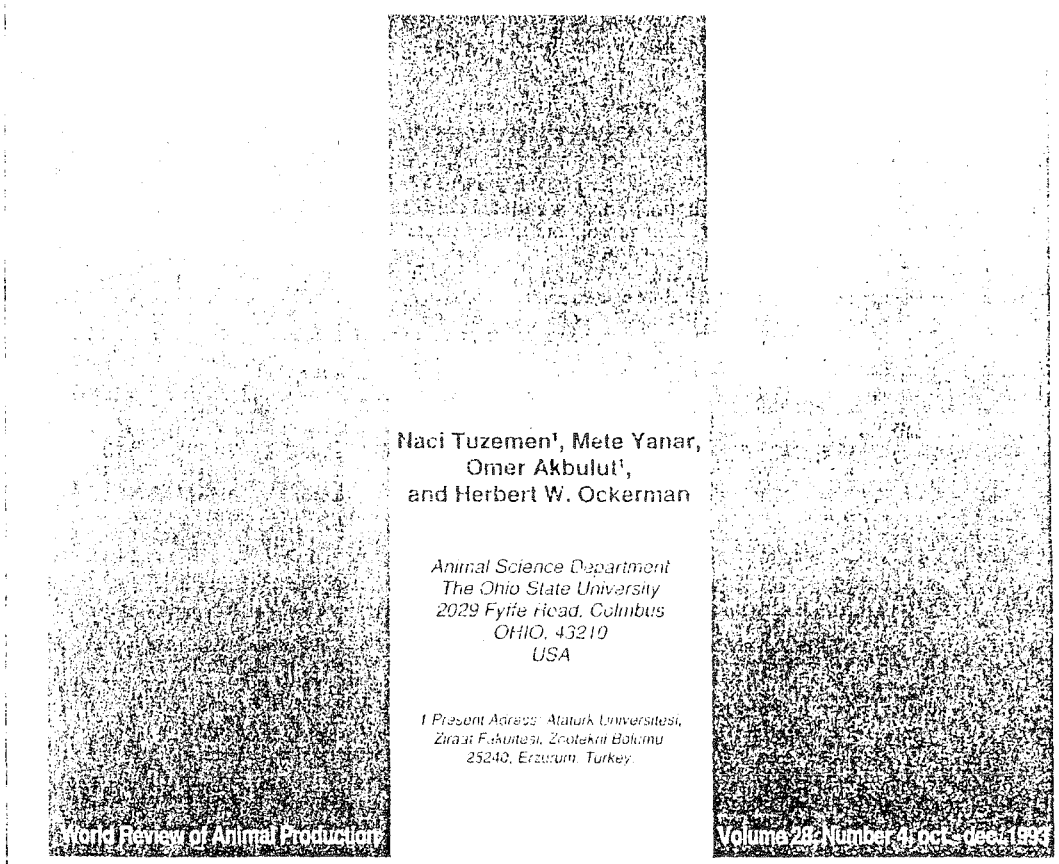
Prediction of Body Weights from Body Measurements in Brown Swiss Calves Reared in the Eastern Region of Turkey



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Introduction

Knowing the body weight of calves is important for various management practices such as determination of the amount of milk to be fed based on birth weight, selection of culled calves according to their body conformation etc. Body weights can be accurately obtained by using weigh-bridges (platform scales), but these facilities are not generally available even in the large dairy farms located in the eastern region of Turkey. Hence, the body weights of calves at different ages have to be predicted by utilizing body measurements.

The present study was undertaken to develop prediction equations for predicting body weight through body measurements at birth, 4 and 6 months of ages.

Material and methods

In this study, seventy-one Brown Swiss calves born on the Research Farm of The College of Agriculture at Ataturk University, Turkey, were used. The calves were born in winter (between December and March). They were housed in a building furnished with individual pens during 6 months and fed milk using milk buckets.

Besides milk, high quality dried hay and a commercial calf starter feed produced by the Turkish Feed Industry Inc. were available in self feeders throughout this research.

Body measurements such as body length (from point of shoulder to the point of tuber ischi), height at withers (from base of hoof to highest point of the wither), hearth girth (circumference of the thoracic cavity immediately behind the fore limbs) and chest depth (from sternum area immediately caudal to the fore limbs to top of the thoracic vertebra area) were measured within 24 hours after the calves were born, and at 4, 6 months of age. A tape measure was utilized for measuring chest girth. Other body measurements were obtained using large calipers. The body weights were also determined immediately after the body measurements were taken.

A stepwise regression method was employed to determine the best combination of body measurements in order to explain the maximum variation in body weight. The overall fit of each equation was determined by the R^2 estimate (Coefficient of Determination), a higher R^2 indicating a better fit. The statistical evaluations were performed by using the SAS statistics program (SAS, 1985).

Table 1. – Prediction Equations for Birth Weight of Male calves

Prediction Equations	Partial Regression Coefficients					
	a	CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 79.067	1.078	– 0.103	0.701	– 0.279	75.2
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	– 78.674	1.033	– 0.176	0.706	–	75.0
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 57.839	1.229	0.210	–	– 0.343	67.3
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 79.642	1.079	–	0.658	0.401	75.1
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 55.960	–	0.126	1.047	0.965	47.3
$Y = a + b_1 X_1 + b_2 X_2$	– 57.158	1.175	0.123	–	–	66.9
$Y = a + b_1 X_1 + b_3 X_3$	– 79.680	0.987	–	0.605	–	74.3
$Y = a + b_1 X_1 + b_4 X_4$	– 53.130	1.248	–	–	0.047	66.5
$Y = a + b_2 X_2 + b_3 X_3$	– 53.543	–	0.181	1.086	–	43.4
$Y = a + b_2 X_2 + b_4 X_4$	– 16.665	–	0.371	–	1.143	28.2
$Y = a + b_3 X_3 + b_4 X_4$	– 56.631	–	–	0.995	0.817	40.7
$Y = a + b_1 X_1$	– 53.404	1.235	–	–	–	69.5
$Y = a + b_2 X_2$	– 12.048	–	0.760	–	–	22.8
$Y = a + b_3 X_3$	– 51.171	–	–	1.219		42.6
$Y = a + b_4 X_4$	– 7.082	–	–	–	1.715	25.6

Y: Predicted Birth Weight in kg. a: Constant (Intercept). CG: Chest Girth. BL: Body Length. HW: Height at Withers. CD: Chest Depth

Table 2. – Prediction Equations for Birth Weight of Female Calves

Prediction Equations	Partial Regression Coefficients a	CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	60.010	0.785	0.235	0.513	– 0.580	77.4
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	58.710	0.769	0.064	0.453	–	76.4
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 57.107	1.043	0.294	–	– 0.169	71.9
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 56.891	0.816	–	0.529	– 0.246	76.6
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 46.520	–	0.406	0.908	0.413	64.6
$Y = a + b_1 X_1 + b_2 X_2$	– 56.800	1.028	0.237	–	–	71.8
$Y = a + b_1 X_1 + b_3 X_3$	– 57.597	0.788	–	0.477	–	76.4
$Y = a + b_1 X_1 + b_4 X_4$	– 53.052	1.094	–	–	0.269	70.8
$Y = a + b_2 X_2 + b_3 X_3$	– 45.790	–	0.281	0.860	–	64.1
$Y = a + b_2 X_2 + b_4 X_4$	– 29.086	–	0.679	–	0.694	41.6
$Y = a + b_3 X_3 + b_4 X_4$	– 39.997	–	–	0.966	0.194	62.4
$Y = a + b_1 X_1$	– 51.550	1.170	–	–	–	70.4
$Y = a + b_2 X_2$	– 28.700	–	0.953	–	–	40.1
$Y = a + b_3 X_3$	– 36.907	–	–	1.023	–	62.2
$Y = a + b_4 X_4$	– 15.721	–	–	–	1.880	35.2

Y: Predicted Birth Weight in kg, a: Constant (Intercept), CG: Chest Girth, BL: Body Length, HW: Height at Withers, CD: Chest Depth

Table 3. – Prediction Equations for 4 Month Weight of Male Calves

Prediction Equations	Partial Regression Coefficients a	CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 190.090	2.230	0.510	0.263	– 0.141	89.7
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	– 190.080	2.210	0.500	0.233	–	89.6
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 185.170	2.296	0.616	–	– 0.094	89.5
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 194.090	2.311	–	0.708	– 0.075	89.0
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 189.550	–	1.030	2.042	0.596	73.5
$Y = a + b_1 X_1 + b_2 X_2$	– 185.546	2.279	0.601	–	–	89.5
$Y = a + b_1 X_1 + b_3 X_3$	– 194.044	2.301	–	0.687	–	89.0
$Y = a + b_1 X_1 + b_4 X_4$	– 177.088	2.654	–	–	0.174	88.2
$Y = a + b_2 X_2 + b_3 X_3$	– 189.550	–	1.090	2.230	–	73.0
$Y = a + b_2 X_2 + b_4 X_4$	– 141.549	–	2.206	–	1.258	68.2
$Y = a + b_3 X_3 + b_4 X_4$	– 197.875	–	–	3.108	0.791	71.1
$Y = a + b_1 X_1$	– 175.954	2.705	–	–	–	88.2
$Y = a + b_2 X_2$	– 131.110	–	2.607	–	–	66.0
$Y = a + b_3 X_3$	– 198.570	–	–	3.450	–	70.3
$Y = a + b_4 X_4$	– 52.460	–	–	–	4.129	40.5

Y: Predicted 4 Month Weight in kg, a: Constant (Intercept), CG: Chest Girth, BL: Body Length, HW: Height at Withers, CD: Chest Depth

Results and discussion

Prediction equations for birth weights of male and female Brown Swiss (BS) calves are presented in tables 1 and 2. Maximum R^2 values of prediction of birth weight of male and female calves were provided when all body measurements were included in the prediction equation. These results are in agreement with finding of Shioya *et al.* (1975), who reported that 77% of variation in the birth weight of Japanese Black calves can be explained using all of the body measurements used in these prediction equations.

As indicated in table 1 and 2, the body length, height at withers, and chest depth caused minor increases when added to chest girth in the R^2 values which implied that these measurements did not add a great deal of additional information necessary to be good predictors for birth weight of male and female calves. However, the chest girth alone produced higher R^2 values than several of the R^2 for equations obtained from double or triple combination of other body measurements. The chest girth accounted for 69.5% and 70.4% of variation in birth weight of male and female BS calves, respectively. These results suggested that when a single body measurement was used for prediction of body weight from a practical standpoint, using chest girth alone would give an acceptably accurate prediction of birth weight. Similar results were reported by Rathi *et al.* (1980), and Jagtap and Kale (1987).

All correlation coefficients between birth weight and body measurements for male and female calves were found to be highly significant ($P < 0.01$). The correlation coefficients with birth weight for male and female calves were 0.815 and 0.839 for chest girth 0.653 and 0.788 for height at withers, and 0.506 and 0.594 for chest depth respectively. The results of Bhalla *et al.* (1967), and Ohh and Yang (1989) were similar to the current findings. These researchers showed that highly significant ($P < 0.01$) correlations between birth weight and body measurements existed in Murrah, Sahiwal and Korean native calves.

Prediction equations for 4 months weights of male and female calves are tabulated and are presented in tables 3 and 4. The highest R^2 value was again provided by the prediction equations which contained all body measurements. Body length, height at withers, and chest depth again did not contribute much additional information to the prediction equation in addition to that supplied by chest girth measurements for prediction of the 4 months weight. However, the chest girth measurements alone from male and female calves provided reasonably high R^2 values (88.2 and 74.5% respectively). These results are in agreement with findings of Rathi (1979), McRae (1986), Jagtap and Kale (1987). The general conclusion that can be drawn from these studies is that chest girth is a good predictor of weight of calves at 4 months of age.

Correlation coefficients with birth weight for male and female BS

Table 4. – Prediction Equations for 4 Month Weight of Female Calves

Prediction Equations	a	Partial Regression Coefficients CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 177.310	1.622	– 0.116	0.696	1.621	78.3
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	– 168.330	1.732	0.019	1.011	–	76.9
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 169.143	1.680	0.099	2.351	–	77.0
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 179.176	1.588	–	0.660	1.568	78.2
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 185.160	–	0.938	1.000	2.970	62.1
$Y = a + b_1 X_1 + b_2 X_2$	– 146.060	1.927	0.525	–	–	73.5
$Y = a + b_1 X_1 + b_3 X_3$	– 167.951	1.738	–	1.020	–	77.0
$Y = a + b_1 X_1 + b_4 X_4$	– 166.971	1.715	–	–	2.437	77.0
$Y = a + b_2 X_2 + b_3 X_3$	– 168.750	–	1.342	1.655	–	57.4
$Y = a + b_2 X_2 + b_4 X_4$	– 173.618	–	1.309	–	4.111	59.4
$Y = a + b_3 X_3 + b_4 X_4$	– 168.326	–	–	1.426	3.775	59.2
$Y = a + b_1 X_1$	– 127.160	2.201	–	–	–	74.5
$Y = a + b_2 X_2$	– 129.570	–	2.496	–	–	47.5
$Y = a + b_3 X_3$	– 134.317	–	–	2.626	–	50.6
$Y = a + b_4 X_4$	– 137.236	–	–	–	6.262	52.5

Y: Predicted 4 Month Weight in kg. a: Constant (Intercept), CG: Chest Girth, BL: Body Length, HW: Height at Withers, CD: Chest Depth

Table 5.– Prediction Equations for 6 Month Weight of Male Calves

Prediction Equations	Partial Regression Coefficients a	CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 222.113	1.680	0.749	0.248	1.663	90.7
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	– 221.597	2.137	0.819	0.363	–	89.9
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 212.122	1.714	0.809	–	1.750	90.6
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 243.042	1.864	–	0.821	2.164	88.2
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 210.876	–	0.926	0.553	4.823	85.4
$Y = a + b_1 X_1 + b_2 X_2$	– 265.593	2.223	0.915	–	–	89.7
$Y = a + b_1 X_1 + b_3 X_3$	– 244.944	2.499	–	1.045	–	86.9
$Y = a + b_1 X_1 + b_4 X_4$	– 209.433	2.058	–	–	2.677	87.1
$Y = a + b_2 X_2 + b_3 X_3$	– 189.447	–	1.630	1.738	–	72.2
$Y = a + b_2 X_2 + b_4 X_4$	– 187.623	–	1.071	–	5.163	84.9
$Y = a + b_3 X_3 + b_4 X_4$	– 235.849	–	–	1.320	5.896	81.5
$Y = a + b_1 X_1$	– 199.782	2.968	–	–	–	86.9
$Y = a + b_2 X_2$	– 97.707	–	2.349	–	–	67.1
$Y = a + b_3 X_3$	– 232.247	–	–	3.923	–	57.8
$Y = a + b_4 X_4$	– 176.815	–	–	–	7.444	78.4

Y: Predicted 6 Month Weight in kg, a: Constant (Intercept), CG: Chest Girth, BL: Body Length, HW: Height at Withers, CD: Chest Depth

Table 6. – Prediction Equations for 6 Month Weight of Female Calves

Prediction Equations	Partial Regression Coefficients a	CG (cm) b_1	BL (cm) b_2	HW (cm) b_3	CD (cm) b_4	R^2 (%)
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 182.000	2.157	– 1.108	– 0.175	4.620	63.9
$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3$	– 175.505	2.472	– 0.640	0.933	–	59.8
$Y = a + b_1 X_1 + b_2 X_2 + b_4 X_4$	– 184.836	2.132	– 1.131	–	4.418	63.8
$Y = a + b_1 X_1 + b_3 X_3 + b_4 X_4$	– 189.552	1.818	–	0.435	3.654	61.8
$Y = a + b_2 X_2 + b_3 X_3 + b_4 X_4$	– 190.327	–	0.145	0.659	6.466	52.7
$Y = a + b_1 X_1 + b_2 X_2$	– 153.790	2.765	– 0.320	–	–	58.7
$Y = a + b_1 X_1 + b_3 X_3$	– 182.023	2.215	–	0.621	–	59.1
$Y = a + b_1 X_1 + b_4 X_4$	– 197.225	1.734	–	–	3.084	61.7
$Y = a + b_2 X_2 + b_3 X_3$	– 183.964	–	0.758	2.486	–	44.3
$Y = a + b_2 X_2 + b_4 X_4$	– 179.392	–	– 0.007	–	7.364	52.3
$Y = a + b_3 X_3 + b_4 X_4$	– 191.273	–	–	0.599	6.276	52.7
$Y = a + b_1 X_1$	– 161.655	2.553	–	–	–	60.0
$Y = a + b_2 X_2$	– 111.503	–	2.372	–	–	34.5
$Y = a + b_3 X_3$	– 176.707	–	–	3.209	–	42.9
$Y = a + b_4 X_4$	– 179.495	–	–	–	7.349	52.3

Y: Predicted 6 Month Weight in kg, a: Constant (Intercept), CG: Chest Girth, BL: Body Length, HW: Height at Withers, CD: Chest Depth

calves were 0.939 and 0.852 for chest girth, 0.812 and 0.689 for body length, 0.838 and 0.712 for height at withers, 0.637 and 0.725 for chest depth. All correlations were statistically significant ($P < 0.01$).

Tables 5 and 6 show the regression equations for 6 months weights of male and female calves. The chest girth alone accounted for 89.9 and 60.0% of the variation in the 6 months weight of male and female calves respectively. These coefficients of determination were very close to the R^2's produced by the equations formed by the combinations of other body measurements. These results are

in agreement with finding of Rao and Nagarcenkar (1979) who reported that R^2 value of chest girth alone ranged from 92.4 to 96.8% in cross-bred calves up to 6 months age. Also, Jagtap and Kale (1987) reported that the prediction of body weight of Gir crosses at 6 month age can be made from chest girth with greater accuracy than from height at withers and body length.

All correlation coefficients between 6 months weight and body measurements were highly significant ($P<0.01$). The correlations with 6 months weight for male and female calves were 0.921 and 0.765 for chest girth, 0.819 and 0.587 for body length, 0.760 and 0.655 for height at withers, 0.885 and 0.723 for chest depth.

The result of the research suggested that birth, 4 and 6 months weights of BS calves reared in the eastern region of Turkey can be predicted satisfactorily on the basis of chest girth measurements.

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