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Institute of Genetics and Animal Breeding, Jastrzębiec, Poland

Obstetrical problems and stillbirth in beef cattle*

Jindrich Citek, Eva Hradecka, Vaclav Rehout, Lenka Hanusova**

Department of Animal Genetics, Breeding and Nutrition,
Faculty of Agriculture, South Bohemia University,
Studentska 13, CZ 370 05 České Budějovice, Czech Republic

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Out of 5970 calvings, 4.29% had an abnormal course (dystocia). The occurrence of stillbirths was 6.98% of all births and 4.15% of normal course births. Stillbirths occurred in 70.31% of dystocias. The highest frequency of stillbirths was in Blonde d´Aquitaine (8.59%) and the lowest in Gasconne (3.96%) cows. A narrow pelvis and an oversized foetus were the causes of more than 50% cases of dystocia. In Charolaise, an extremely high occurrence of oversized foetus, while in Blonde d´Aquitaine uterine inertia were found. A narrow pelvis was especially frequent as the cause of dystocia in the Aberdeen Angus and Limousine breeds. On analysis of stillbirths the most important effect was of the calving course with 24.47% impact on variability. Difficult calving increased the odds of stillbirth by 76 compared to normal calving. The heritability of stillbirth was estimated as 7.80%. It is recommended to restrict the use of sires with a higher incidence of dystocia or stillbirth in the offspring. As genetically determined variability is very low, other systematic measures are necessary to control stillbirth and dystocia. These are: supervision of the herd, obstetrical assistance, appropriate heifer rearing, mating cows at the proper live weight and proper nutrition during the pregnancy.

KEY WORDS: beef cattle / calving /dystocia / heritability / stillbirth

The efficiency of beef cattle breeding is considerably affected by calving performance and the occurrence of stillbirths. Citek *et al.* [2009] maintain that defects of the foetus, stillbirths, dystocia and calves' low viability are important problems in cattle health genetics. In this respect, the paper by Kornmatitsuk *et al.* [2004] should be mentioned who describe the increasing incidence of stillbirths in Swedish

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**Corresponding author: citek@zf.jcu.cz

Holstein heifers to a current average of 11%. Their results indicate that the aetiology of stillbirths varies, depending on the sire used, and is associated with dystocia or low viability of calves. Eriksson *et al.* [2004] referred to an increase in stillbirth in Charolaise and Hereford cattle in Sweden. Their results varied between 6% in the first and 1-2% in later parturitions in both breeds.

In earlier studies many reasons of stillbirth were described. Berglund *et al.* [2003] focused on their non-infectious aetiology. They found that calving difficulties, as the most frequent cause of stillbirth, may explain only about a half of the condition. Similar results were given by Eriksson *et al.* [2004], who estimated that calving difficulties lead to less than a half of stillbirths. Citek *et al*. [2009] reported the possible multi-factorial character of stillbirths. Various non-genetic factors such as season, parity of the dam, sex of the calf, length of gestation period, age at first calving and a prolonged preceding calving interval, affect calving difficulty [Fiedlerova *et al.* 2008].

The aim of the present study was to evaluate the frequency and reasons of obstetrical complications, and to assess the incidence of stillbirths in beef cattle.

Material and methods

The frequency of stillbirths as well as frequency and reasons of dystocia were analysed in 50 herds of beef cattle from 1999 till 2003. The calves delivered were the offspring of 39 sires and each sire had produced at least 25 calves. In total, 5970 calvings were considered, out of which 1136 of Aberdeen-Angus (AA, by 7 sires), 256 of Blonde d´Aquitaine (BA, by 3 sires), 1782 of Charolaise (Ch, by 8 sires), 1113 of Limousine (Li, by 6 sires), 842 of Piedmontese (Pi, by 7 sires), 740 of beef Simmental (Si, by 6 sires) and 101 of Gasconne (Gs, by 2 sires) cows – Table 1. The calves were purebred, i.e. both sire and dam were of the same breed. The data have been recorded by the Veterinary Research Institute, Brno, as an element of a health genetic control programme.

In the text that follows, a stillbirth is defined as a calf born dead. As there is a number of classifications of the birth process, it was important to define a normal course of birth, which was understood in this study as a birth with physiological development of the birth canal, physiological pain and phases, carried out with the assistance of no more than one person. The normal birth course resulted in the delivery of a viable or a stillborn calf.

Uterine torsion is defined as a convolution in the long axis of the uterus, and ***uterine flexion*** when the axis of the uterus becomes vertical in relation to the long axis of the body. ***Uterine inertia*** is diagnosed when the uterine contractions are weak or totally absent so, that parturition could not proceed spontaneously. A pelvis was defined as ***narrow*** when it impeded or totally obstructed the passage of a normally sized foetus. A foetus was classified as ***oversized*** when its dimensions, primarily of the head and thorax, exceeded the breed standards insomuch that the spontaneous birth was baffled. A cervix was ***badly dilated*** when it prevented the passage of the foetus through the cervix canal. Abnormal *posture*, *position*, or *presentation* necessitated manipulation of the physiological status. The causes of dystocia (Tab. 2) were examined, diagnosed and reported by veterinarians. Stillbirths in the normal course of birth were recorded by farmers using "1" for stillbirth and "0" for livebirth.

The influence of different factors on stillbirths' causes and frequency was evaluated using the binomial GLM model, logistic regression technique. The model equation was:

$$\log(\frac{\pi_i}{\pi_{i-1}}) = b_0 + \sum_j b_j X_{ij}$$

where:

π_i – the probability of stillbirth;

$1-\pi_i$ – the probability of livebirth;

b_0 – the intercept;

b_j – the estimated coefficient for *j-th* fixed effect;

X_{ij} – the matrix of fixed effects with one column for continuous variable (year of calving);

q_{i-1} – columns for each cathegorical variable, where q_i is the number of levels.

Here the intercept b_0 is the log-odds of stillbirth for all variables at their base level, *i.e*. a normal delivery of an Angus male calf by a heifer dam during winter 1999 in herd K102. Then $\exp(b_0 + b_j) = \exp(y)$ is the odds of stillbirth for a defined *j-th* effect and $\exp(y) / 1 + \exp(y)$ is the corresponding probability of stillbirth. The ratio of two odds (odds ratio, OR = $\exp(b_j)$) provides a measure of association between the chosen factor and stillbirth. Then OR=1 indicates the lack of association, OR>1 corresponds with the increasing odds and OR<1 with the decreasing odds of stillbirth with the factor.

The equation to estimate the variance was:

$$MN = \mu + PRU_i + KJ_j + POH_k + PL_l + CH_m + ROK_n + SEZ_o + S_p + e_{ijklmnopr}$$

where:

MN – the evaluated trait coded as "0" for alive calf, and "1" for dead calf;

PRU_i – the course of calving coded as "0" for ormal calving, and "1" for calving with complications;

KJ_j – the *j-th* parity of dam ("1" – heifer , "2" – multiparous);

POH_k – the k-th sex of calf ("1" – male, "2" – female, "3" – twin);

PL_l – the l-th breed of sire (AA, BA, Ch, Lie, Pi, Si, G);

CH_m – the m-th herd;

ROK_n – the n-th year of calving;

SEZ_o – the season of calving (1-winter, 2-summer);

S_p – the random effect of the sire of calf;

$e_{ijklmnopr}$ – the residual.

The approach is suitable to evaluate the likelihood that some event happens. Even though the logistic regression is used rather often in medicine, its use in animal breeding is not common.

The statistical analysis was performed with statistical package R ver. 2.4.1. [http://www.r-project.org/; Bates *et al.* 1997].

The sires were not included in logistic model, as only fixed effects were evaluated in this way. Effect of sires was considered as being random to enable the population genetics analysis. The analysis was performed with REMLF 90 (restricted maximum likelihood programme) according to Misztal [1998] which estimates variance components. This programme also takes the pedigrees of animals into account through the relationship matrix A. In the present study, the pedigrees included 254 animals (sires, their parents and grandparents). Used was single sire model. Model equation included fixed effects, which were evaluated as being significant with logistic model, plus the random effect of sire. Estimated variance among the groups of progeny divided by sires (half-siblings) σ_s^2 is 1/4 of genetic variance of stillbirth σ_g^2. From genetic variance σ_g^2 and total variance σ^2 the stillbirth heritability coefficient was calculated ($h^2 = 4*\sigma_s^2/\sigma^2$).

The significant differences of frequencies in dystocia and stillbirths among breeds (Tab. 1) were identified by the test of difference of relative frequencies.

Table 1. Frequency of stillbirths and dystocia in beef cattle

Trait	Breed							
	Aberdeen-Angus	Blonde d´Aquitaine	Charolais	Limousin	Piemontese	Beef Simmental	Gasconne	total
Recorded births (n)	1136	256	1782	1113	842	740	101	5 970
Normal course of birth (n)	1089	234	1712	1073	794	711	101	5714
Stillbirths from normal course of birth (n)	60	7	77	43	23	23	4	237
Stillbirths from normal course of birth (%)	5.51[aA]	2.99	4.50[b]	4.01	2.90[bA]	3.23[a]	3.96	4.15
Dystocia from recorded births (n)	47	22	70	40	48	29	0	256
Frequency of recorded births (%)	4.14[A]	8.59[ABCD]	3.93[aB]	3.59[bC]	5.70[ab]	3.92[D]	0	4.29
Stillbirths from dystocia (n)	34	15	55	26	29	21	0	180
Stillbirths from dystocia (%)	72.34	68.18	78.57[a]	65.00	60.42[a]	72.41	0	70.31
Total stillbirths (n)	94	22	132	69	52	44	4	417
Total stillbirths (%)[1]	8.27	8.59	7.41	6.20	6.18	5.95	3.96	6.98

[1]Differences in the row were not significant.

[aA...]Frequencies with identical letters differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.

Results and discussion

Of 5970 calvings 5714 progressed normally, while in 256 (4.29%) dystocia occurred. The occurrence of stillbirths was as high as 6.98% (417 cases) of all births (Tab. 1).

In a separate analysis of both categories of births – normal course or dystocia – the number of stillbirths differed considerably. Stillbirths from normally running calvings reached 4.15% (237 cases of 5714), while from those with dystocia 70.31% (180 cases of 256) were recorded. Therefore, 5477 births (5970 births total, 237 stillbirths in normal course, 256 births with dystocia), i.e. 91.74% were troublefree to the extent that the course was uneventful and the calf viable. The highest frequency of stillbirth occurred in BA (8.59%) and the lowest (3.96%) in Gs calves, in which no dystocia cases were recorded at all. Thus, the robustness of the breed seems to be confirmed.

Table 2. Causes of dystocia

Trait	Breed						
	Aberdeen-Angus	Blonde d´Aquitaine	Charolais	Limousin	Piemontese	Beef Simmental	Total[1]
Dystocia	47	22	70	40	48	29	256
Uterine torsion (n)	2	1	2	3	2	2	12
Relative to dystocia (%)	4.25	4.55	2.86	7.50	4.17	6.90	4.69
Thereof stillbirth (n)	2	1	2	3	0	2	10
Uterine flexion (n)	0	0	1	0	0	0	1
Relative to dystocia (%)	0	0	1.43	0	0	0	0.39
Thereof stillbirth (n)	0	0	1	0	0	0	1
Uterine inertia (n)	13	9	10	2	7	8	49
Relative to dystocia %	27.66	40.91	14.29	5.00	14.58	27.59	19.14
Thereof stillbirth (n)	5	7	8	2	4	6	32
Narrow pelvis (n)	22	4	13	19	8	7	73
Relative to dystocia %	46.81	18.18	18.57	47.50	16.67	24.14	28.52
Thereof stillbirth (n)	21	3	9	10	5	5	53
Bad cervix opening (n)	0	3	1	1	0	0	5
Relative to dystocia %	0	13.64	1.43	2.50	0	0	1.95
Thereof stillbirth (n)	0	3	1	1	0	0	5
Oversized foetus (n)	6	2	29	7	12	7	63
Relative to dystocia %	12.76	9.09	41.43	17.50	25.00	24.14	24.61
Thereof stillbirth (n)	4	1	22	5	8	5	45
Posture (n)	2	3	3	2	6	4	20
Relative to dystocia %	4.26	13.64	4.29	5.00	12.50	13.79	7.81
Thereof stillbirth (n)	1	0	2	2	4	2	11
Position (n)	0	0	1	3	2	0	6
Relative to dystocia %	0	0	1.43	7.50	4.17	0	2.34
Thereof stillbirth (n)	0	0	1	0	1	0	2
Presentation (n)	1	0	7	1	11	1	21
Relative to dystocia %	2.13	0	10.00	2.50	22.92	3.45	8.20
Thereof stillbirth (n)	0	0	6	1	7	1	15
Malformed foetus (n)	1	0	3	2	0	0	6
Relative to dystocia %	2.13	0	4.29	5.00	0	0	2.34
Thereof stillbirth (n)	1	0	3	2	0	0	6

[1]Gasconne breed is not given, as dystocia did not occurre.

In Table 2, the causes of recorded dystocia are given. Narrow pelvis and oversized foetus were the most frequent, leading to more than 50% of all dystocia cases. The least frequent was uterine flexion, found in one birth only and representing 0.39% of all dystocia cases.

As for individual breeds, an extremely high frequency of oversized foetus was found in Ch representing 41.43% of all dystocias in this breed. Other interesting results were obtained in BA, where a relatively high occurrence of uterine inertia (40.91%) was revealed. This is more than twice of the average rate of uterine inertia in total. Narrow pelvis caused dystocia especially in AA (46.81%) and L (47.50%) cows.

Table 3. The effects on stillbirth evaluated by generalised linear model (binomial, logit)

Effect	df	Deviance	Resid. deviance	Impact of the effect %	$p>\chi^2$
None			3023.79		
Calving course	1	739.81	2283.99	24.47	0.000
Parity of dam	1	12.59	2271.39	0.42	0.000
Sex of calf	2	8.75	2262.64	0.29	0.003
Year of calving	1	11.14	2251.50	0.37	0.000
Season of calving	1	2.36	2249.14	0.08	0.120
Herd	49	107.83	2141.31	3.57	0.000
Breed of sire	6	7.02	2134.29	0.23	0.320
R^2 = 29.43	AIC[1] = 2256				

[1]Akaike Information Criterion.

The results of stillbirths analysis are shown in Table 3. The impact of calving course, parity of dam, sex of calf, year of calving, season of calving, herd, and breed of sire on stillbirths were evaluated, using a generalized linear model (binominal, logit). The effect of calving course with 24.47% impact on stillbirth variation was found to be most important. The next significant effects were herd (3.57%), dam parity (<1%), sex of calf (<1%) and year of calving (<1%). The model used explained only 29.43% of variation and thus, other effects acted in stillbirth which have not been defined. Here, the effects of heifers' body weight, cow body condition, width of pelvis, or calf birth weight should be mentioned to be of interest for the future analyses. The effects of calving season and the sire breed have to be excluded because of their insignificance. Their exclusion negligibly reduced the explained deviation (29%) and Akaike Information Criterion AIC (2256). The correlation of both traits coded as 1 (dead calf, complicated calving) or 0 (live calf, normal calving) was 0.51 (P<0.001).

Table 4 gives the estimates of parameters and odds ratios for all significant effects. The value of intercept (b_0 = -3.38) corresponds to the probability exp(-3.38)/1 + exp(-3.38) = 0.03 for the stillbirth of male calf from normal calving of a heifer during year 1999 in herd K102 (season and breed were omitted as insignificant).

Table 4. Parameter estimates and odds ratios for significant fixed effects[1] from a logistic regression model

Effect	Best value	Coefficient estimate	Standard error	Odds ratio	95% conf. interval
Intercept	-	-3.38	0.51	-	-
Calving course	normal	4.33	0.19	76.02	(52.51; 110.06)
Parity	primip. dam	-0.45	0.13	0.64	(0.49; 0.83)
Sex of calf	male	-0.44	0.13	0.65	(0.50; 0.84)
Sex twins	male	-0.08	0.46	0.92	(0.37; 2.33)
Year of calving	1999	0.08	0.03	1.08	(1.02; 1.15)

[1]The effect of the herd is not shown here because of the high number of levels.

Similarly, the probability of a stillborn male calf delivery but from a dystocia could be calculated by exp(-3.38 + 4.33) / (1 + exp(-3.38 + 4.33)), which is 0.72. The odds ratios (OR) values show that difficult calving increases the odds of stillbirth by 76 compared to normal calving. As given in Table 4, the odds of stillbirth are lesser in multiparous compared to primiparous (heifer) dams, and in female calves and in twins compared to male calves. However, the confidence interval in twins is too wide, and even includes the value of 1, indicating the low relevance of the estimate. This was partly due to the extremely low frequency of twins in the evaluated population, and in cattle generally. The odds of stillbirth also tended to increase by 0.08 per year (the effect of year was treated as continuous). Whether the trend is persistent, or the event is partial for years involved in the paper, would have to be evaluated by long time monitoring.

The population genetic analysis resulted in the estimate of genetic variance caused by sires as σ_s^2 = 1.90%. Then calculated was the value of stillbirth heritability as h^2 = 0.078.

As a troublefree birth is the first condition for successful beef cattle rearing, the incidence of stillbirth is a serious factor in the dairy cattle economy [Meyer *et al.* 2001a]. Both genetic and non-genetic factors affect the incidence, and the analysis is complexified considering that many calves seem clinically normal with no obvious reason for death [Berglund *et al.* 2003].

The heritability of stillbirth estimated in the present study is low, which is conformable with results reported by other authors [Druet *et al.* 2001, Meyer *et al.* 2001b, Eriksson *et al.* 2004]. However, the breeders should not be complacent, and Eriksson *et al.* [2004], recommend including calving difficulty in the genetic evaluation of beef breeds. Steinbock *et al.* [2003] suggest that both stillbirth and calving difficulty should be involved in the genetic evaluation of bulls for calving performance. Bures *et al.* [2008] recommended the pelves measurements and calf birth weight as potential selection criteria to reduce the risk of difficult calving. Gregory *et al.* [1991] and Bleul [2008] also discuss differences in the frequency of dystocia among breeds.

Seeing that genetically caused variability of the trait in question is low, other systematic measures have to be implemented. In analysing the causes of dystocia (Tab. 2), the prophylaxis of the foetus : pelvis disproportion seems to be very important. Evidently, a reduction in the disproportion could reduce the frequency of birth abnormalities substantially, as confirmed by Gregory *et al.* [1991], who found a significantly lower survival rate in calves heavier at birth and delivered with problems. Several preventive measures suggest themselves. First is proper rearing of heifers, mating at the proper age and body weight, and second the avoidance of sires known as giving oversized offspring. It is important to provide well qualified birth assistance. Timely recognition of approaching delivery is the first premise of its management [Sendag *et al.* 2008] Thus, the breeder has an important management tool to affect the course of the parturition.

Though many analyses have been carried out already on calving difficulty, stillbirth and birth weight, further extensive studies for the assessment of their reasons, and quantification of genetic parameters are necessary. Recently, quantitative trait loci affecting the traits mentioned have been established with promising results [Holmberg and Andersson-Eklund 2006, Guillaume *et al.* 2006, Thomasen *et al.* 2008, Olsen *et al.* 2008]. Cole *et al.* [2009] described the QTL affecting dystocia, conformation, and economic merit as being related to calf size or birth weight. Grosz and Mac Neil [2001] revealed the QTL influencing the birth weight with no significant effect on growth from birth to weaning, so potentially the incidence and degree of dystocia can be reduced without compromise of subsequent growth performance.

As birth complications and stillbirths greatly influence the economics of the beef cattle industry, their causation, both genetic and non-genetic, should be investigated seriously. Despite of the low genetic variance, it is recommended that sires with a higher incidence of dystocia or stillbirth in their offspring should not be used on heifers, and their use in breeding should overall be restricted. But breeding must be carried out advisedly, because birth mass and growth capacity correlate positively, and focusing on the course of the birth results in a reduced body mass. In such cases, genome analysis may be promising. However, as genetically caused variability is very low, other systematic care and measures are necessary to control stillbirth and dystocia. These are: proper supervision of the herd, obstetrical assistance, appropriate heifer rearing and mating at the correct weight and age to prevent the disproportion between the foetus size and pelvis dimension, as well as proper nutrition during pregnancy.

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