314 (2025) 106439

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Risk factors associated with tail damage in New Zealand dairy cattle

EL Cuttance [a,*], WA Mason [a], MA Bryan [b], RA Laven [c]

[a] EpiVets, 565 Mahoe Street, Te Awamutu, New Zealand
[b] VetSouth Ltd, Winton, New Zealand
[c] Massey University, School of Veterinary Science, Palmerston North, New Zealand

ARTICLE INFO

Keywords:
Deviation
Trauma
Welfare
Tail scoring
Animal handling

ABSTRACT

Tail damage in dairy cattle is an increasingly recognised cause of poor welfare. However, there have been very few studies of the risk factors associated with the prevalence of tail damage. This analysis combined a 200-farm study of the prevalence of tail damage in New Zealand with a survey of farm management and handling practice with the aim of identifying the risk factors associated with tail damage (defined as either a deviated tail or one with evidence of other injury). Across the farms, the median herd level prevalence of tail damage was 11.5 %. The survey included 42 variables which were analysed at the univariable level. Factors which were identified as being potentially associated based on these univariable analyses included region, parlour type, milking frequency, use of automatic cup removers, use of coaxing to get cows to move and farmer's opinion of how many cows with tail damage they had. The final multivariable model had region, milking frequency (odds of tail damage 1.18 times higher for farms which always milked cows twice daily than for those which did not) and the use of coaxing (i.e. gentle persuasion) (odds of tail damage on farms which used coaxing was 0.83 times that on farms which did not). These results support the hypothesis that poor handling and/or interaction with infrastructure are important causes of tail damage on New Zealand dairy farms. More studies in more countries are needed to better understand the cause of tail damage in dairy cows. In addition, we need to standardise and optimise the repeatability of tail scoring

Introduction

Tail damage has a significant effect on cattle welfare resulting in pain and stress, reduced ability to display normal behaviour and depressed affective state (Laven and Jermy, 2020; Cuttance et al. 2024). In response to concerns that tail damage was a potentially significant welfare issue on many New Zealand dairy farms for which we had very little data (Laven and Jermy, 2020), we undertook a large nationwide cross-sectional study designed to identify the prevalence of tail damage in New Zealand dairy cows (Cuttance et al. 2024). Since Laven and Jermy (2020) there has been an apparent increase in interest around tail damage in dairy cows, with multiple reports of the prevalence of various types of tail damage (e.g. Crossley et al., 2021; Olsen et al. 2023; Kremer-Rücker et al., 2024; Volhøj et al. 2024). However, there are still relatively few studies of prevalence of tail damage (indeed a recent review of lameness and injuries in dairy cattle (Roche et al. 2024) did not even mention tail damage) and thus it is still an under-investigated and, probably, underappreciated problem.

One specific area where we lack information is on the risk factors associated with tail damage. As far as the authors are aware, there are only four peer-reviewed studies of risk factors for tail damage The first study, Zurbrigg et al. (2005) assessed the association between tie-stall design and damaged tails in 317 Canadian dairy farms and reported that for every 2.5 cm decrease in tie rail height, the prevalence of damaged tails increased by 1 %. Olsen et al. (2023) investigated cow-level risk factors in herd with a prevalence of tail damage of 46 %, and identified that age and being treated for mastitis more than once in their lifetime increased prevalence. The limited nature of these two studies (evaluating tie stall design only (Zurbrigg et al. 2005) and using data from a single farm (Olsen et al., 2023) meant that they were not able to evaluate many herd level factors which could potentially influence the prevalence of tail damage. In contrast, Crossley and colleagues evaluated the influence of a wide-range of risk factors on tail damage prevalence in Irish dairy cattle. In a pair of papers, they reported the risk factors associated with tail damage during the grazing period (data from 85 farms; Crossley et al. 2022a) and during the housing period (data from 69 farms; Crossley et al. 2022). For the housing period analysis, Crossley et al. (2022) assessed 33 risk factors which they thought could

* Corresponding author.
E-mail address: emma@epivets.co.nz (E. Cuttance).

https://doi.org/10.1016/j.tvjl.2025.106439
Accepted 12 September 2025
Available online 16 September 2025

be related to tail damage. At the end of the process, they identified that herds with all cubicles outside the recommended width, herds with at least some clean cubicles, and herds which did not have a backing gate all had higher odds of having at least one cow with a broken (deviated) tail. They also found that the use of tail tape, only using artificial insemination (AI) and having wide housing passages were all associated with an increasing proportion of cows in a herd with broken tails. For tail lacerations (trauma) they identified that passage cleaning frequency and shed light level influenced whether a herd had any cows with tail lacerations, while all cubicles being outside recommended lengths was associated with a reduced proportion of cows with tail lacerations. For their grazing period analysis, Crossley et al. (2022) assessed eight factors they thought could be related to tail damage. However, none of them were identified as risk factors for broken tails; for tail laceration, not employing any part time staff, and using only one of natural and AI (rather than a combination) were both associated with an increased proportion of cows with a lacerated tail.

Although Crossley and colleagues undertook a thorough analysis of their data, it was a relatively small number of farms in one specific system (spring-calving Irish farms). We need more data in more systems to better understand the key risk factors for tail damage in dairy cattle. In addition, although animal handling is thought to be a key risk factor for tail damage (Zurbrigg et al. 2005; Laven and Jermy, 2020; Olsen et al. 2023) neither of the Crossley studies analysed animal handling (and nor did Zurbrigg et al. 2005 or Olsen et al. 2023). Thus, alongside our study of the prevalence of tail damage in New Zealand dairy cows, we undertook a survey of farm management and handling practice in order to identify risk factors associated with tail damage on New Zealand dairy farms.

Materials and methods

All animal manipulations were approved by Massey University Animal Ethics Committee application AEC 21/71. This study was a cross-sectional observational study, with 200 farms enrolled across nine regions of New Zealand. Study size was based on estimating herd prevalence of tail damage with a precision of 5 % at 95 % confidence with an expected true prevalence of 14 % (Bryan et al. 2019). It was not powered to detect differences between farm-level risk factors. Full details of the farm selection process are published in Cuttance et al. (2024). To enrol 200 farms a convenience selection of nine veterinary practices (one per region in 9 regions across New Zealand) was made. Within each practice, study farms were randomly selected from active dairy clients within one hour's travel of the veterinary clinic. The number of farms selected per clinic varied from 20 to 25. Once selected, farms were then contacted to assess their willingness to be involved. Farms were free to decline to be involved.

Tail scoring

Tail scoring was undertaken between December 2021 and March 2022 either during a milking event or at pregnancy diagnosis (based on farmer/veterinarian preference). All cows present at that time were eligible to be tail scored. All scoring was carried out in the milking parlour. Scoring was undertaken by one or two trained technicians per region (total of 12 personnel) (see Cuttance et al. (2024) for details of training). Tail lesions were recorded as deviated (i.e. non-linear deformity), shortened (tail appearing shorter than normal) or trauma (all other lesions). For this risk factor analysis, cows with at least one lesion that was either deviated or trauma were recorded as having a 'damaged tail', while cows observed as only having a shortened tail (with no deviation or trauma) and cows in which no lesions were observed were recorded as having 'no damage'.

Survey

Risk factors for tail damage on each farm were collected by an in-person on-farm interview of the farmer (owner/manager) by the technicians who scored the farm, as close to the timing of the tail scoring visit as possible. On the few occasions where it was not possible to have the manager or owner on the farm for the questions, the survey was carried out by the technician over the phone. Data were collected from 192/200 farms on which tail damage prevalence was recorded

Not all returned questionnaires contained completed answers to all the questions. In such cases, the completed answers were used, thus the denominator for the analyses varied between questions, depending on the number of respondents who had completed the question. Variables with more than 10 % missing data were not eligible for multivariable analyses; these consisted predominantly with variables that involved housing.

Statistical analyses

Prevalence estimates

All raw data were converted to CSV files and imported into R to be assessed for completeness, consistency, formatting, and logic. The number of farm responses for each survey question, and the responses from farmers from each region, were tabulated and are reported in the appendices. The survey data collected was analysed using mixed logistic regression modelling techniques. The primary outcome of interest was binary and at the cow-level (tail damage: present/absent). To account for the clustering of animals within herds, a mixed model with a random effect for farm was used. The survey produced 42 variables to analyse. To minimise the number of variables added to the initial multivariable model, each variable was screened with mixed logistic regression for its association with tail damage at the univariable level (with farm as a random effect). Variables with greater than 10 % missing values were excluded from exclusion into the multivariable model (housing over winter, housing during lactation, and whether the farm staff were the same from the previous season). After these exclusions, any remaining variable with $p < 0.20$ from the logistic regression was eligible for inclusion in the initial multivariable mixed logistic regression model. All such variables were assessed for collinearity, with variables with variance inflation factors > 4 deemed to have high collinearity with other predictors, and not included further in the analysis. Remaining continuous variables were assessed for linearity by plotting the logit of the residuals of the model against the linear predictor, with smoothed splines. Any that were deemed to have non-linear associations were either transformed with exponential of logarithmic functions power, or categorised into biologically meaningful categories, as appropriate. Fixed variables were removed from the multivariable model using backward elimination if the log-likelihood ratio test between nested models had a $p > 0.05$, until all remaining fixed effects had a $p \leq 0.05$. Variables were removed in a step-wise manner screening on those with the greatest Wald test *p-value* first. Removed variables were then added back into the model one at a time to assess for confounding. If coefficients or standard errors of the remaining variables altered by > 30 %, a variable was considered a confounder and was retained in the model. Due to the large number of variables, only those variables screened for the initial multivariable model were assessed for confounding. Model diagnostics were assessed using simulation approaches. In particular, outliers and influential observations were assessed and investigated if identified.

Results

A total of 92,348 dairy cows, across 200 farms from nine regions, had their tails scored. The median/mean herd size was 418/462 (interquartile range 258–608, range 61–1879) cows, The median prevalence of tail deviation was 9.5 % (range 0.9–40.3 %), for trauma it was 0.9 %

(range 0–10.7 %). The median prevalence of cows with any form of tail damage ranged between regions from 7 % in the West Coast to 29 % in Southland.

All 200 farmers responded to the survey. The responses for each question by region and overall can be found in Appendices 5–8. The outputs from the univariable analyses are presented in Tables 1 and 2. The continuous variables that were included in the initial multivariable model after screening were: herd size, maximum experience of staff members, maximum years on farm, number of staff members and the percentage of the herd that the farmers thought had normal tails. No linearity issues were identified with any of these variables. The categorical variables included in the initial model were region, predominant breed, maximum age of staff members, dairy shed type, milking frequency, automatic cup removers, who does the AI on farm, whether animals are scanned for pregnancy, noise, and whether coaxing (i.e. gentle persuasion) was used to move stubborn cows or not.

After backwards elimination, the final multivariable mixed logistic regression model included region, whether coaxing animals into the shed was used to deal with stubborn animals and milking frequency (Table 3). Animals from the dairy farms enrolled in the Waikato and Southland had greater odds of tail damage compared to animals from Taranaki, West Coast or Bay of Plenty (BOP). Animals that were milked twice-a-day for the entire lactation had a 1.18 times greater odds of tail damage compared to those milked less than twice-a-day all lactation.[1] Finally, farmers that used gentle coaxing to get stubborn animals to move had a 0.83 times lower odds of tail damage compared to farms that did not report using coaxing.

Discussion

This risk factor analysis was part of a large nationwide cross-sectional study designed to identify the prevalence of tail damage in New Zealand dairy cows. As such the study was designed and powered to measure prevalence rather than identify risk factors. Nevertheless, we believe, as in our similarly designed lameness study (Mason et al. 2024), that our current study was powered to detect a risk factor with a relative risk of approximately 1.15, with an 80 % power and 95 % confidence.

Our study identified three factors as being important in the final multivariable model. The first of these was region. A difference in prevalence between regions in New Zealand was also reported by Moono et al. (2022) in their survey of 29 farms in 3 regions. In that study, and the current study, region was confounded by scorer as scorers did not move between regions. Furthermore, although all scorers received comprehensive training before they recorded tail damage prevalence, the experience level varied between scorers which could have affected their scores. There are no published data on the within- and between rater repeatabilities of tail scoring and how these are affected by training/experience. If we are to use tail scoring as a routine method of welfare assessment this needs to be addressed urgently. Nevertheless, despite Moono et al. (2022) and the current study using different scorers the pattern of prevalence in the 3 regions that were monitored in both studies was similar with Southland having the highest prevalence of tail damage, Taranaki the lowest and Manawatu being in between which suggests that scorer may not be as important as it undoubtedly is for lameness. It is thus likely that the impact of region is only partially explained by scorer and that it also reflects differences between regions not accounted for in our study. More data are needed to address this hypothesis.

Nevertheless, even after accounting for region, this study identified two herd level factors that were associated with tail damage prevalence. Firstly, farms that milked cows twice-a-day throughout lactation had a higher prevalence than those which milked cows less frequently for at

Table 1
Results of univariable analyses of categorical variables thought to be potentially associated with the odds of tail damage.

Characteristic	Number of farms	Number of animals	Number with tail damage	OR (95 % CI)[a]	p-value
Region*	200				< 0.001
Predominant Breed					0.003
Holstein/ Friesian (HF)	86	39,138	4965	—	
Jersey (J)	27	9181	853	0.64 (0.50–0.82)	
HF X J	85	42,929	5658	0.98 (0.83–1.15)	
Other	2	1100	144	1.10 (0.53–2.32)	
Maximum age of staff					0.11
>50	71	30,646	3626	—	
41–50	62	31,392	3643	1.07 (0.88–1.29)	
31–40	48	22,003	3309	1.31 (1.07–1.61)	
26–30	8	3218	386	0.99 (0.65–1.49)	
18–25	6	2314	255	1.06 (0.67–1.68)	
Same staff this season					0.74
No	65	33,594	4243	—	
Yes	106	47,220	6201	1.03 (0.87–1.22)	
Dairy parlour design					0.018
Herringbone	99	32,673	3707	—	
Rotary	96	57,404	7462	1.20 (1.03–1.40)	
Milking frequency					0.002
Varied or always once a day	70	31,498	3315	—	
Once-a-day	14	4767	591	0.94 (0.68–1.30)	
Twice-a-day	108	52,075	7070	1.30 (1.10–1.53)	
Issues with cow flow					0.68
Never	114	52,038	6418	—	
Occasionally	60	30,536	3753	1.01 (0.85–1.19)	
Yes	20	7386	997	1.12 (0.87–1.46)	
Automatic cup removers					0.026
No	86	29,058	3229	—	
Yes	108	60,573	7873	1.19 (1.02–1.40)	
Housing over winter					0.89
No	159	72,441	9024	—	
Yes	23	12,977	1640	0.98 (0.78–1.24)	
Housing during lactation					0.64
No	134	63,934	8016	—	
Yes	21	12,020	1502	0.94 (0.74–1.21)	
Who does the AI					0.076
Combination	9	2665	241	—	
External	163	80,206	10,201	1.65 (1.12–2.41)	
None	1	114	13	1.58 (0.47–5.31)	
Own	24	7756	923	1.50 (0.97–2.31)	

(continued on next page)

[1] These included a mixture of farms that used once-a-day for all lactation, 16 h milkings or once-a-day milking for portions of the lactation.

Table 1 (*continued*)

Characteristic	Number of farms	Number of animals	Number with tail damage	OR (95 % CI)[a]	p-value
Cows scanned for pregnancy					0.14
Never	5	1379	118	—	
Sometimes	3	502	84	2.27 (1.01–5.12)	
Yes	190	89,093	11,185	1.45 (0.87–2.43)	
Personnel scanning					0.40
Lay scanner	25	14,486	1769	—	
Other	8	4158	580	1.28 (0.84–1.97)	
Vet	161	71,477	8973	0.99 (0.79–1.24)	
External foot trimmer					0.46
No	150	66,615	8530	—	
Yes	44	23,421	2683	0.93 (0.78–1.12)	
Number of annual vet visits					0.58
1–5	32	12,881	1762	1.13 (0.88–1.44)	
6–10	96	45,276	5628	1.09 (0.90–1.32)	
11–20	49	21,360	2464	—	
>20	19	10,860	1471	1.20 (0.90–1.60)	
Handling difficult cows					
i) Tail jack					0.64
No	157	71,714	9323	—	
Yes	43	20,634	2297	0.96 (0.79–1.15)	
ii) Cattle crush					0.45
No	158	70,707	8782	—	
Yes	42	21,641	2838	1.07 (0.89–1.30)	
iii) Leg rope					0.63
No	112	56,696	7163	—	
Yes	88	35,652	4457	0.96 (0.82–1.12)	
iv) Hip bar					0.81
No	170	77,867	9747	—	
Yes	30	14,481	1873	1.03 (0.83–1.27)	
v) Immobiliser					0.41
No	187	84,905	10,643	—	
Yes	13	7443	977	1.14 (0.84–1.55)	
vi) Rarely have issues					0.61
No	112	50,988	6149	—	
Yes	88	41,360	5471	1.04 (0.89–1.22)	
How do you/ staff get a stubborn cow to move					
i) Noise					0.079
No	70	33,545	4023	—	
Yes	130	58,803	7597	1.16 (0.98–1.36)	
ii) Pressure					0.31
No	148	69,277	8607	—	
Yes	52	23,071	3013	1.10 (0.92–1.31)	
iii) Push from Behind					0.83
No	69	27,248	3585	—	
Yes	131	65,100	8035	1.02 (0.86–1.20)	
iv) Slap					0.81
No	130	62,028	7654	—	
Yes	70	30,320	3966	1.02 (0.87–1.20)	
v) Pipe					0.92
No	145	73,919	9345	—	
Yes	55	18,429	2275	1.01 (0.85–1.20)	
vi) Wait					0.34
No	138	61,541	7971	—	
Yes	62	30,807	3649	0.92 (0.78–1.09)	
vii) Coax					0.012
No	121	57,992	7762	—	
Yes	79	34,356	3858	0.82 (0.70–0.96)	
Do you body condition score					0.10
No	72	24,894	2760	—	
Yes	121	62,342	8154	1.15 (0.98–1.35)	
Do you tail score					0.62
No	159	65,313	8166	—	
Yes	34	21,923	2748	1.05 (0.86–1.29)	
Do you locomotion score					0.42
No	167	71,814	8901	—	
Yes	26	15,422	2013	1.10 (0.87–1.38)	
How has docking affected tail damage					0.34
Decreased	15	9710	1002	—	
Increased	74	33,064	4261	1.32 (0.97–1.78)	
no difference	90	39,886	4963	1.25 (0.93–1.68)	
Unsure	11	3546	460	1.18 (0.76–1.82)	
Is tail damage an industry problem					0.42
On a minority of farms	74	31,034	4069	—	
No	22	8235	860	0.83 (0.64–1.08)	
Unsure	65	32,241	4374	1.01 (0.84–1.21)	
Yes	33	17,626	2048	0.91 (0.73–1.13)	

* See Table 3 for multivariate analysis of the effect of region on prevalence of tail damage; [a]OR, odds ratio; CI, confidence interval

least some of the lactation. This is consistent with the hypothesis that poor handling is the principal cause of tail damage (Laven and Jermy, 2020), because the frequency of milking is a proxy for how often cows are handled. However, it is also possible that it is the interaction between cows and infrastructure that is causing the tail damage, the opportunity for which is also associated with increased frequency of milking.

Secondly, farmers who recorded that they coaxed stubborn cows to move (as opposed to not using coaxing) had a significantly reduced risk of tail damage. This again supports the poor handling hypothesis, but pressure on the tail which is often thought to be the key driver of tail damage was not associated with prevalence even in the univariable model. For example, the use of a tail jack (lifting the tail straight up to

Table 2
Results of univariable analysis of continuous variable thought likely to be associated with percentage of cows on a farm with tail damage.

Characteristic	Number of farms	Number of animals	Number tail damage	[a]OR (95 % CI)	
Herd size (per 100 cows)	200	92,348	11,620	1.03 (1.00 – 1.06)	0.034
Maximum years experience of staff	194	90,232	11,362	0.99 (0.99–1.00)	0.10
Maximum years on current farm of staff	195	90,472	11,388	1.00 (0.99–1.00)	0.17
Number of staff	200	92,348	11,620	1.07 (1.02–1.13)	0.006
How useful is tail scoring (1–10 score)	194	90,396	11,434	0.99 (0.96–1.02)	0.51
How painful is tail damage (1–10 score)	197	90,815	11,460	1.01 (0.97–1.05)	0.65
% of your herd with normal tails	192	86,110	10,657	0.37 (0.17–0.81)	0.013
% of tail damage that is acceptable	181	80,298	9773	1.42 (0.40–5.08)	0.59
% of your herd with damaged tails	185	83,368	10,132	3.32 (1.25–8.82)	0.016

[a]OR, odds ratio; CI, confidence interval
Interpretation of OR – e.g. for herd size every 100 extra cows in a herd was associated with a 1.03 (95 % CI 1.00 – 1.06) times increase in the odds of tail damage.

distract the cow) is thought to have a high risk of producing tearing of the fascia especially if the tail is twisted or pushed past the vertical (Laven and Jermy, 2020), but we found that cows on farms that reported using tail jacking as a restraint had slightly lower univariable odds of having tail damage, although our data were also compatible with a small increase in odds (OR 0.96; 95 %CI 0.79–1.15), and thus tail jacking was not one of the variables presented to the initial multivariable model. More research is needed to identify how (if) poor handling directly affects tail health.

Whilst it must be stressed that unconditional associations may be biased, some unadjusted associations identified in this current study warrant further discussion. There was a clear effect of breed at the univariable level with cows in herds where the predominant breed was Jerseys having a much lower odds of having tail damage than those where the predominant breed was Holstein (OR 0.64; 95 %CI 0.50–0.82). The cause of this effect, if real, is unclear. It is not plausible that Jerseys have greater resistance to tail damage than Friesians, so it seems likely that this is either a herd effect, with cows in herds where Jerseys are the predominant breed being less likely to be exposed to conditions or handling that result in tail damage, or it is a behavioural effect where Jersey cows are less likely to expose themselves to the conditions/handling that cause tail damage. It seems more likely to be the former, but individual cow level data within herds is needed to properly assess whether there is a breed effect at the individual cow level.

Both rotary parlours and automatic cup removers (ACRs) were associated (at the univariable level) with similar increases in the odds of tail damage (OR 1.20 (95 %CI 1.03–1.40) and 1.19 (95 %CI 1.02–1.40), respectively. This may reflect the increasing risk of tails becoming damaged by getting tangled in infrastructure in rotary parlours and in parlours with ACRs. The authors have observed damage directly caused by ACRs, but just because this can happen does not mean that ACRs are an important cause of tail damage – further focused research may be able to answer this question.

Table 3
Results of the generalised linear regression model of the risk factors that are associated with the odds of damaged tails across 192 dairy farms in New Zealand.

Variable	Number of farms	Number of animals	Number with tail damage (5)	OR (95 % CI)[a]	p-value
Milking frequency					*0.026*
Less than twice-a-day	84	36,265	3906 (10.8)	—	
Twice-a-day all year	108	52,075	7070 (13.6)	1.18 (1.02–1.37)	
Coax stubborn cows to move					*0.013*
No	114	54,171	7146 (13.2)	—	
Yes	78	34,169	3830 (11.2)	0.83 (0.71–0.96)	
Region					*< 0.001*
Bay of Plenty	20	8553	1004 (11.8)	—	
Canterbury	25	17,750	2179 (12.3)	1.07 (0.81–1.42)	
Manawatu	20	6507	889 (13.7)	1.03 (0.76–1.40)	
Northland	17	5779	561 (9.7)	0.84 (0.61–1.16)	
Otago	19	11,387	1313 (11.5)	0.94 (0.68–1.28)	
Southland	23	14,673	2210 (15.1)	1.33 (1.00–1.77)	
Taranaki	25	5865	586 (10)	0.84 (0.63–1.13)	
Waikato	23	8638	1525 (17.7)	1.48 (1.11–1.98)	
West Coast	20	9188	709 (7.7)	0.67 (0.50–0.92)	

[a] OR =Odds Ratio, CI = Confidence Interval

Both Crossley et al. (2022) and Zurbrigg et al. (2005) identified components of housing as a risk factor for tail damage. In contrast we did not demonstrate an effect of housing even at the univariable level. Both of these previous analyses measured cubicle/tie stall dimensions, whereas in our study the variable was housing or not. This would have limited our ability to detect an effect of housing, as data from farms with unsuitable dimensions would have been combined with data from farms with suitable dimensions and from farms using loose housing.

Finally, farmers perspectives on the percentage of cows with tail damage in their herd had an interesting association with actual percentage at the univariable level (Table 2). For every 1 % increase in the percentage of damaged tails that a farmer believed they had in their herd, the odds of tail damage increased by 3.32 times (95 % CI 1.25–8.82 %). Thus if we have one herd with 10 % broken tails and a second herd where everything was identical except that the farmer believed they had a 1 % higher prevalence of tail damage than the farmer in the first herd, this univariable model would predict that the actual prevalence of lameness on the second farm would be 26.9 % (95 %CI 12.2–49.5 %) This suggest that although farmers with high levels of tail damage are likely to think that they have a higher prevalence of tail damage than farmers with low levels of tail damage, they are likely to grossly underestimate true prevalence. Further research is required to understand the factors driving this apparent lack of recognition of tail damage on New Zealand dairy herds

Conclusion

Tail damage is an understudied problem in dairy cattle, for which there are very few studies of risk factors. This study, of dairy cows in

New Zealand, identified three variables as being important in the final multivariable model of risk factors: region of New Zealand (a high level variable which may reflect confounding with tail scorer and/or between region differences in factors associated with tail damage but not measured in this survey); frequency of milking (which may reflect exposure to poor handling or to damaging infrastructure); and whether a farmer used coaxing to persuade cows to move (which may reflect farmer attitudes or cow affective state when being moved).

This was a large-scale study of 200 farms where most cows were never housed (88 %). However, it is only one country and one system, we need more studies in more countries in more countries and more systems so that we can better understand the cause of tail damage in dairy cows. In addition we need to identify the optimal method of identifying damaged tails to increase consistency between studies and to confirm the repeatability of that method.

CRediT authorship contribution statement

Richard Laven: Writing – review & editing, Writing – original draft, Conceptualization. **Winston Mason:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Emma Cuttance:** Writing – review & editing, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Mark Bryan:** Writing – review & editing, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of Competing Interest

None.

Acknowledgements

We would like to acknowledge the teams from Kamo Vets, Okato Vets, Totally Vets, VetEnt, Te Puke Vets, West Coast Vets and Vet South for all the work they did scoring close to 100,000 cattle! We gratefully acknowledge the Ministry of Primary Industries via Sustainable Fibres and Futures Fund, Dairy Cattle Veterinarians Society of the NZVA, WelFarm, VetNZ, VetEnt and Massey University for funding this study.

References

Bryan, M.A., Fruean, S.N., Moono, P., 2019. Tail damage and tailscoring in NZ dairy cows – what is normal. Newsletter of the Society of Dairy Cattle Veterinarians 36 (4), 10–11.

Crossley, R.E., Bokkers, E.A.M., Browne, N., Sugrue, K., Kennedy, E., De Boer, I.J.M., Conneely, M., 2021. Assessing dairy cow welfare during the grazing and housing periods on spring-calving, pasture-based dairy farms. Journal of Animal Science 99 (5). https://doi.org/10.1093/jas/skab093 art. no. skab093.

Crossley, R.E., Bokkers, E.A.M., Browne, N., Sugru, e K., Kennedy, E., Conneely, M., 2022. Risk factors associated with indicators of dairy cow welfare during the housing period in Irish, spring-calving, hybrid pasture-based systems. Preventive Veterinary Medicine 208, 105760. https://doi.org/10.1016/j.prevetmed.2022.105760.

Cuttance, E.L., Mason, W.A., Hea, S.Y., Bryan, M.A., Laven, R.A., 2024. The prevalence of damaged tails in New Zealand dairy cattle. New Zealand Veterinary Journal 72, 123–132. https://doi.org/10.1080/00480169.2024.2321180.

Kremer-Rücker, P.V., Abel, K.M., Lorenz, L.M., Schmidt, C., Lechner, M., Schubert, K.F., Köhler, A.A., Meier, S., Scholz, A.M., 2024. A pilot study: tail tip lesions in dairy cows – an unnoticed animal welfare issue? Archives of Animal Breeding 67, 271–284. https://doi.org/10.5194/aab-67-271-2024.

Laven, R., Jermy, M., 2020. Measuring the torque required to cause vertebral dislocation in cattle tails. New Zealand Veterinary Journal 68, 107–111.

Mason, W.A., Müller, K.R., Laven, L.J., Huxley, J.N., Laven, R.A., 2024. Farm-level risk factors and treatment protocols for lameness in New Zealand dairy cattle. New Zealand Veterinary Journal 72, 171–182. https://doi.org/10.1080/00480169.2024.2345257.

Moono, P., Fruean, S., Hampson, D., Bryan, M., 2022. The frequency of tail damage amongst cows from a sample of New Zealand dairy farms participating in an animal welfare programme. New Zealand Veterinary Journal 70, 1–16. https://doi.org/10.1080/00480169.2022.2069174.

Olsen, H.E., Anderson, K.N., Creutzinger, K.C., Vogel, K.D., 2023. Broken tails in Holstein dairy cattle: a cross-sectional study. JDS Communications 4, 265–268. https://doi.org/10.3168/jdsc.2022-0254.

Roche, S.M., Renaud, D.L., Saraceni, J., Kelton, D.F., DeVries, T.J., 2024. Invited review: prevalence, risk factors, treatment, and barriers to best practice adoption for lameness and injuries in dairy cattle—A narrative review. Journal of Dairy Science 107, 3347–3366. https://doi.org/10.3168/jds.2023-23870.

Volhøj, T., Nielsen, C.K., Schjermer, D.M., Jensen, N.S., Jørgensen, B.M., Nielsen, S.S., Jensen, H.E., 2024. Prevalence and characterisation of band-shaped tail lesions in Holstein cows. Acta Veterinaria Scandinavica 66, 19. https://doi.org/10.1186/s13028-024-00742-0.

Zurbrigg, K., Kelton, D., Anderson, N., Millman, S., 2005. Stall dimensions and the prevalence of lameness, injury, and cleanliness on 317 tie-stall dairy farms in ontario. The Canadian Veterinary Journal 46, 902.