Online ISSN 2344 – 2085 Volume 10, Number 2/2021

THE INFLUENCE OF DAM'S BIOMETRICS MEASUREMENTS ON DYSTOCIA INCIDENCE IN BROWN BREED-THE LOSSES CAUSED BY DYSTOCIA IN CALF'S GROWTH PERFORMANCE

Radu Ionel NEAMȚ[1], Silviu Ilie SĂPLĂCAN[2], Ramona LILE[3]

Abstract. *The aim of the current study was to assess the influence of the dam's biometrics measurements on dystocia incidence in Brown cows. The second goal was to assess the loss caused by dystocia calving in calf growth performances. A total of 1440 records from 360 cows was collected between 2012 - 2020 and used to study the potential influencing factors. Data were analyzed used Statistica software. Biometrics measurements were expressed as least squares means (±standard error) used the Main Effect ANOVA protocol. A factorial regression model was employed to explain the influence level of studied factors. The average rate of dystocia in herd was 12.77%. Significant differences (p≤0.01) were calculated between body weights of eutocyal compared with dystocial calves (32.73±0.51 kg vs. 38.12±0.22 kg). Small size of dam's pelvic size facilitated occurrence of dystocia in calving. Significance differences (p≤0.01) were recorded for cows body weight (621.3±7.22 vs. 649.18±7.21 kg related to dystocia vs eutocya calving), rump lenght (52.13±0.18 vs. 49.87±1.24, p≤0.01), width at hips (53.24±0.48 cm vs. 51.17±0.09 cm, p≤0.01) and width at ischia (36.16±0.17 cm vs 32.97±0.28 cm, p≤0.001). The dystocia calf recorded a 12.36% loss in body weight compared to eutocya ones, at 90 days of age. The current study could provide valuable knowledge regarding the relationship between the specificity of the Brown breed for dams-calf related factors, in terms of risk of dystocia incidence and also in calf growth rate.*

Keywords: Brown breed, dam-calf related factors, dystocia incidence, growth rate, risk of dystocia

1. Introduction

The term dystocia originates from the Greek language, composed of the terms 'dys', meaning difficult, and 'tokos' meaning birth. Generally, dystocia is defined as a difficult and prolonged calving. There are many definitions and scales in order to assess birth difficulty. Dystocia widely ranges from needed veterinary assistance [25] to difficult and very difficult birth [18] or hard pull and surgical

[1]Senior Researcher Ph.D., Research and Development Station for Bovine, 310059, Arad, Romania, (email: neamtr@yahoo.com)
[2]Lecturer Ph.D. Aurel Vlaicu University, Faculty of Economics, 310032, Arad, Romania (silviusaplacan@yahoo.com)
[3]Associate Professor Ph.D., Aurel Vlaicu University, Faculty of Economics, 310032, Arad, Romania, (email: ramona.lile@uav.ro)

intervention [22]. According to the degree of needed assistance, a 5-point scale defined as 1 = unassisted, 2 = slight assistance, 3 = considerable assistance, 4 = considerable force needed and 5 = caesarian, was used by Hossein-Zadeh et al. (2010) to assess birth difficulty [36]. A realistic definition of difficult calving has been offered by Berry D.P. et al. (2007), characterized as "births requiring more attention than usual [5]. Worldwide, the incidence of dystocia range between 2-22% [3]. Different difficulty degree could affect 10% [2] and up to 50% of calving [28] despite lower percentages recorded in other studies, ranging between 4.1% [41], 3-5% [23] or even 1.9% [55].

There are various factors that could cause dystocia such as genetic, management and environmental related factors [2]. Dystocia risk increased proportionally with calves' birth weight due to a strong and negative correlation between these two parameters [56]. A significant influence in dystocia occurrence is represented by a combo between calves' body weight and dams' pelvic area size, where the latter is involved in parturition. Dams' pelvic area size defines the oversized calves. Dystocia negatively affects the production, reproduction and animal welfare. Difficult calving leads to an increased percentage of death in calves. In this respect, Murray et al. (2015) found that 15.9% of calves died up to weaning and 8.1% of calves died during the parturition or within the first 48 hours [47]. Survival of calves presented a decreased vitality, which induced a lower capacity to perform with significant repercussions on subsequent efficiency, physiology and behaviour. A negative long-term effect was recorded by Henderson et al. (2004) on adult age of calves that experienced dystocia regarding production and reproductive performances [30]. Quantifying the milk production decrease, Bicalho et al. (2007) recorded a 0.8 kg milk/day loss, which was maintained throughout lactation [6] due to a higher genetic correlation (0.23-0.34) according to Eaglen et al. 2013 [16]. The occurrence of dystocia decreases reproductive performances, negatively affecting all related traits. Dystocia led to an increase in number of services, a prolonged voluntary waiting period and, implicitly, a prolonged service period. A study conducted by Tenhagen et al. (2007) highlighted a decreased rate of conception until 200 DIM, thus increasing service period for cows that experienced dystocia [57]. Generally, occurrence of dystocia in farms led to significant losses at all levels. Stillbirths caused by difficult labor accounted for $125 million/year losses, according to Meyer et al. (2001) [46]. Dystocia accounted for 41% of losses due to production costs, 34% of losses due to reproductive decreased performances costs and 25% of losses due to of morbidity or mortality in herd's costs. Mee (2008) citing Oltenacu et al., (1988) reported that the impact of dystocia reached four times greater costs than its treatment [44]. Numerous attempts have been made in order to decrease incidence of difficult calving and associated mortality in herds. The heritability of dystocia has been studied for a long time now. A moderate coefficient (0.17) was recently calculated by Gabriela Stefani et al. (2021), indicating that dystocia incidence could be partly reduced through selection [54]. An early previous study conducted by Thompson et al., (1984) recorded a moderate-high heritability coefficient (0.24) by regression of dam to daughter [58]. These results were in contradiction with other authors' results [11, 35] which recorded a very low heritability for this trait, ranging from 0.01 to 0.09. In general, heritability of dystocia is considered relatively high, given the significant effects of various non-genetic influential factors [61].

On the other hand, calf-related traits which exert influence on the calving ease are characterized by highly heritability. In this respect, numerous studies were conducted in order to set up values for the heritability coefficients since several decades. Studies aimed to predict the incidence of dystocia have been based prior to selection on the involved calves' related traits such as body dimensions or body weight at birth. These traits proved to be characterized by a high heritability. In this respect, an early study conducted by Price and Wiltbank (1978) [51] found significant heritability for calves' body length (0.35), width at hip (0.42) or body weight (0.28), results also confirmed by Holm et al. (2014) who recorded an even higher heritability (0.44) for calves' body weight [34].

In order to predict the risk of dystocia occurrence, both internal and external pelvimetry constituted a viable attempt, beginning to widely use in the cattle industry [34]. In general, external pelvimetry is an easy and non-invasive way to measure the pelvic area and can be used in practice due to the strong and positive correlations calculated in relation to internal pelvimetry [52]. The pelvimetry was considered as a method of predicting the risk of dystocia all the more so as is responsible for 5-10% of the variation in dystocia [42]. The average pelvis growth rate reaches 0.27 cm^2 per day up to two years of age and this fixed correction factor can be used to adjust pelvic area based on the age at which measurements are obtained. This value are considered as an adjustment coefficient in order to predict the pelvic area at adult age, based on the next formula:

365 Days Pelvic Area=Actual Pelvic Area (cm2) + [0.27(365-age in days)] [27]

The numerous attempts in order to reduce the incidence of dystocia in the herds have also been based on the high heritability of the pelvic area, which facilities direct selection for this trait. Concerns about the heritability of the pelvic area have long been the subject of intense research in numerous previous studies. In this sense, most studies found a highly heritability range 0.36-0.92 with an average value around 0.61 [13]. By selecting both bulls and heifers for pelvic size, a herd of cows with large pelvic areas could be developed which led to a decreased incidence of difficult calving.

Concluding, the pelvimetry could be a tool capable to predict the risk of dystocia occurrence and should be used in order to minimize the incidence and the negative effects of its in herds. Also, heritability of dystocia and calves body measurements should be integrating in breeding programs as an attempt to decrease the incidence of dystocia.

2. Materials and Methods

Location: The study was carried out in livestock biobase from Research and Development Station for Bovine Arad, Romania (location: 46° 10' 36" N, 21° 18' 4" E, 107 m altitude, 582 mm annual average rainfall 21°C/-1°C average of temperature corresponding seasons summer/winter). Geographically, the experiments were carried out in the Western Plain of Romania.

The confinement system: The confinement system applied in farm is a semi-intensive system type characterized by moderate gains rate for the categories of youth (500-750 g/day) and moderate productive values for dairy cows (5,088-6,200 kg/lactation). Newborn calves are separated from their dams within first 20 minutes after birth, kept in individual pens up to seven days of age, located in space intended of maternity. Between 8-90 days, calves are kept in individual hutch on straw bed with free access to the resting area (1.8 m^2/head) and moving area (2.3 m^2/head). The administration of dairy diet is made in the first three days with maternal colostrum and the next four days with raw milk from his own dam. From the eighth day, raw milk is administered from collector tank. The administration of dairy diet is made in two daily portions, every 12 hours (6 am and 18 pm). In parallel, starting from the 4th day of life, calves receive water, alfa-alfa hay and concentrated forage administered ad libitum until day 60, after which the access is restricted for concentrated forage. Data regarding the calves' body weight were collected within first hour of age.

All cows were included in the Official Performance and Recording Scheme. Cows were milked twice per day (starting at 5:00 and 17:00) in a “herringbone” milking parlour (2 by 14 units). The milking parlour was equipped with AfiMilk 3.076 A-DU software (Afikim, Israel). Furthermore, all cows were fitted with AfiTag pedometers (Afikim, Israel) for production traits, oestrous and specific diseases detection. Production and milk quality data (milk yield, fat yield and percentage, protein yield and percentage) were collected from the results of the official performance recordings, according to the standardized International Committee for Animal Recording (ICAR) guidelines (2012), and also with the proprietary recording system AfiMilk 3.076 A-DU software (Afikim, Israel). Data regarding reproductive performance, type of calving, calving ease and stillborn were recorded by the stockholders in own recording data set. Data regarding cow’s body weight were recorded within the last 72 hours before probable date of calving. Cow's biometric measurements were performed using a compass for external pelvimetry, based on the following lengths, according to Hohnholz et al. (2019) [33].

Table 1. Definitions of dams' external pelvic measurements

Parameter	Unit	Definition
Rump length	cm	Distance between the cranial edge of the tuber coxae and the caudal edge of the tuber ischiadicum
Width at the hips	cm	Distance between the lateral edges of the tuber coxae
Width at the ischia	cm	Distance between the lateral edges of the tuber ischiadicum

Cows included in the current study were managed under a loose system with zero grazing and were between 1st and 4th lactation, with age and parity balanced within the herd. Cows had a space allowance of 9 m^2 in the resting area and free access to shadow, water and feeding zone. They received a daily feed ration made of 15 kg of fresh cut alfalfa, 15 kg of green fodder, 12 kg corn silage, 6 kg of alfalfa hay and 4 kg of concentrates starting from spring until late autumn, and a ration made of 15 kg alfalfa, 25 kg of corn silages, 6 kg of alfalfa hay and 5 kg of concentrates during winter. Cows were fed twice per day and had a feeding space allowance of 70-75 cm/head. They were housed in groups of 70 animals, according to their productivity.

Use of animals and the procedures performed in this study were approved by the Scientific and Ethics Committee of the Research and Development Station for Bovine Arad of the Academy for Agricultural and Forestry Sciences, Decision no. 51 issued on November 11, 2015. Also, the research activities were performed in accordance with the European Union's Directive for animal experimentation (Directive 2010/63/EU).

Data recording:

A data set of 1,440 recording from 360 lactations collected between 2012 and 2020, was analyzed for estimation of the effects of the calves and dams biometric related traits on incidence of dystocia. Statistical processing and data interpretation process aimed: a) identifying and assessing the influential level of dam's biometric traits on calving ease; b) assessing the influence of studied factors on dystocia incidence. The incidence of dystocia was investigated according to a) calves' birth weight; b) dams' body weight; c) dams' rump length; d) dams' width at hips and e) dams' width at ischia.

Data were cleaned by eliminating human recording errors (outliers), redundant entries and incomplete observations. Data from cows with abortions or stillborn were discarded. Also, cows with no information for studied traits. Grubbs' test (Grubbs, 1969) was performed in order to detect outliers in a univariate date set that follows an approximately normal distribution [27].

$$G = \frac{\bar{y} - ymin}{s} \qquad G = \frac{\bar{y} - ymax}{s}$$

where: ȳ=sample mean; s=standard deviation; ymin=minimum value; ymax=maximum value (for individuals measurements)

When suspecting more than one outlier, the Tietjen-Moore test was used to identify and reject them (Tietjen and Moore, 1972) [59].

$$Lk = \frac{\sum_{i-1}^{n-k}(yi - yk)^2}{\sum_{i-1}^{n}(yi - \bar{y})^2}$$

where: k=exactly k outliers in the data set; n=number of data points sorted from smallest to largest; yi=the ith largest data value; ȳ=mean of the full sample; ȳk=sample mean with largest k point deleted.

The effect of studied factors on calving ease was assessed using a factorial ANOVA protocol. Differences were tested using Tukey test.

$$DI = CBW_i + DBW_j + RL_k + Wil_l + WIs_m + e_{ijkl,}$$

where: DI is the dystocia incidence; YCBW=effect of calves body weight at birth; DBW=effect of dams body weight at calving; RL= effect of dams rump length; Wh= effect of dams width at hips; WIs= effect of dams width at ischia.

The analyzed data were expressed as least square means and standard error of mean. Incidence of dystocia were recorded according to biometric factors in order to set up "alarm" thresholds for better designing of the optimal prediction of dystocia occurrence risk protocol. All the statistical inferences were carried out using the software package Statistica (StatSoft Inc., Tulsa, OK USA) [31]. Decisions about the acceptance or rejection of statistical hypothesis have been made at the 0.05 level of significance. A factorial regression model was performed in order to evaluate the influence of studied factors on incidence of dystocia.

$$Y = a + b\ldots \times NGf$$

where: Y is dystocia incidence percentage and NGf are the non-genetic influential factors included in the study.

To determine the effects of non-genetic factors, the traits of interest would be set up as the dependent variables and the dystocia incidence as an independent variable in the model. To determine how influential factors affect the incidence of dystocia, the opposite is done: the dystocia incidence becomes the dependent variable and the influential factors included in the study are the independent variables of interest.

3. Results and discussions

Analyses of data presented in table 1 showed significant differences between studied parameters due to the influential factors. Analyses regarding the incidence of dystocia in herd, highlighted a share of 12.77% from total registered calving.

Table 2. Least square means (±standard error) for calves' body weight at birth and dams' biometric measurements according to calving ease

Calving easy	N	Calves' body weight at birth (kg)	Calves' body weight at 90 days of age (kg)	Dams' body weight (kg)	Dams' Rump length (cm)	Dams' Width at hips (cm)	Dams' Width at ischia (cm)
Eutocya	314^{a}	32.73 ± 0.51^{a}	100.53 ± 1.51^{a}	649.18 ± 7.21^{a}	52.13 ± 0.18^{a}	53.24 ± 0.48^{a}	36.16 ± 0.17^{a}
Dystocia	46^{b}	38.12 ± 0.22^{b}	88.46 ± 0.93^{b}	621.37 ± 7.22^{b}	49.87 ± 1.24^{b}	51.17 ± 0.09^{b}	32.97 ± 0.28^{b}

a,b Column means with different superscripts differ significantly at $p\leq0.05$

Calves body weight at birth presented significance differences ($p\leq0.01$, $F=9.33$) between eutocyal and dystocial calves. Cows with dystocia births proved to be significantly narrower compared to those with eutocyal calving. In this respect, significant differences ($P\leq0.01$, $F=18.24$) for cows' body measurements were recorded explaining the interaction between cows' body weight, cows' pelvic area and calving ease (Table 2).

Cow body weight was highly correlated with the pelvic area traits (rump length, width at the hips, width at the ischia), r=0.2-0.8. Size of pelvic area alongside calves' birth weight limits the calving ease with severe impact on new born calves' viability.

Cows body weight according to calving ease, had significant differences ($p\leq0.01$, $F=6.16$) between cows with eutocya vs. those with dystocia calving. Significant differences of 2.26±0.06 ($p\leq0.01$, $F=9.23$), 2.07±0.39 ($p\leq0.01$, $F=8.87$) and 3.19±0.27 ($p\leq0.001$, $F=6.37$) cm were recorded for rump length, width at hips and width at ischia between cows that experienced eutocya compared to those with dystocia.

Calves growth performance was significant influenced by calving ease. A 12.36% loss was recorded according to this particularly parameter.

Table 3. Regression model for estimate of variables effects on calving ease

Influential factors	**b***	**Std. Err. Of b***	***t* test**	***P* values**
Intercept	-	-	0.56022	0.051578
Calves body weight at birth	0.034	0.011	-2.46520	0.0234
Calves body weight at 90 days	0,012	0,014	-3,1244	0,001
Dams body weight at calving	0.094	0.021	0.045604	0.03486
Dams' Rump length (cm)	0.062	0.017	0.05265	0.03957
Dams' Width at hips	-0.051	0.08	-0.05813	0.019800
Dams' Width at ischia	-0.0013	0.014	6.12091	0.00002

The factorial regression model of the factors influencing the calving ease highlighted a significant interaction ($P<0.01$), $r=0.40865347$. The validity of the test was confirmed by the $F=11.427$. The factorial regression model has shown that calving ease was significantly influenced by the calf birth weight ($p\leq 0.01$), dam's body weight ($p\leq 0.01$), rump length ($p\leq 0.01$), width at the hips ($p\leq 0.01$) and most especially by the width at Ischia (p0. 001).

Difficult calving significant and negative influenced the calf's growth performances in 0-90 days of age interval. Significant differences ($p\leq 0.001$) were recorded in this respect related to calves body weights at 90 days of age (100.53±1.51 vs. 88.46±0.93 kg for eutocya and dystocia calving).

Table 4. Least square means (±standard error) for calves' body weight at birth and 90 days of age according to calving ease

Parameters	Calf's body weight at birth (kg)	Calf's body weight at 90 days of age (kg)
Eutocya calves	32.73±0.51[a]	100.53±1.51[a]
Distocya calves	38.12±0.22[b]	88.46±0.93[b]

a,b Column means with different superscripts differ significantly at $p\leq 0.05$

Dystocia incidence:

Dystocia causes huge loss in farms. It cannot be predicted, but the incidence can be reduced by management measures if the influential factors are identified. That could be realize through ensuring a comfortable calving area, provide optimal assistance at calving and most importantly, through selection of sires and cows for calving ease (based on an adequate pelvic size), which never been done before in this industry. The calving alongside to the weaning constitutes one of the major stressor on cows' biorhythm. There are vary internal and external influential factors that could transform the physiological birth into a disturbing element of both dam and calf welfare condition due to occurrence of difficulty in calving process. The inclusion of vary categories of factors in a case study, may determine their involvement related to difficult degree of calving but it does not allow obtaining an exhaustive result in this sense due to dilution of outcomes. The current study aimed analysis of the biometric factors with impact on dystocia incidence in order to establish the effect of the pelvic area on its occurrence. The current incidence of dystocia reached 12.77% in herd. At the first sight this value is in accordance with others results founded worldwide. There are few studies aimed the tendency of dystocia incidence but all of these recognize an increasing trend in all breeds and crossbred [7, 11].

Generally, a higher incidence was observed in dairy compared to beef breed. This statement was proved over the time. In this respect, Hohnholz et al. (2019) [33] found a 3.4% incidence in beef cows which is consistent with an incidence of 5.6% associated to Italian beef breed and recorded by De Amicis et al. (2018) [12] while Steinbock (2006) [55], Hansen et al. (2004) [28] or Mc Clintock (2004) [41] found a slightly increased incidence in Swedisk, Danisk and Australian Jersey crossbreed with Holstein due to "Holsteinization process". Concluding, an increased proportion of Holstein genes lead to an increased incidence of dystocia, according to numerous studies performed in this sense [13]. Not at least, Mee J.F. et al. (2011) found a huge proportion of needed assistance calving (28-40%) out of 5-9.3% severe dystocia in Holstein [43]. Manual correction could be performed in more than 95% difficult calving, reducing both calves (up to 25%) and dams (up to 11%) mortality [12] compared to those unassisted dystocia calving which tend to increase mortality to over 37% [39]. The incidence of dystocia in primiparous was quantified to be 10-50 % whereas in multiparous the incidence of dystocia ranged between 4-30% [1, 60]. Also, Grohn et al. (1990) reported that the risk of dystocia increased with increasing parity [26]. Conversely, Yildiz H. et al. (2011) found no significant differences related to dystocia incidence according to parity [65].

A customized assessment of dystocia incidence can be developed for each farm depending by the concrete factors that characterize the environment, the general management, the available resources, and especially the individuality of the animals rearing.

Calves' body weight at birth

Calves' growth is largely controlled by various and numerous factors. Body weight at birth (BWB) is strongly correlated with the foetal growth rate, being an important factor in the survivability, performance efficiency and welfare condition of both calves and dams, the latter based most often on calving ease. The main influential factor in calving ease still remains the foetal-maternal disproportion, especially in primiparous dams. Such disproportion leads to a higher pre- or intrapartum mortality, within 48 hours after calving [33]. Calves’ body weight is strongly influenced by genetic factors such as breed and also by non-genetic influential factors such as year or season of calving, dam’s parity, calves sex, feeding management in late gestation, as well as by twinning. Calves’ body weight at birth is a significant influential factor in calving ease. Increase of body weight at birth with 1 kg could increase the risk of dystocia by up to 0.23% [48].

Conversely, Johanson and Berger (2003) recorded that for 1 kg increased body weight there was a 13% increase in risk of dystocia [37]. Also, in the same study, an increased risk of dystocia ranging between 2.1-9.6% was associated to an increase in body weight ranging between 29-52 kg. Similar results were recorded by Berry et al (2007), who estimated a 15% increased risk of difficult calving for calves’ body weight at birth ranging between 20-50 kg [5]. Conversely, Eckterkamp et al. (1999, 2007) found no significant difference regarding the calves’ body weight at birth in eutocious or dystocious calving [19, 20]. A possible explanation could be the direct correlation between the surface of the pelvic area and calving ease. In this case, the width at the ischia plays a major role in calving. The calf’s body weight at birth doesn't seem to be the limiting factor related to calving ease. The strong correlation between the calf’s body weight at birth and width at ischia seems to be the limiting factor.

The current research found a significant difference related to calves’ body weight at birth according to gender, males being heavier on average than females. These results are in accordance with the previous findings of Dkahal K. et al. (2013) and Kwanghyun C. et al. (2021) [14, 9].

In addition, calves’ body weight at birth proved to be significantly influenced by different factors. Olson et al. (2009) and found significant differences according to twinning, also a 3.86 higher risk of dystocia in twinning [50]. The season of calving could influence the calves’ body weight at birth. The results are inconsistent in this sense in previous studies. Wells et al. (1996) found higher body weight at birth for calves delivered in winter, implying a higher risk of dystocia [63]. Similar results were recorded by Cho et al. (2021) [9].

Generally, body weight at birth is higher in winter due to the confinement system and the weather, which does not allow access to pasture in order to facilitate energy consumption as it is redirected to the foetal development and feeding system which does not include the green forage but only high nutritional density feeds. Related to this issue, the previous results obtained proved to be consistent in this respect [43, 56]. Different body weight at birth observations were recorded according to dams’ breed and under crossbreeding effects, inducing different incidence of difficult calving. In this sense, Olson et al. (2009) recorded heavier calves in Holstein compared to Jersey or in Jersey x Holstein compared to Holstein x Jersey [50].

Dam's pelvic area

Significant differences were associated with dam's body measurements according to calving ease. Generally, a higher incidence of dystocia was recorded for dams with lower body weight and lower surface of pelvic area. Our findings were in accordance with those recorded in a study conducted by Bures et al. (2008), which found larger measurements for dam's body weight and pelvic dimensions in eutocya compared to dystocia in cows [7]. Dam's body weight did not directly affect calving ease but it is a pretty good indicator for the risk of dystocia due to a strong correlation with the pelvic area (R=0.8) [24]. A higher impact exerts dystocia in dam's body weight after calving [5]. However, studies conducted over the years have shown that a higher dam's body weight could significantly reduce the risk of dystocia occurrence [32, 45].

The pelvic area proved to be a limitative factor in calving ease. Even if it only has the capacity to increase up to 10-15% at the calving, its original size still remains a tool for predicting the risk of dystocious calving [45]. In this respect, a greater area generally leads to an easier calving. Johanson and Berger (2003) recorded a decreased incidence of dystocia of up to 11% due to an increased pelvic area by 1 dm^2 [37]. The association between the pelvic area and the calf's body weight at birth proved to be the combination with the maximum impact on calving ease. Numerous studies aimed the ratio between these two factors, proving that the pelvic area alone determines only 10% of dystocia phenotypic variance [49].

Losses caused by dystocia calving

In the current research, a significant impact of calving ease was recorded related to calves' viability. The eutocious calving allows setting up a metabolic and physiological balance that facilitates phenotypic outsourcing of hereditary dowry in terms of growth performances. From this point of view, significant differences related to calf's body weight at 90 days of age were recorded. Previous results are inconsistent. As such, several studies found no significant effects of dystocia in growth processes [4, 8, 29, 40]. Other studies found opposing results [15, 64]. A possible cause could be the fact that the calves from dystocious births die during the first days after calving. Also, some studies considered that moderate dystocia has no long-term effects on animal performances. Conversely, there are numerous studies that have found otherwise [17].

In our study, a long-term effect of dystocia was recorded in terms of body weight at 90 days of age, the losses reaching 12.36%. Increasing losses and delays in terms of body weight are based on a decreased calf's viability. Generally, dystocious calving induces a higher cortisol level which reflects a response of hypothalamic-adrenal axis in order to prepare and allow adaptation to a new extrauterine environment [10]. Also, calves that experienced a difficult calving recorded lower levels of immunoglobulin intake and its passive transfer (50% cases compared to 20% in eutocya). A failure in passive transfer leads to a decreased protection against specific diseases [62].

Severe dystocia could lead to a hypoxic state in calves with negative effects in immunoglobulin absorption. Lower immunoglobulin absorption was generally considered as an effect of lower vigor of calves and it is often associated to a significant delay in colostrum consumption and lower amount of colostrum intake. In conclusion, lower viability in dystocia calves could lead to a negative expression of performance.

Conclusions

(1) The current research highlights connections between calving ease and some influential factors thereof.

(2) Also, the effects of dystocia calving in calf's performances up to weaning. Calves welfare condition could be assessed based on their performance. In this sense the calf's welfare condition is directly influenced by the calving ease.

(3) The higher calf's body weight at birth influenced negatively calving ease.

(4) The dimensions of pelvic area are influential factors on calving ease especially the ratio between calf's size and dam's measurements.

(5) Ensuring good management practices in calving could be a viable solution in obtaining viable calves which perform efficiently.

Acknowledgements

The present study was supported by a self-funded grant of SCDCB Arad through the project 5173/2021.

REFERENCES

[1] Abera, D., Management of dystocia cases in the cattle - A review, Journal of Reproduction and Infertility, vol. 8, no. 1, pp. 1-9, (2017).

[2] Atashi, H., Abdolmohammadi, A., Dadpasand, M., Asaadi, A. Prevalence, Risk Factors and Consequent Effect of Dystocia in Holstein Dairy Cows in Iran, Asian-Australas J. Anim. Sci. vol. 25, no 4, pp. 447–451, (2012).

[3] Barrier, A.C., Haskell, M.J., Birch, S., Bagnall, A., Bell, D.J., Dickinson, J., Macrae, A.I., Dwyer, C.M. The impact of dystocia on dairy calf health, welfare, performance and survival, The Veterinary Journal, vol. 195, no. 1, pp. 86-90, (2013).

[4] Barrier, A.C., Haskell, M.J., Dwyer, C.M., Dystocial dairy calves: Condemned to poor welfare? Proceedings of the 5th WAFL Conference, Guelph, Canada, pp. 64, (2011).

[5] Berry, D.P., Lee, J.M., Macdonald, K.A., Roche, J.R. Body Condition Score and Body Weight Effects on Dystocia and Stillbirths and Consequent Effects on Post calving Performance, Journal of Dairy Science, vol. 90, no. 9, pp. 4201-4211, (2007).

[6] Bicalho, R.C., Galvao, K.N., Cheong, S.H., Gilbert, R.O., Warnick, L.D., Guard, C.L. Effect of stillbirths on dam survival and reproduction performance in Holstein dairy cows, J. Dairy Sci. vol. 90, pp. 2797–2803, (2007).

[7] Bureš, D., Bartoň, L., Zahrádková, R., Teslík, V., Fiedlerová, M. Calving difficulty as related to body weights and measurements of cows and calves in a herd of Gascon breed, Czech J. Anim. Sci., vol. 53, no. 5, pp. 187-194, (2008).

[8] Carnier, P, Albera, A, Dal Zotto, R., Groen, A.F., Bona, M., Bittante, G., Genetic parameters for direct and maternal calving ability over parities in Piedmontese cattle, J. Anim. Sci. vol. 78, pp. 2532–2539, (2000).

[9] Cho, K., Song, Y., Yeo, J.-M., Park, J.-K., Kim, D.-W., Roh, S.-H., Seong, P., Lee, W.-Y. Analysis of seasonal effect on Korean native cattle (Hanwoo) birth weight, J. Anim. Sci. Technol., vol. 63, no. 4, pp. 759-765, (2021).

[10] Civelek, T., Celik, H.A., Avci, G., Cingi, C.C., Effects of dystocia on plasma cortisol and cholesterol levels in Holstein heifers and their newborn calves. Bulletin of the Veterinary Institute in Pulawy, vol. 52, pp. 649–654, (2008).

[11] Cole, J.B., Null, D.J., Tsuruta, S., Use of a threshold animal model to estimate calving ease and stillbirth (co) variance components for US Holsteins, J. Anim. Sci., vol. 94 (supplement 5), pp. 186–187, (2016).

[12] De Amicis, I, Veronesi, M.C., Robbe, D., Gloria, A., Carluccio, A., Prevalence, causes, resolution and consequences of bovine dystocia in Italy, Theriogenology, vol. 107, pp. 104-108, Feb., (2018).

[13] Deutscher, G.H., Pelvic measurements for reducing calving difficulty, Neb Guide, G87-839-A, Cooperative Extension, University of Nebraska-Lincoln, (1991).

[14] Dhakal, K., Maltecca, C., Cassady, J.P., Baloche, G., Williams, C.M., Washburn, S.P., Calf birth weight, gestation length, calving ease, and neonatal calf mortality in Holstein, Jersey and crossbred cows in a pasture system, J. Dairy Sci., vol. 96, no. 1, pp. 690-698, (2013).

[15] Donovan, G.A., Dohoo, I.R., Montgomery, D.M., Bennett, F.L., Calf and disease factors affecting growth in female Holstein calves in Florida, USA. Preventive Veterinary Medicine, vol. 33, pp. 1–10, (1998).

[16] Eaglen, S.A.E., Coffey, M.P., Woolliams, J.A., Wall, E., Direct and maternal genetic relationships between calving ease, gestation length, milk production, fertility, type, and lifespan of Holstein-Friesian primiparous cows. J. Dairy Sci. vol. 96, no. 6, pp. 4015–4025, (2013).

[17] Eaglen, S.A.E., Coffey, M.P., Woolliams, J.A., Mrode, R., Wall, E., Phenotypic effects of calving ease on the subsequent fertility and milk production of dam and calf in UK Holstein-Friesian heifers. Journal of Dairy Science, vol. 94, pp. 5413–5423, (2011).

[18] Eaglen, S., Bijma, P. Genetic parameters of direct and maternal effects for calving ease in Dutch Holstein-Friesian cattle, J. Dairy Sci. vol. 92, pp. 2229-2237, (2009).

[19] Echternkamp, S.E., Thallman, R.M., Cushman, R.A., Allan, M.F., Gregory, K.E., Increased calf production in cattle selected for twin ovulations, J. Anim .Sci. vol. 85, pp. 3239–3258, (2007).

[20] Echternkamp, S.E., Gregory, K.E., Effects of twinning on gestation length, retained placenta, and dystocia. J Anim Sci vol. 77, pp. 39–47, (1999).

[21] Fatehi, J., Jamrozik, J., Schaeffer, L.R., Phenotypic and genetic trends in Canadian Holstein female reproductive traits, Abst. Book 8th World Congress Genetics Appl. to Liv. Prod., Brazil, Abst. Vol. 1-56, pp. 21, (2006).

[22] Fourichon, C., Beaudeau, B. F., Seegers, H. Incidence of health disorders in dairy farming systems in western France. Liv. Prod. Sci. vol. 68, pp. 157-170, (2001).

[23] Frame, N. Management of dystocia in cattle. BVA In Practice, vol. 28, no. 8, pp. 470 – 476, (2006).

[24] Gaines, J.D., Peschel, D., Kauffman, R.G., Schaefer, D.M., Badtram, G., Kumi-Diaka, J., Clayton, M.K., Milliken, G., Pelvic growth, calf birth weight and dystocia in Holstein × Hereford heifers, Theriogenology, vol. 40, pp. 33–41, (1993).

[25] Gevrekci, Y., Chang, Y.M., Kizilkaya, K., Gianiola, D., Weigel, K.A., Akbas, Y. Bayesian inference for calving ease and stillbirth in Holsteins using a bivariate threshold sire-maternal grandsire model, Abst. Book 8th World Congress on Genetics Appl. to Liv. Prod. Brazil, Abst. Vol. 1-26, pp. 11, (2006).

[26] Grohn, Y.T., Erb, H.N., McCulloch, C.E., Salonieni H.S., Epidemiology of reproductive disorders in dairy cattle-Associations among host characteristics disease and production, Preventive Veterinary Medicine, vol. 8, no. 1, pp. 25-39, (1990).

[27] Grubbs, F., Procedures for Detecting Outlying Observations in Samples, Technometrics, vol. 11, no. 1, pp. 1-21, (1969).

[28] Hansen, M., Misztal, I., Lund, M.S., Pedersen, J., Christensen, L.G., Undesired phenotypic and genetic trend for stillbirth in Danish Holsteins, Journal of Dairy Science, vol. 87, pp. 1477–1486, (2004).

[29] Heinrichs, A.J., Heinrichs, B.S., Harel, O., Rogers, G.W., Place, N.T., A prospective study of calf factors affecting age, body size, and body condition score at first calving of Holstein dairy heifers, Journal of Dairy Science, vol. 88, pp. 2828– 2835, (2005).

[30] Henderson, L., Miglior, F., Sewalem, A., Kelton, D., Robinson, A., Leslie, K.E., Estimation of genetic parameters for measures of calf survival in a population of Holstein heifer calves from a heifer-raising facility in New York State, Journal of Dairy Science, vol. 94, pp. 461–470, (2004).

[31] Hill, T., Lewicki, P., Statistics: Methods and Applications, Stat Soft, Tulsa, OK, USA, (2007).

[32] Hoffman, P.C., Funk, D.A., Applied dynamics of dairy replacement growth and management, J. Dairy Sci., vol. 75, pp. 2504– 2516., (1992).

[33] Hohnholz, T., Volkmann, N., Gillandt, K., Waßmuth, R., Kemper, N., Risk Factors for Dystocia and Perinatal Mortality in Extensively Kept Angus Suckler Cows in Germany. Agriculture, vol. 9, pp. 85, (2019).

[34] Holm, D.E., Webb, E.C., Thompson, P.N., A new application of pelvis area data as culling tool to aid in the management of dystocia in heifers, J. Anim. Sci., vol. 92, pp. 2296–2303, (2014).

[35] Hossein Salimi, M, Hossein-Zadeh, N.G., Shadparvar, A.A., Eghbal, A.R., Genetic evaluation of dystocia and its relationship with productive and reproductive traits in Holstein cows, Rev. Colomb. Cienc. Pecu, vol. 30, no. 2, pp. 126–137, (2017).

[36] Hossein-Zadeh, N., Nejati-Javaremi, A., Miraei Ashtiani, S.R., Kohram, H. Bioeconomic evaluation of the use of sexed semen at different conception rates and herd sizes in Holstein populations. Anim Reprod Sci, vol. 121, pp 17-23, (2010).

[37] Johanson, J.M., Philip, B., Birth Weight as a Predictor of Calving Ease and Perinatal Mortality in Holstein Cattle. Journal of Dairy Science, vol. 86, no. 11, pp. 3745-55, (2003).

[38] Knob, D.A., Moro Alessio, D.R., Neto, A.T., Mozzaquatro, F.D. Reproductive performance and survival of Holstein and Holstein × Simmental crossbred cows, Tropical Animal Health and Production, vol. 48, no. 7, pp. 1409-1413, (2016).

[39] Lombard, J.E., Garry, F.B., Tomlinson, S.M., Garber, L.P., Impacts of dystocia on health and survival of dairy calves, J. Dairy Sci., vol. 90, pp. 1751-1760, (2007).

[40] Lundborg, G.K., Oltenacu, P.A., Maizon, D.O., Svensson, E.C., Liberg, P.G.A., Dam-related effects on heart girth at birth, morbidity and growth rate from birth to 90 days of age in Swedish dairy calves. Preventive Veterinary Medicine, vol. 60, pp. 175–190, (2003).

[41] McClintock, S.E., A genetic evaluation of dystocia in Australian Holstein–Friesian cattle. Ph.D., University of Melbourne, (2004).

[42] Mee, J., Prevalence and risk factors for dystocia in dairy cattle – With emphasis on confinement systems. WCDS Adv. Dairy Technol, vol. 24, pp. 113–125, (2012).

[43] Mee, J.F., Berry, D.P., Cromie, A.R. Risk factors for calving assistance and dystocia in pasture-based Holstein-Friesian heifers and cows in Ireland, Vet. J. vol. 187, no. 2, pp. 189-94, Feb, (2011).

[44] Mee, J.F., Prevalence and risk factors for dystocia in dairy cattle: A review, The Veterinary Journal vol. 176 pp. 93–101, (2008).

[45] Meijering, A., Dystocia and stillbirth in cattle – a review of causes, relations and implications, Livest. Prod. Sci., vol. 11, pp. 143-177, (1984).

[46] Meyer, C.L., Berger, P.J., Koehler, K.L., Thompson, J.R., Sattler, C.G.Phenotypic trends in incidence of stillbirth for Holsteins in the United States, J. Dairy Sci., vol. 84, pp. 515–523, (2001).

[47] Murray, C.F., Veira, D.M., Nadalin, A.L., Haines, D.M., Jackson, M.L., Pearl, D.L., Leslie, K.E., The effect of dystocia on physiological and behavioral characteristics related to vitality and passive transfer of immunoglobulins in newborn Holstein calves. Can. J. Vet. Res. Vol. 79, no. 2, pp. 109-119, April, (2015).

[48] Nix, J.M., Spitzer, J.C., Grimes, L.W., Burns, L.G., Plyler, B.B. A retrospective analysis of factors contributing to calf mortality and dystocia in beef cattle, Theriogenology, vol. 49, no. 8, pp. 1515-1523, (1998).

[49] Noakes, D.E., Guest editorial: dystocia in cattle, Vet. J. vol. 153, pp. 123–124, (1997).

[50] Olson, K.M., Cassell, B.G., McAllister, A.L., Washburn, S.P. Dystocia, stillbirth, gestation length, and birth weight in Holstein, Jersey, and reciprocal crosses from a planned experiment, J. Dairy Sci., vol. 92, no. 12, pp. 6167-6175, (2009).

[51] Price, T.D., Wiltbank, J.N. Predicting dystocia in heifers, Theriogenology, vol. 9, pp. 221–249, (1978).

[52] Silva, R.L.S., Oliveira, W.D.C., Biagiotti, D., Ferreira, D.J.B.C. Pelvimetry of multiparous Nellore cows in the cycling and early puerperal stages, Animal Morphophysiology Pesq. Vet. Bras. Vol. 39, no. 5, pp. 348-354, (2019).

[53] Smith, J.W. Correlation of pelvic shape and birth weight EPDs in reducing dystocia in beef cattle, Mastes of Science Thesis-University of Tennesse, pp 13, (2005).

[54] Stefani, G., Brandão Aquaroli, D., Gonçalves, J.B., Júniorn, C., Santana Júnior, M.L., Tonhati, H., Sesana, R.C., El Faro, L. Genetic parameters for dystocia, milk yield and age at first calving in Brazilian Holstein cows, Journal of Applied Animal Research, vol. 49, no. 1, pp 1-5, (2021).

[55] Steinbock, L., Comparative analysis on genetics of stillbirth and calving difficulty in Swedish dairy cattle breeds. Licentiate thesis. Swedish University of Agricultural Sciences, Uppsala. Pp. 22, (2006).

[56] Steinbock, L., Näsholm, A., Berglund, B., Johansson, K., Philipsson, J., Genetic Effects on Stillbirth and Calving Difficulty in Swedish Holsteins at First and Second Calving, J. Dairy Sci., vol. 86, pp. 2228–2235, (2003).

[57] Tenhagen, B.A., Helmbold, A., Heuwieser, W., Effect of various degrees of dystocia in dairy cattle on calf viability, milk production, fertility and culling, J. Vet. Med. A Physiol. Pathol. Clin. Med. vol. 54, pp. 98–102, (2007).

[58] Thompson, J.R., Rege, J.E.O. Influences of Dam on Calving Difficulty and Early Calf Mortality, Journal of Dairy Science, vol. 67, no. 4, pp. 847-853, (1984).

[59] Tietjen, G.L., Moore, R.H., Some Grubbs-Type Statistics for the Detection of Outliers, Technometrics, vol. 14, no. 3, pp. 583-597, (1972).

[60] Uzmay, C., Kayo, J., Ayyilmaz, T., Analysis of risk factors for dystocia in a Turkish Holstein herd, Journal of Animal and Veterinary Advances, vol. 9, no. 20, pp. 2571-2577, (2010).

[61] Vanderick, S., Gillon, A., Glorieux, G., Mayeres, P., Mota, R.R., Gengler, N., Usefulness of multi-breed models in genetic evaluation of direct and maternal calving ease in Holstein and Belgian Blue Walloon purebreds and crossbreds, Livest Sci. vol. 198, pp. 129-137, (2017).

[62] Waldner, C.L., Rosengren, L., Factors associated with serum immunoglobulin G levels in beef calves from Alberta and Saskatchewan and associations between passive transfer and health outcomes, Canadian Veterinary Journal, vol. 50, pp. 275–283, (2009).

[63] Wells, S.J., Dargatz, D.A., Ott, S.L., Factors associated with mortality to 21 days of life in dairy heifers in the United States, Prev. Vet. Med., vol. 29, pp. 9–19, (1996).

[64] Wittum, T.E., Salman, M.D., King, M.E., Mortimer, R.G., Odde, K.G., Morris, D.L. Individual animal and maternal risk factors for morbidity and mortality of neonatal beef calves in Colorado, USA. Preventive Veterinary Medicine vol. 19, pp. 1– 13, (1994).

[65] Yıldız, H., Saat, N., Şimşek, H. An investigation on body condition score, body weight, calf weight and hematological profile in crossbred dairy cows suffering from dystocia, Pakistan Veterinary Journal, vol. 31, no. 2, pp. 125-128, (2011).