Association between body condition score change during the dry period and postpartum health and performance

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Introduction

The prepartum period is one of the most important periods in a dairy cow's life for overall health and performance. Usually, a cow's dry matter intake (**DMI**) around calving is associated with health and performance. Decreased DMI during the prepartum period has been associated with impaired innate immunity (Hammon et al., 2006) and increased incidences of health disorders (Huzzey et al., 2007). However, it is not feasible to monitor individual DMI in large dairy herds. Instead, body condition score (**BCS**) may be used as an indirect measure of fatness, mostly subcutaneous depots, and change in BCS can be used as indirect measure of energy balance for individual cows (Roche et al., 2009). At calving, reduced BCS is associated with lower milk yield and reduced likelihood of subsequent pregnancy, while elevated BCS is associated with greater likelihood of postpartum metabolic diseases (reviewed by Roche et al., 2009). Even though studies have demonstrated an association between BCS at calving and postpartum health of dairy cows, little is known about the association between BCS change during the dry period (Δ**BCS**) and postpartum health. The hypothesis of the study was that ΔBCS is associated with incidence of postpartum health disorders, yield of milk and milk components, and reproductive performance. Additionally, it was hypothesized that ΔBCS is mainly explained by the BCS at dry-off and that BCS at dry-off is a consequence of reproductive and productive performance.

Animals, Materials, and Methods

This study used 16,104 lactations from 9,950 parous (≥1st lactation at dry-off) Holstein cows from two commercial dairies located in the San Joaquin Valley of California. At dry-off, cows were approximately 220 days of gestation. Body condition score was determined using the visual technique on a scale of 1 (severe undercondition) to 5 (severe overcondition) in 0.25 increments (Ferguson et al., 1994). Body condition score was assessed at dry-off and at calving by herd personnel. Cows were classified according to ΔBCS as excessive loss (ELBCS; ΔBCS ≤ -0.75 unit), moderate loss (MLBCS; ΔBCS = -0.50 to -0.25), no change (NCBCS; ΔBCS = 0), and gained BCS (GBCS; ΔBCS ≥ 0.25) during the dry period. It is important to note that throughout the study all cows received similar diets, within year and season of calving, independent of their BCS at dry-off. Therefore, any ΔBCS are likely a consequence of differences in DMI during the dry period.

Results

Figure 1 depicts the mean (±SEM) BCS at dry-off and at calving according to ΔBCS. Because cows with ELBCS had the greatest BCS at dry-off and the lowest BCS at calving, they also lost the most BCS during the dry period (ELBCS = -0.89 ± 0.01, MLBCS = -0.38 ± 0.01, NCBCS = -0.04 ± 0.01, and GBCS = 0.29 ± 0.01). We were able to explain 57.4% of the variability in ΔBCS, of which 95% was explained by BCS at dry-off. According to our dataset, the BCS at dry-off most likely to be associated with gain of BCS during the dry period was ≤ 3.25 (Figure 2).

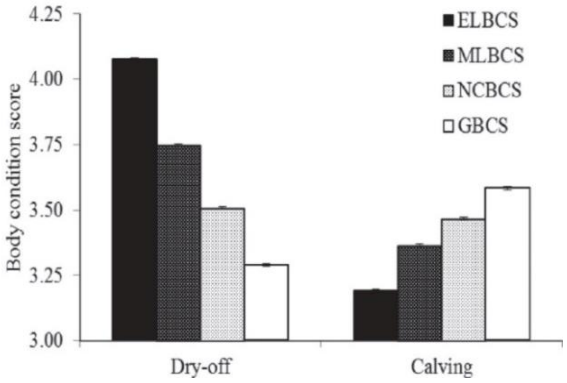

Figure 1. Mean (±SEM) BCS at dry-off and BCS at calving according to change in BCS during the dry period (ΔBCS). ELBCS: ΔBCS ≤ -0.75; MLBCS: ΔBCS = -0.5 to -0.25; NCBCS: ΔBCS = 0; GBCS: ΔBCS ≥ 0.25.

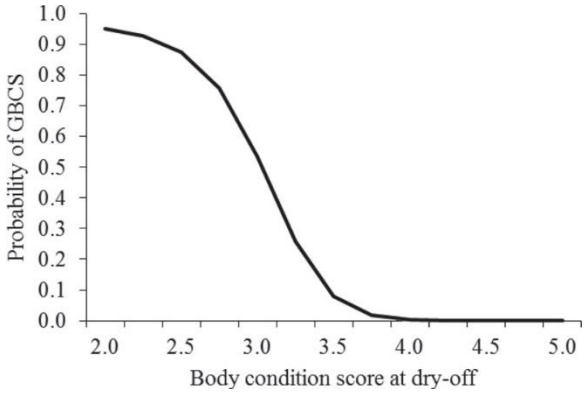

Figure 2. Probability of cows to gain BCS during the dry period (GBCS) according to their BCS at dry-off (BCSD). Results based on the multivariate logistic regression of risk of gaining BCS during the dry period.

In general, cows that lost BCS during the dry period were more likely to be diagnosed with postpartum diseases and be treated (Table 1). For example, Cows with ELBCS were most likely to be diagnosed with uterine disease (retained fetal membranes and/or metritis) and MLBCS cows were more likely to be diagnosed with uterine disease than GBCS cows. There was a tendency for greater risk of indigestion among cows with MLBCS compared with cows with GBCS. As a consequence of the risk of some periparturient diseases, loss of BCS during the dry period was associated with greater risk of treatments during the periparturient period. Cows with ELBCS and MLBCS were more likely to be treated with antibiotics than GBCS cows, and ELBCS cows tended to be more likely to be treated with antibiotics than GBCS cows. Similarly, ELBCS cows were more likely to be treated with anti-inflammatory drugs than NCBCS and GBCS cows. Finally, there was a greater risk of supportive therapy for cows with ELBCS, MLBCS, and NCBCS compared with cows that GBCS. Considering the greater incidence of diseases among ELBCS cows, it is surprising that they were less likely to be culled within 60 DIM than MLBCS and NCBCS cows. This may be a consequence of the greater frequency of treatments among ELBCS compared with MLBCS and, particularly, NCBCS cows. Cows that GBCS were less likely to be culled within 60 DIM compared with MLBCS and NBCS, which may be a consequence of differences in frequency of diseases.

Considering the increase incidence of diseases among cows with ELBCS, MLBCS, and NCBCS compared with GBCS cows, it is not surprising that the latter had better reproductive performance (Table 2). The differences in pregnancy to first and second postpartum AI according to ΔBCS, however, are not solely explained by greater incidence of diseases. When we only analyzed data of healthy cows, GBCS cows still had the best reproductive performance compared with ELBCS, MLBCS, and NCBCS cows. The increases in pregnancy at 75 ± 7 d after first and second postpartum AI are impressive (100% and 65% for first and second postpartum AI between ELBCS and GBCS cows) and is explained by both a greater risk of establishment of

pregnancy, observed by the greater pregnancy at 35 ± 7 d after AI, and lower risk of pregnancy loss from 35 ± 7 to 75 ± 7 d after AI.

Table 1. Association between change in BCS during the dry period and health parameters.

Variables	Change in BCS during the dry period				*P* - value
	ELBCS	MLBCS	NCBCS	GBCS	
Lactations	1,604	6,430	4,819	3,251	
Uterine diseases, %	15.8^{a}	13.6^{b,x}	13.3^{b}	12.2^{b,y}	< 0.001
Indigestion, %	2.7	3.4^{A}	2.8	2.2^{B}	0.01
Antibiotic therapy, %	14.1^{a,A}	12.4^{a}	11.8^{B}	10.1^{b}	< 0.001
Anti-inflammatory, %	13.7^{a}	10.0	7.9^{b}	6.9^{b}	< 0.001
Supportive therapy, %	8.1^{a}	8.4^{a}	7.6^{a}	5.9^{b}	< 0.001
Culling within 60 DIM, %	2.7^{a}	5.5^{b,x}	5.9^{b,x}	4.3^{y}	< 0.001

^{a,b} within lines, means with different superscripts are different ($P \leq 0.01$)
^{x,y} within lines, means with different superscripts are different ($P \leq 0.01$)
^{A,B} within lines, means with different superscripts tended to differ ($0.01 < P \leq 0.05$)

The average daily yield of 3.5% fat-corrected milk up to 305 DIM was associated with ΔBCS. Cows with GBCS produced 1.3 to 2.5 kg/d more 3.5% fat-corrected milk than ELBCS, MLBCS, and NCBCS cows (Table 2). Consequently, GBCS cows had approximately 0.05 to 0.1 kg/d more milk fat and 0.03 to 0.04 kg/d more milk protein than ELBCS, MLBCS, and NCBCS cows. Finally, GBCS cows appeared to have better udder health throughout the lactation because they had lower average linear somatic cell score compared with ELBCS, MLBCS, and NCBCS cows (Table 2).

Table 2. Association between change in BCS during the dry period and reproductive and productive performances.

Variables	Change in BCS during the dry period				P - value
	ELBCS	MLBCS	NCBCS	GBCS	
1st AI (n)	1,540	5,812	4,258	2,955	
Pregnancy at 38 d	24.6^{a}	31.6^{b}	35.8^{c}	43.9^{d}	< 0.001
Pregnancy at 75 d	20.8^{a}	28.3^{b}	33.1^{c}	41.9^{d}	< 0.001
Pregnancy loss from 38 to 75 d	15.6^{a}	10.5^{b}	7.4^{c}	4.5^{d}	< 0.001
2nd AI (n)	1,213	4,081	2,717	1,669	
Pregnancy at 38 d	24.8^{a}	29.4^{b}	30.9^{c}	38.1^{d}	< 0.001
Pregnancy at 75 d	22.1^{a}	26.8^{b}	28.9^{c}	36.4^{d}	< 0.001
Pregnancy loss from 38 to 75 d	11.0^{a}	8.9^{b}	6.4^{c}	4.4^{d}	< 0.001
Performance					
3.5% fat corrected milk (305-d), kg/d	39.4 ± 0.3^{a}	39.9 ± 0.1^{x}	40.6 ± 0.2^{y}	41.9 ± 0.2^{b,z}	< 0.001
Linear somatic cell score	3.55 ± 0.06^{a,A}	3.52 ± 0.03^{x}	3.43 ± 0.03^{B,y}	3.35 ± 0.03^{b,z}	< 0.001

^{a,b,c,d} within lines, means with different superscripts are different ($P \leq 0.01$)
^{x,y,z} within lines, means with different superscripts are different ($P \leq 0.01$)
^{A,B} within lines, means with different superscripts tended to differ ($0.01 < P \leq 0.05$)

Conclusions

In this observational study we determined that ΔBCS negatively impacts health, reproduction, and production. It is important to note that in this study the diets of all cows, within year and season of calving, were the same. Therefore, we speculate that ΔBCS was a consequence of differences in DMI. Hayirli et al. (2002) had demonstrated that cows with BCS > 4 at -21 d before calving had lower DMI than cows with BCS ≤ 4 at -21 d before calving.

Our multivariable model explained 57.4% of the variability in ΔBCS, of which 94% was explained by BCS at dry-off. This is the critical message of this study – that greater BCS at dry-off is associated with reduced chance of gaining BCS during the dry period, a condition associated with improved overall performance. According to our study, cows that were dried-off with BCS = 2.75 gained 0.35 unit of BCS, which corresponds to approximately 24.5 kg of BW and intake of 134.8 Mcal over their maintenance needs. Therefore, a cow dried-off with BCS = 2.75 would have had a daily energy intake 2.25 Mcal greater than their maintenance during a 60 d dry period (Table 3). Conversely, cows that were dried-off with BCS = 4 lost 0.41 unit of BCS, which corresponds to 28.7 kg of BW and intake of 157.9 below their maintenance needs. Consequently, a cow dried-off with BCS = 4 would have had a daily energy intake 2.63 Mcal lower than their maintenance needs during a 60 d dry period.

To maximize overall performance during the postpartum period, it is critical to assure that the majority of cows gain some BCS during the dry period. Thus, in dairy herds in which all dry cows are fed the same diet, independent of their BCS at dry-off, it is critical to assure that the majority of cows are dried-off with BCS = 2.75 to 3.25, which in our study was associated with ΔBCS ≥ 0 and improved health, reproduction, and production.

Table 3. Estimated change in body weight (ΔBW) and daily energy intake during the dry period according to BCS at dry-off, change in BCS during the dry period, and dry period length (NRC, 2001).

BCS at dry-off	ΔBCS	ΔBW (Kg)	Energy cost (Mcal)	Daily energy intake (Mcal/d)		
				Length of dry period		
				30	60	90
2.75	0.35	24.5	134.8	4.49	2.25	1.50
3	0.09	6.3	34.7	1.16	0.58	0.39
3.25	0	0	0	0.00	0.00	0.00
3.5	-0.15	-10.5	-57.8	-1.93	-0.96	-0.64
3.75	-0.30	-21	-115.5	-3.85	-1.93	-1.28
4	-0.41	-28.7	-157.9	-5.26	-2.63	-1.75
4.25	-0.59	-41.3	-227.2	-7.57	-3.79	-2.52

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