THE SUITABILITY OF LINEAR BODY MEASUREMENTS FOR THE PREDICTION OF PELVIS AREA IN DORPER SHEEP

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Abstract

Birth stress is associated amongst other things with a small pelvic surface area in ewes. It is a factor which has far-reaching consequences for the producer. The use of pelvic area size as a selection criterion appears to be promising as pelvic area size is 50-60% heritable. The objective of this study was to develop an instrument that can measure the pelvic area of sheep and to be able to quantify the relationship between pelvic measurements and a number of easy-to-measure body measurements. A pelvis meter was developed and used to measure 322 Dorper ewes (± 12 months old, ± 48kg) and 272 Dorper rams rectally, and to take various body measurements on the same animals. No significant relationship was observed between pelvis measurements and linear body measurements in Dorper ewes or rams. The pelvis meter and measuring technique developed in the study are viewed as usable and accurate aid in measuring the pelvic area.

Keywords: Pelvis meter, pelvis dimensions, linear body measurements, Dorper sheep

1. INTRODUCTION

Although dystocia (birth stress) is responsible worldwide for significant losses in flocks of sheep, its management is complex, and it naturally places the sheep farmer under enormous economic pressure. One of the main causes of dystocia is the lack of proportion between the pelvis area of the uterus and the size of the lamb at birth (Deutscher, 1991; Cook et al., 1993; Troxel, 2008). Dystocia also occurs when there is a malfunction of one or more of the main components in the birth process, namely expulsion force, suitability of the birth canal and foetus size or position (Mee, 2008). Low lifetime production and pre-natal mortality (period just before, during and up to seven days after birth) are associated with small pelvic surface size in ewes (Haughey & Gray, 1982). The interaction between the size and shape of the lamb and the ability of the ewe to give birth, determine the occurrence of dystocia (Anderson, 1992). The assumption is made that poor relationship between the size of the pelvis of the ewe and the size of the lamb at birth are largely responsible for the necessity to assist ewes during birth (Anderson, 1992 & Patterson & Herring, 1997).

Dystocia negatively influences flock economy because of the loss of ewes and lambs, increased labour and veterinary costs, resultant lower reproduction levels and decreased milk production in the ewes (Patterson & Herring, 1997; Hartwig, 2002). Further, animals born during dystocia tend towards lower weaning weight and they are therefore more susceptible to diseases (Walker et al.,1992). It is also well known that ewes that have had difficult lambing, do not easily become pregnant again. Although researchers agree that birth weight has a significant influence on ease of lambing, there is also evidence that the size and shape of the pelvis can significantly influence the ability of a ewe to give birth. These factors contribute to a disproportionate foetus-pelvis relationship.

Anderson (1992) groups the factors that can influence dystocia into two categories:

1) Factors that can influence the size and shape of the lamb, namely length of gestation period, parity (number of times already given birth), gender, genetic selection, breed, nutrition and climate.
2) Factors that influence the ability of the ewe to give birth, namely parity, weight, weight at breeding, age, condition at lambing time.

Over the past two decades, breeding selection in the Dorper industry has focused mainly on characteristics of body shape. Much emphasis has been placed on a symmetrical body shape (Olivier, 2005). This resulted in the changing of certain dimensions of the sheep's body (such as a flatter rump, for instance). It is uncertain, however, whether there is any relationship between body measurements and pelvis dimensions in the Dorper sheep, especially as there are also no reliable measuring instruments that can measure the pelvis area of the sheep.

Over the past few years, there has been aggressive selection for meat characteristics in the Dorper breed, with a great deal of emphasis on show presentation (Olivier, 2005). Reproduction, which is seen as the most important economic characteristic, has not always been a priority. The question can therefore be posed as to whether the breed has become “too pretty” to adapt to the more extensive parts of South Africa (Olivier, 2005). It is also debatable as to whether other characteristics such as ease of lambing and ability to walk have been affected by the selection system that has been applied.

As heredity is a 50 to 60% factor in pelvis area size (Kinne, 2002), it can also be included in the selection criteria for rams, in an effort to ensure bigger pelvis area in their female progeny. It would also be useful to include pelvis measurements in the selection of ewes, although the measuring of the pelvic surface presents a number of challenges.

Body dimensions and the shape of animals can be objectively described with the assistance of body measurements. The relationship between these measurements and the functioning of the animal is of great interest to breeders and meat producers. Irresponsible changes to these measurements can lead to ineffective animals and consequently lower profit margins. It is thus necessary to monitor the relationship between body measurements and production characteristics in selection programmes in order to maintain that balance (Maiwashe, 2000).

The purpose of this study was to develop a pelvis-measuring instrument for sheep, and to research the pelvic and hindquarter dimensions of Dorper ewes and rams. The results should cast light on whether the breed standard selects indirectly for pelvis area, and to quantify the relationship between pelvis area and a number of easy-to-measure body measurements.

2. MATERIALS AND METHODS

2.1 Animals

Three hundred and twenty Dorper ewes (± 12 months old) from three different breeders (representing both Dorpers and white Dorpers) were measured on a once-off basis. All ewes had been raised on the veld and had only received a phosphate lick supplement. Further, 272 rams (Griekwastad Veld Ram Project) that had received similar treatment to that of the ewes, were also used in the study.

2.2 Environment

The study was carried out in central Northern Cape (the Prieska, Marydale and Kenhart region). According to Acocks (1988), this region has a low annual rainfall of 50-300 mm, falling mostly in the summer. The presence of Aloe dichotoma is typical of the vegetation of the area. Other trees and shrubs such as Acacia species (A. mellifer subsp. detinens, A. karroo, A. erioloba) are also prominent in the region. A variety of grasses may also be found here.

2.3 Measuring instrument

A pelvis meter for sheep was developed in cooperation with the Science Park of the Central University of Technology, Free State (CUT). The meter was tested on 90 animals at the Bloemfontein abattoir before the commencement of the study. The animals were measured rectally in a comfortable standing position, before slaughter. Pelvis measurements were also taken shortly after slaughter on the warm carcasses. A significant positive correlation of 0.85 ($P<0.05$) was found between the pelvis measurements of the animals before and after slaughter, which is an indication that the measurements were reliable. The pelvis meter is shown in Figure 1.

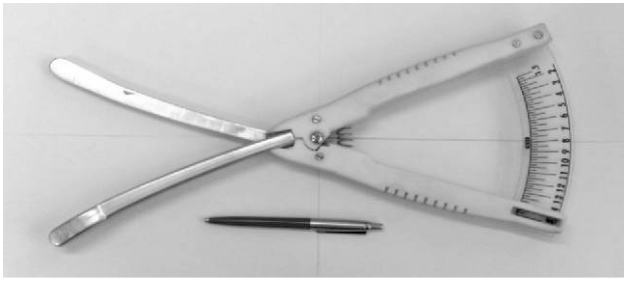

Figure 1: The pelvis meter used in the study

2.4 Measurements

The methods that were used to collect the data will be explained below under the following headings: pelvis measurements, body measurements, and body profile and general build characteristics (evaluated subjectively).

2.4.1 Pelvis measurements

All animals were measured rectally in a comfortable standing position after removal of any faeces from the rectum. Rams were measured five times from ±7 months to 13 months of age at 40-day intervals. The measuring instrument was thoroughly disinfected before each instance of measuring to ensure that no diseases were conveyed. After introducing the instrument into the animal, the instrument is opened while applying light pressure on the handle thereof. The instrument is then twisted from left to right to detect the ossified joint on the pubic symphysis, as a reference point to measure the height between the dorsa pubic tubercle on the floor of the pelvis and the sacrum (spinal column) at the top. The instrument is then turned 90º sideways to measure the width of the pelvis at widest points between the right and left shafts of the ilium bones. This is the horizontal diameter of the pelvis. After that, the instrument is carefully pulled out in the same twisted position to measure the width between the left tuber ischii and the right tuber ischii. The instrument is then removed from the animal (Van Donkersgoed et al., 1990; Walker et al., 1992; Kilgour & Haughey, 1993; Patterson et al., 1997; Cloete et al., 1998). The π (PH/2)*(PB/2) formula was used to calculate the pelvic surface.

2.4.2 Body measurements

The following measurements were taken according to the technique described in Fourie et al. (2002): Weight (kg); shoulder height (cm) measured vertically from the thoracic vertebrae to the ground; depth of chest (cm) measured from the spianus to the xyfoid process of the sternum; breadth of the forequarter (cm) measured from the left scapula to the right scapula and the breadth on the hindquarter (cm) measured between the left and the right thurls.

2.4.3 Body measurements and body profile and build characteristics (evaluated subjectively)

Musculature of the outer thighs (on a 5-point scale where 1 is poorly muscled and 5 is very well muscled); musculature of the inner thighs (on a 5-point scale where 1 is poorly muscled and 5 is very well muscled); body profile and build (on a 5-point scale where 1 represents poorly build and 5 very well build); selection (according to the breed standard of the Dorper where 1 is a cull, 2 is a 2nd selection, 3 commercial, 4 a type 4-stud animal and 5 a type-5 stud animal); chest projection (projection on a 5-point scale where 1 is very flat and 5 is very prominent); slope of rump of ewes (subjectively on a scale of 1-5 with 1 very flat 5 a rump that slopes strongly); condition (on a scale of 1-5 where 1 is very thin and 5 is an over-fat animal). Rump slope in rams is measured with a rump slope measuring instrument.

2.4.4 Questionnaire

An existing questionnaire from the Dorper Breeders Association was used as a basis. It was expanded and refined so that both structured and open-ended questions were included. The questions were answered by means of using interviews while completing the questionnaires. A stratified random sample method was used to select 66 respondents from seven provinces to participate in the study. Questionnaires were completed during a production auction, a veld ram auction and a national auction. The questionnaire included, amongst others, topics such as adaptability, fertility, growth potential, preparation of animals for auction, record-keeping, breeding weight and the amount of dystocia experienced by Dorper farmers and breeders in their flocks.

2.4.5 Data analysis

The questionnaire was coded and results were expressed in frequencies and percentages. A variance analysis was done to determine the relationship between the variables. The data were analysed by using the General Linear Model Procedures of SAS (SAS, 1989). Pearson correlations were also calculated.

3. RESULTS AND DISCUSSION

A question regarding the occurrence of lambing problems over the past 10 years was posed to 66 Dorper breeders/farmers (Figure 2). In answer to this question, 33% responded that it had worsened, while 38% were of the opinion that it had remained the same. 18% indicated that the situation had improved. This might also be the reason why more than 10% of the respondents use other breeds (Damara, Meatmaster, Afrikaner and Van Rooy) to mate their young ewes the first time.

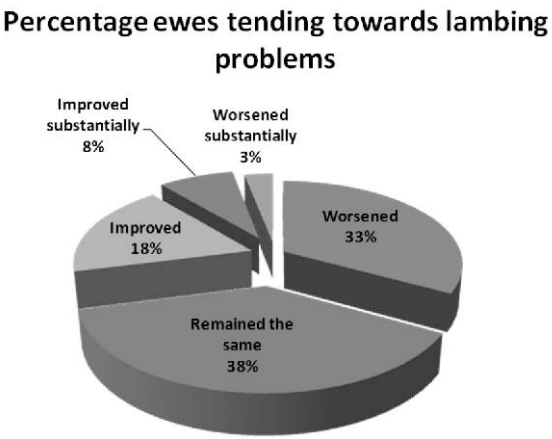

Figure 2: The opinions of farmers and breeders regarding the occurrence of dystocia

These breeds are known for new-born lambs being more delicate of structure. The respondents agreed however that the breed is experiencing more lambing problems than it did in the past. This fact obviously served as a further motivation for this study.

From Table 1 it is clear that there was no significant difference between the pelvis areas of commercial ewes (types 2 and 3), but that the pelvis areas of stud ewes (types 4 and 5) differed significantly from those of commercial ewes. Type 5 ewes had a 19% bigger pelvis area than type 2 ewes, but it must be kept in mind that the commercial ewes (types 2 and 3) were significantly lighter than the stud ewes (types 4 and 5). The effect of more musculature in the inside and outside thighs, especially in the stud ewes, will only be clear when ease of lambing is monitored.

Table 1: The effect of type on pelvis area, pelvis breadth, pelvis height, weight and hindquarter breadth of young Dorper ewes

Parameter	Type 2	Type 3	Type 4	Type 5
Pelvis area $cm^2(\pi)$	33.51 ± 3.77^{a}	33.99 ± 5.30^{a}	36.72 ± 4.30^{b}	39.97 ± 4.30^{b}
Pelvis breadth (cm)	6.44 ± 0.39^{a}	6.39 ± 0.71^{a}	6.70 ± 0.43^{b}	6.73 ± 0.39^{b}
Pelvis height (cm)	6.60 ± 0.41^{a}	$6.74 \pm 0.45^{a,b}$	$6.96 \pm 0.44^{b,c}$	6.97 ± 0.44^{c}
Weight (kg)	44.05 ± 6.23^{a}	$46.58 \pm .68^{a,b}$	48.93 ± 5.13^{b}	52.28 ± 4.76^{c}
Hindquarter breadth	17.86 ± 1.08^{a}	18.17 ± 1.02^{a}	18.38 ± 0.99^{a}	18.78 ± 0.96^{b}
(cm)	n = 22	n = 133	n = 141	n = 36

Averages with different letters in the same line differ significantly: $P < 0.05$

It can be seen from Table 2 that the ewes used in the study weighed on average 48kg. Furthermore, the conclusion can be drawn that the height of the pelvis area of the ewes is 4.5% greater than the width. In beef cattle, it has been found that pelvis height plays a greater role in the Bos Indicus breeds, while pelvis breadth plays a greater role in the Bos Taurus breeds (Briedenhann, 2010). The large difference between the pelvis area of rams (28.22 ± 3.21cm²) and that of ewes (33.55 ± 4,89cm²) was also noteworthy, with ewes having a pelvis area on average 5.33cm^2 larger than that of rams at the same age. Phenotypical correlations between the parameters are indicated in Table 3.

Table 2: Average and standard deviations (s.d.) of parameters of Dorper rams and ewes

Parameter	Ewes Average ± s.d.	Rams Average ± s.d.
Weight (kg)	48.0 ± 5.75	54.11 ± 5.41
Shoulder height (cm)	60.9 ± 2.43	64.1 ± 2.63
Chest depth (cm)	29.1 ± 1.33	28.7 ± 2.49
Shoulder breadth (cm)	21.5 ± 1.22	22.9 ± 1.36
Hindquarter breadth (cm)	18.3 ± 1.02	24.1 ± 1.53
Rump length (cm)	20.4 ± 1.22	23.4 ± 1.79
Pelvis breadth (cm)	6.6 ± 0.45	5.56 ± 0.37
Pelvis height (cm)	6.9 ± 0.46	6.44 ± 0.42
Pelvis area (cm^2)	35.55 ± 4.89	28.22 ± 3.21
Outer thighs (1-5)	3.5 ± 0.67	-
Inner thighs (1-5)	3.7 ± 0.63	-
Body shape (1-5)	3.5 ± 0.64	-
Selection	3.6 ± 0.77	-
Chest projection	3.7 ± 0.47	-
Slope of rump (1-5)	3.6 ± 0.56	34.2 ± 5.22
Tuber Coxae to ischium (cm)	-	23.4 ± 1.79
Ischium to acetabulum (cm)	-	12.4 ± 1.49
Acetabulum to tuber coxae (cm)	-	14.1 ± 1.74
Chest diameter (cm)	-	86.8 ± 3.70

Although the Dorper Breeders Association places much emphasis on breadth in the hindquarter, low correlations (0.14; 0.29; $P < 0.001$) were found between hindquarter breadth (HB) and pelvis area (PA) in rams and ewes respectively. The same tendency was apparent between pelvis breadth (PB) and HB (0.16; 0.3; $P < 0.001$).

Table 3: Phenotypical correlations between parameters with rams above the diagonal and ewes below the diagonal

Parameter	W	HF	D	BF	BH	RL	PB	PH	PA	SR
W		0.489	0.453	0.664	0.483	0.235	0.313	0.253	0.327	-0.042
HF	0.490		0.281	0.276	0.220	0.163	0.143	0.252	0.228	0.077
D	0.668	0.526		0.327	0.273	0.133	0.138	0.101	0.135	-0.087
BF	0.644	0.280	0.489		0.451	0.086	0.205	0.089	0.173	-0.025
BH	0.583	0.424	0.530	0.418		0.140	0.157	0.085	0.141	0.055
RL	0.580	0.468	0.478	0.397	0.490		-0.023	0.154	0.073	-0.195
PB	0.256	0.120	0.239	0.106	0.297	0.037		0.481	0.865	-0.002
PH	0.239	0.089	0.243	0.096	0.240	0.034	0.770		0.855	0.038
PA	0.262	0.114	0.256	0.104	0.287	0.041	0.940	0.939		0.019
SR	0.177	-0.051	0.062	0.046	0.095	0.001	0.205	0.266	0.250	

Weight (W), Height front (HF), Depth (D), Breadth front (BF), Breadth hindquarter (BH), Rump length (RL), Pelvis breadth (PB), Pelvis height (PH), Pelvis area (PA), Slope of rump (SR)

The respective correlations of 0.61 and 0.64 ($P < 0.001$) between inside thighs, outside thighs and body shape are an indication that meat characteristics are highly regarded in the classification of ewes (data not shown).

A low correlation of 0.10 ($P < 0.001$) between condition count and pelvis area was found, which is an indication that the condition of the animals did not influence the measurements significantly (Table 3). A low correlation of 0.26 ($P < 0.05$) was also found between weight and pelvis area of the ewes, which is an indication that the heavier ewes did not necessarily have a greater pelvis area, even though large differences were found between ewes. Unexpectedly, there was also a low correlation of 0.25 ($P < 0.05$) in ewes and 0.019 ($P < 0.05$) in rams respectively between slope of rump and pelvis area. The breed standards for the Dorper however promote a flatter rump than that found in most other sheep or cattle breeds.

Whether the slope of rump has an effect on the birth process in Dorpers, is uncertain, however. Cloete et al. (1998) found that the slope of rump (subjectively evaluated) correlated positively in SA Mutton Merinos with the tempo of lambing; in other words, the flatter the rump the longer the duration of the lambing process. This phenomenon did not appear in Dorper flocks. Furthermore, it has been shown that 80% of lamb deaths take place within seven days after birth and 60% of these may be attributed to dystocia (Cloete et al., 1998). From the data, it is especially clear that body measurements cannot in general be associated with pelvis dimensions.

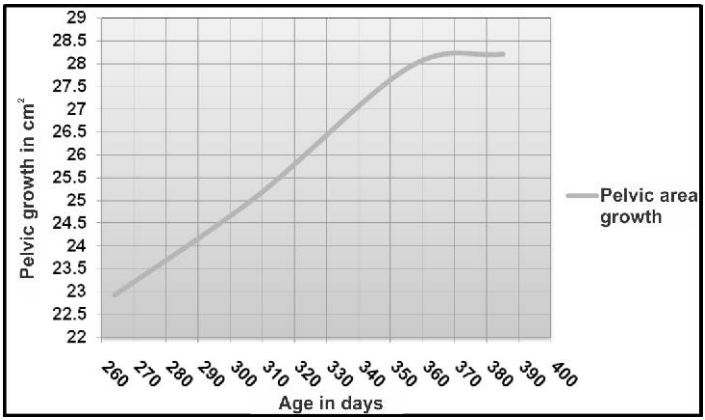

Figure 3: The growth curve of pelvis area in young Dorper rams

The pelvis area in rams grows quickly until the age of approximately 360 days, after which the curve flattens out (Figure 3). A similar tendency is likely in ewes, which is an indication that it is not advisable to mate them while the ewes are too young.

4. CONCLUSION

The pelvis meter that was developed is relatively easy to use and can be seen as a reliable instrument for measuring the pelvis area of sheep. Results also indicate that there is not a significant relationship between pelvis dimensions and linear body measurements (as investigated in this study) in Dorper ewes and rams.

5. RECOMMENDATIONS

Several recommendations can be made from this study:

- Measuring the pelvis area of especially young animals directly, should dramatically limit losses amongst young ewes lambing for the first time. This practice is already being applied with great success in the beef cattle industry.
- Measuring the pelvis area should however not be seen as a method for selecting animals with the greatest pelvis area. It is recommended that selection take place by means of elimination of ewes with the smallest pelvis area in a particular group.
- It is proposed that a follow-up study be undertaken in which the ease of lambing is determined in ewes that have been measured for pelvis area size.
- Because of the heritability of the pelvis area, the measuring thereof in rams in the veld ram projects should be considered.

6. ACKNOWLEDGEMENT

The Griquastad Veld Ram Project and the breeders who made their animals available for the measurements are hereby acknowledged and thanked.

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