0.870	_	_
			LBW = - 0.26 + 0.04BL + 0.05TC + 0.04CH	0.880	_	_
			LBW = 0.24 + 0.03BL + 0.05TC +0.05CH + 0.01CC	0.890	_	_
	Nigerian naked neck chicken	–	LBW = - 0.77 + 0.08CC	0.830	_	_
			LBW = - 0.47 + 0.06CC + 0.04TC	0.850	_	_
			LBW = - 0.50+ 0.04CC + 0.03TC + 0.07SL	0.870	_	_
	Nigerian Frizzled chicken	–	LBW = 0.28 + 0.13TC	0.910	_	_
			LBW = - 0.05 + 0.11TC + 0.02CC	0.940	_	_
			LBW = 0.02+ 0.09TC + 0.02CC + 0.05CH	0.950	_	_
			LBW = 0.24 + 0.08TC + 0.03CC + 0.08CH - 0.24BL	0.960	_	_
Ikeh and Okwesili (2021)	Nigerian heavy local ecotype chicken	F	LBW = - 454.93 + 221.60SL	0.605	_	P < 0.01
			LBW = -1689.96 + 149.25SL + 75.83BL	0.702	_	P < 0.01
			LBW = -1535.15 + 103.30SL + 63.73BL + 48.84TC	0.735	_	P < 0.01
			LBW = - 1515.55 + 85.12SL + 59.32BL + 40.00TC + 9.30CG	0.743	_	P < 0.01
			LBW = - 1485.70 + 82.06SL + 58.34BL + 38.70TC + 8.39CG + 3.85TL	0.746	_	P < 0.01
Akporhuarho and Omoikhoje (2017)	Exotic broiler X local Nigerian chicken (EB*LNC) main	M	LBW = 4040.9 - 59.5BL	0.036	_	_
			LBW = 3848.2 - 60.7BL + 5.1WS	0.042	_	_
			LBW = 7039.9 - 54.6BL + 10.1WS - 146.9WL	0.152	_	_
			LBW = 4331.2 - 53.8BL + 9.9WS - 150.6WL + 151.4TL	0.156	_	_
			LBW = 8170.7 - 42.4BL + 4.3WS - 161.1WL + 53.2TL - 196.8SL	0.223	_	_
			LBW = 6447.2 - 56.04BL + 4.6WS - 162.2WL + 90.3TL - 188.7SL + 24.9	0.226	_	_

			LBW = 6447.2 - 56.0BL + 46WS - 162.2WL + 90.3TL - 188.7SL + 24.9BRG	0.235	–	–
		F	LBW = 1606.3 - 12.28BL	0.002	_	_
			LBW = 1931.6 + 10.4BL - 25.2WS	0.381	_	_
			LBW = 1391.2 + 11.1BL - 25.4WS + 26.6WL	0.382	_	_
			LBW = 698.7 + 8.8BL - 25.2WS + 19.6WL + 63.0TL	0.384	_	_
			LBW = 2264.8 + 4.7BL - 24.8WS + 12.0WL + 23.0TL - 85.2SL	0.413	–	–
			LBW = 3956 + 7.4BL - 25.0WS + 13.72WL + 14.8TL - 87.0SL - 117.5KL	0.416	–	–
			BW = 3716.3 + 8.9BL - 25.9WS + 10.3WL + 18.4TL - 89.6SL - 113.2 + 6.9BRG	0.418	–	–
	Local Nigerian chicken X exotic broiler (LNC*EB) reciprocal	F	LBW = 340 + 1.7BL	0.110	_	_
			LBW = 3183.9 + 1.9BL - 0.58WS	0.160	_	_
			LBW = 3168.6 - 0.2BL - 0.8WS + 4.7WL	0.180	_	_
			LBW = 2798.3 - 1.3BL - 3.2WS + 1.7WL + 28.3TL	0.119	_	_
			LBW = 343.9 - 3.9BL - 5.6WS + 2.5WL + 18.7TL + 230SL	0.155	_	_
			LBW = - 5.15 - 10.2BL - 3.9WS - 3.5 + 5.2TL + 244.3SL + 36.1KL	0.265	–	–
			LBW = 1279.4 - 0.5BL - 3.8WS - 4.4WL - 2.7TL + 261.5SL + 60.7KL - 52.3BRG	0.399	–	–
		M	LBW = 4177.9 - 16.6BL	0.110	_	_
			LBW = 3190.4 - 39.7BL + 32.7WS	0.450	_	_
			LBW = 2937 - 45.2BL + 19.6WS + 40.0WL	0.850	_	_
			LBW = 2879.1 - 47.1BL + 24.0WS + 55.5WL - 24.7TL	0.950	_	_
			LBW = 3791.7 - 52.0BL + 32.2WS + 37.2WL + 1.7TL - 98.5SL	0.150	–	–
			LBW = 4820.6 - 107.3BL + 72.6WS + 86.2WL + 9.9TL - 141.5SL - 87.2KL	0.315	–	–
			LBW = 4238.9 - 125.3 BL + 88.8WS + 95.0WL - 3.9TL + 178.6SL - 98.9KL + 26.1BRG	0.339	–	–
Yakubu and Ari (2018)	Sasso chicken	–	LBW = - 313.67 + 41.22BRG	0.876	19.920	P<0.01
			LBW = - 185.331 + 26.26BRG + 22.23TC	0.923	15.820	P<0.01
			LBW = - 185.65 + 23.86BRG + 17.891TC + 11.98NC	0.932	15.080	P<0.01
	Nigerian Kuroiler chicken	–	LBW = - 181.525 + 163.289SC	0.887	27.510	P<0.01
			LBW = - 410.32 + 94.75SC + 37.95WL	0.940	20.220	P<0.01
			LBW = - 413.09 + 73.50SC + 30.50WL + 23.48TL	0.952	18.300	P<0.01
	Nigerian Fulani chicken	–	LBW = 29.98 + 14.959BL	0.821	17.920	P<0.01
			LBW = - 64.06BL+ 34.17NC	0.877	15.010	P<0.01
			LBW = - 70.32 + 8.65 BL + 27.92NC + 15.76TC	0.898	13.800	P<0.01
Adenaike et al. (2015)	Nigerian Marshal chicken	–	LBW = - 981.656 + 117.564TL	0.762	9.180	_
			LBW = - 981.656 + 48.676BRG + 117.564TL	0.856	12.304	_
	Marshal x naked neck chicken	–	LBW = - 447.878 + 63.141BRG	0.691	6.233	_
			BW = - 626.199 + 41.4716BRG + 78.505TL	0.735	28.733	_
	Naked neck chicken	–	LBW = - 671.302 + 77.303TL	0.755	7.439	_
			LBW = - 704.931 + 40.285BL + 46.221BRG	0.855	8.311	_
	Normal-feathered chicken	–	LBW = - 565.974 + 68.558BRG	0.917	3.116	_
			LBW = - 609.395 + 34.963BL + 43.185BRG	0.939	8.938	_
	Marshal x normal-feathered chicken	–	LBW = - 886.690 + 109.185TL	0.627	10.777	_
			LBW = -1072.933 + 67.933TL + 104.214KL	0.709	25.411	P < 0.01
Bila and Tyasi (2022)	Ross 308 broiler chicken	M	LBW = 0.09 + 0.04SC	0.310	_	P < 0.01
			LBW = - 0.33 + 0.03SC + 0.00BL	0.430	_	P < 0.01
			LBW = - 1.47 + 0.03 + SC + 0.00BL + 0.00BG	0.540	_	P < 0.01
			LBW = - 1.82 + 0.02SC + 0.00BL + 0.00BG + 0.01SL	0.550	_	P < 0.01
			LBW = - 1.84 + 0.02SC + 0.00BL + 0.00BG + 0.01SL + 0.00WL	0.550	–	P < 0.01
		F	LBW = - 0 .29 + 0.02SL	0.260	_	P < 0.01
			LBW = - 0.84 + 0.12SL + 0.01WL	0.330	_	P < 0.01
			LBW = - 1.35 + 0.01SL + 0.01WL + 0.02SC	0.450	_	P < 0.01
			LBW = - 1.65 + 0.01SL + 0.01WL + 0.02SC + 0.03BKL	0.480	_	P < 0.01
			LBW = - 1.82 + 0.01SL + 0.01WL + 0.02SC + 0.03BKL + 0.00BG	0.520	–	P < 0.01
Tyasi et al. (2024)	White leghorn chicken	F	LBW = 0.584 + 0.061BL	0.240	_	P < 0.01
			LBW = - 0.079 + 0.055BL + 0.094SL	0.330	_	P < 0.01
			LBW = - 0.625 + 0.058BL + 0.077SL + 0.014 CNH	0.370	_	P < 0.01
			LBW = - 1.070 + 0.057BL + 0.080SL + 0.12CNH + 0.109SC	0.400	_	P < 0.01
			LBW = - 1.471 + 0.056BL + 0.081SL + 0.012CNH + 0.102SC + 0.013CG	0.440	–	P < 0.01

P value =probability value, P < 0.05 = significant, _ = not stated, RSME = residual square mean of error, M = male, F = female, LBW = live body weight, CH = comb height, BKL = beak length, BL = body length, CC = chest circumference, TC = thigh circumference, SL = shank length, KL = keel length, TL = thigh length, WL = wing length, DS = drum stick, WS = wing span, BRG = breast girth, BG = body girth, SC = shank circumference, CG = chest girth, NC = neck circumference, CNH = chicken height.

Table 4 - Estimation of body weight using multiple linear regression

Author and year	Breed	Sex	Model	Goodness of fit		
				R^2	RMSE	P value
Yunusa and Adeoti (2014)	Nigerian Yoruba chicken	_	LBW = -1.21 + 0.82BL + 0.15BRL	0.970	_	P < 0.05
	Nigerian Fulani chicken	_	LBW = -0.09 + 0.30CC + 0.74BRL - 0.38WL	0.140	_	P < 0.05
Yakubu and Salako (2009)	Nigerian Autochthonus chicken	M	LBW = 0.070 + 0.084TC + 0.051CH + 0.016BL	0.952	_	P < 0.05
		F	LBW = -0.727+ 0.043CH + 0.028BL + 0.066SL + 0.019CC + 0.031TC	0.820	_	P < 0.05
Udeh et al. (2021)	Nigerian Nsuka heavy local chicken	_	LBW = -1076.39 -5.98BL + 84.97SL + 21.66CC + 24.09TC + 57.98TL	0.790	_	P < 0.05
Bila et al. (2021)	Ross 308 broiler chicken	M	LBW = -1.80 + 0.12 BL + 0.03 BKL + 0.23 SC + 0.11 SL	0.550	0.01	P < 0.05
		F	LBW = -0.33 + 0.04 BG + 0.04 BL + 0.22 SC	0.470	0.03	P < 0.05

P value = probability value, P < 0.05 = significant, _ = not stated, RSME = residual square mean of error, M = male, F = female, LBW = live body weight, CH = comb height, BL = body length, CC = chest circumference, TC = thigh circumference, SL = shank length, TL = thigh length, BRL = breast length, BG = body girth, SC = shank circumference, WL = wing length.

Table 5: Estimation of body weight using power non-linear regression

Author and year	Breed	Sex	Model	Goodness of fit		
				R^2	RMSE	P value
Semakula et al. (2011)	Ugandan indigenous chicken	_	$LBW = 0.001CC^{2.417}$	0.830	_	P < 0.01

P value = probability, P < 0.01 = significant, _ = not stated, RSME = residual square mean of error, LBW = live body weight, CC = chest circumference.

Table 6 - Estimation of body weight using exponential non-linear regression

Author and year	Breed	Sex	Model	Goodness of fit		
				R^2	RMSE	P value
Semakula et al. (2011)	Ugandan indigenous chicken	_	$LBW = 0.100e^{0.105CC}$	0.800	_	P < 0.01

P value = probability value, P < 0.01 = significant, _ = not stated, RSME = residual square mean of error, LBW = live body weight, CC = chest circumference.

Table 7 - Estimation of body weight using Polynomial non-linear regression

Author and year	Breed	Sex	Model	Goodness of fit		
				R^2	RMSE	P value
Semakula et al. (2011)	Ugandan indigenous chicken	_	$LBW = 0.002CC^2 + 0.038CC - 0.6214$	0.770	_	P < 0.01

P value = probability value, P < 0.01 = significant, _ = not stated, RSME = residual square mean of error, LBW = live body weight, CC = chest circumference.

DISCUSSION

The live body weight and biometric traits are of economic value in chicken classification and enhancement (Yakubu and Ari, 2018; Sadick et al., 2020). This systematic review was conducted to evaluate the literature on prediction of live body weight of chickens from biometric traits using regression methods. The regression statistical methods enable weighing of live body weight by identifying the traits that might be used for animal husbandry practices and to sale the chickens for profit (Semakula et al., 2011; Yunusa and Adeoti, 2014; Bila et al., 2021). A total number of fourteen articles were included in this review. The results indicated that stepwise linear regression was mostly used by thirty-nine percent of the articles included. The results showed that multiple regression (Yakubu and Salako, 2009; Yunusa and Adeoti, 2014; Bila et al., 2021; Udeh et al., 2021) and simple regression method (Semakula et al., 2011; Sadick et al., 2020; Udeh et al., 2021; Christophe et al., 2024) were second mostly used regression methods by twenty-two percent of the included articles each. The results showed that Yunusa and Adeoti (2014) reported the highest value of ninety-seven percent variation towards live body weight on the combination of BL and BRL using multiple linear regression method on Nigerian Yoruba chickens. The results showed that Akporhuarho and Omoikhoje (2017) reported the least value of 0.2 percent variation towards live body weight on BL using stepwise linear regression method on female EB*LNC crossbreed chickens.

Based on the author's knowledge, there was no systematic review that predicts live body weight from biometric traits of chickens using regression method. Thereof, there has been no comparison of the current findings with other systematic review findings. The implication of this systematic review is that multiple linear regression model can be used to optimally estimate live body weight of different chicken breeds, sexes and ages from differing countries. The power of this review was that there is no similar study that had been conducted to estimate live body weight using linear regression methods in chickens. The contribution of this systematic review in the body of knowledge is to suggest multiple linear regression to be used to estimate live body weight of chickens. The limitation of this systematic review was that 9 out of 14 articles did not include sex, and 4 out of 14 articles did not include the age of the chickens which makes it difficult to draw conclusion for sexes and ages. Udeh et al. (2021) studied different linear regression methods to predict live body weight of Nigerian Nsuka heavy local chickens in Nigeria and concluded that multiple linear regression method is one of the best methods to estimate live body weight. Nevertheless, more studies need to be conducted on the estimation of live body weight using regression methods to validate these results.

CONCLUSION

It is concluded that multiple linear regression method is best in estimating live body weight of chickens followed by stepwise linear regression. Thus, researchers can include multiple linear regression method with combination of body length and breast length when estimating live body weight of chickens. Breeders can select chickens with the highest measurements of body length and breast length to improve live body weight of their chickens

DECLARATIONS

Corresponding Author

Correspondence and requests for materials are supposed to be directed to Thobela Louis TYASI; E-mail: louis.tyasi@ul.ac.za; ORCID: https://orcid.org/0000-0002-3519-780

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' Contribution

Initial thought of the study was by Joas Albino Tsenane and Thobela Louis Tyasi. Joas Albino Tsenane wrote the initial draft of the manuscript. Thobela Louis Tyasi and Obert Tada supervised, reviewed and proofread the manuscript.

Acknowledgements

The authors would like to thank University of Limpopo for providing resources for internet access.

Funding

Many thanks to National Research Foundation (NRF) for providing funding.

Competing interests

The authors declare no competing interests.

REFERENCES

Adenaike AS, Akpan U and Ikeobi CON (2015). Principal components regression of body measurements in five strains of locally adapted chickens in Nigeria. Thai Journal of Agricultural Science, 48(4): 217-225. https://li01.tcithaijo.org/index.php/TJAS/article/view/246191

Akporhuarho PO and Omoikhoje SO (2017). Principal component analysis of body weight and biometric traits of F1 crossbred of exotic broilers× local chickens. Nigerian Journal of Science and Environment, 15(1): 94-103. https://njse.org.ng/user/approved/BCF9245112.pdf

Bila L and Tyasi TL (2022). Multivariate principal component analysis of morphological traits in Ross 308 broiler chicken breed. Asian Journal of Agriculture and Biology, 2022(3): 1-7. https://doi.org/10.35495/ajab.2021.03.132

Bila L, Tyasi TL, Tongwane, TWN and Mulaudzi AP (2021). Correlation and Path analysis of body weight and biometric traits of Ross 308 breed of broiler Chickens. Journal of World's Poultry Research, 11(3): 344-351. https://dx.doi.org/10.36380/jwpr.2021.41

Chrysostome CAAM, Orounladji BM, Akouèdegni G and Behingan MB (2024). Multivariate analyses of morphobiometric traits: A tool for Goliath chicken selection programs in Benin. *Scientific African*, 23(2024): 1-11. https://doi.org/10.1016/j.sciaf.2024.e02115

Ikeh NE and Okwesili OR (2021). Relationships between body weight and some linear morphometric traits in Nigerian Nsukka ecotype local hens. Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension, 20(3): 110-113. https://doi.org/10.4314/as.v20i3.15

Sadick AM, Aryee G, Poku Jnr AP and Kyere CG (2020). Relationship between body weight and linear body measurements in the Cobb broiler chicken. World Journal of Biology Pharmacy and Health Sciences, 4(2): 1-6. https://doi.org/10.30574/wjbphs.2020.4.2.0087

Semakula J, Lusembo P, Kugonza DR, Mutetikka D, Ssennyonjo J and Mwesigwa M (2011). Estimation of live body weight using zoometrical measurements for improved marketing of indigenous chicken in the Lake Victoria basin of Uganda. Livestock Research for Rural Development, 23(8): Article #170. https://www.lrrd.org/lrrd23/8/sema23170.htm

Tyasi TL, Mookamedi KO, Mokoena K and Molabe KM (2024). Body length as predictor for improving body weight of white leghorn chicken. Online Journal of Animal and Feed Research, 14(4): 218-224. https://dx.doi.org/10.51227/ojafr.2024.26

Udeh FU, Ndofor-Foleng HM, Nwosu CC and Ozor DC (2021). Descriptive statistics, correlation and regression coefficient of growth traits in the nigerian heavy local chicken ecotype. International Journal of Recent innovations in Academic Research, 5(4): 1-10. https://journals.indexcopernicus.com/api/file/viewByFileId/1311332

Yakubu A and Ari MM (2018). Principal component and discriminant analyses of body weight and conformation traits of Sasso, Kuroiler and indigenous Fulani chickens in Nigeria. *The Journal of Animal and Plant Sciences*, 28(1): 46-55. https://www.thejaps.org.pk/docs/v-28-01/07.pdf

Yakubu A and Salako AE (2009). Path coefficient analysis of body weight and morphological traits of Nigerian indigenous chickens. Egyptian Poultry Science, 29(3): 837-850. https://www.researchgate.net/publication/300025966_PATH_COEFFICIENT_ANALYSIS_OF_BODY_WEIGHT_AND_MORPHOLOGICAL_TRAITS_OF_NIGERIAN_INDIGENOUS_CHICKENS

Yakubu A, Kuje D and Okpeku M (2009). Principal components as measures of size and shape in Nigerian indigenous chickens. Thai Journal of Agricultural Science, 42(3): 167-176. https://www.thaiscience.info/journals/Article/TJAS/10594469.pdf

Yunusa AJ and Adeoti TM (2014). Multivariate analysis for body weight and some linear body measurements of Nigerian indigenous chickens. Slovak Journal of Animal Science, 47(3): 142-148. https://office.sjas-journal.org/index.php/sjas/article/view/227/215