

Prediction of body weights from linear body parameters of rabbit genotypes in the humid tropics

Obasi, E. N.* and Akinsola, K. L.

Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

*Corresponding author. Email: onyedinmaezinne@gmail.com; obasi.ezinne@mouau.edu.ng

Copyright © 2023 Obasi and Akinsola. This article remains permanently open access under the terms of the [Creative Commons Attribution License 4.0](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Received 21st November 2023; Accepted 28th December 2023

ABSTRACT: This study aimed to determine the association between body weight and linear body parameters in rabbits. A total of 93 kittens generated from crosses of New Zealand White (NZW) x NZW, Chinchilla (CHA) x CHA, NZW x CHA, and CHA x NZW genotypes of rabbit in a nested classification of a Completely Randomized Design were used for this study. Data on body circumference weight (BW) and linear body parameters namely, body length (BL), ear length (EL), heart girth (HG), head-to-shoulder (HS), length of hind limb (LHB), length of forelimb (LFB), tail length (TL) and thigh girth (TG) were taken bi-weekly from weeks 2 to 12. The regression procedure used was a stepwise multiple regression using the backward elimination method. The body weight was regressed on linear body parameters using the stepwise multiple regression procedure in SPSS software. The result showed that the regressions of body weight on linear body parameters are all positive and highly significant ($p < 0.01$; 0.05) except for CHA x CHA in week 2. The values of the coefficient of determination (R^2) ranged from 26 - 91% in NZW x NZW, 85 - 98% in NZW x CHA, 1 - 88% in CHA x CHA, and 92 - 99% in CHA x NZW. CHA x NZW had the highest R^2 value of 94, 99, 94, 97, and 96% in weeks 2, 4, 6, 8 and 12, respectively. NZW x CHA also had a similar R^2 value of 94, 96, and 98% in weeks 2, 8 and 10, respectively. For predicting body weight at weeks 2 and 4, LFB and TG were good predictors of body weight for NZW x NZW mating type while at weeks 6 and 10, LFB was a good predictor of body weight. Also, BL and HS proved to be the best predictors of body weight for NZW x CHA mating type. For CHA x CHA, HG and TG were good predictors of body weight while in CHA x NZW, BL was a good predictor of body weight at these periods except for weeks 10 and 12. This suggests that body weight increases with an increase in linear body measurements. Except CHA x CHA in weeks 2 and 12, all the multiple regression equations were significant; all the parameters had R^2 values above 60% which shows that the linear model was a perfect fit. Hence, BL can be predicted with accuracy using CHA x NZW cross to facilitate the selection of rabbits for body weight-related purposes.

Keywords: Body weights, humid tropics, linear body parameters, prediction model, rabbit genotypes.

INTRODUCTION

The relationship between live body weight and body dimensions is very useful in the prediction of the live body weight of animals (Egena *et al.*, 2014). The final body weight of animals is a reflection of the total weight of all its parts (Ozoje and Mgbere, 2002), this means that a change in any one of the parts could result positively or negatively in the final body weight depending on the direction of the change. Data obtained from such relationships are very

useful to breeders in selecting animals destined for use as breeding stock (Isaac *et al.*, 2011). Consumption of animal protein in Nigeria remains low at about 6.0-8.4 g/head/day which is far below the 13.5 g per day prescribed by the World Health Organization (Egbinike, 1997). Rabbit production is a veritable way of alleviating animal protein deficiency in Nigeria (Ajala and Balogun, 2004). Most references in available literature relating linear measure-

ments to production traits in animals have involved studies with cattle, poultry, sheep, and goats. Information on the interrelationships among linear body measurements of rabbits in the humid tropics is scanty in the available literature (Chineke, 2005). The simple linear body measurements that can reliably predict body weight without necessitating animal slaughter will be particularly desirable (Chineke, 2005).

Moreover, rabbit producers and breeders are interested in the relationship that exists between body weight and linear traits because this information would tell something about rabbit feed efficiency and production performance (Okoro *et al.*, 2010). The relationships among quantitative traits such as body weight, body length, ear length, tail length limb lengths, etc., have been investigated among domestic rabbits (Chineke *et al.*, 2002; Abdullahi *et al.*, 2003; Isaac *et al.*, 2011; Atansuyi *et al.*, 2011). A highly significant interrelationship ($p < 0.001$) between body weight and linear body measurements was observed in a prediction study with broilers (Ajayi *et al.*, 2007). The coefficient of determination varied from 61.57 to 99.25% and the magnitude of the coefficient of determination for each parameter in the regression equations shows the relative contribution of each body measurement to the body weight of the bird for the particular strain of broiler used (Ajayi *et al.*, 2007). The result indicated that as body girth, keel length, and thigh length increase through selection, there will be a corresponding increase in body weight gain. According to Egena *et al.* (2012), a high and positive R^2 value for any trait with body weight is indicative of the fact that the trait has a propensity to increase as body weight increases. This implies that the trait is directly influenced by changes in body weight. This implies that the trait is directly influenced by changes in body weight. Egena *et al.* (2012) observed significant ($p < 0.05$; 0.01) associations between linear body measurements and body weight for the rabbit genotypes measured except for pure CH at 35 days post-partum where no significant ($p < 0.05$) effect was observed. The value of the coefficient of determination (R^2) ranged from 0.49 to 0.99 being maximal for CH x (CH x NZW) cross at 21 and 49 days post-partum. The R^2 values were generally high and positive signifying that the equations could be used to predict IBW efficiently (Egena *et al.*, 2012). Obike *et al.* (2010) observed a positive and highly significant ($p < 0.001$) coefficient of determination (R^2) for both the pre-weaning and post-weaning stages. Obike *et al.* (2010) indicated shoulder-to-tail drop as the best predictor of body weight for the rabbit genotypes used, followed by body length and heart girth for both the pre-weaning and post-weaning stages. According to Oke *et al.* (2004), in their study on the genotype effect on growth traits of rabbits, New Zealand White had the poorest feed efficiency values and smaller body weight gain. The Chinchilla ranked best in the group for the linear parameters at 20 weeks of age. Evidence from his study indicates that the association between body

and linear body traits in the three genotypes of rabbits was linear. The result indicates that for Chinchilla, heart girth and height at withers would best predict body weight at 20 weeks of age. The rabbit has immense potential and good attributes which include a high growth rate, high efficiency in converting forage to meat, short gestation period, high prolificacy, relatively low cost of production, and high nutritional meat quality which includes low fat, sodium, and cholesterol levels. Rabbits have a high protein level of about 20.8% and consumption of rabbit meat is bereft of cultural and religious biases (Biobaku and Oguntona, 1997). This study was therefore aimed at predicting the live body weights of rabbits using different linear body parameters at different ages.

MATERIALS AND METHODS

Location of study

This experiment was carried out at the Rabbitary Unit, Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State. The farm is located at latitude 05°29' North and longitude 07°32' East. The farm lies at an altitude of 122 m and within the rain-forest zone of south-east Nigeria, which has a bimodal rainfall pattern and total annual rainfall of 2177 mm, maximum ambient temperature range of 22 to 36°C during the hot dry season of the year (November – March) and minimum ambient temperature range of 20 to 26°C during the cold rainy season (April-October). The relative humidity ranges from 50-90% depending on the season (NRCRI, 2017).

Experimental animals and their management

Ninety-three (93) kittens produced from crosses comprising of NZW x NZW, CHA x CHA, NZW x CHA, and CHA x NZW (Table 1) were used for this study. The animals were housed in hutches, allowed to mate naturally and kindle. Feed (concentrate and forages-*Panicum maximum* and *Centrosema pubescens*) and water were given to the animals *ad libitum*. The diet fed to the animals consisted of 18% CP, 2600 Kcal/kg, and 8% CF as analyzed. Routine management operations were carried out daily. The animals were given Ivomec injections against endo- and ectoparasites.

Data collection and analysis

The body weight (BW) was taken using a digital scale (0.01 g) and a top-loading Hana power 5 kg scale with a sensitivity of 25 g. The ear length (EL-length from the base to the tip of the ear), body length (BL-length from the middle of the head to the base of the tail), heart girth (HG-

Table 1. Mating scheme and number of progeny produced.

Mating type	Number of sires	Number of dams	Number of progeny
NZW X NZW	3	6	25
NZW X CHA	3	6	20
CHA X CHA	3	7	18
CHA X NZW	3	9	30

NZW= New Zealand White; CHA= Chinchilla.

circumference of the chest region), thigh girth (TG-circumference of the thigh region), length of the forelimb (LFB-length from the base of the ulna bone to the tip of the feet), length of the hind limb (LHB-length from the base of the pelvic bone to the tip of the feet), head-to-shoulder (HS-length from the head to the shoulder) and tail length (TL-length from the base to the tip of the tail) were measured using a tailor's thread and measuring tape graduated in centimeters, and all these were collected bi-weekly starting from the second (2nd) week till the twelfth (12th) week. The regression procedure used was a stepwise multiple regression using backward elimination method. The body weight was regressed on linear body measurements using Stepwise Multiple Regression Procedure in SPSS software. Regression equations were determined for body weight and the association between body weight and linear body parameters was assessed. The generalized model was:

$$Y = a + \sum_{i=1}^k b_i x_i + e_i$$

Where: Y = Body weight, a = Intercept constant, b_i = Partial regression coefficients, x_i = Independent variables (Linear body parameters), e_i = Random error assumed to be normally and independently distributed, with zero mean and constant variance (0, σ).

The accuracy of the prediction was compared using the coefficient of determination (R^2).

RESULTS AND DISCUSSION

Table 2 shows multiple regression of body weight on linear body parameters in weeks 2 – 12 using the backward elimination method. The regressions of body weight on linear body parameters are all significant ($p < 0.01$; 0.05) except for CHA x CHA in week 2. The variations in the variables of the body weight and linear body parameters relationship in this study could be attributed to the differences in the maturing patterns of the different body parts. Russell (1975) observed in cattle that shoulder width (SW) attained 35% of its final size at birth, while body

length (BL) and heart girth (HG) were about 39.9% and 35% matured at birth respectively. The R^2 in this study ranges from 26 - 91% in NZW x NZW, 85 - 98% in NZW x CHA, 1 - 88% in CHA x CHA, and 92 - 99% in CHA x NZW. In weeks 2, 4, 6, 8, and 12, CHA x NZW had the highest R^2 value of 94, 99, 94, 97, and 96%, respectively. NZW x CHA also had a similar R^2 value of 94, 96, and 98% in weeks 2, 8 and 10, respectively. For predicting body weight at weeks 2 and 4, LFB and TG were good predictors of body weight for NZW x NZW mating type while in weeks 6 and 10, LFB was a good predictor of body weight. BL and HS proved to be the best predictors of body weight for NZW x CHA mating type. For CHA x CHA, HG and TG were good predictors of body weight while in CHA x NZW, with the exception of week 10, BL was a good predictor of body weight at these periods, and this in consonance with the finding of Abdullah *et al.* (2003), who reported that shoulder-to-tail (ST) appears to be the best single predictor of body weight in rabbits, followed by body length (BL).

From this result, BL and HS were the best predictors of body weight in the rabbit genotypes across the weeks measured. The observations in this study corroborated the report of Obike *et al.* (2010) who suggested shoulder-to-tail (STD) and BL as the best predictors in the rabbit genotypes both for pre- and post-weaning ages. This result also agrees with the findings of Akanno and Ibe (2006) who suggested BL, body width and STD as important estimators of body weight at different weeks studied.

The very high R^2 obtained when different linear parameters were combined to predict the body weight suggests that the combination of two or more linear body parameters will be more appropriate since there is the existence of variation in the maturing pattern of the various body parts in rabbits. Results from the multiple regression equation showed that the regression coefficient associated with the independent variables and partially representing any amount of change in the dependent variable for each unit change in the linear body parameters had a positive relationship between body weight and linear body parameters. This suggests that body weight is likely to increase with linear body parameters and this in agreement with the finding of Chineke (2005) who reported positive values for the majority of the regression

Table 2. Linear relationship between body weight and the linear body parameters of rabbit crosses using the Backward Elimination Method.

Age	Mating type	Equation	R ²	SE	Sig
2	NZW x NZW	BWT = -56.838 + 14.452(BL) + 20.293(HG) + 21.948(LFB) + 32.111(TG)	83	19.340	**
	NZW x CHA	BWT = -61.828 + 5.433(BL) + 32.310(EL) + 11.077(HS)	94	7.753	**
	CHA x CHA	BWT = -46.877 + 26.608(HG)	1	307.705	NS
	CHA x NZW	BWT = -62.536 + 10.133(BL) + 14.249(HS) + 25.063(TL) + 16.519(TG)	94	12.378	**
4	NZW x NZW	BWT = -438.847 + 26.458(EL) + 43.220(LFB) + 38.031(TG)	91	30.363	**
	NZW x CHA	BWT = -429.944 + 25.801(BL) + 22.392(HS)	68	59.721	**
	CHA x CHA	BWT = -248.935 + 8.151(BL) + 29.706(EL) + 22.968(HG) + 15.672(LFB) + 43.604(TL) + 35.110(TG)	88	29.702	**
	CHA x NZW	BWT = -349.118 + 19.296(BL) + 18.687(HG)	99	16.790	**
6	NZW x NZW	BWT = -57.413 + 61.420(HS) + 34.269(LHB) + 62.402(LFB)	89	47.650	**
	NZW x CHA	BWT = -856.765 + 55.839(BL) + 20.294(TG)	93	41.871	**
	CHA x CHA	BWT = -952.361 + 39.092(BL) + 32.742(HS) + 40.285(TG)	68	73.710	**
	CHA x NZW	BWT = -187.600 + 19.097(BL) + 46.539(TL)	94	44.375	**
8	NZW x NZW	BWT = -419.851 + 27.770(BL) + 22.884(LHB)	90	49.937	**
	NZW x CHA	BWT = -579.763 + 27.199(BL) + 16.623(LHB) + 33.946(TG)	96	30.626	**
	CHA x CHA	BWT = -326.733 + 39.927(HG) + 48.683(TG)	81	57.128	**
	CHA x NZW	BWT = -475.744 + 35.545(BL) + 42.325(HG) + 76.838(TL)	97	41.451	**
10	NZW x NZW	BWT = -915.292 + 71.034(LFB) + 128.959(TL)	83	74.923	**
	NZW x CHA	BWT = -1685.426 + 55.862(BL) + 31.893(EL) + 27.936(HS) + 35.928(LHB)	98	15.184	**
	CHA x CHA	BWT = -533.172 + 19.618(BL) + 38.386(HS) + 39.079(LFB) + 134.342(TG)	87	67.047	**
	CHA x NZW	BWT = -1630.296 + 59.829(LHB) + 149.364(TG)	92	62.938	**
12	NZW x NZW	BWT = 502.965 + 51.752(HS)	26	88.919	*
	NZW x CHA	BWT = -1509.127 + 53.815(HS) + 66.111(LHB) + 103.407(LFB) + 101.942(TL)	93	34.065	**
	CHA x CHA	BWT = 265.961 + 36.773(LHB)	16	94.772	*
	CHA x NZW	BWT = -459.313 + 125.615(EL) + 165.227(HS) + 176.880(TL)	96	45.479	**

MT – Mating type, R² – Regression coefficient, SE – Standard error, NZW – New Zealand White, CHA – Chinchilla, BW – Body Weight, BL – Body Length, EL – Ear Length, HG – Heart Girth, HS – Head to Shoulder, LHB – Length of Hindlimb, LFB – Length of Forelimb, TL – Tail Length, TG – Thigh Girth, SE – Standard error, Sig = Significance level, * - Significant at P<0.05, ** - Significant at P<0.01, NS – Not significant.

coefficients for body weight and linear body parameters. The observation of positive values for regression coefficient could indicate that body weight increases with increase in other body parameters (LFB, HG, TG, BL, HS, TL, EL and LHB). This implies that any increase in body weight was as a result of an increase in the linear parameters. This is in line with the findings of Olufowobi and Olowofeso (2015) and Okoro *et al.* (2010) that under the standard management system of rabbit production, as the body weight increases so also the body dimension increases. High and positive R² value for any regression model indicates the reliability of such predictive equation.

Similar positive relationships between body weight and linear body measurements had been reported in sheep (Searle *et al.*, 1989a), goat (Ozoje and Herbert, 1997), cattle (Omeje *et al.*, 2001), poultry (Lusembo *et al.*, 2011; Gueye *et al.*, 1998) and rabbit (Yakubu *et al.*, 2005). Except CHA x CHA in weeks 2 and 12, all the multiple regression equations were significant; all the parameters had R² values above 60% which shows that the linear model was a perfect fit. Also, the simple linear equation developed using the body size parameter as independent variables can be used to predict bodyweight of rabbit genotypes. Hence, using any of the regressions or

prediction equation so generated from this study based on their strong relationship coefficient determination, BL can be predicted with accuracy using CHA x NZW cross to facilitate the selection of rabbits for body weight related purposes.

Conclusion

There were positive, strong and significant relationships between body weight and other linear body parameters of rabbit crosses under study. Also from the study, CHA x NZW had the highest R² values in all the weeks except for week 10 with BL being the best accurate predictor.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ACKNOWLEDGEMENT

The authors appreciate the magnanimity of the Vice Chancellor of Michael Okpara University of Agriculture Umudike, Abia State, Nigeria and the Head of the Department of Animal Breeding and Physiology, for allowing us to use the university facilities for this research. We also appreciate the laboratory and farm staff of the College of Animal Science and Animal Production for their assistance during the research period.

REFERENCES

- Abdullah, A. R., Sokunbi, O. A., Omisola, O. O., & Adewumi, M. K. (2003). Interrelations between body weight and body linear measurements in domestic rabbits (*Oryctolagus cuniculus*). *Proceedings of 28th Annual Conference of the Nigeria Society for Animal Production*. Pp. 133-136.
- Ajala, M. K., & Balogun, J. K. (2004). Economics of rabbit production in Zaria, Kaduna State. *Tropical Journal of Animal Science*, 7(1), 1-10.
- Ajayi, F. O., Ejiofor, O., & Ironkwe, M. O. (2007). Estimation of body weight from linear body measurements in two commercial meat-type chicken. *Global Journal of Agricultural Sciences*, 7(1), 57-59.
- Akanno, E. C., & Ibe, S. N. (2006). Prediction of body weight of the domestic rabbit at different stages of growth using linear body measurements. *Nigerian Journal of Animal Production*, 33(1), 3-8.
- Atansuyi, A. J., Akeju, O., & Chineke, C. A. (2011, March). Relationship among body weights and linear dimensions of rabbits fed varying levels of fibre sources. In *Proceedings of the 36th Annual Conference of the Nigerian Society for Animal Production* (pp. 51-53).
- Biobaku, W. O., & Oguntona, E. B. (1997). The effect of feeding multi nutrient mini blocks and pelleted diet on the growth of rabbits. *Nigeria Journal for Animal Production*, 24(2), 147-149.
- Chineke, C. A. (2005). The relationship among body weights and linear dimensions in rabbit breed and crosses. *Journal of Animal and Veterinary Advances*, 4(9), 775-784.
- Chineke, C. A., Agaviezor, B., Ikeobi, C. O. N., & Ologun, A. G. (2002). Some factors affecting body weight and measurement of rabbits at pre and post-weaning ages. *Proceedings in the 27th Annual Conference of Nigeria Society for Animal Production*, FUT-Akure, Nigeria. Pp. 1-3.
- Egbunike, G. N. (1997). What is Animal Science? And how can Nigeria get out of malnutrition? In: Ologhobo, A. D., Iyayi, E. A., Adesehinwa, A. O. K., & Bamgbose, M. (eds.). *Livestock products. Proceedings of the 2nd Annual Conference of Animal Science Association of Nigeria*. Held at Airport Hotel, Ikeja-Lagos on the 16th-17th September. Pp. 1-12.
- Egena, S. S. A., Akpa, G. N., Alemede, I. C., & Aremu, A. (2014). Genotype, gestation length, season, parity and sex effects on growth traits of two rabbit breeds and their crosses. *Biotechnology in Animal Husbandry*, 30(4), 717-729.
- Egena, S. S. A., Akpa, G. N., Aremu, A., & Alemede, I. C. (2012). Predicting body weight of rabbits from linear body measurements at various ages by genetic group, parity and sex. *Proceedings in the 10th World Rabbit Science Association Congress – September 3-6*. Pp. 19-23.
- Gueye, E. F., Ndiaye, A., & Branckaert, R. D. S. (1998). Prediction of matured body weight based on body measurement in mature indigenous chicken in Senegal. *Livestock Research for Rural Development*, 10(3).
- Isaac, L. J., Udoh, U. H., Usoro, O. O., Ekanem, E., & William, M. E. (2011). Relationship between body weight and linear body measurements in different breeds of rabbits. In: *Proceedings of 36th Annual Conference of the Nigerian Society of Animal Production*. 13th – 16th March. University of Abuja, Abuja, Nigeria. Pp. 10-12.
- Lusembo, P., Semakula, J., Kugonza, D. R., Mutettika, D., Ssenyonjo, J., & Mwesigwa, M. (2011). Estimation of live body weight using zoometrical measurement for improved marketing of indigenous chicken in the Lake Victoria Basin of Uganda. *Livestock Research for Rural Development*, 23(8). Retrieved from <http://www.irrd.org/irrd23/8/cont2308.htm>.
- NRCRI (2017). Agro-Meteorologic Unit. National Root Crop Research Institute, Umudike, Abia State, Nigeria.
- Obike, O. M., Ibe, S. N., & Oke, U. K. (2010). Estimation of pre- and post-weaning body weight of rabbits in a humid tropical environment using linear body measurements. *American-Eurasian Journal of Agricultural & Environmental Sciences*, 9(4), 440-444.
- Oke, U. K., Ibe, N., & Ogonnaya, E. O. (2004). Effect of genotype on growth traits of rabbits. *International Journal of Agriculture and Rural Development*, 5(1), 61-68.
- Okoro, V. M. O., Ezeokeke, C. T., Ogundu, U. E., & Chukwudum, C. (2010). Phenotypic correlation of bodyweight and linear body measurement in Chinchilla rabbits (*Oryctolagus cuniculus*). *Journal of Agricultural Biotechnology and Sustainable Development*, 2(2), 27-29.
- Olufowobi, O. T., & Olowofeso, O. (2015). Interrelationship between body weight and body size parameters in chinchilla and New Zealand white rabbit genotypes in Abeokuta, Nigeria. *Journal of Biology, Agriculture and Health Care*, 5, Article number 20.
- Omeje, S. I., Nweze, B. O., & Chinyereugo, J. (2001). The pecking, resting and feeding behaviour of four broiler strains in a humid tropical environment. *Nigerian Journal of Animal*

- Production*, 28(1), 103-107.
- Ozoje, M. O., & Herbert, U. (1997). Linear measurement in West African Dwarf (WAD) and WAD cross with Sokoto goats. *Nigerian Journal of Animal Production*, 24(1), 13-19.
- Ozoje, M. O., & Mgbere, O. O. (2002). Coat pigmentation effects in West African Dwarf goats: live weights and body dimensions. *Nigerian Journal of Animal Production*, 29(1), 5-10.
- Russell, W. S. (1975). The growth of Ayrshire cattle: an analysis of linear body measurements. *Animal Science*, 21(3), 217-226.
- Searle, T. W., Graham, N. M., & Donnelly, J. B. (1989). Change of skeletal dimensions during growth in sheep: the effect of nutrition. *The Journal of Agricultural Science*, 112(3), 321-327.
- Yakubu, A., Salako, A. E., Ogali, D. M., Barde, R. E., & Oyefeso, S. (2005). Estimation of body weight from linear body measurement in domestic rabbits (*Oryctolagus cuniculus*). In *Proceedings of the 38th Annual Conference of the Agricultural Society of Nigeria (ASN)*. Pp. 58-51.