Prediction of grasscutters (*Thryonomis swinderianus*) body weight from linear body measurements

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Abstract

A study was conducted to investigate the relationship between linear body measurements (LBMs) and body weights of grasscutters at 2, 4 and 6 weeks of age. Simple linear correlation procedure was used to establish the strength of linear relationships and associations between the different linear body measurements with body weight. These parameters were also subjected to step-wise regression analysis. The goodness of fit (R^2) was tested to determine the contribution of each independent variable measured to the prediction of the dependent variable, the body weight of grasscutters at different ages of 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 weeks. One hundred and thirty-nine (139) juvenile grasscutters obtained from 24 parents comprising of 18 does and 6 bucks were used for the study. Experimental animals were raised under a mixed feeding regime throughout the experimental period of 20 weeks. The linear body measurements assessed are head length (HL), body length (BL), heart girth (HG), ear length (EL) and tail length (TL). Correlation coefficients (r) between body measurements and weights were generally positive and significant ($p < 0.01$) at 2 weeks, demonstrating strong relationships between variables. At 4 weeks, correlation coefficients ranged from 0.013 to 0.829 whereas at 6 weeks values ranged from -0.230 to 0.859. Coefficient of determination (R^2) varied from 0.926 to 0.997, 0.965 to 0.989 and 0.930 to 0.991 at 2, 4 and 6 weeks, respectively. The positive correlation coefficients observed for body length and heart girth shows that these parameters can be improved upon for grasscutters raised under intensive management. Results from this study further revealed that body weight of grasscutters can be estimated under field condition using the ear, head, body lengths and heart girth in the absence of a weighing balance.

Keywords: grasscutter, prediction, body weight, body measurements, correlation

Introduction

The grasscutter also referred to as cane rat belongs to the order *Rodentia*, sub-order *Hystricgnathi* (Jori and Chardonnet, 2001) and family – *Thryomidae* which has only one genus – *Thryonomis* (Wood, 1955; Fayenuwo *et al.*, 2003). This animal is hunted particularly in West Africa for its meat (Ntiamoa-Baidu, 1998). This rodent specie has also been developed as a micro-livestock in several African countries (Jori and Chardonnet, 2001). Nevertheless, vast majority of this animal are still gathered from the wild. This has undoubtedly threatened the animal with extinction except conservation programs geared towards the preservation of this animal type are strictly followed. Domestication and intensive breeding of the grasscutter have been identified by Falconer (1992) and Fayenuwo *et al.* (2003) as the means to increase its population. In the wild, grasscutters range in body length from 35 to 60cm (Fayenuwo *et al.*, 2003) and its tail can be as long as 7 - 25cm. Body weight up to 10kg has been recorded in the wild and weight range of 6 - 7kg has been attained in captivity (Bishop, 1984). Fayenuwo *et al.* (2003) has reported mature body weight of 9kg for males and 5 - 7kg for females.

Arising from the need to diversify to other sources of animal protein for availability; genetic improvement of the grasscutter becomes important in order to increase their contribution to the much needed animal protein. Akanno and Ibe (2006) expressed that one of the pre-requisites for genetic improvement is the knowledge of genetic parameters for important economic traits.

It has been discovered overtime, that the level of management on farms in Africa influence weights and measurements of different livestock. As such, the collection for domestication of a relatively new animal of interest – the grasscutter will require a measure to determine body weight at different ages using body parts in the absence of a scale. According to Groesbeck (2003) the use of linear body measurements (LBMs) is very important because it reduces scale set up and tear down time. Unfortunately, reports on the estimation of body weight of grasscutters using linear measurements are scanty. This research was carried out to establish the relationships that exist between some LBMs and body weight. Body weight was also predicted using these selected body parts.

Materials and methods

Research site

This study was carried out at a grasscutter research farm located in Calabar. Calabar is located at latitude of 4.9517^0 and longitude 8.322^0 with an elevation above sea level of 99 metres. The annual rainfall range from 3000 – 3500mm and the average daily temperature is 25^0 C/77^0 F. Wind speed/direction is 8.1km/h west and the cloud is broken at 1000ft with little cumulonimbus at 2200ft. The time zone in Calabar is Africa/Lagos (Google Earth, 2014).

Experimental animals and management procedure

The data for this study were obtained from 139 (105 males and 34 females) grasscutters obtained from 24 parents comprising of 18 does and 6 bucks. Animals were fed *ad libitum* on formulated ration of 24% crude protein and 2340kcal/kg metabolizable energy (Table 1) and *Pennisetum purpureum*. Fresh water was provided daily throughout the experimental period of 20 weeks.

Data collection

Body weights were taken on individual animal using a top loader (5kg) weighing scale while body measurements were taken using measuring tape. Description of body measurements taken are as follows:

Head length (HL): measured from the nose to the junction of the head and neck

Body length (BL): measured as the length of the animals back from the shoulder to the pin bone (dorsal curvature taken into consideration).

Heart girth (HG): measured as body circumference just behind the fore leg,

Ear length (EL): measured as the distance from the point of attachment of the ear to the head to the tip of the ear.

Tail length (TL): measured from the junction of the hip to the apex of the tail.

Statistical analysis

The simple linear correlation procedure of SAS (1999) was used to establish the strength of linear relationship and associations between the different LBMs together with body weight using the model:

$$r = \frac{XY - (X)(Y)/n}{X^2 - (X)^2/n \quad Y^2 - (Y)^2/n}$$

Where

Table 1. Gross composition of growers' experimental diet (g)

Ingredients	Diet(g/100g)
Maize	36.50
Soya bean meal	34.00
Palm kernel cake	10.00
Wheat offal	15.00
Salt	0.50
*Vitamin premix	0.50
Bone meal	3.00
Lysine	0.30
Methionine	0.20
Total	100.00
Calculated nutrient composition (%)	
Crude protein	24.00
Crude fibre	8.14
ME(Kcal/kg)	2340.00

*vitamin premix supplied the following additional micronutrients: vitamins A: 10,000u;vit.D_3 20,000iu; Vit.E 25g; Vit. 2.5 g; Vit.B_1 3g; Vit.B_2 6g; Niacin, 55g; Calciumpenthothenate, 11.5g; Vit.$B_6$5; Vit. B_{12}, 0.75g; Cholinechloride, 250g; folicacid, 1g; Biotin, 0.05g; Mn., 46g; Fe, 32g; Zn, 40g; Cu, 8g; Iodine, 0.8g; Co., 0.4g; Se., 0.6g; Riboflavin 5g; DL-methionine 50g; L-lysine, 120g; Sipramycin, 5g; antioxidant (IITH) 120g

Table 2. Simple correlations of body weight and LBMs of grasscutter pups at 2 weeks

	BWT	HL	BL	HG	EL	TL
BWT	1.000					
HL	0.837**	1.000				
BL	0.849**	0.874**	1.000			
HG	0.751**	0.728**	0.849**	1.000		
EL	0.551**	0.638**	0.648**	0.601**	1.000	
TL	0.827**	0.818**	0.890**	0.692**	0.661* *	1.000

Where; **BWT** - Body weight; **HL** - Head length; **BL** - Body weight; **HG** - Heart girth; **EL** – Ear length; **TL** – Tail length
** $P < 0.01$

Table 3. Simple correlations of body weight and LBMs of grasscutter pups at 4 weeks

	BWT	HL	BL	HG	EL	TL
BWT	1.000					
HL	0.604**	1.000				
BL	0.818**	0.563**	1.000			
HG	0.559**	0.283	0.387	1.000		
EL	0.613**	0.829**	0.673**	0.013	1.000	
TL	0.562**	0.369	0.243	0.440*	0.291	1.000

Where; **BWT** - Body weight; **HL** - Head length; **BL** - Body weight; **HG** - Heart girth; **EL** – Ear length; **TL** – Tail length
** $P < 0.01$; *$P < 0.05$

r = correlation coefficient

X = the first random variable of an LBM or bodyweight

Y = the second random variable of an LBM or bodyweight

Linear body measurements were subjected to stepwise multiple regression analysis. The goodness of fit (R^2) was tested to determine the contribution of each independent variable measured to the prediction of the dependent variable body weight of the grasscutter at different ages.

Results and Discussion

The results of correlation analysis are presented in Tables 2, 3 and 4 for weeks two, four and six, respectively. At two weeks of age correlation coefficients of linear body measurements to one another and to body weights were positive and highly significant. Values obtained at this age ranged from 0.551 (between body weight and ear length) to 0.890 (between body length and tail length). The implication of this finding is that, as the animal grows, other parts are growing concurrently. This result also showed significant degrees of linear association between linear body measurements and body weights at two weeks of age for grasscutters. This result supports the fact that young animals show faster development of skeletal framework and other growth indicators than older ones. At week four, correlation coefficients between head length and heart girth, head length and tail length, body length and heart girth, body length and tail length, heart girth and ear length, ear length and tail length were neither high nor significant (Table 3). Results showed that coefficients were low between heart girth and ear length (0.013), body length and tail length (0.243), head length and heart length (0.283) and ear length and tail length (0.291). Higher coefficients were obtained between head length and ear length (0.829) and also between body weight and body length (0.818).

The low correlation coefficients observed in this study could be attributed to the growth rate of the smaller body parts in relation to the larger parts. In addition to this, a few of these parts such as lengths of the ear and head were observed to remain constant for some weeks consecutively. The high correlation value observed between

Table 4. Simple correlations of body weight and LBMs of grasscutter pups at 6 weeks

	BWT	HL	BL	HG	EL	TL
BWT	1.000					
HL	0.651**	1.000				
BL	0.859**	0.439	1.000			
HG	- 0.230	-0.535*	0.058	1.000		
EL	0.405	0.011	0.446	0.367	1.000	
TL	0.783**	0.360	0.781**	0.102	0.727**	1.000

Where; **BWT** - Body weight; **HL** - Head length; **BL** - Body weight; **HG** - Heart girth; **EL** – Ear length; **TL** – Tail length

** $P < 0.01$; * $P < 0.05$

head length and ear length could be as a result of the proportionate growth between these body parts in relation to the young age of the animal. For body weight and body length of grasscutters, the value obtained indicated that there is concurrent growth between these parts.

At week six, relationship between fewer traits recorded highly ($P < 0.01$) significant values (Table 4). Correlation coefficients ranged from -0.230 to 0.859. Negative correlations were observed between body weight and heart girth (-0.230) and between head length and heart girth (-0.536). The negative value obtained between body weight and heart girth could be indicative of the fact that both traits did not increase concurrently at this age. More so, the negative but significant correlation observed between head length and heart girth indicated that growth rate between both traits are disproportionate. This may be due to the genetic ceiling for some traits such as head length in relation to the age of grasscutters and in relation to other body parts. Overall results revealed that correlation coefficients for different linear body measurements and body weights at different ages varied in this study. The variations in these values with age may be due to various factors such as sire, dam, season and sex effects (Adebambo *et al.*, 1999); sex and litter size (Ikpeze and Ebenebe, 2004) and strain (Akanno and Ibe, 2006), although all these were not considered in this research. However, variations is the function best describing live body weight and body measurements relationship in this study which could be associated with differences in the maturing pattern of the different body parts.

The regression coefficient associated with independent variables x and partially representing the amount of change in y for each unit change in x had a positive value in the relationship between body weight, body measurements and age (Table 5) . This showed that age directly influenced changes in body weight and linear measurements. The positive values for regression coefficient could indicate that the measured variables increase with increase in age. The coefficients of determination (R^2) were highly ($P< 0.01$) significant for all traits measured at two, four and six weeks of age. These values explained the changes in body weights and linear body measurements accounted for by the changes in age. At two weeks of age, 99.7% of the variation in body weight was explained by age. This value was relatively higher than the values obtained at 4 and 6 weeks of age. For linear body measurements observed at the same age, results showed that 96.6% variation of head length was explained by age. The R^2 value for head length was relatively higher when compared to other body parts at two weeks of age.

The magnitude of the coefficients of determination for linear body measurements ranged from 0.965 to 0.989 at week four and from 0.912 to 0.991 at week 6. These values were observed to decrease from the 4th to 6th week. At four weeks, the R^2 values for head length and body length was 0.971. Similar observations were obtained at the same week for heart girth and ear length in which their values were 0.980. These results showed that growth rate was similar within these traits at this age. Results of this study have also shown that variations in body weight and linear body measurements which could not be explained by age were very minimal. Therefore, body weight and the measured body parts increased with increase in age of grasscutters but at different rates.

The stepwise regression method where the

Table 5. Regression equation relating body weight and body measurements of grasscutters to age at 2, 4 and 6 weeks

Age (weeks)	Regression equation	R^2	S.E
2	BWT = 89.68 + 67.28Age	0.997***	0.87
	HL = 7.28 + 0.29Age	0.966***	0.01
	BL = 13.28 + 0.83Age	0.965***	0.04
	HG = 12.83 + 0.957 Age	0.957***	0.03
	EL = 2.08 + 0.041Age	0.926***	0.003
	TL = 7.67 + 0.513 Age	0.960***	0.03
4	BWT = 25.15+ 81.12Age	0.989***	1.98
	HL = 7.28 + 0.31Age	0.971***	0.01
	BL = 13.69 + 0.82Age	0.971***	0.03
	HG = 13.08 + 0.59 Age	0.980***	0.02
	EL = 1.95 + 0.054Age	0.980***	0.002
	TL = 8.11 + 0.47 Age	0.965***	0.021
6	BWT = 136.82 + 67.65Age	0.991***	1.56
	HL = 8.22 + 0.23Age	0.912***	0.02
	BL = 14.28 + 0.74Age	0.934***	0.05
	HG = 13.89 + 0.51 Age	0.936***	0.03
	EL = 2.07 + 0.05Age	0.941***	0.003
	TL = 8.35 + 0.43 Age	0.930***	0.03

Where; **BWT** - Body weight; **HL** - Head length; **BL** - Body weight; **HG** - Heart girth; **EL** – Ear length; **TL** – Tail length

independent variables were added one at a time in the order of their reduction of residual sum of squares, was used to determine which linear body measurement or combination of linear measurements was a good estimator of the body weight of growing grasscutters. Regression equations to estimate body weight from body measurements of grasscutters at different ages are presented in Table 6. At two weeks of age, ear length alone was a better estimator of body weight and could fairly explain 54.7% of the variation. Heart girth, on the other hand was a good estimator of body weight of grasscutters at 4 weeks of age. Its R^2 value was highly significant and was observed to explain up to 83.3% of the variation in body weight. In another research on sows, Sulabo *et al.* (2006) reported a very strong association between heart girth and body weight.

At weeks six and twenty, body length estimated body weight better than the other body measurements. It was also observed that the R^2 values at week six (0.833) was more highly significant than the value obtained at week 20 (0.595). This result could be explained from the fact that as the animal grew older, energy may be centred on weight gain than on elongation of the body.

Table 6. Stepwise multiple regression prediction of body weight from linear body measurements of grasscutters

Age (weeks)	Regression equation	R^2	S.E
2	BWT = - 167.748 + 194.344EL	0.547*	66.81
4	BWT = - 914.957 + 82.365HG	0.833**	13.95
6	BWT = - 982.520 + 77.652BL	0.856***	12.03
8	BWT = - 1732.944 + 71.871HL	0.923***	24.34
10	BWT = - 1297.19 + 197.86HL	0.783*	39.35
12	BWT = - 1081.82 + 179.32HL	0.542*	62.25
14	BWT = - 1592.11 + 231.49HL	0.650*	64.26
16	BWT = - 2549.54 + 316.36HL	0.793**	61.04
18	BWT = - 2774.42 + 432.55HG – 478.02HL	0.944*	96.27
20	BWT = - 1772.46 + 116.66 BL	0.595*	36.37

Where; **BWT** - Body weight; **HL** - Head length; **BL** - Body weight; **HG** - Heart girth; **EL** – Ear length

From weeks eight to sixteen, head length alone estimated body weight in growing grasscutters. The R^2 values within this period ranged from 0.542 to 0.923. However, earlier reports on the growth trend of this body part in this study showed that head length increased with age although at a slower rate. This therefore implies that although this body part grows at a slower rate it more likely reflects body weight with respect to the age of the animal and could be used to estimate body weight at these ages. Furthermore, the variation in body weight explained by this body part as revealed in the R^2 values at the different ages supports these results.

In all, it was observed that at 18 weeks of age, the nearest estimators of body weight in growing grasscutters were heart girth and head length because they explained 94.4% of the variations in body weight when combined. This result was not surprising owing to the relationship between these body parts and body weight of this animal. Four (ear length, heart girth, body length and head length) out of the five linear body measurements studied would provide a good estimator for predicting body weight at any of the ages considered.

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