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Early-life events associated with first-lactation performance in pasture-based dairy herds

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ABSTRACT

This was a prospective cohort study to determine how events from birth until first calving affect performance during the first lactation in pasture-based dairy herds in Victoria, Australia. Events during the preweaning (0–84 d), prepubertal (85–473 d), and postpubertal (474–804 d) periods were recorded in 6 herds, and their association with first-lactation 100-d and 250-d total milk, fat, and protein yields was quantified. Predictors of first-lactation performance included passive transfer status as a calf; season of birth; age of dam; the presence or absence of dystocia at the time of the heifer's birth; the presence or absence of preweaning diarrhea; preweaning, prepubertal, and postpubertal average daily weight gain; age at first calving; the presence or absence of periparturient disease at first calving; sex of the first-born calf; the presence or absence of a stillborn calf at the first calving; and requirement of assistance at the first calving. Lactation performance was quantified using cumulative 100-d and 250-d milk, fat, and protein yields estimated from herd recording. A multivariable linear regression model was developed for each outcome: cumulative 100-d milk, fat, and protein yield and cumulative 250-d milk, fat, and protein yield. Heifers that experienced dystocia at the time of their birth produced 7.6 kg [95% confidence interval (CI): 1.8–13.3] less fat and 4.8 kg (95% CI: 0.6–8.9) less protein at 100 d in milk in the first lactation compared with heifers that were delivered without dystocia. Heifers born in the summer and autumn produced 20 L (95% CI: 0.8–40) more milk and 20 kg (95% CI: 5.9–33) more protein at 250 d in milk in the first lactation compared with heifers born in the spring. For 100 g/d increases in prepubertal average daily gain, heifers produced an additional 182 L (95% CI: 149–216) of milk, 4.1 kg (95% CI: 2.8–5.5) of fat, and 4.0 kg (95% CI 3.1–5.0) of protein at 100 d in milk and an additional 345 L (95% CI 264–425) of milk, 6.1 kg (95% CI 3.2–9.0) of fat, and 7.5 kg (95% CI 5.3–9.7) of protein at 250 d in milk. Postpubertal average daily gain was positively associated with 100-d milk yield and 250-d milk yield and protein production. We conclude that of all the growth periods assessed in this study, events that occurred during the prepubertal period (85–473 d of age) had the greatest effect on first-lactation performance.
Key words: lactation performance, growth, preweaning, prepubertal, postpubertal

INTRODUCTION

In dairy heifers, early-life events, including episodes of disease, dystocia at the time of birth, and colostrum feeding, have been associated with subsequent lactation performance (Britney et al., 1984; Heinrichs and Heinrichs, 2011; Mohd Nor et al., 2013). These events may exert their effect directly on lactation performance or indirectly through their effect on the risk of disease, age at first calving (**AFC**), BW at first calving, and BCS at first calving.

Milk yield, fat, and protein production have been shown to be affected by early calf health status (Svensson and Hultgren, 2008; Heinrichs and Heinrichs, 2011). Heinrichs and Heinrichs (2011) found that the presence of dystocia (defined as the provision of mechanical assistance to deliver a calf) was associated with a 569-kg decrease in milk production and an 8.6-kg decrease in protein production over the first lactation compared with calves born without assistance. The number of days ill due to diarrhea or respiratory disease during the first 4 mo of life has been shown to have a negative association with 305-d mature equivalent and actual milk, fat, and protein production in the first lactation. Stanton et al. (2012) found that calves with respiratory disease at 2 to 4 mo of age had first test milk yields reduced by 1.1 ± 0.6 kg. These findings are not consistent with other studies that showed no effect of calfhood morbidity on subsequent milk production (Britney et al., 1984; Warnick et al., 1995).

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The preweaning period is defined as the time from birth until milk feeding ceases. Numerous studies have shown that preweaning nutrition and ADG have a lasting effect on subsequent lactation performance (Shamay et al., 2005; Moallem et al., 2010; Soberon et al., 2010; Davis Rincker et al., 2011; Soberon and Van Amburgh, 2013). Hoffman and Funk (1992) suggested that the improved lactation performance was due to an increase in ADG and therefore increased BW at first calving.

The prepubertal period is defined as the first allometric phase of growth from 2 to 3 mo of age to the completion of several estrous cycles (Sinha and Tucker, 1969). The effect of high ADG in the prepubertal period on subsequent milk production has been widely researched with variable findings (Capuco et al., 1995; Sejrsen and Purup, 1997; Van Amburgh et al., 1998; Lammers et al., 1999; Macdonald et al., 2005; Zanton and Heinrichs, 2005; Soberon et al., 2012). High-level feeding on a corn silage diet led to excessive fat deposition and increased accumulation of adipocytes within the mammary parenchyma along with reduced mammary parenchymal DNA and RNA (Capuco et al., 1995). Growth rates greater than 600 to 700 g/d during the prepubertal phase have been found to have a permanent negative effect on subsequent milk yield potential (Sejrsen and Purup, 1997). This negative effect is similar across dairy breeds, although the feeding level required to cause this negative effect can differ according to breed. Conversely, first-lactation milk yield has been found to be highest in heifers gaining 850 to 970 g/d during the prepubertal period (Krpálková et al., 2014), with heifers achieving this ADG producing, on average, around 521 kg more milk over a 305-d lactation compared with those with lower ADG. Fat and protein milk components were also significantly greater in the higher ADG group.

The postpubertal period can be defined as the period after the onset of detected estrus until structural maturity. Some studies have shown that there is no effect on lactation performance of ADG during this period (Abeni et al., 2000), whereas other studies have shown an association (Hoffman et al., 1996; Van Amburgh et al., 1998). The optimal ADG for all 3 growth periods is yet to be defined because of these inconsistencies in the literature. Most of these studies were carried out in non-seasonally calving herds fed either TMR or herds in which concentrate feeds and conserved forages accounted for most of the daily energy intake. To the best of our knowledge, the effect of early-life events on first-lactation performance has never been investigated in Australian pasture-based dairy heifers. To address this knowledge gap, the aim of this study was to determine which factors measured from birth until first calving are associated with first-lactation performance in 6 seasonally calving, pasture-based dairy herds in Victoria, Australia.

MATERIALS AND METHODS

This was a prospective cohort study of individual dairy heifers on 6 dairy herds in southwest Victoria. Data collection took place over a 5-yr period. Selection of dairy herds was purposive and largely based on herd manager compliance with a demonstrated ability to record and maintain individual animal event details to a high level of detail. Two herds were selected with a herd size of less than 300 milking cows, 2 herds with 300 to 450 milking cows, and 2 herds with greater than 450 milking cows. One of the herds comprised 100% Holstein-Friesian cows, 1 herd comprised 100% Jersey cows, and the remaining 4 herds had a combination of Holstein-Friesians, Jerseys, Aussie Reds, and their crosses. In all herds, cows were milked twice daily. During the calving season, calves were removed from the calving area(s) at least once daily.

Prior to the start of the first calving season of the study follow-up period, a comprehensive questionnaire on calf rearing practices was administered by the senior author to each participating herd manager. The questionnaire took 1 to 2 h to administer and solicited details on general herd information, precalving management, record management, colostrum management, feeding regimens, calf environment, health management, and weaning management.

Data Recording

All heifers were born outside in paddocks with their dams grouped according to estimated calving date. For every heifer calf born between February 2011 and November 2012, the following details were recorded on preprinted recording sheets at the time of birth: unique animal identification number, date of birth, breed of dam, age of dam, breed of calf, whether the calf was actively fed colostrum versus being left on the dam, whether the calf experienced dystocia at birth, whether she was one of a twin, and whether she experienced diarrhea during the preweaning period. The presence of diarrhea was defined as visibly loose feces of decreased consistency, with or without the presence of mucous or blood. Records of disease events were kept until weaning. Data were checked by the senior author at weekly herd visits to ensure that all records were complete.

Active feeding of first-milking colostrum by teat or esophageal feeder was encouraged as a routine management practice in all herds. After administration of colostrum, calves were fed between 10 and 20% of their BW in whole waste milk per feed (4–8 L/d). Higher