ADAN J. Agric. 2023, 4: 135-142
DOI:10.36108/adanja/3202.40.0131

ISSN 2736-0385

Influence of weight at hatching on weekly weight of broiler chickens

[1]Kareem-Ibrahim, K. O., [1,2]Abanikannda, O. T. F., [2]Lawal, A. K. and [2]Nwadialo, S.
[1]*Department of Animal Science, School of Agriculture, Lagos State University, Epe – Lagos*
[2]*Department of Zoology and Environmental Biology, Faculty of Science, Lagos State University, Ojo – Lagos*

Corresponding Author:** otfabanikannda@hotmail.com;* ***Phone Number: *08023128376*

Abstract
Broiler production is concerned with raising birds that reach market weight within a short time interval, and efforts are geared at indices that can accurately predict the future growth performance of birds based on their initial measurements. This study investigated the relationship between initial weight taken at hatch and its influence on subsequent weights of birds. Newly hatched day-old chicks were obtained from a reputable hatchery in Ibadan, Oyo state. It comprised of chicks from four different commercial broiler strains (Arbor Acre, Cobb, Marshall and Ross). The chicks were tagged for proper identification and weighed and records of their weekly weights taken over ten (10) week period of the study. At the end of the study, a total of 216 broiler chicks comprising Arbor Acre (48), Cobb (52), Marshall (60) and Ross (56) were analysed. Weekly weight progressively increased with increasing age of the birds, while weight gain increased across the weeks, with a decline and a further rise in values reflecting the different stages of growth. The population was fairly homogenous at the early stages but was later moderately varied with increasing age of birds. There was a highly significant (P<0.001) positive correlation amongst all the weights studied but strongest values were recorded on measurements that are contiguously close. Despite the fact that regression of weekly weights was highly statistically significant on initial weight, it is noteworthy that initial weight as predictors of weekly weight had the best fit on the first weekly weight, but the influence of initial weight consistently decreased with increasing age of the broiler birds. This study revealed that initial weight of broiler birds at hatch is a good predictor of future weight of the birds and can be used to model the future growth performances of the birds.

***Keywords**: Growth Rate, Broiler, Hatching Weight*

Introduction
Food, one of the basic needs of man must be available for the sustenance and continuity of life, and irrespective of status or economic situation, humans must be fed balanced ration for maintenance of metabolic and physiological processes in the body, aimed at the growth and development of human life. Thus, efforts are made from ancient times to ensure that there is a steady supply of essential nutrients from the diverse food consumed by humans.

Major sources of these food in medieval times were from hunting game animals and some wild plants. Soon afterwards, efforts were geared at domestication of these plants and animals to ensure supply for the immediate family. With civilization and its attendant population growth, resulting in more demand for food, humans devised means by which the different kinds of food would be produced in commercial quantities to fulfil the demands of the teeming population. Livestock is regarded as a vital source of employment in rural areas and developing countries, providing food, source of power in ploughing for crops, and transport (FAO, 2011).

Poultry plays a significant role in human economy through provision of food (meat and eggs), use of fecal droppings and feathers in industries as natural unprocessed materials while also creating wealth through job provision for our teeming population (Stiles, 2017; Alders *et al.,* 2019). The nutritional benefits derived from poultry products such as animal protein, minerals, fat-soluble vitamins, carbohydrates, pigments, fluids, and cholesterol is attributable to its relevance as the world major source of food (Dilger *et al.,* 2016).

Broiler farming entails the production of fast-growing bird breeds (6 - 8 weeks) for meat using production methods such as the deep litter system, cage and feed system or the semi-intensive method (Nwandu *et al.,* 2016). Broilers have been the most reared of all the poultry meat because they are easy to raise and yield good profits especially when they aren't reared beyond 6 to 10 weeks. Broiler chicken production has undergone drastic changes and developments over the last few decades. Constant improvements in nutrition and genetic selection over the last two decades have led to a fast growth rate in modern broiler strains, to the extent that the average time required to grow a broiler chicken to 2 kg has reduced nearly by half (from 63 days to 37 days).

Genetic selection for economically important traits such as body weight, growth rate, feed efficiency, and ultimately traits associated with carcass-processing characteristics have tremendously evolved, which have contributed to the increases in productivity and efficiency obtained in the broiler industry (Shim et al., 2012; Thutwa et al., 2012; Hristakieva et al., 2014; Puchała et al., 2015; Udeh, et al., 2015; Tavárez and Solis de los Santos, 2016 and Uhlíová et al., 2018). This has led to the development of several industry standard breeds which are suited to different parts of the world yielding high quality meat (Donohue, 2015).

Chicks' initial weight has an important effect in the broiler industry as it affects subsequent broiler performance such as weight gain, age to maturity, disease resistance and general fit of the bird (Mendes *et al.,* 2011; Al-Nedawi *et al.,* 2019; and Kareem-Ibrahim et al, 2021). This study therefore aims to investigate the relationship between weight of broilers at hatch and its subsequent weekly weight in the ten-week period of rearing the broiler birds, and build a statistical model to predict future weight of the birds based on its initial weight.

Materials and Methods

Experimental Site: This experiment was conducted at the Poultry Research Farm of the Lagos State University, Ojo, Lagos, Nigeria, situated at latitude 6° 27' 59.99" N and longitude 3° 10' 60.00" E in the humid tropics of south west Nigeria, with an average annual mean temperature of 27°C and 1253mm

The animals were reared on a deep litter open floor plan with dimension of 15m x 15m throughout the study, with an adjoining 3m x 3m space for brooding. The birds were given feed and water *ad libitum* throughout the period of the study. Management practices followed standard procedures for broiler breeding and management in line with breeders' recommendations, where birds were fed commercially compounded broiler feed with 2550 - 3100 Kcal/Kg Metabolizable energy and 15.5 - 22% Crude protein depending on the stage of development (Table 1). Routine vaccination schedules and medication were strictly observed.

Experimental Units: Day old chicks of four (4) strains of commercial broiler birds were obtained from a reputable hatchery in Ibadan, Oyo State. On arrival, there were 76 chicks each for the Arbor Acres, Cobb, Marshall and Ross, all totalling 304 birds. The birds were all tagged using numbered coloured leg tags with identification number indicating their strain and serial number within the breed, weighed as soon as they are tagged and the initial weight at day old immediately recorded.

Table 1: Proximate analysis of broiler feed compounded by Hybrid Feeds Limited⁺

Constituents (%)	Broiler Starter (0 – 4 weeks)	Growers (5 – 6 weeks)	Broiler Finisher (7 – 10 weeks)
Crude Protein	22	15.5	19.5
Fat	5.1	3.6	5.5
Crude Fibre	4.3	4.6	3
Calcium	1.2	1.1	1.2
Phosphorus	0.45	0.40	0.44
Methionine	0.56	0.37	0.5
Lysine	1.3	0.75	1.2
Metabolizable Energy (kcal/kg)	3000	2550	3100

⁺Source: Hybrid Feeds Limited

Experimental design: The birds were randomly assigned to each of the four replicates in a completely randomized design and were all subjected to the same rearing conditions. Each replicate consists of 19 randomly selected birds from each of the four strains making a total of 76 birds in each treatment.

Data Collection: Body weight of the birds were taken on a weekly basis using a 0.00g Camry sensitive digital scale with a maximum weight of 5kg and the weights were recorded by their identification number over a period of 10 weeks.

Data Handling and Statistical Analyses: All recorded data were entered in Microsoft Excel® worksheet. Statistical analyses were done using the exploratory modules (boxplots, descriptive and normality tests), correlation and regression analyses of Minitab 17® statistical software.

Aside from birds lost due to mortality across the four breeds, some were also eliminated as outliers from the final analysis, and eventually the final sample size per breed included in the analyses was Arbor Acre (48), Cobb (52), Marshall (60) and Ross (56), all totalling 216.

The statistical model describing the simple linear regression of weekly weight on initial weight is given as:

$$Y_{ij} = \beta_0 + \beta_I X_i + e_{ij}$$

Where Y_{ij} is the response in weekly weight (1 – 10) due to initial weight of each bird

β_0 is the intercept

$\beta_i X_i$ is the slope of regression for each of the weekly weight (i = 1-10)

e_{ij} is the residual error assumed to be normal, independent and random

Results and Discussion

The mean weight from hatching progressively increases with age of the birds as depicted in Table 2. Expectedly, the lowest values were obtained at hatching and successively increases with age of the birds as a reflection of growth. This is in consonance with earlier reports (Mendes et al, 2011; Mukhtar et al 2013 and Rafea and Magid, 2020) who also observed same trend on different breeds of chickens.

Table 2: Descriptive statistics of the weekly weight of broilers indicating mean, standard error (SE), minimum and maximum

Weeks	Mean ± SE (g)	Minimum (g)	Maximum (g)
Initial	37.08 ± 0.26	27.0	46.0
Week 1	169.26 ± 1.88	91.0	220.0
Week 2	448.56 ± 6.28	195.0	614.0
Week 3	752.00 ± 11.6	308.0	1039.0
Week 4	1154.60 ± 19.2	482.0	1680.0
Week 5	1484.80 ± 24.1	662.0	2325.0
Week 6	1750.20 ± 28.8	781.0	2801.0
Week 7	2169.10 ± 35.0	1044.0	3488.0
Week 8	2406.20 ± 36.7	1114.0	3705.0
Week 9	2661.60 ± 38.7	1315.0	3936.0
Week 10	2856.40 ± 41.5	1239.0	4443.0

Variability in measurements were fairly low at the early stages (0 – 3 weeks) of growth of the birds, it moderately increases at the mid stage (4 – 7 weeks) and later marginally drop at later stages (8 – 10 weeks) as reflected in Figure 1. This variability is a reflection of flock uniformity at the different stages of growth of the birds and a measure of homogeneity of measured variables.

There was a consistent increase in the weekly gain from the first week to the fourth week, which coincided with the period the birds were fed the Broiler Starter feed, which was followed by the period (5 – 6 weeks) when birds were fed Growers' mash, which resulted in the decline in weight gain recorded at that period (Figure 2). Introduction of broiler finisher feed at the seventh week elicited an increase in the weekly weight gain before the declining weight gain till tenth week. This observed differences in growth rate is as a result of the differences in the proximate composition of the three feed types as listed in Table 1 and the age of the birds. Typically, growth increases with age of birds, till it reaches a maximum after which it stabilizes afterwards with marginal differences.

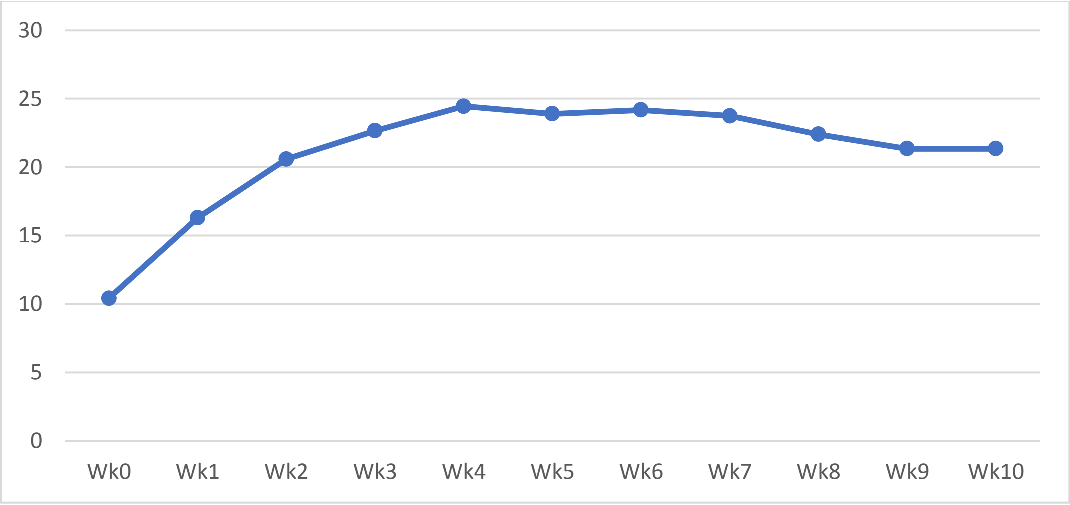

Figure 1: Variability in mean initial and weekly weight as expressed by coefficient of variation

Relationship amongst initial and weekly weights

The strongest correlation between initial weight and subsequent weights was recorded at the first week weight (Table 3), but this influence waned with increasing age of the bird. It is noteworthy that all correlations were highly significant ($P<0.001$) throughout the study, while strongest relationships are between penultimate weight and immediately succeeding weight.

Aside from the 0.640 recorded between week 1 and 2 which was moderately positively correlated, other contiguous pairs were all highly positively correlated. The relationship of the initial weight with other weekly weights though statistically significant, decreased from high to moderate and low as the birds grow older (Table 3). Results from this study revealed that the strength of relationship between preceding and succeeding weights is a function of how close the two weights are in space and time.

Regression of weekly weight on initial weights

The regression model across weekly weight indicated the best fit at week 1 as depicted by the very high coefficient of determination (Table 4). The trend consistently decreased with increasing age of the birds resulting in the lowest coefficient recorded at the 10th week.

It is very instructive that all the ten regression equations were all highly statistically significant ($P<0.001$) throughout the entire study period. However, unlike the observation in coefficient of determination that successively decreases with increasing age, the slope of the regression increases consistently up to the seventh week before its decline thereafter till the tenth week.

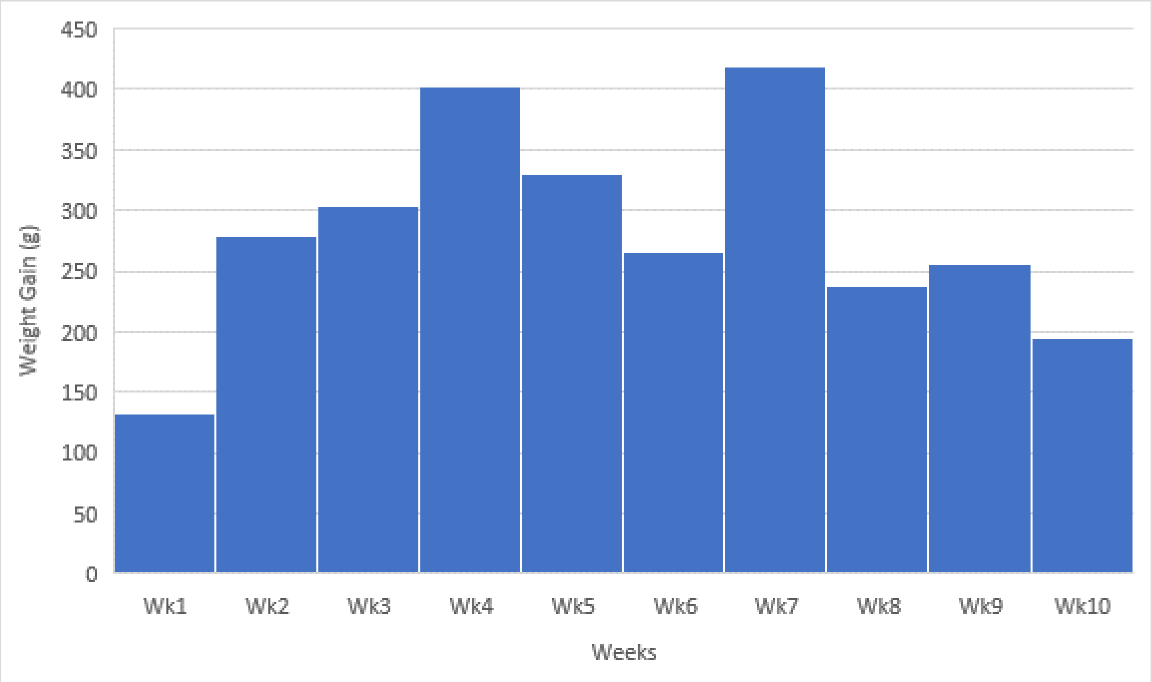

Figure 2: Weekly weight gain across the period of study

Table 3: Correlation matrix of weights (initial weight and weekly weights)§

	Wt 1	Wt 2	Wt 3	Wt 4	Wt 5	Wt 6	Wt 7	Wt 8	Wt 9	Wt 10
Wt 0	0.828	0.443	0.412	0.429	0.423	0.403	0.386	0.354	0.303	0.260
Wt 1		0.640	0.625	0.615	0.612	0.595	0.585	0.547	0.491	0.428
Wt 2			0.956	0.914	0.878	0.816	0.783	0.713	0.614	0.502
Wt 3				0.944	0.896	0.839	0.813	0.747	0.653	0.553
Wt 4					0.924	0.889	0.864	0.799	0.712	0.617
Wt 5						0.942	0.918	0.849	0.742	0.638
Wt 6							0.942	0.888	0.802	0.708
Wt 7								0.962	0.889	0.796
Wt 8									0.959	0.882
Wt 9										0.964

§All correlations are highly statistically significant (P<0.001) Wt=Weight at Week

The influence of initial weight of chickens on their subsequent weights have been earlier reported (Mendes *et al*., 2011; Rafea and Magid, 2020 and Kareem-Ibrahim *et al*., 2021) and this study confirmed their previous researches. However, some other researchers were of the opinion that initial weight did not exert any significant influence of future weights of chickens (Michalczuk, 2010; Petek *et al*., 2010 and Patbandhe, 2017).

Table 4: Regression equations of initial weight on weekly weights§

Weeks	Regression Equations	Coefficient of Determination (R^2)
Week 1	$-50.1 + 5.92X_0$	68.55%
Week 2	$56.0 + 10.59 X_0$	19.59%
Week 3	$78.0 + 18.18 X_0$	16.99%
Week 4	$-10.0 + 31.40 X_0$	18.47%
Week 5	$43.0 + 38.89 X_0$	17.91%
Week 6	$112.0 + 44.19 X_0$	16.28%
Week 7	$261.0 + 51.45 X_0$	14.88%
Week 8	$573.0 + 49.45 X_0$	12.55%
Week 9	$1006.0 + 44.64 X_0$	9.20%
Week 10	$1335.0 + 41.00 X_0$	6.74%

§All regressions are highly statistically significant (P<0.001)

Conclusions and Recommendations

The following conclusions can be drawn from this study;

- That initial weight of broiler chickens at hatch is a good predictor of future growth performances of the bird.
- Relationship between weights of broiler chickens were positively correlated and highly statistically significant (P<0.001) albeit at varying degrees depending on how close the subsequent weight is to the initial weight.
- That influence of initial weight was more pronounced on closer weights than remote weight in terms of time and progressively decrease with age of birds. It is also noteworthy that using initial weight as sole

predictors of future weight of broilers decreases with increasing age of the birds.

Consequently, it can be recommended that initial measurements of chicks' weight at hatch is a good predictor of future weight of the birds and can thus be used in selection of broiler chicks with higher potentials for subsequent weight gain, since that is the major intent of broiler production.

Acknowledgement

The authors wish to gratefully thank Mr. and Mrs. Lawal for financial support of this project work, and also wish to thank all Research Assistants involved with feeding the birds and data collection.

References

Alders, R., Costa, R.,Gallardo, R. A., Sparks, N., & Zhou, H. (2019) Smallholder Poultry: Leveraging for Sustainable Food and Nutrition Security. *Encyclopedia of Food Security and Sustainability*. 3: 340-346.

Al-Nedawi, A., Aljanabi, T., Altaie, S. and Al-Samarai, F. (2019). Effect of sex and day-old weight on subsequent body weight and body mass index in commercial broilers. *Advances in Animal and Veterinary Sciences* 1: 45-48.

Dilger, A., Schroeder, A. and Moseley, W. (2016). Barriers to global implementation of current and development of new performance-enhancing technologies in meat production. Animal frontiers 6: 50-55.

Donohue, M. (2015). The ongoing improvement in broiler production efficiency over the past 20 years is astounding. In: *Congreso de la Asociación Latinoamericana de Avicultura (ALA) Guayaquil, Ecuador*, 7 – 18.

FAO (2011). World Livestock 2011- Livestock in food security. www.fao.org/docrep/014/12373e/12373e.pdf

Hristakieva, P., Mincheva, N., Oblakova, M. and Lalev, M. (2014). Effect of genotype on production traits in broiler chicken. *Slovak Journal of Animal Science*, 47: 19–24.

Kareem-Ibrahim, K. O., Abanikannda, O. T. F. and Saliu, R. (2021). Comparative evaluation of growth parameters of four strains of broiler chickens fed two different feed types. *Nigerian Journal of Animal Science* 23 (2): 18 – 27.

Mendes, A., Paixao, S., Restellato, R., Reffati, R., Possenti, J., De Moura, D., Morello, G. and de Carvalho, T. (2011). Effects of initial body weight and litter material on broiler production. *Brazilian Journal of Poultry Science* 13: 165-170.

Michalczuk, M., Stepinska, M. and Eukasiewiczi, M. (2011). Effect of the initial body weight of Ross 308 chicken broilers on the rate of growth. *Annals of Warsaw University of life sciences* 49: 121-125.

Minitab® 17 Statistical Software (2013). Minitab Inc. USA

Mukhtar, N., Khan, S. and Anjum, M. (2013). Hatchling length is a potential chick
quality parameter in meat type chickens. *World's Poultry Science Journal* 4: 889-896.

Nwandu, P., Ojogbane, J., Okoh, C and Okechukwu, F. (2016), Poultry production business: A means of alleviating poverty among farmers. *International Journal of Innovative*

Agriculture and Biology Research 2: 21-30.

Patbandha, T., Garg, D., Marandi, S., Vaghamashi, D., Patil, S. and Savsani, J. (2017). Effect of chick weight and morphometric traits on growth performance of coloured broiler chicken. *Journal of Entomology and Zoology studies* 2: 22-25.

Petek, M., Orman, S., Dikmen, C. and Alpay, F. (2010). Physical parameters and effects on growth performance in broiler. *Archives of Animal Breeding* 53: 108-115.

Puchała, M., Krawczyk, J., Sokołowicz, Z. and Utnik-Banaš, K. (2015). Effect of breed and production system on physicochemical characteristics of meat from multi-purpose hens. *Annals of Animal Science*, 15: 247–261.

Rafea, M.T. K. and Magid A. S. (2020). Effect of initial weight of chicks on performance of Iraqi local chickens. *Plant Archives* 20 (2): 5686-5690.

Shim, M.Y., Tahir, M., Karnuah, A.B., Miller, M., Pringle, T.D. and Aggrey, S.E. (2012). Strain and sex effects on growth performance and carcass traits of contemporary commercial broiler crosses. *Poultry Science*, 91: 2942–2948.

Stiles, W. (2017). Poultry manure management. https://www.researchgate.net/publication/321001761.

Tavárez, M. A. and Solis de los Santos, F. (2016). Impact of genetics and breeding on broiler production performance: a look into the past, present, and future of the industry. *Frontiers*, 6(4): 37-41.

Thutwa, K., Nsoso, H.J., Kgwatalala, P.M. and Moreki, J.C. (2012). Comparative live weight, growth performance, feed intake carcass traits and meat quality in two strains of Tswana chickens raised under intensive system. *International Journal of Applied Poultry Research*, 11: 121–126.

Udeh, I., Ezebor, P.N. and Akporahuarbo, P.O. (2015). Growth performance and carcass yield of three commercial strains of broiler chickens raised in a tropical environment. *Journal of Biology and Agricultural Health*, 2: 62–67.

Uhlíová, L., Tmová, E., Chodová, D., Vlková, J., Ketta, M. and Volek, Z. (2018). The effect of age, genotype and sex on carcass traits, meat quality and sensory attributes of geese. *Asian-Australasian Journal of Animal Science,* 31: 421–428.