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EFFECT OF SINGLE AND MULTIPLE PREGNANCIES AND CALF SEX ON PARTURITION PROCESS AND PERINATAL MORTALITY*

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Abstract

Material for the study was collected from the SYMLEK database and provided information on 148385 parturitions of Polish Black-and-White Holstein-Friesian cows representing the active population (part of the performance evaluation) in the Pomorze and Kujawy regions. The animals first calved in 2006 and were used or culled by the end of 2012. GLM and chi-square procedures of the SAS package were used for the statistical calculations. The number and sex of calves born had an effect (P≤0.01) on the parturition process and on the level of perinatal mortality. As the number of foetuses increased, the proportion of difficult parturitions increased from 4.3 to 28.6%. A decrease in calving ease was also related to the fact that the calf was of male sex. The risk of perinatal mortality increased after multiple pregnancy and when a bull calf was born (among single calves perinatal mortality was over 3 times as frequent in bull calves compared to heifers; among same-sex twins perinatal mortality was around twice as frequent when two bull calves compared to two heifers were born; for births of opposite-sex twins, perinatal mortality was more frequent among bull calves). It was also found that perinatal mortality of calves increased with increasing level of calving difficulty. For very difficult parturitions, the risk of perinatal mortality among calves, regardless of sex, increased 10-fold in relation to unassisted parturition.

Key words: cattle, calf, twin, perinatal mortality

The interest in the parturition process results from the increased perinatal mortality of calves, which is due among others to difficult parturitions. In most countries, perinatal mortality is defined as cases of stillborn calves or calves having died within 24 hours after birth. In some countries, such as Germany, Israel and the USA, perinatal mortality also covers calves that died at two days of age. A review by Nogalski (2009) does not provide a conclusive answer to whether increased perinatal mortality of calves results from increased incidence of difficult calvings, or vice versa,

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whether difficult parturitions result from the occurrence of dead foetuses. A study by Johanson and Berger (2003) provided evidence that giving birth to dead foetuses and difficult parturitions are different traits that should be improved separately within a population.

Factors which influence the frequency of calving difficulties include (Skrzypek et al., 1989; Gregory et al., 1990; Kuźma and Kuźma, 1994; Gregory et al., 1996; Kuźma, 1998; Wielgosz-Groth et al., 1999; Pogorzelska and Nogalski, 2010; Andreu-Vázquez et al., 2012 b) twin pregnancy, which allows increasing the total number of calves. Gregory et al. (1996) found more periparturient complications in cows with multiple compared to single pregnancies. The same authors reported that difficult calvings were most prevalent in male twins (48.4%) and least frequent in female twins (34.8%). Gregory et al. (1990) hold that calves from cows with multiple pregnancies die over four times as frequently as those from cows with single pregnancies. Nałęcz-Tarwacka et al. (2011) believe that multiple pregnancies are undesirable in dairy cattle because they increase pregnancy loss percentage and perinatal mortality in calves.

The aim of the study was to analyse the effect of single and multiple pregnancies and sex of calves on parturition and perinatal mortality, based on a large body of data concerning performance-tested cows in the Kujawsko-Pomorskie province (around 10% of the national population of performance-tested cows).

Material and methods

Material for the study was gathered from the SYMLEK database and provided information on 148385 parturitions of Polish Black-and-White Holstein-Friesian cows representing the active population in the Pomorze and Kujawy regions. The animals first calved in 2006 and were used or culled by the end of 2012.

The parturition process (calving ease) was classified according to the SYMLEK database as:

– unassisted (natural, without human intervention),
– easy,
– difficult (using much more force than normal),
– very difficult (surgical procedure, injury to the cow or calf, embryotomy),
– caesarean section.

Calf mortality was classified according to the SYMLEK database as:

– live calf (normal live calf born),
– dead calf (stillborn calf or calf having died within 24 hours after birth), so-called perinatal mortality.

The chi-square test of independence (SAS, 2011) was used to analyse:

– the effect of single, twin and triplet pregnancies on the parturition process,
– within the type of birth (single, twin, triplet), the effect of sex on parturition process and calf mortality.

Furthermore, analysis of variance was used to evaluate the effect of type of birth and parturition process on calf mortality. Significant differences were determined using Scheffe's test (SAS, 2011).

Results

In the analysed population there were 2.11% twin pregnancies and just 0.01% triplet pregnancies. Chi-square test results show the effect ($P \leq 0.01$) of the number of calves born on the parturition process (Table 1). The proportion of unassisted parturitions was around 31% for single and twin births, and much lower (only 7%) when triplets were born. The proportion of difficult births increased from 4.3 to 28.6% with the increasing number of foetuses. Very difficult births and caesarean sections were sporadic and occurred with similar frequency when single calves and twins were born.

Table 1. The parturition process depending on the number of calves born

Type of pregnancy $chi^2 = 28.49$xx	Parturition (%)					
	n	unassisted	easy	difficult	very difficult	caesarean section
Single	145241	31.14	64.35	4.30	0.15	0.05
Twin	3130	30.96	63.67	5.21	0.10	0.06
Triplet	14	7.14	64.29	28.57	-	-

xx – $P \leq 0.01$.

As regards sex ratio, most single calves were bull calves. Among twins, opposite-sex twins were the most frequent and bull calves the least frequent. Opposite-sex twins dominated among triplets (Table 2).

Table 2. Effect of calf sex on the parturition process

Type of birth	Sex of calf	Parturition					
		n	unassisted	easy	difficult	very difficult	caesarean section
Single $chi^2 = 1243.78$xx	heifer	69789	34.90	61.88	3.12	0.09	0.02
	bull	75452	27.67	66.63	5.40	0.22	0.09
Twin $chi^2 = 13.54$	heifer+heifer	872	28.78	67.20	3.90	0.11	0
	bull+bull	841	30.68	64.09	5.23	0	0
	heifer+bull	1417	32.46	61.26	6.00	0.14	0.14
Triplet $chi^2 = 3.61$	heifer+heifer+heifer	3	0.00	33.33	66.67	0.00	0.00
	bull+bull+bull	3	0.00	66.67	33.33	0.00	0.00
	bulls and heifers	8	12.5	75.00	12.50	0.00	0.00

xx – $P \leq 0.01$.

Analysis of the results given in Table 2 shows that heifer calves were born more easily than bull calves, but this effect was only significant for single births (P≤0.01). In the case of twin births, easy calvings were most prevalent when two heifers were born, whereas difficult births, very difficult births and caesarean sections were most frequent when a heifer and bull were born.

Our results show higher perinatal mortality in twins (Table 3), but despite the losses 1.81 live calves were produced from a twin pregnancy compared to only 0.92 from a single calving (Table 4).

Table 3. Mortality (%) of single, twin and triplet calves depending on sex

Item	Type of pregnancy (chi^2 = 29.67xx)		
	single	twin	triplet
	n=145241	n=3130	n=14
Live-born bulls	46.18	22.81	14.29
Live-born heifers	46.33	26.01	7.14
Stillborn bulls	5.77	3.19	
Stillborn heifers	1.72	1.44	
Live-born and stillborn bulls		0.86	7,14
Live-born and stillborn heifers		0.42	14,28
Stillborn heifers+bulls		2.65	
Live-born heifers+bulls		39.84	42,87
Live-born and stillborn heifers+bulls		2.78	14,28
Total	100	100	100

Table 4. Number of live-born and stillborn heifers and bulls depending on type of birth and parturition process

Factor			Live-born calves		Stillborn calves	
			bull	heifer	bull	heifer
Type of birth	Single	1	0.462	0.463	0.058	0.017
	Twin	2	0.874	0.939	0.116	0.070
	Triplet	3	1.500	1.000	0.071	0.429
	Significance of differences		1–2.3xx 2–3xx	1–2.3xx	1–2.3x	1–2.3xx 2–3xx
Parturition	Unassisted	1	0.432	0.531	0.038	0.014
	Easy	2	0.486	0.450	0.053	0.016
	Difficult	3	0.378	0.279	0.0264	0.074
	Very difficult	4	0.280	0.121	0.410	0.151
	Caesarean section	5	0.542	0.156	0.265	0.024
	Significance of differences		1–2.3.4xx 2–3.4xx 4–5xx	1–2.3.4.5xx 2–3.4.5xx 3–4xx	1–2.3.4.5xx 2–3.4.5xx 3-4xx 4–5xx	1–3.4xx 2–3.4xx 3–4x.5x 4–5xx

x – P≤0.05, xx – P≤0.01.

In the case of single calvings, the number of live-born bulls and heifers was similar (46%), whereas the percentage of dead bull calves was over 3 times that of dead heifers (Table 3). Analysis of twin calvings demonstrated that the proportion of two live-born calves was highest (39.84%) when twins were of opposite sex, and lowest (22.81%) when two bulls were born. Perinatal mortality was highest (3.19%) when two bulls were born, and over twice as low when two heifers were born. For the births of opposite-sex twins perinatal mortality was 2.65%, and when one calf was alive and another dead, heifers survived more often. The relatively small number of triplet births (14 cases) and the different sex combinations in triplets make it difficult to interpret the results conclusively.

Analysis of the results presented in Table 4 confirms that bulls were more often affected by perinatal mortality than heifers, and multiple pregnancies were found to increase the risk of perinatal mortality in calves. Also a decrease in calving ease (increased calving difficulties and complications) increases many-fold the risk of perinatal mortality in calves. For very difficult parturitions, the risk of calves being stillborn or dying within 24 hours after birth, regardless of sex, increased 10-fold in relation to unassisted parturition.

Discussion

The frequency of multiple pregnancies, which resulted in a greater number of calves (most often two) born in our study, supports the findings of other Polish studies, which show that twins account for 1 to 4% of the calves born (Skrzypek et al., 1989; Kuźma and Kuźma, 1994; Wielgosz et al., 1999; Sawa, 2001; Sawa et al., 2012). Johanson et al. (2001), who investigated 1.3 million calvings in North America, found twin pregnancies in 5% of the cows. According to Des Coteaux et al. (2010) and Lopez-Gatius and Hunter (2005), twin pregnancies are estimated to occur with a frequency of around 10% in dairy cattle (with a positive relationship between milk yield and multiple pregnancies), but are far less frequent in beef cattle. An even greater share of twin pregnancies in dairy cattle (17.9%) was reported by Andreu-Vázquez et al. (2012), who found that twin pregnancy rates differed among herds ($P \leq 0.0001$) and ranged from 12.4% to 23.9%. As regards sex ratio of foetuses from multiple pregnancies, opposite-sex foetuses were dominant, which concurs with the results of Nałęcz-Tarwacka et al. (2011).

In our study, the chi-square test showed the effect ($P \leq 0.01$) of the number of calves born on calving ease, an important trait determining the birth of live and healthy offspring, which is fundamental to successful herd reproduction. Also other authors (Kuźma and Kuźma, 1994; Sawa et al., 2012; Gregory et al., 1990) mention multiple pregnancies among the factors that have a direct influence on the parturition process. Kuźma and Kuźma (1994) report that pregnancy losses, premature and difficult births occur in twinning cows twice as often as in cows with single pregnancies, and attribute this, among others, to poorly balanced ration during the dry period (energy deficiency). According to Gregory et al. (1990), the incidence of assistance

was 35% among twin-calving cows and 23% among single-producing cows. The authors note that 4.3% of the single calves were delivered by caesarean section and 20.8% of the calvings were classified as difficult. In twins, caesarean sections accounted for 17.4% and difficult calvings for 7.5%. According to Sawa et al. (2012), almost two-thirds of twin calvings required human assistance, including veterinary assistance (1.1%); for single calvings, 54% of the cows required human assistance, including veterinary assistance (0.5%).

According to Echternkamp et al. (2007), the increased frequency of twin calving complications in relation to single calvings results from foetal malpresentation during birth (especially abnormal foetal lie and presentation) or simultaneous impaction of the presenting parts. Excessive total weight of foetuses may also prove an obstruction during parturition (Nałęcz-Tarwacka et al., 2011).

Similarly to other authors (Nogalski, 2003), our results demonstrated that the incidence of male calf sex was associated with a decrease in calving ease. According to Nogalski (2003) this was related to the generally higher body weight of bull calves being born. Likewise, the highest frequency of difficult births, very difficult births and caesarean sections, found in our study for twin-calving cows with opposite-sex pregnancies supports the results of Nałęcz-Tarwacka et al. (2011) – twin pregnancy (heifer+bull, 27.25%), twin pregnancy (2 bulls, 22.40%), twin pregnancy (2 heifers, 23.94%) – but is different from the conclusion of Gregory et al. (1996) that difficult births dominate among male same-sex twins (48.4%).

In our study, perinatal mortality of the calves was around 6%, which is similar to the result reported by Nogalski and Mordas (2012). The overall 0- to 2-day-old calf mortality rate was around 6.7%, which is similar to the low range of values reported in the literature (Raboisson et al., 2013). Calf mortality was found to depend on both the parturition process and the type of parturition. When analysing parturitions of Holstein-Friesian calves, Bicalho et al. (2007) found a strongly positive correlation between calving ease and perinatal mortality. Pogorzelska and Nogalski (2010) demonstrated that calf death loss shortly after calving (within the first 24 hours) due to dystocia, including hard pull, calvings requiring surgical assistance and Caesarean section, reached 21.09%, 46.57% and 43.28, respectively. Nogalski and Mordas (2012) reported that perinatal mortality in Holstein-Friesian calves was 4.84% after easy calving and 16.67% after difficult calving. Also according to Azzam et al. (1993), calves born to cows with dystocia were at a five times greater risk of death than calves born unassisted. Our finding that multiple pregnancy increases the risk of perinatal mortality in calves agrees with the observations of other authors (Gregory et al., 1990, 1996; Nałęcz-Tarwacka et al., 2011). According to Gregory et al. (1996), dystocia is twice as frequent in cows producing twins relative to cows producing singles. Likewise, Skrzypek et al. (1989) found a higher proportion of stillborn twins compared to single calves. In a study by Sawa (1994), perinatal mortality was 14.3% for twins and 7.8% for singles. Gregory et al. (1990) reported that the effect of dystocia on calf survival was important at 72 hours, 100 days and 200 days. Survival of calves without dystocia was greater by 11%, 13% and 14% at 72 hours, 100 days and 200 days, respectively. It is assumed that the most appropriate date of diagnosis of multiple pregnancy in cattle is 7–9 weeks (Davis and Haibel, 1993; Max, 2001).

Early diagnosis of multiple pregnancies, proper veterinary care and nursing, and especially appropriate feeding (analysis of the feed and rational dietetics) and management of pregnant cows may largely reduce the unwanted consequences of multiple pregnancies (Kuźma and Kuźma, 1994; Max, 1996). Even after considering that heifers originating from opposite-sex pregnancies are generally infertile (Nałęcz-Tarwacka et al., 2011), from the economic point of view it appears that it is beneficial to obtain twins, especially when they are intended for fattening.

The greater survival of female compared to male twins, shown in the present study, confirms the results of other authors (Gregory et al., 1996).

It is concluded that the number and sex of calves born had an effect ($P \leq 0.01$) on the parturition process and on the level of perinatal mortality. As the number of foetuses increased, the proportion of difficult parturitions increased from 4.3 to 28.6%. A decrease in calving ease was also related to the fact that the calf was of male sex. The risk of perinatal mortality increased after multiple pregnancy and when a bull calf was born. Among single calves perinatal mortality was over 3 times as frequent in bull calves compared to heifers; among same-sex twins perinatal mortality was around twice as frequent when two bull calves compared to two heifers were born; for births of opposite-sex twins, perinatal mortality was more frequent among bull calves. It was also found that perinatal mortality of calves increased with increasing level of calving difficulty. For very difficult parturitions, the risk of perinatal mortality among calves, regardless of sex, increased 10-fold in relation to unassisted parturition.

References

Andreu-Vázquez C., Garcia-Ispierto I., López-Gatius F. (2012 a). Photoperiod length and the estrus synchronization protocol used before AI affect the twin pregnancy rate in dairy cattle. Theriogenology, 78: 1209–1216.

Andreu-Vázquez C., Garcia-Ispierto I., Ganau S., Fricke P.M., López-Gatius F. (2012 b). Effects of twinning on the subsequent reproductive performance and productive lifespan of high-producing dairy cows. Theriogenology, 78: 2061–2070.

Azzam S.M., Kinder J.E., Nielsen M.K., Werth L.A., Gregory K.E., Cundiff L.V., Koch R.M. (1993). Environmental effects on neonatal mortality of beef calves. J. Anim. Sci., 71: 282–290.

Bicalho R.C., Galvao K. N., Cheong S.H., Gilbert R.O., Warnick L.D., Guard C.L. (2007). Effect of stillbirth on dam's survival and reproduction performance in Holstein dairy cows. J. Dairy Sci., 90: 2797–2803.

Davis M.E., Haibel G.K. (1993). Use of real-time ultrasound to identify multiple foetuses in beef cattle. Theriogenology, 40: 373–382.

Des Coteaux L., Gnemmi G., Colloton J. (2010). Practical atlas of ruminant and camelid reproductive ultrasonography. Blackwell Publishing, pp. 1–244.

Echternkamp S.E., Thallman R.M., Cushman R.A., Allan M.F., Gregory K.E. (2007). Increased calf production in cattle selected for twin ovulations. J. Anim. Sci., 85: 3239–3248.

Gregory K.E., Echternkamp S.E., Dickerson G.E., Cundiff L.V., Koch R.M., Van Vleck L.D. (1990). Twinning in cattle: III. Effects of twinning on dystocia, reproductive traits, calf survival, calf growth and cow productivity. J. Anim. Sci., 68: 3133–3144.

Gregory K.E., Echternkamp S.E., Cundiff L.V. (1996). Effects of twinning on dystocia, calf survival, calf growth, carcass traits, and cow productivity. J. Anim. Sci., 74: 1223–1233.

Johanson J.M., Berger P.J. (2003). Birth weight as a predictor of calving ease and perinatal mortality in Holstein cattle. J. Dairy Sci., 86: 3745–3755.
Johanson J.M., Berger P.J., Kirkpatrick B.W., Dentine M.R. (2001). Twinning for North American Holstein sires. J. Dairy. Sci., 84: 2081–2088.
Kuźma R., Kuźma K. (1994). The occurrence of multiple calving in dairy cows under natural conditions and their impact on parturition, postpartum period and fertility (in Polish). Prz. Hod., 9: 1–6.
Kuźma R., Kuźma K., Malinowski E. (1998). Occurrence and effect of multiple births on the health and fertility of cows (in Polish). 45th Anniversary Symposium of the Department of Animal Science, AR Kraków, pp. 89–90.
Lopez-Gatius F., Hunter R.H. (2005). Spontaneous reduction of advanced twin embryos: its occurrence and clinical relevance in dairy cattle. Theriogenology, 63: 118–125.
Max A. (1996). Twin pregnancy in cattle (in Polish). Med. Weter., 89: 5–6.
Max A. (2001). Pregnancies in heifers after induced poly-ovulation (in Polish). Med. Weter., 57: 433–436.
Nałęcz-Tarwacka T., Palińska K., Grodzki H. (2011). Influence of multiple pregnancy on delivery complications and calf mortality (in Polish). Med. Weter., 67: 409–411.
Nogalski Z. (2003). Relations between the course of parturition, body weights and measurements of Holstein-Friesian calves. Czech J. Anim. Sci., 48: 51–59
Nogalski Z. (2009). Perinatal mortality of calves in dairy herds (in Polish). Pr. Mat. Zoot., 67: 167–176.
Nogalski Z., Mordas W. (2012). Pelvic parameters in Holstein-Friesian and Jersey heifers in relation to their calving. Pakistan Vet. J., 32: 507–510.
Pogorzelska P., Nogalski Z. (2010). Calving difficulty in cows and heifers of the Polish dairy cattle population in 2007-2008. Rocz. Nauk. PTZ, 6, 3: 103–110.
Raboisson D., Delor F., Cahuzac E., Gendre C., Sans P., Allaire G. (2013). Perinatal, neonatal, and rearing period mortality of dairy calves and replacement heifers in France. J. Dairy Sci., 96: 2913–2924.
Sawa A. (1994). Influence of twin pregnancy on usefulness of cows (in Polish). Zesz. Nauk. ATR Bydgoszcz, Zoot, 26: 7–14.
Sawa A. (2001). Effect of birth type on performance, fertility and culling of Black-and-White cows. Ann. Anim. Sci., 1: 13–24.
Sawa A., Bogucki M., Krężel-Czopek S. (2012). Reproduction performance of cows with single, twin and triplet calves. Acta Vet., Brno, 81: 347–352.
Skrzypek R., Baraniak R., Grycz J. (1989). Influence of twin pregnancy on milk productivity, breeding and culling of cows and calves born alive (in Polish). Rocz. AR Poznań, Zoot., 38: 83–94.
SYMLEK http://www.pfhb.pl/?strona=symlek_polaczenie.htm
Wielgosz-Groth Z., Cieślak S., Kijak Z., Cichocki M. (1999). The incidence of various types of deliveries, and the relationship between the type of calving and milk production (in Polish). Zesz. Nauk. PTZ, 44: 249–256.

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