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Effectiveness of training parturition and dystocia management on days open of dairy cows in traditional farming systems: a field trial

Hadi Keshipour[1], Alireza Bahonar[1]*, Mehdi Vodjgani[2], Ehsan Anassori[3]

[1] Department of Food Hygiene and Quality Control, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran; [2] Department of Theriogenology, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran; [3] Department of Internal Medicine and Clinical Pathology, Faculty of Veterinary Medicine, Urmia University, Urmia, Iran.

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Abstract

The interval between parturition and subsequent pregnancy is called the days open or calving to conception interval and is affected by several factors, especially dystocia. Dystocia is an abnormal or difficult calving that may require assistance during labor. This study is a field trial in health education and the research team developed a comprehensive training program for farmers to educate them about the normal process of parturition in dairy cows and when and how to assist in parturition or dystocia. A series of classes was held for farmers and the study covered 486 multi-parous dairy cows, with 173 belonging to the group of trained farms (educated farmers) and 313 to the control group (non-educated farmers). Although dystocia was lower in the educated group, there were no significant differences in retained placenta between two groups. However, cows in the educated group had a better conception rate (lower service *per* conception) in subsequent parturitions. Hence, the median number of days open for cows from trained farmers was significantly lower than other farmers (85 days compared to 120 days, respectively). Based on Cox regression analysis, uterine prolapse, retained placenta, and dystocia could significantly impact subsequent pregnancies. Dystocia affects days open, and training on parturition and dystocia management can effectively reduce the numbers of days open in dairy cows.

Introduction

The significant parameter that affects dairy cows' reproductive performance is the numbers of days open, being the interval between parturition and subsequent pregnancy.[1,2] Its optimal range varies in countries and regions,[1,3] and several factors influence the duration of this period, including genetic traits,[4,5] unbalanced nutrition,[5] low farm biosecurity,[6,7] milk production,[8-10] cow parity,[11] dystocia,[12,13] uterine prolapse,[14] cystic ovary,[15] season,[16] management,[6,17] farmer knowledge,[18,19] unbalanced weight or undesirable body condition score,[20] infectious diseases,[21] metabolic diseases[22] and mineral deficiency.[23,24]

Dystocia is defined as a difficult calving for any reason needing human assistance. It has negative effects on dairy cows' production and reproductive performance and has many consequences for the health of both the cow and the calf. Consequently, it can impose a tremendous economic burden on farmers.[12,13,25-27]

Dystocia may be caused by cow- or fetus-related factors. Fetal abnormalities in presentation, position, or posture can be crucial in dystocia. However, the fetal pelvic disproportion is a significant cause of dystocia in heifers. Also, fetal over-size, uterine inertia, pelvic abnormalities, dam obesity, incomplete cervical dilatation and uterine torsion are other important causes of dystocia.[12,25]

The productivity of dairy cows in conventional farming systems is relatively low; so, it is necessary to raise the profitability of farms through enhancing reproductive efficiency.[28,29] Reducing the number of days open is crucial to improve reproductive efficiency and in dairy cows, it requires high-level management and sufficient funds to control several factors in the herd.[17] However, management in traditional dairy herds is poor, and farmers cannot afford high costs.[30,31] Therefore, producers in this livestock farming system should endeavor to implement cost-effective changes to achieve their objectives. Training is one of the least expensive and effective ways to improve and develop the dairy industry.

***Correspondence:**

Alireza Bahonar. DVM, DVSc
Department of Food Hygiene and Quality Control, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
E-mail: abahonar@ut.ac.ir

Several studies have shown how farmers' education affects their farm production.[18,19,32-34] The effects of dystocia on the number of days open have also been reported in previous studies.[12,13,25,26] Therefore, the primary objective of this study was to examine the impact of farmer training regarding parturition and dystocia management on reducing the number of days open in dairy cows within traditional farming systems.

Material and Methods

Study type. This study is a field trial in the health education sector and the research team developed a comprehensive training program for this study. The program focuses on the parturition management and appropriate responses for dystocia cases. The team presented the package to five livestock farmers as a pre-test and resolved any issues or defects.

Target population. This research was carried out in Miandoab, being situated in a mountainous region in the northwest of Iran. The area experiences cold winters and hot, dry summers. Compared to the other parts of Iran, this region has a higher concentration of cattle, with both industrial and traditional cattle farms present. While the majority of dairy farms are managed in traditional ways, there are also a few industrial ones. Farmers of conventional dairy farms as a target population for this study contributed. For this purpose, four villages were selected as a training group; while, ten villages were designated as a control group. The educational program was presented to the farmers in the four villages during September, October and November 2022. This study was approved by the Ethics Committee of the Faculty of Veterinary Medicine of the University of Tehran, Tehran, Iran (IR.UT.VETMED.REC.1402.040).

Inclusion and exclusion criteria. In this study, the inclusion criteria included the following:

I. The cows of trained farmers were used for the intervention group.
II. The cows of untrained farmers were used for the control group.
III. The farms had to have less than 50 dairy cows and being managed traditionally.
IV. The farmers needed to have complete and accurate information about the calving of their cows, which they provided us.
V. The cows were required to give birth in September, October or November.

Also, the exclusion criteria included the following:

I. Farmers who did not cooperate as required were excluded.
II. In the case the information provided by the farmer did not match our observations, it was excluded.
III. Cows that had been slaughtered or sold were also excluded.

Sample size. The minimum sample size for each group in the clinical trial was estimated using the following formula.[35] Preliminary data on the average numbers of days open for conventional dairy cows in this region were collected. These data and the optimum value reported by Abd-El Hamed and Kamel[1] were used to determine the minimum required sample size for the study.

$$n = (Z_{1-\alpha/2} + Z_{1-\beta})^2 \times (\delta_1^2 + \delta_2^2) \times (\mu_1 - \mu_2)^{-2}$$

where, the confidence interval is assumed to be 95.00%; therefore, α is 0.05. The value of $Z_{1-\alpha/2}$ in the two-tailed test is 1.96 according to the standard tables. The $1-\beta$ is the power of study (β = 0.10); thus, $Z_{1-\beta}$ is 1.28. The power of this study is assumed to be 90.00%. The value of $Z_{1-\beta}$ is 1.28 according to the standard tables. The $\mu 1$ is the mean of the 1st study (132.28), and $\mu 2$ is the mean of the 2nd study (100.00). The δ_1^2 is the variance of the 1st study (48.45^2) and δ_2^2 is the variance of the 2nd study (87.30^2). The minimum sample size for this study was 163 cows for each group.

Data collection. The calving season affects the number of days open. Farmers were trained towards the end of summer. To minimize the impact of seasonal variations, cows with an autumn calving season were explicitly chosen for both groups. The necessary information was acquired by visiting the farms and completing a questionnaire after 6 months.

Training program. The training program for the treatment group consisted of the following components: Reproduction records in dairy cows, economic aspects of the reproduction of dairy cows, the process of parturition in cows, symptoms indicating the start of parturition in cows, management of cows during calving, when and how to intervene in parturition, dystocia, including causes and complications, appropriate actions for dealing with dystocia cases, post-partum measures for the health of cows and preparation for subsequent pregnancy and estrus detection in cows.

Questionnaire structure. The 1st section of the questionnaire included details about recording other characteristics of the farms and farmers. The 2nd part of the questionnaire contained data related to the studied cows. These data included the date of previous parturition, the number of inseminations performed for this pregnancy, the interval between preceding pregnancy and day of the last insemination resulted in the current pregnancy (days open) and the date of commencement of current pregnancy, and all data about the history of cows were covered in this study such as dystocia, uterine prolapse, cystic ovarian diseases and abortion.

Statistical analysis. Data from the questionnaire were transferred to Excel (version 2019; Microsoft Corp., Redmond, USA) for ordering, validation and preliminary analysis. All statistical analyses were performed using SPSS Software (version 22.0; IBM Corp., Armonk, USA).

Distributions and descriptive statistics were done for each variable. The normality of the variables was examined by the Kolmogorov-Smirnov test. The independent samples *t*-test and the Chi-square test were used to determine the differences between groups. Ovarian cyst, uterine prolapse, abortion and dystocia were coded as categorical variables by 0 and 1. Code 0 is a sign of absence and code 1 is a sign of an event. In each group, the association between each explanatory variable thought to influence days open was examined using the log-rank test. Each explanatory variable was categorized into two levels. The Kaplan-Meier survival curves for each level of an explanatory variable comprised of two groups were plotted, and the homogeneity of the curves between levels was examined using the log-rank statistic. All graphs were drawn using SPSS Software. A *p*-value of $p < 0.05$ was considered statistically significant.

Results

Before training, the mean and median days open in the control group (n = 340 cows) were 131.10 and 120.00 days, respectively. The training group (n = 245 cows) had the mean days open of 126.54 and the median of 120.00 days. No statistically significant difference in the mean and median days open was observed between the trained and control groups before the implementation of the training program (Table 1). This study investigated 173 multi-parous dairy cows from the trained farms and 313 ones from the control farms to compare the training effect (Table 1). After training, the median number of days open in the cows of the trained farmers (85.00) was significantly lower than that of the control group (120.00; $p < 0.05$). There were no significant differences in the incidence of retained placenta and uterine prolapse between the cows in the experimental groups. However, the cows in the trained group had a significant decrease in the number of inseminations *per* pregnancy and lower prevalence of dystocia compared to the control group ($p < 0.05$). More than 98.00% of the cows belonging to the trained farmers were pregnant after 6 months of parturition; whereas, only 80.20% of the cows were pregnant after 6 months of parturition in the control group (Table 1).

Cox regression analysis showed that training, dystocia, retained placenta and uterine prolapse significantly affected pregnancy ($p < 0.05$). In addition, the odds ratio for training was 0.38 (Table 2). A comparison of the causes of dystocia in the control and trained groups clearly showed that dystocia due to farmer's inappropriate actions decreased and caused the overall rate of dystocia to decrease (Table 3).

Figure 1 illustrates the Kaplan-Meier hazard curve for comparing the pregnancy occurrence of cows in the trained and control groups. Pregnancy occurred earlier in the trained group's cows compared to the control group. As depicted in the Figure 2, the incidence of unassisted parturition (without dystocia) and dystocia with unknown causes was significantly lower in the cows of the trained group than control group. No significant difference was observed in the prevalence of other causes of dystocia between two groups. The survival curve for the occurrence of pregnancy, considering various causes of dystocia, showed that cows without dystocia exhibited a faster rate of pregnancy occurrence compared to the cows with all other causes of dystocia.

Table 1. Descriptive statistics of the cows of trained and control groups after training.

Variables	Before training		After training	
	Control	Training	Control	Training
Frequency	340.00	245.00	313.00	173.00
The median of days open	120.00	120.00	120.00	85.00*
The mean of days open	131.10	126.54	-	-
Standard deviation	52.34	41.85	-	-
Retained placenta	-	-	3.70	5.10
Prolapse	-	-	2.20	1.20
Insemination *per* pregnancy	-	-	2.58	1.96*
Dystocia	-	-	56.50	37.30*
Pregnancy percentage after 6 months of calving	-	-	80.20	98.30*
Censored percentage after 6 months of calving	-	-	19.80	1.70*

In the trained group, each variable marked with * significantly differs from the control group ($p < 0.05$).

Table 2. Variables in the equation of Cox regression analysis. Days open is the dependent variable.

Variables	B	SE	Wald	Exp(B)	Sig.
Training	– 0.96	0.01	90.58	0.38	0.001
Dystocia	– 0.61	0.10	36.47	0.54	0.000
Retained placenta	– 0.70	0.27	6.98	0.49	0.008
Uterine prolapse	– 0.81	0.41	3.90	0.44	0.048

B: Estimation of regression coefficient; SE: Standard error; Wald: The Wald statistic in proportional hazards hypothesis testing; Exp(B) or odds ratio: The predicted change in odds for a unit increase in the predictor.

Table 3. Dystocia prevalence for any reason in cows of trained and control groups.

Dystocia type	Control		Training	
	Frequency	Percentage	Frequency	Percentage
No dystocia	136.00	43.45	107	61.84*
Unknown reasons	99.00	31.62	28	16.18*
Fetus abnormality	35.00	11.18	12	6.93*
Calf size	19.00	6.07	11	6.35
Cow obesity	11.00	3.51	7	4.04
Uterine inertia	9.00	2.87	6	3.46
Uterine torsion	4.00	1.28	2	1.15
Total	313.00	100	173	100

In the trained group, each variable marked with * significantly differs from the control group ($p < 0.05$).

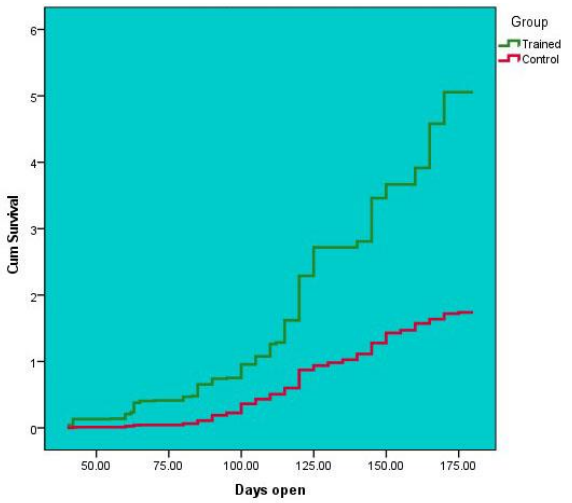

Fig. 1. The hazard curve to compare pregnancy events and days open of trained and control farms.

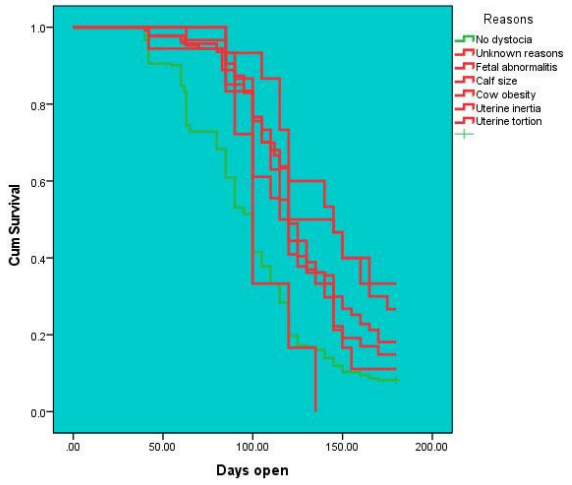

Fig. 2. The survival curve comparing pregnancy events and days open time of cows for each reason of dystocia.

Discussion

The means and medians of days open in the control and training groups in the current study before the training exceeded 120 days, being the same as other research conducted on cattle farms in Iran.[25,36-40] However, the number of days open in the cows in the trained farms after training has significantly decreased, being close to the optimal ranges in previous reports. The optimal range of open days varies in different countries depending on the economic indicators and conditions of cow farming in those regions. According to Abd-El Hamed and Kamel, the optimal range is between 90.00 and 110.00 days. The average in similar research was 75.00 days.[1,3]

Ansari-Lari *et al*. aimed to describe the current reproductive parameters of Holstein dairy cows in Iran and determine the factors affecting reproductive performance, with a focus on high-yielding dairy cows. These authors reported that the number of days open for Holstein cows was 134.00 ± 89.00 days.[37] According to Ghavi Hossein-Zadeh, dystocia affects the reproductive traits and lactation of dairy cows. He reported that the mean number of days open for Iranian Holstein cows was 128.72.[13] Additionally, a retrospective cohort study by Bahonar *et al*. found that dairy cows had an average number of days open of 152.00 days (median 123.00 days).[39] Recently, Zahedi *et al*. investigated six herds from 2007 to 2018 and reported that the number of days open increased from 132.00 to 136.00 days during these years.[36] According to these studies, several risk factors, especially dystocia, affect the number of days open.

In contrast to previous research, dystocia was much more common in both study groups. According to Atashi *et al*., 10.80% of industrial farms in Iran had dystocia.[25] Also, 21.30% of dystocia cases documented in both industrial and non-industrial cattle farms in Iran were associated with hypocalcemia.[24] Furthermore, our study also found that training had a significant effect on reducing the prevalence of dystocia within the trained group.

There is an evidence showing that dystocia can greatly prolong the days open in cattle.[13,25,27] According to the Cox regression analysis, the odds ratio of dystocia is 0.55, indicating that cows with dystocia have almost half the chance of getting pregnant compared to the cows without it. In addition, dystocia affects the cow's reproductive organs. Prolonged stress can also cause a weakened immune system and susceptibility to infectious and non-infectious diseases, ultimately delaying the preparation of the reproductive system for the subsequent pregnancy.[13,41] Based on our findings, the survival curve analysis of pregnancy occurrence in cows with various causes of

dystocia compared to the cows without dystocia, revealed that the cows without dystocia had faster pregnancy occurrence than all other groups.

As shown, the prevalence of dystocia was high in cows from both the trained and control groups. These findings, therefore, demonstrated that parturition management, mainly focusing on dystocia, was one of the main problems in the dairy industry in traditional systems. The highest prevalence of dystocia can be attributed to a lack of farmers' knowledge about reproduction physiology and how to manage parturition in cows. When comparing the two groups' parturition management, it was found that the trained group had a 37.00% rate of dystocia with unknown causes, which was a 35.00% reduction compared to the control group's rate of 57.00%. The pregnancy rate on different milking days is one of the reproductive performances in dairy cows and covers several indices such as service *per* conception, conception rate, days open, and others.

We observed significant differences in the outcome variables and censored cases between the two groups when examining the six-month performance of the cows. Specifically, the pregnancy percentage of cows at 180.00 days in milk was 98.00% for cows in trained farms; while, it was 80.20% for cows in the control group. According to the findings of this study, the mean insemination rate *per* pregnancy was lower in the cows of the trained group compared to the control group. In studies conducted in Iran, the mean number of inseminations for each pregnancy reported by Mahnani *et al*. and Sirjani *et al*. was 2.70 and 2.51 inseminations *per* pregnancy, respectively.[20,38] In other countries, this number is reported differently. For example, a study in the Netherlands, found less than two inseminations *per* pregnancy;[42] while, a study in Ethiopia, reported 1.15 inseminations *per* pregnancy.[16]

This study can serve as an initial step toward implementing ongoing educational interventions for livestock farmers. Therefore, it is suggested that further studies examine the effect of training on other factors influencing the enhancement of livestock's productive and reproductive efficiencies.

Based on our findings, training in calving and dystocia management can effectively decrease the number of days open in dairy cows. Additionally, our research revealed a significantly higher occurrence of dystocia in traditional farms than industrial ones. Moreover, cows went through dystocia had longer periods of being open compared to those did not experience dystocia.

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Conflict of interest

The authors declare no competing interest.

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