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Effect of moving from being extensively managed out in pasture into training on the incidence of equine gastric ulcer syndrome in Icelandic horses

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OBJECTIVE
To investigate equine squamous gastric disease (ESGD) and equine glandular gastric disease (EGGD) in Icelandic horses moving from pasture into training.

ANIMALS
81 horses (median age, 3 years; interquartile range, 1 year) from 10 farms representing 4 different Icelandic regions.

PROCEDURES
Initial gastroscopy was undertaken within 2 weeks of moving from pasture into a training establishment. A total of 71 horses underwent endoscopic examination again 8 weeks later. Various management and behavioral factors were assessed through face-to-face questionnaires with the owners or trainers. Multivariable logistic regression was used to determine factors contributing to any change in ESGD and EGGD severity score during the 8-week training period.

RESULTS
Incidence of EGGD and ESGD in this feral population was similar to that found in domesticated horses. ESGD incidence (severity score, ≥ 2; score range, 0 to 4) reduced from an initial 71.6% (58/81) to 25.4% (18/71). On multivariable analysis, sex (ie, being a stallion or a female vs gelding) increased the likelihood of ulcer grade reduction. Being fed preserved forage 3 or more times a day also improved the likelihood of ESGD reduction (odds ratio, 17.95; 95% CI, 1.67 to 193.40; P = .017). Overall, the farm explained 35% of the variance, confirming the importance of management factors. Incidence of EGGD (severity score, ≥ 1; score range, 0 to 2) reduced from 47% (38/81) to 40.8% (29/71) during the same period. No measured variables were associated significantly with EGGD incidence or reduction.

CLINICAL RELEVANCE
Pasture provision (without supplementary feed or forage) does not result automatically in a low incidence of gastric ulcers. Regular provision of preserved forage is a key factor in reducing ESGD incidence.

Equine gastric ulcer syndrome[1] (EGUS) is the overriding term for erosive and ulcerative pathology of the equine stomach. EGUS has more recently been subdivided[2] into equine squamous gastric disease (ESGD), which describes the pathology in the squamous part of the stomach; and equine glandular gastric disease (EGGD), which covers the pathology in the glandular part (ie, cardia, glandular fundus, antrum, and pylorus). Equine gastric ulcer syndrome[1] may be diagnosed in around 90% of actively training and exercising animals depending on the inclusion criteria—for example, the scoring system used and grades included.[2,3] Even in pleasure riding horses, EGUS incidence can be up to 80%, depending again on the inclusion criteria.[4] Current knowledge suggests that ESGD and EGGD are separate diagnoses with different pathophysiology, risk factors, and response to medical treatment, but both have the potential for a negative influence on welfare and performance. Nutritional factors such as low fiber intake, long gaps between forage provision, and the feeding of starch-rich complementary feeds are major risk factors for ESGD ulcers[3,5] in horses. Although exercise intensity is important for ESGD,[1] intensity as well as frequency is perhaps more relevant for EGGD ulcers, for which there is less evidence for the role of nutrition and management.[3,5,6]

The five-gaited Icelandic horse is believed to have been developed from ponies originally taken to Iceland by Norse settlers.[7] The extra gaits that set the Icelandic horse apart from other breeds are called the tölt and flying pace, although not all horses can achieve all five gaits. It is the only breed of horse in Iceland, and Icelandic law prevents horses from being imported into the country, and exported animals are not allowed to return. Today, Icelandic horses can be found in many countries of the world[8] as a result of their increasing popularity as leisure and sport horses, with more than 400,000 registered in the studbook of origin for the Icelandic horse.[9] Typically, Icelandic horses are managed extensively either out in pastures or on a low-concentrate, high-forage–based diet when stabled. Therefore, it has been suggested that the incidence of gastric ulceration may be low.[10,11] In addition, training tends not to start until they are around 3 to 4 years of age, and even then, the training is not intensive.[12] In a retrospective postmortem study of Swedish horses,[13] cold-blooded horses (including Icelandic horses) had the lowest percentage of ulcers (7%) compared with ~19% in the Thoroughbred and Standardbred horses. Icelandic horses do develop ulcers[14]; however, no studies on EGUS incidence or possible risk factors have been undertaken in Icelandic horses in Iceland. This study aimed to address this by evaluating the incidence of EGUS in Icelandic horses brought in, off pasture, at the start of Icelandic winter (October) and then again after 8 weeks of training.

Materials and Methods

All the horses in this study were owned and microchipped. From birth until they entered training at the start of this study, they were managed extensively as larger herds out at pasture. They were fed forage at regular intervals through the winters and were moved to larger grazing areas during the summer. They were checked regularly while out grazing, and were typically treated with anthelmintics once or twice a year. Some of the animals may have been brought in briefly for handling the year before this study was undertaken to accustom them to having a headcollar/halter.

Gastroscopy was performed on 81 horses (age range, 3 to 7 years; median age, 3 years; interquartile range [IQR], 1 year; 50 horses were 3 years old) from 10 equine establishments representing 4 different regions of Iceland (North, West, South, and around the capital of Reykjavik) in early October 2021. Most of the horses had been born and raised on their respective farms and were gathered quietly from the grasslands around the farm. Only the horses from the Reykjavik area were transported from their home pastures to the training stable (maximum transportation, 2 hours). The majority were female (n = 50), 16 were stallions, and 15 were geldings. Gastroscopy was repeated on 71 horses 8 weeks later. Ten horses only underwent endoscopic examination on the first occasion and were then excluded from the study for various reasons (eg, one was started on treatment for ulcers, others were moved to a different location or returned to pasture). All horses underwent endoscopic examination initially within 2 weeks of moving them in from pasture. Of the 81 animals, 41 underwent endoscopic examination within 1 to 3 days of arrival (38 of which came directly from pasture for the fasting procedure), 24 within 4 to 6 days, and 16 between 7 and 14 days of arrival. None of the horses had started any training before the initial scope was undertaken, and they were given time to settle in before training started. During the first 2 weeks of training, the horses did very little actual structured exercise, just getting used to the saddle, bridle, and so forth. After that, structured exercise was increased gradually so that all horses ended up training 3 to 5 days per week. In total, they spent up to 2 hours/week being given light-intensity structured exercise that included walk, trot, and cantering, but no training of special gaits (pace and tölt). The second endoscopic examination occurred after around 2 months of training.

At the same time as undergoing endoscopic examination, a body condition score[15] (BCS; 1 to 9) and a cresty neck score[16] (CNS; 1 to 5) were assigned by an experienced assessor (NL), and questionnaires were completed by interviewing the owners or trainers. At the initial endoscopic examination, details of the horses' age, sex, and type of summer pasture in which they had been kept were obtained; during the second endoscopic examination, details of complementary feeds and forage provision (amount and times per day) as well as management practices and training programs (intensity, duration, and times per week) were collected. In addition, another short questionnaire on individual horse behavior when in the stable or out at pasture was completed by interviewing the owners or trainers.

Gastroscopy was undertaken after 15 to 18 hours of feed and forage (but not water) withdrawal. All gastroscopies were undertaken by one experienced clinician (NL). All gastroscopic findings and images of any lesions were recorded. Light sedation was used (detomidine 8 to 10 µg/kg and butorphanol 10 to 12 µg/kg). A complete evaluation of the nonglandular region of the stomach was undertaken, and a record of any lesions made using the EGUS council severity scoring system (0 to 4/4).[2] ESGD scores were therefore determined on a scale from 0 to 4, with 0 being no ulcers, 2 being clinically significant, and a score of 3 or 4 being considered clinically severe. EGGD scores were determined on a scale of 0 to 2,[2,6] where a score of 0 means no ulcer is present or only hyperemia, a score of 1 represents the presence of mild to moderate lesions with evidence of loss of mucosal integrity, and a score of 2 indicates the presence of severe lesions with evidence of loss of mucosal integrity.

All owners were informed of the possible consequences of horses having significant ulcers. The option of medical treatment for any ulcers found was discussed fully with the owners. Other than for 1 horse, the owners declined this option. The treated horse was removed from the study. All owners or

trainers were instructed to contact their own veterinarian if the horses showed any clinical signs such as colic, lack of appetite, and weight loss. Ethical permission was obtained from Animal Health and Welfare of the Icelandic Food and Veterinary Authority, and all trainers or owners signed a permission form.

Statistical analysis

The effect of age, sex, region, farm, type of summer pasture, transportation, and nights in stable before first score and days since arrival at the training stable were evaluated using the nonparametric Kruskal–Wallis test, with significance set at $P \leq .05$.

The effect of the 8-week training period on ESGD and EGGD score was evaluated using the nonparametric Mann–Whitney test for paired data. The cohort of 71 horses that underwent endoscopic examination on both the first and second occasions was analyzed using multivariable logistic regression to understand factors that might have contributed to changes in ESGD and EGGD scores during the 8-week training period. New outcome variables "ESGD score reduced" and "EGGD score reduction" were calculated using the ESGD/EGGD score that was measured at each endoscopic examination 8 weeks apart. A binary variable was calculated, with "yes" including any horse with a score that decreased after 8 weeks and "no" including any horse with a score that stayed the same or increased after 8 weeks.

Analysis was performed in bespoke code written in R version 4.2.1 (R Foundation for Statistical Computing). The Tidyverse version 1.3.1 (R Foundation for Statistical Computing) family of packages was used during initial data cleaning and sorting, and for figure and table production.[17]

Two multivariable models were constructed, one for each binary outcome "ESGD score reduced" and "EGGD score reduced" as described earlier. The variables of interest were selected based on biologic plausibility after a review of the complete data set. The first stage of model-building was to construct a univariable logistic regression model for each variable. A threshold *P* value of .2 was used to determine which variables were carried forward into the multivariable analysis. The multivariable logistic regression model was constructed in a stepwise bidirectional process, with the Akaike information criterion used to identify the best-fitting model at each step. Variables rejected at the univariable and multivariable stages were assessed as potential confounders in the final model. The Hosmer–Lemeshow goodness-of-fit test was used to assess overall fit of the final model. Farm name was included as a random effect in a mixed-effects model for comparison with the final single-level model.

Results

None of the horses showed or had shown (since arrival for training) signs consistent of clinical consequences of gastric ulcers. No veterinarian was asked to attend a horse for gastric ulcer–associated clinical conditions between the first and second endoscopic examination.

On arrival

None of the horses had a BCS less than 5/9, with the majority being overweight (BCS = 6, n = 36) or obese (ie, BCS ≥ 7, n = 24). The median BCS was 6 and the IQR was 1. Very few horses had a CNS of 1 (n = 2) or 5 (n = 1), and most of the horses had a CNS of 2 (n = 54) or 3 (n = 24). The median CNS was 2 and the IQR was 1. Sex, region, farm, type of summer pasture and horse age did not affect the CNS, but all except region influenced the BCS. Females were more likely to be overweight or obese (41/50) than the males (19/31), and the stallions were most likely to be in a good (5/9) body condition (8/16; Kruskal–Wallis test, $P = .015$). In 2 of the farms, the majority of the animals were obese (BCS, 7 or 8). Being kept in a summer pasture, described as being marshland (wetlands) rather than dry (not marsh), increased the risk of being obese ($P = .001$). The 3-year-olds comprised around 85% of the animals with a BCS of 5/9.

Equine squamous gastric disease

At the first endoscopic examination, 26% of the horses (21/81) had ulcers of clinical grade 2, 40% (32/81) had grade 3, and 6% (5/81) had grade 4 **(Table 1)**. On arrival, the ESGD score was not affected significantly by sex, the type of summer pasture in which the horses had been, or the age of the horse. No evidence was found of any association between transportation type ($P = .2$) or nights spent in a stable before the first endoscopic examination ($P = .82$) and ESGD score at the first endoscopic examination. However, there was a significant association between ESGD score and three variables **(Tables 2 and 3)**: farm, region, and the number of days since arrival at the training stable before the endoscopy was performed. For example, horses from the South region were 5.68 times more likely (95% CI, 1.55 to 20.85; $P < .01$) to have a high ESGD score compared to horses from the North region. However, further inspection revealed these three variables to be confounded significantly. For example, 61% of horses that underwent endoscopic examination within 1 to 3 days of arrival were from the North region, whereas 88% of horses that underwent endoscopic

Table 1—Equine squamous gastric disease (ESGD) and equine glandular gastric disease (EGGD) prevalence at each score.

	ESGD, n (%)		EGGD, n (%)	
ESGD/ EGGD score	First scope (n = 81)	Second scope (n = 71)	First cope (n = 81)	Second scope (n = 71)
0	11 (13.6)	38 (53.5)	43 (53.1)	42 (51.9)
1	12 (14.8)	15 (21.1)	22 (27.2)	23 (32.4)
2	21 (25.9)	10 (14.1)	16 (19.8)	6 (8.5)
3	32 (39.5)	8 (11.3)	—	—
4	5 (6.2)	—	—	—

Table 2—Influence of farm and region on equine squamous gastric disease (ESGD) score on arrival.

Farm (region)	Horses, n	Horses with a low ESGD score of 0 or 1, n (%)	Horses with a high ESGD score of 2+, n (%)
A (North)	3	3 (100)	0 (0)
B (North)	13	8 (61.5)	5 (38.5)
C (North)	10	0 (0)	10 (100)
D (Reykjavik)	5	2 (40)	3 (60)
E (Reykjavik)	8	5 (62.5)	3 (37.5)
F (South)	12	0 (0)	12 (100)
G (South)	10	1 (10)	9 (90)
H (South)	6	2 (33.3)	4 (66.7)
I (South)	7	1 (14.3)	6 (85.7)
J (West)	7	1 (14.3)	6 (85.7)

Table 3—Relationship between region and days since arrival at stables.

Days since arrival at stables	Region (no. of farms)			
	North (n = 3)	Reykjavik (n = 2)	South (n = 4)	West (n = 1)
1–3	25	4	6	6
10–14	1	3	1	1
4–6	0	3	21	0
7–9	0	3	7	0

examination within 4 to 6 days of arrival were from the South region.

Equine glandular gastric disease

At the first endoscopic examination, 27% of the horses (22/81) had ulcers of clinical grade 1; 20% (16/81) had grade 2, as shown in Table 1. No significant associations were found between EGGD score on arrival and each of the following variables: age, sex, type of summer pasture, farm, and days since arrival. No evidence was found of any association between transportation type (P = .39) or nights spent in a stable before the first endoscopic examination (P = .46) and EGGD score at the first endoscopic examination. When grouped into binary categories, horses from the South region were 0.4 times less likely (95% CI, 0.16 to 1.00; P < .049) to have a high EGGD score compared to horses from any other region. There was no significant association found between the EGGD and ESGD scores on arrival.

Training period

Complementary feeding

The majority of the horses (57/71) were fed forage only. Eleven were given very small amounts of soaked sugar beet pulp (50 to 100 g/day dry weight). Three horses were fed a small amount of a commercial feed with an average starch intake of 0.4g/kg body weight/day. No horse was fed > 0.5g starch/kg body weight/day.

Equine squamous gastric disease

At the second endoscopic examination, 14% of horses (10/71) were found to have grade 2 ulcers; 11% (8/71) had grade 3 ulcers. No horse had grade 4 ulcers at the second endoscopic examination. There was a statistically significant reduction in ESGD scores recorded at the first and second endoscopic examinations (P = .028), as illustrated in **Figure 1**.

On univariate analysis, region, BCS, type of summer pasture, behavior in the stable or when handling, eating in the box or on turnout, as well as trainer-reported apparent social hierarchical position when turned out in a group did not affect the likelihood of an ESGD score reduction. Similarly, the number of hours given structured exercise did not have a significant association. **Table 4** shows the results of the univariable regression model for those variables associated (P < .2) with the outcome "ESGD score reduced."

The final mixed-level multivariable model for "ESGD score reduced" included the following variables: horse sex and number of meals per day as forage, along with farm name as a random effect. Being fed 3 or more meals of forage a day resulted in an increased likelihood of a reduction in ulcer score, with an odds ratio of nearly 18 compared to feeding 2 meals or less. Stallions and mares were more likely to have a reduction in ulcer scores compared to geldings.

No second-order interactions terms were retained in the final model. The Hosmer–Lemeshow goodness-of-fit test found no evidence of a lack of fit for the final model (P = .92). **Table 5** shows the results of the final multivariable logistic regression model.

Equine glandular gastric disease

At the second endoscopic examination, 32% of the horses (23/71) were found to have grade 1 ulcers and 9% (6/71) had grade 2 (Table 1). At the

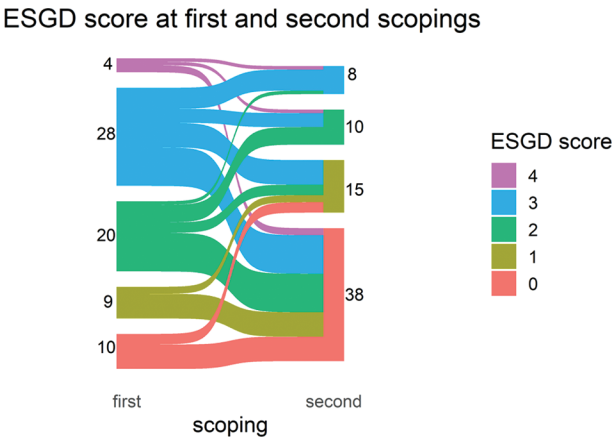

Figure 1—Sankey plot showing the change in equine squamous gastric disease (ESGD) score after 8 weeks for each of the 71 horses in the study cohort that underwent endoscopic examination twice.

Table 4—Results of the univariable regression modeling for those variables associated with the equine squamous gastric disease (ESGD) outcome score reduced ($P < .2$).

Variable	Horses, n	Where ESGD reduced, n (%)	Odds ratio	95% Confidence interval	*P* value
Region					
North, West, or Reykjavik[a]	40	23 (57.5)	1	—	—
South	31	24 (77.4)	2.53	0.89–7.24	.083
Horse age (years)					
3[a]	43	32 (74.4)	1	—	—
4	10	3 (30.0)	0.15	0.03–0.67	.013
≥ 5	18	12 (66.7)	0.69	0.21–2.27	.539
Horse gender					
Gelding[a]	12	5 (41.7)	1	—	—
Female	48	33 (68.8)	3.08	0.84–11.3	.09
Stallion	11	9 (81.8)	6.3	0.93–42.73	.06
Days since arrival before first endoscopic examination					
1–3[a]	37	20 (54.1)	1	—	—
4–6	20	17 (85.0)	4.82	1.2–19.29	.026
7–9	9	7 (77.8)	2.97	0.54–16.27	.209
10–14	5	3 (60.0)	1.28	0.19–8.55	.802
Summer pasture type					
Wet grassland[a]	52	32 (61.5)	1	—	—
Dry grassland	19	15 (78.9)	2.34	0.68–8.07	.177
Preserved forage/100-kg horse/day, kg					
1.5[a]	24	12 (50.0)	1	—	—
> 1.5–2	20	16 (80.0)	4	1.03–15.53	.045
> 2	27	19 (70.4)	2.37	0.75–7.5	.14
Meals of forage/day, n					
0–2 (low)[a]	16	5 (31.3)	1	—	—
≥ 3 (high)	55	42 (76.4)	7.11	2.08–24.23	.002
Grass as a significant part of diet					
No[a,b]	35	29 (82.9)	1	—	—
Yes	36	18 (50.0)	0.21	0.07–0.62	.005
Horse living predominantly outdoors					
No[a,c]	55	42 (76.4)	1	—	—
Yes[d]	16	5 (31.3)	0.14	0.04–0.48	.002
Time in paddock per day, hours					
> 4[a]	34	14 (41.2)	1	—	—
≤ 4	37	33 (89.2)	11.79	3.4–40.82	< .001
Type of paddock					
Grass or semidry lot[a]	45	26 (57.8)	1	—	—
Gravel	26	21 (80.8)	3.07	0.98–9.6	.054
Horses in paddock, n					
> 10[a]	20	7 (35.0)	1	—	—
1	12	10 (83.3)	9.29	1.57–54.77	.014
2–4	18	14 (77.8)	6.5	1.54–27.49	.011
5–10	21	16 (76.2)	5.94	1.52–23.18	.01
Forage available on paddock					
No[e]	57	41 (71.9)	1	—	—
Yes[f]	14	6 (42.9)	0.29	0.09–0.98	.046
Stable type					
Only outdoor [a,g]	17	6 (35.3)	1	—	—
Individual stall[h]	44	32 (72.7)	4.89	1.48–16.16	.009
Stalls[i]	10	9 (90.0)	16.5	1.67–163.4	.017
Days worked per week, n					
4–5[a]	53	38 (71.7)	1	—	—
2–3	16	8 (50.0)	0.39	0.13–1.24	.112
0–1	2	1 (50.0)	0.39	0.02–6.73	.521

[a]Reference category. [b]Maximum 2 hours in a semidry lot. [c]Does spend some time outside. [d]Only inside when being trained; no forage when inside. [e]No forage if out in paddock. [f]Some or all when out in paddock. [g]Other than when in for tacking up and training. [h]But not necessarily all day. [i]Different management.

Table 5—Final multivariable logistic regression model for equine squamous gastric disease (ESGD) reduced, showing fixed effects only.

Variable	Horses, n	ESGD reduced, n (%)	Odds ratio	95% Confidence interval	*P* value
No. of meals of forage/day					
Up to 2[a]	16	5 (31.3)	1	—	—
3 or more	55	42 (76.4)	17.95	1.67–193.40	.017
Horse gender					
Gelding[a]	12	5 (41.7)	1	—	—
Female	48	33 (68.8)	6.80	1.09–42.34	.040
Stallion	11	9 (81.8)	24.87	1.10–562.08	.043

[a]Reference category.
Farm name was retained as a random effect and accounted for 35% of the variance in the final model.

univariable level, 5 variables were found to have *P* values less than .2 for EGGD reduction: horse age, body condition score on arrival, behavior during eating and turnout, number of days worked per week, and reduced performance. None of these was retained in a multivariable model, and there were no significant associations at the level of $P < .05$ between EGGD score reduced and any variables assessed during the model-building process.

Discussion

Most of the previous work on the incidence of gastric ulcers and their risk factors has been undertaken on managed/stabled horses.[2,4] However, one study based on abattoir data in the United Kingdom suggested that feral horses were less likely to have gastric ulcers than domesticated horses (22.2% vs 60.8% for ESGD, and 29.5% vs 70.6% for EGGD).[18] However, as these were abattoir data, the information may have been influenced by transportation, fasting, and concurrent clinical disease. Our study showed the incidence of ESGD on the initial endoscopic examination to be high, with 73% of the animals having a score of 2 or more and nearly 45% having a score of 3 or 4/4. Nearly 50% of the horses had glandular ulcers present. This is very similar to the levels reported in previous work in managed or stabled horses, including our previous survey of Danish pleasure horses.[4] These comparable levels of incidence were despite the Icelandic horses having been out in pasture for many months, and for many not having been handled to any great extent. Many of the Icelandic horses evaluated in our study had been out their whole life in large herds, typically of more than 40 horses. This means they were being kept on large, extensive grazing areas and were only supplied with forage during the hard winter months when there is no access to grass. Even in Nordic countries outside Iceland, Icelandic horses are more likely to be kept permanently in groups (36%) than warmbloods (16%) or ponies (15%).[19]

There was an effect of region on ESGD incidence on arrival, but this was confounded by how many days since arrival the endoscopic examination was undertaken. Unfortunately, it was not practically feasible to ensure in this field study that all endoscopic examinations were undertaken at the same time after arrival from pasture. It is therefore possible that the cumulative changes in management that occurred prior to undergoing endoscopic examination initiated the ulcers that were then picked up during the endoscopic examination, especially in the horses evaluated slightly later, thereby explaining the association between time from arrival and ulcer score. However, most of the horses had been born and bred on their particular farm and they were collected quietly, with no transportation from the grasslands around the training stables, and moved to the training area. None of the horses started training before their initial scope and therefore training per se was not an initiating factor. There was no evidence that transportation or nights spent stabled before the first endoscopic examination was associated with significant ESGD or EGGD scores. In addition, for example, all the horses from farm C in the North had significant ESGD ulcers and yet they had not been transported, nor stabled nor fed anything but grass, and were not handled before undergoing endoscopic examination for the first time, most of them within a few days of being moved to the paddocks closer to the training stables. It is possible that differences in management (including pasture-associated effects) between farms were therefore the driving factor for this association, rather than days since arrival. Further investigation, therefore, is required to establish whether there are any differences in management, including the pasture, which could account for differences in ESGD score.

When discussing risk factors for the domesticated animal, pasture turnout is often suggested to reduce the risk and be a possible positive management factor.[2,3] However, this comparably high incidence in the horses moving in from pasture suggests that this is not always the case. This was also shown during the training period, when being kept outdoors (and only moving in to be prepared for training, during which time forage was not available) actually reduced the likelihood of the squamous ulcers reducing (univariable odds ratio, 0.14). Certainly previous work has suggested that pasture turnout with the feeding of starch- and sugar-rich feed does not appear to be protective with respect to gastric ulcers.[20–23] However, in our study, the horses were not being fed any complementary feed when out in

the pasture, and at least 2 other studies have shown that ESGD scores can be worse for horses in pasture, even when starch- and sugar-rich feed are not being fed, and that scores improve when the horses are brought in and stabled.[23,24] In the most recent article,[24] the authors comment that "the finding of decreased non glandular ulcer scores in both groups when stall confined was unexpected," and suggested that it might be a result of the greater plane of nutrition during stall confinement, especially because they noted that body weight increased slightly during their 28-day study period. Interestingly both these previous studies, as well as ours, were undertaken in the autumn and winter, suggesting there could be some protective effect of bringing in at this time, individually feeding and providing shelter from the weather, and so on. It should be noted that in our study, none of the animals were in poor body condition and many were, in fact, obese and overweight, suggesting other factors may be involved than nutritional adequacy. However, research has suggested that Icelandic horse may be more likely to maintain a positive energy balance compared to other breeds, despite not having a better digestive capacity,[25] and therefore having an acceptable body condition may not rule out the importance of the plane of nutrition nor the quality or texture of the forage on ulcer incidence. Certainly, there appeared to be an influence of the farm in the incidence of ESGD, although this was confounded by an association between farm, region, and days since arrival before undergoing endoscopic examination. This does suggest some possible association between farm location, management, pasture type and the risk of pasture-associated ESGD. Farm was also important in the final model for reduction in ESGD, representing around 35% of variance, indicating that local management was a significant contributor to the likelihood of ESGD score reduction during the 8 weeks. More work is needed to understand the role of season, farm pasture, and farm location and management practices on ESGD incidence.

Intake of starch and sugar is a known risk factor for ESGD, with recommendations made that intake per meal should be less than 1 g/kg body weight.[3,6] In our study, even those horses that received some complementary feed were receiving less than 0.5 g starch/kg body weight/day. The feeding of predominantly forage with only an occasional small amount of starch- and sugar-rich complementary feed, appears to be typical in Iceland.[26]

Regular provision of preserved forage is another key recommended nutrition management factor[2,3,6,] to help reduce ESGD incidence, and this was strongly supported by our study. Feeding preserved forage at 1.6% of body weight or more in the univariable analysis had an odds ratio of 4 of reducing the ESGD score, and the protective effect of being housed in stalls (univariable odds ratio, 16.5) when stabled was likely a result of the fact that all the horses that were housed in stalls were provided with more than 3 meals of forage a day. This fits with the multiple feeding of forage being retained in the final multivariable model. Providing forage in 3 or more meals a day had an odds ratio of nearly 18, for a reduction in ESGD score over the 8 weeks of training compared with feeding 0 to 2 times per day, emphasizing its importance.

There was an increased chance of ulcers being reduced in the females and especially the stallions compared to the geldings, which might just reflect the increased management and care provided to these genders when they are brought in for training. Females at this age are potential breeding stock, as are the stallions, and therefore may be managed more carefully than geldings. There has not been a consistent effect of sex reported on ulcer incidence.[2] Most studies have found no influence of sex, although in the postmortem study mentioned earlier,[13] for example, the opposite to the findings reported here in vivo was found in that a greater incidence was reported in stallions. However, interestingly, a previous study[27] showed that although the overall prevalence of ulceration was comparable between sexes, the relative risk increased with age in geldings and decreased in females and stallions, suggesting that further work may be beneficial in this area. The absolute number of both stallions (n = 11, all fed ≥ 3 meals of forage per day) and geldings (n = 12, all fed ≥ 3 meals of forage per day) compared to females (n = 48, 38 fed ≥ 3 meals of forage per day) in the final study cohort was not high enough to determine which management factors specifically might have driven this increased reduction in ESGD over the 2 months. Further study designed specifically around a cohort with balanced numbers of each sex of horse is required to draw any further conclusions. These findings also confirm that although the feeding of 3 or more meals of forage a day increases the chance of ulcer healing significantly it does not mean that ulcers will improve in all horses when provided with 3 meals of forage a day (as all geldings were provided 3 or more forage meals per day). Similarly, not all ulcers, even mild ulcers, will resolve after medical/pharmacologic treatment.[2]

No effect of sex, age, region, farm, pasture type, or days since arrival at the training stable were found on the incidence of EGGD, although a relatively high proportion of the horses had glandular ulcers. Transportation was not a contributing factor either, especially as 100% of cases with an EGGD score of 2 had not been transported in a trailer. Other unidentified factors, therefore, are important in the pathogenesis of EGGD, as has been recognized previously,[6] and this aspect needs to be explored further. Typically, at 3 years of age, Icelandic horses are brought in for initial handling and light training for a few months before being turned out again in their large groups. Most of the horses in this study, therefore, would never have been stabled before nor would they have had any close interaction with humans, and would not have been used to being stabled. The change in management would have been thought to have been a stressor and therefore potentially increased the risk of ulcers as they underwent the training, but this was not seen. At the multivariable

level, no management risk factors were identified in this study for either EGGD reduction or increase over the 8 weeks of training, despite the study being sufficiently powered to show significant effects for ESGD. It should be noted, however, that these horses were not fed high intakes of starch and sugar per day, which in one study was associated with an increased risk of EGGD.[5] Perhaps more importantly, as mentioned earlier, they were not being exercised very hard or frequently. This might explain the lack of an increase in glandular ulceration during the training period. A previous study[12] suggested that even in top Icelandic pace horses, serious training appears to commence at a relatively mature age (typically 5.4 ± 1.0 years), and although they are trained most weekdays, training in pace is limited (1.6 ± 0.9 times per week). It would therefore be interesting to repeat the incidence survey in more animals at different stages of training.

In conclusion, this study confirms that a high prevalence of both ESGD and EGGD can be found in horses kept out in groups in pasture. As a result of their severity in some horses, they are likely to have had some impact on equine health and welfare, although no clinical signs were reported. Bringing these horses in under human management and providing them with multiple meals of forage a day resulted in a significant reduction in ESGD scores, although there was little impact on EGGD prevalence. This emphasizes the importance of forage provision to horse health, and suggests that appropriate management practices can be of benefit with respect to nonglandular ulcers. However, more work is required to understand the factors contributing to the high incidence of ulcers when having come from autumn and winter pasture.

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