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Effect of different body measurements on body weight in Ghungroo pigs

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The path coefficient method is used in plant breeding and social science research for analysis of quantitative characters. However, its use in pig breeding remained limited only to estimate the coefficient of relationship and inbreeding coefficient and the information on using this method for analysis of quantitative characters in animal breeding are minimal (Banik and Tomar 2003, Naskar *et al.* 2006a, b). Contemplation has therefore been made in the present investigation to establish the causal association of factors affecting pre-weaning body weight in Ghungroo pigs by adopting path analysis approach. The path coefficient measures the amount of variation directly caused by the independent variables and the amount of variation of the total variation indirectly caused by the independent variables through other variables. Thus, it tells about the direct and indirect relationship among dependent and independent variables. So, the present investigation was planned to study the effect of different body measurement traits on pre-weaning body weight by path analysis.

The causal component of pre-weaning body weight of selected 264 records of Ghungroo pigs maintained at institute farm from 2007–2010 was considered for present investigation. Piglets were housed with their dam in indoor pens (12.0 ft × 10.0 ft with concrete flooring) varying from 6 to 10 piglets/pen. Water was available *ad lib.* at all times. Creep ration (maize-56.5 parts, wheat bran-10.0 parts, soybean meal-12.0 parts, groundnut cake-19.0 parts, mineral mixture–2.0 parts, and salt–0.5 parts) of 20% CP and 2779 Kcal/ kg were offered to them from 15th day @ 20g / piglet till weaning. The creep ration was increased @ 20 g/ piglet to consume 120 g creep ration / piglet at the time of weaning at 8 week.

Body measurement traits including body weight of all the piglets were recorded. The records of 151 male and 113 female pigs were studied to find out the direct and indirect effect of different components, viz. heart girth (circumference around barrel behind forelegs), paunch girth (circumference around barrel before hind legs), height at shoulder (ground to point of shoulder), height at back (ground to point of pin bone), height at fore leg (ground to barrel at fore leg), height at hind leg (ground to barrel at hind leg), and body length (point of wither to starting point of tail) on pre-weaning body weight of piglets by path analysis method (Wright 1921, Singh and Choudhary 1977 and Tomar 2000). The correlation coefficients among the traits were estimated following Snedecor and Cochran (1994). A set of simultaneous equation was set up and analysed by matrix analyses to determine the effect of various factors on body weight. The contribution of each independent factor was derived by determining the coefficient of determination, which is square of path coefficient values of corresponding factors.

To know the direct and indirect effects of various independent variables on the body weight, the method of the path coefficients analysis was used. Path effects were obtained by solving the simultaneous equations setup for the purpose using the correlation matrix. Considering x_i independent variable to be influencing the dependent variable Y, the simultaneous equation would be:

$$rX_iY = PYX_i + \sum_{j=1}^{n} rX_iX_j \times PYX_i \quad for,\ i = 1, 2, 3, \text{----}\ n$$

where: r_{XiY} is the correlation coefficient of x_i with Y; P_{YX_i} is the direct effect of ith variable $\sum_{j=1}^{n} rX_iX_j \times PYX_i$ is the indirect effect ith variable through jth variable. By solving the equations in matrix method for all the correlated characters the direct and indirect effects were determined.

The overall mean body weight, heart girth, paunch girth, height at shoulder, height at back, height at fore leg, height at back leg, body length and respective traits are presented in Table 1. The sex of the animals did not show any significant difference in body measurement traits. The correlation coefficient of different body measurement traits (Table 2)

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Table 1. Different body measurement traits of pre-weaned Ghungroo pigs

Traits	Male (151)	Female (113)	Overall (164)
Body weight (kg)	3.84±0.19	3.41±0.21	3.66±0.14
Heart girth (cm)	32.05±0.70	31.12±0.82	31.65±0.53
Paunch girth (cm)	27.41±0.67	26.41±0.79	26.98±0.51
Height at shoulder (cm)	22.27±0.45	22.12±0.55	22.21±0.35
Height at back (cm)	22.11±0.43	21.72±0.51	21.94±0.33
Height at fore leg (cm)	15.72±0.29	15.23±0.35	15.51±0.23
Height at back leg (cm)	15.68±0.29	15.17±0.35	15.46±0.22
Body length (cm)	32.34±0.76	31.46±0.88	31.96±0.57

Figures in the parentheses show the number of observations.

showed high correlation among themselves for male, female and overall observations.

The perusal of path coefficient analysis is presented in Table 3. The heart girth contributed 81.9% for pre-weaning body weight of the animals for overall data. But the direct effect of heart girth was very small, only to the extent of 6.60%. The indirect effects of heart girth through body length and height at foreleg were higher and amounted to 18 and 17%, respectively. The effect of heart girth via others traits are negligible except through height at hind leg which showed negative effect. Similar trend was observed for male and female animals when analysed individually.

The effect of paunch girth towards pre-weaning body weight showed high total effect up to 79.7% for overall data but its direct effect was meager (5.80%). The indirect effects of paunch girth via height at foreleg and body length ware moderately high. Paunch girth affected body weight negatively via height at hind leg. Its effect through other traits was negligible. Male and female animals also showed similar type of effect for this trait.

Height at shoulder affected body weight to the extent of 70.45% but its direct effect was negligible. The high correlation between these 2 traits was due to higher indirect effect through height at fore leg and body length. Its effect via height at hind leg was negative for overall as well as separately for male and female animals.

Total effect of height at back on pre-weaning body weight was high (76.5%) but its direct effect was very less up to 2.20% only for overall data. Higher total effect was attributed to indirect effects via height at fore leg and body length. Its effect via height at back leg was negative. Indirect effects of height at back on body weight via other traits were moderate.

Height at fore leg had high correlation with pre-weaning body weight and total effect was up to the extent of 76.28% out of which the direct effect was most important. The direct effect was observed as 20.98% for the overall observation. This trait also affected moderately via body length to the body weight (16.34%). The indirect effect was negative via height at hind leg. Indirect effect through other traits on body weight was negligible.

Although height at hind leg had high positive correlation with body weight (74.04%), interestingly its direct effect was negative to the extent of 28.77% for overall observations. The higher total effect was mainly due to highly positive indirect effect via height at foreleg (20.33%) and body length (16.23%). Other traits showed very small indirect effect.

The effect of body length was very high on body weight

Table 2. Correlation coefficient among different body measurement traits with body weight

Traits	Body weight	Heart Girth	Paunch girth	Height at shoulder	Height at back	Height at fore leg	Height at hind leg	Body length
Male and female animals								
Body weight	1	0.9077	0.8867	0.8613	0.8831	0.8636	0.8549	0.9128
Heart girth	0.9026	1	0.9699	0.8959	0.9301	0.9348	0.9383	0.9465
Paunch girth	0.9012	0.9661	1	0.8705	0.9036	0.9038	0.9102	0.9109
Height at shoulder	0.8190	0.8403	0.8582	1	0.9530	0.8929	0.8959	0.9242
Height at back	0.8663	0.9105	0.9115	0.9650	1	0.9372	0.9414	0.9399
Height at fore leg	0.8861	0.9347	0.9231	0.9136	0.9482	1	0.9851	0.9146
Height at hind leg	0.8671	0.9422	0.9343	0.9151	0.9544	0.9836	1	0.9146
Body length	0.9039	0.9371	0.9248	0.9188	0.9387	0.9359	0.9284	1
Upper and lower diagonal values represents male and female animals, respectively								
Overall (*male + female*)								
Body weight	1							
Heart girth	0.9051	1						
Paunch girth	0.8927	0.9683	1					
Height at shoulder	0.8394	0.8702	0.8639	1				
Height at back	0.8748	0.9216	0.9070	0.9579	1			
Height at fore leg	0.8734	0.9348	0.9124	0.9012	0.9418	1		
Height at hind leg	0.8605	0.9399	0.9209	0.9032	0.9467	0.9844	1	
Body length	0.9084	0.9425	0.9171	0.9210	0.9394	0.9238	0.9204	1

Table 3. Direct and indirect effects of correlated characters on pre-weaning body weight

Direct and indirect effects				Male	Female	Overall
Heart girth and body weight						
Total effect (direct + indirect)	=	r_{YX1}	=	0.9077	0.9026	0.9051
Direct effect	=	P_{YX1}	=	0.287	0.1831	0.2573
Indirect effect via paunch girth	=	$P_{YX2}\ r_{X1X2}$	=	0.1676	0.3431	0.234
Indirect effect via height at shoulder	=	$P_{YX3}\ r_{X1X3}$	=	0.0164	–0.1277	–0.0507
Indirect effect via height at back	=	$P_{YX4}r_{X1X4}$	=	0.1275	0.1766	0.1367
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X1X5}$	=	0.3049	0.6292	0.4281
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X1X6}$	=	–0.4291	–0.6563	–0.5128
Indirect effect via body length	=	$P_{YX7}\ r_{X1X7}$	=	0.4334	0.3546	0.4125
Pounch girth and body weight						
Total effect (direct + indirect)	=	r_{YX2}	=	0.8867	0.9012	0.8927
Direct effect	=	P_{YX2}	=	0.1728	0.3551	0.2416
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X2}$	=	0.2783	0.1769	0.2492
Indirect effect via height at shoulder	=	$P_{YX3}\ r_{X2X3}$	=	0.0159	–0.1304	–0.0503
Indirect effect via height at back	=	$P_{YX4}r_{X2X4}$	=	0.1239	0.179	0.1354
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X2X5}$	=	0.2948	0.6214	0.4179
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X2X6}$	=	–0.4162	–0.6508	–0.5025
Indirect effect via body length	=	$P_{YX7}\ r_{X2X7}$	=	0.4172	0.35	0.4014
Height at shoulder and body weight						
Total effect (direct + indirect)	=	r_{YX3}	=	0.8613	0.819	0.8394
Direct effect	=	P_{YX3}	=	0.0183	–0.152	–0.0583
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X3}$	=	0.2571	0.1538	0.2239
Indirect effect via paunch girth	=	$P_{YX2}\ r_{X2X3}$	=	0.1505	0.3048	0.2087
Indirect effect via height at back	=	$P_{YX4}r_{X3X4}$	=	0.1306	0.1871	0.1421
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X3X5}$	=	0.2913	0.615	0.4127
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X3X6}$	=	–0.4097	–0.6374	–0.4928
Indirect effect via body length	=	$P_{YX7}\ r_{X3X7}$	=	0.4232	0.3477	0.4031
Height at back and body weight						
Total effect (direct + indirect)	=	r_{YX4}	=	0.8831	0.8663	0.8748
Direct effect	=	P_{YX4}	=	0.137	0.1939	0.1484
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X4}$	=	0.2669	0.1667	0.2371
Indirect effect via paunch girth	=	$P_{YX2}\ r_{X2X4}$	=	0.1562	0.3237	0.2192
Indirect effect via height at shoulder	=	$P_{YX3}r_{X3X4}$	=	0.0174	–0.1467	–0.0558
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X4X5}$	=	0.3057	0.6383	0.4313
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X4X6}$	=	–0.4305	–0.6648	–0.5165
Indirect effect via body length	=	$P_{YX7}\ r_{X4X7}$	=	0.4304	0.3552	0.4111
Height at fore leg and body weight						
Total effect (direct + indirect)	=	r_{YX5}	=	0.8636	0.8861	0.8734
Direct effect	=	P_{YX5}	=	0.3262	0.6732	0.458
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X5}$	=	0.2682	0.1711	0.2405
Indirect effect via pounch girth	=	$P_{YX2}\ r_{X2X5}$	=	0.1562	0.3278	0.2205
Indirect effect via height at shoulder	=	$P_{YX3}r_{X3X5}$	=	0.0163	–0.1389	–0.0525
Indirect effect via height at back	=	$P_{YX4}\ r_{X4X5}$	=	0.1284	0.1839	0.1397
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X5X6}$	=	–0.4505	–0.6851	–0.5371
Indirect effect via body length	=	$P_{YX7}\ r_{X5X7}$	=	0.4188	0.3541	0.4043
Height at hind leg and body weight						
Total effect (direct + indirect)	=	r_{YX6}	=	0.8549	0.8671	0.8605
Direct effect	=	P_{YX6}	=	–0.4573	–0.6966	–0.5456
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X6}$	=	0.2693	0.1725	0.2419
Indirect effect via pounch girth	=	$P_{YX2}\ r_{X2X6}$	=	0.1573	0.3318	0.2225
Indirect effect via height at shoulder	=	$P_{YX3}r_{X3X6}$	=	0.0164	–0.1391	–0.0526
Indirect effect via height at back	=	$P_{YX4}\ r_{X4X6}$	=	0.129	0.1851	0.1405
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X5X6}$	=	0.3213	0.6621	0.4509
Indirect effect via body length	=	$P_{YX7}\ r_{X5X7}$	=	0.4189	0.3513	0.4029
Body length and body weight						
Total effect (direct + indirect)	=	r_{YX7}	=	0.9128	0.9039	0.9084
Direct effect	=	P_{YX7}	=	0.458	0.3784	0.4377
Indirect effect via heart girth	=	$P_{YX1}\ r_{X1X7}$	=	0.2716	0.1715	0.2425
Indirect effect via paunch girth	=	$P_{YX2}\ r_{X2X7}$	=	0.1574	0.3284	0.2216
Indirect effect via height at shoulder	=	$P_{YX3}r_{X3X7}$	=	0.0169	-0.1397	-0.0537
Indirect effect via height at back	=	$P_{YX4}\ r_{X4X7}$	=	0.1288	0.182	0.1394
Indirect effect via height at fore leg	=	$P_{YX5}\ r_{X5X7}$	=	0.2983	0.63	0.4231
Indirect effect via height at hind leg	=	$P_{YX6}\ r_{X6X7}$	=	-0.4182	-0.6467	-0.5022
Residual effect			=	0.1613	0.3039	0.2641

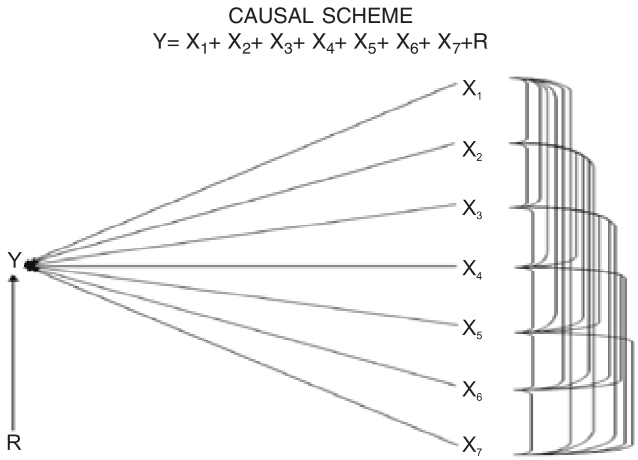

Fig. 1. Path diagram of pre-weaning body weight and correlated characters. Y, Body weight; X_1, heart girth; X_2, paunch girth; X_3, height at shoulder; X_4, height at back; X_5, height at fore leg; X_6, height at hind leg; X_7, body length; R, residual effect.

to the extent of 82.52% and it contributed primarily through its direct effect (19.15%) for overall data. Its effect via height at foreleg was also high (17.90%). Indirect effects via heart girth and paunch girth ware observed to be moderate. Its indirect effect through height at hind leg was negative for both the sex as well as overall data.

The residual effect determines the amount of unexplained variation. It was 0.2641 for overall data, suggesting that nearly 73.5% variation of preweaning bodyweight was explained by the variables considered in the model. For male and female sex, almost 83 and 69% variation was explained by this model, respectively.

The path analysis of pre-weaning body weight of Ghungroo pigs showed that maximum variability in it was explained by height at foreleg (20.98%), followed by body length (19.50%), heart girth (6.60%) and paunch girth (5.80%) (Fig. 1). Though there was high correlation of height at hind leg with body weight, but its direct effect was negative. The path analysis also showed that the effect of height at shoulder was negligible. From the present study, it was concluded that among different body measurement traits to explain the pre-weaning bodyweight of Ghungroo pigs, major importance is to be given to height at fore leg, body length, heart girth and paunch girth and subsequently these traits may be used for construction of selection index.

SUMMARY

The present investigation was carried out to study the effect of different body measurement traits on pre-weaning body weight of 264 records of Ghungroo pigs maintained at the Institute Farm of National Research Centre on Pig, Guwahati, Assam by path analysis. The result showed that maximum variability in pre-weaning body weight was explained by height at fore leg (20.98%); followed by body length (19.50%), heart girth (6.60%) and paunch girth (5.80%). Though there is high correlation of height at hind leg with body weight, but its direct effect is negative. Effect of height at shoulder is also negligible. It was concluded from the present study, that among different body measurement traits to explain the pre-weaning body weight of Ghungroo pigs major importance is to be given to height at fore leg, body length, heart and paunch girth.

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