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Research Article

FACTORS AFFECTING CALVING DIFFICULTY ON HOLSTEIN DAIRY CATTLE

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ABSTRACT
The objective of this study was to analyze the effects of factors affecting calving difficulty in the Holstein population of the Isfahan dairy farms for subsequent compilation of the model for genetic evaluation as well as for herd management practice**.** Calving difficulty recorded in 2008-2012 was assessed in five categories1=natural, 2= with the assistance of one person without complications, 3=with the assistance of two persons with some complications, 4= hard pull, with the assistance of three or more persons, with vaginal or neck contusions and5= complicated, with serious difficulties and veterinary assistance required. A data set containing 128259 records were analyzed by a linear model with fixed effects of season, parity of dam, sex of calf. All these effects were significant, and their appropriate categorization was considered. Analyses of additional factors such as gestation length, age at first calving and calf birth weight were performed. The results revealed that gestation length was in a relationship with calving difficulty. A higher risk of difficult calving was associated with short or long gestation in multiparous cows. Data showed that dystocia heritability is between 0.13±0.01 and 0.05±0.02 on first and fifth calving parity respectively. It is obviously that calving difficulty should be adjusted for these factors. Also a decreased risk of difficult calving could be achieved by an altering of calving interval and age at first calving as a management tool.

Keywords: *Calving Difficulty, Gestation Length, Age at First Calving, Heritability, Dairy Cattle*

INTRODUCTION

Calving difficulty (dystocia) is becoming a greater concern for cattle breeders, because of the increased emphasis on rapid growth rates and improved cow efficiency. Dystocia is affected by two categories of factors: (1) those attributed to the dam, and (2) those attributed to the calf (Bellows, 1969; Xu, 2003). High calf birth weights are the main cause of dystocia (Bellows, 1969). Pelvic area of the dam must be large enough to accommodate the calf (Bellows, 2003).

Calving difficulty causes negative impact on the profitability of a herd through increased calf and heifer mortality, slower rebreeding performance, great economic losses and veterinary costs (Anderson, 1992; Belcher, 1979). Also it is affected by several nongenetic and genetic factors, including age and parity of dam sex of calf, year season, size of calf and evaluator of birth difficulty (Thompson, 1981; Bennett *et al.,* 2001; Eriksson *et al.,* 2004).

The incidence of dystocia and stillbirths tends to be population specific because of genetic factors and a range of nongenetic factors (Berry *et al.,* 2007). Mee (2008) concluded that national dystocia rates in dairy cows varied between 2% and 14%.

While occasional dystocia is almost unavoidable, through proper management, farmers can minimize that and to do this, both genetics and environmental or nutritional factors must be controlled. Previous analysis showed that cows with shorter wither height and shorter pelvises tended to require more calving assistance and heavier calves, winter calving and earlier parity all were related to increased dystocia (Fiedlerova *et al.,* 2008; Hansen *et al.,* 2004; Mohiuddin, 1993; Philipsson, 1976).

It would be highly desirable to identify factors associated with calving difficulty. Such information could be beneficial in determining procedures to identify and cull heifers with a high likelihood of being difficult calvers and developing management techniques to minimize calving problems in the breeding herd. The objective of this study was to analyze the effects of factors affecting calving difficulty in the

Holstein population of the Isfahan dairy farms in Iran. Furthermore, the knowledge of these investigated effects might also be applied in herd management practice.

MATERIALS AND METHODS

Records of reproductive traits such as days of gestation, birth weight, age of each cow, year and season of calving, twin birth and calving difficulty and dystocia rate in the Holstein breed gathered by Vahdat Cooperative Company in Isfahan, Iran dairy farms due 2008-2012 were used in this study (about 128259 record were used). Multiple births were omitted. Together with the calving score, the sex of the calf born was recorded but not in stillbirths. Mother's age at calving was obtained by subtracting the date of their birth and calving date of them. Gestation period was obtained by subtracting of inoculation resulted in pregnancy and calving date. Calving difficulty was assessed by farmers in five categories: 1= natural, 2 = with the assistance of one person without complications, 3 = with the assistance of two persons with some complications, 4 = hard pull, with the assistance of three or more persons, with vaginal or neck contusions and 5 = complicated, with serious difficulties and veterinary assistance required.

Statically Analysis

Fixed factors affecting dystocia include seasons, age, birth mothers, type of birth and sex of calves were included in the statistical model. Analyses undertaken to identify none genetic sources of variation used the GLM procedure of SAS (2003) for the multivariate least squares method. Also additional models were compiled for investigating the possible structure of these factors or for adding others (herd, year, season, type of birth, gestation length, age at first calving, preceding calving interval).

Estimation of Genetic Parameters

The different breeds were analyzed separately. Both univariate and bivariate linear animal models were used. The basic bivariate model for estimating variance components for first parity traits was:

$y = Xb + Z_d d + Z_m m + e$

Where: d= Random additive genetic effect of calf, m= Maternal genetic random effects, Z_d and Z_m = Correlation matrix of the observations.

Heritability

Co variances were estimated using the average information algorithm for restricted maximum likelihood included in the DMU package (Jensen and Madsen, 1994). Standard errors of genetic correlations were obtained by Taylor series expansions (Madsen and Jensen, 2000). Direct and maternal heritabilities on the observable scale were calculated as σ 2a / σ 2P and σ 2m /σ 2P , respectively, where σ 2P = σ 2m + σ a,m + σ 2a + σ 2e for all traits in the first parity and σ 2P = σ 2pe + σ 2m + σ a,m + σ 2a+ σ 2e for later parities. Heritabilities on the under lying continuous scale were approximated from the heritabilities on the observable scale to enable comparisons with other studies, using a transformation described by Gianola (1982):

$$h^2_{\text{underlying}} = h^2_{\text{observed}} \left[\left(\sum_{k=1}^{m} \eta_k^2 \pi_k \right) - \left(\sum_{k=1}^{m} \eta_k \pi_k \right)^2 \right] \Bigg/ \left[\sum_{k=1}^{m-1} z_k (\eta_{k+1} - \eta_k) \right]^2$$

Where ηk is the score for response, π k is the probability of response in the kth category (k = 1, 2… m), and zk is the ordinate of a standard normal density function corresponding to thresholds between categories k and k + 1. For two response categories as for stillbirth, it reduces to: h 2 underlying =h 2 observed [π (1 − π)]/z 2, as shown in (Dempster and Lerner, 1949).

RESULTS AND DISCUSSION

Results

The means for varying levels of fixed effects on dystocia are shown in table 1. According to this analysis of variances, herd and year of calving traits were significant on dystocia (p≤0.01). The effect of parity on five different levels of dystocia was significant and multiparous cows had greater tend to dystocia

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compared to heifers ($p \leq 0.01$). Also dystocia had seen greater in twin calving. The effect of sex of calf was significant on dystocia and it was at highest on causing male cows ($p \leq 0.01$). Data showed that the gestation period had a linear relationship with dystocia and cows with long gestation periods more talented to dystocia. In addition the effect of maternal age and calf birth weight were significant on dystocia probability.

Table 1: Incidence analysis of factors affecting dystocia

Traits and effects	GLM Generalized Linear
Herd	***
Year of calving	***
Season	
Spring	$2.037 \pm 0.013^{a**}$
Summer	2.019 ± 0.013^{b}
Autumn	2.031 ± 0.013^{a}
Winter	2.035 ± 0.013^{a}
Parity	
1	1.84 ± 0.01^{e}
2	1.93 ± 0.01^{d}
3	2.02 ± 0.01^{c}
4	2.11 ± 0.01^{b}
5	2.16 ± 0.01^{a}
Type of birth	
Single	1.083 ± 0.012^{b}
Twins	2.020 ± 0.014^{a}
Sex	
Male	1.97 ± 0.01^{b}
Female	2.07 ± 0.01^{a}
Gestation length	$0.0008 \pm 0.0001^{**}$
Age	$0.0002 \pm 0.0001^{**}$
Calf birth weight	$0.0151 \pm 0.0003^{**}$

***Means within row with no common on letter are significantly different ($p<0.01$)*

The results of logistic regression are shown in table 2. These data showed that with different levels affecting dystocia significant effects of these changes would be seen ($p \leq 0.01$).The spring was associated with more difficult calvings, whereas the autumn with slightly easier ones, as shown in table 2. There is, however, hardly any possibility of generalizing the differences in calving performance based on the seasons of calving.

Table 2: Logistic regression analysis of factors affecting dystocia

Traits and effects	Likelihood ratio
Herd	***
Year of calving	***
Season	
Spring	1.03[a]
Summer	0.97[b]
Autumn	1.00[ab]
Winter	1.02[a]
Parity	
1	0.77[b]
2	0.24[e]
3	0.36[d]
4	0.54[c]
5	1.00[a]
Type of birth	
Single	1.00[a]
Twins	0.25[b]
Sex	
Male	1.00[a]
Female	0.68[b]
Gestation length	1.004**
Age	1.001**
Calf birth weight	1.064**

***Means within row with no common on letter are significantly different (p<0.01)*

Parity was fitted as a 5 level factor, according to the lactation number. Calving difficulty in primiparous cows were significantly differed ($p \leq 0.01$) to each other. The estimated effect of parity 5 was at the highest, which means the highest frequency of difficult calvings, whereas the fewest difficulties were in parity 2, and after that calving difficulty rose until parity 5 significantly($p \leq 0.01$). The sex of the calf born was the strongest effect in the model show a great difference between male and female calf sex groups ($p \leq 0.01$). Also Male calves were delivered with more difficult calvings. Gestation length is often analyzed as a calving trait ($p \leq 0.01$). Data from this study showed that gestation length, age and calf birth weight had significant effects on dystocia ($p \leq 0.01$).
A multivariate analysis by the linear model for variance components and genetic parameters for dystocia is shown in table 3. Considering calving difficulty as a trait of the calf and using records from cows of all age classes heritability was estimated at 0.13±0.01 and 0.05±0.02 on first and fifth calving parity respectively.

Table 3: Multivariate analysis by the linear model for genetic parameters for dystocia

Parity	σ^2_a	σ^2_{hys}	σ^2_e	σ^2_p	$h^2 \pm s.e$	hys^2
1	0.0065	0.0017	0.0032	0.3478	0.02±0.01	0.02±0.02
2	0.0065	0.0017	0.0032	0.3478	0.02±0.01	0.02±0.02
3	0.0040	0.0011	0.0042	0.3017	0.13±0.01	0.02±0.02
4	0.0042	0.0054	0.2520	0.2615	0.02±0.01	0.02±0.01
5	0.0104	0.0033	0.1940	0.3074	0.05±0.02	0.02±0.01

Discussion

In this study herd and year of calving traits were significant on dystocia and the effect of parity on five different levels of dystocia was significant and multiparous cows had greater tend to dystocia compared to heifers. Calving difficulties increase the risk of calf death at or shortly after calving 2.91-fold in primiparous cows and 4.67-fold in multi-parous cows (Meyer *et al.*, 2001). Kontik *et al.*, (2009) showed that Effects of parity, single or twin births and birth weight were highly statically significant (P<0.001).Also they showed that high percent age of difficult calving at first parity, whereas among other there were no statically significant differences. Difficult calving was around three times more frequent at first parity then later parities. Dargatz *et al.*, (2004) analyzed 29,375 suckler cows and established 16.7% of dystocia at heifers and 2.8% at other cows. Anderson (1992) represented results of calving difficulty on crossbred cows.

Akpa *et al.*, (2007) reported that the age, parity and dam body condition had significant effect (P<0.01) on calving ease of the dams. They also showed that the variation of calving ease due to the effect of age, parity and body condition of the dam. Cady (2004) reported that the heritability of calving ease is at low range from 5 to 15%, this means that, at most, about 85% of the variation in dystocia can be attributed to environmental or management factors.

Akpa *et al.*, (2002) showed that calving ease increased with parity and body condition of dam with highest parity and body condition producing the best calving ease of 89 and 67%, respectively.

Some scientists showed that dystocia score was significantly affected by county of birth, parity of dam, sire, type of birth, twin birth and birth weight (P < 0·001) but there were no significant effects of breed or size of cow (Thompson *et al.*, 1981; Johanson, 2003; Hansen *et al.*, 2004; Gregory *et al.*, 1996).

The research indicated that heifer calves were associated with fewer calving problems than were bull calves. However, since calf sex is determined at conception, we are not able to do much about this problem unless sex control can be achieved. Production of only female calves from first-calf heifers would potentially reduce dystocia (Bellows, 1969).

Some researchers showed that since the heifers were all treated alike following the winter diet treatments, the calving data shows an important carryover effect of the dietary level. Development of heifers on the low feed level was retarded, and they had smaller pelvic areas at calving and a higher incidence of dystocia (Dematawewa *et al.*, 1997; Berger *et al.*, 1992; Anderson, 1992).

Dystocia studies conducted to date have examined many factors perceived to relate to both incidence and severity of dystocia. Specific factors studied include breed of dam, breed of sire, gestation feed levels, age of dam, shape, size, and pelvic area of the dam, calf shape, size, and sex, gestation length, etc. By examining the R2 values (coefficient of determination) of dystocia studies in the literature you discover a very important point (Bellows, 2003).

Smidt and Cloppenburg (1967) reported heritability estimates of 0.043 in first calf heifers and 0.037 in older cows.

The variations in gestation length with breed origin observed in this study had also been reported by (Goyache *et al.*, 2002).

Brinks *et al.*, (1973) showed that most calving difficulty occurs in first calf and 2year-old dams. They showed that frequency of calving difficulty differed with ages of dam with 2year-old dams experiencing the most difficulty (29.7%), they also reported that calving difficulty was more pronounced with male births (10.5%) than with births of females (7.1%).

Eriksson *et al.*, (2004) reported that heritabilities on the observable scale for calving difficulty score of Charolais and Hereford, scored in three classes, ranged from 0.11 to 0.16 for direct and 0.07 to 0.12 for maternal effects at first parity, and lower at later parities.

Calving difficulty and stillbirth generally have higher incidences in the first parity vs. later parities and have been suggested in some studies to be genetically different, but correlated, traits in first-and second-parity cows (Steinbock *et al.*, 2003).

Eriksson *et al.*, (2004) showed that there was a clear tendency for increased risk of calving difficulty for calves with high birth weights.

Eriksson *et al.,* (2004) reported that the estimated heritabilities on the observable scale for calving difficulty score at later parities ranged from 0.02 to 0.04 and from 0.004 to 0.03 for direct and maternal effects, respectively.

Lower heritabilities of calving traits for cows than for heifers are commonly found in the literature (Steinbock *et al.,* 2003).

Koots *et al.,* (1994) reported high positive average genetic correlations between calving ease in heifers and cows, both for direct (0.81) and maternal (0.75) effects, and a lower correlation of 0.32 between direct effects on perinatal mortality in heifers and cows. Mee *et al.,* (2008) demonstrated that many of the significant risk factors associated with dystocia detected here were largely not under management control (month of calving, twin calving, prim parity, previous dystocia, and fetal gender). Siber *et al.,* (1989) found that heavier calves, winter calvings, and earlier parity all were related to increased dystocia and male calves were heavier than female calves and also were associated with greater calving difficulty. The results of (Fiedlerova *et al.,* 2008) study revealed that gestation length was in a non-linear relationship with calving difficulty. A higher risk of difficult calving was associated with short or long gestation and with a prolonged preceding calving interval in multiparous cows.

These results agree with other studies indicating important influences of age of dam, sex of calf and type of breeding on calving difficulty (Brinks *et al.,* 1973; Siber *et al.,* 1989; Mee *et al.,* 2008; Steinbock *et al.,* 2003; Dematawewa *et al.,* 1997).

Conclusion

Many factors affect calving difficulty, which can reduce the maximum production capability of the calf and extends the post partum interval of the dam. Managing herd with the goal of reducing calving difficulty should result in more live, vigorous calves that achieve desired weight gains, along with dams that breed during the designated breeding season, and ultimately improve overall production potential. The important point to improve calving performance is precision of data recording and reducing the influence of many non-genetic factors. The analysis of these effects showed significant effects of gestation length and preceding calving interval as well. Therefore, dystocia should be adjusted for these factors. An altered calving interval and age at first calving could be used as a management tool for decreasing the risk of difficult calvings, and these should be considered in a mating strategy.

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