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Associations between herd-level factors and lying behavior of freestall-housed dairy cows

K. Ito,*† N. Chapinal,* D. M. Weary,* and M. A. G. von Keyserlingk*[1]
*Animal Welfare Program, University of British Columbia, Vancouver, BC V6T 1Z4, Canada
†Novus International Inc., St. Charles, MO 63304

ABSTRACT

Our objective was to investigate the associations between herd-level factors and lying behavior of high-producing dairy cows housed in freestall barns. Lying behavior of approximately 40 focal cows in one high-producing pen was monitored on each of 40 farms in the northeastern United States (NE) and 39 farms in California (CA). All cows within the pen were gait scored using a 1-to-5 scale to calculate the prevalence of clinical lameness (score ≥3) and severe lameness (score ≥4). Facility and management measures, including stall design, bedding, and flooring type within the pen, were collected. Herd-level factors associated with daily lying time, standard deviation (SD) of daily lying time, frequency of lying bouts, and lying bout duration at the univariate level were submitted to multivariable general linear models. In the NE, daily lying time increased with the use of deep bedding (estimate = 0.80 ± 0.31 h/d) and as average days in milk (DIM) of the focal cows increased (estimate = 0.08 ± 0.04 h/d for a 10-d increase in DIM). The SD of daily lying time decreased as stall stocking density increased (estimate = −0.08 ± 0.03 h/d for a 10% increase), and increased with the presence of rubber flooring in the pen (estimate = 0.16 ± 0.08 h/d) and percentage of stalls with fecal contamination (estimate = 0.04 ± 0.01 h/d for a 10% increase). Frequency of lying bouts decreased (estimate = −1.90 ± 0.63 bouts/d) and average bout duration increased (estimate = 15.44 ± 3.02 min) with the use of deep bedding. In CA, where all farms used deep bedding, daily lying time increased as average DIM of the focal cows increased (estimate = 0.08 ± 0.03 h/d for a 10-d increase). The SD of daily lying time decreased when feed was delivered more than once per day (estimate = −0.24 ± 0.08 h/d). The percentage of lame cows was correlated with the percentage of stalls with fecal contamination (r = 0.45), which in turn was associated with fewer (estimate = −0.25 ± 0.06 bouts/d) and longer lying bouts (estimate = 1.85 ± 0.39 min/d). These findings suggest that lying time be interpreted in conjunction with variability in lying time and bout structure and in context with lameness prevalence, production parameters, and facility characteristics.
Key words: cow comfort, deep bedding, management, stall design

INTRODUCTION

Lying behavior, particularly the time spent lying down, the frequency of lying bouts (i.e., a transition from standing to lying), and the duration of individual bouts can be used to assess the quality of the lying area (Haley et al., 2000). For example, cows spend more time lying down and have a higher frequency of lying bouts on mattresses or rubber mats compared with concrete lying surfaces (Haley et al., 2001; Rushen et al., 2007), and on deep bedding versus poorly bedded mattresses (Tucker et al., 2003). Similarly, cows spend more time lying down and have longer bouts in wider stalls (Tucker et al., 2004) and on deep-bedded sand stalls compared with mattresses (Gomez and Cook, 2010). Lying time also responds to changes in management and environmental conditions. For example, lying time increased from 11.4 to 13.7 h/d when deep-bedded sand stalls were consistently maintained versus stalls with the sand dug out 6.2 cm below the curb (Drissler et al., 2005). Lying time decreased by 1.7 h/d when the stocking density (number of cows per stall) increased from 100 to 150% (Fregonesi et al., 2007), and was reduced by as much as 3 h/d when the temperature-humidity index (**THI**) in the barn exceeded 72 for more than 10 h/d (Cook et al., 2007).

Lying behavior is also influenced by the health and production status of the cow. For instance, lame cows have increased lying times and longer lying bouts (Chapinal et al., 2009; Ito et al., 2010), although changes in lying behavior by lame cows depend on the type of stall surface, time available for lying down, and stall standing activity (Gomez and Cook, 2010). In contrast, cows with clinical mastitis spend more time standing, suggesting discomfort while lying down (Cyples et al.,

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[1]Corresponding author: marina.vonkeyserlingk@ubc.ca

2012). Among healthy cows, daily lying time increases as DIM increases (Endres and Barberg, 2007; Bewley et al., 2010; Vasseur et al., 2012) and is lower for cows producing more milk (Fregonesi and Leaver, 2001; Norring et al., 2012), likely because of the increased time spent feeding by high-yielding cows.

Previous research has shown that dairy cows in tie-stalls are motivated to maintain approximately 12 h/d of lying time (Jensen et al., 2005). Lying down is a higher priority behavior compared with feeding or social contact (Munksgaard et al., 2005), and chronic lying deprivation is physiologically harmful as demonstrated by heightened hypothalamic-pituitary-adrenal activity (Munksgaard and Simonsen, 1996). Lying may also facilitate recovery from illness (Hart, 1988; Johnson, 2002). Average lying times of approximately 12 to 13 h/d (e.g., Drissler et al., 2005; Fregonesi et al., 2007; Gomez and Cook, 2010) are now widely accepted as the target for lactating dairy cows in freestall facilities (NFACC, 2009). However, cross-sectional studies on commercial dairy farms across North America found that average lying times among high-producing cows were 10 to 11 h/d, with few farms having an average lying time over 12 h/d (Ito et al., 2009; von Keyserlingk et al., 2012). These studies have also found more variation in lying behavior among individual cows within farms than across farms (Ito et al., 2009).

Lying behavior in commercial settings is likely influenced by a combination of factors, such as management, facility design, and the prevalence of lameness. However, most research to date has focused on cow-level factors, such as lameness status (Ito et al., 2010) or DIM (Bewley et al., 2010), and characteristics of the lying surface (Tucker and Weary, 2004), and has primarily been conducted either in controlled settings or on a limited number of commercial farms within a certain region. The objective of this study was to undertake a comprehensive investigation of the associations between herd-level factors such as the prevalence of lameness, management and facility design, and different lying behavior measures (including measures of variability within farm) in high-producing dairy cows on freestall commercial farms in the northeastern United States and California. These 2 regions were selected because of their differences in the prevalence of lameness, management, and facility design (see von Keyserlingk et al., 2012).

MATERIALS AND METHODS

Farm Selection and Visits

A total of 40 farms in the northeastern United States (**NE**; n = 28 in New York, n = 8 in Pennsylvania, and n = 4 in Vermont), and 39 farms in California (**CA**) were selected within the Novus C.O.W.S. program, a partnership between The University of British Columbia and Novus International Inc. (http://www.novusint.com/en/Market-Segments/Dairy/COWS), for this cross-sectional study. Consulting nutritionists (n = 24 in NE; n = 8 in CA) were asked to select farms considering 2 inclusion criteria: freestall housing and TMR feeding. Nutritionists were asked to randomly identify dairies that met the criteria and were willing to participate in the study. The farms (n = 79) included in this study made up a portion of the farms described in von Keyserlingk et al. (2012), which presented descriptive analyses regarding facility design, lying behavior, skin injuries, and lameness of 121 freestall farms located in 3 different regions of North America. The farms used in the current study are also the same farms described by Chapinal et al. (2013) and Barrientos et al. (2013), which focused on identifying facility and management risk factors for lameness and hock injuries, respectively. This current study describes the associations between herd-level factors and lying behavior of freestall-housed dairy cows, which has not yet been reported and, to our knowledge, will make use of the most comprehensive data set available to date. The University of British Columbia's Animal Care Committee, following the standards of CCAC (2009), approved all animal-based measures.

Farms were visited between March and May 2010 in CA, and between July and October 2010 in NE. The same 2 trained observers visited each farm twice, with approximately 3 to 5 d between visits, collecting a range of measures (Table 1). The group with the highest milk production and consisting of primarily multiparous cows was assessed on each farm (assessment group).

Animal-Based Measures

Lying Behavior. From the assessment group, 40 cows were systematically selected as "focal cows" based on the number of units in the milking parlor. For example, if the parlor had 20 units and the group had 100 cows, 8 cows per rotation were selected (to have a final sample size of 40 cows). This systematic selection was done to remove any effect of milking order, as previous work has shown an association between order of milking and lameness (e.g., Main et al., 2010). The sample size was decided based on Ito et al. (2009), who found reliable estimates of lying behavior on commercial dairy farms using at least 3 d of continuous recordings (at 1-min intervals) from at least 30 focal cows per group. Lying behavior was recorded using electronic data loggers (Hobo Pendant G Acceleration Data Loggers, Onset Computer Corp., Pocasset, MA) at 1-min intervals for 3 d (72 h), as validated by Ledgerwood et