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Factors Associated with Dystocia in Beef Heifers[1,2]

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Abstract

Data were obtained on 1178 first-calf heifers from 11 commercial ranches and three experimental herds throughout Oregon. The objectives of the study were to examine the relationship among factors associated with dystocia and possibly to develop predictive formulas. Dystocia occurred in 34% of the heifers observed and ranged from 11 to 69% among ranches. Variables correlated ($P<.05$) with dystocia and the corresponding r values were heifer birth weight (.14), calf birth weight (.35), calf sex (–.22), heifer age at calving (–.23), and the heifer's pelvic area/calf birth weight ratio (–.17). Pelvic area was not different ($P>.05$) between heifers experiencing dystocia and those calving without assistance. Factors associated ($P<.05$) with calf birth weight and the corresponding r values were gestation length (.17), sire birth weight (.25), calf sex (–.22), heifer birth weight (.37), heifer prebreeding weight (.38), and pelvic area (.15). Discriminant analysis indicated that birth weight of calves and age of heifer would adequately classify heifers into dystocia groups. Birth weight of the calf was always needed to give acceptable classification accuracy. Results would indicate that heifer management systems that included breeding for lighter birth weights will dramatically reduce incidence and severity of dystocia.
(Key Words: Dystocia, Beef Heifers, Pelvic Measures.)

Introduction

Breeding heifers to calve at 2 yr of age can increase lifetime beef production; however, heifers at first calving are prone to dystocia. In the absence of dystocia, heifers calving first as 2-yr-olds have a tendency to calve earlier in subsequent years, wean heavier calves, and produce a higher percent calf crop than heifers calving first as 3-yr-olds (11). However, heifers at first calving are three to four times more likely to suffer dystocia than at second and later calvings (13). Doornbos et al. (7) reported 2-yr-old heifers experienced prolonged labor and required 1.5 times more assistance during parturition than mature cows. Consequences of dystocia include increased calf mortality (1), reduced conception at subsequent matings (10), and increased calving intervals (4).

Numerous factors have been examined as possibly influencing the frequency and severity of dystocia. Fetopelvic incompatibility is likely the main reason for calving difficulty in heifers (13). Calves with heavy birth weights and large frames experience more difficulty at birth than average-sized calves (18). Precalving pelvic area has been correlated to dystocia (2), and heifers with pelvic openings less than about 200 cm^2 are high risks for difficulty (12). Other factors positively correlated with dystocia are prolonged gestation, sex of calf, birth weight of the sire, and dam weight (13, 17).

The objectives of this research were to: 1) examine the above relationships by determining the effects of these various factors on incidence of dystocia in 2-yr-old commercial beef heifers, and 2) use discriminant analysis procedures to develop classification functions, which will aid management decision processes directed toward alleviating dystocia problems in heifers.

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Materials and Methods

Data were obtained on 1178 first-calf heifers from 11 commercial beef cattle ranches and three experimental herds throughout Oregon. Data collection included only spring-calving (January to April) herds. All data were collected in the same year. Heifers were of various breeding and management systems, but all were bred to calve at 22 to 25 mo of age. The following variables were recorded, if known, immediately prior to the breeding season: heifer age, birth weight, internal pelvic area (pelvic height × pelvic width), condition score, and weight. All pelvic measurements were taken by one technician using a Rice Pelvimeter. Height represented the linear distance between the dorsal surface of the cranial end of the symphysis pubis and the ventral surface of the midsacrum, and width the maximum distance between the shafts of the ilia (14). Condition scores, utilizing a 1 to 9 system with 1 being emaciated and 9 extremely fat, were estimated by palpating subcutaneous fat over the backbone, ribs, and tailhead. The following data were collected at parturition: calf birth date, birth weight, sex, and severity of dystocia. Calves were weighed within 24 h after birth. Severity of dystocia was scored from descriptions at parturition as follows: 1 – no difficulty, birth unassisted; 2 – slight difficulty, nonmechanical assistance required; 3 – considerable difficulty, hard pull by hand or mechanical assistance required; 4 – extreme difficulty requiring caesarean section; and 5 – malpresentation of calf (deleted from all the statistical analysis). Additional data recorded were gestation length, sire birth weight, and PA/Bwt ratio calculated as pelvic area divided by calf birth weight (5). Breed of dam, sire, and calf were also recorded, when available, but not analyzed due to the wide array of breeds represented and number of breeds within individuals which made categorization very difficult.

Correlation coefficients (r) were calculated between all variables. Calf sex was coded 1 for male and 2 for female. Analysis of variance was used to test the effects of pelvic area, heifer condition score, heifer prebreeding weight, calf birth weight, PA/Bwt, and gestation length on severity of dystocia. An analysis of variance was conducted with each dependent variable tested separately. The data were blocked by ranches in a randomized complete block design. Total degrees of freedom for the analyses were 55 with 13 for block, 3 for treatment and 39 in the error term for each analysis. Tukey's procedure (19) was used to distinguish differences among dystocia score groups within variables ($P<0.05$). Chi-square was used to test the null hypothesis that dystocia occurred in equal proportions among heifers having above and below mean pelvic areas, calf birth weights, and prebreeding weights.

Data were also analyzed using stepwise discriminant analysis (9) to compute linear classification functions in a forward selection procedure. The jackknifed classification matrix was used as a validation procedure to reduce bias. Heifers were classified into two dystocia groups: assisted (dystocia scores 2 to 4), unassisted (dystocia score 1).

Results and Discussion

Dystocia occurred in 34% of the heifers observed and ranged from 19 to 69% among cooperating ranches. Among heifers suffering dystocia, 49% experienced slight difficulty, 41% considerable difficulty, and 5% required caesarean sections. The remaining 5% experienced malpresentation of their calves and were excluded from analyses involving severity of dystocia. When examined prior to breeding, heifers averaged 13 mo of age and ranged from 11 to 15 mo.

Variables correlated ($P<0.05$) with severity of dystocia were heifer birth weight, heifer age at calving, calf birth weight, calf sex, and PA/Bwt ratio (Table 1). Meijering (13) found birth weight of calf and pelvic area of dam had the greatest influence on ease of calving in heifers. However, this study demonstrated little correlation between pelvic area and dystocia (–0.01). Natural and managerial selection pressure may alleviate some problem lines of females with small pelvic openings and subsequent dystocia in some herds. Correlations between pelvic size and dystocia may also be reduced by low repeatability of pelvic measurements (6). Heritability estimates of pelvic size appear to be quite high in 2-yr-old heifers with reported values of 40 to 50% (3, 8), which indicates that if pelvic area were highly correlated to dystocia fairly rapid progress could be made through selection and culling.

TABLE 1. Correlation coefficients (r) among variables.

Variable	Heifer birth wt (n=285)	Pelvic area (n=1177)	Heifer cond. score (n=1177)	Heifer prebreeding wt (n=461)	Heifer age at calving (n=356)	Calf birth wt (n=821)	Calf sex[a] (n=873)	Dystocia score (n=878)	Gestation length (n=194)	Sire birth wt (n=63)
Heifer birth wt	1.0									
Pelvic area	−0.25*	1.0								
Heifer condition score	0.11	0.21*	1.0							
Heifer prebreeding wt	0.27*	0.31*	0.41*	1.0						
Heifer age at calving	0.04	0.32*	0.05	0.06	1.0					
Calf birth wt	0.37*	0.15*	0.09*	0.38*	0.01	1.0				
Calf sex[a]	0.07	0.02	0.00	0.00	0.16	−0.22	1.0			
Dystocia score	0.14*	−0.01	0.02	−0.08	−0.23*	0.35*	−0.22*	1.0		
Gestation length	−0.09	0.10	−0.34*	−0.30*	−0.03	0.17*	−0.07	−0.03	1.0	
Sire birth wt	0.36	−0.38	−0.01	0.39	−0.40	0.25*	0.26*	0.06	–	1.0
PA/Bwt ratio[b]	−0.13*	0.52*	0.13*	0.03	0.22	−0.65*	0.16*	−0.17*	−0.40*	

[a]Calf sex code: 1 = male, 2 = female.

[b]PA/Bwt ratio is pelvic area divided by calf birth weight.

*Values significant (P<0.05).

Pelvic area ranged from 100 to 271 cm^2 yet did not have an effect (P>0.05) on dystocia scores (Table 2). Mean pelvic area of heifers calving unassisted was 177 cm^2, well below the 200 cm^2 suggested by Makarechian and Berg (12) as the threshold of increased calving difficulty. The observed incidence of dystocia did not differ (P>0.05) from expected for heifers with above or below mean pelvic areas (Table 3, Case 1). Data in Table 3 (Case 4) also indicate that when a heifer with a larger than average pelvic area gave birth to a calf below the mean birth weight, the incidence of dystocia was 19%. However, when the pelvic area was below the average, and birth weight above (Case 5), the incidence of dystocia roughly tripled to 60%, significantly higher (P<0.05) than expected.

Increasing calf birth weight had an effect (P<0.05) on the severity of dystocia (Table 2). Unassisted calves averaged 31 kg, and those experiencing dystocia averaged 37 kg. Calves with above-average birth weight experienced 52% dystocia, while those below average had only 20% (Table 3, Case 2). Increasing birth weight has frequently been associated with dystocia (7, 12, 15, 17). Factors directly correlated with calf birth weight were heifer birth weight, heifer prebreeding weight, sire birth weight, and gestation length (Table 1). The values in this table also indicate a negative correlation between calf sex and birth weight. Calf sex was negatively correlated with dystocia (P<0.05), indicating males experienced dystocia more frequently than females.

The effect of pelvic area and calf birth weight was expressed in PA/Bwt ratio. The ratio had a higher correlation to dystocia than pelvic area, but not as high as calf birth weight (Table 1). The PA/

TABLE 2. Variable means by dystocia score groups.

Variable	Dystocia Score[a] 1	2	3	4
no. heifers	575	147	131	18
	Mean (S.E.)	Mean (S.E.)	Mean (S.E.)	Mean (S.E.)
Pelvic area (cm^2)	177 ± 1.2	178 ± 2.1	174 ± 2.4	173 ± 5.2
Heifer condition score	5.0 ± 0.02	5.1 ± 0.04	5.0 ± 0.04	4.8 ± 0.14
Heifer prebreeding wt (kg)	288 ± 3.4	290 ± 6.3	290 ± 5.3	279 ± 10.1
Heifer age at calving	729^{b} ± 1.9	725^{b} ± 3.1	722^{b} ± 3.3	669^{c} ± 35.4
Calf birth wt (kg)	31^{b} ± 0.2	34^{c} ± 0.3	37^{d} ± 0.4	39^{d} ± 1.6
Pelvic area/birth wt ratio	2.6^{b} ± 0.02	2.3^{c} ± 0.03	2.1^{d} ± 0.04	2.0^{d} ± 0.13
Gestation length (d)	286 ± 1	287 ± 1.6	290 ± 1.7	288 ± 4.9

[a]1 = no assistance; 2 = light assistance (hand pull); 3 = hard pull; 4 = caesarean section.

[b,c,d]Means in rows with different superscripts are significantly different (P<0.05).

TABLE 3. Results of chi-square analysis testing equal occurrence of dystocia in heifers with above and below mean pelvic area, calf birth weight, and prebreeding weight.

Case no.	Variable	n	Percent dystocia Observed	Expected
1.	Above mean pelvic area	417	31	35
	Below mean pelvic area	455	39	35
2.	Above mean calf birth wt	399	52	35*
	Below mean calf birth wt	428	20	35*
3.	Above mean heifer prebreeding wt	186	39	39
	Below mean heifer prebreeding wt	150	40	39
4.	Above mean pelvic area and below mean calf birth wt	192	19	40*
5.	Below mean pelvic area and above mean calf birth wt	196	60	40*

*Differs significantly ($P<0.05$) from observed value.

Bwt ratio averaged 2.6 for unassisted birth but decreased ($P<0.05$) with increasing severity of dystocia (Table 2). In a study conducted by Deutscher and Zerfoss (5), major calving difficulty was experienced when the ratio approached 3. In this study, the same severity of dystocia was reached when the ratio approached 2.

Condition scores of dams did not differ ($P>0.05$) among dystocia scores (Table 2) but were negatively correlated with gestation length (Table 1). Assuming palpable subcutaneous fat reflects a heifer's level of nutrition, this correlation indicates the importance of adequately feeding gravid heifers. Underconditioned or overconditioned heifers have been reported to experience increased dystocia (13). Condition scores ranged from 3 to 6, with no emaciated or fat animals observed. In this study, gestation length did not differ ($P>0.05$) among levels of dystocia severity (Table 2). Gestation length was, however, negatively correlated ($P<0.05$) with heifer prebreeding weight (Table 1).

Prebreeding weight did not have an effect ($P>0.05$) on dystocia (Table 2) but was significantly correlated with pelvic area (Table 1). Sire birth weight was significantly correlated with calf birth weight but was not ($P>0.05$) correlated with dystocia (Table 1). Heifer age was correlated ($P<0.05$) with pelvic area (Table 1) and a significant ($P<.05$) factor in severe dystocia represented by a score of 4 (Table 2).

The stepwise discriminant analysis procedure was conducted utilizing 333 observations to classify heifers into dystocia and nondystocia groups. These were the animals with data complete in all factors included in the analysis. Calf birth weight was by far the most important factor and was required to properly classify heifers into the appropriate dystocia groups. Heifer age at calving was the only other variable which significantly improved classification. None of the other factors including heifer birth weight, internal pelvic area, condition score or weight at breeding improved the classification and were eliminated by the discriminant analysis procedure. The approximate F-statistics for the discriminant function model and standardized coefficients for canonical variables are shown in Table 4.

The model correctly classified 69.1% of the heifers into the appropriate group. The jackknifed classification gave 68.5% correct classification percentage. Using the proportional choice criterion described by Morrison et al. (16), the number of correct classifications exceeded proportional choice by 15.7%, indicating acceptable classification accuracy. A priori measurements did not appear to be significant predictors of dystocia, because birth weight of the calf was always needed to give acceptable classification accuracy.

In summary, data on 1178 first-calf heifers and their calves indicate calf birth weight was the

TABLE 4. Dystocia group summary, showing classification matrix, group centroids, and standardized discriminant function coefficients, determined by stepwise discriminant analysis.

Dystocia group	Cases	Predicted membership Unassisted	Assisted	% Correct	Centroid	F	Prob. > F
Unassisted	210	148	62	71.0	0.32	28.47	0.0001
Assisted	123	43	80	65.9	−0.54		

Entered variables:	Standard coefficients
1. Calf birth wt	−2.65
2. Heifer age at calving	0.36

primary factor influencing dystocia. The ratio of pelvic area divided by calf birth weight also was a highly significant factor in dystocia; however, pelvic area alone was not a significant factor. Discriminate analysis results show heifer age was the only factor after birth weight that improved the predictive equation for dystocia. Results indicate breeding for lighter birth weights will dramatically reduce incidence and severity of dystocia and selecting older heifers will also have some effect. Factors associated with heavy calves at birth were heavy parents, sex of calf, and prolonged gestation.

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