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PATH COEFFICIENT MODEL FOR ASSESSMENT OF WEIGHT USING LINEAR TRAITS AT BIRTH AND AT WEANING IN NIGERIAN INDIGENOUS PIG

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Abstract: Direct and indirect effects of some explanatory variables ((body length (BL), rump height (RH), rump length (RL) , rump width (RW) , shoulder width (SW), wither height (WH), heart girth (HG) and flank length (FL)) influence on live weight at birth and at weaning in Nigerian indigenous pigs, managed under semi intensive system were investigated using path analysis. Results of the analysis indicated that the correlation coefficient between body weight and body length at birth was highest (0.59) while at weaning, rump width had the highest correlation coefficient with body weight (0.60). The relationships were from low to high. The direct effect of linear traits to body weight at birth were highest with wither height and flank length similarly heart girth and rump length had better direct effect on body weight at weaning than other linear traits. The findings show that there is variability in relationship between body weight and linear traits with age, similarly both tissues and bone development play significant role in weight determination in the indigenous pigs. Thus selection for weight increase at adult phase can better be achieved at weaning, providing direction for selection towards increase weight in indigenous pigs.

Keywords: indigenous pig, path coefficient, selection, birth, weaning.

Introduction

Nigeria is estimated to have 4.4 million pigs and about 78% of these are found in the sub humid zones of Northern and southern guinea savannah (*Shaibu et al., 1997*). Most of the pigs are reared in the extensive system and their productivity have been reported to be low (*Okorie, 1978*). Efforts have been directed towards improving their productivity through selection and cross breeding.

Improvement of this animal through selection is important because of the inherent advantages associated with their adaptation.

Body weight is an important component of breed evaluation and plays a significant role in breeding value determination. Many factors are reported to influence body weight in most domestic animals, which include body length, chest girth etc. as reported by *Wu et al. (2008*) in rabbit, *Cankaya et al. (2008*) in calves, *Subalini et al. (2010*) in pigs. These traits have significant and positive correlation with body weight. The relationships between body size and shape of the animals, and different production traits, such as live weight, growth rate, carcass weight, milk yield, and nutritional requirements, have been investigated in different species by several authors (*Heinrichs et al., 1992; Wilson et al., 1997; Radović et al. 2007; Radović et al. 2009*). These relationships are considered an important way to describe growth and development of animals.

Systems of animal can be complex, it can be difficult to isolate causes and effect because each component potentially can influence others through a network of direct and indirect interactions (*Smith et al., 1997; Radović et al. 2009*). A mispecified model therefore can generate a serious bias in the estimation of the coefficient of each independent variable (*Jeonghoon, 2002*). To address this limitation, path analysis could be more suitable. It provide an effective means for finding of direct and indirect causal of association and permit a critical examination of the specific forces acting to produce a given correlation.

The aim of this study was to estimate body weight at birth and at weaning using biometric traits from direct and indirect associations using path analysis with a view to determine the most appropriate age to predict body weight and produce appropriate selection criterion for weight development in Nigerian indigenous pig.

Materials and Methods

The animals used in this experiment were 52 piglets from ten sows raised semi extensively by native farmers in Lafia, Nasarawa State, Nigeria. The data was generated between April and September 2009. The traits measured include body weight (BWT), body length (BL), rump height (RH), rump length (RL), rump width (RW), shoulder width (SW), wither height (WH), heart girth (HG) and flank length (FL) measured at birth period and the same traits measured at six period as described by (*Subalini et al., 2010*).

Statistical analysis

Descriptive statistics of the body weight and linear traits of pigs at birth and at weaning were computed. Pair wise correlation among body weight and linear traits were also determined. Standardized partial regression coefficient called path coefficient (Beta weight) were calculated. The process gives direct comparison of values to reflect the relative importance of independent variables to explain variation in the dependent variable. The path coefficient from an explanatory variable (X) to a response variable (Y) as described by *Mendes et al. (2005)* is shown below

$$P_{yx1} - b_1 \frac{s_{x1}}{s_y}$$

Where

Pyx_1 = path coefficient for X_1 to Y (i=BL, RH, RL, RW, SW, WH, HG and FL)

b_1= partial regression coefficient

S_{X1}= standardized deviation of x_1

S_Y= standardized deviation of Y

The multiple linear regression model adopted was

$Y= a+b_1x_1 +b_2x_2 +b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+e$

Where

Y= endogenous variable (body weight)

a= intercept

b= regression coefficients

xi= exogenous variable,(BL, RH, RL, RW, SW, WH, HG and FL)

e= error term normally distributed with mean zero and variance

The significance of each path coefficient in the multiple linear regression model was tested by t-statistics using the following model.

The indirect effect of x_1 on y through x_j were calculated as follows

$IE_{yx\,i} = r_{xixj}p_{yxj}$

Where

IE_{yxi}= The direct effect of x_1 via x_j on y

$r_{xixj=}$ correlation coefficient between ith and jth independent variables.

p_{yxj}= path coefficient that indicates the direct effect of jth independent (exogenous) variable on the dependent (endogenous) variable.

Results and Discussion

The basic data of the indigenous pig at birth and at weaning are presented in Table1. The mean birth weight and weaning weight obtained here are higher than what *Ncube et al .(2003*) obtained for local pig genotype in Zimbabwe (0.97) and (4.17), but the birth weight in this study is comparable to that of local pigs of Mexico (1.32) as reported by *Mota et al. (2003*) with a superior weaning weight of (9.49). Other linear traits are similar to what was reported by (*Na-Lampang, 2010* and *Subalini et al., 2010*). The coefficient of variation for all the traits were generally low to moderate, this could be due to homogeneity of the population. Phenotypic correlations displaying the relationship between body measurements at birth and at weaning are given in Table 2. The highest correlation was predicted between rump height at birth and body length at weaning (0.814) while the lowest correlation was between body length at birth and rump height at weaning. There were positive relationship between the body measurements and live weight both at birth and at weaning. The relationship between the body measurement and weight at weaning were generally higher than that at birth. This similar finding was reported by *Cankaya et al. (2008*), who reported that there are variation in live weight determination and is common in animal research and that body measurements such as body length, hearth girth and chest width are reported as important indicators of the live weight in animal growth traits.

Table1. Descriptive statistics of body weight and linear traits of the indigenous pig at birth and at weaning

Trait	Age	Mean±se	Coefficient of Variation
Body weight	Birth	1.34±0.02	9.35
	Weaning	4.49±0.02	3.15
Body length	Birth	23.35±0.25	8.03
	Weaning	25.80±0.26	8.19
Rump height	birth	19.86±0.22	8.25
	Weaning	22.88±0.25	8.69
Rump length	Birth	10.13±0.18	12.91
	Weaning	13.25±0.20	11.92
Rump width	Birth	9.21±0.07	5.79
	Weaning	11.94±0.12	7.85
Shoulder width	Birth	12.25±0.19	11.52
	Weaning	14.25±0.28	10.38
Wither height	Birth	21.20±0.27	9.38
	Weaning	24.58±0.24	7.71
Heart girth	Birth	21.89±0.26	8.93
	Weaning	25.01±0.24	7.67
Flank length	Birth	10.59±0.14	8.93
	Weaning	13.56±0.12	9.42

Table 2. Correlation coefficient between traits at birth (above diagonal) and at weaning below diagonal

	WT	BL	RH	RL	RW	SW	WH	HG	FL
WT		0.59	0.16	0.43	0.58	0.34	0.18	23	0.39
BL	0.57		0.39	0.48	0.54	0.56	0.56	0.49	0.57
RH	0.32	0.52		0.1	-0.1	0.12	-0.2	-0.24	-0.26
RL	0.39	0.25	0.25		0.42	0.6	0.11	0.06	0.25
RW	0.6	0.5	0.11	0.39		0.6	0.55	0.56	0.74
SW	0.51	0.32	0.19	0.58	0.24		0.36	0.37	0.62
WH	0.36	0.6	0.25	0.1	0.37	0.23		0.94	0.87
HG	0.4	0.45	-0.26	-.03	0.41	0.13	0.77		0.92
FL	0.43	0.44	-0.29	-.10	0.39	0.35	0.6	0.82	

Bodyweight = WT, body length =BL, rump height = RH, rump length = RL, rump width = RW, shoulder width =SW, wither height = WH, hearth girth = HG, flank length = FL

The results of the path coefficient analysis of the independent variables at birth and at weaning are presented in Table 3 and 4. Path analysis permits the partitioning of correlation coefficient into component parts. The first component is the path coefficient (beta weight) that measures the direct effect of the predictor variables on the response variable. The second component estimates the effect of the predictor variable on the response variable through other predictor variable (indirect effect) (*Yakubu and Salako, 2009*). At birth both body length and rump width had moderate and positive correlation to body weight, but only body length had significant (P<0.05) direct effect on body weight. The indirect effect was 0.831 via flank length. Although wither height and flank length show high and positive direct effect on body weight, the estimate was outside the normal range.

Table 3. Analysis of direct and indirect effect of traits at birth

Traits	Correlation coeff.	Direct effect	Indirect effects							
			BL	RH	RL	RW	SW	WH	HG	FL
BL	0.59	0.44		0.122	0.13	0.158	-0.2	0.683	0.966	0.831
RH	0.16	0.318	0.172		0.03	0.169	-0.7	0.154	-0.26	0.192
RL	0.43	0.272	0.213	0.03		0.123	-0.1	0.13	0.039	0.358
RW	0.58	0.296	0.239	0.191	0.11		-0.1	0.664	0.53	1.257
SW	0.34	-0.718	0.251	0.005	0.16	0.175		0.439	0.347	0.907
WH	0.18	1.217	0.25	0.255	0.03	0.162	-0.4		0.99	1.259
HG	0.23	-0.025	0.219	0.081	0.02	0.164	-0.3	1.138		1.338
FL	0.39	1.456	0.255	0.054	0.07	0.218	-0.1	1.052	0.894	

Bodyweight = WT, body length =BL, rump height = RH, rump length = RL, rump width = RW, shoulder width =SW, wither height = WH, hearth girth = HG, flank length = FL

Table 4. Analysis of direct and indirect effect of traits at weaning

Traits	Correlation coeff.	Direct effect	Indirect effects							
			BL	RH	RL	RW	SW	WH	HG	FL
BL	0.57	-0.191		0.425	0	0.18	0.11	-0.21	0.445	0.059
RH	0.32	0.819	-0.099		0.004	0.012	0.06	-0.55	0.77	-0.166
RL	0.39	0.016	-0.047	0.208	0.139		0.19	-0.7	1.01	0.028
RW	0.6	0.358	-0.096	0.089	0.006	0.076		-0.43	0.419	0.049
SW	0.51	0.325	-0.062	0.152	0.009	0.084	-0.6		0.135	0.043
WH	0.36	-0.802	-0.114	0.205	0.002	0.134	0.07	0.793		0.074
HG	0.4	0.032	-0.086	0.557	0	0.145	0.04	0		0.102
FL	0.43	0.124	-0.083	0.519	-0.01	0.141	0.11	-0.48	0.85	

Bodyweight = WT, body length =BL, rump height = RH, rump length = RL, rump width = RW, shoulder width =SW, wither height = WH, hearth girth = HG, flank length = FL

At weaning the result of path analysis indicate that though body length and rump width had higher and significant correlation with body weight, they had least direct effect on the weight. To the contrary rump height had higher, positive and significant direct effect on weight, while wither height had higher negative (-0.802) effect. The variation in correlation and direct effect of the linear traits to body weight at older age explained what *Alvin et al. (1975)* and *Gurbuz et al. (1999*) asserted that using simple correlation coefficient between traits and explanatory variables may not explain the relationship in all aspect and may be inadequate in investigating the causal effect among the variables.

Conclusion

There are variation in body weight relationship with linear traits with age in the animals studied, this must be attributable to bone and muscle variation in the ages, suggesting the inappropriateness of early evaluation in weight determination.

Model za ocenu težine korišćenjem linearnih osobina na rođenju i zalučenju nigerijske autohtone rase svinja

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Rezime

Direktni i indirektni efekti pojedinih varijabli (dužina tela (BL), visina krsta (RH), dužina krsta (RL), širina krsta (RV), širina plećke (SV), visina grebena

(WH), obim grudi (HG) i dužina slabine (FL) uticaj na živu mase na rođenju i odlučenju nigerijske autohtone rase svinja, u polu intenzivnom sistemu držanja, su ispitivani pomoću analize pravca/puta. Rezultati analize ukazuju da je koeficijent korelacije između telesne težine i dužine tela pri rođenju najviši (0,59), dok je na odbijanja, širina krsta imala najveći koeficijent korelacije sa telesnom težinom (0,60). Odnosi su bili od niskog do visokog. Direktan efekat linearnih osobina na telesnu težinu na rođenju su bili najviši sa visiniom grebena i dužinom slabine, slično tome, obim grudi i dužina krsta imali su bolji direktan uticaj na telesnu težinu na odlučenju od drugih linearnih osobina. Rezultati pokazuju da postoji varijabilnost u odnosu između telesne težine i linearnih osobina sa uzrastom, slično tome, razvoj tkiva i kostiju igra značajnu ulogu u određivanju težine u autohtonih svinja. Tako selekcija na povećanje težine u odrasloj fazi grla se može bolje postići pri odbijanju, pružajući pravac za selekciju na povećanje težine u autohtonih svinja.

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