Scientific Research Publishing

Open Journal of Veterinary Medicine, 2023, 13, 23-32
https://www.scirp.org/journal/ojvm
ISSN Online: 2165-3364
ISSN Print: 2165-3356

Causes and Effects of Stillbirths on Days Open and Cow Herd Survival in Holstein Friesian Cows

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How to cite this paper: Constantin, G. and Mihaela, R. (2023) Causes and Effects of Stillbirths on Days Open and Cow Herd Survival in Holstein Friesian Cows. *Open Journal of Veterinary Medicine*, **13**, 23-32.
https://doi.org/10.4236/ojvm.2023.133003

Received: January 27, 2023
Accepted: March 28, 2023
Published: March 31, 2023

Abstract

The aim of this retrospective study was to investigate the causes and the effects of stillbirth on the number of days open and cow herd survival in subsequent lactation of Holstein Friesian cows. A total of 1371 calvings from research dairy farm were used. Stillbirth in calves was defined as the death of a fetus before or during calving at full term (≥270 days of gestation) or within 24 hours after calving. During the period from January 2006 to December 2017 a percent of 95.04% of the calvings were with live calves, and 4.96% of the calvings were stillbirths. The major causes of stillbirth identified were: calving difficulty, parity of the cows, and sex of the calves at calving. A five point scale was used to assess calving difficulties, and numbers 1, 2 and 3 were considered unassisted calvings and number 4 and 5 as assisted. The twin calvings were not taken into account. Days open were measured as days from first calving to conception, and cow herd survival from first calving to culling or death. Trend test and multivariate data analysis were used. The findings revealed that primiparous cows were at higher risk of having stillbirths compared with multiparous cows. Cows that were at calving male calves were at higher risk of having stillbirths compared with cows that had female calves at calving. Also, cows with assisted calving were at higher risk of having stillbirths compared with cows with unassisted calvings. Cows with stillbirths had a increase mean of days open with 32 days. Cow herd survival was better in the cows with live calves at calving compared with the cows that had stillbirth at calvings.

Keywords

Stillbirth, Culling, Calving Difficulty, Days Open

1. Introduction

At farm level calving difficulty and stillbirth are the biggest problems and the

perinatal period (24 to 48 hours after calving) is one of the highest risk periods for calf mortality and for dam health disorders.

Death of the calf or of its mother cow also exists and dystocia is the most important risk factor. Stillbirth at calving makes up the direct losses, due to veterinary treatments and services [1] [2]. Over the past decades stillbirths had a increasing trend and more attention is needed in Holstein cow population [3] [4] [5] [6] [7].

Berglung *et al*., (1996) [8] in Sweden and Hansen, (2005) [9] in Denmark showed an increase of stillbirth after importation of semen from North American Holstein bulls, and concluded that genetic variation of stillbirth exists, and has two components: genetic variation in the calf and genetic variation in its Dam. Hansen (2005) [9] recommended to take into account the two components when stillbirth genetic data is analyzed.

Researchers have identified many factors that cause stillbirth. Some of them are: 1) dystocia (calf birth weight, body condition score, genetics, parity, fetal position, size and form of pelvic canal of dam); 2) age at first calving; 3) calving management (precalving movement, calving location, calving supervision, calving intervention, post-calving management of the calf and the dam); 4) twinning [10] [11].

Bicalho *et al*., (2007) [11] showed a significant decreasing trend regarding stillbirth cases by party (1 to ≥4) and a significant increasing trend regarding stillbirth cases as the calving difficulty score increased from 1 to 4. Also cows with female calves born were less to have stillbirth than cows with male calves born at calving [12] [13].

Stillbirth in cows significantly causes a premature culling and more days open.

The aim of this research was to investigate the causes and the effects of stillbirth on the number of days open and cow herd survival in subsequent lactation.

2. Materials and Methods

Animals and management

This study was performed on the research dairy farm of Agricultural Research and Development Station (ARDS) Simnic-Craiova, Romania. All data were collected from January 10th 2006 to December 20th 2017. The research dairy farm is located in the South-West region (182 m above sea level: 44˚19'N, 23˚48'E). The dairy herd size is 280 Holstein-Friesian cattle that belonged to a long and large genetic improvement program. The initial dairy cattle herd imported from Denmark (1977, as Danish Black and white cattle). An inference about genetic variation of stillbirths for original Danish Black and White (ODBW) race and Holstein Friesian (HF) race was communicated by Hansen *et al*., 2004 [7]. As results of Holsteinisation (begun 1970) the stillbirths rate at first calving increased. ARDS Simnic imported in 1977 a herd of heifers as ODBW and then we used it for their reproduction Danish sire semen and HF semen from North America. Today the most genes from the ODBW in our herd have been replaced

by HF genes. We concluded that a genetic variation of stillbirths in our actual herd exists. Also, the same results were observed by Meyer *et al.* (2001) [14]. The research farm has good cow and calf data records. All data were collected from Unique Reproduction Register and Veterinary Treatments Register. ARDS Simnic has a farm stuff (professional team) and research team (I am the coordinator and control productive, reproductive and health status of the lactating cows).

Nutritional and management strategies for dairy cattle are used to prepare the animals for lactation and to minimize the incidence of disease disorders after calving. Forage, a small amount of concentrate, and a trace mineral salt constitute the dry cow ration during early period. Subsequently a close-up ration is fed which provides additional nutrients. All feed rations were calculated to provide recommended nutrients for dairy cows. All feeds consisting of corn silage, haylage, chopped alfalfa, fodder beet and grains were produced locally.

All lactating cows were milked two times a day (05:00 a.m. and 17:00 p.m.) and were housed free in barns bedded with straw. Cows had ad libitum access to fresh water. At 3 weeks before due date cows were moved into the close-up pen, where the farm workers monitor the calving process.

Research design and selection of data

For this study we used retrospective method (birth cohort study), and information was collected from farm past records (January 2006 to December 2017). After parturition the cows were divided into 2 categories: 1) cows with live calf and 2) cows with stillborn calf. Stillbirth in calves was defined as death of a fetus before or during calving at full term (≥260 days) or within 24 h of parturition. Cow herd survival was quantified in terms of the number of days from first calving to culling or death. Reproduction records were used to quantify the days open (calving to insemination interval) for each cow. Additional informations included: parity (primiparous and multiparous cows), sex of calf (female or male) and calving difficulty score.

Calving difficulty score (CDS) was measured on five-pointscale, each number corresponds with the level of difficulty required to birth the calf:

1 = easy birth, no assistance; 2 = over 2 hours in labor, no assistance; 3 = minimum assistance, no calving difficulty; 4 = used obstetrical chains; 5 = extremely difficulty birth using mechanical puller. The number of cows with calving difficulty point 5 was too small and was included in the calving difficulty point.

The twin calvings were not taken into account.

Statistical analysis

A trend test, using the FREQ procedure, was used to analyze the increasing or decreasing trend regarding stillbirth cases by parity number (1 to ≥4) and by calving ease point scale (1 to 5). In multivariable analysis the variables CES, and parity were divided, to facilitate analysis and results interpretation.

The new variables were: calving ease group: unassisted calving (included 1, 2 and 3 points scale) and assisted calvings (included 4 and 5 points scale). Parity groups (first parity group) for all primiparous cows and multiparity group for all

multiparous cows.

A regression model was used for investigating the associations between the stillbirths and days open or with cow herd survival days.

The variables used were stillbirth, calf sex, parity and calving ease group and calving difficulty group.

The associations of parity group, calf sex, and calving ease group or calving difficulty with stillbirths was analyzed by logistic regression.

3. Results

A total of 1371 calvings was used for the final analyses, and 95.04% of the calvings were with live calves and 4.96% of the calvings were stillbirths cases.

An increase trend ($P < 0.05$) in the cases of stillbirth (%) in the period from year 2006 to year 2017 was detected. A decreasing trend ($p \leq 0.01$) of the cases of stillbirths (%) in the same period was detected as parity increased from first to ≥4.

The percent of stillbirths cases in first, second, third and ≥fourth parity was 8.58%, 3.30%, 4.26%, and 3.00% respectively (Figure 1). The incidence of stillbirth in primiparous cows ranged from 7.6% to 10%, and in multiparous cows from 2.6% to 4.8%.

An increasing trend ($p < 0.01$) of the cases of stillbirths (%) in years 2006 to 2017 was detected as calving ease points increased from 1 to 5 (Figure 2). The percent of stillbirth cases in each calving ease point (1; 2; 3; 4 and 5) was 2.78, 11.67, 21.43 and 26.83 respectively.

The percent of stillbirth cases in primiparous and multiparous cows was 8.6 and 3.5% respectively (Table 1). The odds ratio (OR) for stillbirth cases was 2.66 times higher ($P < 0.001$) for primiparous cows versus multiparous cows (Table 1).

The OR for stillbirth cases was 0.61 for mother cows that give a female calf versus the mother cows that give a male calf at calving.

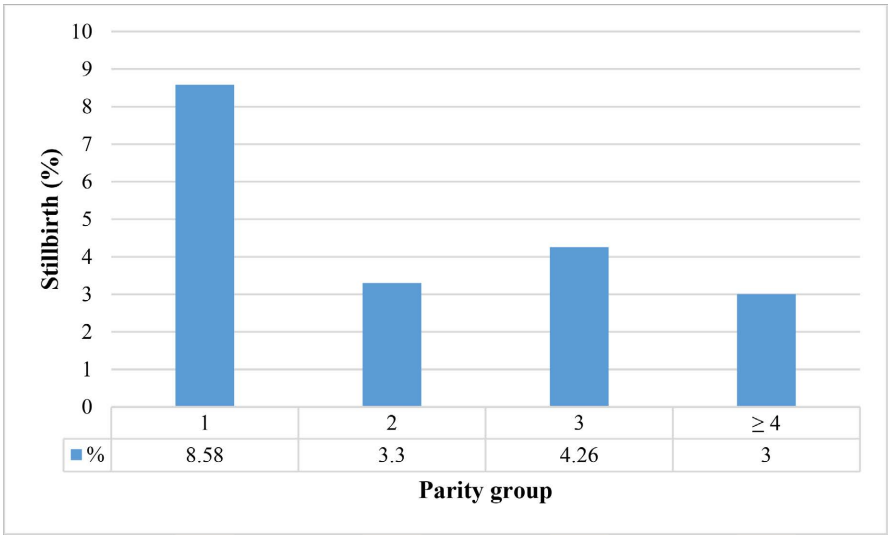

Figure 1. Stillbirth cases (%) versus parity in Holstein-Friesian cows.

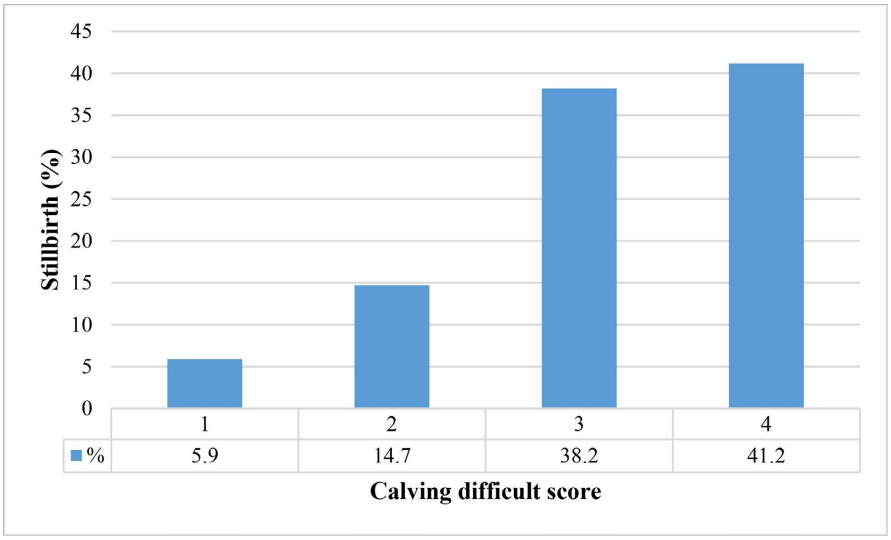

Figure 2. Stillbirth cases (%) versus calving difficult score (1 to 4) in Holstein Friesian cows.

Table 1. Association of stillbirth cases with parity group, calf sex and calving difficulty score in Holstein-Friesian cows.

Measure	Stillbirth[a] % (n/n)	OR[b]	95% CI[c]	p-value
Parity group:				
primiparous	8.6 (34/396)	1	Referent	
multiparous	3.5 (34/975)	2.66	2.47 - 2.77	<0.001
Calf sex:				
Female	3.8 (26/681)	1	Referent	
Male	6.1 (42/690)	0.61	0.51 - 0.74	<0.001
Calving difficulty group[d]				
Unassisted	3.73 (48/1288)	1	Referent	
Assisted	24.09 (20/83)	0.16	0.11 - 0.14	<0.001

[a]Stillbirth was defined as death of calf that occurs just prior to, during, or within 24 h from parturition. [b]OR = odds ratio. [c]95% CI = 95% confidence interval. [d]Unassisted = include calving difficult score 1, 2 and 3, and assisted include calving difficult score 4 and 5.

The OR for stillbirth cases was 0.16 for unassisted versus assisted calvings which means that the odds of stillbirth were 84% lower for unassisted calvings ($p < 0.001$) versus calvings (Table 1).

For the analysis of the effect of stillbirths on Dam's Reproductive Performance a total of 1371 cows were enrolled.

For the cows that gave birth to live calves 54.4% (of 1303) were diagnosed pregnant; and for the cows that had stillborn calves, 368% (of 68) were diagnosed pregnant. The mean days open was 146 days for cows that had live calves and 178 days for cows that had stillbirths.

The hazard ratio for time to conception was 0.74 ($p < 0.001$) for cows that had

stillbirth vs. cows that had live calves. The hazard rate of becoming pregnant was 26% lower for the cows that had stillbirth compared with cows that had live calves.

The hazard ratio for days open was 0.93 ($p = 0.003$), 0.89 ($p < 0.01$) and 0.84 ($p = 0.004$) for male vs. female calves, multiparous vs. primiparous cows, and assisted calving vs. unassisted calving respectively (Table 2).

A total of 1371 cows were enrolled for analysis of the effects of stillbirth on Dam's survival of which 226 were culled or died and 1145 were censored. For the analysis of the effects of stillbirth on dam's survival we used the cox proportional hazards model. The variable retained were stillbirth, PG and CDS. Of all cows that gave birth to live calves 16.2% (of 1303) died or were culled, whereas 22.2% (of 68) of cows that had stillbirth were culled or died.

The hazard ratio of death/cull was 1.44 ($p < 0.001$) for cows that had stillbirths vs. cows that had live calves.

The hazard rate of death/cull was 44% higher for cows that had stillbirths. Also, the PG and CDS affected cow survival (Table 3).

4. Discussion

Number of stillbirth cases in the research herd of Holstein-Friesian dairy cow increased in the period from 2006 to 2017. We consider that this unfavorable trend was as the result of intense use of semen from selected Holstein Friesian sires, which increased the proportion of Holstein Friesian genes in our cows. The Holstein genes have some direct effects of calving difficulty and stillbirth [14]. Hansen *et al.*, (2004) [7] reported an unfavorable genetic trend of stillbirth for both direct and maternal effect as a result of intense use of Holstein Friesian sires as sires of sons, and most genes from the original Danish Black and White cattle have been substituted by Holstein genes. ARDS Simnic-Craiova imported

Table 2. Cox proportional hazard analysis for calving to conception interval.

Variable	d. f.	Parameter estimate	SE	Hazard ratio	p-value
Stillbirth vs. live calf	1	−27	0.06	0.74	<0.001
Male vs. female calf	1	−0.07	0.04	0.93	0.003
Multiparous vs. primiparous	1	−0.11	0.04	0.89	<0.01
Assisted vs. unassisted	1	−0.18	0.06	0.84	0.004

Table 3. Cox proportional hazards analysis for dam survival[a].

Variable	d. f.	Parameter estimate	SE	Hazard ratio	p-value
Stillbirth vs. live calf	1	0.36	0.07	1.37	<0.001
Multiparous vs. primiparous	1	0.70	0.04	2.00	<0.001
Assisted vs. unassisted	1	0.18	0.08	1.14	<0.04

[a]Cows survival was measured as days from calving to culling or death.

in 1977-1978 Danish Black and White heifers.

The stillbirth cases were higher for primiparous cows compared with multiparous cows, partially as improper ratio between pelvic area size of the primiparous cows and size of the calves. Heifers with small pelvises experience a higher incidence of calving difficulty.

Meyer *et al.*, (2001) [14] showed that stillbirth cases in primiparous cows increased by 4% between 1985 and 1995 in US Holstein primiparous cows and by 1% in multiparous cows. A February 2016 USDA report showed an average of 5.6% stillbirths. We recorded between 2006 and 2017, 4.96% stillbirth.

We excluded twin calvings, and time stillbirth cases could be higher. Hossein-Zadeh, (2010) [11] reported in Iran a prevalence of stillbirth from 2.9% to 9.8% (average 4.9%). Also Mahnani *et al.* 2018 [15] reported 4.2% on average in Iranian Holstein cattle.

Uematsu *et al.*, (2013) [16] reported that excessive fetal weigh, primiparity, and low temperature in winter were causes for dystocia and stillbirths in Japanese Black cattle.

In this study we found that stillbirths were higher in cows with male calves (6.1%) at calving compared with cows that had female calves (3.8%) at calving. Male calves have a longer gestation that female calves and this could be a risk of stillbirth. Also male calves have 9% greater birth weight than female calves [17] [18]. Dystocia in large birth weight calves causes hypoxia and anoxia or metabolic and respiratory acidosis. In perinatal mortality infections are a minor diagnosed cause, and can be parasitic, viral or bacterial infections. Congenital defects can also occur (hydrocephalus, cerebellar hypoplasia, intestinal atresia, *schistosomus reflexus*).

In a recent research, Morek-Kopec *et al.* (2021) [19] reported for Polish Holstein Friesian cows that stillbirth rate from male calves at calving was 7.7% and for female calves 3.7%.

In our research we found that calving difficulty had a strong association with the number of stillbirths. The proportion of stillbirths in unassisted calvings was 3.73%, and in assisted calvings 24.09%. The proportion of stillbirth cases increased with increasing calvings difficult score.

In the past reports, stillbirth in dairy cows is presented as the results of interactions of numerous factors from which difficult calvings as the main cause [18] [19] [20] [21]. Also some reports showed that stillbirths in dairy cows may have a genetic component if stillbirth cases are increasing [4] [7] [9] [14].

Another aim of this study was to evaluate the effects of stillbirth on days open and survival of mother cows after calving.

Days open (calving to conception interval) is the major parameter to determine reproductive performance in dairy cows. Early resumption of ovarian activity, and estral cyclicity, adequate estrus detection, and insemination at the correct time in relation to ovulation are decisive for a good conception after calving. Stillbirth in our study increased the mean calving-to-conception interval 32 days compared with normal calvings.

Several reports [11] [12] [16] [22] found an increased in days open between 14.6 to 49 days.

A financial implication of increased days open at various stages of lactation in high yielding dairy cows was evaluated by Esslemont *et al.*, (2018) [23]. The net cost of one day of increase in days open was evaluated at £ 2.48 when conception is delayed from 85 to 115 days after calving, and £ 6.52 per day when conception take place between 206 and 235 days after calving. On the basis of the above costs and taking into consideration the cost of culling for poor fertility it was concluded that breakeven point for cow with high milk yield was at 290 days after calving.

Culling is the removal of cows from the herd, because of sale, slaughter, salvage or death (undesirable animals).

In the Cox proportional-hazards model for investigating the association between the survival time of cows, the prcolictor variables were: stillbirth live calf, multiparous vs. primiparous cows and assisted vs. unassisted calvings in subsequent lactation. Cows with stillbirth had 43% higher hazard rate of culling death that cows with live calves at calving.

The knowledge attained from this studies, can help farmers to manage cows at calving time to enhance the chance of having a live calf at calving and a health mother cow in the subsequent lactation.

5. Conclusion

Based on our results the stillbirth cases for primiparous cows were 8.58%, and 3.30% for second-parity, 4.26% for the third-parity and 3.00% for parity ≥ 4 cows. Primiparous cows had higher stillbirth rates compared with multiparous cows. The incidence of stillbirth was highly correlated with calving difficult sex of calf born, and parity of dam score. Cows with stillbirths had a significantly increased hazard rate of culling/death throughout the lactation. Cows that had a stillbirth had their calving-to-conception interval significantly prolonged. The farmers or herd manager of dairy operation must pay more attention for primiparous cows at calving.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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