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Association between timing of hoof trimming in primiparous cows and hoof health and survival in second lactation

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ABSTRACT

Lameness in dairy cows, primarily caused by claw lesions, generates significant welfare and economic challenges. Hoof trimming is a key preventive measure, with scientific support for 2 to 3 trimmings per lactation. However, the optimal timing of these trimmings has not yet been fully explored. This retrospective cohort study aimed to investigate the association between timing of 2 hoof trimmings during first lactation and subsequent hoof health and culling in second lactation. Data from 10,349 primiparous cows across 185 Swedish dairy herds (2015–2018) were analyzed. Multivariable mixed-effect logistic (models L1 and L2) and multinomial logistic regression models (models ML1 and ML2) assessed associations with hoof health in early second lactation (within 90 DIM) and survival during second lactation (within 300 DIM). Explanatory variables included timings of the first and second trimmings, interval between trimmings, hoof health at trimming, and breed. Herd was incorporated as a random effect or cluster to account for herd-level variations. The L1 model indicated that most trimming combinations other than a late first trim (>120 d after calving) coupled with a late second trim (<61 d before calving) significantly reduced the odds of claw lesions. However, the ML2 model showed that the association varied somewhat depending on the type of claw lesion found. The L2 model generally displayed lower odds of culling (dead, euthanized, and slaughtered) for cows trimmed early in first lactation and further from second calving than 60 d. Although the ML2 model revealed no association between timing of trimming and mortality (dead and euthanized), it did find a significant association with being sent to slaughter. In summary, strategic timing of hoof trimming, early in first lactation and well before second calving, can improve hoof health and survival in dairy cows and consequently have the potential to improve animal welfare and sustainability within the dairy sector.

Key words: mortality, lameness, timing of hoof trimming, routine hoof trimming

INTRODUCTION

Lameness, primarily caused by claw lesions (Flower and Weary, 2006; Becker et al., 2014), presents significant animal welfare (Ventura et al., 2013) and economic challenges in the dairy industry (Huxley, 2013). With a global median prevalence of 22% (Thomsen et al., 2023), lameness negatively affects fertility, milk production, and survival (Charfeddine and Pérez-Cabal, 2017). Hoof trimming is an important preventive measure, widely accepted for preventing and detecting claw lesions (Manske et al., 2002a; Hernandez et al., 2007), promoting early treatment (van der Tol et al., 2004), and preventing premature culling (Cramer et al., 2009).

Locomotor disorders are frequently cited as a primary reason for on-farm euthanasia (Alvåsen et al., 2014; Thomsen et al., 2004). Several studies have shown lameness or different claw lesions to be associated with a higher risk of culling (slaughter, unassisted death, or euthanasia; Thomsen and Houe, 2023; Sogstad et al., 2007; Cramer et al., 2009). Machado et al. (2010) demonstrated the importance of good hoof health at dry-off for survival in the next lactation and Reimus et al. (2020) concluded that that routine trimming was associated with lower mortality. It has been shown that 2 to 3 trimmings in primiparous cows reduces the risk of being culled in early second lactation (Åkerström et al., 2024), but the optimal timing in lactation of these trimmings has not yet been fully explored.

Claw lesions are commonly divided into infectious lesions (caused by infectious agents or poor hygiene and affecting skin of lower legs) and claw horn lesions (developing within the claw horn capsule, due to trauma or internal factors; Randall et al., 2018; Alvergnas et

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al., 2019). Severe claw lesions, such as foot rot, digital dermatitis**,** sole ulcers and white line disease, are more prone to cause lameness (Manske et al., 2002b; Flower and Weary, 2006; Archer et al., 2010).

The transition period (3 wk before and after calving) is recognized as a high-risk period for developing metabolic and infectious diseases (Wankhade et al., 2017) and claw lesions (Daros et al., 2019). The hormonal and physiological changes occurring in the cow during the transition period are important factors in the etiology of claw horn lesions (Tarlton et al., 2002; Bicalho et al., 2009). There are also many external factors changing in this period, such as feeding, housing, social structure and flooring (Bergsten et al., 2015), which also could be risk factors for claw lesions and lameness.

Several studies have identified specific periods during lactation as high-risk times for claw lesions and lameness. The greatest risk of lameness in primiparous cows has been reported at 0 to 42 DIM (Mahendran et al., 2017), with a peak occurring at 60 to 150 DIM (Green et al., 2002) and claw lesions have been shown to become more severe 60 to 90 DIM (Leach et al., 1997; Holzhauer et al., 2006, 2008). Sole hemorrhages and sole ulcers, have a strong positive association with the period 61 to 120 DIM (Vaarst et al., 1998), with a majority (66%) of sole ulcers occurring before 100 DIM (Collick et al., 1989). Furthermore, Holzhauer et al. (2006) showed that 30 to 60 DIM was positively associated with DD.

The recommendation to trim at least 2 times per lactation or year is supported by several studies (Manske et al., 2002a; Åkerström et al., 2024), but there is limited scientific evidence of when in lactation these trimming occasions are most beneficial to perform (Sadiq et al., 2020; Pedersen et al., 2022). Studies on the optimal timing of hoof trimming reveal varied outcomes. Trimming in early lactation (60–100 DIM) has been associated with a 50% reduction in herd lameness prevalence (Griffiths et al., 2018), and a mid lactation trim (204 DIM) decreased lameness incidence later in lactation (Hernandez et al., 2007). A precalving trim (3 wk prior) for heifers was linked to a significantly higher lameness prevalence at 100 DIM in their first lactation (Mahendran et al., 2017). Trimming around dry-off (90–31 d before calving or within 100 d before dry-off respectively) showed benefits, reducing lameness risk and sole ulcers in the following lactation (Thomsen et al., 2019; Daros et al., 2019). Although these studies have investigated trimming in specific periods of lactation, the comparisons are made against not trimming and to the best of our knowledge there are no studies comparing timing of 2 or more trimming occasions in different periods of lactation to each other and what is most beneficial for hoof health and survival. Using the same dataset as in Åkerström et al. (2024), this study aimed to address this knowledge gap by investigating the timing of 2 hoof trimmings in the first lactation and when it is most beneficial to perform these to enhance hoof health and survival in the second lactation.

MATERIALS AND METHODS

Study Herds

The same dataset that was investigated in the study by Åkerström et al. (2024) was used in the present study and, hence, the selection of herds is described in Åkerström et al. (2024). In brief, all farms with a freestall barn in the Växa cow database with a herd size of ≥200 cows and trimming records from 2015 to 2018 were included in the study. In this study, exposure was comprised of the timing of hoof trimmings during first lactation in relation to first and second calving (days from first calving to first trimming and days from last trimming to second calving) and the outcomes considered were hoof health and survival in second lactation.

Study Animals

Cows considered eligible for inclusion were primiparous cows with a second calving (n = 77,922) that had 2 trimming occasions during first lactation (n = 25,248). Moreover, these primiparous cows should also have (1) no hoof trimming before first calving, (2) an interval between first and second calving of <475 d, and (3) hoof trimming within 90 d after second calving. After applying the inclusion criteria 10,349 cows remained in the dataset (Figure 1). Only primiparous cows were included in the analysis to reduce potential bias from prior claw lesions and to make the association between hoof trimming and claw lesions and survival clearer. Inclusion criterion (1) was implemented to enhance group homogeneity regarding claw lesions, thereby reducing the likelihood that enrolled cows had previously undergone preventive or therapeutic trimming that could affect the outcomes. Criterion (2) aimed to further standardize the study population, based on the assumption that primiparous cows with atypically long first lactation may differ significantly from those with a more normal first lactation length. Lastly, criterion (3) ensured that cows were at a comparable stage of lactation, thereby mitigating the influence of temporal factors.

Data on breed (Swedish Red [**SR**], Swedish Holstein [**SH**], SR×SH crosses, and all other breeds and crosses), calving date, and culling (death, euthanized, or slaughtered) for these cows throughout the study period 2015 to 2018 were retrieved from the Swedish Official Milk Recording Scheme (**SOMRS**) database. The motivation of the first 3 inclusion criteria is described in Åkerström

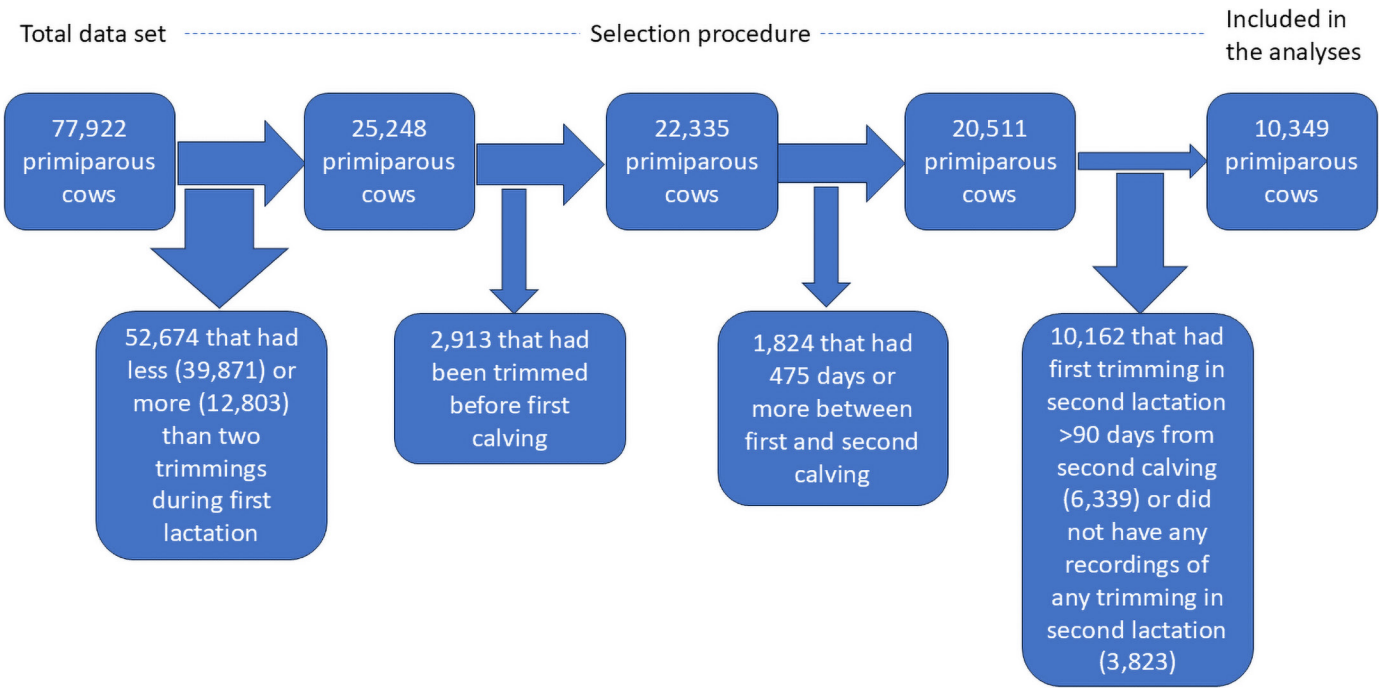

Figure 1. Flowchart showing the procedure used for selection of primiparous cows from 202 Swedish dairy herds to be included in statistical analysis of associations between timing of hoof trimming in first lactation and hoof health and survival in second lactation.

et al. (2024). The decision to select primiparous cows with 2 trimmings in first lactation is based on the results of Åkerström et al. (2024), which show that 2 (or 3) trimmings are the most beneficial for hoof health and survival in second lactation compared with none, one, or more than 3 trims, and that 2 trimmings are, at least in Sweden, the most common practice (Växa, 2025).

For the outcome "survival in second lactation," only culling up to 300 d after second calving was included, as later decisions on culling would probably be less affected by hoof trimming during first lactation.

Hoof-Trimming Data

All records from the hoof-trimming data obtained from SOMRS for the study period followed the Nordic Claw Atlas definitions (Nordic Cattle Genetic Evaluation, 2020) and were voluntarily reported by Swedish hoof trimmers to the Swedish National Database on Hoof Health (**SNDHH**), which is managed by Växa. Claw lesions recorded by hoof trimmers throughout the period 2015 to 2018 and categories of lesions used in statistical analyses are presented in Table 1. Claw lesions were categorized into 3 major groups: infectious claw lesions (located in the skin of lower legs, and related to infective agents or poor hygiene), claw horn lesions (located in the claw horn, and related to trauma or animal-based risk factors related to the internal structure and function of the claw), and other claw lesions (deviant claw conformation, leg injury, lameness for unknown reasons), as described in the Nordic Claw Atlas (Nordic Cattle Genetic Evaluation, 2020). A further subdivision of mild and severe was made for infectious claw lesions and claw horn lesions based on the likelihood of the lesions to induce lameness.

Professional hoof trimmers in Sweden are generally certified, meaning that their trimming technique and theoretical knowledge is scrutinized in theoretical and practical examinations, respectively. The recommended, and most used, trimming method is the Dutch Five-Step Method (Toussaint Raven et al., 1985), with the modification of greater modeling of the sole at the typical sole ulcer site. Swedish hoof trimmers use a grinder with a range of discs (125–150 mm diameter, 2–6 welded blades).

Data Editing

All data from SOMRS and SNDHH (breed, calving dates, hoof-trimming records) were obtained as .dct files. These files were imported into Stata (release 17.0; StataCorp. LLC) and merged by the unique cow identity (herd ID, animal ID, and birth year).

As previously described in Åkerström et al. (2024) the number of trimmings per cow was calculated and for this study only primiparous cows that received no trimming

Table 1. Categories and descriptions of recorded claw lesions used in this study

Category	Claw lesion status
Healthy	Cows with reported hoof trimming without any claw lesions
Severe infectious claw lesions	Digital dermatitis (includes M1, M2, M4.1 [Döpfer et al., 1997; Berry et al., 2012]), foot rot, interdigital hyperplasia, chronic dermatitis/wart growth (includes M4)
Mild infectious claw lesions	Mild dermatitis (interdigital dermatitis), heel horn erosion
Severe claw horn lesions	Sole ulcer, toe ulcer, white line ulcer or abscess
Mild claw horn lesions	White line lesion, double sole, chronic laminitis or laminitic ring, sole hemorrhage
Other	Asymmetric claw, scissor claw, overgrown claws, corkscrew claw, hock lesion, lameness

before their first calving and 2 trimmings in first lactation were included in the statistical analyses.

The timing of the first and second trimming were each categorized into 3 periods: "early first" <61 d after first calving, "mid first" 61 to 120 d after first calving, and "late first" >120 d after first calving; and "early second" >120 d before second calving, "mid second" 120 to 61 d before second calving, and "late second" <61 d before second calving, respectively (Figure 2). These were then combined, making the explanatory variable "time of trimming in first lactation," a variable with 9 categories with the different combinations of time of trimming of first and second trimming in first lactation. The choice of these intervals was based on the need to have enough observations for each combination of first and second trimming and that a 30 d/monthly interval was an easy comprehendible interval. Moreover, a variable with months between first and second trimming in first lactation (i.e., days between trimmings categorized into months) which contained 5 categories: <4 (<120 d), 4 (120–149 d), 5 (150–179 d), 6 (180–209 d), and >6 (>209 d) months was constructed. Hoof health at first and second trimming in first lactation, as well as hoof health at first trimming in second lactation (as explanatory variable), were categorized to "healthy (no lesions)," "mild lesions" (mild dermatitis, heel horn erosion, chronic laminitis or laminitic ring, double sole, sole hemorrhage, and white line lesion), "severe lesions" (wart growth, digital dermatitis, foot rot, interdigital hyperplasia, sole ulcer, toe ulcer, white line ulcer or abscess, and "other remarks" (asymmetry, scissor claw, hock lesion, overgrown claw, corkscrew claw, lameness).

Statistical Analyses

Descriptive statistics were used to describe the distributions of primiparous cows with a certain timing of hoof trimmings in first lactation, number and type of claw lesions at first trimming in second lactation, and the total number of cows culled and per culling reason (using the "tabulate" command in Stata).

As there were few explanatory variables included in each model, and because the focus was not on the univariable unadjusted associations, a univariate analysis was not performed. We also chose not to include herd characteristics, as the aim was not to investigate associations between herd types and the outcomes; however, we did include herd as a cluster or random factor to adjust for these in the model. All included cows were primiparous, thus there was no need to adjust for parity. However, because previous Swedish studies have shown an association between breed and claw lesions (Manske, 2002; Bergsten et al., 2015) breed was included as an explanatory variable (SH, SR, SH×SR cross breeds, and all other breeds).

The outcome "hoof health at first trimming within 90 d from second calving" was first analyzed in a multivariable mixed-effect logistic regression model (hereafter referred to as the L1 model), with the outcome coded as healthy (i.e., no claw lesions) or not (i.e., having one or more claw lesions). It also included the timing of trimming, months between the 2 trimmings, hoof health at first and second trimming in first lactation, hoof health at first trimming in second lactation, and breed as explanatory variables, and retained if $P < 0.05$. Herd was included as a random effect using an independent variance-covariance structure of the random effects equation ("melogit" command in Stata). To investigate specific associations between the different categories of claw lesions (outcome) in Table 1 (healthy, mild infectious claw lesions, mild claw horn lesions, both mild infectious and mild claw horn lesions, severe infectious claw lesions, severe claw horn lesions, both severe infectious and severe claw horn lesions, and other lesions) and timing of trimming, months between the 2 trimmings, hoof health at first and second trimming in first lactation, hoof health at first trimming in second lactation, and breed (as explanatory variables), a multivariable multinomial logistic regression model (ML1 model) was used. Standard errors in the ML1-model were adjusted for repeated measurements within herd ("mlogit" command in Stata with herd as cluster sandwich estimator). All 2-way interactions between the explanatory variables were investigated in both the L1 and ML1 models and retained if $P < 0.05$. To graphically describe the associations found in the L1 and ML1 models, mean predicted probabilities were obtained using the "margins" command in Stata after running the model.

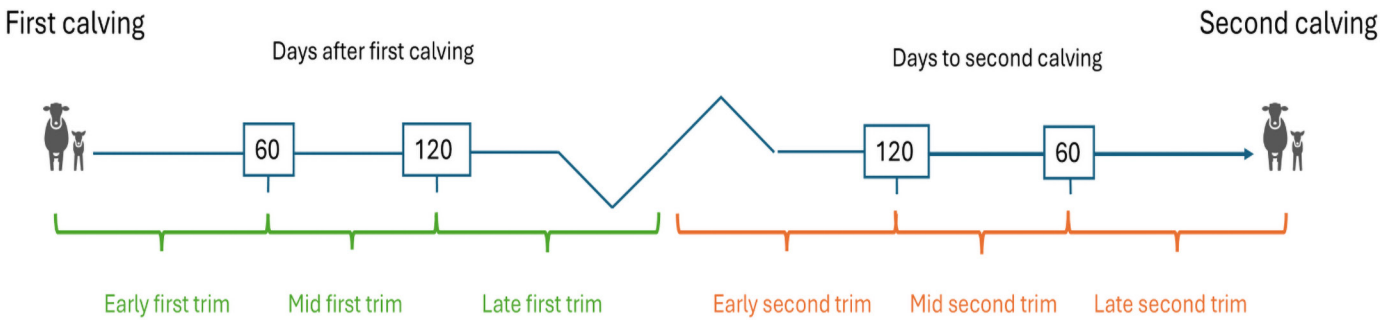

Figure 2. Categorization of timing of the first and second trimming occasions in first lactation: "early first" (<61 d after first calving), "mid first" (61–120 d after first calving), and "late first" (>120 d after first calving) and "early second" (>120 d before second calving), "mid second" (120–61 d before second calving), and "late second" (<61 d before second calving).

The outcome "culling in second lactation within 300 da after second calving" was initially analyzed using a multivariable mixed-effect logistic regression model (L2 model), which included timing of trimming, months between the 2 trimmings, hoof health at first and second trimming in first lactation, hoof health at first trimming in second lactation, and breed as explanatory variables, and retained if $P < 0.05$. Herd was included as a random effect using an independent variance-covariance structure of the random effects equation ("melogit" command in Stata). To investigate specific associations between the different reasons for culling (outcome; not culled, i.e., cows surviving second lactation), mortality [death on-farm or euthanasia], slaughtered with the primary reason being "claw and leg disorder," slaughtered for "other reason"), and time of trimming, months between the 2 trimmings, hoof health at first and second trimming in first lactation, hoof health at first trimming in second lactation, and breed (explanatory variables), a multivariable multinomial logistic regression model (ML2 model) was used. Standard errors in the ML2 model were adjusted for repeated measurements within herd ("mlogit" command in Stata with herd as cluster sandwich estimator). Hoof health status at the first trimming after second calving (suffering from a claw lesion or not) was also included as an explanatory variable in both the L2 and ML2 models, to adjust for that effect (intervening factor) and to prevent it disguising the effect of time to trimming in first lactation on culling in second lactation. Moreover, all 2-way interactions between the explanatory variables were investigated in both the L2 and ML2 models and retained if $P < 0.05$. To graphically describe the associations found between the time of trimmings and culling in second lactation, mean predicted probabilities were obtained using the "margins" command in Stata 17.0 after the model was run.

Model fit of the L1 and L2 models was tested through a visual examination of diagnostic plots (of observed and predicted outcomes) and, based on Dohoo et al. (2010), normal plots of the standardized residuals and the predicted mean. There is no standard method for assessing the fit of multinomial logistic regression models, and therefore the fit of the ML1 and ML2 models was not assessed. However, the results were similar to those obtained with the L1 and L2 models, thereby indicating that they were robust.

RESULTS

Descriptive Statistics

Descriptive data about the herds and trimmers are presented in Åkerström et al. (2024). In total, 185 herds comprised of 10,349 cows that fulfilled the selection criteria were included in the analysis.

The distribution of the time of the first and second trimming in the first lactation is presented in Supplemental Figure S1 (See Notes). The mean time to first trimming after first calving was 91 d (SD = 64 d, median = 78 d, CR = 41–129 d) and mean time from second trimming to second calving was 119 d (SD = 47 d, median = −117 d, CR = −149 to −86 d). The most common combination of trimmings (28% of the cases) was to have an early first and early second trim (Table 2).

The timing of the 2 trimmings during first lactation and recorded claw lesions at first trimming after second calving are displayed in Table 3. The highest proportion (67%) of cows considered as healthy (i.e., no claw lesions) at the first trimming after second calving were cows with a mid first and mid second trim, and the lowest proportion of healthy (51%) cows were those with a late first and late second trim.

The distribution of the number of cows with different days to trimming combinations during first lactation and whether they were culled or not at second lactation is presented in Table 4. The numerically highest proportion (20%) of cows that were culled (dead, euthanized, or slaughtered) were those with a late first trim, indepen-

Table 2. Distribution of cows with different timing of first and second trimmings for primiparous cows trimmed twice during first lactation (n = 10,349 cows across 185 dairy herds)

	Days before second calving			
Days after first calving	Early second trim >120 (μ = 159)	Mid second trim 61 to 120 (μ = 93)	Late second trim <61 (μ = 42)	Total
Early first trim <61 (μ = 31)	2,855	1,023	101	3,979
Mid first trim 61 to 120 (μ = 88)	1,484	1,716	222	3,422
Late first trim >120 (μ = 175)	502	1,776	670	2,948
Total	4,841	4,515	993	10,349

dent of when the second trimming occurred, whereas the lowest proportion (13%) were cows with an early first and mid second trim.

Hoof health at the first and second trimming occasion in first lactation is presented in Supplemental Table S1 and S2 (see Notes). Overall, 59% and 61% of the cows were considered healthy (no claw lesions) at each trimming, respectively.

Of the 10,349 primiparous cows included in the analysis, 61% were of SH breed, 29% SR breed, 8% SR×SH crossbreed, and 2% other breeds.

Associations with Hoof Health in Second Lactation: L1 Model

A summary of the results is presented below and the full version with all pairwise comparisons in the L1 model is presented in Supplemental Data S1 and Supplemental Table S3 (see Notes). Only statistically significant associations are presented.

The results from the L1 model evaluating the association between the timing of trimming in first lactation and hoof health at first trimming in second lactation (outcome: presence or absence of claw lesions) are presented in Supplemental Table S3. The random effect of herd was significant, and visual examination of the model fit showed a good fit of the data.

Timing of Trimming. Cows with the combination late first and late second trim had higher odds of having claw lesions at first trimming in second lactation compared with those subjected to all other timing combinations, except for cows with the combination mid first and late second trim. (Supplemental Table S3; Figure 3). Moreover, cows with a late first and mid second trim, or a mid first and late second trim, had higher odds of having claw lesions at first trimming in second lactation compared with cows with an early first and early or mid second trim, or a mid first and early or mid second trim (Supplemental Data S1).

Time Between Trimmings. Cows with <4, 5, 6, or >6 mo between trimmings in first lactation had an increased likelihood of having claw lesions at first trimming in second lactation compared with those with 4 mo between trimmings in first lactation (Supplemental Table S3).

Hoof Health at Trimmings in First Lactation. Moreover, cows with claw lesions at first or second trimming in first lactation had an increased likelihood of claw lesions at first trimming in second lactation compared with cows without claw lesions at first or second trimming in first lactation (Supplemental Table S3). Further, cows with severe claw lesions or other remarks at first trimming, and cows with severe claw lesions at second trimming in first lactation, had higher odds of having claw lesions at first trimming in second lactation compared with cows with only mild claw lesions at first or second trimming in first lactation, respectively (Supplemental Data S1).

Associations with Hoof Health in Second Lactation: ML1 Model

A summary of the results is presented below and the full version with all pairwise comparisons in the ML1 model is presented in Supplemental Data S2 (see Notes) and in Supplemental Table S4 (see Notes). Only significant ($P < 0.05$) associations are presented. The time between trimmings was not significant overall but was included as a confounder because it affected the estimates as such.

The ML1 analysis of the association between the timing of trimmings in first lactation and different outcome categories (no claw lesions; i.e., healthy, mild infectious claw lesion, mild claw horn lesions, both mild infectious and mild claw horn lesions, severe infectious claw lesions, severe claw horn lesions, both severe infectious and severe claw horn lesions, and other lesions) revealed significant associations (Supplemental Table S4; Figure 4). Model-predicted probabilities of a cow having no lesions or different claw lesion types are presented in Figure 4 to facilitate interpretation of the results. The results from the ML1 model showed that the mean predicted probability of not having claw lesions was lowest for cows that had a late first and late second trim (Figure 4A).

Mild Infectious Claw Lesions and Timing of Trimming. Cows with a late first and late second trim had higher

Table 3. Timing of first and second trimmings in first lactation and number (%) of recorded claw lesions at cow level at first trimming within 90 d after second calving for cows with a calving interval of 475 d or less (n = 10,349 cows across 185 dairy herds)[1]

	Combination of 2 trimming periods in first lactation									
Claw lesion type	Early first + early second	Early first + mid second	Early first + late second	Mid first + early second	Mid first + mid second	Mid first + late second	Late first + early second	Late first + mid second	Late first + late second	Total
Healthy (no claw lesions)	1,792	641	67	946	1,158	133	298	989	339	6,360
	(63)	(63)	(66)	(64)	(67)	(59)	(59)	(56)	(51)	(61)
Mild infectious claw lesion[2]	284	107	10	145	163	34	47	203	75	1,068
	(10)	(10)	(10)	(10)	(9)	(15)	(9)	(11)	(11)	(10)
Mild claw horn lesion[3]	185	68	9	132	127	17	36	144	65	783
	(6)	(7)	(9)	(9)	(7)	(8)	(7)	(8)	(10)	(8)
Mild infectious claw lesion and mild claw horn lesion	142	46	4	77	62	7	41	125	57	561
	(5)	(4)	(4)	(5)	(4)	(3)	(8)	(7)	(8)	(5)
Severe infectious claw lesion[4]	334	120	8	131	139	28	50	220	80	1,110
	(12)	(12)	(8)	(9)	(8)	(13)	(10)	(12)	(12)	(11)
Severe claw horn lesion[5]	62	24	3	24	40	4	16	51	34	258
	(2)	(2)	(3)	(2)	(2)	(3)	(3)	(3)	(5)	(2)
Severe infectious claw lesions and severe claw horn lesions	4	8	0	2	8	2	0	10	9	43
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(0)
Other[6]	48	13	0	24	21	1	10	34	15	166
	(2)	(1)	(0)	(2)	(1)	(0)	(2)	(2)	(2)	(2)
Total	2,855	1,023	101	1,484	1,716	222	502	1,776	670	10,349

[1]Timing of first and second trimmings were each categorized into 3 periods: "early first" <61 d after first calving, "mid first" 61–120 d after first calving, and "late first" >120 d after first calving; and "early second" >120 d before second calving, "mid second" 120–61 d before second calving, and "late second" <61 d before second calving, respectively.

[2]Mild dermatitis and heel horn erosion.

[3]Chronic laminitis or laminitic ring, double sole, sole hemorrhage, and white line lesion.

[4]Wart growth, digital dermatitis, foot rot, and interdigital hyperplasia.

[5]Sole ulcer, toe ulcer, white line ulcer/abscess.

[6]Asymmetry, scissor claw, hock lesion, overgrown claw, corkscrew claw, lameness.

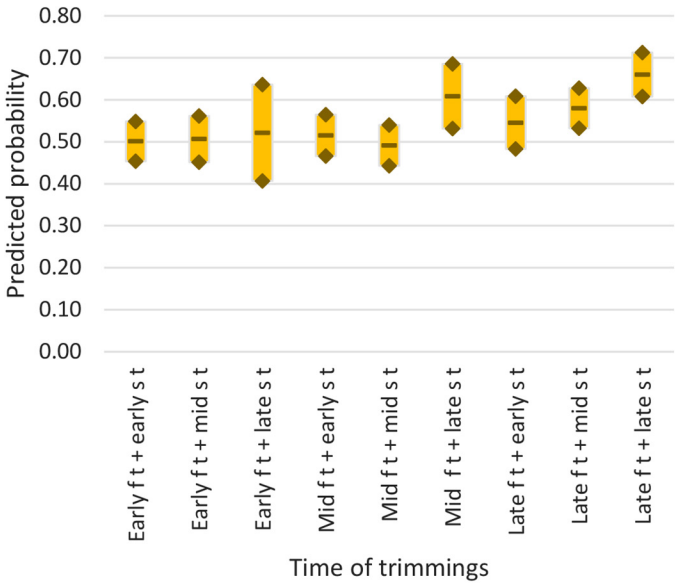

Figure 3. Mean predicted probabilities (line), adjusted for breed, time between trimmings, and herd, and 95% CI (diamond) in the L1 model for a cow having claw lesions at the first trimming in second lactation depending on when trimmings occurred in first lactation (early, mid, or late first trim [f t], and early, mid, or late second trim [s t]; n = 10,349 cows in 185 dairy herds).

relative risk ratio (**RRR**) for having mild infectious claw lesions at first trimming in second lactation compared with cows with an early first and early second trim or a mid first and early or mid second trim (Supplemental Table S4; Figure 4B). Moreover, the likelihood of mild infectious claw lesions at first trimming in second lactation was increased for cows with a late first and mid second trim or mid first and late second trim compared with cows with a mid first and mid second trim (Supplemental Data S2).

Mild Infectious Claw Lesions and Hoof Health at Trimmings in First Lactation. Furthermore, cows with claw lesions at first or second trimming in first lactation had higher RRR for having mild infectious claw lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). Moreover, cows with mild claw lesions at second trimming in first lactation had higher RRR for having mild infectious claw lesions at first trimming in second lactation than cows with severe claw lesions at second trimming in first lactation (Supplemental Data S2).

Mild Infectious Claw Lesions and Breed. In addition, cows of the SR and the SR×SH breeds had lower RRR for having mild infectious claw lesions at first trimming in second lactation compared with cows of the SH breed (Supplemental Table S4), and the RRR for having mild infectious claw lesions was higher for cows of the SR breed and the SR×SH breed compared with cows of other breeds (Supplemental Data S2).

Table 4. Timing of first and second trimmings (%) in first lactation and culling during second lactation for cows with a first trimming in second lactation within 90 d and a calving interval of 475 d or less (n = 10,349 cows in 185 dairy herds)[1]

	Combination of 2 trimming periods in first lactation								
	Early first + late second	Early first + mid second	Early first + early second	Mid first + late second	Mid first + mid second	Mid first + early second	Late first + late second	Late first + mid second	Late first + early second	Total
Not culled	2,453	885	82	1,278	1,478	186	400	1,420	534	8,716
	(86)	(87)	(81)	(86)	(86)	(84)	(80)	(80)	(80)	(84)
Mortality (dead or euthanized on farm)	74	22	4	36	43	7	12	45	20	263
	(3)	(2)	(4)	(2)	(2)	(3)	(2)	(2)	(3)	(3)
Slaughter with primary reason being claw and leg disorders	28	8	4	15	10	4	9	43	24	145
	(1)	(1)	(4)	(1)	(1)	(2)	(2)	(2)	(4)	(1)
Slaughter for other reasons	300	108	11	155	185	25	81	268	92	1,225
	(10)	(11)	(11)	(10)	(11)	(11)	(16)	(15)	(14)	(12)
Total	2,855	1,023	101	1,484	1,716	222	502	1,776	670	10,349

[1]Timing of first and second trimmings were each categorized into 3 periods: "early first trim" <61 d after first calving, "mid first trim" 61–120 d after first calving, and "late first trim" >120 d after first calving; and "early second trim" >120 d before second calving, "mid second trim" 120–61 d before second calving, and "late second trim" <61 d before second calving, respectively.

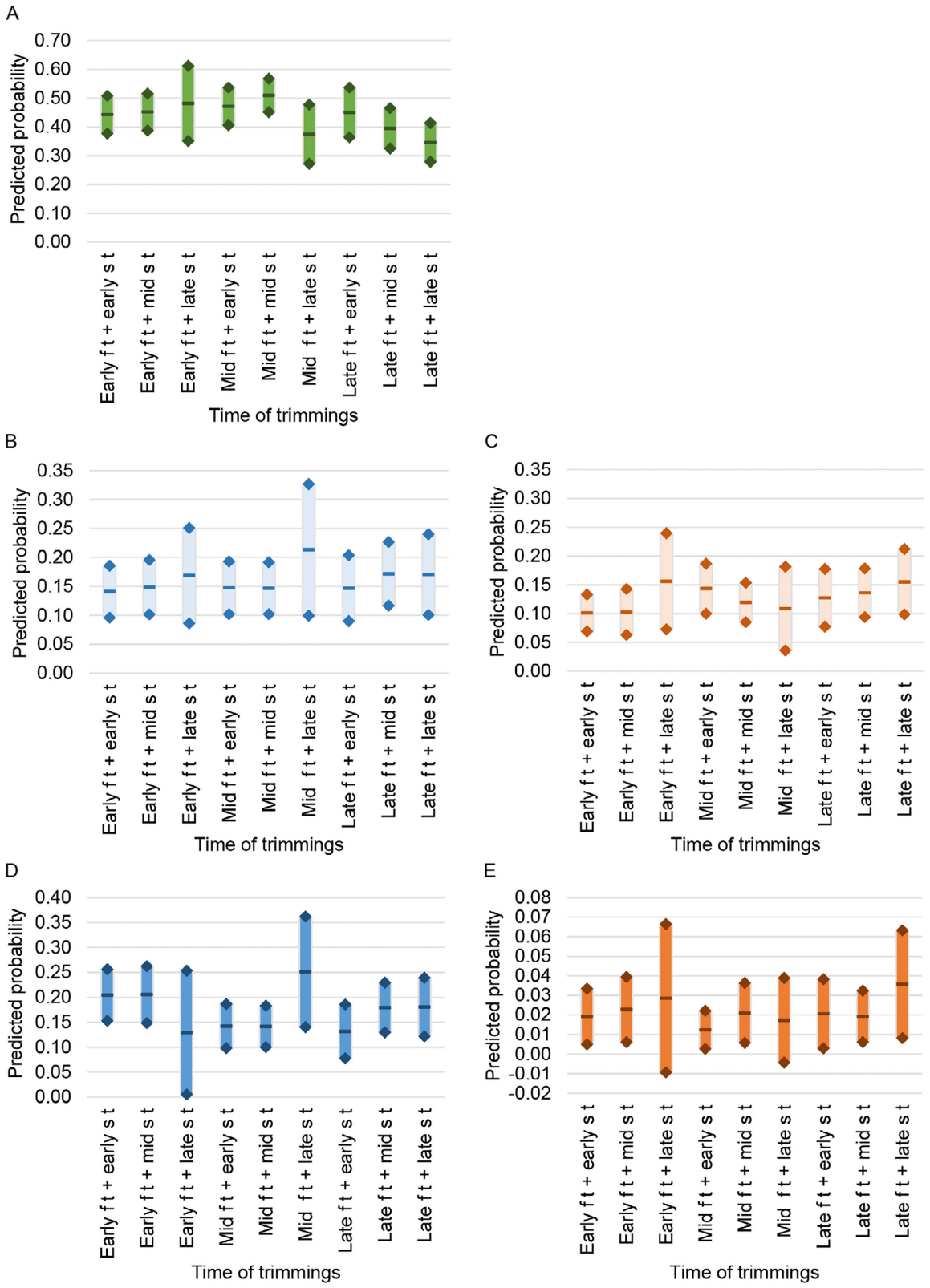

Figure 4. Mean predicted probabilities (line), adjusted for time between trimmings, breed and herd effects, and 95% CI (diamond) in the ML1 model for a cow having (A) no claw lesions, (B) mild infectious claw lesions, (C) mild claw horn lesions, (D) severe infectious claw lesions, or (E) severe claw horn lesions at first hoof trimming in the second lactation depending on time of trimmings (early, mid, or late first trim [f t] and early, mid, or late second trim [s t]) in the first lactation (n = 10,349 cows in 185 dairy herds). Note the different scales on the y-axis depending on outcome.

Mild Claw Horn Lesions and Timing of Trimming. Cows with a late first and late second trim had higher RRR for having mild claw horn lesions at first trimming in second lactation compared with cows with an early first and early or mid second trim, and for cows with a mid first and early or mid second trim (Supplemental Table S4; Figure 4C). Furthermore, the likelihood of mild claw horn lesions at first trimming in second lactation was increased for cows with a late first and mid second trim compared with cows with an early first and early or mid second trim, and cows with a mid first and mid second trim (Supplemental Data S2). Moreover, cows with a mid first and early second trim had higher RRR for having mild claw horn lesions at first trimming in second lactation compared with cows with an early first and early second trim (Supplemental Data S2).

Mild Claw Horn Lesions and Hoof Health at Trimmings in Early Lactation. In addition, cows with claw lesions at first or second trimming in first lactation had higher RRR for having mild claw horn lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). Cows with other remarks at first trimming in first lactation had higher RRR for having mild claw horn lesions at first trimming in second lactation compared with cows with severe claw lesions at first trimming in first lactation (Supplemental Data S2). This was also seen for cows with mild claw lesions or other remarks at second trimming in first lactation compared with cows with severe claw lesions at second trimming in first lactation, and for cows with other remarks at second trimming in first lactation compared with cows with mild claw lesions at second trimming in first lactation (Supplemental Data S2).

Both Mild Infectious and Mild Claw Horn Lesions and Time of Trimmings. Cows with a late first and late second trim had higher RRR for having both mild infectious and mild claw horn lesions at first trimming in second lactation compared with cows with an early first and early, mid, or late second trim, and for cows with a mid first and early, mid, or late second trim (Supplemental Table S4). Moreover, cows with a late first and mid second trim had higher RRR than cows with an early first and early or mid second trim, or a mid first and early, mid, or late second trim (Supplemental Data S2). Cows with a late first and early second trim had a higher RRR than cows with an early first and mid second trim, or a mid first and early or mid second trim (Supplemental Data S2). The RRR was also higher for cows with a mid first and early second trim compared with cows with a mid first and mid second trim (Supplemental Data S2).

Both Mild Infectious and Mild Claw Horn Lesions and Hoof Health at Trimmings in First Lactation. Cows with claw lesions at first or second trimming in first lactation had higher RRR for having both mild infectious and mild claw horn lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). In addition, the RRR for having both mild infectious and mild claw horn lesions at first trimming in second lactation was higher for cows with mild claw lesions at second trimming in first lactation compared with cows with severe claw lesions or cows with other remarks at second trimming in first lactation (Supplemental Data S2).

Both Mild Infectious and Mild Claw Horn Lesions and Breed. The likelihood of a cow having both mild infectious and mild claw horn lesions at first trimming in second lactation was reduced for cows of other breeds compared with cows of the SH breed (Supplemental Table S4), the SR breed and the SR×SH breed (Supplemental Data S2).

Severe Infectious Claw Lesions and Time of Trimmings. Cows with a late first and late second trim had higher RRR for having severe infectious claw lesions at first trimming in second lactation compared with cows with a mid first and early or mid second trim (Supplemental Table S4; Figure 4D). Furthermore, cows with a late first and mid second trim had higher RRR compared with cows with a mid first and early or mid second, and to cows with a late first and early second trim (Supplemental Data S2). The likelihood of having severe infectious claw lesions at first trimming in second lactation was increased for cows with a mid first and late second trim, or an early first and early second trim, compared with cows with a mid first and early or mid second trim, and to cows with a late first and early second trim (Supplemental Data S2). In addition, cows with an early first and mid second trim had higher RRR for having severe infectious claw lesions than cows with a mid first and early or mid second trim (Supplemental Data S2).

Severe Infectious Claw Lesions and Hoof Health at Trimmings in First Lactation. Furthermore, cows with claw lesions at first or second trimming in first lactation had higher RRR for having severe infectious claw lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). The RRR for having severe infectious claw lesions was also higher for cows with severe claw lesions at first or second trimming in first lactation compared with cow with mild claw lesions (Supplemental Data S2; See Notes). Moreover, the RRR for having severe infectious claw lesions was significantly higher for cows with severe claw lesions at second trimming in first lactation compared with cows with other remarks at second trimming in first lactation (Supplemental Data S2; See Notes).

Severe Infectious Claw Lesions and Breed. In addition, the RRR for a cow having severe infectious claw lesions at first trimming in second lactation was higher for cows of the SR×SH breed compared with cows of the SR breed (Supplemental Data S2).

Severe Claw Horn Lesions and Time of Trimmings. Cows with a late first and late second trim had higher RRR for having severe claw horn lesions at first trimming in second lactation compared with cows with an early first and early or mid second trim, cows with a mid first and early or mid second trim, and cows with a late first and mid second trim (Supplemental Table S4; Figure 4E). The RRR for having severe claw horn lesions was also higher for cows with a late first and mid second trim than cows with a mid first and early second trim (Supplemental Data S2).

Severe Claw Horn Lesions and Hoof Health at Trimmings in First Lactation. Furthermore, cows with mild or severe claw lesions at first trimming in first lactation had higher RRR for having severe claw horn lesions at first trimming in second lactation compared with cows without claw lesions (Supplemental Table S4; see Notes). The RRR for having severe claw horn lesions was also higher for cows with severe claw lesions compared with cow with mild claw lesions (Supplemental Data S2). In addition, cows with claw lesions at second trimming in first lactation had higher RRR for having severe claw horn lesions at first trimming in second lactation compared with cows without claw lesions at second trimming in first lactation (Supplemental Table S4).

Severe Claw Horn Lesions and Breed. Moreover, the likelihood for a cow to have severe claw horn lesions at first trimming in second lactation was decreased for cows of other breeds compared with cows of the SH breed (Supplemental Table S4) and the SR×SH breed (Supplemental Data S2).

Both Severe Infectious and Severe Claw Horn Lesions and Time of Trimmings. No significant associations were found between the timing of trimming and the occurrence of both severe infectious and severe claw horn lesions at first trimming in second lactation.

Both Severe Infectious and Severe Claw Horn Lesions and Hoof Health at Trimmings in First Lactation. Cows that had mild or severe claw lesions at first or second trimming in first lactation had higher RRR for having both severe infectious and severe claw horn lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). An increase in RRR for having both severe infectious and severe claw horn lesions was also seen for cows with severe claw lesions at first or second trimming in first lactation compared with cow with mild claw lesions at first or second trimming, respectively (Supplemental Data S2).

Other Types of Lesions and Time of Trimmings. No significant associations were found between the timing of trimming and the occurrence of other types of lesions at first trimming in second lactation.

Other Types of Lesions and Hoof Health at Trimmings in First Lactation. Cows with mild claw lesions or other remarks at first or second trimming in first lactation had higher RRR for having other types of claw lesions at first trimming in second lactation compared with cows without claw lesions in first lactation (Supplemental Table S4). Moreover, cows with severe claw lesions at first trimming in first lactation had higher RRR for having other types of claw lesions than cows without claw lesions at first trimming in first lactation (Supplemental Table S4).

Furthermore, cows with mild or severe claw lesions at second trimming in first lactation had lower RRR for having other types of claw lesions for other types of lesions at first trimming in second lactation than cows with other remarks at second trimming in first lactation, as well as cows with severe claw lesions at second trimming in first lactation compared with cows with mild claw lesions at second trimming in first lactation (Supplemental Data S2).

Associations with Culling in Second Lactation: L2 Model

A summary of the results is presented below and the full version with all pairwise comparisons in the L2 model is presented in Supplemental Data S3 (see Notes) and in Supplemental Table S5. Only significant associations are presented ($P < 0.05$).

Timing of Trimming. The odds of being culled during second lactation were higher for cows with a late first and late second trim compared with those with an early first and early or mid second, or a mid first and early or mid second trim (Supplemental Table S5; Figure 5). Moreover, the odds of a cow being culled were higher for cows with a late first and early or mid second trim compared with cows with an early first and early or mid second trim, and for cows with a mid first and early or mid second trim (Supplemental Data S3).

Hoof Health at First Trimming in Second Lactation. The odds of being culled were higher for cows with claw lesions at first trimming in second lactation than for cows without claw lesions at first trimming in second lactation (Supplemental Table S5).

Breed. Cows of the SR breed had an increased likelihood of being culled compared with both SH (Supplemental Table S5) and SR×SH cows (Supplemental Data S3).

Associations with Culling in Second Lactation: ML2 Model

A summary of the results is presented below and the full version with all pairwise comparisons in the ML2 model is presented in Supplemental Data S4 (see Notes) and Supplemental Table S6 (see Notes). Only significant associations are presented ($P < 0.05$).

The ML2 model displayed significant associations between the timing of trimming in first lactation and

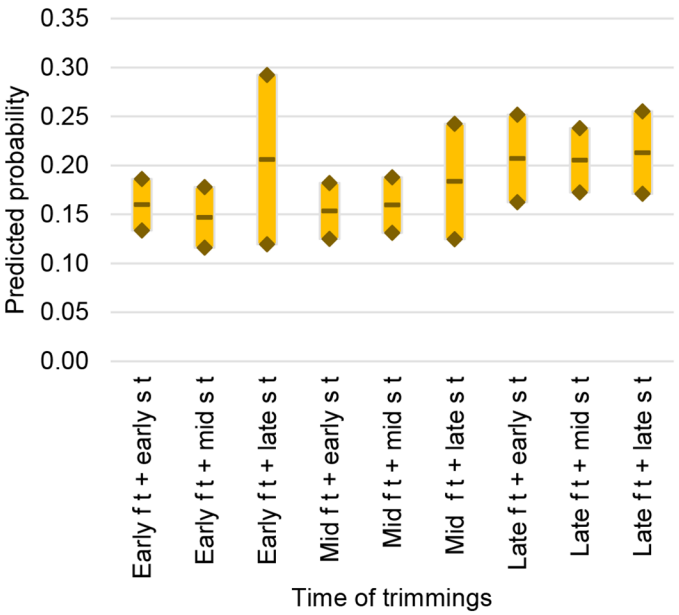

Figure 5. Mean predicted probabilities (line), adjusted for breed, presence of claw lesions at first trimming in second lactation, and herd, and 95% CI (diamond) in the L2 model of being culled in the second lactation depending on when trimmings occurred in first lactation (early, mid, or late first trim [f t] and early, mid or late second trim [s t]; n = 10,349 cows in 185 dairy herds).

the outcome categories not being culled, dead, or euthanized on-farm (mortality), slaughtered with the primary reason being "claw and leg disorders," and slaughtered for "other reasons" (Supplemental Table S6). Predicted probabilities from the model are presented in Figure 6 to facilitate interpretation of the results. The results from the ML2 model showed that the mean predicted probability of not being culled was lowest for cows that had a late first and early, mid, or late second trim (Figure 6A).

Mortality and Time of Trimmings. The results from the ML2 model showed no association between the timing of trimmings in first lactation and mortality (dead on farm or euthanized; Supplemental Table S6).

Mortality and Hoof Health at Second Trimming in First Lactation. The results showed no association between hoof health at second trimming in first lactation and mortality (dead on farm or euthanized; Supplemental Table S6).

Mortality and Hoof Health at First Trimming in Second Lactation. Cows with severe claw lesions or other remarks at first trimming in second lactation had a higher RRR of death or euthanasia on-farm, than cows without claw lesions at first trimming in second lactation (Supplemental Table S6).

Mortality and Breed. Moreover, cows of the SR breed had a lower RRR of death and euthanasia on-farm than cows of the SH breed (Supplemental Table S6).

Slaughter Due to Claw and Leg Disorders and Time of Trimmings. Cows with a late first and late second trim had higher RRR for being sent to slaughter with the primary reason being "claw and leg disorder" compared with cows with an early first and early or mid second trim, and cows with a mid first and early or mid second trim (Supplemental Table S6). Moreover, cows with a late first and mid second trim, or an early first and late second trim, had higher RRR for being sent to slaughter with the primary reason being "claw and leg disorder" compared with cows with an early first and early or mid second trim, and for cows with a mid first and early or mid second trim (Supplemental Data S4, see Notes).

Slaughter Due to Claw and Leg Disorders and Hoof Health at Second Trimming in First Lactation. Cows with severe claw lesions at second trimming in first lactation or severe claw lesions at first trimming in second lactation had higher RRR of being sent to slaughter for "claw and leg disorder" than cows without claw lesions and cows with mild claw lesions at second trimming in first lactation (Supplemental Data S4).

Slaughter Due to Other Reasons and Time of Trimmings. Cows with a late first and late second trim had higher RRR for being sent to slaughter for "other reason" compared with cows with an early first and early second trim (Supplemental Table S6). Moreover, cows with a late first and early or mid second trim had higher RRR for being sent to slaughter for "other reason" compared with cows with an early first and early or mid second trim, and for cows with a mid first and early or mid second trim (Supplemental Data S4).

Slaughter Due to Other Reasons and Hoof Health at Second Trimming in First Lactation. Cows with mild claw lesions or other remarks at second trimming in first lactation had a higher RRR of being sent to slaughter for "other reasons" than cows with severe claw lesions at second trimming in first lactation (Supplemental Data S4).

Slaughter Due to Other Reasons and Hoof Health at First Trimming in Second Lactation. Moreover, cows with mild or severe claw lesions at first trimming in second lactation had a higher RRR of being sent to slaughter for "other reasons" than cows without claw lesions at first trimming in second lactation (Supplemental Table S6).

Slaughter Due to Other Reasons and Breed. The RRR for a cow being sent to slaughter for "other reasons" was higher for SR cows than SH cows (Supplemental Table S6) and SR×SH cows (Supplemental Data S4).

DISCUSSION

The results show that the timing of trimming in first lactation is associated with both hoof health and survival in early second lactation. In general, trimming

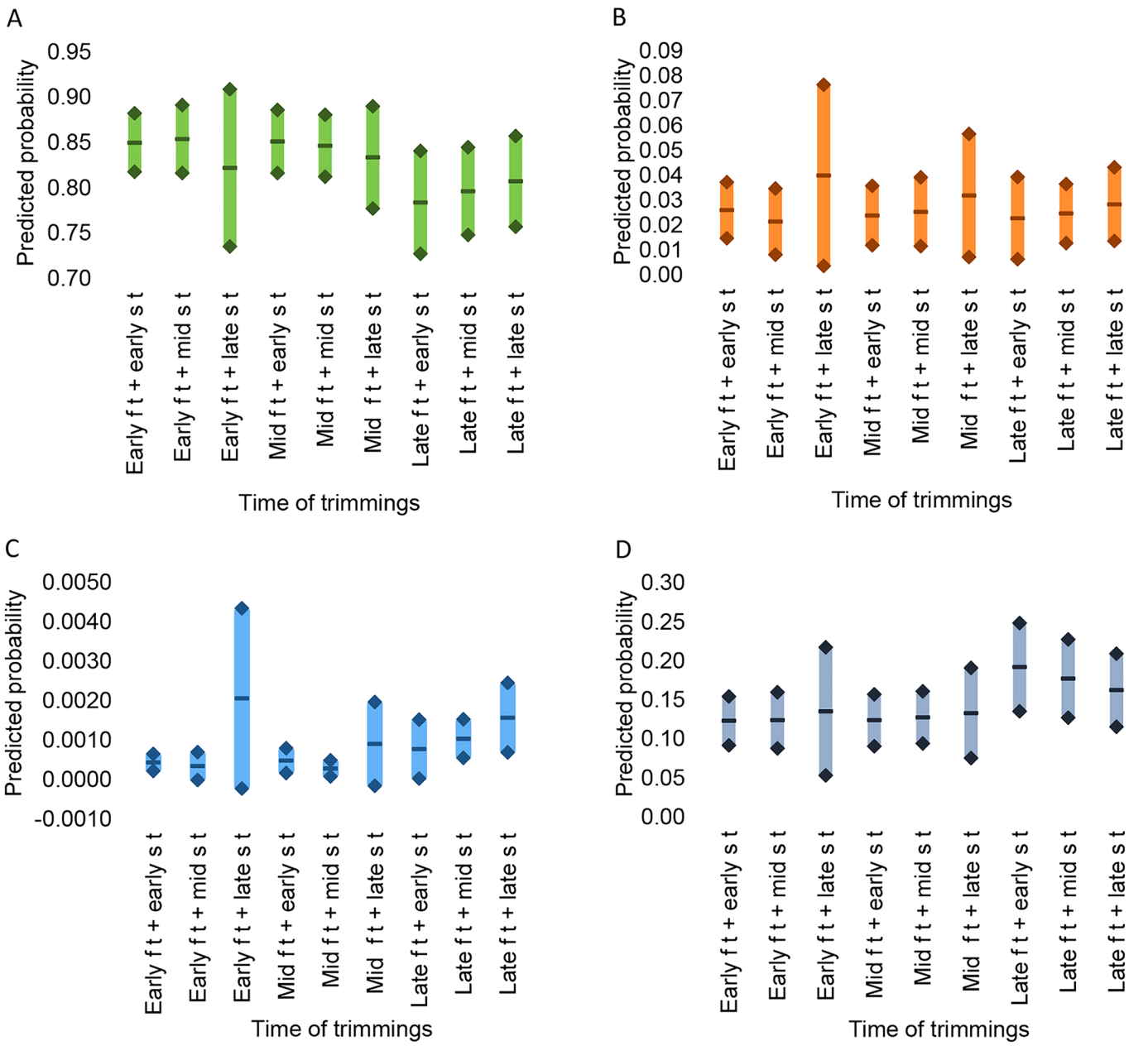

Figure 6. Mean predicted probability (line), adjusted for hoof health at first trimming in second lactation, breed, and herd effects, and 95% CI (diamond) in the ML2 model of (A) not being culled, (B) mortality (dead or euthanized on-farm), (C) sent to slaughter with primary reason being claw and leg disorders, or (D) sent to slaughter for other reasons, in the second lactation depending on time of trimmings (early, mid, or late first trim [f t] and early, mid, or late second trim [s t]) in the first lactation (n = 10,349 cows in 185 dairy herds). Note the different scales on y-axis depending on the outcome.

within 4 mo after first calving and more than 2 mo before second calving seems to be the most beneficial when considering both hoof health and survival in early second lactation. Similar results were seen both when the hoof health and survival outcome were yes or no and when the outcomes were more specific. Concerning severe infectious claw lesions at first trimming in second lactation, there was a slight difference in results. Mid first and early or mid second trim combination were significantly better than late first and late or mid second trim and early first and early or mid second trim (Figure 4D). Considering culling the results were similar for the outcomes "culled due to claw and leg disorders" and "culled due to other reasons," whereas no association between timing of trimming in first lactation and mortality could be seen.

Risk Period of Lameness and Claw Lesions

The notion that the first trimming should occur in early lactation seems logical considering that there are several studies showing that different claw lesions are more common and sometimes also more severe during early lactation. Indeed, Collick et al. (1989) stated that 66% of sole ulcers occurred before 100 DIM, whereas Leach et al. (1997) found that white line lesions were most severe at 63 DIM. Additionally, Vaarst et al. (1998) found a strong association between the presence of claw horn lesions and the time period 61 to 120 DIM, and Holzhauer et al. (2006) stated that both digital dermatitis and sole ulcers are aggravating at 60 to 90 DIM. Ninety percent of all lameness is caused by claw lesions (Eriksson et al., 2020), and there is also scientific support for early lactation being the period with the greatest risk of lameness (Mahendran et al., 2017; Sadiq et al., 2020). Having a trimming occasion in early lactation provides the opportunity to discover and treat lesions before they become chronic or too severe to recover with treatment, which should be beneficial for overall hoof health.

Mahendran et al. (2017) investigated the combination of 2 different trimming occasions. However, in their study, the comparison was made between trimming once, twice, or not trimming at all, and they did not compare different timings of 2 trimming occasions, and thus, it is not completely comparable to the present study. To the best of our knowledge no study has compared 2 or 3 trimming occasions at different points in lactation to each other. This gap in the literature highlights the need for further research with a specific focus on when the best time to trim is.

Although certain studies have investigated trimming in different periods of lactation, the comparisons are made to no trimming at all during these periods which renders it hard to evaluate if the observed positive effect is due to trimming or the specific timing in lactation. Griffiths et al. (2018) also highlighted the importance of an early-lactation trim and found that farms where cows were routinely trimmed in early lactation (60–100 DIM) had a lower proportion of lame cows compared with farms that did not conduct an early-lactation trim. Furthermore, Hernandez et al. (2007) found a lower proportion of lame cows that received a mid lactation trim (204 DIM) compared with those not trimmed at all, so it is hard to determine if the effect of that trimming occasion is linked to the timing of trimming or if it was just an effect of trimming.

Trim at Dry-Off, Hoof Health, and Lameness

Our results indicate that a cow should not be trimmed within the last 60 d before their second calving. Depending on when the cow is dried off, a suitable time to trim, according to our results, could be around dry-off or earlier. There may be a dual purpose to trimming at dry-off. First, it provides a follow up to the previous post calving trim and ensures optimal hoof health and claw conformation before the next transition period and upcoming lactation. Second, it is practical to check feet and enable the possibility of providing treatment to a cow before it is likely moved to another group. Two studies that found positive effects of trimming at dry-off are the studies of Daros et al. (2019) and Thomsen et al. (2019). These studies only included one trimming occasion in the time interval that they studied and compared with no trimming, but cows in both these studies could have been trimmed once or several times earlier in lactation and it is therefore challenging to compare these results to ours.

Ensuring that trimming does not occur too close to second calving ("late second trim") is also a matter of welfare for the pregnant cow, according to the findings of Thomsen et al. (2020), who found a higher risk of abortion if the cows were trimmed within the last 4 wk of gestation. The conclusion about the timing of trimming in the review of Sadiq et al. (2020) of combining one trim 40 to 60 DIM and one trim around dry-off are in line with our results regarding timing, but not regarding the interval between trimmings.

Association of Timing of Hoof Trimming and Culling

There was no association between timing of two trimmings and being euthanized or dying on farm, but there was an association between timing of two trimmings and the risk of being sent to slaughter. In our previous study on the same data set (Åkerström et al., 2024) we found that trimming 2 or 3 times during first lactation, compared with not at all or only once, increased the probability of survival in early second lactation and the number of trimmings is potentially more important for survival than the timing of them in first lactation. To our knowledge, there are no published studies on the timing of trimming and survival, and further studies are necessary to investigate this. However, others have shown that good hoof health at dry-off is important for survival in the upcoming lactation (Machado et al., 2010).

Associations of Hoof Health and Culling

Moreover, severe claw lesions at second hoof trimming in first lactation were associated with increased risk of slaughter due to claw and leg disorders, although not with mortality or risk of being slaughtered due to other reasons. This finding was somewhat unexpected, as such severe lesions have the potential to cause lameness, which prevents cows from being transported to slaughter.

Therefore, in our view, the association with mortality would have been more likely. One possible partial explanation could be that cows with severe hoof lesions receive treatment and recover, but the farmer subsequently decides to cull them to avoid recurrent hoof lesions.

Additionally, claw lesions at first trimming in second lactation increased the likelihood of culling, regardless of trimming timing in first lactation. Booth et al. (2004) also found evidence that lameness in early lactation increased the risk of culling. This finding is consistent with previous research, given that claw and leg disorders have been identified as a common reason for euthanasia on farm in several studies (Thomsen et al., 2004; Alvåsen et al., 2014), and multiple studies have demonstrated an association between claw lesions or lameness and risk of being culled (Sogstad et al., 2007; Cramer et al., 2009).

Trimming Heifers Before Calving

We did not include heifers that were trimmed before first calving, due to a small number of observations and to further reduce the complexity of the statistical analyses. However, others that have investigated the effect of trimming before calving of heifers have shown both advantages (Pedersen, 2024) and disadvantages (Mahendran et al., 2017) compared with not trimming heifers before calving.

Associations with Breed

In general, there were no large differences in our data regarding breed. We found that irrespective of the timing of trimming SR cows typically had a lower risk of claw lesions in early second lactation, but specifically a higher risk of mild infectious claw lesions and other claw lesions at first trimming in second lactation, compared with SH cows. Previous Swedish studies have also shown that SR have better hoof health than SH (Manske et al., 2002b; Bergsten et al., 2015; Åkerström et al., 2024). Regarding culling, SR cows had a higher risk of being slaughtered in early lactation, specifically due to reasons aside from claw and leg disorders. However, mortality was significantly lower for SR cows than for SH cows. A somewhat surprising finding was that SR had a higher risk of being culled in early second lactation, but their lower risk of mortality compared with SH is similar to results from a study comparing mortality between Danish Holstein and Danish Red (Thomsen et al., 2004).

Trimming Interval

We found that a trimming interval during first lactation consisting of less or more than 4 mo between first and second trimming increased the odds of having claw lesions at first trimming in early second lactation. The biological reasoning for this is unknown to us, but Manske et al. (2002a) found a similar interval of 4 to 5 mo to significantly reduce lameness and claw horn disruption lesions in an experimental treatment study where this interval was compared with one of approximately 12 mo.

Practical Implementations in Farms

When implementing trimming in certain time periods during lactation on farms, it is probably more practical to make the time intervals as wide as possible. A wider interval reduces the risk of accidentally missing cows in the interval depending on how often the hoof trimmer visits the herd. Our results suggest trimming the first time within 120 DIM in first lactation and a second trim more than 60 d before second calving. The transition period is crucial for the rest of the lactation, and we should aim to place as little stress here as possible because there are already many unavoidable internal and external factors changing in this period. Our results did not highlight dry-off as the only superior period for the second trim, but it included the most common time for dry-off (60 d before calving). Although it could be beneficial to have the second trim at dry-off to ensure all infectious claw lesions are treated and healed before the cow changes group. Indeed, implementing this as a "drying-off routine" could also make it easier to remember.

Farmers that chose to trim their cows in specific periods in lactation also embrace the fact that the trimmer will visit the herd on a more regular basis, and this could lead to other positive effects, such as shorter working days for farmers and hoof trimmers, which will lead to less stress for both the people and cattle involved in the trimming process, earlier hoof checks on lame cows, and greater ease for following up on treatments.

Methodological Considerations

Overall, the precision/reliability of this retrospective cohort study, which analyzed over 10,000 observations can considered to be high, supporting the consistency of the estimated probabilities of claw lesions and culling due to timing of hoof trimming in first lactation. Although large datasets may produce significant results from minor numerical differences, our finding that trimming in early lactation (within 120 DIM), combined with a second trim more than 60 d before the second calving, is biologically relevant because it reduced the odds of claw lesions and being culled in general by 25% to 56% and 27% to 37%, respectively, compared with a first trim in mid lactation (>120 DIM), combined with a second trim close (<60 d) to second calving, or irrespectively of when the second trim occurs.

Regarding validity of our findings for the target population, primiparous cows in large herds in Sweden, potential selection bias should be considered due to the inclusion criteria implemented. One criterion required that primiparous cows had to have a hoof-trimming occasion within 90 d in second lactation. This time frame was selected because it aligns with when most claw disorders tend to manifest (Bergsten and Frank, 1996; Leach et al., 1997; Green et al., 2002), making it appropriate for evaluating the preventive effect of timing of trimming in first lactation. Extending the follow-up period could introduce additional intervening or confounding factors beyond our control, potentially affecting the results. Conversely, a shorter time frame would result in fewer observations and reduced the power to detect differences. The chosen interval is consistent with previous studies assessing claw lesion prevalence (Bergsten and Frank, 1996; Wilhelm et al., 2015), supporting its suitability. However, we are unable to draw conclusions regarding whether timing of trimming in first lactation exhibits the same association with claw lesions and survival later in second lactation or in subsequent lactations. This emphasizing the need for further research, although Randall et al. (2018) showed that claw horn lesions detected in primiparous cows in early lactation (second to fourth month) were associated with an increased risk of future lameness and not just in the following lactation.

Our study focused exclusively on primiparous cows, limiting the applicability of the results to higher parities. This design choice was made to reduce confounding from prior claw lesions, as multiparous cows are more likely to have sustained claw lesions in earlier lactations. However, the absence of data on hoof health before first calving means we cannot confirm that all enrolled primiparous cows were lesion-free at baseline.

Although our study has certain limitations, we maintain that the external validity is sufficiently robust to justify applying these results to primiparous cows in all Swedish dairy herds with 200 cows or more. We based this on the fact that our study population encompassed approximately two-thirds of all large Swedish dairy herds, which generally share comparable housing, milking systems, and management practices. Although the findings may not be directly transferable to smaller dairy herds, there is no compelling evidence to suggest significant disparities, as also indicated by Manske (2002). The deliberate focus on herds with 200 cows or more was intentional, as such herds are more representative of the structure of future dairy operations from a global perspective (Barkema et al., 2015).

All hoof-trimming records were made by Swedish hoof trimmers, and according to previous studies (Manske, 2002; Capion et al., 2021; F. Åkerström, C. Bergsten, and A. Nyman, Växa, Stockholm, Sweden; unpublished data) the accuracy of hoof-trimming records is higher for severe claw lesions (sole ulcer, digital dermatitis, and interdigital hyperplasia) than for milder claw lesions (heel horn erosion and mild dermatitis). Another limitation regarding the recordings is that therapeutic trimmings cannot be distinguished from preventive routine trimmings of healthy cows. However, we can assume from practical experience and national data (Växa, 2025) that most recordings are made at routine preventive trimmings.

A limitation of our dataset is that it does not allow us to determine with certainty whether the timing of hoof trimmings was random or the result of deliberate planning by the farmer. Based on practical experience with hoof care strategies in Sweden during the period 2015 to 2018, our assumption is that most herds in our data did not follow a consciously timed hoof-trimming strategy. As herd sizes continue to increase in Sweden and awareness of the importance of hoof health for production and animal welfare grows, it is likely that more farmers would have made this deliberate choice if a more recent dataset had been available.

Another perspective, also discussed by Mahendran et al. (2017), is that trimming results could have been influenced by the trimming technique. This highlights the important fact that all hoof trimmings might not be adequately performed, and one major issue could be the failure to conserve enough sole thickness. Should “hoof trim” perhaps be replaced by “hoof inspection” or “hoof care” to encourage sole depth conservation? Although hoof trimming is supposed to prevent claw lesions, and does in most cases, there are also practical instances of cows becoming lame after hoof trimming. There is a large variation among Swedish trimmers, and the way they shape the claw at trimming (Åkerström and Telezhenko, 2022). However, because our study includes copious observations and there is no reason to suppose that trimming errors are more common in a particular period in lactation, and that it would be a random distribution of such errors, this most likely did not affect our results.

CONCLUSIONS

The timing of first and second trimming of primiparous cows during their first lactation was associated with hoof health at first trimming in the second lactation and survival in the second lactation. First hoof trimming within 120 d after first calving and second trimming exceeding 60 d before second calving led to a reduced probability of claw lesions at first trimming in the second lactation and a reduced probability of the cow being sent to slaughter in second lactation. A first trimming occurring more than 120 d after first calving increased the probability of both claw lesions and being sent to slaughter in early second lactation.

NOTES

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Nonstandard abbreviations used: f t = first trimming; SNDHH = Swedish National Database on Hoof Health; SH = Swedish Holstein; SOMRS = Swedish Official Milk Recording Scheme; SR = Swedish Red; s t = second trimming.

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