

Evaluation of the effect of cow exterior on calf size at parturition

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The aim of this research was to evaluate the effect of cow exterior on the weight of the calf at parturition and the size of the calf's head. 453 purebred Holstein Friesian dairy cows at a selected farm were analysed within this research, and the measurements of the withers height, hip width, backside width and ischial width were taken from each specimen. Considering the calves, the measurements taken were the width and length of the head and weight at parturition. The research did not prove any significant ($p > 0.05$) effect of the cow body conformation on any of the measured proportions of the calf. There was, however, a significant ($p < 0.05$) difference in the head length and weight in calves in relation to the calving ease. As opposed to our expectations, the parturition weight of calves going through a more difficult parturition was lower (30.36 kg, as opposed to 36.57 kg in the less difficult parturition) and the length of the head was lower as well (23.47 cm, as opposed to 23.98 cm in a less difficult parturition). At the same time, the weight and head length increased with each undergone lactation cycle of the mother – more specifically, this trend of increasing was observed from the first to the fifth lactation cycle. The parturition weight of calves was significantly affected by the gestation length itself. Another factors that had an effect on the weight and size of the calves were the season during which calving took place and the effect of the father bull. The results show a possibility of using the data collected in this research for breeding value estimation in difficult parturitions, since the effect of the father of the calf has to be taken into consideration as well as the effect of the the cow's father.

Keywords: Holstein, Width, Weight, Exterior, Calving

1 Introduction

A smooth parturition process is as important for the new-born calf as it is for the mother, who is to start a new lactation cycle and thus help the farm to reach economic sustainability. The process of parturition can be affected by a number of factors, some of which are the sex of the calf, the gestation length, the feed, the housing of the animal, the cow's age and, of course, the genetic predispositions of the animal (Dhakal et al., 2013). The relations between the cow's pelvis size and the length and width of the calf's head were dealt with for example by Nugent et al. (1991) or Nogalski (2003). The cow's pelvis size and the length and width of the calf's head, as well as the calf's parturition weight, can have an effect on the calving ease (Nogalski 2003). Similar issues in dairy and beef cattle were tackled by Bureš et al. (2008) or Vostrý et al. (2015).

2 Material and methods

This study analysed data from 453 purebred Holstein Friesian dairy cows from one selected farm. The cows were going through their 1st to 9th lactation cycle (for the sake of this analysis, the lactation cycles 6 to 9 were grouped into one group for its low occurrence in the herd). The monitoring (year and month of gestation) itself took place from January 2015 to November 2016, during which the research aimed to evaluate the effect of the cows body conformation (withers height, hip width, backside width and ischial width) on the exterior of the new-born calf (head width – Whead, head length – Lhead) and its weight (Weight). The withers height was measured with Lydtin's rod,

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the pelvis and head measurements were taken with a pair of measuring compasses. The weight of the animals was measured through digital weighing scales designated for animal weighing.

The effect of each factor on the body conformation of new-born calves was tested through the GLM method (SAS software) using the following model equation:

$$y_{ijklm} = \mu + b_1 \times ges + b_2 \times wheight + b_3 \times hwidth + b_4 \times bwidth + b_5 \times iwidth + ce_i + bull_j + cs_k + lac_l + sex_m$$

where y is the dependent variable (calf weight, calf head width or length), and b_1 - b_5 are the regression coefficients showing the relation of y to the gestation length (ges), withers height ($wheight$), hip width ($hwidth$), backside width ($bwidth$) and ischial width ($iwidth$). As the categorical variables there is the calving ease (ce , 3 levels), used breeding male – the calf's father ($bull$, 30 levels), the effect of the calving season (cs , 5 levels), the number of lactation cycle (lac , 6 levels) and the effect of the calf sex (sex , 2 levels: 1, bull – 47%, 2, heifer – 53%). The calving season consists of the month of parturition (the months are grouped into 4 seasons – December to February, March to May, June to August and September to November) and the year of parturition.

The subsequent statistical evaluation of the differences in averages of the levels of each factor entered into the GLM was done through the Tukey-Kramer method. To set the regression coefficients, or correlation between the factors, the REG procedure, or more precisely the CORR procedure in the SAS software, was used.

3 Results and discussion

The analysed herd of 453 Holstein Friesian cows had the average pregnancy length of 278.05 days. The average withers height of a cow was 146.39 cm, the average hip width was 55.18 cm, average backside width was 49.54 cm and average ischial width was 43.85 cm (Table 1). The average calf weigh was 35.62 kg, the calf head length was 24.35 cm and width 10.13 cm on average. The analysed herd was large enough, which has been proven by the low standard error value in all the analysed values. The highest variability coefficients (CV) were found in the data about new-born calf weight ($CV = 17.93\%$), which is caused by the big span of weights in the calves. A quite high variability was also found in the backside width of cow ($CV = 13.12\%$), mainly as opposed to the hip width ($CV = 5.07\%$). The lowest variability ($CV = 1.73\%$) was found in the gestation length, where the majority of cows went into calving a week earlier than is usually stated for a gestation length in cattle. Similar values in gestation length are stated for example by Dhakal et al. (2013). Kertz et al. (1997) state the Holstein Friesian cows' average withers height in the USA to be 141 cm, while currently in the Czech Republic the withers height of the Holstein Friesian cow is said to be 146.5 cm, which corresponds to the results of this research. As of the cattle parturition weight in Holstein Friesian breed, Linden et al. (2009) state the average weight of 43 kg, while Dhakal et al. (2013) state the average weight to be 34–36.6 kg. Dhakal (2003) states this value to be 39.6 kg and the calf head width to be 11.4 cm on average.

Table 1 Description of base data

Variable	N	Mean	Minimum	Maximum	SD	SE	CV
Gestation length (days)	453	278.05	262	293	4.82	0.23	1.73
Withers height of cow (cm)	453	146.39	135	155	2.78	0.13	1.90
Hip width of cow (cm)	453	55.18	44	62	2.80	0.13	5.07
Backside width of cow (cm)	453	49.54	30	52	5.75	0.27	13.12
Ischial width of cow (cm)	453	43.85	37	60	3.71	0.17	7.48
Head width of calf (cm)	453	10.13	8	13	1.02	0.05	10.06
Head length of calf (cm)	453	24.35	18	29	1.78	0.08	7.32
Weight of calf (kg)	453	35.62	20	55	6.39	0.30	17.93

SD – standard deviation, SE – standard error of mean, CV – coefficient of variability (%)

The significance of the effect of each factor on the calf weight and head size is shown in Table 2. As of the calf head length, a statistically significant relation of this measurement to the calving ease ($p < 0.05$), to the calf's father, to the season in which calving took place, and the number of lactation cycles the mother had undergone before ($p < 0.01$)

was proven. A similar relation was found between the head width and the previously stated factors. From the factors analysed by this study, the calf birth weight ($p < 0.05$) was mainly affected by the choice of a father, the season in which the calving took place, the number of lactation cycles the mother had undergone before and the gestation length. The parturition weight is also closely tied to the calving ease ($p < 0.05$). Our research has not proven any significant ($p < 0.05$) effect of the analysed measurements of the cow and the calf's sex on the calf weight and head size. Similar results were reported by Dhakal et al. (2013), Kertz et al. (1997) and Nugent et al. (1991).

Table 2 Significance of factors on birth weight, head width and head length

Factors	P values (TYPE III SS)		
	head width	head length	calf weight
Calving ease	0.0501*	0.0294*	0.0224*
Bull (sire of calf)	<.0001*	0.0025*	<.0001*
Calving season	0.0224*	<.0001*	<.0001*
Parity	<.0001*	0.0014*	0.0108*
Sex of calf	0.0693	0.4145	0.1404
Gestation length	0.0699	0.8132	0.0210*
Withers height of cow	0.5940	0.0834	0.5348
Hip width of cow	0.6369	0.6026	0.6475
Backside width of cow	0.1708	0.1248	0.1600
Ischial width of cow	0.5792	0.7472	0.6967

p values marked * are lower than 0.05

The differences in averages according to the categorical variables (calving ease, calving season, parity, and sex) and their probabilities are stated in Table 3.

Table 3 Least square means of calves weight, head width and head length

Factors	Levels of effects	LS Means		
		head width (cm)	head length (cm)	calf weight (kg)
Calving ease	1	10.48 ^a	23.98 ^a	36.57 ^a
	2	10.18 ^b	23.47 ^b	35.96 ^a
	3	10.13 ^{a,b}	23.65 ^{a,b}	30.36 ^b
Calving season	1: Dec–Feb, 2015	10.72 ^{a,b}	20.92 ^a	34.44 ^{b,c}
	2: Dec–Feb, 2016	11.06 ^a	24.11 ^b	33.78 ^{b,c}
	3: Mar–May, 2016	10.13 ^{a,b}	24.45 ^b	33.62 ^b
	4: Jun–Aug, 2016	9.63 ^b	23.92 ^b	40.33 ^{a,c}
	5: Sep–Nov, 2016	9.77 ^a	25.07 ^b	29.33 ^b
Parity	1	9.69 ^a	23.22 ^b	32.13 ^a
	2	10.24 ^{b,c}	23.80 ^{b,c}	33.50 ^{a,b}
	3	10.55 ^{b,c}	24.24 ^{a,c}	34.80 ^b
	4	10.34 ^{b,c}	23.61 ^{b,c}	35.06 ^b
	5	10.84 ^c	24.20 ^{b,c}	35.72 ^b
	6–9	9.92 ^{a,b}	23.12 ^b	34.57 ^{a,b}
Sex of calf	male	10.35 ^a	23.75 ^a	34.63 ^a
	female	10.18 ^a	23.64 ^a	33.97 ^a

Least square means with different letters are significantly different at the $P < 0.05$ within factors

The calf head size (length and width) closely corresponded with the calving ease. The research found a provable difference ($p < 0.05$) between the average head size in parturitions graded as difficulties 1 and 2. As of the complicated parturitions (grade 3), no significant relation between the head size and the calving ease has been proven. However, an interesting fact arose – the more difficult parturitions occurred in calves with lower weight and smaller head size.

As of the effect of the calving season, the research shows that during the summer and autumn months, the calves were born with significantly ($p < 0.05$) lower head width (9.63 in summer, 9.77 in autumn months). As of the head length, a significant ($p < 0.05$) difference was found between the December–February 2015 season (20.92 cm) and the rest of the seasons, where the calf head length was 3 to 4 cm higher.

The lowest birth weight and smallest head sizes were recorded at calves born from the cows going into their first parity. The research found that with each new lactation cycle there was a significant ($p < 0.05$) increase of the calf head length and width, as well as an increase of the birth weight. This trend stopped at the cows going into their 6th to 9th lactation cycle, where an insignificant ($p > 0.05$) decrease of the birth weight, as well as a decrease of the size of the calf head, took place.

The relation of exterior measurements of the mother and those of calf can be described by the correlation coefficients (Table 4). The highest correlation coefficient value ($r = 0.4036$) was found between the calf head length and the mother's hip width. A strong relation was proven only between the hip width and backside width ($r = 0.7544$) and a mid-strength relation was observed between the hip width and ischial width ($r = 0.6765$) and between the calf head length and width ($r = 0.5378$).

Table 4 Correlation coefficients between variables

	Ges	Wheight	Hwidth	Bwidth	lwidth	Lhead	Whead	Weight
Ges	1	0.0342	-0.0593	0.1132*	0.0331	0.0335	0.1235*	0.1187*
Wheight		1	0.4318*	0.2539*	0.3043*	0.1955*	0.0670	0.1387*
Hwidth			1	0.4098*	0.6765*	0.2303*	0.0583	0.2086*
Bwidth				1	0.7544*	0.3532*	0.0659	0.2726*
lwidth					1	0.4036*	0.0547	0.2038*
Lhead						1	0.5378*	0.1428*
Whead							1	0.2708*
Weight								1

Correlation coefficients marked * are statistically significant ($P < 0.05$)

4 Conclusions

The results show that the pelvis size of the cow has no significant effect on the birth weight and head size of the calf. However, there appears to be a relation between the calving ease and the weight and head size of the calf. A significant impact of the calf's father, the calving season, and the number of lactation cycles on the calf's size and weight has been proven in this research. As of the parturition weight, another key factor is the gestation length and mother's age. The results, as shown in this paper, point to a possibility of taking the new-born calves' weight and size into consideration during the breeding processes, as it might lead to less difficult calving.

References

- Bureš, D. et al. (2008). Calving difficulty as related to body weights and measurements of cows and calves in a herd of Gascon breed. *Czech Journal of Animal Science*, 53(5), 187–194. DOI: <https://doi.org/10.17221/312-CJAS>
- Dhakal, K. et al. (2013). Calf birth weight, gestation length, calving ease, and neonatal calf mortality in Holstein, Jersey, and crossbred cows in a pasture system. *Journal of Dairy Science*, 96, 690–698. DOI: <https://doi.org/10.3168/jds.2012-5817>
- Kertz, A. F. et al. (1997). Body Weight, Body Condition Score, and Wither Height of Prepartum Holstein Cows and Birth Weight and Sex of Calves by Parity: A Database and Summary. *Journal of Dairy Science*, 80, 525–529.
- Linden, T. C. et al. (2009). Calf birth weight and its association with calf and cow survivability, disease incidence, reproductive performance, and milk production. *Journal of Dairy Science*, 92, 2580–2588. DOI: <https://doi.org/10.3168/jds.2008-1603>

Nogalski, Z. (2003). Relations between the course of parturition, body weights and measurements of Holstein-Friesian calves. *Czech Journal of Animal Science*, 48(2), 51–59.

Nugent, R. A. et al. (1991). Body measurements of newborn calves and relationship of calf shape to sire breeding values for birth weight and calving ease. *Journal of Animal Science*, 69, 2413–2421. DOI: <https://doi.org/10.2527/1991.6962413x>

Vostrý, L. et al. (2015). Genetic relationships among calving ease, birth weight and perinatal calf survival in Charolais cattle. *Animal Science Papers and Reports*, 33(3), 233–242.