Comparing the milking behaviour of primiparous vs. multiparous Holstein and Jersey cows in an automatic batch milking system

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Abstract

The onset of lactation and the subsequent period of habituation to the milking routine is a stressful process for dairy cows, where new social groups and novel stimuli converge. This period seems to be particularly challenging for primiparous cows. The objective of this study was to compare the dynamics of milking behaviour during the early lactation of primiparous vs. multiparous Holstein (HO) and Jersey (JE) cows, under an automatic milking system with a semi-voluntary batch milking design. This retrospective observational study included information from milking events in 2,138 cows from May to December 2023 in an organic certified herd in Texas, USA. Milking behaviour information for the first four weeks of lactation included % of incomplete milkings (INC), % of kick-offs (KO), and % of teat cleaning failure (TCF), collected from DelPro software (DeLaval, Sweden) and used as a proxy for habituation to the milking routine and system. Cows were moved to the milking barn twice per day, where they could select their milking visits among 22 robots (DeLaval, Sweden). Parity [primiparous (PRIM) and multiparous (MULT)] and calving data were extracted from PCDART software (DRMS, NC, USA). Data were analysed by logistic regression to assess the differences in milking behaviour between PRIM and MULT cows within two breed groups (HO and JE) in weekly intervals following calving (W1; W2; W3; and W4). After edits, 28,165 milking records were analysed in 2,138 cows (27% primiparous; 73% multiparous). The frequencies of undesirable milking behaviours (INC; KO; and TCF) were greatest in PRI cows in both HO and JE during most of the weekly periods. The greatest frequencies of INC per milking event were in PRI cows during W2 (HO = 8.6% and JE = 12.0%). The greatest frequencies of KO were also in PRI during W1 (HO = 10.2%; JE = 17.2%), while the greatest TCF for HO and JE were 8.38% (W1) and 4.98% (W2), respectively. In HO, the odds (95% confidence interval) of INC were greater for PRIM compared with MULT cows during W2 [2.39 (1.72-3.31)], W3 [1.63 (1.21-2.18)] and W4 [1.65 (1.20-2.25)]. Similarly, in JE the odds of INC were greater for PRIM for all the weekly periods: W1 = 77.6 (15.1-1,419), W2 = 7.54 (5.28-10.9), W3 = 3.06 (2.19-4.27), and W4 = 2.75 (1.94-3.87). The odds of KO were greater in PRIM HO during W1 [3.42 (1.74-6.62)], W2 [2.28 (1.66-3.12)], and W3 [1.83 (1.35-2.48)]. In JE, the odds of KO were greater in PRIM during W1 [8.33 (4.53-15.48)], W2 [3.61 (2.76-4.70)], W3 [2.43 (1.90-3.08)], and W4 [1.69 (1.30-2.18)]. Finally, the odds of TCF were greater in PRIM HO during W1 [2.05 (1.02-3.92)] and W2 [1.98 (1.39-2.80)]. In JE, the odds of TCF were greater in PRIM during W1 [4.09 (1.35-11.5)], W2 [5.10 (3.08-8.44], and W3 [2.71 (1.39-5.15)]. These results highlight the differences in milking behaviour during the early lactation of primiparous vs. multiparous cows in both Holstein and Jersey cows. As anticipated, the magnitude

of these differences decreased during weeks 3 and 4, which may be associated with the process of habituation to milking during the first lactation. The greater disparity between primiparous and multiparous reported in Jersey compared with Holsten cows may relate to differences in udder conformation, incidence of udder oedema, body size, or temperament.

Keywords: primiparous, habituation, automatic milking, behaviour:
Presented at the ICAR Anual Conference 2024 in Bled at the Session 1a: Decision Support Tools of the Future – Promoting Sustainability Farm Management

Introduction

Acute stress in dairy cows, characterized by negative affective states, is widely acknowledged to have detrimental effects on both welfare and productivity. Moreover, it can significantly impact cattle handling practices and compromise worker safety (Grandin, 1993; 1999), especially during the milking process (Grandin, 1998; Douphrate *et al*., 2013; Edwards and Kuhn-Sherlock, 2021).

The onset of a dairy cow's first lactation and the subsequent habituation period to the milking routine constitute a particularly stressful phase in their lives. This period involves increased interaction with human caretakers, integration into new social groups, and exposure to various novel stimuli during milking. Handling primiparous heifers during this transition can also pose challenges to human handlers, increasing the difficulty of milking tasks and the risk of cattle-related injuries (Sorge *et al*., 2014; Edwards and Kuhn-Sherlock, 2021; Phillips *et al*., 2021). Despite this, there remains a research gap regarding specific behavioural changes in cows throughout the first lactation.

Previous studies on heifer habituation to the milking routine have shown that primiparous cows tend to exhibit higher levels of excitability compared to multiparous cows at various stages of the milking process (Andrea *et al*., 2015). Most research efforts have primarily focused on expediting the habituation process through pre-lactation exposure to milking routines and/or early lactation interactions with caretakers (Bremner, 1997; Kutzer *et al*., 2015).

The behavioural responses exhibited by dairy cows to novel stimuli, such as kicking during the milking are a reflection of stress or discomfort. Consequently, a deeper understanding of this process is particularly relevant. Interestingly, in a recent study by Kness *et al* (2023) where milking unit kick-off was used as a proxy for habituation to the milking procedure, this behaviour was consistently greater in primiparous compared to multiparous cows. Furthermore, the relationship between days in milk and the proportion of cows displaying milking unit kick-off was not linear, but rather increased for the first several weeks before decreasing again.

In recent decades, automatic milking systems (AMS) have been steadily gaining in popularity. Among multiple advantages provided by AMS, improved cow comfort is considered central to these systems. However, heifers may exhibit stress reactions, such as kicking and stepping as well as vocalization and elimination, during their first visits to the milking robot (Jacobs and Siegford, 2012). Moreover, although in these systems the human-cow interaction component is significantly reduced, first parity cows, require some guidance and training during the beginning of their lactation (Jago *et al*., 2011; Tse *et al*., 2018).

Notably, studies documenting daily changes in stress behaviours during the habituation period or differences in these behaviours between primiparous and multiparous cows during the initial months of lactation in AMS are scarce (von Kuhlberg *et al*., 2020). Moreover, to the best of the authors' knowledge, studies analysing data originated from AMS with a semi-voluntary batch milking design are missing. In these systems,

cows are moved to the milking barn at fixed times of the day, where they can select their milking visits among multiple robots.

We hypothesized that adverse behaviours [milking unit kick-off (KO)] and undesirable events [incomplete milking (INC), teat cleaning failure (TCF)] would be most frequent in primiparous cows that are starting their lactation, as compared to older cows. We also envisioned that there is variation in these behaviours associated with the cow's breed. In consequence, the objective of this study was to compare the dynamics of milking behaviour during the early lactation of Holstein (HO) and Jersey (JE) cows in an automatic milking system with a semi-voluntary batch milking design.

Material and methods

This retrospective observational study included information from milking events in 2,138 cows from May to December 2023 in a grass-fed organic certified herd in Texas, USA. Milking behaviour information for the first four weeks of lactation included incomplete milkings (%), milking unit kick-off (%), and teat cleaning failure (%), collected from DelPro software (DeLaval, Sweden) and used as a proxy for habituation to the milking routine and system.

Cows were moved to the milking barn by grazing group twice per day, where they could select their milking visits among 22 robots (DeLaval, Sweden). Parity [primiparous (PRIM) and multiparous (MULT)] and calving data were extracted from PCDART software (DRMS, NC, USA).

Data exploration and descriptive analyses for the variables in analysis were performed using R, version 4.2.2 (R Core Team, 2022) using the lmer4 (Bates *et al*., 2015), lmerTest (Kuznetsova *et al*., 2017), and emmeans (Lenth, 2022) packages. Data were analysed by logistic regression to assess the differences in milking behaviour between PRIM and MULT cows within two breed groups (HO and JE) in weekly intervals following calving (W1; W2; W3; and W4). Cow ID was considered as random effect for adjustment. Potential interactions were tested and removed from the models when not significant. Average milking trait values were compared using Tukey-adjusted pairwise comparisons. Statistical significance was assessed at $P < 0.05$ level using a likelihood ratio test.

Results and discussion

After edits, 28,165 milking records were analysed in 2,138 cows (27% primiparous; 73% multiparous). The frequencies of undesirable milking behaviours (INC; KO; and TCF) were greatest in PRI cows in both HO and JE during most of the weekly periods (Figure 1 and Figure 2). The greatest frequencies of INC per milking event were in PRI cows during W2 (HO = 8.6% and JE = 12.0%). The greatest frequencies of KO were also in PRI during W1 (HO = 10.2%; JE = 17.2%), while the greatest TCF for HO and JE were 8.38% (W1) and 4.98% (W2), respectively.

In HO, the odds (95% confidence interval) of INC were greater for PRIM compared with MULT cows during W2, W3 and W4 (Table 1). Similarly, in JE the odds of INC were greater for PRIM for all the weekly periods (Table 2). The odds of KO were greater in PRIM HO during W1, W2, and W3. In JE, the odds of KO were greater in PRIM during all the weekly periods (Table 4). Finally, the odds of TCF were greater in PRIM HO during W1 and W2. In JE, the odds of TCF were greater in PRIM during W1, W2, and W3.

Figure 1. Frequency (%) of incomplete milking (top panel), milking unit kick-off (middle panel), and teat cleaning failure (bottom panel) in primiparous versus multiparous Holstein cows by week postpartum.

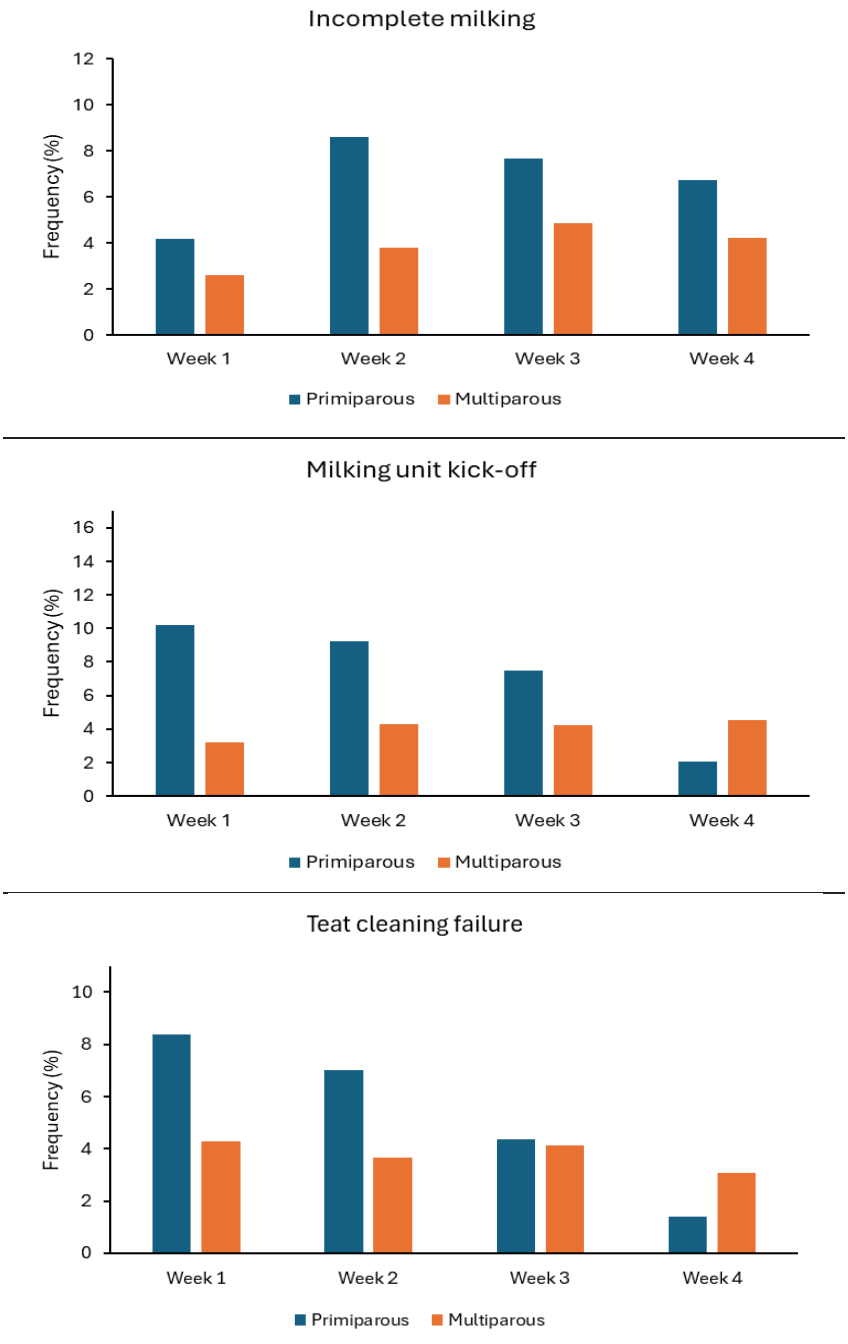
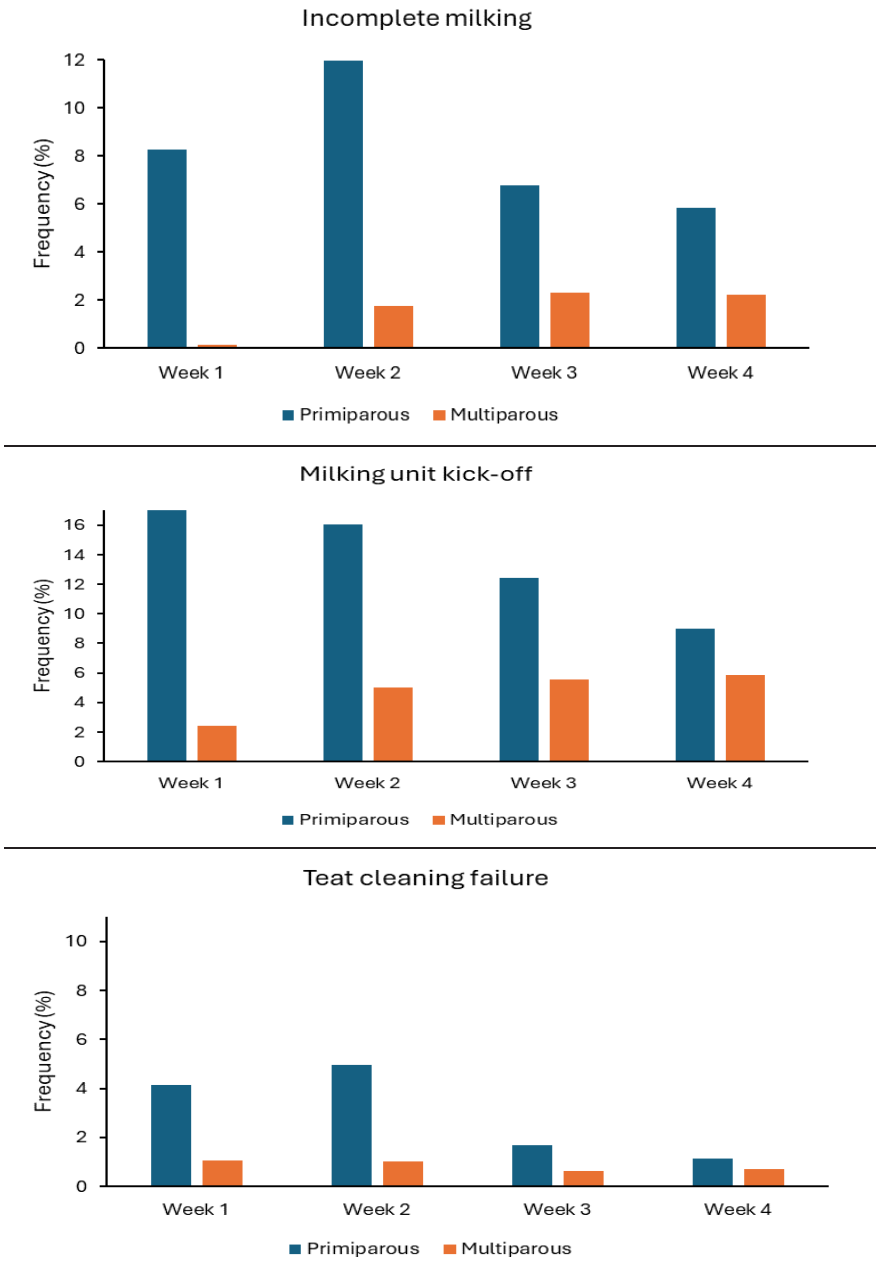


Figure 2. Frequency (%) of incomplete milking (top panel), milking unit kick-off (middle panel), and teat cleaning failure (bottom panel) in primiparous versus multiparous Jersey cows by week postpartum.



Earlier studies focused on cow behavior at the milking parlor are based on visual observation (Rousing *et al*., 2004; Cerqueira *et al*., 2017). However, the advent of precision technologies and in particular the precise information provided by robotic milking creates opportunities for the monitoring of multiple behaviors in large numbers of animals.

Supporting the concept of habituation to novel conditions, in a recent study, von Kuhlberg *et al*. (2020) reported that training of heifers on a phantom milking robot prepared the animals for being milked in the AMS, resulting in increased number of milking visits and a reduced proportion of animals that had to be fetched into the AMS for milking.

In agreement with Knees *et al*. (2023), in our study, occurrence of KO was greater in PRIM than in MULT during most of the monitoring period (up to 90 DIM). Moreover, the decreasing trend as primiparous cows advanced in their lactation agrees with Bremner (1997), which found that primiparous cows moved and kicked more frequently during the first 7 milkings than during subsequent milkings.

Overall, the results from the current study highlight the differences in milking behaviour during the early lactation of primiparous vs. multiparous cows in both Holstein and Jersey cows. As anticipated, the magnitude of these differences decreased as the lactation advanced, which may be associated with the process of habituation to milking during the first lactation. The greater disparity between primiparous and multiparous reported in Jersey compared with Holsten cows may relate to differences in udder conformation, incidence of udder oedema, body size, or temperament.

A better understanding of these undesirable behaviours using data originated from automatic milking systems, as well as research exploring strategies to reduce their incidences during early lactation, could result in improved transition of first parity cows into milking.

Table 1. Adjusted odds ratios (OR) and 95% CI for incomplete milking, milking unit kick-off, and teat cleaning failure in primiparous versus multiparous (reference) Holstein cows by week postpartum.

Week	Incompletes			Kick-offs			Teat cleaning failure		
	OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
1	1.64	0.62-3.87	>0.05	3.42	1.74-6.62	<0.001	2.05	1.02-3.92	0.04
2	2.39	1.72-3.31	<0.001	2.28	1.66-3.12	<0.001	1.98	1.39-2.80	0.0002
3	1.63	1.21-2.18	0.002	1.83	1.35-2.48	0.001	1.05	0.73-1.50	>0.05
4	1.65	1.20-2.25	0.002	1.34	0.96-1.84	0.08	1.35	0.91-1.97	>0.05

Table 2. Adjusted odds ratios (OR) and 95% CI for incomplete milking, milking unit kick-off, and teat cleaning failure in primiparous versus multiparous (reference) Jersey cows by week postpartum.

Week	Incompletes			Kick-offs			Teat cleaning failure		
	OR	95% CI		OR	95% CI		OR	95% CI	
1	77.6	15.1-14.2	< 0.001	8.33	4.53-15.5	< 0.001	4.09	1.35-11.5	0.01
2	7.54	5.28-10.9	< 0.001	3.61	2.76-4.70	< 0.001	5.1	3.08-8.44	< 0.001
3	3.06	2.19-4.27	< 0.001	2.43	1.90-3.08	< 0.001	2.71	1.39-5.15	0.004
4	2.75	1.94-3.87	< 0.001	1.69	1.30-2.18	<0.001	1.75	0.84-3.47	> 0.05

Acknowledgement

This work was supported by Food and Agriculture Cyberinformatics and Tools grant no. 2019-67021-28823 from the USDA National Institute of Food and Agriculture. We thank Aurora Organic Dairy for allowing access to their cow records and DeLaval, International AB, Tumba, Sweden for providing their assistance in the data acquisition from DelPro Farm Manager software. The authors declare that they have no competing interests. Ilka Klaas is employed by DeLaval International AB, Sweden.

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