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Prevalence, Risk Factors and Consequent Effect of Dystocia in Holstein Dairy Cows in Iran

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ABSTRACT : The objective of this research was to determine the prevalence, risk factors and consequent effect of dystocia on lactation performance in Holstein dairy cows in Iran. The data set consisted of 55,577 calving records on 30,879 Holstein cows in 30 dairy herds for the period March 2000 to April 2009. Factors affecting dystocia were analyzed using multivariable logistic regression models through the maximum likelihood method in the GENMOD procedure. The effect of dystocia on lactation performance and factors affecting calf birth weight were analyzed using mixed linear model in the MIXED procedure. The average incidence of dystocia was 10.8% and the mean (SD) calf birth weight was 42.13 (5.42) kg. Primiparous cows had calves with lower body weight and were more likely to require assistance at parturition (p<0.05). Female calves had lower body weight, and had a lower odds ratio for dystocia than male calves (p<0.05). Twins had lower birth weight, and had a higher odds ratio for dystocia than singletons (p<0.05). Cows which gave birth to a calf with higher weight at birth experienced more calving difficulty (OR (95% CI) = 1.1(1.08-1.11). Total 305-d milk, fat and protein yield was 135 (23), 3.16 (0.80) and 6.52 (1.01) kg less, in cows that experienced dystocia at calving compared with those that did not (p<0.05). (**Key Words :** Birth Weight, Dystocia, Holstein)

INTRODUCTION

Dystocia, more commonly known as difficult calving, defined as a prolonged or difficult parturition varies from the need for increased producer attention to the loss of the cow and calf (Meijering, 1984; Carnier et al., 2000). Difficult birth is a leading cause of calf death at or shortly after birth and leads to uterine infections and more retained placentas. Several studies have implicated dystocia as contributing factors to reduced milk yield and reproductive performance (Dematawena and Berger, 1997; Fourichon et al., 2000; Lopez de Maturana et al., 2007). Genetic, environmental, and management factors have varying degrees of influence on dystocia (Johanson and Berger, 2003; Adamec et al., 2006; Mee, 2008).

The objective of this study was to determine prevalence and risk factors for dystocia in Holstein dairy cows in Iran. The effect of dystocia on the subsequent lactation performance was examined as well.

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MATERIALS AND METHODS

Data editing and traits definition

The data were collected by dairy producers according to the instructions of the Animal Breeding Center of Iran. The data set consisted of 55,577 calving records on 30,879 Holstein cows in 30 dairy herds for the period March 2000 to April 2009. Information recorded included date of calving, dystocia score, calf gender, birth number (single vs. twin), calf birth weight, dam parity, age at first caving (FCA) and 305-d lactation performance.

The herds were managed under conditions similar to most developed countries and were under official performance and pedigree recording. Herd size varied from 20 to 3,000 dairy cows and 305-d milk yield varied from 6,000 to 12,500 kg averaging over 7,000 kg. Cows were milked 3 times a day. The main components of the dairy ration consisted of corn silage, alfalfa hay, barley grain, fat powder, beet pulp, and feed additives and cows were fed by total mixed ration. Although, recording of production data for individual cows goes back to the early 1980s, the main emphasis in selecting bulls and cows in Iran is focused on estimated breeding value of milk yield. Artificial insemination is used for almost all of the Holstein dairy herds, and 60 to 80% of semen is usually of North American proven sires.

Farmers, upon observing parturition, subjectively assigned scores according to degree of assistance provided. Recognized dystocia scores were CES1 = no problem, CES2 = slight problem, CES3 = needed assistance, CES4 = considerable force, CES5 = extreme difficulty. In the present study, dystocia scores of 1 or 2 were coded as unassisted, and scores of ≥3 were coded as assisted calvings. The interaction combinations of calf sex and birth number were shown by SST and coded as SM and SF for male and female sex in singletons, TMM, TFF and TMF for male pairs, female pairs and mixed-sex pairs in twin births. Data on parity number of cows were grouped into five classes, parities 1, 2, 3, 4, or ≥5.

Statistical methods

Factors affecting calf birth weight were analyzed using mixed linear model by the PROC MIXED in SAS (2003). In the model, sire of the calf was included as a random effect with a compound symmetry correlation structure assumed among progeny within sire. Factors included in the model were year of calving, season of calving, herd, parity of dam, SST as well as FCA.

Factors affecting dystocia were analyzed using multivariable logistic regression model through maximum likelihood method of the PROC GENMOD in SAS (2003). Dependent variables, dystocia scores, were 0 for unassisted and 1 for assisted calving, sire of the calf was included as a random effect with a compound symmetry correlation structure assumed among progeny within sire. Factors included in the model were farm, year and season of calving, parity of dam, SST, as well as FCA and calf birth weight (the average birth weights of calves, in twin births). Reference categories for the comparison of odds ratios (ORs) for each effect were as follows: spring, parity 1, and SM. For calf birth weight and FCA as continuous independent variables, the change in the OR of the dependent variable per 1unit change in the independent variable was evaluated.

The effect of dystocia on 305-d milk, fat and protein yield was determined using multiple regression mixed models in SAS (2003) through the inclusion of dystocia, parity, herd, calving year, calving season, birth number, FCA, calf birth weight and random effect of dam's sire.

RESULTS

Factors affecting twinning and calf birth weight

Of 55,577 births, 96.9% were singleton and 3.11% were twin. The percentage of male and female calves among all singleton births was 50.7 and 49.3%, respectively. Of the 1,731 twin births, 28.0, 27.2, and 44.8% were of male pairs, female pairs and mixed-sex pairs, respectively.

Twinning was significantly influenced by calving year, calving season, parity of dam and herd ($p<0.05$). There was no difference between the observed twinning rates in calving season of spring and summer (OR (95% CI) = 0.99 (0.86-1.12) for summer vs. spring calving), but twinning rate in calving season of fall and winter was smaller than in spring (ORs (95% CI) = 0.82(0.72-0.94) and 0.79(0.66-0.94) for fall and winter vs. spring calving, respectively). Parity of the dam was a significant source of variation for twinning with percentages of twinning for parities 1, 2, 3, 4 and ≥5 being 0.77, 3.7, 4.2, 4.4, and 4.3%, respectively ($p<0.05$).

The mean (SD) calf birth weight was 42.13 (5.42) kg with a range of 19.6 to 64.7 kg. Factors affecting the calf birth weight were farm, parity of dam, SST, calving year and calving season. The least squares mean (SE) calf weight of male and female singletons were 43.9 (0.03), and 41.4 (0.03) kg, respectively ($p<0.05$), while corresponding values for male pairs, female pairs and mixed-sex pairs in twin births were 34.4 (0.21), 32.9 (0.22), and 33.9 (0.17) kg, respectively. Calves born in spring had the highest (37.8 (0.08)) and those born in fall had the lowest (36.9 (0.08) kg) birth weight ($p<0.05$). Calves from primiparous cows had lower birth weights than those from multiparous cows ($p<0.05$). The estimated least squares mean (SE) of calf weight of first parity cows was 35.2 (0.08) kg, while corresponding value for parity 2, 3, 4 and ≥5 was 37.3 (0.08), 37.9 (0.08), 38.1 (0.09), and 37.8 (0.09) kg, respectively ($p<0.05$).

Factors affecting dystocia

Of 55,577 births, 89.2% required no assistance, while 10.8% required assistance of some sort. Odds ratios and corresponding confidence intervals for dystocia are in Table 1. Factors associated with the presence of dystocia were calving season, calving year, SST, herd, calf birth weight and parity of dam ($p<0.05$). The season of calving significantly influenced calving difficulty where the lowest dystocia frequency was observed when parturition occurred in summer and fall (ORs (95% CI) = 0.89(0.79-0.99) and 0.78 (0.69-0.87) for calving season of summer and fall vs. spring, respectively). There was no difference between probabilities of calving difficulty for parturitions occurred in spring and winter (OR (95% CI) = 0.93(0.84-1.04)). As expected, gender of calf and birth number (single vs. twin) explained significant variation for dystocia ($p<0.05$). In singletons, 8.84% of female calves were delivered with assistance compared with 12.5% of male calves (OR (95% CI) = 0.81(0.74-0.88) for dams giving birth to female than male calves). The risk was considerably higher when twin births occurred (ORs (95% CI) = 33(11.3-99), 43(14-129),

Table 1. Odds ratios (95% CI) for the effects of parity, calving season, SST[1] and change in calf birth weight on dystocia in Holstein cows in Iran (n = 55,577)

Variable	No. of calvings	Odds ratio (95% CI)	p-value
SST			<0.05
SM[2]	27,293	OR reference value	
SF[3]	26,553	0.81 (0.74-0.88)	<0.05
TMM[4]	485	33 (11.3-99)	<0.05
TMF[5]	776	43 (14.2-129)	<0.05
TFF[6]	470	38 (12.2-117)	<0.05
Parity			<0.05
Parity = 1	16,220	OR reference value	
Parity = 2	14,295	0.29 (0.26-0.33)	<0.05
Parity = 3	10,358	0.29 (0.26-0.33)	<0.05
Parity = 4	6,913	0.28 (0.25-0.33)	<0.05
Parity ≥5	7,791	0.30 (0.26-0.35)	<0.05
Calving season			<0.05
Spring	12,816	OR reference value	
Summer	15,978	0.89 (0.79-0.99)	<0.05
Fall	14,629	0.78 (0.69-0.87)	<0.05
Winter	12,154	0.93 (0.84-1.04)	≥0.05
Per kg increase in calf birth weight			
In singletons		1.10 (1.08-1.11)	<0.05
In twin births		1.02 (0.99-1.05)	<0.05

[1] The interaction combinations of calf sex and birth number.
[2] SM = Male sex in singleton births.
[3] SF = Female sex in singleton births.
[4] TMM = Male pairs in twin births.
[5] TMF = Mixed-sex pairs in twin births.
[6] TFF = Female pairs in twin births.

and 38(12-117) for TMM, TMF and TFF vs. SM, respectively). Cows which gave birth to a calf with higher weight at birth experienced more difficult at the calving (OR (95% CI) = 1.1(1.08-1.11)), but such an association was not found in cows which gave birth to two calves (OR (95% CI) = 1.02(0.99-1.05)).

Parity of the dam was a significant source of variation for dystocia ($p<0.05$). First-parity cows were more likely to have a difficult calving relative to older cows, whereas older parity cows did not significantly differ from each other in risk of dystocia. The odds (95% CI) of dystocia for a second, third, fourth, and fifth or greater parity cow relative to a first-parity heifer was 0.29 (0.26-0.33), 0.29 (0.26-0.33), 0.28 (0.25-0.33), and 0.30 (0.26-0.35), respectively.

Effect of dystocia on the subsequent lactation performance

The mean (SD) of 305-d milk, fat and protein yield was 7,512 (1,780), 237.4 (51.3), and 238.5 (64.2) kg, respectively. 305-d lactation performance was associated with dystocia, parity, herd, calving year, calving season, FCA, as well as calf birth weight (Table 2). The estimated least squares mean of 305-d milk, fat and protein yield in cows with assisted and unassisted calving was 7,558 (40) and 7,693 (34), 239 (1.3) and 242 (1.2), and 232 (3.7) and 238 (2) kg, respectively ($p<0.05$). Total 305-d milk, fat and protein yield was 135 (23), 3.16 (0.80) and 6.52 (1.01) kg less, in cows that experienced dystocia at calving compared with those that did not. Birth number had no significant effect on subsequent 305-d milk, fat, or protein yield ($p\geq0.05$). Cows which gave birth to calf with higher weight at birth, produced more 305-d milk, fat and protein in the subsequent lactation ($p<0.05$).

DISCUSSION

In the present study, more than 3.11% of calves were twins with the majority of twins born to multiparous cows. The twinning rate in the present study, although smaller than reported in some studies (Nielen et al., 1989; Olson et al., 2009), was within the range reported by others (Eddy et al., 1991; Berry et al., 2007). The mean (SD) calf birth weight was 42.1 (5.4) kg and affected by farm, parity of dam, SST, calving year and calving season which is in close agreement with earlier research (Johanson and Berger, 2003; Linden et al., 2009; Olson et al., 2009).

The average incidence of dystocia was 10.8%, and varied from 16 to 8% in primiparous and multiparous dams, respectively. The incidence of dystocia observed in the present study is comparable to other international estimates (Berry et al., 2007; Mee, 2008; Linden et al., 2009) apart from in the US (Meyer et al., 2001; Johanson and Berger, 2003; Lombard et al., 2007). Because most researchers excluded twin births (Johanson and Berger, 2003; Lombard et al., 2007; Linden et al., 2009), fewer reports are available on the effect of birth number (single vs. twin) on dystocia. In the present study, twins had lower birth weight, and were more likely to require assistance during calving than singletons, which is in agreement with earlier reports (Echternkamp and Gregory, 1999; Ettema and Santos, 2004; Berry et al., 2007).

Cows which gave birth to a calf with higher weight at birth experienced more difficult at the calving, which confirms earlier results that calf weight is associated with dystocia (Johanson and Berger, 2003; Berry et al., 2007; Lombard et al., 2007; Linden et al., 2009). Because birth weight is not commonly measured in field data for Holsteins, few studies have examined the relationship between calf birth weight and dystocia (Johanson and Berger, 2003). Despite the inclusion of calf weight in the statistical model, in singletons, cows that delivered a male calf were 0.20 times more likely to experience dystocia than

Table 2. Estimated least squares mean (se) of the effect of parity, calving season, dystocia birth number, and calf birth weight on 305-d lactation performance in Holstein cows in Iran (n = 55,577)

Variable	305-d milk (kg)	305-d fat (kg)	305-d protein (kg)
Birth number			
Singletons	7,568 (12.7)[a]	240.7 (0.45)[a]	234.2 (1.5)[a]
Twin births	7,683 (68.0)[a]	240.1 (2.4)[a]	235.6 (3.2)[a]
Parity			
1	7,157 (37.2)[e]	224.1 (1.3)[d]	217.7 (2.1)[d]
2	7,834 (37.1)[b]	244.4 (1.3)[b]	240.9 (2.1)[b]
3	7,985 (37.8)[a]	249.4 (1.3)[a]	244.5 (2.1)[a]
4	7,783 (39.0)[c]	243.9 (1.4)[b]	235.9 (2.2)[c]
≥5	7,370 (38.8)[d]	239.7 (1.4)[c]	235.4 (2.2)[c]
Calving season			
Spring	7,507 (37.2)[c]	233.5 (1.3)[d]	231.3 (2.1)[b]
Summer	7,421 (37.2)[d]	237.5 (1.3)[c]	230.4 (2.1)[b]
Fall	7,810 (37.2)[a]	247.4 (1.3)[a]	238.8 (2.1)[a]
Winter	7,370 (37.2)[b]	243.3 (1.3)[b]	239.1 (2.1)[a]
Dystocia			
Unassisted calving	7,693 (34)[a]	242.1(1.2)[a]	238.2 (2.0)[a]
Assisted calving	7,558 (40)[b]	239.2 (1.3)[b]	231.6 (2.2)[b]
Increase in lactation performance per kg increase in calf birth weight:			
In singletons	34.3 (1.35)*	0.87 (0.04)*	0.97 (0.06)*
In twin births	31.7 (7.15)*	0.61 (0.20)*	0.66 (0.30)*

[a-d] Within columns for each factor, the least square means with a common superscript do not differ significantly ($p \geq 0.05$).
* Significant at $p<0.05$.

cows that delivered a female calf, which is in agreement with the earlier reports (Johanson and Berger, 2003; Berry et al., 2007). This indicates, that differences between calf sex other than birth weight influence dystocia (Berry et al., 2007). Cows calved in summer and fall had lower birth weight and was 0.11 and 0.22 times less likely to develop dystocia than those calved in spring, respectively. Johanson and Berger (2003) reported that calves born in winter were 15% more likely to need assistance than calves born in summer. Andersen and Plum (1965) reported that calves born during winter had slightly longer gestations and were a little heavier at birth.

Lactation performance was influenced by dystocia where total 305-d milk, fat and protein yield was 135 (23), 3.16 (0.80) and 6.52 (1.01) kg less, in cows that experienced dystocia at calving compared with those that did not, which is in a close agreement with earlier studies (Dematawena and Berger, 1997; Berry et al., 2007). Berry et al. (2007) reported that total 60 and 270-d milk yield was 42.0 and 61.9 kg less, respectively, in cows that experienced dystocia at calving compared with those that did not. The negative effect of dystocia on lactation performance is comparable with mastitis or lameness (Dematawena and Berger, 1997; Rajala-Schultz et al., 1999; Rajala-Schultz and Grohn, 1999).

IMPLICATIONS

Although, calf weight and birth number (single vs. twin) have been reported as the most important factors influencing dystocia by several researchers (Johanson and Berger, 2003; Berry et al., 2007; Linden et al., 2009), there is no formal genetic evaluation of sires for calf birth weight or twinning in Holstein. This study suggests that genetic selection for lowering the birth weight of calf could be one means of reducing the incidence of dystocia in dairy cattle.

Because younger females experience higher rates of dystocia than older ones and females producing heifers have lower incidence of dystocia than those producing males, mating younger cows with sexed semen to produce heifer calves may also be a practical way of reducing calving difficult (Norman et al., 2010). Dystocia significantly decreased lactation performance, so in any economic evaluation of dystocia, not only the lost calf, veterinary costs, the reduced survival, and the increased days open should be taken into account, but also the decreased lactation performance.

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