Correlation of actual live weight and estimates of live weights of Camel calves (*Camelus dromedarius*) in Samburu District of Northern Kenya

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Abstract

A study was conducted in Samburu district of northern Kenya in pastoral production systems to develop a formula for estimating the live weight of camel calves. Heart girth (HG), abdominal girth (AG) and shoulder (wither) height (SH) measurements were taken by a tape measure. Also the camel calves were gently suspended on a scale using a sling and the actual live weight measured. Fifty nine (59) camel calves were measured. The abdominal girth and the heart girth had highly significant ($P < 0.01$) correlation coefficient of $r = 0.957$ and $r = 0.934$ respectively than shoulder (wither) height ($r = 0.432$) to the live weight of camel calves. This suggested that the abdominal girth had the greatest influence on live weight of camel calves followed by the heart girth. Shoulder height had the least influence on live weight. However, multiple regression analysis showed that combined effect of HG, AG and SH on the live weight estimates had coefficient of determination R^2 accounting for 92.3% of variation ($P < 0.01$) which was higher than individual and any two combined variables. The formula developed to estimate live weight was; Live body weight (Kg) = - 100.6 + 101.2AG(m) + 58.2 HG(m) + 9.91SH(m).This formula could be used to estimate the live weight of camel calves in pastoral production systems where weighing machines are not available.

Key words: Camel calves, linear body measurements, predicted weight.

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1. Introduction

Live weight measurements is an important management tool which can assess the growth rate and the effect of feeding regime in farm animals (Brown et al., 1973; Kunene et al., 2007). Indication of live weight especially for a growing animal is important in assessing growth rate and for drug administration in determining dosage (Hile et al., 1997; Thiruvenkanden, 2005). Estimation of body weight can be useful in the evaluation of feeding programmes, nutritional status and management practices such as selection of replacement heifers (Dingwell et al., 2006). Body weight information can also be used in determining the value of animals and the efficiency of rearing. It's an important tool in marketing of animals; the farmers can get value for their animals when prices are pegged on the weight. Body measurements are also used in breed identification and classification, a prerequisite for management and conservation of animal genetic resources (Al-Hazni, 1994; Gatesy and Arctander, 2000; Mwacharo et al., 2006). Linear body measurements are useful in estimating the live weight of animals in a less complicated and inexpensive way (Heinrichs et al., 1992; Goe et al., 2001) especially so in a place where weighing machines are not available (Bhadula et al., 1979; Hile et al., 1997; Raji et al., 2008; Cam et al., 2010). The potential of breeding stock may also be assessed through linear body measurements (Luo et al., 1997; Alderson, 1997). According to Rege (2001) and Zechner et al., (2001), breeding goals can also be evaluated by morphological descriptions. There are two categories of linear body measurements, the skeletal and the tissue measurements (Essien and Adesope, 2003; Kunene et al, 2007). Skeletal measurements such as ulna length, body height and length, chest and chest depth better describe inherent characteristics while width, girth and body weight indicate muscle and fat deposition and are nutrition related (Blackmore et al., 1958; Kamalzadeh et al., 1998; Kunene et al., 2007).

Schwartz et al., (1983) developed the linear body measurement equation from mature camels while Simpkin (1998) measured calves but included calves older than one year. Kuria et al., (2007) study was for calves up to seven months. There was only one study for prediction of weight for calves less than one year old in similar pastoral production systems. This is the critical period for assessing the performance of the camel calf. The current study endeavoured to develop a regression equation to predict weight of camel calves up to one year.

2. Materials and Methods

2.1. The study area

Three locations were selected (Opiroi, Barsaloi and Kawop) due to their close resemblance in respect to camel rearing areas and their altitudes within the larger Samburu district. Opiroi is located on the Eastern side of Kirisia hills and is 1500 m.a.s.l, the median annual rainfall is 500 to 600 mm; Barsaloi is on the riverline of Barsaloi lagga and is 1500 m.a.s.l with median annual rainfall of 450 to 500 mm while Kawop is in Albarta plains and is 1200 to 1500 m.a.s.l. with median rainfall of 400 to 450 mm. The three locations were chosen because they are among the camel rearing area within the ASAL-based Livestock and Livelihood Support Project (ALLPRO) working sites. The locations were purposefully selected among the areas the project had activities and are in the lowlands where camels are reared. The sites are the pilot areas for ALLPRO project where Participatory Integrated Community Developments (PICDs) methods identify and prioritize community needs. Some micro- projects are being implemented in the sites. Households were selected from clustered random samples of *manyattas*. Each location had a number of *manyattas* which comprises a number of households. It’s out of these locations the respondents were randomly selected. Selected households within a *manyatta* to be considered required to have had one or more camels with calves. The first two locations are inhabited by the Samburus and the other by the Turkanas.

Samburu are plain nilotes of northern Kenya that are related to but distinct from the Maasai. They are semi nomadic pastoralists who keep mainly cattle but also sheep, goats and of late camels. Camel keeping among the Samburu increased in the last three decades due to increased frequency of droughts (Simpkin, 1995) and interventions of development agencies such as Food and Agricultural Research Management (FARM–Africa) and German and International Development Cooperation (Deutche Gesellschaft fur Technische Zusammenarbeit–GTZ). Milk is a valued part of the Samburu diet when available and is taken fresh or fermented in the guard. Camels are kept mainly for milk though meat from camels is taken in ceremonies or when the animal dies. Meat from small stock is often preferred due to their small size. However, today they have increasingly changed to cereals because of famine relief interventions (Holtzman, 2009). Turkana are also plain nilotic people inhabiting Turkana district and part of Samburu district covered by this study. Turkana are mainly cattle keepers but have acquired camels through intertribal raids with the Gabra and Rendille (Dioli, 1995). They rely on camels for their livelihood and have kept camels longer than Samburu. Turkana take milk meat, milk and blood from camels. Camels are kept to provide milk and blood. Famine interventions have equally influenced their eating habit from the traditional. Samburu way of rearing camels is largely similar to Turkana because they learned from them.

2.2. Instruments and data collected

Randomly selected camel calves were weighed using a Hanson® round spring balance. Fifty nine (59) calves were weighed. These calves were of different age and sex but up to one year old. The age of camel calves were determined from recall information given by the camel owners. The accuracy on the age depends on the camel owners giving the correct information otherwise this is a better way to get information from pastoral communities who do not keep written records. Dental formula is the other alternative but is also limited when the camel calf age is less than a year. The camel calves to be weighed were gently suspended on a scale using a sling and the weight taken. A tape measure (30 m) was used to take the linear body measurements. All measurements were done early in the morning before the calves were fed or taken out to graze, to reduce the error. The linear measurements taken were the shoulder height, the heart girth and abdominal girth of the calves' body.

2.3. Analysis of the data

The linear regression equations of the best fit of the body linear measurements were derived from the data run in Genstat® (VSNI, 2008). The output was fitted into the model which was used to estimate the live weight of camel calves. The estimated live weights were correlated to the actual live weight and coefficient of correlation used to determine the degree of association.

3. Results and Discussion

The general model describing the estimation of live weight through body linear measurements was similar to the one used by Hile et al., (1997), Mwacharo et al., (2006), Alade et al., (2008) and Keith et al., 2009). This model is shown below.

$$Y_i = a + bx_i + \varepsilon_i,$$

Where Y_i = estimated live weight of camel calves

- i= 1.....n observations
- X_i = Independent variables either heart girth, abdominal girth or shoulder height of camel calves
- a= intercept on Y
- b= regression coefficient of Y on x
- ε_i= residual for observation

A descriptive statistics of the linear body measurements and actual live weights generated from this study are shown in Table 1. The mean values were 1.17 ± 0.18 m, 1.32 ± 0.26 m, 1.29 ± 0.18 m, 103.25 ± 39.04 Kg for heart girth (HG), abdominal girth (AG), shoulder height (SH) and live weight (Wt) respectively. Body weight is useful in determining the performance of animals in the farm (Keith et al., 2009) but is often unavailable in the resource poor pastoral communities. Regression of linear body measurements becomes handy in estimating the weight of farm animals (Bhadula et al., 1979, Keith et al., 2009).

Table 1. Descriptive statistics of linear body measurements.

Linear measurement	Number of camel calves	Mean (m)
Heart Girth	59	1.17 ± 0.18
Abdominal Girth	59	1.32 ± 0.26
Shoulder Height	59	1.29 ± 0.18
Live Weight	59	103.25± 39.04

N.B. one time measurement for each animal

A highly significant ($P<0.01$) correlation coefficient of $r = 0.957$ and $r = 0.934$ was found between the live weights of camel calves and the abdominal girth and heart girth respectively except for shoulder height where $r = 0.432$ (Table 2). This suggested that the abdominal girth was the best single weight estimator contrary to Kuria et al., (2007) and Mwacharo et al., (2006) who recorded heart girth. However, the r value for abdominal girth is similar to Kuria et al., (2007). The predictive equation and coefficient of determination (R^2) expressed as a percentage variance for the body weight and estimated using the heart girth (HG), abdominal girth (AG), shoulder height (SH) and a combination of two or three linear body measurement is shown in Table 3. Abdominal girth coefficient of determination R^2 accounts for 91.4%, heart girth 87% and shoulder height 17.2% of the body weight variation respectively. For simple linear regression abdominal girth equation (-73.9 + 142.42x) accounts for a higher percentage of variation and would therefore be a more reliable single predictor of the weight of camel calves but the time when measurements should be taken is critical for accuracy. It should be early in the morning when the animals have not fed to reduce the measurement variability. A multiple regression of abdominal girth and heart girth explains 92.2% of the variation. An addition of shoulder height in the regression causes an insignificant percentage variation (0.1%). The correlation of predicted weights and the actual live weights at $P< 0.01$ was high ($r = 0.963$) for the multiple regression equation (-100.6 + 101.2AG + 58.2 HG + 9.91SH) derived from the three linear body measurements.

Table 2. Correlation coefficients (r) between live body weight, heart girth, abdominal girth and shoulder height of 59 camel calves.

	Body weight	Heart Girth	Abdominal Girth	Shoulder Height
Body weight	1.00	0.934	0.957	0.432
Heart Girth		1.00	0.941	0.421
Abdominal Girth			1.00	0.397
Shoulder Height				1.00

Table 3. The predictive equation and coefficient of determination (R^2) for camel calves body weight using the HG, AG, SH and the combination of the three parameters based on the linear regression analysis.

Parameters	Regression equation	Adjusted R^2	Significance
HG	-113.0 + 197.7HG	0.87	**
AG	-73.9 + 142.42AG	0.91	**
SH	19.8 + 92.4SH	0.17	NS
Combined HG and AG	-92.5 + 101.2AG + 62.3 HG	0.922	**
All three combined (HG, AG, SH)	-100.6 + 101.2AG + 58.2 HG + 9.91SH	0.923	**

** P< 0.01; NS = not significant; n= 59 calves

In order to compare models, projected linear body measurements were fitted into Schwartz et al., (1983), Simpkin (1998), Kuria's et al., (2007) and the ones derived from this study's so as to generate respective growth curves (Fig. 1). Schwartz et al., (1983) estimated the weight of camels by AG x HG x SH x 50. The multiplication factor was modified by Simpkin (1998) to 44.9 ± 0.26 for camel calves. The growth curves generated by the regressions of this study are linear and gave higher weight estimates for the first four months but show a low growth rate. Schwartz's et al., (1983) and Simpkin's (1998) regressions are exponential though the former depicts a faster growth. Kuria's et al., (2007) regression model gave a linear growth curve similar to the one of this study. It shows a faster growth. The variation from the expected sigmoid growth curve could be due to the small sample used in this study and the measurements which were taken once for each calf. Repeated data collection proves difficult in a pastoral community because of high mobility. Also the calves measured were different and at different age and locality. In addition the age given was highly dependent on the accuracy of the recall information from respondents. The calves were under different management too. However in the pastoral systems where migration is the norm, a onetime data collection is a better option. The growth of camel calves also for the first year is linear (Bissa et al., 1998).

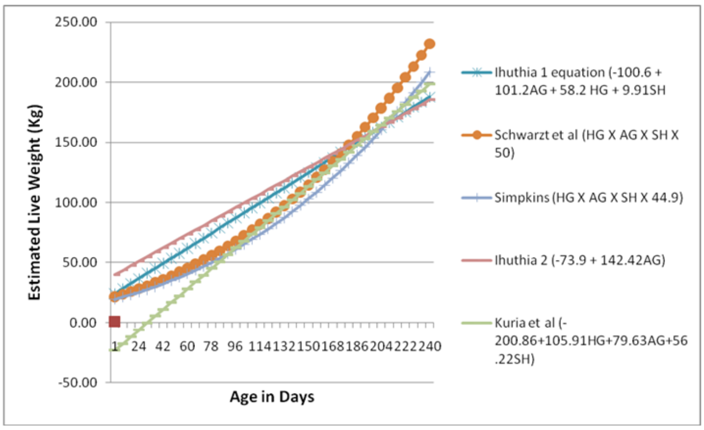

Figure 1. Comparison of live weight estimates by prediction equations of this study and of other researchers.

N.B. Ihuthia 1 and 2 equations are results of this study (see table 3). Ihuthia 1 predicts weight using all the three linear measurements (HG, AG, SH) while Ihuthia 2 is the best single predictor using the abdominal girth.

4. Conclusion and recommendation

Heart girth, abdominal girth and shoulder height regression (Y= -100.6 + 101.2AG + 58.2 HG + 9.91SH) gave a better estimate of weights of camel calves but for a single linear measurement abdominal girth is preferred (Y= -73.9 + 142.42x). Shoulder height was non-significant for live weight estimation. The results suggested that the values for linear body measurements when fitted in the formulae gives estimated live weight of camel calves useful in ASAL. The predictive equations developed for estimating live weight of camel calves would enhance management of camels when incorporated in the pastoral production systems.

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