The Effect of Season of Birth On The Morphometrics of Newborn Belgian Blue Calves

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Abstract

Breed type and environmental factors such as breeding season may have a significant impact on neonatal weight loss calf size. We followed a total of 236 elective cesarean sections in Belgian Blue (BB) cattle, in which neonatal calves were morphometrically measured (in cm) in the first 72 hours after delivery of the child using a strictly standardized protocol. The influence of the season of birth on each calf measurement was analyzed using a mixed linear regression models, including farm of origin as a random effect. Calves born in spring had a longer diagonal length ($P = 0.05$) (69.7 ± 1.24) than those born in autumn (66.9 ± 1.16). The tibial length of calves born in spring (35.8 ± 0.48) was longer ($P > 0.02$) than those born in autumn (33.1 ± 0.57) or summer (34.1 ± 0.49). Calves born in autumn have a shorter head diameter ($P > 0.02$) (12.9 ± 0.23) than those born in summer (12.6 ± 0.29) or winter (13.5 ± 0.22). For all other parameters, no differences were found ($P > 0.08$). Based on the results of this study, it can be concluded that the birth season influences the morphometrics of neonatal BB calves, with a tendency for spring to be associated with the largest body size. The latter is important to know to avoid dystocia when BB cattle are crossed with other breeds.

Introduction

Dystocia is a well-known problem since it increases the incidence of neonatal calf death (Bleul, 2011; Barrier et al. 2013) and hereby compromises the income of the farmer (Hohnholz et al. 2019). Multiple factors such as breed, genetic potential of bulls and dams, sex of the calf, the degree of inbreeding and/or genetic disorder, are all known to be associated with the weight and size of a newborn calf, while some authors furthermore highlighted the effect of environmental factors likethe effect of season to be associated with neonatal calves morphometrics (Koçak et al. 2007). Belgian Blue (BB) cattle has double-muscled properties, resulting in an excellent carcass conformation, but with an increased incidence of dystocia (Olivier and Cartwright 1968). Cases of severe dystocia requiring surgical intervention are usually those caused by a disproportion between shoulders, hip or rump of the fetus and the anterior pelvic canal or pelvic opening of the double muscled dam (Ménissier et al. 1979).

We investigated the impact of calving seasons on body measurements of neonatal BB calves. We hypothesized that season of birth impacts newborn BB calf sizes because of multiple prenatal factors, including the cow's physiology to adapt to heat stress and the frequently observed seasonal changes in diet.

Materials And Methods

Two hundred and thirty-six BB cows from 42 farms in Belgium that delivered between October 2016 and June 2020 were enrolled. All calves were born by elective cesarean section (CS) in the Clinic of Reproduction and Obstetrics at the Faculty of Veterinary Medicine of the Ghent University (Belgium). From each CS, the following data were recorded: farm of origin, date of birth and parity of the dam, date of CS, calf gender, calf birth weight, height at the withers, width at the shoulder, pelvic height and width, radial and tibial length, metacarpal and metatarsal length, head diameter and circumference, hearth girth, circumference at the claws, and diagonal length as decribed in detail by (Kamal et al. 2014) (Fig. 2).

Statistical analyses were performed using RStudio version 4.0.4 (R Core Team, Vienna, Austria). The calf was considered as the unit of interest. Cows originated from 42 farms, but farms that provided ≤ 10 cows (n = 30) were classified in 1 farm category. The effect of season: spring (March 21 - June 21), summer (June 22 - September 23), fall (September 24 - December 22) and winter (December 23 - March 20), on each calf measurement was analyzed using mixed linear regression models, with farm of origin as random effect. Season of birth was forced into each model and covariates [parity (primiparous or multiparous) and calf gender (male or female)] were offered into each model and retained when $P < 0.05$. Model residuals were assessed using a scatterplot of the studentized residuals for homoscedasticity, a linear predictor for linearity, and a Shapiro-Wilk test for normality. Differences between levels of explanatory variables (winter, spring, summer, and fall) were assessed with Tukey's post hoc test. Results are expressed as least squares means and standard errors. A Pearson correlation plot was used to describe the coefficients of determination among each calf measurement and a heat map was made to better visualize the results.

Results And Discussion

Fig. 1 shows the Pearson correlation coefficients among each calf measurement. All variables were positively correlated among each other and the variables with the greatest and significant (P ≤ 0.05) correlation values were: height at the withers and pelvic height (r = 0.75), pelvic height and tibial length (r = 0.72), tibial length and metatarsal length (r = 0.69), withers height and weight (r = 0.67), withers height and hearth girth (r = 0.42), radial length and metacarpal length (r = 0.65), weight and shoulder width (r = 0.64), and weight and pelvic height (r = 0.62). Table 1 and supplementary material 1show the data and outcome for each model respectively. Calves that were born in spring had a longer (P = 0.05) diagonal length (69.7 ± 1.24 cm) than those delivered in fall (66.9 ± 1.16 cm). The tibial length of calves delivered in spring (35.8 ± 0.48 cm) was longer (P > 0.02) in comparison to those born in fall (33.1 ± 0.57 cm) or summer (34.1 ± 0.49 cm). Calves that were born in winter had a longer (P > 0.02) head diameter (13.5 ± 0.22 cm) than those born in summer (12.6 ± 0.29 cm) or fall (12.9 ± 0.23 cm). For all the other parameters, no differences were found (P > 0.08). In general, results show that calves born in spring have larger body sizes in comparison to calves born in other seasons. This is in line with some previous studies which revealed that Holstein-Friesian calves born in spring have higher weight in comparison to those born in other seasons (Aksakal et al. 2009). Authors have explained these results by differences in ambient temperature and ration of the dam during pregnancy. Comfort ambient temperature during gestation will result in optimal intra-uterine development due to sufficient provision of nutrients for the fetus via the maternal blood flow. In contrast, in heat stress conditions, the pregnant dam will direct a greater portion of the blood flow to peripheral tissues for cooling by transpiration. Therefore, blood flow to the core of the cow will be lower, resulting in a decrease in the amount of nutrients being transferred to the fetus (Koçak et al. 2007). The next reason might be due to the better diet of the pregnant cows (Fiems et al. 2009). In Belgium, in the last trimester of pregnancy, spring calving cows are stabled and offered a high-quality ration in comparison to pregnant cows that are in pasture. Variation in supply and composition of the ration has shown to significantly affect the growth and weight of livestock at different life stages including intra-uterine development and weight of the subsequently newborn calf (Sundaram et al. 2012). A limitation of the study is that cows originated from multiple farms, which may have introduced some bias. Although the genetic diversity among the BB breed is relatively low, typical individual herd management factors may have affected our results.

Declarations

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Competing interests

None.

Ethical approval

No ethical approval was obtained because this study did not involve a prospective evaluation and only involved non-invasive procedures

Consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

Not applicable.

Code availability

Not applicable.

Authors' contributions

HSAT, GR, B: writing; MVE, KV, and MM: study design; OBP and AVS: co-supervision, and GO: supervision.

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Table

Table 1 Summary of mixed linear regression models for the effect of season on Belgian Blue calves measurements involving a total of 236 elective cesarean sections. The season was forced into each model and dam parity and calf gender were offered as covariates to all models.

Outcome	n	Least square means ± standard error				P-value	Note
		Winter	Spring	Summer	Fall		
Weight (kg)	211	54.8 ± 1.71[a]	58.1 ± 1.94[a]	56.3 ± 2.09[a]	54.2 ± 1.82[a]	0.13	1
Height at the withers (cm)	236	71.1 ± 0.70[a]	71.1 ± 0.82[a]	71.7 ± 0.90[a]	70.7 ± 0.76[a]	0.35	2
Width at the shoulder (cm)	236	25.5 ± 0.44[a]	25.4 ± 0.51[a]	24.9 ± 0.56[a]	24.8 ± 0.48[a]	0.35	3
Diagonal length (cm)	236	67.3 ± 1.08[ab]	69.7 ± 1.24[a]	68.6 ± 1.34[ab]	66.9 ± 1.16[b]	0.05	4
Pelvic height (cm)	107	75.1 ± 0.68[a]	77.1 ± 0.72[a]	75.8 ± 0.73[a]	74.4 ± 0.91[a]	0.06	5
Pelvic width (cm)	236	27.0 ± 0.43[a]	27.3 ± 0.50[a]	26.6 ± 0.55[a]	26.5 ± 0.46[a]	0.43	6
Radial length (cm)	236	27.2 ± 0.53[a]	28.0 ± 0.60[a]	27.8 ± 0.65[a]	27.3 ± 0.57[a]	0.33	7
Metacarpal length (cm)	107	23.9 ± 0.26[a]	23.9 ± 0.28[a]	24.2 ± 0.28[a]	24.5 ± 0.36[a]	0.37	8
Tibial length (cm)	107	35.4 ± 0.47[ab]	35.8 ± 0.48[a]	34.1 ± 0.49[bc]	33.1 ± 0.57[c]	0.0001	9
Metatarsal length (cm)	236	31.6 ± 0.56[a]	32.4 ± 0.62[a]	31.1 ± 0.65[a]	31.4 ± 0.59[a]	0.11	10
Head diameter (cm)	236	13.5 ± 0.22[a]	13.4 ± 0.28[ab]	12.6 ± 0.29[b]	12.9 ± 0.23[b]	0.002	11
Head circumference (cm)	236	51.0 ± 0.45[a]	51.1 ± 0.65[a]	50.4 ± 0.68[a]	49.8 ± 0.49[a]	0.16	12
Heart girth (cm)	236	80.2 ± 0.97[a]	82.1 ± 1.16[a]	79.6 ± 1.27[a]	81.0 ± 1.06[a]	0.21	13
Circumference at the claws (cm)	169	17.7 ± 0.16[a]	17.5 ± 0.18[a]	17.4 ± 0.22[a]	17.9 ± 0.26[a]	0.36	14

1. Model covariates are parity and calf gender ($P = 0.001$ and $P < 0.0001$, respectively).

2. Model covariates are parity and calf gender ($P = 0.009$ and $P = 0.001$, respectively).

3. Model covariates are parity and calf gender ($P = 0.009$ and $P < 0.0001$, respectively).

4. Model covariates are parity and calf gender (P = 0.002 and P = 0.007, respectively).

5. Model covariate is calf gender (P = 0.03).

6. Model covariates are parity and calf gender (P = 0.02 and P = 0.03, respectively).

7. Model covariates are parity and calf gender (P = 0.007 and P = 0.009, respectively).

8. Model includes season only.

9. Model includes season only.

10. Model covariates are parity and calf gender (P = 0.004 and P = 0.02, respectively).

11. Model covariate is calf gender (P = 0.01).

12. Model covariate is calf gender (P = 0.001).

13. Model covariates are parity and calf gender (P = 0.0006 and P = 0.0008, respectively).

14. Model covariates are parity and calf gender (P = 0.0001 and P = 0.03, respectively).

Figures

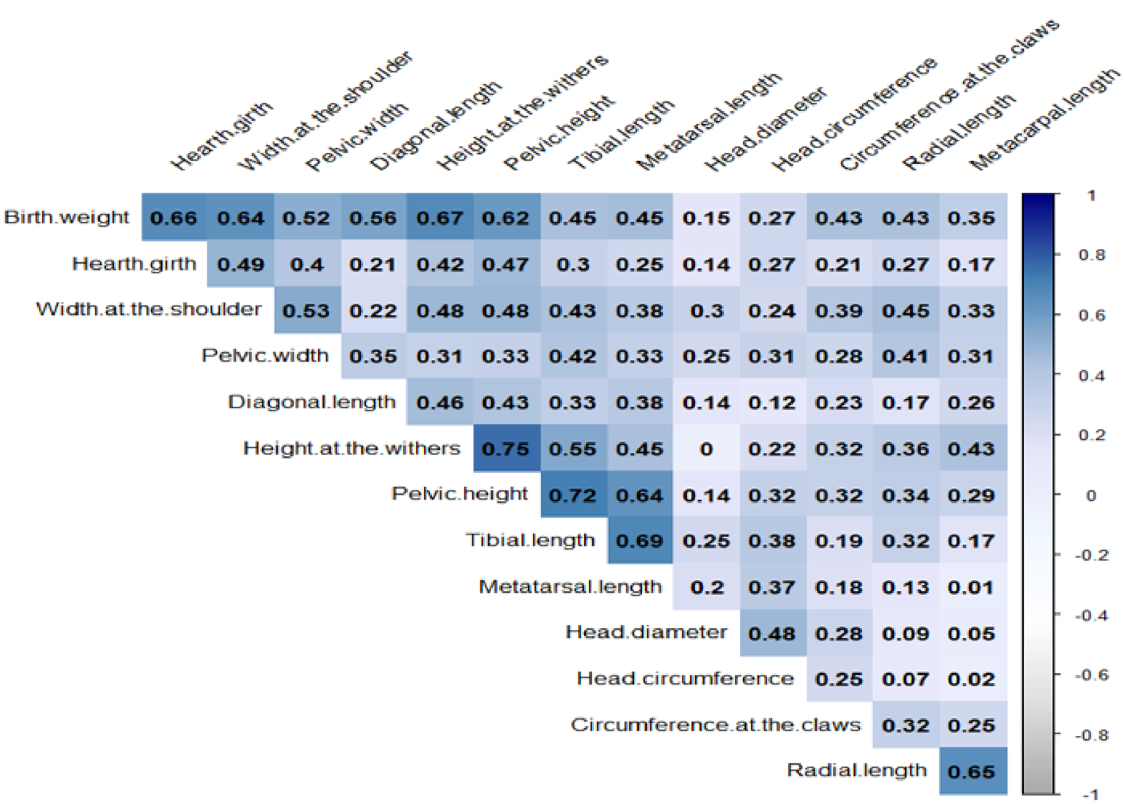

Figure 1

Correlation plot showing the associations among Belgian Blue calf measurements involving a total of 236 elective cesarean sections. The color intensity is proportional to the strength of the (Pearson) correlation.

Figure 2

Illustration of morphometric parameters on Belgian Blue calves: a) width at the shoulder, b) pelvic width, c) height at the withers, d) tibial length, e) metatarsal length, f) head circumference, g) head diameter, h) heart girth, i) pelvic height, j) circumference at the claws, k) radial length, l) metacarpal length, m) diagonal length.

Supplementary Files

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