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Association between dry period length and lactation performance, lactation curve, calf birth weight, and dystocia in Holstein dairy cows in Iran

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ABSTRACT

In this study, 65,971 lactations on 41,842 cows in 64 herds were used to determine the association between dry period length (DPL) and lactation performance, lactation curve, calf birth weight, and the incidence of calving difficulty during the subsequent parity in Holstein dairy cows in Iran. The length of the dry period was classified into 7 categories: 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d. Cows with the standard DPL (51 to 60 d) produced more 305-d milk, fat, and protein over the next lactation compared with those with shorter dry periods. Shorter dry periods (0 to 35 d and 36 to 50 d) were associated with lower initial milk yield, steeper inclining and declining slopes of the lactation curve, and higher milk persistency compared with dry period length of 51 to 60 d. Peak lactation was achieved later in cows with 0- to 35-d and 36- to 50-d dry period length than in those with dry period length of 51 to 60 d. We also observed a relationship between DPL and calf birth weight: smaller calf birth weight was recorded with a dry period of 51 to 60 d compared with longer dry periods. The incidence of calving difficulty did not differ in cows with 51- to 60-d dry period compared with cows with 0- to 35-d and 36- to 50-d dry periods. In conclusion, the results of this study did not support previous findings that suggested a shorter dry period could be beneficial to dairy production.
Key words: dry period length, lactation performance, lactation curve

INTRODUCTION

It is traditionally believed that dairy cows require a dry period between lactations to achieve maximum milk yield in the subsequent lactation (Collier et al., 2012). The traditional 305-d lactation and 51- to 60-d dry period has been in practice since World War II in the United Kingdom and later in the United States (Bachman and Schairer, 2003). However, optimal dry period length (**DPL**) may vary depending on parity, herd size, and level of milk production, among other factors (Grummer and Rastani 2004). Quantifying the potential effect of DPL on subsequent lactation performance is critical for choosing an optimum DPL in dairy cows (Sørensen and Enevoldsen, 1991; Annen et al., 2004; Rastani et al., 2005). Shortening the DPL between lactations in dairy cows has been an active area of research for several years (Gulay et al., 2003; Grummer and Rastani, 2004; Gumen et al., 2011; Collier et al., 2012). Although several reports indicated that reducing the DPL resulted in a reduction in milk yield in the next lactation (Dias and Allaire, 1982; Sørensen and Enevoldsen, 1991; Makuza and McDaniel, 1996; Watters et al., 2008; Mantovani et al.,2010), other studies indicated that the optimum DPL may be shorter than previously considered, and that a 30- to 40-d dry period is sufficient for maximizing milk yield in dairy cows (Bachman, 2002; Bachman and Schairer, 2003; Gulay et al., 2003; Annen et al., 2004; Pezeshki et al., 2007). Watters et al. (2009) also reported that shortening the dry period (35 vs. 43 d) was associated with better postpartum reproductive performance. The effect of DPL on subsequent lactation performance may be quantified more accurately, and in more detail, using mathematical models describing the lactation curve (Rajala and Grohn, 1998). Therefore, the first aim of this research was to characterize the DPL in Holstein cows in Iran. The second aim was to use an incomplete gamma function to quantify the association between different lengths of dry period and the subsequent lactation curve and partial and 305-d lactation performance. The association of different lengths of dry period with calf birth weight and dystocia during the subsequent lactation was also determined.

MATERIALS AND METHODS

Data used in this study were records on Holstein cows collected from January 2000 to December 2009 by the Animal Breeding Center of Iran (Karaj, Iran). The herds evaluated were purebred Holsteins, managed under conditions similar to those used in most developed countries, and were under official performance and pedigree recording. The diet was fed as a TMR

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and consisted of corn silage, alfalfa hay, barley grain, fat powder, beet pulp, and feed additives. Monthly milk recording was performed by trained technicians of the Iranian Animal Breeding Center, according to the guidelines of the International Committee for Animal Recording (ICAR, 2011). Farmers, upon observing parturition, subjectively assigned a calving ease score according to the degree of assistance provided. Recognized dystocia scores were as follows: 1 = no problem, 2 = slight problem, 3 = needed assistance, 4 = needed considerable force, and 5 = extreme difficulty. In this study, dystocia scores of 1 or 2 were coded as easy calving, and scores of ≥3 were coded as difficult calving.

Cows with missed birth date, calving date, breeding date, drying date, and parity number were deleted. Cows were required to have a minimum of 5 test-day records per lactation. Tests before 6 d or after 320 d were excluded. First calving age was calculated as the difference between birth date and calving date at first parity and was restricted to the range of 540 to 1,200 d. Dry period length was calculated as the time length between previous drying off date and the subsequent calving date. Days dry were required to be between 0 and 160 d in length. Ultimately, the data set used to describe lactation curve included 789,254 test-day records from 85,816 lactations on 52,421 cows distributed in 64 herds.

To describe the lactation curve, an incomplete gamma function proposed by Wood (1967) was used. The function was as follows: $y_t = at^b e^{-ct}$, where y_t is the daily milk yield (kg/d) at DIM t, the variable t represents the length of time since calving, e is the Neper number, a is a parameter representing yield at the beginning of lactation, and b and c are factors associated with the upward and downward slopes of the lactation curve, respectively. The incomplete gamma function was transformed logarithmically into a linear form as $\ln(y_t) = \ln(a) + b\ln(t) - ct$, and was fitted to 789,254 test-day milk records corresponding to 85,816 lactations, using a simple program written in Visual Basic (Microsoft Corp., Redmond, WA). The time at which peak lactation occurred ($T_{\max}$) was defined as $T_{\max} = (b/c)$, expected maximum yield ($y_{\max}$) was calculated as follows: $y_{\max} = a(b/c)^b e^{-b}$, persistency ($s$) was calculated as follows: $s = -(b + 1)\ln(c)$, and total yield from the time of calving up to 100, 200, and 305 DIM was calculated as $y = a\int_1^n t^b e^{-ct}\mathrm{d}t$, where n = 100, 200, and 305, respectively. Typical lactation curves had positive a, b, and c, and curves with negative a, b, or c were considered atypical. Of 85,816 lactations, 19,845 (23.12%) had atypical lactation curves and were excluded. Finally, a total of 607,814 test-day milk records corresponding to 65,971 lactations on 41,842 in 64 herds, were used to determine the association between DPL and lactation performance, lactation curve, calf birth weight, and the incidence of calving difficulty during the subsequent parity.

The effect of level of 305-d milk yield on the subsequent DPL was determined using a mixed linear model through the inclusion of herd-calving year-calving season combination (**HYS**), parity (1, 2, 3, and ≥4), age at first calving (**FCA**), and random effect of the dam's sire.

The effect of DPL on subsequent lactation performance, lactation curve parameters, birth weight, and dystocia was determined using a categorical variable for DPL, as suggested by Kuhn and Hutchison (2005). The DPL was classified into 7 categories: 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d. The corresponding number of animals in each category was 3,427, 5,197, 15,929, 21,204, 11,253, 4,824, and 4,137. Cows were also grouped by parity: primiparous (n = 30,558) and multiparous (n = 35,413) cows. The effect of DPL on parameters describing the subsequent lactation curve, as well as partial and 305-d lactation performance, was determined using multiple regression mixed models using PROC MIXED (SAS Institute, 1999) through the inclusion of DPL in a 2-way interaction with parity (primiparous vs. multiparous), fixed effect of HYS, covariate effect of FCA, and random effect of the dam's sire.

The effect of DPL on calf birth weight at subsequent calving was determined using the explained model, but the fixed effect of calf sex and the random effect of service sire were included, and the random effect of the dam's sire was excluded from the model. The effect of DPL on calving difficulty was investigated using a multivariable logistic regression model through the maximum likelihood method of PROC GENMOD (SAS Institute, 1999). In the model, the dependent variable, dystocia score, was 0 for easy and 1 for difficult calving, and the independent variables were herd, calving year, calving season, DPL, parity, FCA, calf sex, calf birth weight, and random effect of service sire. Reference categories for comparison of odds ratios for each effect were as follows: spring, primiparous, male, and DPL of 51 to 60 d. Because cows with higher production tend to have shorter dry period compared with lower producing cows, previous 305-d milk yield was included in the models as a covariate effect (Kuhn and Hutchison, 2005).

RESULTS

DPL

The distribution of DPL is presented in Table 1. The mean (SD) dry period length was 67.3 (23.7) d. About 5.19 and 6.27% of all dry period records lasted 35 d or

Table 1. Categories, corresponding range, arithmetic means, standard deviation, and frequency distribution of individual dry period length

Days dry category	Days dry	Mean (d)	SD (d)	Frequency (no.)	Percentage
1	0–35	17.2	7.5	3,427	5.19
2	36–50	45.9	3.8	5,197	7.88
3	51–60	56.3	2.8	15,929	24.15
4	61–70	65.3	2.8	21,204	32.14
5	71–85	75.9	4.1	11,253	17.1
6	86–110	96.7	7.2	4,824	7.31
7	111–160	132	14.4	4,137	6.27

less, and 111 d or more, respectively. More than half of the dry periods (56.29%) were between 51 and 70 d (Table 1). The cows with higher milk yield tended to have shorter dry periods, where the DPL decreased by 1.42 (0.03) d for every extra 500 kg of 305-d milk yield. Advancing parity was associated with longer dry period, where the length of the dry period in first-parity cows was 7.12 (0.21), 9.47 (0.25), and 10.22 (0.31) d shorter than those in the second, third and ≥fourth lactations, respectively.

Association of DPL with Subsequent Lactation Performance

The length of the dry period influenced subsequent milk, fat, and protein yields (Table 2). Primiparous cows that were dried for 51 to 60 d produced 1,212 (38), 24.5 (1.30), and 26.2 (1.24) kg more 305-d milk, fat and protein, respectively, during the next lactation than did those with a dry period of ≤35 d. Similarly, multiparous cows with a dry period of 51 to 60 d produced 1,166 (41), 26.5 (1.50), and 26.3 (1.36) kg more milk, fat and protein, respectively, compared with those with a dry period of ≤35 d. Dry periods between 36 and 50 d resulted in lower milk, milk fat, and milk protein yields during the next lactation in both primiparous and multiparous cows compared with 51 to 60-d dry periods. The decrease in milk, milk fat, and milk protein yields was 415 (31), 8.7 (1.1), and 10.1 (0.98) kg in primiparous and 227 (33), 6.6 (1.11), and 4.5 (1.10) kg in multiparous cows, respectively.

The yields of milk, fat, and protein in the subsequent lactation were maximized when the dry period lasted 61 to 70 d or 71 to 85 d. Dry periods >85 d were associated with higher production than dry periods lasting 51 to 60 d, but were associated with lower milk production compared with dry periods lasting 61 to 70 d and 71 to 85 d.

Association of DPL with Subsequent Lactation Curve Parameters

The length of dry period affected the lactation curve parameters ($P < 0.05$). Cows with 51- to 60-d dry periods had higher daily milk production than did those with 36- to 50-d and 0- to 35-d dry periods. The results revealed that the peak yield at subsequent lactation was decreased by 4.9 (0.15), and 1.7 (0.13) kg/d in primiparous cows with DPL of 0 to 35 d and 36 to 50 d, compared with those with DPL of 51 to 60 d, whereas corresponding values for multiparous cows were 4.6 (0.17), and 1.0 (0.13) kg/d (Table 2). Cows with DPL of 0 to 35 d and those with DPL ≥61 d had the lowest and highest peak yields in the following lactation, respectively (Table 2). Cows with DPL of 0 to 35 d and 36 to 50 d had lower initial yields, steeper inclining and declining slopes, and higher milk persistency compared with those with DPL of 51 to 60 d (Table 3). The length of dry period influenced the time at which peak lactation occurred: cows with DPL of 0 to 35 d and 36 to 50 d reached their peak daily yields later than did those with 51- to 60-d dry periods (Table 3).

Association of DPL with Calf Birth Weight and Dystocia

The mean (SD) calf birth weight was 41.72 (5.13) kg. The least squares means (SE) of male and female calf weights were 42.80 (0.06), and 40.47 (0.06) kg, respectively ($P < 0.05$). Calf birth weight did not differ for cows with DPL of 0 to 35 d, 36 to 50 d, and 51 to 60 d ($P \geq 0.05$). The average calf birth weight for cows with standard DPL (51 to 60 d) was less than in those with longer dry periods (Table 3). Odds ratios and corresponding confidence intervals for the effects of calf sex, parity, and dry period length on the incidence of dystocia are shown in Table 4. The rate of dystocia was 6.8%, which was associated with calving season, calving year, calf sex, calf birth weight, DPL, and parity of the dam ($P < 0.05$). The rate of calving difficulty did not differ for cows with 51- to 60-d dry periods compared with those with shorter dry periods ($P \geq 0.05$). However, dystocia was more frequent in cows with dry periods >60 d compared with those with shorter dry periods (Table 4).

DISCUSSION

The cows with higher milk yield tended to have shorter subsequent dry periods, in line with previous

Table 2. Effects of dry period length on subsequent milk,[1] fat and protein yield in primiparous and multiparous cows (n = 65,971)

Parity[2]	DPL[3]	100-d milk[4] (kg)	200-d milk[5] (kg)	305-d milk[6] (kg)	305-d fat (kg)	305-d protein (kg)	Peak yield[7] (kg/d)
Primiparous	1	3,291 (13)[f]	6,286 (22)[f]	8,627 (32)[e]	241.1 (1.3)[d]	240.0 (1.2)[e]	36.2 (0.1)[e]
	2	3,617 (10)[e]	6,884 (18)[e]	9,424 (26)[d]	256.9 (1.1)[c]	256.1 (1.0)[d]	39.4 (0.1)[d]
	3	3,784 (6)[d]	7,190 (10)[d]	9,839 (13)[c]	265.6 (0.7)[b]	266.2 (0.7)[c]	41.1 (0.1)[c]
	4	3,865 (5)[ab]	7,332 (9)[ab]	10,029 (11)[a]	271.2 (0.8)[a]	270.3 (0.7)[ab]	41.9 (0.1)[ab]
	5	3,875 (8)[a]	7,361 (13)[a]	10,071 (18)[a]	272.8 (0.7)[a]	271.8 (0.8)[a]	42.1 (0.1)[a]
	6	3,836 (14)[bc]	7,284 (24)[bc]	9,950 (35)[b]	271.2 (1.3)[a]	268.5 (1.4)[bc]	41.8 (0.2)[ab]
	7	3,799 (16)[cd]	7,229 (28)[cd]	9,877 (40)[bc]	270.9 (1.5)[a]	266.2 (1.6)[c]	41.6 (0.2)[b]
Multiparous	1	3,278 (14)[e]	6,076 (25)[e]	8,088 (36)[e]	236.7 (1.4)[d]	232.0 (1.3)[d]	36.3 (0.1)[e]
	2	3,618 (11)[d]	6,755 (19)[d]	9,027 (28)[d]	256.6 (1.1)[c]	253.8 (1.0)[c]	39.9 (0.1)[d]
	3	3,728 (6)[c]	6,932 (11)[c]	9,254 (14)[c]	263.2 (0.7)[b]	258.3 (0.7)[b]	40.9 (0.1)[c]
	4	3,780 (5)[ab]	7,023 (9)[a]	9,368 (11)[ab]	266.2 (0.7)[a]	260.5 (0.7)[a]	41.5 (0.1)[b]
	5	3,786 (6)[a]	7,042 (11)[a]	9,386 (15)[a]	266.2 (0.7)[a]	260.9 (0.7)[a]	41.7 (0.1)[a]
	6	3,759 (9)[b]	7,002 (16)[ab]	9,329 (23)[ab]	265.6 (1.0)[a]	258.5 (0.9)[b]	41.7 (0.1)[a]
	7	3,720 (10)[c]	6,966 (18)[bc]	9,312 (25)[b]	266.1 (1.1)[a]	258.5 (1.0)[b]	41.4 (0.1)[b]

[a–f]Least squares means with different superscripts (DPL within parity) differ significantly ($P < 0.05$).

[1]Calculated using the following incomplete gamma function: $\ln(y_t) = \ln(a) + b[\ln(t)] - ct$, where y_t is the daily milk yield (kg/d) at DIM t, the variable t represents the length of time since calving, a is a parameter representing yield at the beginning of lactation, and b and c are factors associated with the upward and downward slopes of the lactation curve, respectively.

[2]The cows were classified into 2 classes: primiparous cows (n = 30,558), and multiparous cows (n = 35,413).

[3]Based on dry period length (DPL), the cows were classified into 7 classes: DPL of 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d (DPL1 to DPL7, respectively).

[4]Total yield from calving up to DIM of 100 calculated as $y = a\int_1^{100} t^b e^{-ct} dt$.

[5]Total yield from calving up to DIM of 200 calculated as $y = a\int_{101}^{200} t^b e^{-ct} dt$.

[6]Total yield from calving up to DIM of 305 calculated as $y = a\int_1^{305} t^b e^{-ct} dt$.

[7]Peak yield calculated as $a(b/c)be^{-b}$.

reports (Bachman and Schairer, 2003; Kuhn et al., 2005, 2007). Daily milk yield in less productive cows often decreases to very low levels before the usual drying date; therefore, farmers no longer keep these cows in production, which results in longer dry periods compared with more productive cows (Kuhn et al., 2007). The results showed that advancing parity was associated with a longer dry period, where heifers had shorter dry periods compared with multiparous cows, probably because they were better at getting bred back (Kuhn et al., 2005). Heifers have more persistent milk production and managers tend to keep them in production for longer periods than multiparous cows (Kuhn et al., 2007).

The length of dry period influenced the subsequent milk, fat, and protein yields. Previous studies have reported that both longer and shorter dry periods are associated with loss of production (Schaeffer and Henderson, 1972; Keown and Everett, 1986; Sørensen and Enevoldsen, 1991; de Feu et al., 2009). Rastani et al. (2005) reported that mean milk production was greater for cows with a 56-d dry period compared with those with a 28-d dry period. In contrast, Gulay et al. (2003) reported that decreasing the length of the dry period from 60 to 30 d had no effect on milk yield during the first 10 wk of lactation in multiparous Holstein cows. Pezeshki et al. (2008) reported that decreasing days dry from 49 to 28 d had no effect on 305-d milk yield in multiparous cows.

In this study, significant interactions were found between DPL and parity for partial and 305-d milk yields. The reported data on the parity by DPL interaction are not consistent. Santschi et al. (2011) reported that second-lactation cows with a 35-d DPL produced less milk than did second-lactation cows with a 60-d dry period, but no difference was found for cows in third or greater lactation. Pezeshki et al. (2007) reported that decreasing the dry period from 56 to 35 d had no effect on milk yield in multiparous cows but did reduce milk yield in primiparous cows. Rastani et al. (2005) reported lower milk yields for both primiparous and multiparous cows when shortening the dry period from 56 to 28 d. Parity is thought to be the most important factor that negatively affects milk yield when DPL is shortened. This effect may be associated with a greater requirement for mammary cell turnover between the first and second lactations (Collier et al., 2012). In the current study, cows with a short dry period produced less fat and protein during the next lactation compared with those with a traditional DPL. Only a few studies report on the effect of DPL on fat and protein yields. Rastani et al. (2005) reported significant increases in milk fat and protein contents in cows with a 28-d dry

Table 3. Effects of dry period length on subsequent lactation curve parameters,[1] and calf birth weight[2] in primiparous and multiparous cows (n = 65,971)

Parity[3]	DPL[4]	ln(*a*[5])	*b*[6]	*c*[7]	*s*[8]	Peak time[9]	Calf birth weight (kg)
Primiparous	1	2.64 (0.02)[e]	0.289 (0.004)[a]	0.00484 (0.00006)[a]	7.01 (0.01)[a]	60.7 (0.6)[a]	40.50 (0.1)[cd]
	2	2.80 (0.01)[d]	0.272 (0.004)[bc]	0.00465 (0.00005)[bc]	6.95 (0.01)[b]	58.8 (0.5)[b]	40.23 (0.1)[d]
	3	2.87 (0.01)[b]	0.265 (0.002)[c]	0.00457 (0.00003)[cd]	6.92 (0.01)[bc]	56.9 (0.3)[c]	40.38 (0.1)[d]
	4	2.92 (0.01)[a]	0.257 (0.002)[d]	0.00451 (0.00003)[d]	6.89 (0.01)[c]	55.9 (0.2)[d]	40.76 (0.1)[bc]
	5	2.90 (0.01)[a]	0.264 (0.003)[cd]	0.00456 (0.00004)[cd]	6.91 (0.01)[c]	56.7 (0.4)[cd]	41.05 (0.1)[a]
	6	2.85 (0.02)[bc]	0.276 (0.005)[ab]	0.00475 (0.00007)[ab]	6.95 (0.01)[bc]	57.4 (0.6)[bc]	40.95 (0.1)[ab]
	7	2.81 (0.02)[cd]	0.284 (0.006)[ab]	0.00480 (0.00008)[ab]	6.97 (0.01)[ab]	58.8 (0.7)[b]	41.01 (0.1)[ab]
Multiparous	1	2.56 (0.02)[d]	0.324 (0.005)[b]	0.00599 (0.00007)[ab]	6.88 (0.01)[d]	54.8 (0.6)[cd]	42.45 (0.1)[bc]
	2	2.66 (0.01)[c]	0.322 (0.005)[b]	0.00571 (0.00006)[c]	6.91 (0.01)[c]	55.5 (0.5)[bc]	42.00 (0.1)[c]
	3	2.74 (0.01)[a]	0.309 (0.002)[c]	0.00567 (0.00003)[c]	6.87 (0.01)[d]	53.6 (0.3)[d]	42.20 (0.1)[c]
	4	2.76 (0.01)[a]	0.310 (0.002)[c]	0.00569 (0.00002)[c]	6.88 (0.01)[d]	53.4 (0.2)[d]	42.62 (0.1)[b]
	5	2.71 (0.01)[b]	0.326 (0.002)[b]	0.00587 (0.00003)[b]	6.91 (0.01)[cd]	54.7 (0.3)[c]	42.87 (0.1)[a]
	6	2.64 (0.01)[c]	0.344 (0.004)[a]	0.00609 (0.00005)[a]	6.95 (0.01)[b]	56.3 (0.4)[b]	42.99 (0.1)[a]
	7	2.60 (0.01)[d]	0.352 (0.004)[a]	0.00612 (0.00005)[a]	6.99 (0.01)[a]	58.2 (0.4)[a]	42.87 (0.1)[a]

[a–e]Least squares means with different superscripts (DPL within parity) differ significantly ($P < 0.05$).

[1]Modeled as $\ln(y_t) = \ln(a) + b[\ln(t)] - ct$, where y_t is the daily milk yield (kg/d) at DIM t, the variable t represents the length of time since calving, a is a parameter representing yield at the beginning of lactation, and b and c are factors associated with the upward and downward slopes of the lactation curve, respectively.

[2]n = 52,890.

[3]The cows were classified into primiparous cows (n = 30,558) and multiparous cows (n = 35,413).

[4]Based on dry period length (DPL), the cows were classified into 7 classes: DPL of 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d (DPL1 to DPL7, respectively).

[5]Factor to represent yield at the beginning of lactation.

[6]Factors associated with the inclining slope of the lactation curve.

[7]Factors associated with the declining slopes of the lactation curve.

[8]Persistency, calculated as $s = -(b + 1)\ln(t)$.

[9]DIM at peak yield, calculated as (b/c).

period compared with cows with a 56-d dry period. de Feu et al. (2009) reported that the yields of fat and protein were decreased, but milk protein concentration was increased in cows with no dry period compared with those with an 8-wk dry period. Butler et al. (2010) reported that reducing the dry period duration from 62 to 6 d resulted in an increase in milk protein concentration. Santschi et al. (2011) reported that fat percentage was not affected by DPL, but protein content was increased in second-lactation cows with a 35-d dry period compared with those having a 60-d dry period. In contrast, Pezeshki et al. (2008) reported that decreasing DPL from 49 d to 28 d had no effect on milk protein and fat percentage.

Table 4. Odds ratios (OR) and 95% CI for the effects of calf sex, dry period length, and parity (primiparous or multiparous) on dystocia in Holstein cows (n = 50,948)

Variable	No. of births	Dystocia (%)	Odds ratio (95% CI)	*P*-value
Calf sex				<0.05
Male	25,394	8.49	OR reference value	
Female	25,554	5.13	0.69 (0.63–0.75)	
Dry period length[1]				<0.05
DPL1	2,420	10.0	1.06 (0.91–1.23)	
DPL2	4,013	7.95	1.13 (0.93–1.38)	
DPL3	12,670	6.12	OR reference value	
DPL4	16,765	6.51	1.13 (1.02–1.25)	
DPL5	8,291	6.56	1.08 (0.95–1.23)	
DPL6	3,573	7.36	1.30 (1.11–1.54)	
DPL7	3,216	7.34	1.38 (1.18–1.63)	
Parity				<0.05
Primiparous	23,016	10.2	OR reference value	
Multiparous	27,932	4.00	0.25 (0.22–0.28)	

[1]Based on dry period length (DPL), the cows were classified into 7 classes: DPL of 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d (DPL1 to DPL7, respectively).

Cows with a 51- to 60-d dry period reached peak production earlier, had higher daily milk yield, produced more milk at peak, and showed a lower milk yield persistency (i.e., quicker decrease in milk yield after peak) than did cows with shorter dry periods. Santschi et al. (2011) reported that second-lactation cows with a 35-d dry period had lower average milk yield than did cows with 60-d dry period. According to Mantovani et al. (2010), cows with no dry period reached their peak earlier and produced less milk at peak but showed a lower milk yield persistency than did cows with a dry period of 50-d.

Calf birth weight did not differ for cows with DPL of 0 to 35 d, 36 to 50 d, or 51 to 60 d. The average calf birth weight for cows with standard DPL (51 to 60 d) was less than in those with longer dry periods. Very few studies exist on the effect of DPL on calf birth weight. Previous researchers reported no differences in calf birth weight for cows with 28- and 49-d dry periods (Pezeshki et al., 2008), or for cows with 30-d and 60-d dry periods (Gulay et al., 2003). Caja et al. (2006) reported that DPL influenced kid birth weight, where average birth weights of kids in goats with 0-, 27-, and 56-d dry periods were 1.7, 2.2, and 2.1 kg, respectively. The rate of calving difficulty did not differ for cows with 51- to 60-d dry period compared with those with shorter dry periods. However, dystocia was more frequent in cows with dry periods >60 d compared with those with shorter dry periods. Enevoldsen and Sørensen (1992) reported that for a short period open (0–88 d), the risk of calving difficulty was higher in cows with 10-wk dry periods than in those with 7- or 4-wk dry periods. For a long period open (89 d and more), the risk of calving difficulty was lowest at 10 wk dry (Enevoldsen and Sørensen 1992). Pezeshki et al. (2007) reported that decreasing the dry period from 56 to 35 d had no effect on dystocia.

CONCLUSIONS

Numerous papers report on the effect of DPL on milk yield, but information on parameters such as lactation curve traits, calf birth weight, and dystocia is limited. In this study, the effects of DPL on subsequent lactation curve traits were quantified using monthly test-day milk samples. Cows with short dry periods had lower lactation performance than those with a standard (traditional) dry period length. Further studies are required before general application of shortened dry period in commercial farms can be recommended.

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