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Relationships between fertility and postpartum changes in body condition and body weight in lactating dairy cows

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ABSTRACT

The relationship between energy status and fertility in dairy cattle was retrospectively analyzed by comparing fertility with body condition score (BCS) near artificial insemination (AI; experiment 1), early postpartum changes in BCS (experiment 2), and postpartum changes in body weight (BW; experiment 3). To reduce the effect of cyclicity status, all cows were synchronized with Double-Ovsynch protocol before timed AI. In experiment 1, BCS of lactating dairy cows (n = 1,103) was evaluated near AI. Most cows (93%) were cycling at initiation of the breeding Ovsynch protocol (first GnRH injection). A lower percentage pregnant to AI (P/AI) was found in cows with lower (≤2.50) versus higher (≥2.75) BCS (40.4 vs. 49.2%). In experiment 2, lactating dairy cows on 2 commercial dairies (n = 1,887) were divided by BCS change from calving until the third week postpartum. Overall, P/AI at 70-d pregnancy diagnosis differed dramatically by BCS change and was least for cows that lost BCS, intermediate for cows that maintained BCS, and greatest for cows that gained BCS [22.8% (180/789), 36.0% (243/675), and 78.3% (331/423), respectively]. Surprisingly, a difference existed between farms with BCS change dramatically affecting P/AI on one farm and no effect on the other farm. In experiment 3, lactating dairy cows (n = 71) had BW measured weekly from the first to ninth week postpartum and then had superovulation induced using a modified Double-Ovsynch protocol. Cows were divided into quartiles (Q) by percentage of BW change (Q1 = least change; Q4 = most change) from calving until the third week postpartum. No effect was detected of quartile on number of ovulations, total embryos collected, or percentage of oocytes that were fertilized; however, the percentage of fertilized oocytes that were transferable embryos was greater for cows in Q1, Q2, and Q3 than Q4 (83.8, 75.2, 82.6, and 53.2%, respectively). In addition, percentage of degenerated embryos was least for cows in Q1, Q2, and Q3 and greatest for Q4 (9.6, 14.5, 12.6, and 35.2% respectively). In conclusion, for cows synchronized with a Double-Ovsynch protocol, an effect of low BCS (≤2.50) near AI on fertility was detected, but change in BCS during the first 3 wk postpartum had a more profound effect on P/AI to first timed AI. This effect could be partially explained by the reduction in embryo quality and increase in degenerate embryos by d 7 after AI in cows that lost more BW from the first to third week postpartum.
Key words: body condition score loss, body weight loss, embryo quality, fertility

INTRODUCTION

The transition period, defined as the period from 3 wk before to 3 wk after calving, represents a challenge for dairy cows as milk production and DMI increase dramatically (Bell, 1995; Grummer, 1995; Herdt, 2000). In some cows, a lack of optimal synchronization of these 2 processes can result in negative energy balance (**NEB**; Herdt, 2000; Grummer, 2008), fat mobilization from adipose tissue (Herdt, 2000; Weber et al., 2013), and losses in BCS and BW (Ferguson, 1996; Grummer and Rastani, 2003). The association of energy status during the transition period and reproductive efficiency in dairy cows has been demonstrated in multiple studies. For example, a retrospective analysis of 7 studies of prepartum nutrition found that feeding a high-energy diet during the close-up period resulted in increased BCS loss postpartum and increased time to pregnancy (Cardoso et al., 2013). In addition, 2 studies found that increases in NEFA concentrations during the transition period were predictive of reduced risk of pregnancy by 70 d after the voluntary waiting period in evaluations of >2,000 lactating dairy cows (Ospina et al., 2010b) or reduced 21-d pregnancy rate in herd-level evaluations of 60 freestall herds (Ospina et al., 2010a). Recently,

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a study of 156 lactating dairy cows (Garverick et al., 2013) reported that the probability of pregnancy at first timed AI (**TAI**) was decreased as serum NEFA concentrations on d-3 postpartum increased. Other studies also indicate a negative relationship between postpartum NEFA or loss of BCS and fertility (López-Gatius et al., 2003; Chapinal et al., 2012b). In contrast, no effect of increased NEFA or BHBA concentrations during the transition period was found in a recent large (n = 2,365), multi-region study (Chapinal et al., 2012a). Unfortunately, none of those studies provided detailed information on reproductive management protocols, except for Garverick et al. (2013). Thus, further studies on the effects of early postpartum energy balance on reproductive performance, particularly in herds using systematic reproductive synchronization protocols, could provide valuable information on biological mechanisms regulating reproductive efficiency as well as practical strategies for managing reproduction in dairy herds.

Multiple potential mechanisms exist whereby energy status during the postpartum period could reduce fertility in dairy cows. Negative energy balance decreases dominant follicle growth and estradiol production, possibly because of decreases in circulating insulin, IGF-1, and LH pulses (Canfield and Butler, 1990; Butler, 2003, 2005). A longer time from calving until energy balance nadir has been associated with an increased interval to first postpartum ovulation (Canfield and Butler, 1990; Zurek et al., 1995; Gümen et al., 2005). In addition, the magnitude of BCS loss after calving can increase the percentage of cows that are not cycling at the end of the voluntary waiting period (Gümen et al., 2003, Santos et al., 2004a, 2009; Lopez et al., 2005). Thus, early postpartum NEB may decrease reproductive efficiency by increasing the percentage of anovular cows. Indeed, anovular cows have lower reproductive efficiency in programs using detection of estrus or TAI protocols (Gümen et al., 2003; Santos et al., 2009). Furthermore, cows that begin TAI programs in a low-progesterone (**P4**) environment have reduced fertility, independent of cyclicity status (Denicol et al., 2012; Giordano et al., 2012b; Lopes et al., 2013). In addition, cows with lower BCS near the time of AI have decreased fertility (Moreira et al., 2000; Souza et al., 2008; Santos et al., 2009) and this may be related to increased anovulation as BCS decreases. Of particular importance to the current study, excessive BCS loss between parturition and first insemination is associated with poor reproductive performance (López-Gatius et al., 2003; Santos et al., 2009). A classical hypothesis was introduced by Britt (1992), who postulated that energy status during the early postpartum period could alter follicular/oocyte quality, resulting in negative effects on subsequent fertility in lactating dairy cows. However, definitive evidence for this hypothesis as well as definition of the cellular mechanisms and reproductive targets of early postpartum NEB (fertilization or early embryo development) has not yet been delineated.

In this study, we conducted a retrospective analysis of previous studies in which we had indicators of energy balance during the postpartum period (BCS, BCS changes, and BW losses) and fertility measurements at first postpartum AI. To minimize the potential confounding effects of cyclicity status at initiation of the Ovsynch56 protocol (Denicol et al., 2012; Giordano et al., 2012a,b, 2013), we chose to evaluate only cows that had been treated with a Double-Ovsynch protocol, which induces cyclicity in most cows before beginning the breeding Ovsynch protocol (Herlihy et al., 2012; Ayres et al., 2013). Our specific objectives were to (1) evaluate the association between BCS near TAI on fertility at first AI, (2) evaluate the association between BCS change early postpartum on fertility of lactating dairy cows at first AI, and (3) evaluate the effect of postpartum BW change on circulating NEFA concentrations and embryo production in high-producing dairy cows that were superovulated at first AI. Our hypotheses were (1) cows with low BCS near AI will have decreased fertility at first TAI, (2) cows with greater BCS loss early postpartum will have decreased fertility at first TAI compared with cows with lesser BCS loss, and (3) cows with increased postpartum BW loss will have greater circulating NEFA concentrations and poorer embryo quality.

MATERIALS AND METHODS

All procedures were approved by the Animal Care and Use Committee for the College of Agricultural and Life Sciences of the University of Wisconsin-Madison.

Experiment 1

Animals, Housing, and AI. This experiment was conducted on 3 commercial dairy farms and 1 research farm in south-central Wisconsin. Lactating dairy cows (n = 1,103; 465 primiparous and 638 multiparous) were housed in freestall facilities bedded with sand and equipped with self-locking head gates at the feed line, and had ad libitum access to fresh feed and water. Cows were milked 3 times daily on the commercial farms, whereas cows were milked twice daily at the research farm. Cows were fed TMR diets using corn and alfalfa silage as forage and corn- and soybean-meal based concentrates and supplemented with minerals and vitamins. On all farms, TMR diets were balanced by a professional nutritionist using the NRC (2001)