Morphological characteristics of working donkeys in south–western Zimbabwe

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Abstract

Live weight, age and body dimensions of 302 working donkeys in the Matobo and Nkayi districts of south-western Zimbabwe were recorded. The average age of the animals was eight to nine years (range less than one to greater than 14 years) and average weight was 144 kg (range 78–222 kg) with a height at the withers of 105 cm. There were no significant differences between body dimensions in male and female donkeys. Heart girth was the best single predictor of live weight: Live weight (kg) = -239.16 + 2.29 heart girth (cm) ($r^2 = 0.84$, se = 0.084). Live weight and body condition of 32 donkeys from the Matobo district were monitored over the course of a year. The animals progressively gained weight from January (mid-wet season) until July (mid-dry season), after which weight showed only a small decrease through to October/November (late-dry season). This suggested that donkeys can more or less maintain their live weight and body condition in the dry season in rural areas. The size and body dimensions of these donkeys in western Zimbabwe were similar to those reported in other studies for donkeys elsewhere in Africa.

Introduction

It is estimated that there are between 300,000 and 350,000 donkeys in Zimbabwe (Prasad, Marovanidze and Nyathi, 1991; Pandey and Eysker, 1991). Most of the donkeys are found in the semi-arid regions in the south-western portion of the country, where they are particularly appropriate (Mpande, 1992) due to their ability to tolerate the dry conditions. It has been suggested that donkeys in Zimbabwe originate from North Africa (Jones, 1991). However, there is a general lack of information on the breed type(s) of the 'Zimbabwean' donkey and its typical traits have not been established. Morphological characteristics (frame size, as determined by the dimensions of heart and umbilical girths, body length and height) could usefully indicate draft and therefore performance capacity of Zimbabwean donkeys, since Tembo (1989) suggested that draft capability is directly proportional to size. This information could then be used to assess the donkey draft power resource available to the smallholder farmer, the main user of the donkey. The information would also allow meaningful comparisons to be made between the Zimbabwean donkey and those used elsewhere in Africa for work.

The live weight of an animal is important in determining the potential to carry out prescribed draft tasks (Bartholomew et al, 1993). Proper management of donkeys requires the ability to match the animals' live weight to draft tasks required. However, most smallholder farmers have no access to a livestock scale. Therefore there is a need to establish simple and practical methods of estimating live weight of donkeys from simple body dimensions. A reliable and practical method of estimating live weight is also useful when dosing animals with medicine, in the assessment of the impact of nutritional and veterinary interventions on donkeys and in determining recommendations for load carrying (Pearson and Ouassat, 1996).

Seasonal fluctuations in nutrition and exposure to disease may affect the donkey's live weight and body condition, hence its capacity to do work. In normal rainfall years in Zimbabwe, grazing mature donkeys are heaviest and in the best body condition at the end of the growing season (April/May) due to the abundance of grazing and supplements of crop residues post-harvest. Live weight and body condition decline progressively in the dry season (July/October) when the quality and quantity of the grazing declines. Donkeys are generally worked throughout the year without taking these fluctuations in live weight into account. However, the amount of work done depends on the season with the heaviest workload normally being experienced during wet season plowing. It is important to know the magnitude of these changes in live weight over the seasons. If such fluctuations are large, donkeys may be required at times to undertake tasks that are at the limit of their capacity, with resultant poor performance.

Two studies of working donkeys in western Zimbabwe were conducted to determine:
- the morphological attributes as indicated by body dimensions.
- the relationship between simple body measurements and live weight
- the seasonal changes in live weight and body condition of donkeys.

Materials and methods

Study 1
Three hundred and two working donkeys were measured in the Matobo and Nkayi districts of south-western Zimbabwe. The following body measurements were recorded (adapted from Pearson and Ouassat, 1996):
- ***Body length:*** from the olecranon process of the elbow to tuber ischii;
- ***Height:*** from level ground to the highest point on the withers;
- ***Heart girth:*** circumference from the caudal edge of the withers behind the elbow;
- ***Umbilical girth:*** circumference over the widest part of the abdomen;
- ***Cannon bone:*** circumference at the narrowest part of the cannon bone;
- ***Live weight:*** the weight of animal to the nearest kg (portable electronic weighing scale, Ruddweigh, NSW, Australia);
- ***Age:*** as determined by dentition (Tutt, 1984);

A measuring stick was used to measure height (cm) and length (cm) while a tape measure was used for heart (cm) and umbilical girths (cm) and cannon bone (cm) circumference.

Study 2
A total of 32 donkeys from the Matobo district were monitored from January to November 1995. The animals' live weight and body condition were recorded four times a year in the periods described below. Body condition scoring was based on a scoring system of 1 to 9, 1 being emaciated and 9 obese (Pearson and Ouassat, 1996). The body condition scoring method used is shown in Table 1.

Monitoring was in the months of January/February, March/April, July/August and October/November. These months were selected to reflect seasonal variations, assuming normal rainfall patterns.

Statistical analysis
Data were analysed using the SAS statistical package and ANOVA performed with sex as a source of variation. Linear regression analysis was carried out to compute regression lines for predicting live weight from the other variables measured.

Results

Sex and phenotype
There were no significant differences ($p>0.05$) between body dimensions of male and female donkeys. The results are presented in Table 2. The average age of male and female donkeys was 8 and 9 years, respectively. The age distribution of the donkey population studied is shown in Figure 1.

Predicting live weight
Prediction equations were derived by pooling all data regardless of sex, age, body condition or physiological state. Models were developed by regressing the predictor variables against live weight (Y-variable). The prediction of live weight using single-variable models are shown below for heart girth (Equation 1) and umbilical girth (Equation 2):

Table 1: Guide to the body condition scoring of donkeys (adapted from Pearson and Ouassat, 1995)

Body condition score	*Description*
1 Very thin (emaciated)	Animal markedly emaciated; condemned; bone structure easily seen over body; little muscle present; animal weak; lethargic
2 Thin	Animal emaciated; individual spinous processes, ribs, tubers coxae and ischii and scapular spine all prominent; sharply defined; some muscle development; neck thin; prominent withers; shoulders sharply angular
3 Less thin	Vertebral column prominent and individual spinous processes can be felt (palpated); little fat, but superspinous musculature apparent over spinous, ribs tubers coxae and ischii prominent; loin area and rump concave; little muscle or fat covering over withers and shoulders
4 Less than moderate	Vertebral column visible; tuber ischii palpable but not visible, tuber coxae rounded but visible; rump flat rather than concave; ribs palpable but not obvious; withers, shoulders, neck with some muscle and fat cover; scapular less clearly defined
5 Moderate	Superspinous muscles developed and readily apparent; can palpate vertebral column; tuber coxae rounded; rump rounded, convex; tuber ischii not visible; some fat palpable in pectoral region and at base of neck; can palpate ribs, but not visible
6 More than moderate	Cannot palpate spinous processes easily; back becoming flat, well covered; rump convex and well muscled; some fat palpable on neck, base of neck and pectoral region; neck filled into shoulder, tuber coxae just visible
7 Less fat	Back flat, cannot palpate spinous processes; tuber coxae just visible; fat on neck and pectoral region beginning to expand over ribs; flank filling, neck thickening
8 Fat	Animal appears well covered with body rounded with fat and bones not discernible; flanks filled; broad back
9 Very fat (obese)	Bones buried in fat; back broad or flat. in some cases crease down back; large accumulations of fat on neck, over pectoral area and ribs; flank filled with fat

Table 2: Mean live weight (kg) and body measurements (cm) of working donkeys in the smallholder farming areas of Matobo and Nkayi in south-western Zimbabwe (n=302, 172 males and 130 females)

Measurement	***Average***	***Males***	***Females***	***± Pooled SD***	***Range***
Live weight	143	144	143	24.9	78–222
Heart girth	115	115	115	6.9	95–140
Umbilical girth	140	139	142	10.8	112–173
Length	89	89	89	6.2	67–103
Height	105	106	105	4.7	94–120
Canon bone circumference	14	14	13	1.0	11–17

Equation 1: Live weight (kg) = -239.16 + (3.32 x Heart girth (cm))
Adjusted r^2 = 0.84; se = 0.084

Equation 2: Live weight (kg) = -133.85 + (1.98 x Umbilical girth (cm))
Adjusted r^2 = 0.74; se = 0.068

Heart girth was the best single predictor of live weight (adjusted r^2 = 0.84). When this equation was used, 96 per cent of the residuals were within ±20 kg and 72 per cent within ±10 kg. The mean error of the fitted values was 5.3 per cent. When data from male and females were analysed separately the umbilical girth was a better predictor of live weight with female rather than male donkeys (r^2 = 0.79 vs r^2 = 0.74), respectively. Body condition was the worst predictor of live

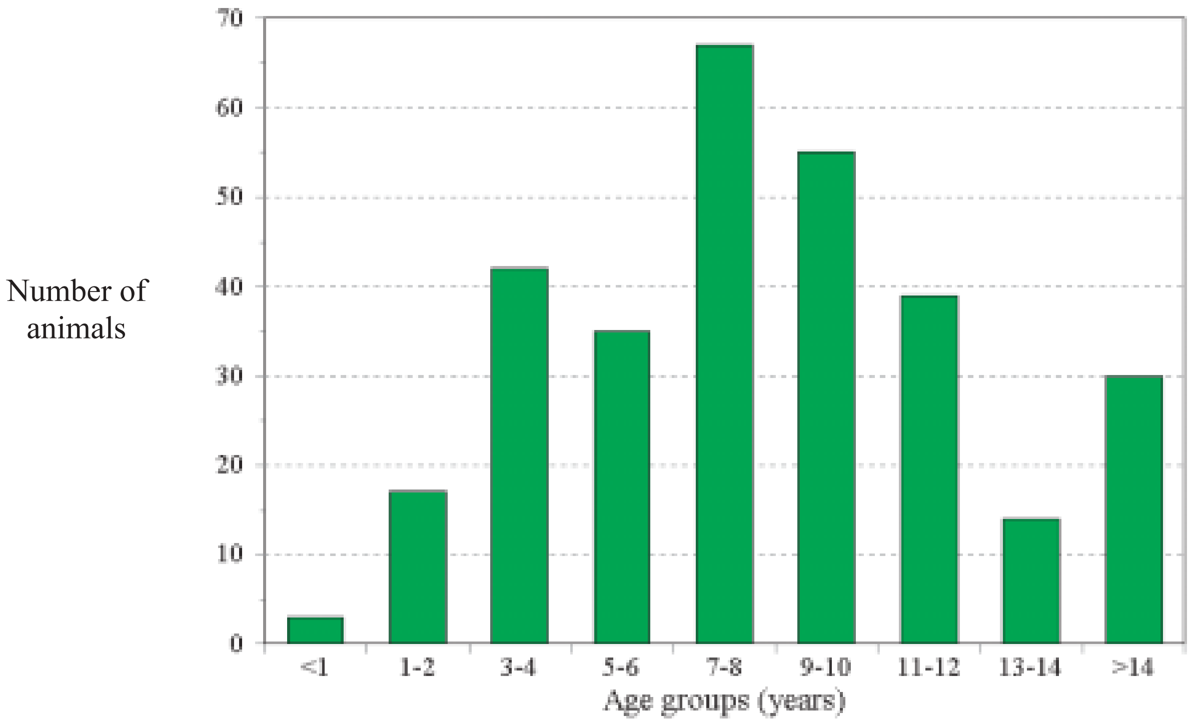

Figure 1: Age distribution of the donkeys studied

weight ($r^2 = 0.20$). When heart and umbilical girths were used together to estimate live weight, the prediction was enhanced.

Equation 3: Live weight (kg) = -236.05 + 2.29 x Heart girth (cm)
+ 0.82 x Umbilical girth (cm)
Adjusted $r^2 = 0.89$; se = 0.116; 0.074

This equation resulted in 98% of the residuals within ±20 kg and 80% within ±10 kg. The mean error of the fitted values was 4.6%.

The inclusion of more than two variables slightly increased the precision of prediction of live weight.

Equation 4: Live weight (kg) = -250 + 1.75 x Heart girth (cm)
+ 0.81 x Umbilical girth (cm)
+ 0.88 x Length (cm)
Adjusted $r^2 = 0.91$; se = 0.120; 0.075; 0.099

Seasonal changes in body condition

The mean live weight and body condition changes of the 32 donkeys monitored are presented in Table 3. The results indicate that the donkeys progressively gained weight from January/February (mid-wet season) until July/August (mid-dry season), before losing some in the late-dry season (October/November). Body condition improved from January/February (score 5) and appeared to be maintained even in the dry season (score 6). The monitoring of these and other donkeys continues.

Discussion

The frame size of donkeys in western Zimbabwe (assumed to be representative of the 'Zimbabwean' donkey), suggests that this population resembles donkeys elsewhere in Africa (eg Morocco; Pearson and Ouassat, 1996). Wilson (1981) reported that there was little physical variation in donkeys found throughout Africa and that donkeys rarely exceed a height at the withers of 105 cm. The same height of 105 cm was recorded in this study. There were no significant differences in body sizes between male and female donkeys, although males tended to be taller than their female counterparts. The larger umbilical girths of female donkeys could be

Table 3: Live weight (kg) (±se) and body condition score (±se) of 32 working donkeys monitored in the Matobo district of south-western Zimbabwe

	Jan/Feb	*Apr/May*	*Jul/Aug*	*Oct/Nov*
Live weight	136±5.4	143±4.4	160±4.5	153±4.6
% change[1]	–	+5	+18	+13
Body condition score	5±0.19	5±0.16	6±0.13	6±0.15

[1] percentage change when compared to weight in January/February

attributed to pregnancy, as some of the females were known to be pregnant while others appeared to be. No pregnancy diagnosis tests were conducted.

The other body dimensions of the Zimbabwean donkey, as well as live weight, indicated no major differences between male and female donkeys. Given this lack of sexual dimorphism, a farmer could probably expect similar draft performance from male and female donkeys of similar maturity, frame size and live weight. However, the physiological status of working female donkeys eg gestation, particularly in the later stages, would probably affect their performance, although in the present study the additional requirement for nutrients during pregnancy and lactation were not reflected in lower body condition of female donkeys.

Body weight prediction equation
There were strong relationships between live weight and some body dimensions, particularly heart girth ($r^2 = 0.84$). This is in general agreement with results published elsewhere (Eley and French, 1993; Pearson and Ouassat, 1996).

The equation of Pearson and Ouassat (1996):

Live weight = heart girth $^{2.65}$ / 2188   (adjusted $r^2 = 0.81$)

is fairly accurate in predicting the live weights of donkeys, but in the present study, underestimated the actual weights by an average of 6 per cent. The results in the present study indicate that the similarities between the donkey populations in Morocco (Pearson and Ouassat, 1996) and Zimbabwe, could allow the use of both equations on either populations. The equation of Eley and French (1993):

Live weight = height$^{0.24}$ x heart girth$^{2.576}$ x 0.000252 (Corrected $r^2 = 0.92$)

which included body height, also underestimated the weights of donkeys in this study by 9 per cent. The differences observed between this equation and the one derived in the present study are due to the use of height in the former. Given the inaccuracy of prediction of the equation of Eley and French (1993) on Zimbabwean donkeys, its use is therefore not appropriate.

Although the accuracy of prediction of live weight was increased by including three variables, the complications involved in creating and interpreting a nomogram (a series of scales stacking live weight against other measurements eg heart girth, length; see Pearson and Ouassat, 1996) for use by farmers, make it less practical. The use of heart girth as a predictor is easy and practical as it enables farmers, most of whom have access to tape measures, to estimate the live weight of their donkeys. Despite the relatively high degree of precision using umbilical girth ($r^2 = 0.74$), the incidence of pregnancy and of pot-bellies in donkeys fed high roughage diets limits its use as an accurate predictor of live weight in adult donkeys. However, results of work carried out in Morocco indicate that umbilical girth can be an accurate predictor of live weight in young growing animals (under 3 years of age, Pearson and Ouassat, 1996). In this study, no comparisons have yet been made on the precision of different body dimensions in estimating live weight between adult and growing working donkeys. Length and height were less accurate in predicting live weight (r^2 = 0.58 and 0.55, respectively) than were heart or umbilical girth dimensions.

Seasonal variation in condition

In the monitoring study, donkeys progressively gained weight and improved in body condition from the mid-wet (January/February) to mid-dry season (July/August). Precipitation in the 1994–95 rainy season was below normal and there was a mid-season drought (December 1994). However, range cover for grazing during the mid-dry season appeared generally adequate in the area of monitoring. The donkeys responded by gaining weight up to July/August (18 percent of January/February weight). As the dry season progressed, the quality and quantity of grazing deteriorated, and the donkeys lost weight from about September onwards (loss of 4 percent when compared to July/August weight). Results from studies with cattle indicate that even in normal rainfall seasons, without dry season supplementation, these animals start losing weight as early as July (Moyo, pers. comm, Nengomasha, unpubl. data). A rapid rural appraisal (Ellis-Jones et al, 1994) revealed that donkeys were in good body condition at least until the end of August (mid-dry season). It is possible that donkeys are better able to utilise dry season grazing than are cattle, thus accounting for their better maintenance of body weight and condition. Also most owners involved in the present study indicated that the donkeys were worked less in the dry season than in other seasons. A few farmers apparently gave supplements during the dry season, mainly crop residues, to their donkeys and these animals weighed more and were in better body condition than their unsupplemented counterparts. These results suggest that donkeys are capable of minimising weight and body condition losses in the dry season. However, supplementation of donkeys in the late-dry season (October/November) might be necessary to increase live weight and improve body condition in anticipation of the draft power demands of the following plowing season.

Conclusions

The results of these studies suggest that there are morphological similarities between the 'Zimbabwean' donkey and those in other parts of Africa. Estimation of live weight using certain easily measured body dimensions is supported by both this study and earlier studies on donkeys in Morocco (Pearson and Ouassat, 1996). Donkeys seem capable of maintaining their live weight and body condition, even during the dry season. The effect of seasonal fluctuations in the incidence of disease on donkey live weight and condition requires investigation.

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