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Comparison of Influencing Factors on Birth Weight between Holstein and Jersey Calves

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ABSTRACT

The birth weight of calves indicates livestock production performance even before birth, significantly impacting calf health and overall farm productivity. This study was conducted on the factors influencing the birth weight of Holstein and Jersey calves born under the same environmental and feeding conditions. Data were collected during 2016-2024 on 635 cows (Holstein, n = 572; Jersey, n = 63) and their calves, including details such as breed, age and parity of the dam, difference between the date of birth and estimated due date (DBE), birth season, sex and birth weight. The calving season was categorized into spring (March-May), summer (June-August), autumn (September-November) andwinter (December-February). Stepwise multiple regression analyses were conducted to determine the impact of these variables on the birth weight of calves. In Holstein calves, DBE (β = 0.350) had the most substantial impact, followed by sex (β = 0.316), age of dam (β = 0.083) andbirth during autumn (β = -0.112) ($p<0.05$). For Jersey calves, DBE (β = 0.448) was the most significant factor, followed by sex (β = 0.277) and age of dam (β = 0.228). Unlike Holsteins, no seasonal effect was observed in Jerseys. These findings highlight the influence of various factors on birth weight of calves, suggesting that Jersey cattle may possess certain advantages in seasonal birth conditions compared to those of holstein cattle.

Key words: Birth weight, calves, Holstein, Jersey.

In Korea, dairy consumption trends are shifting from fluid milk toward processed dairy products such as cheese and butter. Holstein cows dominate the Korean dairy industry, but climate stress and rising feed costs are increasingly challenging farm sustainability (KOSIS, 2024). Jersey cows are gaining attention as an alternative due to their high milk solids content, feed efficiency and heat tolerance (US JERSEY, 2021).

Despite their potential, studies on Jerseys under Korean conditions are limited. Birth weight is a fundamental indicator of calf viability and future productivity (Ugurlu *et al.*, 2014). Heavier calves are typically healthier, more robust andyield better growth and milk production outcomes (Lorenz, 2021).

Identifying breed-specific factors influencing calf birth weight can inform tailored breeding and management strategies (Soberon *et al.*, 2012). Therefore, this study compares the impact of dam age, parity, gestation length, season and calf sex on birth weight in Holstein and Jersey calves raised under uniform conditions.

All procedures were approved by the Institutional Animal Care and Use Committee of the National Institute of Animal Science, Republic of Korea (approval number: NIAS-20210502).

Animals, diet and data collection

This study analyzed 635 dairy cows (Holstein: 572; Jersey: 63) raised under identical management on a farm in Cheonan, Korea, from March 2016 to March 2024. All cows conceived via artificial insemination and were relocated to a single pen 21 days before calving, receiving a standardized close-up TMR diet (13 kg DM·cow^{-1}·day^{1}; CP 11.1%, NDF 48.2%, ADF 26.9%, Ca 0.4%, P 0.15%) with ad libitum water. Calves were of the same breed as their dams; abortions and twin births were excluded.

Data collected included breed, dam's age and parity, gestation deviation (DBE), birth season (spring, summer, autumn, winter), sex and birth weight. Birth seasons were categorized as spring (March-May), summer (June-August), autumn (September-November) and winter (December-February).

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Statistical analyses

Statistical analyses were conducted using SPSS v27.0 (IBM, Chicago, IL, USA). Stepwise multiple regression identified key predictors of calf birth weight among dam age, parity, DBE, birth season andsex. Variables were added or removed based on statistical significance (entry: $p<0.05$; removal: $p>0.10$) to construct a parsimonious model while minimizing multicollinearity. Model assumptions-including linearity, independence, homoscedasticity andnormality-were verified. Multicollinearity was assessed via tolerance (> 0.1) and variance inflation factor (VIF < 10). Final models were selected after stepwise refinement.

Table 1: Descriptive statistics for holstein and Jersey cattle used in this study.

Variable	Holstein (mean ± SD)	Jersey (mean ± SD)
Number	572	63
Calf birth weight, kg	42.7±5.8	25.3±4.1
Age, year	5.1±1.8	4.4±1.9
Parity of dam	2.5±1.2	2.1±1.2
DBE	-1.5±5.3	-0.2±6.6
Season		
Spring	127 (22.2%)	17 (25.4%)
Summer	122 (21.3%)	13 (20.6%)
Autumn	164 (28.7%)	14 (22.2%)
Winter	159 (27.8%)	20 (31.7%)
Sex		
Male	295 (51.6%)	34 (54.0%)
Female	277 (48.4%)	29 (46.0%)

SD: Standard deviation; VIF: Variance inflation factor; DBE: Difference between the date of birth and estimated due date; D-W: Durbin-watson.

Breed characteristics and calf birth weight

Holstein dams had a mean age of 5.1 years (SD = 1.8), parity of 2.5 (SD = 1.2) and a DBE of -1.5 days (SD = 5.3). Their calves had an average birth weight of 42.7 kg (SD = 5.8). Jersey dams were slightly younger, with a mean age of 4.4 years (SD = 1.8), parity of 2.1 (SD = 1.2) and a DBE of -0.2 days (SD = 6.6). Jersey calves were considerably lighter, with an average birth weight of 25.3 kg (SD = 4.1). The calf sex ratio showed a slight male predominance in both breeds (Holstein: 51.6%; Jersey: 54.0%) (Table 1). This considerable difference in birth weight between breeds reflects their physiological and genetic characteristics. The values obtained align with previously reported ranges for each breed (Ugurlu *et al.*, 2014), confirming breed-specific size differences at birth.

Regression analysis and key factors affecting birth weight

Stepwise multiple regression revealed that Holstein calf birth weights were significantly affected by DBE (β = 0.350), sex (β = 0.316), birth season (β = -0.112) and dam age (β = 0.083) ($p<0.05$). The model explained 27.3% of the variance (adj $R^2 = 0.268$) (Table 2). For Jerseys, DBE (β = 0.448), sex (β = 0.277) and dam age (β = 0.228) were significant predictors ($p<0.05$), explaining 31.4% of the variance in birth weight (Table 3). No seasonal effect was observed for Jerseys.

Impact of dam age

Dam age positively influenced birth weight in both breeds, with a stronger effect in Jerseys. This supports findings that older cows, especially multiparous, provide better uterine environments and nutrient supply for fetal development (Duncan *et al.*, 2023). Previous studies have shown that calves born to multiparous cows can weigh 3-

Table 2: Effects of age and parity of dam, birth date and sex on the birth weight of holstein calves.

Variable	B	Standard error	β	T	p-value	Tolerance	VIF
Coefficients							
(Constant)	40.549	0.704		57.612	<0.001		
Age of dam, year	0.268	0.117	0.083	2.296	0.022	0.977	1.023
DBE	0.384	0.040	0.350	9.647	<0.001	0.976	1.025
Season (Spring = reference)							
Autumn	-1.429	0.460	-0.112	-3.108	0.002	0.988	1.012
Sex (Female=reference)							
Male	3.656	0.416	0.316	8.790	<0.001	0.989	1.012
Excluded variables							
Variable	β	t	p-value	Partial correlation	Tolerance	VIF	Minimum tolerance
Parity of dam	-0.004	-0.074	0.941	-0.003	0.355	2.814	0.350
Season (Spring=reference)							
Summer	-0.057	-1.515	0.130	-0.064	0.888	1.126	0.881
Winter	0.052	1.340	0.181	0.056	0.843	1.186	0.834

$F = 53.343$ ($p < 0.001$), $R^2 = 0.273$, $_{adj} R^2 = 0.268$, D-W = 1.816.

VIF: Variance inflation factor; DBE: Difference between the date of birth and estimated due date; D-W: Durbin-watson.

Table 3: Effects of age and parity of dam, birth date and sex on the birth weight of Jersey calves.

Variable	B	Standard error	β	T	p-value	Tolerance	VIF
Coefficients							
(Constant)	22.227	1.247		17.822	<0.001		
Age of dam, year	0.482	0.231	0.228	2.085	0.041	0.924	1.082
DBE	0.277	0.066	0.448	4.165	<0.001	0.956	1.046
Sex (Female=reference)							
Male	2.230	0.863	0.277	2.583	0.012	0.965	1.036
Excluded variables							
Variable	β	t	p-value	Partial correlation	Tolerance	VIF	Minimum tolerance
Parity of dam	0.038	0.202	0.841	0.026	0.314	3.189	0.311
Season (Spring = reference)							
Summer	-0.097	-0.896	0.374	-0.117	0.940	1.064	0.908
Autumn	0.142	1.348	0.183	0.174	0.989	1.011	0.918
Winter	-0.017	-0.151	0.881	-0.020	0.908	1.101	0.895

$F = 10.458$ ($p < 0.001$), $R^2 = 0.347$, $_{adj} R^2 = 0.314$, D-W = 1.609.

VIF: Variance inflation factor; DBE: Difference between the date of birth and estimated due date; D-W: Durbin-watson.

4 kg more than those from primiparous cows (Johanson and Berger, 2003; Olson *et al.*, 2009).

Gestation length (DBE)

DBE was the most influential factor for both breeds, indicating that extended gestation allows for greater fetal growth. This observation is consistent with nutritional and developmental principles reported in previous studies (Micke *et al.*, 2010).

Seasonal effects

Only Holstein calves showed significantly lower birth weights when born in autumn. This may reflect heat stress during late gestation in summer, which can impair maternal metabolism and reduce feed intake, thereby limiting nutrient availability to the fetus (West, 2003; Rhoads *et al.*, 2009). Related studies have linked high THI prior to calving with reduced birth weight and placental efficiency (Reynolds *et al.*, 2006).

Jersey calves were not significantly affected by season, suggesting greater resilience to environmental stress. Jerseys are known for their heat tolerance, with lower metabolic heat production and more efficient respiratory cooling than Holsteins (Lim *et al.*, 2021; Cook *et al.*, 2007). This physiological adaptation may explain their stable birth weights across seasons.

Effect of calf sex

Male calves were heavier than females in both breeds, with holstein males averaging 3.7 kg more and Jersey males 2.2 kg more. These results are consistent with sex-based fetal growth patterns observed in cattle (Wilson *et al.*, 2017), reinforcing previous findings (Olson *et al.*, 2009).

CONCLUSION

While previous studies have independently explored the effects of breed, parity, gestation length and environmental factors on calf birth weight, this study is one of the few that simultaneously evaluates these variables in both Holstein and Jersey calves under the same analytical framework. This integrated analysis allows for a clearer understanding of how breed-specific characteristics interact with management and environmental conditions, offering more practical implications for farms with mixed herds. Furthermore, our findings emphasize not just confirmation but also quantification of known patterns in a Korean dairy context, which has received limited international attention. As climate-related stressors and breed diversification increase globally, confirming such relationships under localized conditions is essential for evidence-based herd management strategies.

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Disclaimers

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Informed consent

All animal procedures for experiments were approved by the committee of experimental animal care and handling techniques were approved by the university of animal care committee.

Conflict of interest

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