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The Effect of Screw-in Studs on Equine Hoof and Limb Kinematics while Cantering and Jumping on an Artificial Surface

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Abstract

Studs are used to optimize hoof grip upon contact with the surface to prevent slip and enhance performance. Previous research has explored the influence of uniaxially placed studs on a grass surface during canter, the influence of stud length on braking forces, and the effect of restricted foot slip on bone strains. However, previous work has not addressed the influence of biaxially placed screw-in studs during canter and jumping on an artificial surface. A study was designed using seven actively competing showjumping horses which were subjected to two treatments: no studs (control) and studs. Studs were placed biaxially in the heel of each shoe. Kinematic analysis was conducted using high-speed video footage during canter and jumping. The test fence was set at a height of 1.20m with a width of 1m. No differences in slip distance or slip duration were observed across all phases ($P > 0.05$). A decrease in stance duration of the leading forelimb was seen at jump landing ($P < 0.05$). Take-off angle increased by 4.5° ($P < 0.05$), elbow angle during suspension was more acute ($P < 0.05$) and landing distance from the fence was greater by 0.31m ($P < 0.05$). The study demonstrates that canter kinematics were largely unaffected by stud use on an artificial surface; however, unexpectedly, some jumping parameters significantly improved. A reduction in the stance duration at jump landing is concerning as this may lead to higher braking forces in the distal limb, potentially resulting in an increased risk of overload injuries.

Keywords

Slip; traction; shoes; grip; biomechanics; performance

1. Introduction

The use of screw-in studs is a significant aspect of horse sport and competition [1]. The aim of using studs is to maximize the amount of grip the hoof has as it contacts the surface to reduce foot slip and optimize competitive performance. Studs are most commonly used in show jumping, eventing, and polo when competition surfaces have a greater potential for the horse to slip [1]. In recent years, many horses have competed successfully at the top level barefoot, with others remaining shod; this has sparked debate relating to competition surfaces, injury, shod versus unshod, and the hoof-surface interaction. Studs are most frequently employed on grass surfaces, with anecdotal evidence suggesting their use on artificial surfaces as well. However, studding decisions remain largely based on personal experience and preference rather than consultation of reliable scientific knowledge because there is a lack of evidence to support such guidance [1].

The hoof-surface interaction and the subsequent action of generated forces on the distal limb tissues are believed to be a principal element in the incidence of injury [2]. It has been previously suggested that studding choices may play a role in injury, as highlighted at the 2004 Olympic Games in Athens when several horses sustained injuries which were later thought to be due to the interaction of studs used and the competition surfaces [3]. At impact, a certain

amount of foot slip is suggested to be a desirable part of the natural mechanism of shock attenuation [4,5]. This sliding mechanism of the hoof as it decelerates, dissipates the forces associated with impact [6,7]. The hoof-surface interaction is a complex process influenced by a myriad of factors. Peterson *et al.* [8] have previously divided the stance phase of the limb into stages: primary impact, secondary impact, support, and rollover. It is a secondary impact that the leg is pushed forward by the body, in turn causing the hoof to slide forward over the surface [4]. The amount of hoof slip will be influenced by surface properties, speed of the horse, interaction between the layers of the surface, surface material, and the coefficient of friction between the hoof-surface interface [3,9]. Therefore, the use of traction devices, such as screw-in studs, alters this natural mechanism and may have injury implications [1,10,11].

To date, research relating to the effect of traction alterations and screw-in studs is lacking and has largely focused on grass surfaces. Early investigations focusing on toe grabs, a projection made into the shoe at the toe used in Thoroughbred racehorses in the past, have been identified as a potential factor for fatal musculoskeletal injury due to the resulting kinematic changes [12,13]. Furthermore, Harvey *et al.* [1] investigated the effect of a uniaxial stud placed at the lateral heel during canter on a grass surface. In this context, it was shown that the use of studs significantly shortened the hoof slip distance with stud efficacy also varying between limbs [1]. More recently, in vitro studies using cadaveric forelimbs demonstrated that restriction of the forward sliding of the equine hoof during loading can affect bone strains more proximal in the limb [10]. In addition, investigations of factors influencing rotational shear resistance of arena surfaces have shown that the use of studs resulted in increased maximum torque and rotational shear resistance increased as stud length increased [11]. Alteration of hoof-surface interaction on artificial surfaces remains largely unexplored. The current study aimed to investigate the effect of biaxially placed screw-in studs on hoof and limb kinematics during canter and jumping on an artificial surface. Information relating to the effect of studs during jumping or on an artificial surface is currently lacking. The null hypothesis was that biaxially placed screw-in studs would not alter hoof and limb kinematics in horses cantering and jumping on a sand and fiber surface.

2. Materials and Methods

2.1. Horses

Seven warmblood show jumping horses, 7.85 ± 2.04 years of age, with a height at the withers of 168.57 ± 1.03 cm, were included in the study (mean ± standard error). This group of subject horses was chosen as they were actively competing and accustomed to wearing studs, to give a more accurate representation of competition conditions. All horses were in active-ridden exercise at the time of data collection. Horses were shod with standard steel shoes, tapped with regular stud holes, on all four feet. To reduce variability in riding style, the same test rider was used for the duration of data collection. All horses undertook testing in their respective saddle and bridle, with only studs altering between treatments. All horses wore protective boots on each limb during each treatment. Subject horses were randomly split into two groups **(Table 1)**, with testing taking place over four days. Group 1 was tested on Days 1 and 3; Group 2 was tested on Days 2 and 4. This was done due to time constraints on behalf of the test rider. For all procedures carried out, consent was obtained from the horse owner.

2.2. Study Design

The studs chosen for this study were those routinely used in competition **(Figure 1)**. Two studs were placed in the heel of each shoe; therefore, larger studs were placed in the hind shoe as compared to the front shoe. For kinematic analysis, reflective markers were placed at palpable anatomical locations: these included the lateral aspect of the carpal joint, lateral aspect of the metacarpophalangeal joint, posterior part of the greater tubercle of the humerus, and the distal tibia at the lateral malleolus **(Figure 2)**. White titanium-based solvent (correction fluid) was used to create circular markers on the toe of each hoof, lateral aspect of the leading limbs, and the medial aspect of the trailing limbs. This procedure was similar to that used by Harvey *et al.* [1] **(Figure 2)**.

An outdoor arena with a surface that consisted of (by weight) 97% silica sand and 3% fiber (EqueFibre, Belgium) was used for the trial duration. The arena surface was harrowed to a depth of 2.5 inches using a standard equine arena harrow (Falcon Harrow, Equine Engineering) as per manufacturer recommendation, one hour before data collection began on each trial day. The test fence was set at a 1.20m high oxer fence with a width of 1m. This height was chosen to simulate competition conditions as it was comparable to the competition level of the subject horses. To reduce any variability in horse position at take-off, a ground-line pole was placed 30cm from the base of the fence, with another placing pole set 650cm from the ground-line pole. Two high-speed cameras (Casio Exilim EXZR800) were used for video recording during the trial. All footage was recorded at 120 frames/sec. One high-speed camera (camera 2) was used to record an overall view of the horse while cantering and jumping. The second camera (camera 1) was used to record a closer view of the hoof-surface interaction. Trial area setup and camera placement are illustrated in **Figure 3**. The setup design was decided after the analysis of the pilot study data.

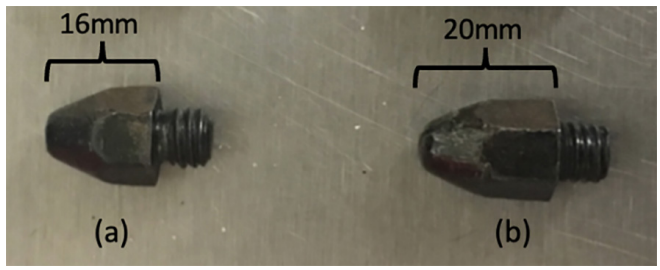

Figure 1: Studs used during the trial period. Studs (a) placed in the front shoes. Studs (b) placed in hind shoes.

Figure 2: Anatomical marker placement for data collection and kinematic analysis.

2.3. Experimental Procedure

Horses were subjected to two treatments: Treatment 1 with no studs (control) and Treatment 2 with studs. Treatments were assigned to each horse on a randomized basis **(Table 1)**. To begin the trial, horses completed a warm-up ranging between 20 to 25 minutes in duration to mimic their standard competition warm-up. This included walk, trot, canter, on both reins and over small warm-up fences until the rider felt the horse was ready to begin. All canter variables were collected first by cantering the horses through a chute three times **(Figure 3a)**. This was an overall view of the horse (camera 2) and a closer view of the hoof-surface interaction (camera 1), recorded simultaneously. Camera 1 captured slip distance, slip duration, and stance duration only, while camera 2 captured all other variables.

All jumping variables were captured as each horse progressed through the jump chute six times **(Figure 3b)**. For all six jumping efforts, an overall view of the horse from take-off to landing was recorded (camera 2). For jump trials 1–3, a closer view of the hoof-surface interaction at take-off was captured (camera 1), then for jump trials 4–6, this camera was moved to record the hoof-surface interaction at landing, as shown in **Figure 3b**. This was due to limited high-speed camera availability at the time of the study. No fences were knocked during the trial period by any of the subject horses. Following completion of the trial, each subject horse was cooled off, brought back to the stable, and the next horse was prepared. All footage was recorded from the left side of each horse and on the left rein.

2.4. Kinematic Analysis

Kinematic analysis was carried out in Image J Analysis software **(www.imagej.net)** and was blinded to the treatments. The resulting data was exported to Microsoft Excel (Excel 2021, Microsoft) for later statistical analysis. Foot-on was specified as the frame number (time) when any point of the hoof made contact with the surface. Toe-off was defined as the time when the toe was shown to leave the ground on high-speed footage. The method used to determine all indicators during footage analysis was validated and demonstrated to be a repeatable procedure, compared to alternative approaches, as adapted from **[1]**. Anatomical movement was calculated as the distance between markers in a horizontal plane, parallel to the ground. Similar to **[1]**, slip distance was defined as the horizontal distance moved by the toe marker from foot-on to heel-lift, with toe marker coordinates alone being used in the calculation of slip distance. Kinematic parameters measured are detailed in **Figure 4**. All joint angles at canter, jump take-off, and jump landing were measured at mid-stance. Bascule angle was measured from jump take-off, through suspension, to jump landing.

2.5. Statistical Analysis

Statistical analysis was carried out using IBM SPSS software Version 29. The data was initially tested for normality, and based on this, the appropriate statistical tests were used. These were the Paired T-Test and Wilcoxon Signed-Rank Test. A significance level of $P < 0.05$ was used for all statistical tests.

Table 1: Randomized Trial Order for the duration of data collection.

Horse No.	Day 1	Day 2	Day 3	Day 4
1	Treatment 2	-	Treatment 1	-
2	Treatment 1	-	Treatment 2	-
3	Treatment 2	-	Treatment 1	-
4	Treatment 1	-	Treatment 2	-
5	-	Treatment 1	-	Treatment 2
6	-	Treatment 1	-	Treatment 2
7	-	Treatment 2	-	Treatment 1

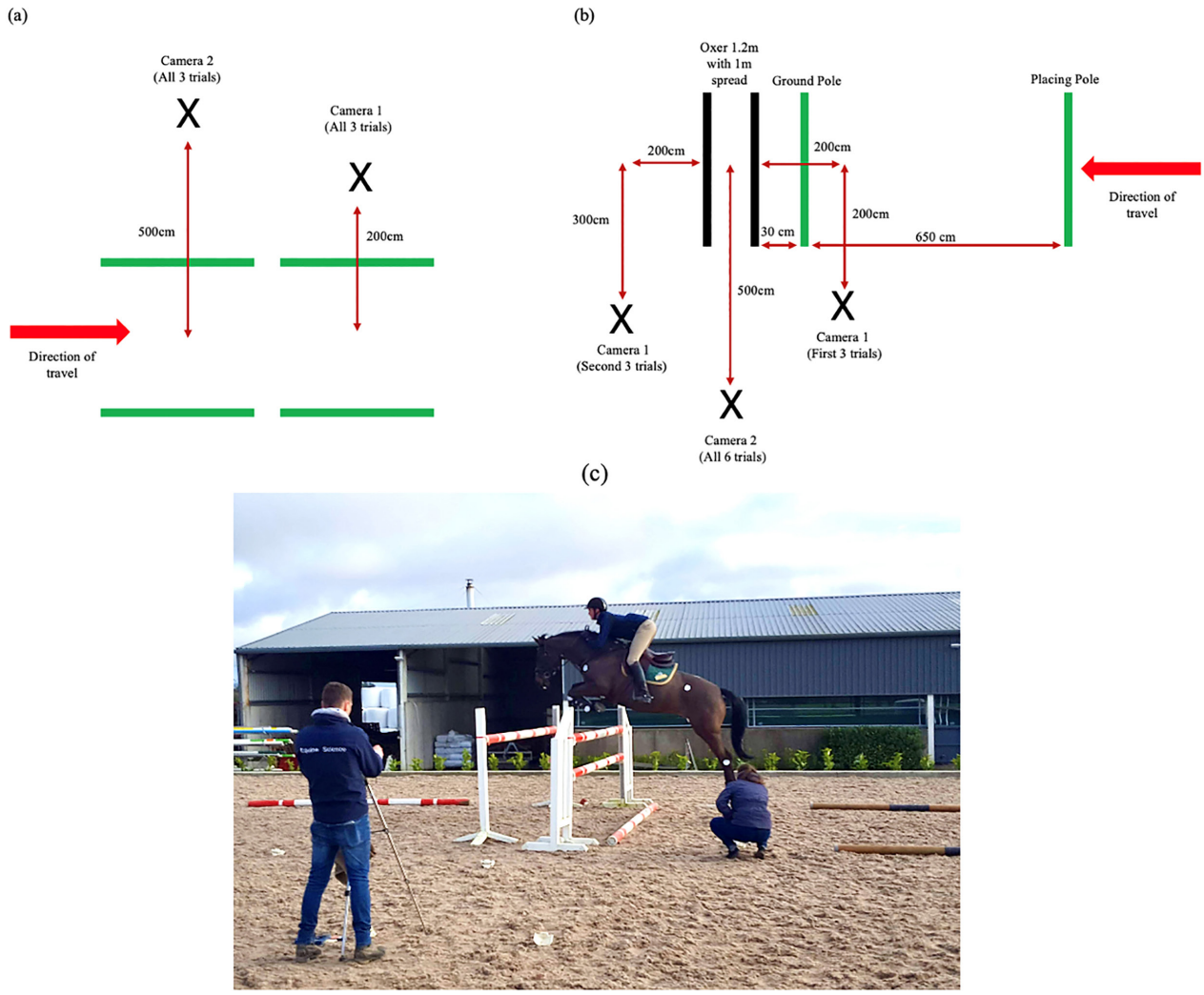

Figure 3: Trial area setup and camera placement for (a) the canter chute, (b) the jumping chute during the trial period, and (c) data collection at jump take-off.

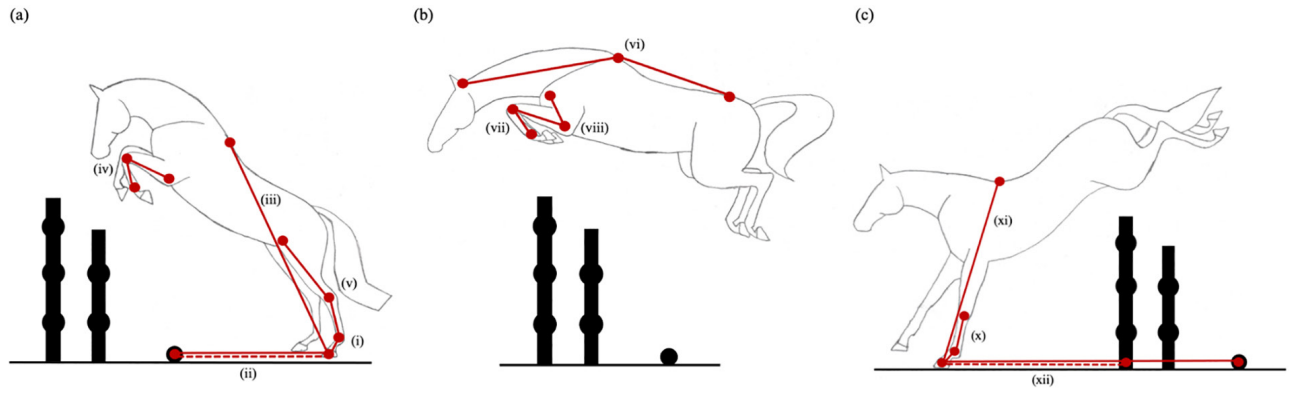

Figure 4: Kinematic parameters measured at jump: (a) take-off, (b) suspension, and (c) landing: (i) Hind fetlock angle (hoof – fetlock – hock), (ii) Distance from the fence (ground pole – hoof of the last limb to leave the ground), (iii) Take-off angle (ground pole – hoof – wither), (iv) Knee angle (fetlock – knee – elbow), (v) Hock angle (fetlock – hock – stifle), (vi) Bascule angle (shoulder – wither – stifle), (vii) Knee angle (fetlock – knee – elbow), (viii) elbow angle (knee – elbow – shoulder), (ix) Fore fetlock angle (hoof – fetlock – knee), (x) Landing angle (knee – hoof – ground pole), and (xi) Distance from the fence (hoof – fence).

3. Results

All results are illustrated as mean ± SE. A significant difference between treatments is denoted with an asterisk and/or highlighted in bold.

3.1. Hoof-Surface Interaction

3.1.1. Slip Distance

There was no significant difference shown in slip distance during canter, jump take-off, or jump landing with studs compared to without studs ($P > 0.05$; **Figure 5**).

Slip distance reductions at canter expressed as a percentage are by 22% in the LF, by 40% in the TF, by 28% in the LH, and by 46% in the TH. At jump take-off, hoof slip distances were reduced by 0.5% in the LF, by 46% in the TF, by 0.1% in the LH, and by 7% in the TH. However, at jump landing, hoof slip distances were increased by 2% in the LF, by 64% in the TF, by 21% in the LH, and by 7% in the TH.

3.1.2. Slip Duration

There was no significant difference shown in slip duration during canter, jump take-off, or jump landing with studs compared to without studs ($P > 0.05$; **Table 2**).

3.1.3. Stance Duration

Stance duration during canter and jump take-off showed no significant difference **(Table 3)**. It was only the leading fore limb at jump landing that showed a significant decrease in stance duration between treatments ($P < 0.05$; **Table 3**). This was a 14.78 ms reduction in stance duration.

3.2. Canter Kinematics

There was no significant difference shown in any kinematic parameters at canter ($P > 0.05$; **Table 4**).

3.3. Jump Kinematics

Jump kinematics are presented in **Table 5** and **Figure 6**, respectively. At jump take-off, hind fetlock angle appeared significantly decreased by 5.99° ($P = 0.025$) with studs. Take-off angle was significantly increased by 4.5° with the addition of screw-in studs ($P = 0.035$). Moreover, elbow angle at suspension was significantly decreased by 4.41° ($P = 0.045$). Landing distance from the fence was shown to significantly increase by 0.31 m with studs compared to without studs ($P = 0.015$).

4. Discussion

This study aimed to investigate the effect of screw-in studs on equine hoof and limb kinematics. Previous research has explored the influence of uniaxially placed studs on a grass surface during canter **[1]**, the influence of stud length on braking forces **[11]**, and the effect of restricted foot slip on bone strains **[10]**. However, previous work has not addressed the influence of biaxially placed screw-in studs during canter and jumping on an artificial surface.

The current study showed no significant difference in hoof slip distance with studs while cantering on an artificial surface. As previously illustrated by Harvey *et al.* **[1]**, a significantly shorter slip distance across all four feet was observed using a uniaxial stud placed on the outside of the foot while cantering on grass. While it would be expected to see a decrease in slip distance with the use of studs on a grass surface, the sand and fiber surface used in the current study is more deformable compared to grass, which may explain the results presented here **[6,14]**. The use of fiber in a sand-based surface is suggested to be advantageous in providing enhanced cushioning and stability to the surface **[3]**, while also creating a root-like structure similar to turf surfaces **[15]**. This may offer what is described as a more natural footing, yet it may not influence hoof kinematics, specifically hoof slip, to the same extent as a grass surface. However, exact surface properties were not measured in the current study. Additionally, canter speeds reported by Harvey *et al.* **[1]** were greater than those observed in the current work. This may further explain the reduced effect of screw-in studs in the current study, as hoof slip is influenced by horse speed and surface properties **[3,9]**. Future work should investigate the effects of screw-in studs across a range of speeds and surface types before a more definitive conclusion can be drawn.

Moreover, it was observed in the current study that studs had the greatest increase in grip at canter in the hind limbs compared to the forelimbs, and in the trailing limbs compared to the leading limbs, as shown by the percentage alteration in slip distances. Although these differences were not statistically significant, they align with the findings of Harvey *et al.* **[1]** and support the suggestion that the kinematic patterns of the fore and hind limbs are functionally different. During canter, the forelimbs are found to 'bounce' with higher vertical hoof velocity and accelerations at impact compared to the hind limbs, which 'slide' with increased horizontal hoof velocity and accelerations at impact **[16]**. Indeed, these findings reinforce the idea proposed by Harvey *et al.* **[1]** that stud choice is perhaps better tailored to the limb of interest. If a decrease in slip and an increase in grip is the desired outcome, it may be more prudent to apply studs solely to the hind limbs. In addition, the increased efficacy of studs in the trailing limbs may be made clear by the asymmetric nature of the canter gait, as such, there is greater loading and vertical force transmitted to the trailing limbs, thus generating a greater slip distance, which is then further restricted by the mechanism of heel studs **[17,18]**.

It was the leading forelimb alone that had a significantly shortened stance duration by 14.78 ms with the addition of screw-in studs, which may further increase jarring forces experienced by the limb at jump landing. Previous research attempting to characterize hoof kinematics while jumping showed that at landing, the leading forelimb functions as a brake to retard jump acceleration **[19,20]**, with significantly greater horizontal decelerations in the leading limb compared to the trailing limb **[21]**. The leading forelimb also experiences the largest braking forces compared to the other limbs **[18]**. However, larger vertical ground reaction forces have previously been associated with the trailing limb compared to the leading limb **[14]**. Additionally, it is the trailing limb that experiences almost exclusively vertical movement, with a lack of horizontal movement **[2]**. This previous research explains the lack of effect seen in the trailing forelimb at jump landing with the addition of studs. Therefore, as suggested by Rohlf *et al.* **[21]**, the leading forelimb may be at a greater risk of injury at jump landing, further compounded by the use of screw-in studs.

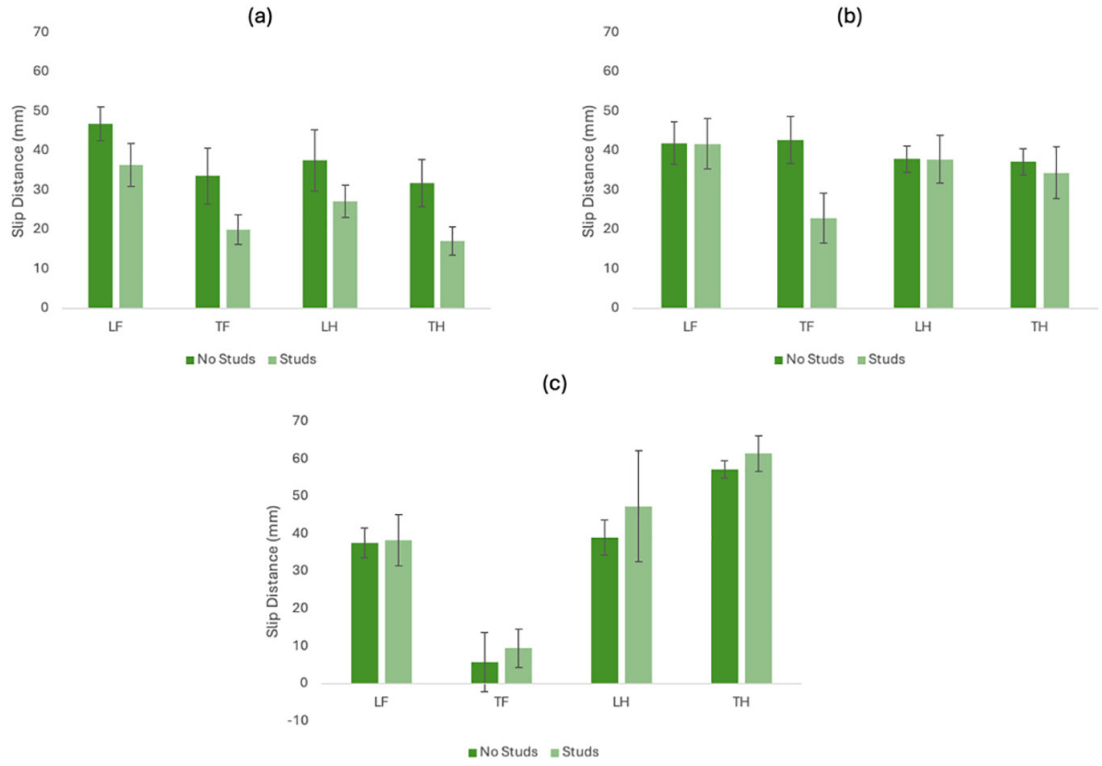

Figure 5: Mean slip distance in millimeters (mm) for each limb; Leading fore (LF), Trailing fore (TF), Leading hind (LH), and Trailing hind (TH) at (a) canter, (b) jump take-off, and (c) jump landing on an artificial surface with (right) and without (left) studs.

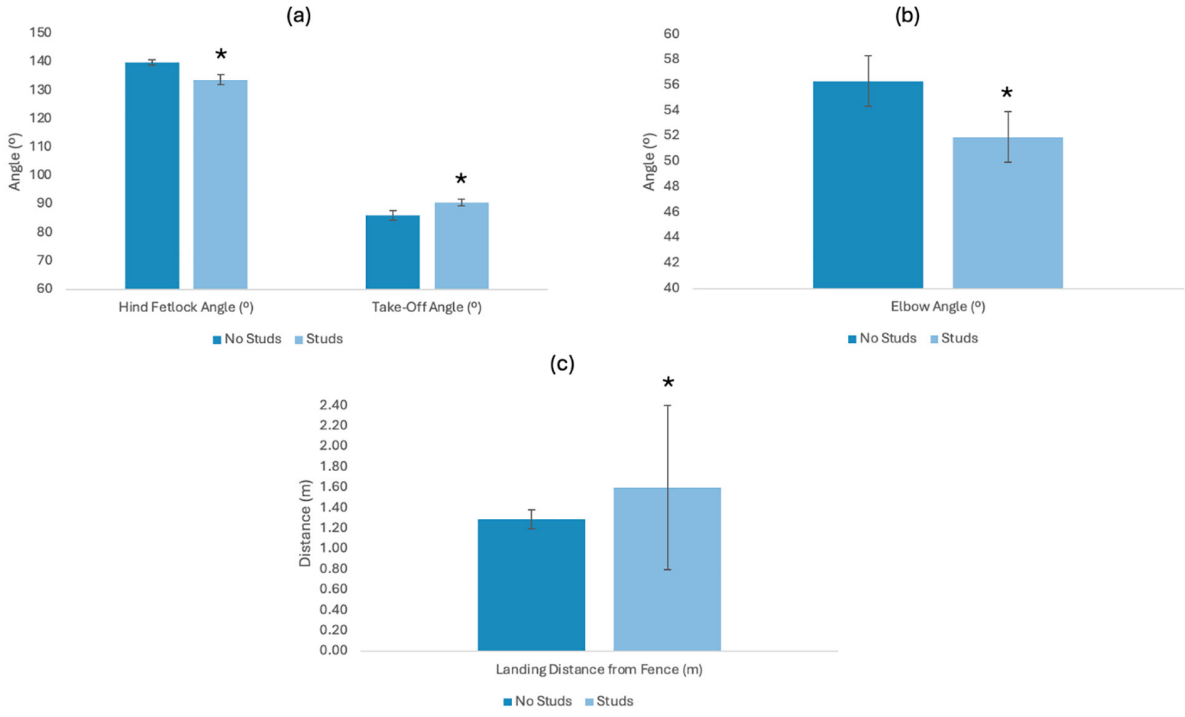

Figure 6: Jump kinematics at (a) jump take-off, (b) suspension, and (c) jump landing on an artificial surface without and with screw-in studs.

Table 2: Mean slip duration in milliseconds (ms) for each limb (mean ± SE); Leading fore (LF), Trailing fore (TF), Leading hind (LH), and Trailing hind (TH) at canter, jump take-off, and jump landing on an artificial surface without and with screw-in studs.

		Without Studs	With Studs	*P*-Value
Canter	LF	53.19 ± 3.65	55.63 ± 4.97	0.394
	TF	55.04 ± 5.10	58.10 ± 3.77	0.480
	LH	53.29 ± 5.01	44.27 ± 7.52	0.096
	TH	52.14 ± 3.51	47.14 ± 6.46	0.328
Jump Take-Off	LF	31.03 ± 1.92	31.86 ± 2.29	0.754
	TF	31.34 ± 1.38	28.59 ± 3.92	0.504
	LH	30.23 ± 1.23	27.87 ± 3.37	0.523
	TH	30.97 ± 1.33	27.87 ± 3.47	0.458
Jump Landing	LF	37.29 ± 3.03	41.71 ± 2.63	0.368
	TF	40.43 ± 2.51	41.29 ± 3.47	0.887
	LH	36.71 ± 1.67	42.00 ± 4.39	0.371
	TH	36.14 ± 0.83	40.14 ± 2.96	0.237

Table 3: Mean stance duration in milliseconds (ms) for each limb (mean ± SE); Leading fore (LF), Trailing fore (TF), Leading hind (LH), and Trailing hind (TH) at canter, jump take-off, and jump landing on an artificial surface without and with screw-in studs.

		Without Studs	With Studs	*P*-Value
Canter	LF	221.27 ± 4.89	223.04 ± 5.88	0.847
	TF	210.70 ± 8.22	214.27 ± 6.67	0.714
	LH	216.40 ± 3.75	223.03 ± 3.82	0.288
	TH	212.84 ± 8.23	213.54 ± 5.54	0.943
Jump Take-Off	LF	181.74 ± 6.39	168.31 ± 4.61	0.072
	TF	178.17 ± 13.35	191.66 ± 3.92	0.341
	LH	216.87 ± 9.49	204.17 ± 6.64	0.355
	TH	220.44 ± 9.95	202.20 ± 5.69	0.126
Jump Landing	LF	217.21 ± 4.54	202.43 ± 5.46	<0.001*
	TF	187.44 ± 5.81	181.53 ± 3.21	0.415
	LH	201.34 ± 6.38	202.90 ± 6.63	0.558
	TH	192.80 ± 7.22	185.93 ± 4.65	0.161

Certain jumping performance parameters appeared to improve with the addition of screw-in studs. These were a significantly more acute hind fetlock angle at take-off, a more acute elbow angle during suspension, and a significant increase in landing distance from the fence. Take-off, landing, and limb clearance over the obstacle play a crucial role in show jumping performance **[22]**. Recent work by Clayton *et al.* **[23]** highlighted that trunk elevation at take-off appears to be a decisive factor in achieving maximal height during suspension and the horizontal distance jumped. This is highlighted in the current work by a significant increase of 4.5° in take-off angle, resulting in a 0.31 m increase in landing distance from the fence with studs. Furthermore, this increase in take-off angle is a desirable aspect of jumping technique, with many linear scoring evaluations awarding greater distinction to this more upward take-off trajectory. Recent research has highlighted links between linear scoring evaluations and later jumping career performance **[24,25]**, with the direction of take-off being significantly associated with performance **[26]**. Due to this alteration at jump take-off, the latter stages of the jump phase appeared improved, as the suspension phase is determined at take-off **[27]**. This is a significantly more acute elbow angle of 4.41°, suggesting greater limb clearance over the fence and, as such, overall jumping performance. With limited significant alterations in hoof kinematics to explain these notable improvements

in jumping performance, the authors reason that the subject horses may have felt increased confidence while jumping with the addition of screw-in studs. Confidence while jumping is a difficult parameter to quantify; however, anecdotally, it is suggested that when competitive horses feel they have greater purchase and grip on a surface, this leads to a more confident, explosive, and expressive jumping performance.

Improved jumping performance with the use of screw-in studs, combined with hoof kinematic alterations, may result in increased injury risk. Previous research has highlighted that near-maximal tendon forces are experienced at fence heights of 1.20 m **[19]**, with loads experienced by the forelimbs increasing as fence height increases **[28]**. Furthermore, Singer *et al.* **[10]** demonstrated that a restriction of foot slip by 30 mm significantly altered bone strains in the distal limb. In this study, hoof slip reductions were not significant; however, they ranged between 10.3 mm to 19.8 mm across all feet and phases. This is of some concern, considering the fence height was at 1.20 m. During competition, with increasing fence height and less deformable surfaces, these reductions may approach levels seen by Singer *et al.* **[10]**.

Comparisons made here are tenuous due to differences in experimental design between studies. However, repeatedly altering the natural shock attenuation mechanisms of the hoof while jumping may, over time, overload the soft tissues of the distal limb, leading to injury development **[29]**. This suggests that the use of screw-in heel studs may play a role in injury development; yet, much more work is needed in this area. Further research is required to fully understand the implications of studding horses for competition and to identify links between alterations in hoof and limb kinematics and mechanisms of injury. Determining the most favorable stud size, stud shape, placement, and configuration to minimize potential injury across various surface types, without conceding increased grip as a requirement for competition, would lead to the best decisions for horse welfare and career longevity in modern equestrian sport.

Table 4: Limb Kinematics at canter (mean ± SE) without and with studs.

		Without Studs	With Studs	*P*-Value
Canter	Stride Length (m)	4.06 ± 0.19	3.69 ± 0.13	0.083
	Speed (m/s)	6.45 ± 0.31	5.49 ± 0.29	0.073
	Step Length (m)	1.41 ± 0.04	1.38 ± 0.06	0.511
	Fore Fetlock Angle (°)	114.28 ± 3.34	116.93 ± 2.66	0.399
	Hind Fetlock Angle (°)	134.18 ± 1.04	137.21 ± 1.78	0.164
	Hock Angle (°)	134.62 ± 1.02	134.83 ± 1.13	0.867

Table 5: Jump Kinematics (mean ± SE) without and with studs.

		Without Studs	With Studs	*P*-Value
Take-off	Hind Fetlock Angle (°)	139.74 ± 0.92	133.75 ± 1.76	0.025*
	Distance from Fence (m)	2.17 ± 0.16	2.05 ± 0.15	0.621
	Take-off Angle (°)	86.05 ± 1.61	90.55 ± 1.08	0.035*
	Knee Angle (°)	116.17 ± 4.09	105.83 ± 3.52	0.111
	Hock Angle (°)	134.62 ± 1.02	134.83 ± 1.13	0.867
Suspension	Bascule Angle (°)	181.81 ± 1.37	182.01 ± 1.23	0.852
	Knee Angle (°)	41.74 ± 4.42	38.86 ± 3.73	0.548
	Elbow Angle (°)	56.33 ± 1.86	51.92 ± 1.90	0.045*
	Duration of Suspension (sec)	0.49 ± 0.01	0.48 ± 0.01	0.731
	Speed of Suspension (m/s)	11.44 ± 0.42	12.36 ± 0.62	0.161
	Suspension Stride Length (m)	5.59 ± 0.16	5.95 ± 0.27	0.053
Landing	Fore Fetlock Angle (°)	109.62 ± 2.19	107.03 ± 2.29	0.386
	Landing Angle (°)	63.49 ± 2.29	64.17 ± 1.61	0.655
	Distance from Fence (m)	1.29 ± 0.9	1.60 ± 0.08	0.015*

5. Limitations

The current study did not measure exact surface properties. Future work should combine both surface property measurements with the influence of traction devices. While surface properties are influential in altering kinematics, they were kept consistent during the four-day testing period. The surface was prepared using the same protocol and weather conditions remained consistent throughout the trial.

Studs chosen for the trial were based on industry experience of the authors, in the absence of scientifically informed guidelines. Both authors groomed and studded horses at FEI 5* level show jumping. Future research is needed to understand what screw-in studs industry stakeholders are using across various surface types, so that investigations may be better informed.

6. Conclusions

The findings of this study reject the null hypothesis that the use of studs would not influence limb kinematics and the hoof-surface interaction while jumping and cantering on an artificial surface. Screw-in studs significantly altered the stance duration of the leading forelimb during jump landing, while kinematics during canter appeared relatively unaffected. Certain jumping performance parameters appeared improved with the addition of screw-in studs, these being an increased take-off angle, greater limb clearance during suspension, and a greater landing distance from the fence.

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Authors' Contributions

TD – conceptualization, data collection, data analysis, and paper writing. SM – conceptualization, supervision, and paper review. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data supporting the findings of this study are available upon reasonable request from the corresponding author.

Funding

No funding was received for this research project.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

Ethical approval was granted by the University of Limerick Animal Ethics Committee (ULAEC) (Reference Number: 2016_11_3_ULAEC). This study adhered to the guidelines of the Declaration of Helsinki.

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Prevalence and Severity of Gastrointestinal Symptoms in Recreational and Elite Equestrian Athletes in Training and Competition: An Exploratory Analysis

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Abstract

Equestrian sports present a unique challenge to the rider's gastrointestinal (GI) tract and health as they meet nutritional requirements for performance, execute riding discipline-specific skills, and coordinate their hip and abdominal movements with their equine movement pattern. Additional gastrointestinal challenges may result from the known gut-brain axis, as previous research reports a high rate of anxiety in equestrian athletes. A survey was administered to assess the prevalence and severity of gastrointestinal symptoms in recreational and elite equestrian athletes across a range of disciplines. Participants reported the prevalence of 12 symptoms on a 0–10 point scale and stool consistency using a modified validated questionnaire. Total symptom score, symptom perception, and symptom region (Upper GI tract, Lower GI tract, and Other) were assessed. A subset of elite riders repeated the questionnaire post-competition. Elite riders had a higher average total GI symptom score but did not differ significantly from the recreational sample ($W = 438.50$; $p = 0.13$; $r_B = 0.19$; *Small*). There were no regional symptom differences between groups. The prevalence of all abnormal stool consistencies was higher in the elite sample compared to the recreational sample. Five elite athletes (25%) reported blood in the stool. Symptoms are not correlated with nor predicted by rider age or number of competitions performed per year (all $p > 0.05$; $R^2 = 0.10–0.59$). Symptoms were not significantly different in competition. The majority of equestrians present with some GI symptoms, with a small proportion of elite and recreational riders showing symptoms that impair exercise performance. The questionnaire provides a useful starting point for athletes, coaches, and support personnel to understand the prevalence and severity of symptoms in equestrians.

Keywords

Horse riding; gut health; show-jumping; eventing; dressage; elite athletes; recreational activity

1. Introduction

Equestrian sports are under-researched across the sports sciences [1] and are uniquely complicated as the only Olympic discipline requiring a cooperative partnership between human and non-human (equine) athletes to compete. Equestrian athletes must satisfy the additional performance and welfare management requirements of equine athletes alongside their own personal and training needs. These additional requirements can place significant financial costs and psychological stress upon equestrian athletes [2,3].

The ability to manage psychological stressors is a prerequisite for elite sports achievement and performance [4,5]. Equestrian sport psychology has focused on rider anxiety [6–9] and how a rider's psychological state may

impact rider and horse physiology and performance [2,9–12]. Appropriate sports nutrition support may enhance athletes' psychological state and optimize performance [2]. There is a growing understanding of how the gastrointestinal (GI) tract and brain interact in response to physiological stress or exercise and modify GI and psychological functions [13–15]. For athletes, this may manifest in potential performance-disrupting GI symptoms such as a stitch, or the urge to defecate or vomit, potentially increasing rider error. This bidirectional communication is referred to as the gut-brain axis and comprises the autonomic nervous system and enteric nervous system in the GI tract [13,14]. The gut-brain axis is primarily governed by the Vagus nerve, running from the brainstem to the digestive tract, and is responsible for the control of digested materials [14]. Secondary mediating factors are gut hormones (e.g., 5-hydroxyptamine, noradrenaline) and gut microbiota (e.g., Turicibacter spp, Ruminococcus gnavus) [13,16]. Inappropriate nutritional choices and a lack of gut training or familiarity may also increase GI distress. Stressors of particular concern for athletes in the gut-brain axis include anxiety, exercise-induced hyperthermia, exercise duration and intensity, and nutrition circa exercise [6,15,17–21]. Each of the named stressors has been shown to influence the prevalence and severity of GI symptoms during exercise and may respond to training or intervention.

GI symptoms during exercise have traditionally been considered within an (ultra-)endurance context [17,22,23] and from a broad perspective [24]. There is an increased focus on the location of symptoms within the GI tract [24,25] and breadth of contexts (e.g., [26]). GI symptoms in sports are typically assessed in relatively fixed (cycling) or vertically oscillating (running) torso movement patterns. Equestrian sports require the rider to oscillate their lower abdomen and pelvis in all three axes while coordinating and accommodating the horse's gait and unique/individualized movement patterns [27–29]. Each discipline requires additional consideration depending on saddle design, movement patterns (e.g., jumping), and rider position [30–33]. Potential links to pathology should also be considered, and how we best support athletes in equestrian contexts with nutritional and psychological coaching warrants further investigation [2,9], once baseline GI symptom prevalence and severity are understood.

This research aims to capture the prevalence and severity of GI symptoms in equestrian athletes. It is hypothesized that the prevalence of symptoms may exceed that of the general population and other athletic groups due to the previous interest in anxiety and competition practices within equestrian sports. We also hypothesize that severity will vary between individuals, and symptoms will be higher in competition than in training.

2. Methods

Ethical approval for this project was provided by the Waikato Institute of Technology's Human Ethics in Research Group (Approval number: WTLR16010523) and supported by Equestrian Sports New Zealand (ESNZ).

2.1. Questionnaire Design

Questionnaires were developed and hosted using the lead author's institute's preferred software to facilitate distribution (Qualtrics, Utah, USA). Paper copies were not used. IP address and captcha data were gathered to ensure responses were performed by humans and any repeat responses could be queried or removed. The training questionnaire design was adapted from previously published work on equestrian participation demographics [34] and gastrointestinal symptoms in endurance athletes [25]. Demographic factors included respondent age, sex, years of riding experience, preferred discipline, competitive level, and annual competition participation (an average number in a typical year). Gaskell *et al.*'s questionnaire [25] was modified to assess athlete perception of GI symptoms (Overall gut discomfort), total, upper, and lower GI symptoms using a 0–10 point Likert scale and defecation behaviors as Yes/No responses. A rating of 0 indicated no symptoms for that particular factor. Ratings of 1–4 indicated a sensation of GI symptoms but no interference with exercise performance, 5–9 indicated GI symptoms potentially impacted or inhibited exercise performance, and a rating of 10 indicated either severely impacted exercise performance or cessation [25].

Practitioner engagement was assessed in questionnaires that were distributed to both recreational and elite groups. In the recreational group, athletes were asked whether they had ever visited a doctor or other medical practitioner for symptoms related to GI symptoms or anxiety with available response options of Yes, No, Unsure, and Prefer not to say. Elite athletes were asked the same questions as the recreational group and were also asked about sports psychology and dietetic engagement. More specifically, whether they had sought support from a sports psychologist or related practitioner for anxiety or mental aspects of performance and whether they had sought support from a sports dietitian or related practitioner for support related to GI symptoms or nutrition as it related to sports performance. No distinction was made between whether this advice from support personnel was sought for clinical or performance reasons either exclusively or congruently. The training and competition questionnaires are available as **Supplementary Materials**.

2.2. Questionnaire Distribution

Distribution took place via introductory articles that contained both a direct link and QR code, published online and in lay publications in New Zealand; distribution was supported by social media. Data were collected over three months online (Recreational: May–August 2023; Elite: July–September 2023). A known elite sample was recruited through direct contact via national governing body performance pathways (ESNZ, Wellington, New Zealand). Given the relative novelty and potential sensitivity of the topic, we anticipated a low uptake relative to the potential sample size within each group. To assess competition symptoms, elite participants were requested to provide the date of their next competition, and a condensed version of the training questionnaire focusing on symptoms experienced by the athlete and the extent to which preparation and nutritional intake were habitual was distributed via email on the Monday morning following the competition. Athletes

had 24 hours to complete their competition survey. Within competition data are only reported for the Elite group, due to being able to validate participation via ESNZ.

2.3. Statistical Analyses

Demographic data and responses to binary questions are reported using a comprehensive range of descriptive statistics and percentages, respectively. One-sample t-tests were used to assess the prevalence and severity of symptoms, using participants' perception of overall symptoms, against predetermined thresholds of a rating of ≥1 (awareness of non-zero symptoms) and a rating of ≥5 (symptoms may inhibit performance) for each group. Differences between groups were assessed via independent samples Mann-Whitney t-tests, due to differences in sample sizes between groups. Differences between training and competition data were assessed via Wilcoxon signed rank tests, with the direction and hypothesis of comparison being training < competition. For defecation symptoms, differences between groups were assessed using contingency tables and chi-square (χ^2) statistics for independence. Relationships between demographic data and symptom severity are assessed via linear regression(s), with years riding and numbers of competitions per year as covariates; checks for residuals, normality, and linearity are performed using appropriate plots **[35]**.

All analyses are accompanied by effect sizes. In the case of the independent samples t-tests, rank biserial correlation which is interpreted as per descriptors for Spearman correlation coefficients: <0.1 *trivial*, 0.1–0.3 *small*, 0.3–0.5 *moderate*, ≥0.5 *large*. For paired and one-sample tests, standardized mean differences (Hedge's *g*) are considered *trivial*, *small*, *moderate*, *large*, and *very large* at thresholds of <0.2, 0.2–0.6, 0.6–1.2, 1.2–2.0, and ≥2.0 standard deviations **[36]**. Thresholds for statistical significance across all analyses were $p < 0.05$.

3. Results

A total of 84 surveys were returned, with 57 complete surveys included for analysis, forming the recreational sample. In the elite sample, 20 complete surveys were obtained from 31 responses, out of a possible 80 athletes. Only complete surveys were included for analyses and reporting to ensure consistency of interpretation. Data were analyzed in two sub-groups of recreational riders and Elite with national and international riders, as per ESNZ.

3.1. Demographics

Demographic data for the recreational and elite samples are provided in **Table 1**, including age, sex, years of riding experience, level of competition, and number of competitions participated in per year. The recreational sample included athletes from a wide variety of equestrian events, while the Elite encompassed those riders who were part of the national high-performance system and included international representation (eventing, showjumping, and dressage). Event preferences for the recreational sample are presented in **Figure 1**, panel A, and for the elite sample in **Figure 1**, Panel B. Due to specialization, elite athletes only selected one response, whereas the recreational sample was free to select multiple responses, hence response numbers exceeded the sample size (**Figure 1**, panel A). Response selection decreased as the number of disciplines selected increased; for example, 27 respondents selected a second discipline, 19 respondents selected a third discipline, and two respondents selected a fourth discipline (see **Supplementary Materials**). The wide age range and years of participation in equestrian activities are illustrated, ranging from under 18 years to over 60 years old and from 4 years to 42 years of riding experience.

3.2. Practitioner Engagement

3.2.1. Recreational

The recreational participation group reported low practitioner support engagement (services including medical, psychological, and nutrition) due to GI symptoms within the last year. Thirty-two (56%) respondents reported not having visited a doctor, one stated they were unsure, and four visited a doctor for GI symptoms. For anxiety-related symptoms, practitioner engagement within the last year was higher and more evenly distributed. Twenty-one (37%) respondents reported not having visited a doctor, while the remaining sixteen respondents had visited a doctor for anxiety-related symptoms. There was no correlation between visiting a doctor for GI symptoms and anxiety ($r = -0.02$; *Trivial*).

3.2.2. Elite

The Elite group also reported low practitioner support engagement due to GI symptoms within the last year. Fifteen (75%) respondents reported not visiting a doctor, one was unsure, and four visited a doctor for GI symptoms. Similar values were reported for anxiety: fourteen respondents had not visited a doctor, and six visited a doctor for anxiety-related symptoms. Due to the wider availability of specialist support staff, elite athletes were also asked about their engagement with psychologists and dietitians. Eight (40%) reported not having consulted with a psychologist within the last year, one was unsure, and eleven had or were actively being supported by a psychologist. No dietitian engagement was indicated by twelve riders, one was unsure and seven had or were actively being supported by a dietitian.

3.3. Prevalence and Severity of Symptoms

The prevalence and severity of symptoms are reported for both groups during training.

3.3.1. Training

Data in the recreational sample were non-normally distributed, as assessed against previously stated criteria **[35]**, Shapiro-Wilk values, and visual inspection of Q-Q plots. The elite sample appeared to be normally distributed for all variables except lower GI symptoms. However, due to the relatively small sample size of the elite group and the uneven sample sizes between groups, we opted to perform and report non-parametric equivalents. Comparisons between recreational and elite groups by region are outlined in **Figure 2**.

Table 1: Demographics of Recreational and Elite riding populations.

	Characteristic						
Age range*	Under 18	18–19	20–29	30–39	40–49	50–59	60 or over
Recreational	0	2	10	5	11	5	4
Elite	3	4	9	1	1	2	0
Gender	Female	Male					
Recreational	35	2					
Elite	19	1					
Years of riding*^	Mean ± SD	Median ± Range	Minimum	Maximum			
Recreational	27 ± 13	28 ± 46	4	50			
Elite	17 ± 9	14 ± 37	5	42			
Competition level*	Recreational	Local	Regional	National	International		
Recreational	4	8	11	13	1		
Elite	0	0	0	11	9		
Competitions per year*^	Mean ± SD	Median	Range				
Recreational	12 ± 7	10	0–40				
Elite	17 ± 6	15	6–30				

Significant differences between groups are denoted using*. ^Values are rounded to the nearest whole year.

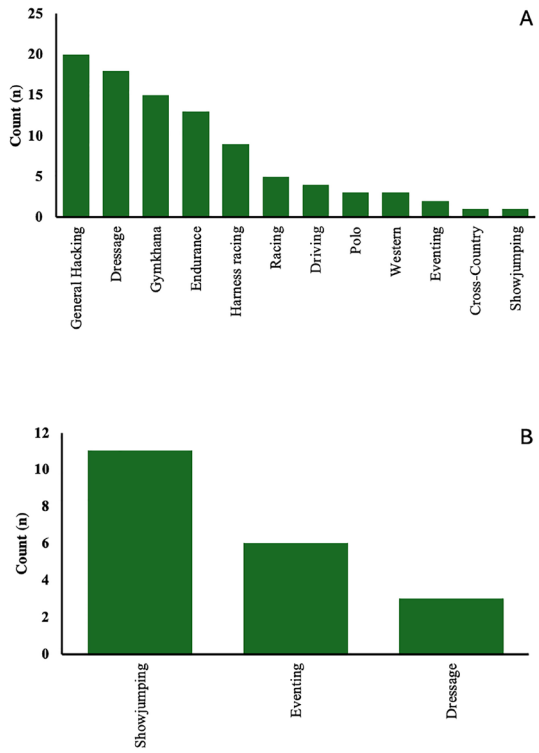

Figure 1: Preferred discipline for Recreational (n = 57; Panel A) and Elite (n = 20; Panel B) samples. Recreational participants could select up to three disciplines. Elite athletes were asked to select the discipline in which they competed that aligned with their governing body performance pathway selection.

3.3.1.1.Total GI Symptom Scores and Overall Perception of GI Symptoms

Total GI symptom scores comprise the sum of upper, lower, and other GI symptom scores. The median total score for the recreational sample was 19, ranging from 0 to 63 (mean ± SD = 20.00 ± 16.60). The median total score for the elite sample was 24, ranging from 0 to 54.5 (mean ± SD = 24.05 ± 14.95). While the elite sample had a higher average total GI symptom score, they did not differ significantly from the recreational sample (W = 438.50; $p = 0.13$; $r_B = 0.19$; *small*).

Overall perception is an athlete-reported measure of GI symptom experience, scored from 0 to 10. The median overall value for the recreational sample was 2, ranging from 0 to 8 (mean ± SD = 2.27 ± 2.03). The median overall value for the elite sample was 2, ranging from 0 to 7 (mean ± SD = 2.42 ± 2.02). Differences between samples in overall GI symptom perception were *trivial* (W = 390.50; $p = 0.37$; $r_B = 0.06$).

3.3.1.2.Upper GI Symptom Scores

Upper GI symptoms comprised belching, heartburn, bloating, the urge to regurgitate, and vomiting. Symptoms experienced by the recreational sample ranged from 0 to 29, with a median value of 6, from a possible maximum score of 50 (mean ± SD = 7.70 ± 7.31). In the elite sample, the median value was 8, with a range of 0 to 23 (mean ± SD = 9.68 ± 7.42). Differences in upper GI symptoms between samples were not significant (W = 432.50; $p = 0.15$; $r_B = 0.17$; *small*).

3.3.1.3.Lower GI Symptom Scores

Lower GI symptoms comprised flatulence, lower bloating, left intestinal pain, and right intestinal pain. Symptoms experienced by the recreational sample had a median value of 4 and ranged from 0 to 26, from a possible maximum of 40 (mean ± SD = 7.45 ± 7.27). The elite sample had a median value of 7.5 and ranged from 0 to 20 (mean ± SD = 8.55 ± 6.62). Differences in lower GI symptoms between samples were not significant (W = 425.00; $p = 0.18$; $r_B = 0.15$; *small*).

3.3.1.4.Other GI Symptom Scores and Defecation

Other GI symptoms incorporated nausea, dizziness, and stitch. The recreational sample had a median value of 3 and ranged from 0 to 23 (mean ± SD = 4.85 ± 5.61), from a possible maximum of 30. The elite sample had a median of 5.5 and ranged from 0 to 13.5 (mean ± SD = 5.83 ± 3.70). Differences in other GI symptoms between samples were not significant (W = 460.00; $p = 0.07$; $r_B = 0.24$; *small*).

Defecation responses for recreational and elite groups are provided below in **Table 2**. The prevalence of normal stool consistency was significantly lower in the elite sample compared to the recreational sample (χ^2 (1) = 8.51; $p < 0.001$). The prevalence of all abnormal stool consistencies was higher in the elite sample compared to the recreational sample; however, only values for bloody stool differed significantly (χ^2 (1) = 6.84; $p < 0.001$).

3.3.2. Competition

Overall symptom perception did not differ significantly between training and competition (W = 2.50; $p = 0.50$; r_B = -0.17; *small*). Similarly, the total sample score did not differ between training and competition (W = 12.00; $p = 0.91$; r_B = 0.60; *large*). Neither upper (W = 9.00; $p = 0.95$; $r_B = 0.80$; *very large*), lower (W = 9.50; $p = 0.75$; $r_B = 0.27$; *small*), nor other GI symptoms (W = 4.00; $p = 0.22$; $r_B = -0.47$; *moderate*) were significantly worse during competition. However, effect sizes indicate a range of responses across participants. In other words, if GI symptoms are prevalent during training, they are likely to remain during competition but do not necessarily worsen **(Figure 3)**.

Similarly, for defecation symptoms, there were no differences in normal (W = 0.00; $p = 0.50$; $r_B = -1.00$; *very large*), loose stools (W = 4.00; $p = 0.81$; $r_B = 0.33$; *moderate*), diarrhoea (W = 1.00; $p = 0.98$; $r_B = 1.00$; *very large*), or constipation (W = 1.50; $p = 0.68$; $r_B = 0.00$; *null*). No participants for whom competition data were available reported bloody stools in either training or competition.

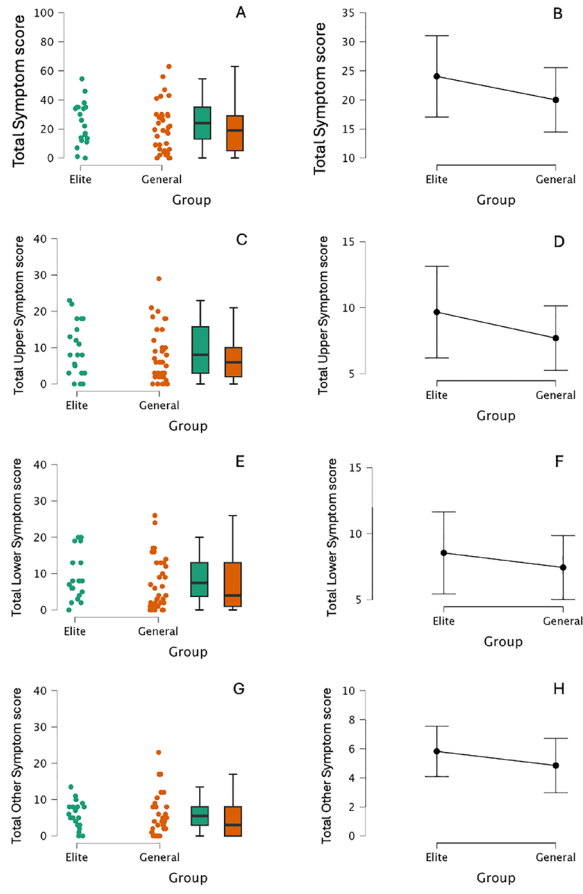

Figure 2: Symptom location within and between recreational and elite equestrian groups for Total (Panels A and B), Upper (Panels C and D), Lower (Panels E and F), and Other (Panels G and H) GI symptom scores.

3.3.3. Within-Group Comparisons Against Symptomatic Reference Values

Figure 4 shows athlete perception of symptoms against symptomatic reference values for prevalence and severity with respect to performance impairment in elite and recreational samples.

Athlete perceptions of symptoms in the recreational group showed a significant prevalence of GI symptoms compared to the predefined symptomatic value (W = 442.50; $p = 3.33 \times 10^{-4}$; $r_B = 0.68$; *large*). However, symptom severity was significantly lower than the value considered to impair performance (W = 25.50; $p = 9.66 \times 10^{-7}$; $r_B = 0.76$; *large*).

Athlete perceptions of symptoms in the elite group also showed a significant prevalence of GI symptoms compared to the predefined symptomatic value (W = 120.00; $p = 3.55 \times 10^{-3}$; $r_B = 0.76$; *large*). However, symptom severity was not considered to significantly impair performance (W = 7.50; $p = 1.00$; $r_B = -0.92$; *large*), as it was lower than the threshold value in the majority of the population.

Table 2: Reported defecation consistency prevalence of recreational (n = 57) and elite equestrian athletes (n = 20) experienced during training.

	Stool Consistency				
Group/response	Normal	Abnormally loose	Diarrhoea	Bloody Stool	Constipation
Recreational					
Yes	18	21	10	0	--
No	19	14	25	35	--
Blank	0	2	2	2	--
Elite					
Yes	2	14	8	5	2
No	18	6	12	15	18
Blank	0	0	0	0	0

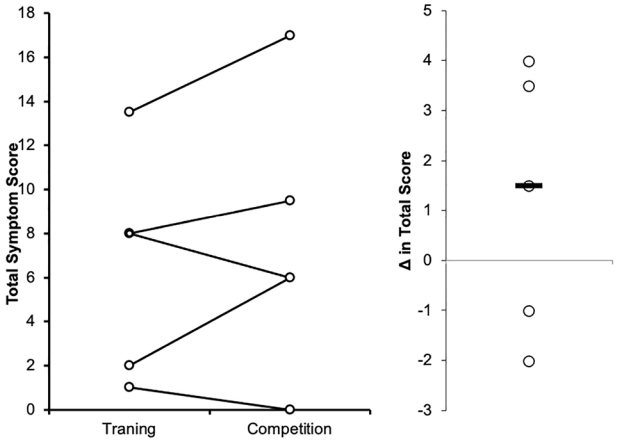

Figure 3: Individual scores in training and competition for GI symptoms by region in five elite riders who completed both questionnaires. The black line indicates the median difference in total GI symptom scores between training and competition. Figures are produced using sheets available from **[37]**.

3.3.4. Relationships Between Demographic Factors and Total Symptoms

Three linear regressions were performed with a view to predict total GI symptoms: participant age group ($F(8,43) = 1.46$, $p = 0.20$, $R^2 = 0.21$), preferred discipline ($F(25,26) = 1.51$, $p = 0.15$, $R^2 = 0.59$), and level of competition ($F(5,46) = 1.00$, $p = 0.43$, $R^2 = 0.10$). None of which were statistically significant predictors of total GI symptoms. Participant sex was not considered due to the underrepresentation of males within the sample. This suggests that GI symptoms are non-discriminatory, and their prevalence cannot be readily predicted when accounting for years of riding experience and the number of competitions per year. Neither years of riding experience (-0.09; $p = 0.53$; *trivial*), nor the number of competitions per year (-0.16; $p = 0.26$; *trivial*) were significantly correlated with total GI symptom score. While it appears that more riders sought advice for anxiety-related GI symptoms, it is unclear how many sought additional nutritional advice to complement the bidirectional impact of the brain-gut axis and achieved relief or improvement in symptoms.

4. Discussion

The current study assessed the prevalence and severity of GI symptoms in equestrian athletes. We hypothesized that severity would vary between individuals, but symptoms would be higher in competition than in training; this was not the case. We also hypothesized that the prevalence of symptoms may exceed that of the general population and other athletic groups due to previous sport psychology research within equestrian sport highlighting the role of anxiety and its known impact on GI symptoms **[13,21]**. While symptom prevalence exceeded that of the general population (≤60% **[38]**, it was comparable to other sports, with 92% of athletes reporting symptoms or non-zero values. This is comparable to ultra-endurance runners who have reported symptom prevalence of up to 96% **[17]**.

Gastrointestinal symptoms are prevalent in recreational and elite equestrians. Despite differences in how symptoms are distributed between groups, upper GI symptoms are more prevalent than lower GI symptoms, irrespective of the sample. Differences between groups are statistically *small* ($p = 0.13$; $r_B = 0.19$), but the higher mean/median values in the elite sample suggest that factors contributing to GI symptom severity may differ between elite and recreational equestrians, or be a product of different training and working practices between these groups, such as prolonged reduction in gastrointestinal blood flow due to increased ridden exercise volume **[17,39]**.

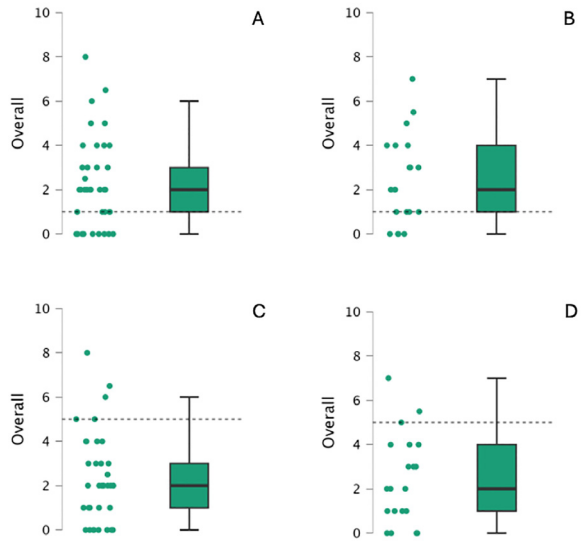

Figure 4: Athlete perception of symptoms against symptomatic reference values (dashed line) for prevalence (≥1) and severity (≥5) with respect to performance impairment in elite (panels B and D) and recreational (panels A and C) samples.

Years of riding experience have no effect on symptom prevalence or severity. It could be assumed that equestrian riders are accepting of GI symptoms, and these behaviors have become normalized. Values peak sooner in the elite sample (10–15 years) compared to later in recreational riders (15–20 years), indicating a possible link to ridden volume or variety in horses ridden and GI distress. This may occur if riding professionally, producing horses for income, or riding someone else's horses as a form of income increases ridden volume. GI symptom prevalence and severity may increase through alterations in blood flow away from the GI tract, biomechanical factors, reduced eating opportunities, and inadequate hydration status **[39,40]**. These findings warrant continued research into differences between elite and recreational equestrian groups, concomitantly capturing symptom prevalence and possible physiological mechanisms. Similar relationships are seen in equestrian injury, where ridden volume and participation in larger volumes of seemingly low-risk activities impart a greater rate of injury **[41,42]**, due to increased baseline exposure to risk factors.

Bloating and flatulence were the most commonly reported symptoms in both groups, with the elite group also reporting these symptoms as impacting performance in the competition questionnaire responses. Biomechanical issues, posture, and breathing warrant consideration in both groups alongside gut training and pre-training/pre-event nutritional/food selection. These symptoms may also be a product of eating differently or what is perceived to be healthier (often higher in fiber) in the build-up to competition or due to low quality and possibly limited food provision at competition venues. Further information is required to confirm these hypotheses. Regardless, education is required to support general nutrition habits and competition-specific nutrition and hydration practices, where the total, timing, and type of food intake may differ from training/recreational riding **[2]** to minimize GI disturbance and maximize performance.

Perceived GI symptom severity is low (Median = 2/10), but frequent in both groups (23/37 in the recreational sample; 13/20 in the elite sample), with approximately 15% in each group perceiving symptoms to be severe enough to impact their ridden performance (≥5/10 perceived symptom rating reported). This does not appear to change or does so only minimally (e.g., 0.5 to 1.0 units) as a result of competition in the elite sample. These values strongly indicate that athletes are aware of their GI symptoms and their severity but are unaware of their potential adverse impacts on health and performance. Athletes may either consider GI symptoms an accepted part of equestrian participation or are not aware of the availability of support from medical or dietetic practitioners. This is further evidenced by low reporting of doctor's visits due to GI symptoms in both groups, and only 35% of elite riders consulting with a dietitian, despite *moderate* to *large* correlations between symptom perception and total symptom score in both groups ($r = 0.73$ to 0.81).

Conversely, 16 (43%) recreational riders reported seeking medical attention for anxiety. Relatively fewer elite riders sought support for anxiety (30%), but more than half (11/20) reported currently or having previously consulted with a psychologist. This is a possible corollary to the lower prevalence of anxiety in elite athletes. Likewise, while only 7 elite athletes had previously or were actively being supported by a dietitian, four athletes perceived their symptoms as a 0, and only 1 athlete had a total score of 0, indicating a need for nutritional support in this group, especially for GI symptom management. We recommend adopting a more interdisciplinary approach to supporting GI issues within all equestrian populations due to the potential role of the gut-brain axis and how it can be impacted by diet and exercise **[13,18]**. Evidence for the use of psychological and nutrition co-intervention in supporting GI conditions in clinical populations shows beneficial effects **[43,44]**, as both elements of the gut-brain axis are addressed congruently. However, it should be acknowledged that much of the work that takes an interdisciplinary approach and shows larger effect sizes is in palliative populations **[45,46]**. Ideally, an integrated approach would provide a greater breadth and depth of education and strategies for athletes and build upon the existing acceptance and knowledge base of psychological support in equestrian sports to date, while increasing the uptake of nutrition counseling. Further work on clinical aspects of GI function is also required at the gut and microbiome levels, exploring how these may differ in equestrians compared to other groups and sports, e.g., animal ownership, lifestyle, and hygiene factors compared to other sports may predispose equestrians to certain risk factors or microflora populations, as per other domestic animals **[47–49]**.

Loose/diarrhoea in the elite group was reported by 14 riders, with 2 reporting constipation in training. More concerning was the 5 riders reporting blood in stool which is a significant concern. The majority of riders reported normal or loose in the competition sample. With the higher microbial load of the equestrian environment, riders need to pay great attention to hygiene practices (eating in the

stable environment, hand-to-face contact, equine-to-human contact, cleaning stables), and gut health (consider probiotic use, hand sanitizing, and hand washing before handling food), especially when in a new environment, just as these actions are taken with the equine athlete.

The survey was the first of its kind in equestrian sport, and so carries some limitations and considerations for future research. Given the novelty and potential sensitivity of the topic, we anticipated a low uptake relative to potential sample size. There is a need to break down any perceived barriers and provide quality information for athletes, especially where athlete health may be compromised due to lack of awareness or inaction (e.g., blood in stool). We intend to repeat the survey at a later date, as athlete awareness and access increase. Male athletes are frequently underrepresented in equestrian data, and this was also the case in these participant sets (n = 3/57 pooled; ~5%). Interestingly, male recreational athletes reported total GI scores approximating that of the mean/median for their group, but the elite male exceeded the average values of the elite group. Upper GI symptoms were most prevalent in males, with belching and bloating the most highly rated symptoms. We anticipate that GI symptoms and wider research in equestrian sport will progress similarly to relative energy deficiency in sport (REDS **[50–52]**). REDS links energy availability to wider systemic acute and chronic athlete health effects, well-being, and performance; whereas previous frameworks focused almost exclusively on symptoms related to female athletes (low energy availability, late-onset or lack of menstruation, and poor bone density outcomes **[53,54]**), REDS accounts for the breadth of symptoms and their ability to affect both male and female health and performance **[50–52,55]**. There is a definite need for future research targeting male equestrian athletes to maximize our understanding of equestrian sport. However, participation demographic data consistently highlight that equestrian sports are a fantastic opportunity to undertake wider female sports science research and should not be ignored due to perceived complexity **[56]**.

The questionnaire itself is a useful screening tool for GI symptoms and possible routes of referral need to be considered. We caution that although the questionnaire is useful for screening GI symptom prevalence and severity, and their potential for performance impact, there are populations who may ride and display adverse gut health/GI symptoms. This could be due to co-pathology and or sustained impairment, e.g., Paralympic riders **[57,58]**, or other disability riders who may experience a predisposition to GI conditions, e.g., Down Syndrome **[59]**. We welcome open discussion of GI symptoms in the equestrian communities but encourage referral and 'zooming out' to consider potential causes and explanations for GI symptoms. We do not intend this work to empower coaches or support personnel to diagnose or treat GI or associated symptoms in their riders unless appropriately qualified to do so.

In conclusion, GI symptoms are prevalent and of sufficient severity in equestrian athletes, irrespective of participation level, to be considered a modifiable factor with respect to riding performance. Symptoms do not appear to significantly worsen in competition, nor are they predicated by age, event, or level of participation. More simply, athletes may enjoy or improve their riding when GI symptoms are addressed; they do not have to be an accepted part of equestrian sport and may point to greater underlying health risks. Appropriate support from medical and dietetic practitioners should be sought where symptoms persist and certainly, if they impact ridden performance.

Supplementary Materials

The questionnaires administered to athletes to gather GI symptom data in training and post-competition are available as **Supplementary Materials**.

Authors' Contributions

RB and JP contributed to the manuscript equally, both taking account for participant recruitment, data collection, analyses, and manuscript preparation and revisions.

Data Availability

All data are available as **Supplementary Materials** and on **ResearchGate**.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethical Approval

The study received appropriate ethical approval by the Waikato Institute of Technology's Human Ethics in Research Group (Approval number: WTLR16010523) and supported by Equestrian Sports New Zealand (ESNZ). The whole study was conducted in accordance with the declaration of Helsinki.

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Seroepidemiology and Risk Factors Associated with *Theileria equi* and *Babesia caballi* Infections in Horses from Borno and Yobe States, Nigeria

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Abstract

Background: *Theileria equi* and *Babesia caballi* are tick-borne hemoparasites that infect horses, causing significant economic losses. This study aimed to determine the seroprevalence and risk factors associated with *T. equi* and *B. caballi* infections in horses from Borno and Yobe states, Nigeria. **Methods:** A cross-sectional study was done on 384 horses from Borno and Yobe states. Blood samples were collected and analyzed using ELISA to detect antibodies against *T. equi* and *B. caballi*. Relative risk (RR) and odds ratio (OR) were computed to determine the association between risk factors and seropositivity. **Results:** The overall seroprevalence of *T. equi* and *B. caballi* was 60.4% and 71.9%, respectively. The data were analyzed using relative risk and odds ratio, which revealed that horses from Borno state (RR = 0.7692, 95% CI: 0.6410 to 0.9231) were less likely to be *T. equi* seropositive. Similarly, horses from Yobe state (RR = 1.0714, 95% CI: 0.8519 to 1.3476) were at a higher risk of being *B. caballi* seropositive. **Conclusion:** This study revealed a high seroprevalence of *T. equi* and *B. caballi* in horses from Borno and Yobe states, Nigeria. Horses from Borno state and those with tick infestation were at a higher risk of *B. caballi* seropositivity, while horses from Yobe state and those with tick infestation were at a higher risk of *T. equi* seropositivity. These findings highlight the need for effective tick control measures and regular monitoring of horses for *T. equi* and *B. caballi* infections.

Keywords

Seroepidemiology; risk factors; piroplasmosis; horses

1. Introduction

Horses are retained for cultural, athletic, security, and research purposes in northern Nigeria. However, a serious health issue that affects horses in this region of the nation is equine piroplasmosis (EP) [1]. *Theileria equi* and *Babesia caballi* are two different intra-erythrocytic protozoan parasites that cause EP, a tick-borne illness that affects horses [2].

According to [3], the disease is primarily found in tropical, subtropical, and temperate regions of the world. It is transmitted by ixodid ticks belonging to the genera Hyalomma, Dermacentor, and Rhipicephalus [4]. Following a whole-genome sequence, a novel species was identified as *T. haneyi* [5], which was also found among horses in South Africa [6]. Microsatellite analysis of the Florida strain of *T. equi* recently showed significant genetic diversity and 48 SNP

differences in the 18SrRNA gene. The World Organization for Animal Health (OIE) has declared equine piroplasmosis (EP) a reportable disease because 90% of horses are thought to live in regions where the disease is endemic [7].

Numerous epidemiological studies on EP and its risk factors have been conducted on several continents throughout the world in the past 50 years [8]. Erythrocytes are parasitized by *Theileria equi* and *Babesia caballi*, which can co-infect animals [9]. Numerous symptoms including fever, anemia, jaundice, hematuria, and lymphadenopathy are indicative of the illness [10,11]. Although the initial acute phase can result in death, the animals that survive serve as carriers and reservoirs of infection [12]. Seroepidemiological and risk factor data regarding *Theileria equi* and *Babesia caballi* in Nigerian horses from Borno and Yobe States are scarce. Thus, the purpose of this study is to examine the risk factors and seroepidemiological characteristics linked to *Babesia caballi* and *Theileria equi* in horses from Nigeria's Borno and Yobe States.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Borno and Yobe States of Northeastern Nigeria from August to October 2023. These two states are situated in the Savannah and Sahel ecological zones of Nigeria.

2.2. Samples Collection

The samples were collected from two local governments in Borno (Maiduguri Metropolitan Council (MMC) and Jere) and Yobe (Geidam and Nguru). A total of 384 blood samples were collected from clinically healthy equids of different breeds with ticks present on their bodies (192 horses from Borno state and 192 horses from Yobe state). The horses were randomly selected from various locations, including stables where they were kept and cared for by riders for business, hobby markets, and farming households (from August to October 2023). Horses of both sexes were used in this study. Horses were classified as young if their age ranged between 1–10 years, while those with ages ranging between 11 and above 20 years were classified as adults. The body weights of the horses ranged between 350 and 450 kg. The body weights of the horses were estimated using a weighing type method. Horses were properly restrained, and antiseptic gauze was used to disinfect the site of collection by wiping to help remove superficial dirt as well as help in visualizing the raised vein after which a sterile needle was used to collect 4 ml of blood from the jugular vein, the needle was removed gently and the collected blood was then transferred into a well-labeled plane vacutainer tubes and the needles were disposed of properly.

2.3. Sample Transportation

The collected blood samples were carefully taken and labeled with information such as age, sex, body weight, and location of the animals. The samples were then packaged using cushioning materials to minimize shifting and stored in a temperature-controlled environment at a temperature of 8°C.

The collected blood samples were allowed to clot at room temperature for 25–30 minutes. The samples were then centrifuged at a speed of 2000 rpm for 10 minutes to separate the serum from the cellular components. Following centrifugation, the supernatant (serum) was gently transferred into well-labeled cryotubes immediately and stored at a freezing temperature of -20°C.

2.4. Sample Preparation

2.4.1. Serum/Plasma

Dilute serum samples with a 20-fold dilution using sample diluent (5 µl of serum was added to 96 µl of sample diluent to obtain a 1:20 dilution). Dilution was performed at room temperature and used immediately. Serum samples were stored at -20°C.

2.4.2. Reagent Preparation

All frozen reagents were brought up to room temperature before use (1–2 hours at 20–25°C). All Solutions were prepared prior to performing ELISA. Also, all reagents were mixed by inversion before use. Strict measures were taken to avoid returning pipette tips or any reagent to the original stock tube. A disposable reservoir was used during the handling of reagents to minimize the risk of contamination.

2.4.3. Preparation of Wash Buffer Solution

One volume of 20X Wash solution was mixed with 19 volumes of distilled water. For a 96-well plate, multiply 250 µl by 5 and then by 2 to calculate the total volume required for the wash.

2.4.4. Preparation of Conjugated Antibody Solution

One volume of 25 ml HRP (horse radish peroxidase) conjugate antibody solution was mixed with 24 volumes of BC antibody diluent.

2.5. ELISA Protocol

Babesia equi antigen-coated plate and all reagent components were brought and kept at room temperature for at least an hour. 90 µl of BQ Assay Diluent was added to each well of antigen-coated plate/strips. An aliquot of *B. equi* positive control (10 µl per well) was added to two wells of the antigen-coated plate. An aliquot of *B. equi* negative control (10 µl per well) was added to two wells of the antigen-coated plate. The positive and negative controls were separated from each other by placing them at the upper left-hand and bottom-right-hand corner wells of the plate respectively. 10 µl of the previously diluted serum/plasma sample (1:20) was added per well, and the solutions were mixed in the well.

2.6. Data Analysis

The prevalence rate of *Theileria equi* and *Babesia caballi* infection in the serum samples from the horses was calculated using the formula:

$$\text{Seroprevalence} = \frac{\textit{Number of sample positive}}{\textit{Total number of samples analyzed}} \times 100$$

The data were analyzed using Chi-Square, relative risk, and odds ratio with MedCalc® Statistical Software version 23.0.9 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2024). The seroprevalence of piroplasmosis was evaluated using VassarStat for confidence intervals. A *P*-value less than 0.05 was considered significant.

3. Results

The relative risk (RR) and odds ratio (OR) are two commonly used measures to assess the association between risk factors and the development of piroplasmosis in equids in Borno and Yobe States, Nigeria.

3.1. Prevalence, Relative Risk, and Odds Ratio of Babesia caballi in Borno State (Jere and MMC), Nigeria

3.1.1. Prevalence

The prevalence of *Babesia caballi* in MMC and Jere local government areas was 71.9%, with a confidence interval of 65.1 to 77.8 **(Table 1)**.

3.1.2. Relative Risk (RR)

The relative risk is a measure of the ratio of the probability of developing piroplasmosis in the exposed group to the probability of developing piroplasmosis in the non-exposed group. An RR of 1 indicates no association between the risk factor and piroplasmosis, while an RR greater than 1 indicates a higher risk of developing piroplasmosis.

In the current study, as shown in **Table 1**, horses in MMC, Borno State, Nigeria, that were exposed to ticks had a relative risk (RR) of 0.7692 for developing piroplasmosis caused by *Babesia caballi*, compared to horses in Jere that were not exposed to ticks. This finding suggests that horses exposed to ticks in MMC were 23.08% less likely to develop piroplasmosis due to *Babesia caballi* than their unexposed counterparts in Jere.

In MMC, Borno State, Nigeria, young horses exposed to ticks exhibited a relative risk (RR) of 1.0738 for developing piroplasmosis caused by *Babesia caballi*, compared to those that were not exposed in Jere. This finding suggests that young horses in MMC with tick exposure face an elevated risk of developing piroplasmosis due to *Babesia caballi* in comparison to their unexposed counterparts in Jere.

In MMC, Borno State, Nigeria, male horses exposed to ticks demonstrated a relative risk (RR) of 6.1818 for developing piroplasmosis caused by *Babesia caballi*, in contrast to female horses that were not exposed in Jere. This finding indicates that male horses in MMC with tick exposure were substantially at greater risk of developing piroplasmosis due to *Babesia caballi* compared to their unexposed female counterparts in Jere.

3.1.3. Odds Ratio (OR)

The odds ratio is a measure of the ratio of the odds of developing piroplasmosis in the exposed group to the odds of developing piroplasmosis in the non-exposed group. An OR of 1 indicates no association between the risk factor and piroplasmosis, while an OR greater than 1 indicates a higher risk of developing piroplasmosis.

In the present study, horses in MMC with a history of tick infestation had an OR of 0.3846. They had reduced odds of developing piroplasmosis due to *Babesia caballi* compared to horses in Jere without a history of tick infestation **(Table 1)**. This means that horses with a history of tick infestation in MMC were 0.3846 times less likely to develop piroplasmosis due to *Babesia caballi* than horses without a history of tick infestation in the Jere local government area.

In addition, young horses with a history of tick infestation had an OR of 1.2830. They had increased odds of developing piroplasmosis due to *Babesia caballi* compared to adult horses without a history of tick infestation **(Table 1)**. This means that young horses with a history of tick infestation were 1.2830 times more likely to develop piroplasmosis due to *Babesia caballi* than adult horses without a history of tick infestation.

Furthermore, male horses with a history of tick infestation had an OR of 23.8000. They had increased odds of developing piroplasmosis due to *Babesia caballi* compared to female horses without a history of tick infestation **(Table 1)**. This means that male horses with a history of tick infestation were 23.8000 times more likely to develop piroplasmosis due to *Babesia caballi* than female horses without a history of tick infestation.

3.2. Prevalence, Relative Risk, and Odds Ratio of Theileria equi in Borno State (Jere and MMC), Nigeria

3.2.1. Prevalence

The prevalence of *Theileria equi* in MMC and Jere local government areas was 76%, with a confidence interval of 69.53 to 81.53 **(Table 2)**.

3.2.2. Relative Risk (RR)

In the current study, as shown in **Table 2**, horses in MMC, Borno State, Nigeria, that were exposed to ticks had a relative risk (RR) of 0.9211 for developing piroplasmosis caused by *Theileria equi*, compared to horses in Jere that were not exposed to ticks. This finding suggests that horses exposed to ticks in MMC were 7.89% less likely to develop piroplasmosis due to *Theileria equi* than their unexposed counterparts in Jere.

In MMC, Borno State, Nigeria, young horses exposed to ticks exhibited a relative risk (RR) of 0.8821 for developing piroplasmosis caused by *Theileria equi*, compared to those that were not exposed in Jere. This finding suggests that young horses in MMC with tick exposure faced a reduced risk (11.79%) of developing piroplasmosis due to *Theileria equi* in comparison to their unexposed counterparts in Jere.

In MMC, Borno State, Nigeria, male horses exposed to ticks demonstrated a relative risk (RR) of 3.2273 for developing piroplasmosis caused by *Theileria equi*, in contrast to female horses that were not exposed in Jere. This finding indicates that male horses in MMC with tick exposure were substantially at greater risk of developing piroplasmosis due to *Theileria equi* compared to their unexposed female counterparts in Jere.

3.2.3. Odds Ratio (OR)

In the present study, horses in MMC with a history of tick infestation had an OR of 0.7085. They had reduced odds of developing piroplasmosis due to *Theileria equi* compared to horses in Jere without a history of tick infestation **(Table 2)**. This means that horses with a history of tick infestation in MMC were 0.7085 times less likely to develop piroplasmosis due to *Theileria equi* than horses without a history of tick infestation in the Jere local government area.

Table 1: Prevalence, relative risk, and odds ratio of *Babesia caballi* in Borno State (Jere and MMC), Nigeria.

Babesia caballi	Locations		Prevalence %	95% C.I
	Jere	MMC (Exposed Location)		
Negative	18	36	54 (28.1)	22.3 to 34.9
Positive	78	60	138 (71.9)	65.1 to 77.8
Relative risk				0.7692
95% C.I				0.6410 to 0.9231
Significance level				$P = 0.0048$
Odds ratio				0.3846
95% C.I				0.1991 to 0.7429
Significance level				$P = 0.0044$
Babesia caballi	Age		Prevalence %	95% C.I
	Adult	Young (Exposed Group)		
Negative	24	30	54 (28.1)	22.3 to 34.9
Positive	53	85	138 (71.9)	65.1 to 77.8
Relative risk				1.0738
95% C.I				0.8921 to 1.2926
Significance level				$P = 0.4515$
Odds ratio				1.2830
95% C.I				0.6785 to 2.4260
Significance level				$P = 0.4432$
Babesia caballi	Sex		Prevalence %	95% C.I
	Male (Exposed Group)	Female		
Negative	14	40	54 (28.1%)	22.3 to 34.9
Positive	2	136	138 (71.9%)	65.1 to 77.8
Relative risk				6.1818
95% C.I				1.6866 to 22.6578
Significance level				$P = 0.0060$
Odds ratio				23.8000
95% C.I				5.1898 to 109.1444
Significance level				$P < 0.0001$

MMC = Maiduguri Metropolitan Council.

In addition, young horses with a history of tick infestation had an OR of 0.5764. They had increased odds of developing piroplasmosis due to *Theileria equi* compared to adult horses without a history of tick infestation **(Table 2)**. This means that young horses with a history of tick infestation were 0.5764 times more likely to develop piroplasmosis due to *Theileria equi* than adult horses without a history of tick infestation.

Furthermore, male horses with a history of tick infestation had an OR of 12.5294. They had increased odds of developing piroplasmosis due to *Theileria equi* compared to female horses without a history of tick infestation **(Table 2)**. This means that male horses with a history of tick infestation were 12.5294 times more likely to develop piroplasmosis due to *Theileria equi* than female horses without a history of tick infestation.

3.3. Prevalence, Relative Risk, and Odds Ratio of Babesia caballi in Yobe State (Geidam and Nguru), Nigeria

3.3.1. Prevalence

The prevalence of *Babesia caballi* in Geidam and Nguru local government areas of Yobe State was 60.4%, with a confidence interval of 53.4 to 67.0 **(Table 3)**.

Table 2: Prevalence, relative risk, and odds ratio of *Theileria equi* in Borno State (Jere and MMC), Nigeria.

Theileria equi	Locations		Prevalence %	95% C.I
	Jere	MMC (Exposed Location)		
Negative	20	26	46 (24.0%)	18.47 to 30.47
Positive	76	70	146 (76.0%)	69.53 to 81.53
Relative risk				0.9211
95% C.I				0.7854 to 1.0802
Significance level				$P = 0.3118$
Odds ratio				0.7085
95% C.I				0.3635 to 1.3808
Significance level				$P = 0.3114$
Theileria equi	Age		Prevalence %	95% C.I
	Adult	Young (Exposed Group)		
Negative	14	32	46 (24.0%)	18.47 to 30.47
Positive	63	83	146 (76.0%)	69.53 to 81.53
Relative risk				0.8821
95% C.I				0.7556 to 1.0298
Significance level				$P = 0.1123$
Odds ratio				0.5764
95% C.I				0.2839 to 1.1704
Significance level				$P = 0.1274$
Theileria equi	Sex		Prevalence %	95% C.I
	Male (Exposed Group)	Female		
Negative	12	34	46 (24.0%)	18.47 to 30.47
Positive	4	142	146 (76.0%)	69.53 to 81.53
Relative risk				3.2273
95% C.I				1.3769 to 7.5641
Significance level				$P = 0.0070$
Odds ratio				12.5294
95% C.I				3.8046 to 41.2626
Significance level				$P < 0.0001$

MMC = Maiduguri Metropolitan Council.

3.3.2. Relative Risk (RR)

According to **Table 3**, horses exposed to ticks in Geidam, Yobe State, Nigeria, had a relative risk (RR) of 1.0714 for contracting piroplasmosis caused by *Babesia caballi*, compared to horses in the Nguru local government area that were not exposed to ticks. This result indicates that horses in Geidam exposed to ticks had a higher risk of contracting *Babesia caballi*-caused piroplasmosis than horses in Nguru, Yobe State.

Young horses exposed to ticks in Geidam, Yobe State, Nigeria, had a relative risk (RR) of 1.0189 for contracting piroplasmosis caused by *Babesia caballi*, compared to those not exposed in Nguru, Yobe State. This finding suggests that juvenile horses in Geidam exposed to ticks were more likely to contract *Babesia caballi*-caused piroplasmosis than their counterparts in Nguru, Yobe State.

Compared to female horses that were not exposed in Nguru, Yobe State, male horses exposed to ticks in Geidam, Yobe State, showed a relative risk (RR) of 10.4545 for contracting *Babesia caballi*-caused piroplasmosis. According to this finding, male horses in Geidam exposed to ticks were significantly more likely to contract *Babesia caballi*-caused piroplasmosis than their unexposed female counterparts in Nguru, Yobe State.

Table 3: Prevalence, relative risk, and odds ratio of *Babesia caballi* in Yobe State (Geidam and Nguru), Nigeria.

Babesia caballi	Locations		Prevalence %	95% C.I
	Geidam (Exposed Location)	Nguru		
Negative	36	40	76 (39.6%)	32.9 to 46.6
Positive	60	56	116 (60.4%)	53.4 to 67.0
Relative risk				1.0714
95% C.I				0.8519 to 1.3476
Significance level				$P = 0.5554$
Odds ratio				1.1905
95% C.I				0.6671 to 2.1244
Significance level				$P = 0.5551$
Babesia caballi	Age		Prevalence %	95% C.I
	Adult	Young (Exposed Group)		
Negative	31	45	76 (39.6%)	22.3 to 34.9
Positive	46	70	116 (60.4%)	65.1 to 77.8
Relative risk				1.0189
95% C.I				0.8057 to 1.2885
Significance level				$P = 0.8757$
Odds ratio				1.0483
95% C.I				0.5813 to 1.8905
Significance level				$P = 0.8754$
Babesia caballi	Sex		Prevalence %	95% C.I
	Male (Exposed Group)	Female		
Negative	15	61	76 (39.6%)	22.3 to 34.9
Positive	1	115	116 (60.4%)	65.1 to 77.8
Relative risk				10.4545
95% C.I				1.5624 to 69.9546
Significance level				$P = 0.0155$
Odds ratio				28.2787
95% C.I				3.6479 to 219.2157
Significance level				$P = 0.0014$

3.3.3. Odds Ratio (OR)

Tick infestation history was associated with an OR of 1.1905 for horses in Geidam in the current investigation. They were less likely than horses in Yobe State's Nguru local government area without a history of tick infestation to contract piroplasmosis from *Babesia caballi* **(Table 3)**. Thus, compared to horses in the Nguru local government area of Yobe State that had never experienced a tick infestation, horses with a history of tick infestation in Geidam had a 1.1905-fold increased risk of contracting piroplasmosis from *Babesia caballi*.

Young horses with a history of tick infestation had an OR of 1.0483 in the current study. Compared to adult horses without a history of tick infestation, they were more likely to have *Babesia caballi*-caused piroplasmosis **(Table 3)**. This indicates that young horses with a history of tick infestation had a 1.0483-fold increased risk of contracting *Babesia caballi*-caused piroplasmosis than adult horses without a history of tick infestation.

Male horses with a history of tick infestation had an odds ratio (OR) of 28.2787 in the current study. Compared to female horses without a history of tick infestation, they were more likely to contract piroplasmosis caused by *Babesia caballi* **(Table 3)**. This indicates that male horses with a

history of tick infestation had a 28.2787-fold higher risk of contracting *Babesia caballi*-caused piroplasmosis than female horses without a history of tick infestation.

3.4. Prevalence, Relative Risk, and Odds Ratio of Theileria equi in Yobe State (Geidam and Nguru), Nigeria

3.4.1. Prevalence

The prevalence of *Theileria equi* in Geidam and Nguru local government areas of Yobe State was 63.0%, with a confidence interval of 56.00 to 69.53 **(Table 4)**.

3.4.2. Relative Risk (RR)

Compared to horses in the Nguru local government area that were not exposed to ticks, horses in Geidam, Yobe State, Nigeria, that were exposed to ticks had a relative risk of 1.4694 for acquiring piroplasmosis caused by *Theileria equi* **(Table 4)**. This study found that horses exposed to ticks in Geidam were more likely to contract *Theileria equi*-caused piroplasmosis than horses in Nguru, Yobe State.

The relative risk (RR) of *Theileria equi*-caused piroplasmosis was 1.0542 for young horses exposed to ticks in Geidam, Yobe State, Nigeria, compared to those not exposed in Nguru, Yobe State. This indicates that tick exposure increased the risk of piroplasmosis from *Theileria equi* in young horses in Geidam compared to those in Yobe State's Nguru local government area.

Male horses exposed to ticks in Geidam, Yobe State, Nigeria, had a relative risk (RR) of 1.2841 for acquiring *Theileria equi*-caused piroplasmosis, compared to female horses not exposed in the Nguru local government area of Yobe State. This study found that male horses in Geidam exposed to ticks had a significantly higher risk of developing piroplasmosis from *Theileria equi* than their unexposed female counterparts in Nguru, Yobe State.

3.4.3. Odds Ratio (OR)

In the current study, a history of tick infestation was linked to an OR of 2.8776 for horses in Geidam. In Yobe State's Nguru local government area, they had a lower risk of piroplasmosis from *Theileria equi* than horses without a history of tick infestation **(Table 4)**. Therefore, horses with a history of tick infestation in Geidam were 2.8776 times more likely to get piroplasmosis from *Theileria equi* than horses in Yobe State's Nguru local government area that had never had a tick infestation.

Additionally, the OR for young horses with a history of tick infection was 1.1520. *Theileria equi*-caused piroplasmosis was more common in these adult horses than in those without a history of tick infestation **(Table 4)**. This suggests that juvenile horses with a history of tick infestation had a 1.1520-fold higher risk of catching piroplasmosis from *Theileria equi* than adult horses without a tick infestation history.

Furthermore, the OR for male horses with a history of tick infestation was 1.7937. *Theileria equi*-caused piroplasmosis was more common in female horses with a history of tick infestation than in those without **(Table 4)**. This means that male horses with a history of tick infestation were 1.7937 times more likely to get piroplasmosis from *Theileria equi* than female horses without a tick infestation history.

4. Discussion

Piroplasmosis, caused by *Babesia caballi* and *Theileria equi*, is a significant disease affecting horses in Nigeria, particularly in Borno and Yobe States. This discussion provides an overview of the prevalence, relative risk, and odds ratio of piroplasmosis in horses in these states.

Studies have shown that piroplasmosis is prevalent in horses in Borno and Yobe States. A study **[12]** reported a prevalence of 34.38 % in donkeys in Yobe State. However, the current study revealed a prevalence of *Babesia caballi* and *Theileria equi* of 71.9% and 76.0%, respectively. This could attributed to climatic and environmental factors that favors the survival and multiplication of *Babesia caballi* and *Theileria equi*, which are commonly found in tropical and subtropical regions, as reported in **[13]**. Furthermore, the presence of vegetation and rainfall provides a conducive environment for the survival and multiplication of ticks, which are the primary vectors of *Babesia caballi* and *Theileria equi* **[14]**. Additionally, the distribution and abundance of ticks, particularly Dermacentor and Hyalomma species, are higher in tropical and subtropical regions, increasing the risk of transmission of *Babesia caballi* and *Theileria equi* **[13]**. Another reason for the higher prevalence of equine piroplasmosis could be attributed to the feeding behavior of ticks, as feeding on horses increases the risk of transmission of *Babesia caballi* and *Theileria equi* **[14]**.

The relative risk (RR) of piroplasmosis in horses in Borno and Yobe States has been investigated in several studies. A study **[15]** found that horses in Punjab (India) exposed to ticks had an RR of 2.27 for developing piroplasmosis compared to those that were not exposed. However, in the present study, the relative risk (RR) of piroplasmosis in horses in Borno and Yobe States for *Babesia caballi* and *Theileria equi* were 0.7692 and 0.9211 in Borno, while Yobe state had 1.0714 and 1.4694 for *Babesia caballi* and *Theileria equi*. This variation in RR could be due to human movement and activity, particularly in tropical and subtropical regions, which may increase the risk of transmission of *Babesia caballi* and *Theileria equi*, as reported in **[16]**. Moreover, a lack of awareness and knowledge among horse owners and handlers can contribute to the higher prevalence of *Babesia caballi* and *Theileria equi*.

The odds ratio (OR) of piroplasmosis in horses in Borno and Yobe States, as investigated in the current study, could be attributed to several factors associated with the risk of piroplasmosis in these states. These include exposure to ticks, which is a significant risk factor for piroplasmosis in horses in both states. Similarly, younger horses are more susceptible to piroplasmosis than older horses. Certain breeds of horses, such as the Arabian breed, are more susceptible to piroplasmosis than others. Additionally, the risk of piroplasmosis is higher during the wet season than during the dry season.

Table 4: Prevalence, relative risk, and odds ratio of *Theileria equi* in Yobe State (Geidam and Nguru), Nigeria.

Theileria equi	Locations		Prevalence %	95% C.I
	Geidam (Exposed Location)	Nguru		
Negative	24	47	71 (37.0%)	30.47 to 44.00
Positive	72	49	121 (63.0%)	56.00 to 69.53
Relative risk				1.4694
95% C.I				1.1705 to 1.8446
Significance level				$P = 0.0009$
Odds ratio				2.8776
95% C.I				1.5617 to 5.3023
Significance level				$P = 0.0007$
Theileria equi	Age		Prevalence %	95% C.I
	Adult	Young (Exposed Group)		
Negative	30	41	71 (37.0%)	30.47 to 44.00
Positive	47	74	121 (63.0%)	56.00 to 69.53
Relative risk				1.0542
95% C.I				0.8423 to 1.3194
Significance level				$P = 0.6447$
Odds ratio				1.1520
95% C.I				0.6347 to 2.0911
Significance level				$P = 0.6417$
Theileria equi	Sex		Prevalence %	95% C.I
	Male (Exposed Group)	Female		
Negative	8	63	71 (37.0%)	30.47 to 44.00
Positive	8	113	121 (63.0%)	56.00 to 69.53
Relative risk				1.2841
95% C.I				0.7771 to 2.1219
Significance level				$P = 0.3292$
Odds ratio				1.7937
95% C.I				0.6421 to 5.0107
Significance level				$P = 0.2650$

5. Conclusion

Piroplasmosis is a significant disease affecting horses in Borno and Yobe States. The prevalence, relative risk, and odds ratio of the disease have been investigated in several studies. The results of these studies suggest that exposure to ticks, age, sex, and location are significant risk factors for piroplasmosis in horses. Further research is needed to develop effective control measures for the disease.

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Authors' Contributions

The concept was developed and planned by Falmata Kyari, and Babagana K. Kayeri; the data were gathered and checked by Benjamen Joseph Haziel, and Ibrahim Nuhu Ibrahim. Falmata Kyari and Mohammed Kyari Zango wrote the paper, and Lawan Adamu reviewed the manuscript, evaluating and interpreting the data statistically.

Data Availability

The data supporting the findings of this study are available within the article.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

The Institutional Animal Care and Use Committee (IACUC) of the University of Maiduguri authorized the study protocol using number 0758 prior to its start, ensuring that it adhered to the standards of studies involving animals.

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The Meaning of the Place – A Socio-Spatial Analysis of Equine Yards

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Abstract

Climate change and biodiversity loss are interconnected global challenges that require urgent and transformative changes in land use and management. Equine yards have a unique potential to contribute positively to biodiversity while supporting equine welfare and providing economic and social value. This study explores the perspectives of equine yard owners in Germany and the Netherlands regarding the socio-spatial aspects they consider important when designing and managing equine yards that balance biodiversity, equine welfare, and operational needs. The research employed a qualitative socio-spatial analysis framework, drawing on semi-structured interviews with 17 equine yard owners. The findings reveal that a wide range of socio-spatial aspects—including land use, social infrastructure, accessibility, and the integration of biodiversity—play significant roles in yard design and management. Cultural differences were also observed, with German yards generally emphasizing safety and seclusion, while Dutch yards focused on controlled access and integration into the local community. The study highlights the challenges of balancing equine welfare, biodiversity, and community needs, particularly in relation to land availability, accessibility, and cultural contexts. Despite the focus on a limited number of yards in Germany and the Netherlands, the findings provide valuable insights into the socio-spatial factors that shape equine yard management. A set of preliminary guidelines for yard design is proposed, emphasizing the integration of equine welfare, biodiversity, community engagement, and sustainable business practices to enhance the contribution of equine yards to the agroecological transition.

Keywords

Socio-spatial analysis; biodiversity; equine welfare; financial sustainability; agroecological transition

1. Introduction

Climate change and biodiversity loss are interconnected global challenges of unprecedented scale. Over the past 150 years, global temperatures have risen by 1.1°C, leading to widespread species extinctions and significant ecosystem disruptions **[1]**. Approximately 30% of known species have become endangered or extinct since 1500, with ongoing biodiversity loss threatening ecosystem services vital to human survival, such as food security, water regulation, and climate stabilization **[2]**. Addressing these issues sustainably requires urgent and transformative changes, particularly in land use and management **[3]**.

Agriculture is a primary driver of biodiversity loss, impacting 86% of species at risk of extinction **[4,5]**. However, with 50% of European Union (EU) species relying on agricultural habitats, increasing the role of the agricultural industry in conservation efforts is one of the core objectives of the European Green Deal **[6]**.

With approximately 6 million equids occupying at least 6 million hectares of permanent grassland in the EU, the equine sector is traditionally considered part of the agricultural sector **[7,8]**. However, as equine yards often fall outside typical agricultural statistics, figures relating to their numbers and impact are generally underestimated **[8,9]**. As a result, the equine sector has been largely excluded

from discussions on the agroecological transformation [10]. This exclusion has resulted in substantial areas of land being overlooked in coordinated efforts to improve biodiversity and nature inclusivity in rural and peri-urban landscapes. Moreover, the continued marginalization of equine yards means that their "biodiversity potential" remains underappreciated and largely untapped [11–13].

Since the mid-20th century, equine yards have taken on increasingly multifunctional roles, spanning agricultural production, ecological regulation, and community functions [9]. Wilton [14] suggests that equine yards sit at the "interaction of a productivist agricultural landscape and a post-productivist social and aesthetic landscape." Economically, the European equine sector contributes an estimated €100 billion annually and supports over 500,000 direct and indirect jobs [15,16]. Though smaller than the agricultural industry, valued at €537.1 billion [17], the equine sector contributes significantly, up to one-fifth of its economic value. Germany and the Netherlands, two of Europe's leading equestrian nations, are key contributors, with economic impacts of approximately €7 billion and €1.5–2 billion, respectively. Both nations have dense equestrian facilities, with around 1.2 million and 450,000 horses, respectively [18,19].

Beyond economic value, the social contributions of equine yards are notable [11,14]. Interaction with horses enhances social, psychological, and motor skills while also promoting physical and mental well-being [20–22]. Lastly, from an ecological perspective, equine yards may be able to contribute in diverse ways. Horses, evolved as mixed grazers, feed on grasses and browse on shrubs, supporting landscape biodiversity [23–25]. Unlike ruminants, horses excel at grazing low-lying plants, enabling them to thrive even in sparse pastures, making them suitable for restoring various landscapes [26,27].

Furthermore, equine yards often host diverse small landscape features, such as hedges, woody strips, and flower strips [13,28]. These features support blue-green infrastructure, provide habitats, contribute to carbon sequestration, and aid in soil and water management [29]. When strategically designed, equine yards could serve as ecological corridors, reconnecting fragmented habitats and enhancing landscape connectivity across Europe [30,31]. However, without comprehensive data on the ecological roles of equine yards, policymakers may continue to overlook this sector, thus forgoing potentially significant contributions to biodiversity and nature-inclusive land management.

Yet, despite the equine sector's potential in multifunctional rural land use, empirical data is limited on how to design modern equine yards to optimize biodiversity, equine welfare, and social and economic benefits. Without clear guidelines on the socio-spatial elements most relevant to European equine yards, this sector is likely to continue being overlooked in the broader agroecological transformation.

Therefore, as a first step, the current study aims to explore equine yard owners' perspectives on the socio-spatial aspects they find essential for designing yards that balance equine welfare, biodiversity, and operational needs, with a focus on Germany and the Netherlands.

2. Methodology

This study employed a qualitative research design, drawing on semi-structured interviews with equine yard owners in Germany and the Netherlands. The research was guided by a socio-spatial analysis framework to explore the integration of biodiversity and equine welfare into yard design, with a focus on the perspectives of the yard owners.

2.1. Participants

A total of 17 equine yards, selected through convenience sampling, were invited to participate in the study, with eight (N = 8) located in Germany and nine (N = 9) in the Netherlands. Participants included yard owners from a variety of yard types, such as riding schools and livery yards, to capture a broad spectrum of perspectives on yard design, biodiversity, and equine welfare.

Prior to participation, all yard owners were informed of the study's aims, signed an informed consent form, and were made aware of their right to withdraw from the study at any time without negative consequences. To ensure the anonymity of yard owners, aspects such as the size of the yard and the number of horses were not included in the data collection.

2.2. Socio-Spatial Analysis Framework

Semi-structured interviews were held with all yard owners, loosely organized around the socio-spatial framework by van Goorbergh [32], which contains nine aspects of open space: Location, Function/Social Impact, Anchoring, Accessibility, Routes, Ambiance, Uses and Activities, Gregariousness, and Biodiversity (adapted for this research). The aspect of Uniqueness assesses competition from adjacent areas. Considering the use of equine yards is very specific, Uniqueness was not considered applicable and thus excluded from the model. Biodiversity, on the other hand, was added to better capture the ecological dimension relevant to equine yards.

See **Table 1** for a brief definition of each of the factors, based on the model by van Goorbergh [32].

2.3. Data Collection

Data collection took place in person at participating yards. Each visit lasted between 2 and 3 hours and consisted of a tour of the premises and an interview. Interviews were conducted in the participants' native languages: Dutch (second author) and German (third author). See **supplementary materials** for the interview questions. All interviews were recorded on a smartphone and subsequently transcribed verbatim for detailed analysis.

GIS mapping was employed to provide additional context, offering visual and spatial data that complemented the qualitative findings. GIS maps were generated to visualize the physical layout of each yard, its integration with the surrounding landscape, and the spatial distribution of biodiversity features, adding additional context with regard to the environmental and geographic factors influencing yard design. The GIS analysis drew on ArcGIS Pro version 3.2.2, with all data processed in the RD New coordinate system. The GIS layer Natura 2000 (WMS) [33] was used to identify the proximity of equine yards to protected Natura 2000 sites; the layer entitled Bestand Bodemgebruik

[34] (land use) to determine zoning areas; and the layer Bodemkaart [35] (soil map), for detailed information on types of soil.

2.4. Data Processing and Analysis

Following verbatim transcription, the interview data were imported into Microsoft Excel and analyzed using thematic analysis [36]. The first stage involved immersion in the data. To ensure that all nuances and meanings expressed by participants were accurately captured, the second and third authors read the native language transcripts (in German and Dutch) multiple times.

The data were analyzed line-by-line, according to the participants' responses to each socio-spatial theme. Words or phrases carrying similar meanings were tagged and grouped into thematic categories. Categories considered conceptually related were clustered into lower-order themes. Relevant lower-order themes were subsequently combined into higher-order themes. This iterative process involved constant comparison between the categories, themes, and data. The thematic analysis generally followed a deductive approach, using the factors of the socio-spatial analysis as a framework to structure the higher-order themes **(Table 1)**. Whenever themes emerged that did not fit the socio-spatial framework, an inductive approach was followed.

The first author, who is trilingual, reviewed the coded data throughout the process in the original native language. Any discrepancies identified during this process were discussed until consensus was reached. Before translating the codes and themes into English, the second and third authors compared meanings to ensure that translations across languages accurately reflected all intended meanings. The first author then reviewed all codes and themes again to ensure coherence and distinctiveness in the data set. Care was taken to ensure the authenticity of the responses and minimize the risk of misinterpretation during the coding process while accounting for linguistic and cultural nuances.

The thematic analysis was complemented by geographical data derived from the GIS maps. Descriptive and qualitative data were documented in a structured overview, enabling direct comparisons between the different yards and countries for the different aspects of the Socio-Spatial Analysis Framework.

While some quantitative comparisons were drawn from the thematic categories, the primary focus was on identifying patterns, meanings, and emerging themes related to the socio-spatial aspects of yard design, biodiversity, and equine welfare. This ensured that the qualitative depth of the study remained central while allowing for meaningful comparisons between yards.

Table 1: The nine aspects of the Socio-Spatial Analysis Framework [32] adapted for the current study.

Aspect	Definition
Location	This aspect was adapted to focus on the geographical positioning of the yard in relation to its surrounding area, based on yard owners' perceptions of their location, the surrounding environment (rural, suburban, etc.), and the general level of activity (e.g., traffic, pedestrians). It explored how yard owners view the potential audience their location serves.
Function/ Social Impact	This factor examined the functions offered at the yard and how they influence the yard's social role. Interviews explored whether the yard serves not only equestrians but also potentially non-equestrians, and how yard design might support daily operations and social impact.
Anchoring	Anchoring referred to how well the yard integrates into its surrounding territory. Yard owners were asked whether they felt their yard fits into the local environment and if they considered the surroundings during the yard's design process, with a focus on both social and traffic safety.
Accessibility	Yard owners discussed how easy the yard is to reach for both visitors and clients, considering aspects such as transportation options, parking, and whether the yard is easy to find and navigate.
Routes	This aspect examined the yard's position relative to passers-by and how accessible or restricted it is for those who are not direct users of the yard. Owners discussed whether people are welcome to pass through the yard and how they feel about such interactions.
Ambiance	Yard owners were asked to describe the atmosphere of the yard, focusing on how elements like beauty, psychological safety, and the overall aesthetic appeal influence the user experience and the feeling of comfort and care.
Uses and Activities	This factor explored the range of activities and facilities at the yard, including whether facilities are multifunctional and how users actively engage with the space.
Gregariousness	Yard owners discussed aspects that encourage social interaction, such as seating areas, places for visitors to gather, and whether Gregariousness was considered during yard design.
Biodiversity	Yard owners were asked about the level of biodiversity in their yards and whether they considered biodiversity important. They also discussed how they might integrate more ecological considerations into their yard management.

3. Results

3.1. Location

German yards were located in the regions of Nordrhein-Westfalen, Hessen, Niedersachsen, and Rheinland-Pfalz and engaged in a variety of equestrian activities, such as riding schools, livery services, and therapeutic riding, with a minority offering additional services, such as hotel accommodations. The proximity to Natura 2000 sites varied across the yards, with distances ranging from 21 meters to over 6 kilometers. Land use appeared relatively uniform, with most yards registered as pastures or urban fabric, and soil types predominantly comprising clay slurries and silt. Exceptions included one yard located on pure sand and another on moorland.

In contrast, Dutch yards, located in the provinces of Utrecht, Gelderland, Limburg, Overijssel, and Zuid Holland, displayed greater diversity in both business activities and land use. They employed a broader range of operations, including breeding, event hosting, and training centers, in addition to the more traditional livery and riding school services. Their proximity to Natura 2000 sites also varied, with some as close as 35 meters and others nearly 9 kilometers away. The diversity of land use in Dutch yards was reflected in their classification, ranging from agricultural and sociocultural facilities to sports grounds and business sites. Soil types were similarly diverse, including manured soils, humus podzolic soils, and peatlands, in contrast to the more homogeneous soil compositions seen in Germany **(Table 2)**.

Table 2: Overview of key themes and descriptive categories for location in German and Dutch equine yards.

Yard	Country	Province (GIS)	Main business	Distance to nearest Natura 2000 (GIS) in m	Specification of land use (GIS)	Soil type (GIS)
1	GER	Nordrhein-Westfalen	Riding school, livery, & hotel	3280	Pastures	Clay slurries/ silt
2	GER	Hessen	Riding school, livery, & hotel	1838	Urban fabric/ discontinuous urban fabric	Clay slurries/ silt
3	GER	Nordrhein-Westfalen	Therapeutic riding & livery	980	Pastures	Pure sand
4	GER	Niedersachsen	Riding school & livery	21	Artificial, non-agricultural vegetated areas/sport, & leisure facilities	Clay slurries/ silt
5	GER	Rheinland-Pfalz	Therapeutic riding	2115	Urban fabric/discontinuous urban fabric	Clay slurries/ silt
6	GER	Nordrhein-Westfalen	Riding school & livery	264	Arable land/non-irrigated arable land	Moor/marsh
7	GER	Nordrhein-Westfalen	Riding school & livery	3733	Pastures	Clay slurries/ silt
8	GER	Nordrhein-Westfalen	Riding school & livery	6329	Pastures	Clay slurries/ silt
9	NL	Utrecht	Breeding	2994	Other agricultural use	Manured soil
10	NL	Gelderland	Hotel & training school	261	Sociocultural facilities	Humus podzolic soils
11	NL	Utrecht	Riding school & livery	9123	Sport and recreation	Calcareous sandy soils
12	NL	Limburg	Training	745	Other agricultural use	Loamy soils
13	NL	Gelderland	Event	35	Sport and recreation	Humus podzolic soils
14	NL	Utrecht	Livery	6854	Business site	Calcareous sandy soils
15	NL	Overijssel	Livery	8769	Other agricultural use	Old clay soils
16	NL	Utrecht	Livery	4430	Other agricultural use	Peatlands
17	NL	Zuid Holland	Riding school	118	Sport and recreation	Diverse

3.2. Function/Social Impact

When discussing the social impact of yards, German yard owners placed a strong emphasis on the physical facilities and additional services they could provide. A common theme was the importance of offering diverse facilities, including indoor and outdoor riding arenas, pastures, and paddocks. Many also stressed the value of tailored services to meet clients' specific needs, such as vacation stays and customized offerings. These services were viewed as essential to maintaining the yard's social relevance and attracting clientele.

Dutch yard owners, in contrast, highlighted the broader social function of their yards. Many viewed the yard as a hub for community engagement, emphasizing cooperation with stakeholders and the creation of a social environment where equestrians and non-equestrians alike could benefit. Governmental policies were also a significant factor in shaping this social impact, with yard owners divided over whether they viewed such policies as positive or negative. This ambivalence suggests that Dutch yard owners are navigating both the benefits and challenges posed by government involvement in their operations **(Table 3)**.

3.3. Anchoring

In terms of how yards are integrated into their environment, the type of surroundings, landscape integration, and safety emerged as important themes for both German and Dutch yard owners. The majority of German yards described themselves as being situated in rural areas. Half of the participants indicated that the neighborhood was lively and busy, while the other half emphasized the quietness of the areas. Yard owners also commented on different aspects of yard integration into the landscape. While some yards developed organically over time to meet the needs of clients, others encountered logistical challenges, such as the distance between essential grazing pastures or a lack of deliberate design. These differences highlight a mix of purposeful planning and adaptations driven by practical needs.

Safety was a major concern for German yards. Yard owners often stressed the importance of ensuring that children could reach the yard safely, though not all had achieved this goal. Some yards implemented additional safety measures, such as secure terrain and the use of monitoring systems like cameras, to address these concerns.

Table 3: Overview of key themes and descriptive categories for function/social impact in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Additional offers	Hotel/vacation	Opportunity to offer vacation stays at the yard.	25
GER	Additional offers	Customized service	Provision of specialized or tailored services to clients.	62.5
GER	Facilities available	Hacking area	Surrounding terrain suitable for outdoor riding (hacking).	62.5
GER	Facilities available	Indoor riding arena	Enclosed indoor arena for equestrian activities, particularly dressage.	75
GER	Facilities available	Other facilities	Additional facilities that do not fall into standard categories (e.g., oval track, solarium).	37.5
GER	Facilities available	Outdoor riding arena	Open-air arena designed for equestrian sports, such as dressage.	100
GER	Facilities available	Paddocks	Enclosed areas where horses can move freely and engage in social interactions.	50
GER	Facilities available	Pastures	Grassland areas for horses to graze and roam freely.	75
GER	Facilities available	Round pen/lunging circle	Circular arena used for groundwork and lunging exercises.	50
NL	Impact government	Negative governmental influence	Perceived negative impact of governmental policies on yard management.	44
NL	Impact government	Positive governmental influence	Perceived positive impact of governmental policies on yard management.	44
NL	Social function	Cooperation	Recognition of the importance of collaboration among stakeholders.	33
NL	Social function	Community engagement	Providing equestrian services that benefit the broader community.	67
NL	Social function	Transparency	Building confidence and trust by demonstrating activities and processes visibly.	22

In the Netherlands, while many yard owners preferred that their yards remain out of sight, they also prioritized safety and controlled access. Common safety measures included gated entrances, provisions to protect both clients and animals, and concerns over strangers entering the premises. Some yards even considered continuous monitoring with cameras as part of their safety strategy. Dutch yards tended to be closely linked to natural landscapes, with many situated near nature habitats despite being in busier, more populated regions **(Table 4)**.

Table 4: Overview of key themes and descriptive categories for anchoring in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Landscape Integration	Integrated design	During construction, yard owners considered how to integrate their yard into the surrounding landscape.	50
GER	Landscape Integration	Organic expansion of yard	The yard has grown slowly and in response to needs over several years.	50
GER	Landscape Integration	Previously different purpose	The yard was previously used for different activities before becoming an equine yard (e.g., a dairy yard).	50
GER	Landscape Integration	Problems with pastures	The yard does not have pastures connected to the property, or the pastures are too few or too far away.	37.5
GER	Landscape Integration	Not consciously designed	The yard and the property it is on were not consciously or purposefully designed.	25
GER	Landscape Integration	Yard fits in with surrounding landscape	The yard and its infrastructure integrate well with the surrounding landscape.	50
GER	Safety	Not safely reachable	Children cannot reach the yard safely on their own.	37.5
GER	Safety	Safe terrain	The yard is considered safe and/or monitored by cameras.	50
GER	Safety	Safe to reach	Importance of children being able to reach the yard safely on their own.	87.5
GER	Surroundings	Busy neighborhood	There is a lot of traffic (cars, people, bicycles, etc.) in the yard's immediate surroundings.	50
GER	Surroundings	Quiet neighborhood	There is little to no traffic (cars, people, bicycles, etc.) in the yard's immediate surroundings.	50
GER	Surroundings	Nature close by	The yard is in proximity to nature	50
GER	Surroundings	Few immediate neighbors	No or hardly any neighbors in immediate proximity to the yard.	62.5
GER	Surroundings	Rural	An area outside of the city/urban center, characterized by a low population density, open spaces, a focus on agriculture, small communities, and natural landscapes.	87.5
GER	Surroundings	Suburban location	A location at the outskirts of a city/urban center, is often characterized by residential neighborhoods with a lower population density.	75
NL	Landscape Integration	Flowing lines	Yard owners expressed a preference for flowing, organic lines in the yard's design.	22
NL	Landscape Integration	Preferable remains hidden	Yard owners prefer that the yard is not easily visible from the outside.	44
NL	Landscape Integration	Yard fits in with surrounding landscape	The yard and its infrastructure integrate well with the surrounding landscape.	33
NL	Safety	(Automatic) gate	The yard has a gate at the entrance, with only two having non-automatic gates.	56
NL	Safety	Safe space	Yard owners expressed the importance of providing a safe space for clients.	44
NL	Safety	Human-animal safety considerations	Yard owners emphasized the importance of safety considerations for both humans and animals.	44
NL	Safety	Monitoring	Yard owners expressed a desire to monitor the yard with cameras.	22

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
NL	Safety	Stranger safety concerns	Yard owners expressed feeling less safe when strangers are on the yard.	44
NL	Safety	Work delayed opening	The yard's opening is delayed to ensure safety during work.	33
NL	Surroundings	Busy neighborhood	There is a lot of traffic (cars, people, bicycles, etc.) in the yard's immediate surroundings.	56
NL	Surroundings	Nature close by	The yard is in proximity to nature.	78
NL	Surroundings	Quiet neighborhood	There is little to no traffic (cars, people, bicycles, etc.) in the yard's immediate surroundings.	44
NL	Type of Landscape	Forest landscape	The yard is surrounded by a forest.	22
NL	Type of Landscape	Industrial landscape	The yard is located in an industrial area.	11
NL	Type of Landscape	Rural landscape	The yard is situated in a rural landscape.	44

3.4. Accessibility

Accessibility presented challenges for both German and Dutch yards, though the specific concerns varied. In Germany, all yards reported difficulties with public transport access, making it difficult for clients to reach the yards by anything other than a car, bike, or on foot. Many yards also noted the functional limitations of their infrastructure, with several reporting that their layout did not fully meet operational needs. Additionally, some yards described their secluded locations, which, while providing privacy, also limited their visibility and ease of access for new visitors. Despite these challenges, German yard owners emphasized the importance of maintaining a user-friendly layout for clients, with most yards highlighting the smooth flow of clients and visitors as a key priority.

Dutch yards reported a more varied experience with accessibility. While some yards faced challenges with public transport, others noted that they were accessible by multiple means of transport, including cars and bicycles. Dutch yard owners, like their German counterparts, stressed the importance of user-friendly layouts, aiming to facilitate easy navigation around the property. Additionally, parking infrastructure emerged as an important aspect for Dutch yards, with most yards offering ample parking spaces for cars and trailers. Interestingly, some Dutch yards expressed a preference for unpaved parking, suggesting different priorities regarding aesthetic or practical considerations.

One key difference between the two countries was the emphasis on controlled access. While several German yards indicated that they benefited from their more secluded locations, all Dutch yards highlighted the importance of having a single, controlled entrance. This suggests a focus on ensuring security and maintaining oversight of who can enter the property, which may reflect differences in population density and proximity to urban areas between the two countries **(Table 5)**.

3.5. Routes

The level of access for passers-by, or those not directly connected to the yard, emerged as a complex issue for German yard owners. While the majority of German yards indicated that public access was neither possible nor desirable, a significant proportion of them reported that the public did enter the yard or that they would be open to non-equestrians visiting the yard upon request. This apparent contradiction may reflect the tension between the desire for privacy and the practical reality that some level of public access is inevitable. Yard owners in Germany were concerned with third-party traffic in the vicinity and emphasized the need to control access to maintain safety, privacy, and the well-being of their horses.

In contrast, fewer Dutch yards reported significant third-party traffic in the vicinity. Only a minority of yard owners indicated that public access would be possible, while not quite half of the yards reported that they were open to strangers upon request. Interestingly, their primary focus tended to be on maintaining a consistent and familiar clientele. These findings mirror those in earlier themes, which indicate the pronounced need for privacy and creating a secure and consistent environment within the yard **(Table 6)**.

Table 5: Overview of key themes and descriptive categories for accessibility in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definitions	% of yards mentioning theme
GER	Transport	Poor public transport	Reaching the yard by public transport is difficult and/or not the best option.	100
GER	Transport	Non-motorized accessibility	The yard can be reached by bicycle and/or on foot.	100
GER	Transport	Good connectivity	The yard is relatively close to a city, motorway, or is easily reachable from different places.	75
GER	Transport	Motorized accessibility	The majority of clients require a car to reach the yard.	50
GER	Location	Easy to find	The yard can be easily found.	50
GER	Location	Secluded	The yard is hidden within its surroundings and thus not easily visible or accessible to strangers.	50
GER	Functional challenges	Limited constructional changes	The yard's facilities cannot easily be changed or repurposed.	50
GER	Functional challenges	Suboptimal infrastructure	The yard's infrastructure does not optimally serve its purpose.	37.5
GER	Functional infrastructure	Functional accessibility	The yard's facilities can be accessed with machines for work purposes.	62.5
GER	Functional infrastructure	Importance functional infrastructure	Infrastructure is serving the yard's purpose.	62.5
GER	Functional infrastructure	Paved infrastructure	All necessary paths are paved in some manner.	50
GER	Functional infrastructure	Yard size essential	The yard's size is essential and cannot be changed for the viability of its operations.	37.5
GER	Functional infrastructure	Parking	Having parking spaces available for cars (and trailers).	62.5
GER	Operational client flow	User-friendly layout	Ease of navigation around the yard.	87.5
GER	Operational client flow	Busy yard	The yard is usually busy with a number of clients.	62.5
NL	Transport	Multiple means of transport	The yard is accessible by car, bike, and public transport.	44
NL	Transport	Poor public transport	Reaching the yard by public transport is difficult and/or not the best option.	44
NL	Location	Easy to find	The yard can be easily found.	56
NL	Functional infrastructure	Importance functional infrastructure	Infrastructure is serving the yard's purpose.	67
NL	Functional infrastructure	Parking	Having parking spaces available for cars (and trailers).	89
NL	Functional infrastructure	Unpaved parking	Yard owners expressed an interest in unpaved parking.	22
NL	Limited points of entry	One entrance	Yard owners expressed the benefits of having only one entrance to the property.	100
NL	Operational client flow	User-friendly layout	Ease of navigation around the yard.	78

Table 6: Overview of key themes and descriptive categories for routes in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Level of public accessibility	Public access not possible or desired	It is not possible/desirable for strangers to enter or pass through the yard.	87.5
GER	Level of public accessibility	Third-party traffic in the vicinity	The presence of people unrelated to the yard within its surroundings (e.g., cyclists, people walking, etc.).	75
GER	Level of public accessibility	Open to non-equestrians	Open to strangers upon request.	62.5
GER	Level of public accessibility	Public access possible	The public can and does enter the yard.	50
GER	Level of public accessibility	No/hardly any third-party traffic on yard	Little to no presence of strangers unrelated to the yard within its surroundings (e.g., cyclists, people walking, etc.).	50
GER	Access for clientele	Exclusively for equestrians	The yard is solely open to clients and other equestrians.	25
GER	Restricted access	Fear of incidents	Access is restricted due to specific reasons, such as strangers feeding the horses, destroying private property, or jeopardizing the horses' safety in any way.	25
GER	Restricted access	Protection of privacy	Owners living in their yards wish to maintain a certain level of privacy.	25
NL	Level of public accessibility	Third-party traffic in the vicinity	The presence of people unrelated to the yard within its surroundings (e.g., cyclists, people walking, etc.).	33
NL	Level of public accessibility	No/hardly any third-party traffic on yard	Little to no presence of strangers unrelated to the yard within its surroundings (e.g., cyclists, people walking, etc.).	56
NL	Level of public accessibility	Public access possible	The public can and does enter the yard.	22
NL	Access for clientele	Always open house	Always open to clients during designated hours.	33
NL	Level of public accessibility	Open to non-equestrians	Open to strangers upon request.	44
NL	Access for clientele	Usual clientele	The same customers visit the yard.	89

3.6. Ambiance

The emotional value of yards and their overall ambiance emerged as a key theme in both Germany and the Netherlands. However, distinct differences between the two countries became apparent, particularly in how yard owners view the yard's emotional importance and the impact of interpersonal relationships on the overall atmosphere.

In Germany, a strong emphasis emerged on creating a positive impression and maintaining close relations with third parties, such as clients, neighbors, and the broader community. Yard owners often viewed their yards as the realization of their life's dream, viewing them as central to their lives. Clients were also thought to place significant emotional value on the yard, with closeness to nature considered a highlight. The desire to cultivate a tranquil and comforting atmosphere emerged as a clear priority, reflected in the importance yard owners place on creating a comfortable and calm environment. This commitment to ambiance was further emphasized by the role of interpersonal relationships, with yard owners stressing that the atmosphere is shaped by interactions between clients and owners. Friendly and familiar interactions were seen as essential for maintaining social cohesion and a positive atmosphere.

Dutch yards showed a similar concern for emotional value but with a more practical focus on managing interpersonal relations. Yard owners emphasized transparency and trust in their interactions with clients, seeing these values as central to maintaining a harmonious environment. Managing clientele was considered a key strategy for maintaining a positive ambiance, as yard owners took a more deliberate approach to fostering harmony within the yard. While the ambiance was frequently described as calm, some yard owners also highlighted the role of regular management routines in maintaining a peaceful atmosphere, reinforcing the structured nature of yard management in the Netherlands **(Table 7)**.

Table 7: Overview of key themes and descriptive categories for ambiance in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Desired portrayal of yard	Good impression	The yard's positive impression and good relations with third parties, like parents or neighbors, are important for maintaining a good image.	87.5
GER	Desired portrayal of yard	A place for horses, nature, & people	The yard should be a place where horses can live comfortably, and humans can feel at ease in nature—a place that integrates all these elements harmoniously.	50
GER	Emotional value for clients	Closeness to nature	Clients value the feeling of being close to and in harmony with nature.	75
GER	Emotional value for clients	Vacation vibes	Clients made to feel like they are on vacation or enjoy a brief escape from daily life when at the yard.	62.5
GER	Emotional value for clients	Home from home	Clients feel that both they and their horses are made to feel at home.	50
GER	Emotional value for owners	Life's dream	The yard is the realization of the owner's life dream or ambition, and it often centers around their entire life.	87.5
GER	Emotional value for owners	Love-hate relationship	The yard means everything to the owner, although they sometimes feel exhausted by it.	62.5
GER	Emotional value for owners	Home	The yard is the owner's home.	37.5
GER	Interpersonal relations	Impact on atmosphere	The interpersonal relationships between clients, and between clients and owners, greatly impact the yard's atmosphere.	87.5
GER	Interpersonal relations	Friendly interactions	Interactions between owners and clients, and among clients themselves, are familiar and friendly.	75
GER	Interpersonal relations	Importance of perception	How clients perceive others at the yard is considered significant.	37.5
GER	Perceived atmosphere	Comfort	The yard is perceived as a comfortable and comforting place.	87.5
GER	Perceived atmosphere	Calm	The overall ambiance of the yard is perceived as peaceful, quiet, or calm.	75
NL	Emotional value for clients	Connectivity	It is very important that clients feel connected, happy, and loved.	44
NL	Emotional value for clients	Home from home	Clients feel that they and their horses are made to feel at home.	78
NL	Emotional value for owner	Respectfulness	It is important for the owner to show respect to both people and animals.	33
NL	Emotional value for clients	Personal experience	Yard owners stress the importance of providing a personal experience for clients.	33
NL	Interpersonal relations	Transparency	Yard owners emphasized the importance of transparency and trust.	56
NL	Interpersonal relations	Managing clientele	Yard owners expressed the need to carefully manage who comes to and stays at the yard to maintain a positive overall ambiance.	56
NL	Perceived atmosphere	Calm	The overall ambiance of the yard is perceived as peaceful, quiet, or calm.	56
NL	Perceived atmosphere	Routine	The regularity and routine of yard management are considered an important part of maintaining a positive ambiance.	33
NL	Infrastructure impact	Facilities influence ambiance	Yard owners highlighted the influence that facilities can have on the yard's ambiance.	22

3.7. Uses & Activities

Both German and Dutch yards place a significant emphasis on equine-related activities, but the specific types and balance between equine and non-equine activities differ between the two countries.

German yards reported a strong focus on specialized equine services, with three-quarters of yards offering riding lessons, leisure riding, and other horse-related activities, such as clinics and courses. Non-equine activities are also relatively common, with more than half of the German yards offering events and festivities, and half offering additional leisure activities. However, German yards largely appear content with their current offerings, as indicated by a majority stating that they do not plan to introduce non-horse activities.

Dutch yards, on the other hand, show a broader range of equine-related activities, including practice competitions, clinics, and different equestrian sports events. Leisure riding also plays a central role, with the majority of Dutch yards offering this service. Although non-equine activities, such as hosting events and providing accommodations, are less prominent, they are still offered by a significant number of Dutch yards, indicating a more diversified use of yard space compared to Germany **(Table 8)**.

3.8. Gregariousness

German yard owners emphasized the importance of social infrastructure, with all yards highlighting the significance of common rooms for people to meet, gather, and socialize. Outdoor seating was also commonly mentioned as an important feature, creating spaces for interaction. Many yards consciously foster a strong sense of community, with efforts made to build relationships among clients. Some yards adapted their infrastructure specifically for equestrian use, though in a few cases, the placement of social areas was not structurally considered during the yard's design.

Dutch yard owners similarly valued social infrastructure, frequently mentioning the presence of common rooms and seating alongside arenas. There is a focus on creating spaces for clients to gather, with yard owners often stressing the importance of seating areas with views of the arenas. Transparency and communication with the community were also highlighted, with yard owners recognizing the importance of sharing information to foster trust and a sense of openness **(Table 9)**.

Table 8: Overview of key themes and descriptive categories for uses/activities in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Equine-related activities	Specialized offers	Unique equine services tailored to specific needs, such as dressage or jumping.	75
GER	Equine-related activities	Riding lessons	Formal lessons focused on teaching clients riding skills and techniques.	75
GER	Equine-related activities	Leisure riding	Horseback riding for recreational purposes without a competitive focus.	75
GER	Equine-related activities	Other activities with horses	Activities involving horses other than riding, such as groundwork or lunging.	62.5
GER	Equine-related activities	Clinics/courses	Workshops or courses that provide specialized equine training or education.	62.5
GER	Equine-related activities	Equestrian sport	Participation in competitive equestrian sports, such as showjumping or dressage.	25
GER	Non-equine activities	Festivities/events	Organizing social events, such as open days or holiday celebrations, on the yard.	62.5
GER	Non-equine activities	Other leisure activities	Recreational activities not related to horses, like hiking or picnics.	50
GER	Non-equine activities	Holidays	Offering holiday accommodations, such as equestrian vacation stays.	25
GER	Expansion of activities	No non-horse activities	Yard owners have decided not to offer any non-horse-related activities.	62.5
GER	Expansion of activities	Currently (almost) at capacity	Yard is currently operating at or near full capacity, limiting expansion options.	37.5
GER	Expansion of activities	Interest in non-horse activities	Yard owners have expressed interest in introducing non-horse-related activities.	25
GER	Expansion of activities	No interest in non-horse activities	Yard owners have no desire to expand to non-horse-related activities.	25

Country	Lower-order theme	Descriptive code	Definition	% of yards mentioning theme
GER	Equine husbandry	Breeding	Breeding horses, either as a primary business activity or to supplement yard services.	37.5
NL	Equine-related activities	(Practice)competitions	Hosting practice competitions for riders to simulate competitive environments.	44.4
NL	Equine-related activities	Clinics/courses	Workshops or courses that provide specialized equine training or education.	55.6
NL	Equine-related activities	Equestrian sport	Participation in or hosting competitive equestrian sports, such as showjumping or dressage.	55.6
NL	Equine-related activities	Breeding	Breeding horses, either as a primary business activity or to supplement yard services.	22.2
NL	Equine-related activities	Leisure riding	Riding for recreational purposes without a competitive focus.	66.7
NL	Equine-related activities	Riding lessons	Formal lessons focused on teaching clients riding skills and techniques.	22.2
NL	Equine-related activities	Training for others	Training horses on behalf of clients, which may include breaking, schooling, or advanced training.	33.3
NL	Equine-related activities	Therapeutic riding	Riding activities focused on therapeutic benefits for individuals with physical or psychological needs.	11.1
NL	Non-equine activities	Holidays	Offering holiday accommodations, such as equestrian vacation stays.	22.2
NL	Non-equine activities	Festivities/events	Organizing social events, such as open days or holiday celebrations, on the yard.	33.3
NL	Extra activities	Accommodation	Providing facilities for overnight stays, either for clients or as an additional business.	22.2
NL	Extra activities	Non-horse activities	Providing activities that do not involve horses, such as nature walks or workshops unrelated to equestrianism.	33.3

Table 9: Overview of key themes and descriptive categories for gregariousness in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Descriptions	% of yards mentioning theme
GER	Social infrastructure	Common rooms	Places indoors and/or outdoors for people to meet, gather, sit down, and socialize.	100
GER	Social infrastructure	Outdoor seating	Benches and other outdoor seating on the yard.	75
GER	Social infrastructure	Restructured for equestrian use	The yard's infrastructure was adjusted to meet the needs of equestrianism.	50
GER	Social infrastructure	Additional outdoor meeting points	Areas other than outdoor seating for people to meet.	37.5
GER	Social infrastructure	Integration not structurally considered	During construction, the placement of social areas was not a primary concern.	25
GER	Social infrastructure	More indoor places to stay	The desire to create more indoor social spaces in various forms.	25
GER	Social community	Sense of community	Valuing a strong community is perceived as important.	100
GER	Social community	Good yard community	The yard has a well-functioning community.	75
GER	Social community	Active community building	Efforts are consciously made to foster interpersonal relationships.	75
GER	Amenities	Drinks/snacks available	Drinks and/or snacks are available at the yard.	37.5

Country	Lower-order theme	Descriptive code	Descriptions	% of yards mentioning theme
NL	Social infrastructure	Common room	Places indoors and/or outdoors for people to meet, gather, sit down, and socialize.	78
NL	Social infrastructure	Seating alongside arena	Seating with a view of the arena.	67
NL	Social infrastructure	Outdoor seating	Benches and other outdoor seating on the yard.	67
NL	Amenities	Drinks snacks available	Providing basic drinks and/or snacks for clients.	56
NL	Amenities	Smoke area	A secluded area designated for smoking.	11
NL	Amenities	Changing room	Providing a place to easily change clothes.	11
NL	Social community	Sense of community	Valuing a strong community is perceived as important.	56
NL	Social community	Transparency with community	Yard owners emphasized the importance of sharing what they are doing with surroundings/customers.	44

3.9. Biodiversity

In Germany, attitudes toward biodiversity were generally positive, with yard owners emphasizing the importance of respecting nature and expressing openness to further integrating biodiversity. Many yard owners mentioned that they actively managed their grasslands and considered habitat conservation as part of their management strategies. However, there were challenges in specific areas, such as sustainable manure disposal, which was only being practiced by a smaller number of yards.

Yard owners reported the presence of small landscape elements, such as trees and hedges, but indicated that bird life and blue landscape features, like ponds or streams, were less common. Some participants expressed concerns about the conflict between nature conservation efforts and equine welfare regulations, noting that these regulations sometimes made it difficult to strike a balance. A portion of the yard owners also voiced skepticism toward the benefits of integrating more biodiversity, indicating potential barriers to further adoption of biodiversity practices.

In the Netherlands, yard owners had similarly positive attitudes toward biodiversity, with many seeing it as a key factor in improving both equine welfare and water management. Dutch yards often focused on the practical benefits of biodiversity, such as improving grassland quality and managing wet landscape features for better water quality. Yard owners expressed strong confidence in their current biodiversity practices, with several considering their efforts to be adequate or optimal.

Despite this, some Dutch yard owners pointed out practical concerns, such as managing bird waste and the potential negative impact of biodiversity on the tidiness of the yard. This suggests that while Dutch yards have embraced biodiversity, there are still challenges to address in maintaining a balance between aesthetics, functionality, and natural integration **(Table 10)**.

3.10. Equine Welfare

During data analysis, equine welfare emerged as an additional topic, with yard owners discussing the importance of forage, freedom of movement, social contact, and housing conditions in maintaining equine well-being.

In Germany, equine welfare practices were found to revolve around forage management and providing freedom of movement. Most yards emphasized the importance of allowing horses to graze during the summer and providing high-quality roughage. Innovative feeding systems, such as automatic hay racks and spread-out feeding stations, were also in place in some yards, although less widespread.

Many yards highlighted the need for spacious housing conditions that allow horses to move freely. Group housing systems were also common, indicating a strong emphasis on fostering social interactions. However, while some yards were focused on improving housing conditions and creating more space for free movement, others felt they had already optimized their facilities with no further room for improvement. While a majority of yards considered welfare their key priority, many also pointed out the difficulty of balancing equine needs with external circumstances, such as client demands, nature conservation regulations, or structural conditions.

Dutch yard owners also emphasized the importance of equine welfare, with a strong focus on social contact and turnout. The majority of yards ensured that horses have regular access to outdoor spaces and opportunities for interaction with conspecifics.

Housing considerations, such as managing natural light and sufficiently spacious stables, were also mentioned by a number of yards as playing a role in creating comfortable environments for horses. Similar to Germany, Dutch yard owners also raised the difficulty of balancing welfare with external demands, including local government restrictions, client demands, and the threat of wolves in some regions **(Table 11)**.

Table 10: Overview of key themes and descriptive categories for biodiversity in German and Dutch equine yards.

Country	Lower-order theme	Descriptive code	Descriptions	% of yards mentioning theme
GER	Attitude toward biodiversity	Respect for nature	Yard owners perceive respectful and sustainable treatment of nature as important.	75
GER	Attitude toward biodiversity	Open for further integration	Yard owners express their willingness to learn more about and further integrate biodiversity.	62.5
GER	Attitude toward biodiversity	Close to nature	Yard owners believe themselves to be closely connected to nature.	50
GER	Attitude toward biodiversity	Aesthetic value of plants	Yard owners and clients perceive green landscape elements as aesthetically pleasing.	50
GER	Attitude toward biodiversity	Unavoidable biodiversity integration	Yard owners consider further integration of biodiversity on yards as unavoidable.	25
GER	Current actions	Own grassland management	Yards managing their own grassland.	75
GER	Current actions	Considerations of habitat conservation	Conscious consideration of habitats on the yard.	62.5
GER	Current actions	Own roughage production	Yards producing their own roughage.	37.5
GER	Current actions	No chemical pesticides	No use of chemical pesticides in land and forage management.	37.5
GER	Current actions	Sustainable manure disposal	Yards with a sustainable method for disposing of manure, such as using biogas plants.	37.5
GER	Current actions	No roughage production	Yards without their own roughage production.	25
GER	Own biodiversity rating	Unfamiliarity with assessing own yard	Biodiversity has never been discussed or considered, and/or the yard's current biodiversity level cannot be assessed.	62.5
GER	Own biodiversity rating	Green yard	Yard owners assessing their yard as quite biodiverse.	37.5
GER	Perceived biodiversity indicators on site	Green landscape elements	Presence of green landscape elements like trees, bushes, hedges, etc., on the yard.	87.5
GER	Perceived biodiversity indicators on site	Bird life	Large presence of birds at the yard.	37.5
GER	Perceived biodiversity indicators on site	Blue landscape elements	Presence of blue landscape elements like ponds, streams, etc., on the yard.	25
GER	Perceived biodiversity indicators on site	Other domestic animals	Presence of domestic animals like cats, dogs, etc.	25
GER	Perceived challenges	Conflict between nature conservation and animal welfare	The conflict of contradicting nature conservation and animal welfare regulations experienced by yard owners.	50
GER	Perceived challenges	Manure disposal	Issues with rule-conforming and practical manure disposal.	37.5
GER	Perceived challenges	Soil quality	The unfitness of the soil for equestrianism at a yard.	37.5
GER	Perceived challenges	No perceived advantages	Yard owners expressing that they do not see any advantages in further integrating biodiversity and feel skeptical toward it.	37.5
GER	Perceived challenges	Unwilling to integrate more biodiversity	Yard owners expressing their unwillingness to further integrate biodiversity at this moment.	37.5

Country	Lower-order theme	Descriptive code	Descriptions	% of yards mentioning theme
GER	Perceived challenges	Conflict between poisonous plants and biodiversity	Plants that are poisonous for horses are negatively associated with biodiversity by yard owners.	25
GER	Policy requirements	Compensatory planting	Planting landscape elements as compensation for nature lost, e.g., due to construction.	62.5
NL	Biodiversity awareness and attitudes	Biodiversity impact on image	Respondents stated that biodiversity influences the yard's image.	33
NL	Biodiversity awareness and attitudes	Biodiversity vs. business priorities	Respondents expressed the need to balance biodiversity efforts with the practicalities of running a business.	44
NL	Biodiversity awareness and attitudes	Preserving natural habitat	Providing space for and being careful with nature.	56
NL	Biodiversity benefits	Biodiversity for equine welfare	Yards that expressed the use of biodiversity to improve equine welfare.	56
NL	Biodiversity benefits	Biodiversity for functional benefits	Yards expressed ideas for utilizing biodiversity for material and functional benefits.	44
NL	Biodiversity benefits	Biodiversity to improve water quality	Yards that would like to or are using wet landscape features to improve water management.	56
NL	Biodiversity benefits	Grassland quality	Biodiverse grassland is considered better than monoculture grassland.	44
NL	Biodiversity self-evaluation	Perceived insufficient biodiversity	Self-evaluated as having insufficient biodiversity.	22
NL	Biodiversity self-evaluation	Perceived adequate biodiversity	Self-evaluated as having sufficient biodiversity.	67
NL	Biodiversity self-evaluation	Perceived perfect biodiversity	Self-evaluated as having an optimal integration of biodiversity.	67
NL	Perceived biodiversity indicators on site	Bird life	Large presence of birds at the yard.	56
NL	Perceived biodiversity indicators on site	Land-based animals	Wild land-based animals on the yard.	56
NL	Perceived challenges	Managing bird waste	Utilizing shelves to minimize bird mess.	22
NL	Perceived challenges	Negative impact on tidiness	Yard owners commented that it takes more work to maintain a neat appearance of the yard.	44

3.11. Financial Viability

Financial viability also emerged as an additional topic during the interviews, with yard owners highlighting the importance of infrastructure, customer satisfaction, and diverse income streams.

German yards emphasized the importance of structural requirements, with a strong focus on ensuring that the physical infrastructure of the yard supported financial stability. Financial sustainability was often linked to having a sufficient number of satisfied customers, maintaining a balance between economic viability and yard improvements, and having diversified sources of income.

German yard owners also indicated facing significant barriers to financial stability, including a lack of external resources and skilled personnel. Additionally, some yards expressed concerns about non-profitable aspects, such as owning too many horses that do not generate income, highlighting the financial pressures of maintaining the yard.

In the Netherlands, a number of yard owners expressed a need for governmental financial assistance, particularly if it serves a useful purpose or supports biodiversity.

Dutch yards also adopted more collaborative and customer-centric strategies, with many emphasizing the importance of working together with other yard owners to reduce costs and passing extra expenses on to clients. They also indicated prioritizing the reuse of materials or manufacturing their own. Diversification of income remained important, but Dutch yards appeared more willing to adapt and collaborate to achieve financial sustainability **(Table 12)**.

Table 11: Overview of key themes and descriptive categories for equine welfare in German and Dutch equine yards.

Country	Lower-order theme	Descriptive category	Descriptions	% of yards mentioning theme
GER	Forage	Grazing in summer	Emphasized the importance of allowing horses to graze on pastures during the summer.	75
GER	Forage	Good-quality roughage	Highlighted the need to provide good-quality roughage.	62.5
GER	Forage	Innovative feeding methods	Yards employing innovative feeding methods, such as automatic hay racks or multiple feeding stations spread across the enclosure.	37.5
GER	Freedom	Freedom of movement	Emphasized the importance of providing housing conditions spacious enough to allow free movement.	75
GER	Friends	Group housing	Yards implementing group housing systems.	62.5
GER	Future ambitions	More space for free movement	Emphasized the need for larger enclosures to allow horses to move freely.	50
GER	Future ambitions	Improving housing conditions	Improving individual stables or adding paddocks to individual stalls.	50
GER	Future ambitions	Room for improvement	Many opportunities were identified for improving the yard to better promote equine welfare.	25
GER	Future ambitions	No room for improvement	No further opportunities are available to improve the yard to promote equine welfare.	25
GER	Future ambitions	Improving riding arenas	Improving arenas to provide better training conditions.	25
GER	Housing	Species-appropriate housing	Yard owners emphasized the importance of providing species-appropriate housing conditions to ensure welfare.	75
GER	Housing	Shelter & lying areas	Yard owners highlighted the presence of shelter and lying areas.	37.5
GER	Housing	Safety	Consideration of safety in horses' outdoor areas, including safe constructions and protection from poisonous plants.	25
GER	Welfare aspects	Additional exercise	Emphasized the importance of providing enough additional exercise to maintain the horses' health.	37.5
GER	Welfare challenges	Feed management	The challenge of satisfying individual roughage needs in group housing systems.	37.5
GER	Welfare challenges	Conflict between nature conservation & equine welfare regulations	The challenge of complying with both nature conservation and equine welfare regulations.	25
GER	Welfare challenges	Conflict between human- & equine welfare	Conflict noted between human clients' needs/desires and equine welfare requirements.	25
GER	Welfare challenges	Restrictions due to lack of resources/ structures	Implementation of measures to enhance equine welfare is restricted by limited monetary resources and/or structural conditions.	25
GER	Welfare challenges	Suitable herd dynamics	The challenge of creating harmonious herds in group housing systems.	25
GER	Welfare priority	Equine welfare = No. 1 priority	Equine welfare is considered the top priority by yard owners.	62.5
NL	Feed management	Feed management	Emphasized the importance of effective feed management.	44
NL	Freedom	Turnout	Emphasized the importance of turnout	67
NL	Friends	Social contact	Highlighted the importance of social contact among horses.	67

Country	Lower-order theme	Descriptive category	Descriptions	% of yards mentioning theme
NL	Housing	Light management	Emphasized that stables should be naturally well-lit.	33
NL	Housing	Size stables	Stressed the importance of having sufficiently large boxes.	33
NL	Welfare challenges	Local government restrictions	Yard owners aiming to improve certain welfare aspects but are hindered by local government regulations.	44
NL	Welfare challenges	Conflict between human- & equine welfare	Conflict noted between the needs/desires of human clients and the requirements for equine welfare.	44
NL	Welfare priority	Basic/natural needs	Emphasized the importance of tending to the horses' natural needs, often expressed as "let a horse be a horse."	67
NL	Wolf threat solution	Wolf solution: horses indoors	Keeping horses indoors as a solution to ensure safety from wolves.	33
NL	Wolf threat solution	Wolf solution: fence	Installing special fencing to keep out wolves.	33

Table 12: Overview of key themes and descriptive categories for financial viability in German and Dutch equine yards.

Country	Lower-order theme	Descriptive category	Descriptions	% of yards mentioning theme
GER	Structural requirements	Sufficient yard infrastructure	The necessity of having appropriate, yard-specific infrastructure.	75%
GER	Financial sustainability strategies	Enough satisfied customers	Yards need enough satisfied customers to remain viable.	62.50%
GER	Financial sustainability strategies	Balance between economic viability & ideas for improvement	The importance of maintaining a balance between income and expenses when making improvements.	50%
GER	Financial sustainability strategies	Several sources of income	Diversifying yard activities to have multiple sources of income, such as combining a riding school with a livery yard or other aspects.	50%
GER	Financial sustainability strategies	Attractive & affordable offers	The need to offer attractive and affordable services to remain competitive.	25%
GER	Financial sustainability strategies	Voluntary support	The need for voluntary support to help run the yard.	25%
GER	Barriers to financial stability	Lack of external resources	Any improvements would require a combination of new regulations (nature- or welfare-related), additional funding, or increased labor input, making it a complex challenge.	62.50%
GER	Barriers to financial stability	Lack of skilled personnel	The severe shortage of skilled staff is currently faced by the yards.	37.50%
GER	Barriers to financial stability	Non-profitable aspects	Yards expressing concerns about non-profitable aspects, such as owning too many horses that do not generate income.	25%
GER	Structural requirements	Functional stable design	Yards that have consciously designed their stables to require minimal labor input.	25%
NL	Financial support	Pro-governmental financial help	Would like or need governmental financial support.	56%
NL	Financial support	Governmental financial help only for bio/purposeful	Specifically expressed a preference for governmental financial support only if it serves a useful purpose or supports biodiversity.	44%

Country	Lower-order theme	Descriptive category	Descriptions	% of yards mentioning theme
NL	Financial sustainability strategies	Reuse/produce own materials	When materials that would normally need to be purchased can now be reused or produced by the yard.	44%
NL	Financial sustainability strategies	Quality over cost	When quality is prioritized as being more important than cost.	33%
NL	Financial sustainability strategies	Work together	Reducing costs by working together with other yard owners.	56%
NL	Financial sustainability strategies	Diversification of income	Diversifying yard activities to have multiple sources of income, such as combining a riding school with a livery yard or other aspects.	44%
NL	Financial sustainability strategies	Customer-centric financial strategy	Passing extra expenses on to customers and adapting to changes over time.	56%

4. Discussion

The aim of this study was to investigate equine yard owners' perceptions of what they consider important when designing biodiverse, functional yards. The findings demonstrate that a variety of aspects—ranging from land use and social interactions to accessibility and biodiversity—play a significant role in yard design and management. At the same time, certain cultural differences became apparent, even between countries as geographically close as Germany and the Netherlands. Previous research has shown that differences in historical and cultural influences shape the way individuals prioritize and balance environmental, social, and economic factors, including landscape features **[37–39]**.

The results show that designing equine yards requires balancing the needs of horses with the broader social and ecological requirements of the yard, reflecting the idea that equine yards exist at the intersection of functional agricultural landscapes and socially meaningful spaces **[14,22,40]**. Yard owners in both countries emphasized the significance of equine welfare, particularly through the 3Fs—Freedom, Forage, and Friends. These principles underline the importance of natural behavior, such as grazing and social interactions, which directly influence the layout of yards. Group housing and extensive pasture space were prioritized to support equine well-being, reflecting practices that encourage biodiversity and ecological management **[23,24]**.

However, the practical integration of these welfare measures with biodiversity goals varied somewhat between Germany and the Netherlands, due in part to differences in available land and cultural attitudes toward ecological integration. Dutch yards demonstrated a more diverse approach to multifunctional land use, frequently incorporating blue and green landscape elements for both functional and ecological purposes. These findings align with previous research by Wolframm *et al.* **[13]** and lend additional weight to the role the equine industry can play in enhancing agriculture's contribution to biodiversity **[41]**. Conversely, German yards, while often open to the idea of enhancing biodiversity, reported challenges in harmonizing biodiversity with equine welfare, such as dealing with poisonous plants that posed risks to equine health **[25,42]**.

While German and Dutch yards share similar goals related to welfare and biodiversity, cultural differences tend to shape their approaches on how to incorporate these aspects into yard design and management. Dutch yards showed a higher degree of multifunctionality, leveraging blue and green infrastructure for ecosystem services like water management, while simultaneously enhancing the landscape's aesthetic and functional value. These findings align with Hedenborg *et al.* **[43]**, who argued that equine yards have responsibilities that extend beyond their core functions, contributing to ecological connectivity and engaging with the wider community.

German yards, on the other hand, appeared more homogeneous in their use of land, focusing largely on equestrian functions. This emphasis on facilities and specialized activities, such as riding schools and therapeutic riding, reflects a narrower yet potentially more stable operational model where equine welfare and infrastructure are more rigidly defined. Cultural differences in land availability and government policies likely contribute to these distinctions, as the limited land in the Netherlands requires more diverse land-use strategies **[44]**.

Current findings suggest that, at present, Dutch yard owners prefer for their yards to remain out of sight, with controlled access to strangers through gates and restricted entry points. As Dutch yard owners are generally faced with greater population density and greater proximity to urban areas, these measures likely reflect genuine concerns about safety and protecting both horses and clients. However, such an emphasis on privacy and limiting public interaction carries the risk of being perceived as isolated and relevant only to an exclusive group of users. Given the high population density and the need for multifunctional land use in the Netherlands, a more proactive approach to interacting with members of the public could facilitate the integration of equine yards into the local community and

their contribution toward the collective action required in the agroecological transition [2,3,45].

Interestingly, for German yard owners, the underlying sentiment of how to balance community engagement and yard safety seemed very similar to that of their Dutch counterparts, yet they also demonstrated a different approach on how to deal with it. While German yard owners did indicate the desire to remain secluded, they also acknowledged the need to allow access to non-equestrians more readily. Germany, of course, is a much larger country, with greater levels of seclusion, particularly in the countryside. As a result, yard owners may be much more aware of the importance of encouraging community engagement despite their personal preferences for keeping the yard—and its inhabitants—shielded from too much outside interference.

After all, equine yards are not merely functional agricultural units; they are also social spaces that need to cater to and accommodate the needs of both equine and human users [22]. People-centered approaches have been increasingly used in open-space design, emphasizing the importance of incorporating the perspectives of individuals directly affected by the design [46,47]. According to [48], spaces that consider human needs beyond physical requirements are likely to be more functional, beautiful, and meaningful. In practice, this means designing yards that incorporate areas for social gatherings, such as common rooms or seating with views of riding arenas, where clients and visitors can interact in a welcoming and inclusive setting. Both Dutch and German yards highlighted the importance of social spaces and fostering close relationships within the equestrian community. This reflects a desire to build social cohesion within the regular clientele as well as visitors. Considering the increasing pressure to demonstrate the broader societal (and ecological) value of equine yards to the broader community, such an approach becomes increasingly important in maintaining the social, economic, and ecological validity of equine yards [49].

Current findings also showed that financial viability is a core consideration for yard owners, influencing their ability to implement welfare or biodiversity measures. Both German and Dutch yards adopted strategies to diversify income, such as hosting non-equine activities or offering accommodations, to enhance their financial sustainability [29]. The Dutch preference for governmental financial support, especially in support of biodiversity, indicates a greater reliance on external funding mechanisms to maintain operations. This reliance aligns with the European Green Deal's focus on incentivizing ecological contributions through financial support [6]. However, it also demonstrates the importance of creating the conditions necessary to implement changes [13,50,51]. This means that to realize the significant potential of equine yards for enhancing biodiversity and fulfilling multifunctional roles in rural landscapes, their role and contribution need to be acknowledged in agricultural and ecological policy frameworks. To that end, accessible, actionable guidelines are required to help both yard owners and policymakers design and manage spaces that support both biodiversity and equine welfare while ensuring economic viability. Based on current findings, a number of preliminary design guidelines were drawn up with these aims in mind. Future research should aim to expand and define these guidelines.

5. Preliminary Design Recommendations

5.1. Equine Welfare

Design for the 3Fs: Ensure yard layouts support free movement of horses ("freedom"), access to high-quality forage, and social interactions with conspecifics ("friends") to enhance equine welfare.

Green-blue corridors: Integrate hedgerows, ponds, and other green-blue elements into the yard design, for example, as natural barriers between fields, to enhance landscape connectivity and ecological function.

Natural shelter and shade: Plant trees and shrubs to provide shelter and shade, supporting both equine welfare and local biodiversity.

5.2. Biodiversity

Mixed habitats: Utilize mixed habitat designs featuring native shrubs, wildflowers, and pastures to stimulate natural grazing behavior in horses and increase ecological benefits.

Biodiversity zones: Establish specific biodiversity zones that are entirely or partially inaccessible to horses, maintaining a balance between conservation and welfare needs.

5.3. Social Function

Social hubs: Design common areas where clients and visitors can gather, enhancing the yard's role as a community hub and encouraging interaction beyond equine activities.

Public accessibility: Improve public transport and pedestrian access to make yards more inclusive, fostering community involvement and engagement in biodiversity initiatives.

Controlled access: Implement controlled entry points to manage visitor flow and ensure safety for horses, people, and sensitive ecological areas.

5.4. Financial Sustainability

Diversify business strategies: Develop separate income streams by incorporating non-equine activities such as workshops, accommodations, or eco-tours to support multifunctionality.

Collaborative resource management: Work with neighboring yards to share resources, thereby reducing costs and increasing financial resilience.

6. Limitations

Lastly, to ensure appropriate interpretation of current findings, a number of limitations to the current study need to be borne in mind. The convenience sampling approach used to select participants may limit the generalizability of the results, as selected yards are likely not fully representative of all equine yards in Germany and the Netherlands [52]. Additionally, while the use of semi-structured interviews provided rich qualitative data, it may

have introduced biases based on the participants' subjective views and the interviewers' framing of questions [53].

The socio-spatial analysis framework applied in this study provided a structured approach to yard evaluation, but its adaptation meant the exclusion of certain original aspects, such as uniqueness, which could have contributed additional insights. By concentrating on Germany and the Netherlands, the findings may not be directly applicable to other European countries with different cultural, regulatory, or geographical contexts.

7. Conclusion

The comparison between Germany and the Netherlands across these themes reveals distinct priorities and approaches in managing equine yards. Germany tends to focus more on tangible infrastructure, internal resources, and optimizing existing facilities, while the Netherlands emphasizes social dynamics, collaboration, and adapting to external influences. Both countries show a strong commitment to equine welfare and biodiversity, but some of the strategies employed reflect their unique cultural and environmental contexts.

Current findings show that the integration of biodiversity into equine yards is a multifaceted approach that offers significant benefits for the environment, equine welfare, and the financial sustainability of equine businesses. In order to maximize the potential of equine yards to contribute toward the agroecological transition, concrete, effective guidelines are required for yard owners and policymakers. After all, the success of the agroecological transition hinges in no small part on the practical implementation of biodiversity and equine-related measures in the social, ecological, and economic context of each yard.

The future of equine yard management lies in the adoption of sustainable practices that balance the needs of the environment, animals, and people. As the equine sector continues to evolve, it has the potential to become a leader in biodiversity conservation and sustainable land management, contributing to a more resilient and ecologically diverse landscape.

Supplementary Materials

Supplementary materials include the full list of semi-structured interview questions used in the study.

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Authors' Contribution

Conceptualization, I.W.; methodology, I.W.; formal analysis, L.L., T.S., and I.W. Writing—original draft preparation, L.L., T.S., I.W., and S.R.; writing—reviewing and editing, I.W.; supervision, I.W. and S.R.; All authors have read and agreed to the published version of the manuscript.

Data Availability

Data storage was conducted according to the Research Data Management policy framework of the University of Applied Sciences Van Hall Larenstein. Data management will adhere to the principles of Open Science, and data is accessible upon request.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

The study was conducted according to the Netherlands Code of Conduct for Research Integrity and followed the guidelines of the Declaration of Helsinki.

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"If You Can Walk, If You Can Breathe, You Don't Need to Go to Hospital": Psychological Responses of British Horseracing Staff to Occupational Injury

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Abstract

Horseracing staff have multifaceted roles, acting as caregivers, skilled athletes, and equine experts, subject to high emotional, physical, and cognitive demands, and an elevated incidence of injury. Racing staff are unlikely to seek support, take time off, or report injuries, and research has yet to explore their lived psycho-emotional experiences. This study aimed to investigate the psychological responses to occupational injury in British horseracing staff. Twelve horseracing staff (two males, 10 females, $\bar{x}$ age = 37.25 ± 14.12 years) were interviewed about their experiences following a serious injury sustained while working in horseracing. Injuries must have resulted in 21 days of disruption to daily life but could be acute or chronic. Thematic analysis identified four higher-order themes aligned to individual injury experiences: injury impact, emotional responses, injury management, and barriers to help-seeking. Staff highlighted negative impacts on their health and wellbeing, discussing the physical, occupational, and financial consequences and the effect injury had on self-worth and identity. All participants discussed denial, frustration, and guilt, which strongly influenced return-to-work decisions. Horseracing staff took a proactive approach to injury recovery, however, they typically opted for self-management rather than seeking professional medical support. Several barriers to help-seeking were identified, including a lack of trust in medical services, normative expectations of injury within horseracing, and limited awareness of the resources available to them. Strategies to improve employee return-to-work following injury, including national return-to-work guidelines and early-contact training for senior staff, would benefit the sector and align with strategic industry objectives on staff retention.

Keywords

Help-seeking; emotion; thoroughbred stud; racing groom; return-to-work; injury culture

1. Introduction

British Horse Racing is a billion-pound industry, contributing £3.5bn to the UK economy per annum [1], and indirectly employs 85,000 people. In 2021, there were 7,961 registered racing employees, including licensed jockeys, working for 581 licensed trainers, responsible for the care and training of over 20,000 horses in the UK [2]. In addition, the industry estimates a further 3,500 staff working in the Thoroughbred breeding sector [1]. Horseracing staff play a multifaceted role within the industry, including horse care—such as training, feeding, stable duties, and health management—as well as race day management, including equipment checks and escorting the horse to the paddock [3].

The skilled nature of the role was recognized by the industry in 2017, which rebranded the role as racing groom [4]. The extensive time commitment and responsibility of care seen by staff in the racing and breeding sectors mean that a member of staff's day-to-day life is impacted in a way not seen in many other industries, making employment in racing *'a way of life'* rather than a part of life [5].

Concerns for the stability of the horseracing workforce are evident in both industry and academic literature [6], with declining trends in staff retention rates, vacancy rates, and job satisfaction reported in the last five years [2], despite targeted investment from the industry. There is an increasing interest within the sector in the physical and mental health of horseracing staff and the implications these areas could have on staff wellbeing, recruitment, retention, and employee satisfaction [3,5,7].

An industry report identified that 72% of training yard staff experienced stress, anxiety, or depression in the previous 12 months [5], while recent research in Korea identified that racing staff have high physical demands, with increased workloads, time pressure, reduced remuneration, and a greater sense of responsibility, all contributing to an increased risk of depression [3].

Occupations where staff experience greater physical or emotional stress are often associated with organizational assumptions that employees are physically and mentally strong [8], and accustomed to working through pain [9]. While these characteristics may be beneficial in a fast-paced working environment such as horseracing [10], they can become problematic for employee mental health when those assumptions are challenged, for example, due to injury [11].

There is a high incidence of injury in horseracing staff, with employees self-reporting an average of 3.3 injuries per annum, ranging from chronic back and musculoskeletal pain to concussion, fractures, and internal organ damage (see [12] for review). While most reported injuries are chronic and low grade in nature, industry data suggest over 50% of yards report more than one serious accident per year [13], with hospital visits required in 28%–71% of cases, highlighting the severity and nature of injury type as far-reaching within horseracing [14].

While horseracing staff experience high levels of occupational injury, the likelihood of reporting injuries, seeking time off or treatment, or resting during recovery is low [12–15]. The apparent disregard for personal injury seen in racing staff has fostered a culture of presenteeism [5], reducing not only the efficacy of the workforce but also influencing the long-term physical and mental health of horseracing staff [16]. Despite this, limited research exists on the mental and physical health of the wider horseracing workforce beyond the role of a jockey.

Injury is widely recognized as a significant factor in occupational stress, particularly for high-risk sectors (e.g., operating heavy machinery, animal handling, or working long or unsociable hours) [17]. Early research in the field investigated the psychosocial implications of injury in workers [18], with employees experiencing threats to their psychological wellbeing, commonly attributed to the loss of worker 'identity' and sense of self [19]. Injured workers often discussed procedural complexities [17], negative attitudes from workplace organizations, and ongoing economic losses as factors for reduced mental health during injury recovery [20]. However, much of this knowledge has been gained from surveys, and researchers noted a need to utilize more qualitative methods to explore the complex experiences of injured workers [19].

Despite this call for more qualitative inquiry, only limited research has investigated the lived psycho-emotional experiences of injured workers, beyond the implications for return-to-work procedures [21] or procedural unfairness [17]. For athletes, considerable research has been undertaken considering the implications of injury on psychological health and wellbeing [11,22,23], as well as performance and continued sports participation. To date, however, research has only explored the impact of injury on the athlete, with no research focusing on support staff to identify the implications of injury on occupational stress, wellbeing, and workplace performance.

The role of sports science support is to maintain the physical health and mental wellbeing of the athlete and manage performance preparations and training—responsibilities akin to those working in horseracing, with the exception that the 'athlete' under care is a non-human animal. The unique nature of horseracing job roles, along with cultural considerations of horseracing as a competitive sport and industry (see [7] for full review), poses a novel situation within which to consider the effects of injury on the workforce.

The result of such research could have important implications for knowledge regarding the psycho-emotional responses to injury, coping strategies utilized within horseracing staff, and staff engagement with current occupational health provision in horseracing.

The aim of this study, therefore, was to investigate the psychological responses to occupational injury in British horseracing staff. The objectives were to: a) explore the psychological appraisal and subsequent emotional and behavioral responses to injury experiences by horseracing staff through narrative inquiry, b) identify current coping mechanisms used and whether they are sufficient to promote positive mental health post-injury, and c) consider whether injury experiences are influenced by cultural considerations that may exist within British Horseracing.

2. Methods

2.1. Design

The quality of qualitative research in sport psychology is determined by the methodological coherence and transparency demonstrated by researchers [24,25]. This study was underpinned by the methodological assumption that knowledge is socially constructed and that meaning and cultural context are important for the interpretation of results. Hence, a social constructivist epistemology was applied to answer the research aim. It has been suggested that injury can only be understood as a sociological inquiry due to the implications that social arrangement,

institutionalism, and embodiment play on the exposure to, reporting, and consequences of injury [26].

The Cartesian dualism of pain, often represented as mind and body, limits the sociopsychological implications of pain and injury. Therefore, this study sought to evaluate the social and institutional habitus formed by the racing industry by asking social context questions [26]. Research into the social construction of identity, habitus, and injury relationships in dance has utilized narrative approaches to discuss the readjustment experienced by injured dancers [27]. Narrative inquiry is the systematic process of gathering information through storytelling, focusing on the participants' lived experiences, how they understand those experiences, and how society, culture, and institutions shape those experiences [28,29]. Social constructivism often utilizes narrative inquiry within interviews to support the understanding of social context [30], thus narrative inquiry was adopted for this study.

2.2. Participants

Twelve horseracing staff (two males, 10 females, $\bar{x}$ age = 37.25 ± 14.12 years (range 20 – 60 years old), $\bar{x}$ time off 3.7 ± 6.2 weeks (range 0 – 20 weeks)) were selected based on their injury experiences. Participant recruitment was obtained using purposive and snowball sampling methods [31], utilizing the researcher, and the University's contacts within the horseracing industry, and through colleagues and employees of these contacts [32]. The use of snowball sampling allowed for recommendations of the researchers' credibility between participants and can instill trust, supporting an open, honest discussion. Previous research has identified a concern with injury reporting, and injury minimalization in horseracing [5,7,12] that hindered a larger sample size being obtained, resulting in a sample size of 12 racing staff interviewed across a 12-month period. Similar sample sizes have been reported in other studies, including Everard *et al.*'s [33] narrative life-story interviews with elite athletes (n = 15), Mosewich *et al.*'s [34] study on elite female athletes (n = 5), and elite equestrian athletes ([35], n = 12).

2.3. Inclusion Criteria

The inclusion criteria required that staff must have experienced a serious injury in the last 12 months while working in horseracing. The current study focused on workplace injury, which was defined as an injury or illness caused, contributed to, or significantly aggravated by events or exposures in the work environment [36]. Injuries were accepted to be acute, chronic, or resulting from overuse; may or may not have required medical attention; and may or may not have required time away from work. A serious injury has previously been defined in psychology of injury literature as a minimum of three weeks' disruption from normal life protocols [34], including time away from sport in athletic populations, time off work in occupational settings, or required adjustments to transport, work situations or homelife as a requirement of injury restriction [37,38]. These re-adjustments to normal life processes are considered disruptive and require reappraisal to support coping and are considered as significant time for psychological impact [39]. Further support exists for this time frame within the racing industry, currently, horseracing insurance claims classify a serious injury as requiring three or more weeks away from activity [40,41]. While previous research has utilized sick leave of absence from training, competition, or work as a measure of injury severity, the presenteeism previously reported in the racing population could have affected the sample available of injured staff who have explicitly taken >21 days absence [5,7,12]. When no time has been lost (work or training), injuries are referred to as transient, and this is often due to the normative social culture of denial [42,43]. It was therefore decided a minimum of >21 days of disruption to life protocols, including adjustments to daily life (e.g., driving, restrictions at work), rather than specified sick leave, would be utilized as inclusion criteria. At the time of the interview, nine racing staff had returned to work, with a further three opting to leave the horseracing industry following their injury.

2.4. Measures

In line with narrative inquiry, interviews were deemed the most appropriate method for this study. The interviews followed an initial short-life story framework [44], focusing on key moments in the life of the interviewee that are linked to the research aims, i.e., workplace injury. The term life story is defined as drawing on people's experiences, assuming individuals construct their identities by narrating stories about themselves [45]. Participants were asked to recount stories of their life in horseracing to date, their current role in the industry, and their experiences of a workplace injury in the previous 12 months. This allowed for a window into the participants' experiences, and where required, prompts were used to obtain further detail however care was taken that these were not biasing or directing the answers of the participants. Probing techniques included echo, re-questioning, silence, repetition, and encouragement probes, as utilized in Kerr's [46] research into vicarious trauma and injury responses. Horridge *et al.* [47] suggest that prompts, summaries, and clarifying statements increase the researchers' understanding of the participants' experience and may further develop important themes. When the participant and interviewer felt there was no more information or thoughts to add to the stories being told, the researchers considered data saturation to be reached in terms of the individual short-life stories [48]. Before undertaking interviews with participants, a pilot interview was conducted with a former horseracing staff member who had experienced injury. The completion of the pilot interview confirmed the interview protocol was appropriate to meet the aims of the study. The pilot data were not included in the analyses. One concern in the investigation of this field, and with this participant group, was the risk of hidden narrative, whereby due to a lack of integration in the social and cultural field, the researcher is not permitted to discussions of true experiences [32]. Instead, participants may report occupational and organizational viewpoints on the subject, due to fear of being judged or misunderstood by 'outsiders'. Previously seen in the military, racing, dance, and nursing sectors, participants reported a lack of engagement in personal topics with those they felt were not part of the existing culture [27,32]. The primary researcher (ED) is considered a member of this community and has significant experience with injuries obtained in a similar context (equestrian industry). While the 'insider' status may have developed open discourse during the interview, shared injury experiences between the researcher and

participant can pose several challenges, including imposing one's own beliefs or values onto participants **[49]**. Everard *et al.* **[33]** noted that when participants were aware of the researcher's injury experiences, they used this knowledge to reinforce their beliefs (e.g., you know what it's like), which was seen in several participants in this study, despite the researcher maintaining neutral responses to avoid leading the participant.

2.5. Procedure

Following institutional ethics approval by the Hartpury University Human Research Ethics Committee (approval number ETHICS2021-09) and informed consent, 12 horseracing staff were interviewed on their experiences of occupational injury. Recruitment was achieved through personal and organizational industry contacts, collaborating industry partners, and social media groups/pages to recruit participants **[31]** who met the inclusion/exclusion criteria. To protect the anonymity of the participants, all participants in this study were allocated numbers (i.e., P1, P2). Each interview, conducted by the first author, lasted on average 51.3 ± 19.9 minutes (range: 16–90 minutes) and was audio and/or video recorded using either the Philips VoiceTracer Audio Recorder (DVT28100/00) device, Microsoft Teams (Version 1.5.00.22362) or Zoom (Version 5.12.0 (11129)). Interviews utilized a mix of face-to-face (n = 6) and online methods (n = 6); the interview method was determined based on participant preference. The use of online interviews allowed for a wider geographical representation of participants and mitigated the implications of any COVID-19 regulations during the data collection **[50]**. Interviews were scheduled to accommodate participants' busy schedules, which is a challenge often seen in research exploring the horseracing industry **[32]**. Online interviews have been shown to gather data equivalent to face-to-face interviews, with the advantage of participants being comfortable in their environment which may facilitate deeper discussion on sensitive topics **[51]**, thus the research team felt the use of both online and face-to-face interviews was appropriate.

2.6. Data Analysis

This study utilized thematic analysis to allow new information to be extracted from the data and did not seek to answer a hypothesis or quantify themes **[52]**. The data were analyzed using an eight-stage approach adapted from **[53] (Table 1)**.

The lead researcher's epistemological perspective is a social constructivist lens, which framed how the thematic analysis was undertaken. It should be acknowledged that the interpretation of the findings and emergent themes may have been influenced by the primary researcher's experiences with personal injury within equestrianism. While this provided strength in offering opportunities for connection, rapport, and empathy through shared experiences during the interview process, recognition and reflection following the interviews were conducted alongside the remaining researchers to ensure that the first author's positioning had not influenced the coding and subsequent themes identified.

Table 1: Description of analysis process.

Stage	Description of analysis process
1	Transcription of the interviews.
2	Data were checked and re-read to ensure familiarity.
3	Direct quotes were extracted and divided into categories **(Figure 1)**.
4	Inductive grounded theory analysis was undertaken using open coding line by line to represent each participant's personal interpretation.
5	Focused coding was used to formulate themes (ED).
6	Themes were organized to represent their relationship with the aims **(Figure 1)**.
7	Validation consensus was conducted by researchers.
8	Discussion to determine whether the research aims had been appropriately met.

3. Results

Participants (n = 12) worked in a range of groom and groom/rider-based roles across the horseracing sector, including stud, flat training, jump training, pre-training, and rehabilitation yards. All participants were actively working within the horseracing industry at the time of their injury, with three part-time and nine full-time staff. All staff experienced an injury that resulted in more than three weeks of disruption to occupational demands within the last 12 months. At the time of the interview, nine participants had returned to work, and three had left the industry **(Table 2)**. Ultimately, the analysis resulted in four higher-order themes aligned to individual injury experiences: (A) injury impact, (B) emotional responses, (C) injury management, and (D) barriers to help-seeking **(Figure 1)**.

3.1. Theme A: Injury Impact

Horseracing staff described several consequences associated with experiencing workplace injury, including 1) physical; 2) occupational; 3) financial; and 4) implications for self-worth.

Participants believed injury negatively influenced future employment opportunities, career progression, or physical and mental health.

3.1.1. A1: Physical Impact

Most participants reported experiencing physical consequences from their workplace injury, including subsequent pain, acute physiological responses to the injury incident, or longer-term physical limitations. Some participants described in detail the physical sensations of pain they experienced: *"... it's like someone puts a knife into your back... start off with a shooting pain, then all the muscles around it go into spasm..."* (P4). While others minimized their experiences of pain, perceiving it as less significant in comparison to prior injury experiences or other patients. This was suggested by one participant during her time in the intensive care unit (ICU) following an incident that punctured her lung, dislocated her jaw, and broke several ribs: *"I didn't consider my pain to be painful..."* (P10).

Table 2: Participants' Demographics.

Pp.	Age (years)	Gender	Industry sector	Part-/ Full-Time	Injuries	Injury Causation	Time off work	Outcome
P1	20	Female	Jump racing	PT	Concussion, leg and back pain, lacerations	Fall	1 week	Remained in racing industry
P2	21	Female	Pre-training Yard	PT	Fractured scaphoid	Fall	2 weeks	Remained in racing industry
P3	32	Female	Stud	FT	Rotator cuff injury, crushed hand, kick to the head	Leading horses, kick	0 weeks	Remained in racing industry
P4	42	Female	Jump racing	FT	Back pain	Chronic	0 weeks	Racing welfare support; remained in racing industry
P5	25	Female	Flat racing	FT	A) Fractured cheekbone & eye socket, broken nose B) Ankle ligament damage, two broken ribs, lacerated quadriceps C) Fractured scapula, fractured cervical vertebrae, torn muscle (shoulder)	Kick (A) Fall (B & C)	A) 0 weeks B) Left C) 4.5 weeks	Left racing industry
P6	25	Female	Rehabilitation yard	PT	Leg injury, soft tissue damage, cause undetermined	Fall	0 weeks	Remained in racing industry
P7	41	Male	Stud	FT	Broken finger, torn ligaments	Handling horses	0 weeks	Remained in racing industry
P8	52	Female	Traveling groom, stud	FT	Hand injury – unknown diagnosis	Slip	0 weeks	Remained in racing industry
P9	23	Female	Jump racing	FT	Five broken ribs, lacerated liver, kidney damage, internal bleeding	Kicked by horse	12 weeks	ICU stay; left racing industry
P10	57	Female	P2P, jump racing	FT	Dislocated jaw, punctured lung, six broken ribs	Reared on, kicked by horse, trampled	3 weeks	Hospital stay (4 days); remained in racing industry
P11	49	Male	P2P, jump racing	FT	Broken leg	Kicked by horse (mounted)	11 days	Hospital stay (5 days); surgical Intervention; remained in racing industry
P12	60	Female	Flat racing	FT	Golfer's elbow, nerve pinching	Chronic	20 weeks	Surgical Intervention; left racing industry

One participant was also very descriptive about other physical sensations she experienced while waiting for medical support at the time of the injury incident: *"It was freezing cold and wet… I was shivering… it was really hurting my stomach… I couldn't move… I was really struggling to breathe… I was just so cold, and I was really thirsty… I was just so uncomfortable. And it was like, honestly, the worst thing that I could ever. It was horrible"* (P9).

Other individuals chose to emphasize the chronic physical limitations of their injury, highlighting concerns with restricted or reduced movement, sleep difficulties, weight gain, or their ability to drive or ride their own horses: *"You literally you would drop the knife because you couldn't grip it…"* (P12). These participants often discussed how the injury had ongoing negative consequences for their health and wellbeing after their return to work. One such participant highlighted the physical and mental consequences of an injury that reduced his hand dexterity and affected his confidence in social situations as a result: *"… it affects hobbies, as well as outside of work… it makes you very clumsy and you drop things… not only does it affect you physically, but mentally it probably has a bigger effect on me as well… What if I dropped my wine glass…? I never used to be like that…"* (P7).

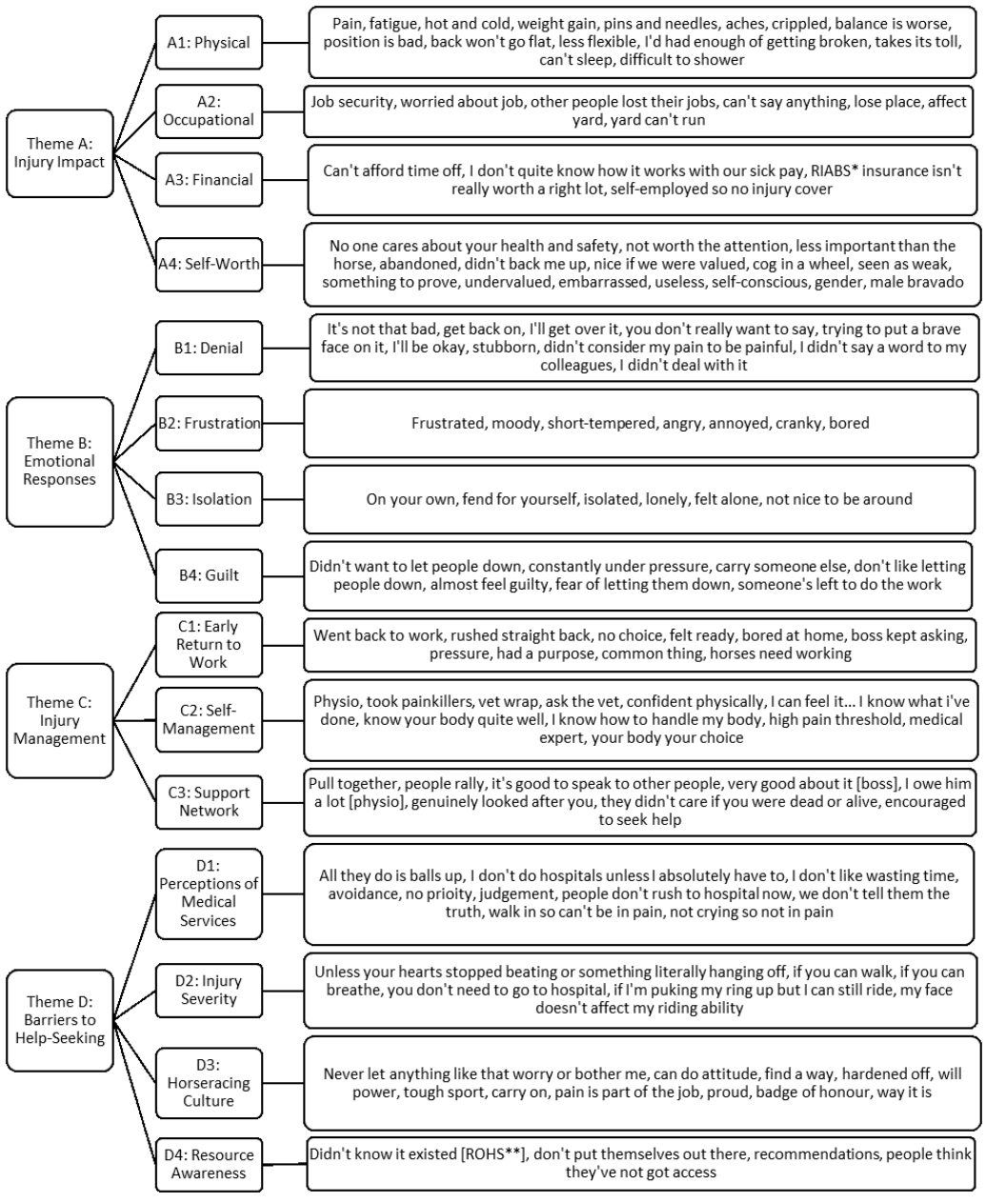

Figure 1: Higher- and lower-order themes (*RIABS – Racing Industry Accident Benefit Scheme; **ROHS – Racing Occupational Health Service).

3.1.2. A2: Occupational Impact

Many participants described concerns about how their injury would affect their employment, including job insecurity, an inability to attend work, a sense of missing out, and physical limitations affecting job demands. Participant 2 felt they experienced minimal effects on their home life; however, when forced by their employer to take several weeks off work due to a fractured hand, they noted: *"It wasn't too devasting in my actual life, it was more directly affecting my work life more than anything..."* (P2).

For injured participants who took time off, many reported concerns over job security, as well as fears about missing out on career opportunities: *"I didn't want to blow my chances for the future..."* (P8), or feeling guilty for letting their teams down. Several staff noted that the working conditions in the industry made it harder for them to feel comfortable either taking time off or reducing their duties following an injury, due to the consequential effects on their colleagues' workload, with participant 4 highlighting this struggle: *"Every yard in the country is short staffed. There is no room for breaks or sit downs, or oh I can't be bothered to muck out my six because, you know, because then some else has to do 10"* (P4). Another staff member, one of the younger participants in the study, felt left out socially when off work, stating: *"... then having a week off knowing that everyone else is at work and because I enjoy work it was harder... it's really hard because*

everyone's getting ready for the races, and you can't be a part of it" (P1).

Job security was a key concern for several participants. One participant felt that, in missing work due to injury, their job role was at risk, despite legal protections offered for injured and sick employees: *"I didn't want to lose my job. That was the fundamental basis of everything. I didn't want to let the boss down, and therefore lose my job… I was very easily replaceable, or I thought I was…"* (P6).

3.1.3. A3: Financial Impact

Several participants discussed the financial implications of injury and the various options, or lack thereof, for financial support available to them. Participants described how their decision to continue working was influenced by financial motives, often an inability to afford time off because of injury: *"I couldn't afford the statutory sick pay, so erm I kind of, I had to keep working through injuries because I couldn't time off… I just thought about what I could afford to do"* (P3). This sentiment was also echoed by staff classified as part-time or self-employed, who felt they lacked additional support mechanisms to permit them to take time off. One such participant describes: *"It was more the financial side of it because obviously I was self-employed so there's no injury cover or anything"* (P2). Staff typically chose to return to work earlier than might be anticipated by medical advice and financial security was a significant factor in this decision.

Within the British horseracing industry, a national Racing Industry Accident Benefit Scheme (RIABS) exists to financially assist eligible persons following accidental injury out of their duties for a licensed trainer. Several staff highlighted that RIABS was their only form of injury or accident insurance, and they had experienced financial difficulties as a result of not being able to continue to work following injury, either from limited financial remuneration from the scheme: *"It was just what the RIABS pay sick pay and that was what I had to survive on… RIABS insurance isn't really worth a right lot…"* (P5), or that they felt they were unable to access the financial support due to technicalities about their injury. One such participant experienced a chronic overuse injury resulting in 5 months off work prior to surgical intervention, and due to the chronic nature of her injury, felt this impeded her ability to seek RIABS support: *"The union didn't back me either. I tried to claim on RIABS… the only way I have this injury is because of the job I do. But they [RIABS] have turned me down… It's wear and tear and you won't get nothing for that…why was I paying?"* (P12).

3.1.4. A4: Implications for Self-Worth

While not always explicitly stated by participants during their interviews, an overall theme of self-worth was identified by the researchers during the analysis. For some horseracing staff in this study, their injuries seemed to interact with their sense of self-worth, with multiple staff reporting feeling undervalued or not appreciated, with descriptions such as *"useless"* (P3), or *"embarrassed"* used to describe themselves while injured, and one participant felt like a *"cog in a wheel"* and an *"inconvenience"* (P12), not appreciated or valued by their employer. One participant (P8) suggested that due to their choice to work with young horses in the industry, their injuries were deserved: *"I probably would say, I've got what I deserved over the years…"* (P8). Several staff also highlighted the disparity in the care shown by employers or colleagues to their state of health compared to if a horse had been injured: *"… and they [trainers] give a shit more about the horse."* (P5), *"the value of us compared to the value of the horse…"* (P3), and *"there's not really a lot of priority on human health when compared to horse welfare…"* (P2).

Interestingly, the role gender plays in feelings of self-worth and perceptions of weakness was also identified by both male and female participants. Participant 7 (male) felt that as the type of injury they experienced was not deemed "severe," they needed to maintain a masculine bravado response: *"… it was more bravado on my front… sounds a bit silly, but I was a man and I have broken me fingers…"* (P7). In contrast, one of the female participants who worked in a male-dominated sector of the horseracing industry felt that being the only female increased the likelihood of being perceived as weak by their colleagues if they complained about an injury: *"But it was the fear of being singled out I think as a female as much as anything. Most of the ********** [company grooms] are men so I was slightly concerned I didn't want the you know the woman to be the weak link…"* (P8).

3.2. Theme B: Emotional Responses

All the horseracing staff interviewed in this study discussed a mixed range of emotional responses to their injuries, which included denial, frustration, isolation, and guilt. The emotional profile of injured staff in this study highlights the importance of further research and interventions to support employees working within horseracing.

3.2.1. B1: Denial

All participants within this study denied the severity of their injuries; denial varied in nature between individuals, ranging from several staff who initially denied their injury severity until after they were medically assessed, to those staff who at the time of interview still considered their injuries to be *"not that bad"* (P6), some despite medical diagnoses to the contrary.

Participants who initially self-assessed their injuries as less serious were often encouraged (or forced) to seek medical attention by colleagues, employers, or family and friends. Support networks, with an external perspective, often saw the severity of the injury more clearly than the injured party: *"The director was there at the time, actually, he did say to me, you need to get that seen to… he sent me a phone number for his doctor…"* (P7). One participant, who was kicked in the leg while riding, resulting in fracture and subsequent surgical intervention, noted that despite feedback from eyewitnesses to the contrary, their initial assessment of their injuries was not as serious: *"I wasn't convinced that it is broken, probably trying to put a brave face on it, according to eye witnesses they said they knew it was broken straight away…"* (P11).

Other participants were still confident at the time of the interview that their injuries were not overly serious, despite either follow-up medical advice, or chronic issues following the injury. Participant 10, who was trampled by a horse and experienced a dislocated jaw, punctured lung, and rib fractures, compared their injury severity to other participants during their stay in the hospital, despite the severity of their own injuries *"… wasn't so high priority. Yeah,*

and you're thinking well, yeah, the next stop home because someone else needs this bed, yeah really needs this bed" (P10). Participant 2, a younger participant who fractured their wrist during part-time employment in the racing industry said: *"I didn't view it as that serious an injury…"* (P2). This participant reported arthritis in their wrist as a partial consequence of that injury (and two prior wrist fractures) but downplayed the severity of that consequence, and the chronic issues they faced as a result: *"… its just a bit niggly day to day and it's interesting like it does affect my work life, erm, but er, yeah, I'm quite easy-going about it. I don't, I don't mind, you just find a work to work around it, erm…you just sort of look at that, take some painkillers and move on [laughing]"* (P2).

3.2.2. B2: Frustration

Half the participants in this study reported feeling frustrated by their injuries, in response to impaired or restricted ability to continue daily activities, such as work, driving, or riding. Participant 2, who fractured their scaphoid, was frustrated over having to find cover to care for their horse: *"Er, a little bit frustrated… trying to work out obviously with my feral pony for 2 weeks [laughs], but er yeah that's it really, just frustrated,"* while participant 12 felt more frustrated by the impact on their home life: *"I couldn't butter bread, it was you know, it was so frustrating…"* Participant 8 also described how they felt frustrated by the situation, that they had made a mistake causing the injury to occur: *"That's my own personal upset because of the pain and the frustration… it was a rookie error."* Finally, participant 10, who also lives onsite at their workplace, felt the effect on their typical routine, stating: *"Frustrating, frustrating… No, it's frustrating when you can't work… Just like part of that routine, isn't it. The normal things you do every day that you then can't do."*

3.2.3. B3: Isolation

Several of the horseracing staff discussed feeling isolated and lonely following their injuries. These individuals were all younger female participants who did not live in onsite accommodations, working both full- and part-time within the industry. For two of the participants, isolation was specifically linked to the COVID-19 pandemic and restrictions imposed by lockdowns or hospital procedures. Participant 9 was worried about not being able to see their family: *"We weren't allowed visitors or anything because it was during COVID."* Participant 2 lived in a rural area, limiting their social interactions during recovery: *"I couldn't drive so, erm, fairly isolated to my house, it's very rural where I live um it didn't, the time frame because it was corona…"* The other participant who felt lonely after their injury had just moved to a new area for work, and their partner was working abroad, thus they didn't have a strong social support network within their current geographical location: *"I didn't know anyone down here. I couldn't go to my mom's coz I couldn't drive that far like it was, it was… it was sort of like, hey, you're on your own now, fend for yourself… I yeah, I was [lonely], it wasn't pleasant"* (P5).

3.2.4. B4: Guilt

Most horseracing staff in this study reported feeling guilty about their injuries, expressing concern for colleagues, or sometimes employers, about additional workloads to compensate for their recovery. Participants described how their injuries reduced their ability to 'carry their own weight' in the workplace, meaning they often felt that they were *"a hindrance to the team…"* (P3) or that *"someone else is gonna have to pick up the slack"* (P5). All discussed feeling guilty, or that they were *"letting every[one] down…"* (P4) due to taking days off. Participant 4 describes this feeling in this quote: *"Because you just feel that thing that you're letting every people down by not being there. And you know how, how much work and how hard it is on them just doing your own jobs. But then if you have to carry someone else, as well"* (P4).

Staff suggested the increased feelings of guilt were due to staff shortages within the industry overall, or specifically at their workplace. Participant 2 worked in a small yard as a team of three people and felt that their absence had a significant effect on workloads: *"I just I knew they were struggling just between the two of them because it was quite a lot of horses…"* (P2). However, other staff felt that the wider staffing issues within horseracing led to a cultural ethos of working as a team: *"… the desire to not let people down, I think that goes back to the racing industry, it's teamwork"* (P8) suggesting a larger industry perception regardless of yard size.

3.3. Theme C: Injury Management

When asked to describe how they had managed their injury, horseracing staff typically described a proactive management approach, often preferring to return to work earlier than advised, or would be considered appropriate, and self-medicate or self-manage injuries, rather than seek professional medical intervention. Participants also discussed the role of their work colleagues and employers in key factors in managing injuries.

3.3.1. C1: Early Return to Work

Most horseracing staff in this study reported continuing to attend daily working commitments despite serious injury, or returning to work before their suggested medical leave was completed. This was usually connected to either a desire to alleviate boredom or frustration from periods of inactivity, such as seen in participant 9: *"I just could do nothing, so I decided to go back early"* or because participants felt that work commitments were a priority: *"Yeah, I got back on after and I still worked him, erm and then I carried on riding the other four lots I had that day…"* (P1). One participant described a sense of purpose and pride from returning to work while injured: *"I almost felt proud that I was [working]… you always you want people to realize that"* (P7). Horse care was often described as a critical reason to either stay at work post-injury or to return to work sooner than recommended. One participant described the early return to work as *"quite a common thing in our industry…"* citing *"the horses need working and the horses need doing and people go back to it perhaps before they should"* (P10) while another suggested *"that's just how we do things. Wasn't heroic or anything like that. It was just these horses needed brushing"* (P12). Interestingly, another participant took a different view and noted that horses often act as non-judgmental friends, thus encouraging injured staff to want to spend time around them, which may explain the earlier return to work in some cases: *"I think the connection with, one thing I am forgetting I think, probably a connection with the horses is probably sometimes, when everything goes wrong in your life, it never goes wrong with horses…why perhaps I don't take time off… horses don't judge it do they? So even when you're offered those, if you're offered a 2 weeks, you haven't got that, that that*

friend beside you, which is a horse who don't judge you. So that's another thing as well" (P7).

3.3.2. C2: Self-Management

Many participants discussed an approach of self-management of their injuries, preferring to rely on knowledge obtained from prior injury experiences, an enhanced understanding of anatomy and physiology, and unorthodox sources of medical advice to support recovery, rather than seek professional medical attention.

Participants described feeling like they intrinsically knew what injuries they had or had not experienced, and the best methods by which to treat them. Several individuals reported a sense of 'knowing' about the outcome of injury investigations prior to seeking medical expertise: *"I am good at guessing what I've done…"* (P5), or in how to treat or manage their injuries due to prior experiences: *"Because I have been broken a lot. I know I know how to handle my body"* (P10). Participant 5 suggests that their job role was the main reason for their better understanding of injury and what their body could cope with: *"I think when you have a physical job you know your body quite well… I know what the difference is in feelings or in the way something looks"* (P5). Other participants had physical 'checklists' by which they deduced the extent of their injuries and treated accordingly. Participant 10 described how the type of pain experienced was used as an indicator of the injury type: *"But I hadn't got that shoot pain, what I would consider a break… I treated it as a break."* Another example was given by participant 3, who felt that their ability to undertake certain physical tasks while injured determined the extent of the injury: *"My theory was if I could lift up a heavy weight [pitchfork of muck from stable duties] with a broken wrist, I wouldn't be able to do it… and the fact I could lift a fork full of **** [poo], which was fairly heavy, meant that it wasn't broken"* (P3).

Furthermore, several participants in this study reported an advanced level of anatomical and medical expertise because of their career choice. One participant described how she knew that her injury was not serious enough, in her opinion, to seek medical attention: *"Working with horses, you think you're a bit of a sort of medical expert, don't you?"* (P8). Another participant suggested that they had learned how to rehabilitate injuries for themselves based on how they would do so in a horse: *"Erm, cuz now I've learned that, for injuries to heal you have to have time off which is why they give horses time off [laughs]"* (P3).

Two participants described alternative sources of medical advice. Both participants stated that prior to attending an accident and emergency department (A & E), they sought advice from an equine veterinary surgeon, who was visiting their workplace close to the time of the injury incident. One participant asked the vet to complete some diagnostic imaging: *"I did ask the vet to x-ray my hand…"* (P3) while the other went further to ask for medical assistance in resolving a dislocation: *"I actually asked the vet to pull it back for me, the vet was there… he said I can't do that…"* (P7).

3.3.3. C3: Occupational Support Network

Horseracing staff in this study felt that the key contributors to successful injury periods were their employers and the staff surrounding them at work, and during the interview process, more readily highlighted occupational support networks than personal ones, suggesting these were a priority for them. The role of the employer appeared to be a critical factor in participants' responses, with some praising the contributions and support of employers, such as P7, who notes: *"All the way through it the director, he was worried… he sent me to his doctor… there wasn't any pressure not to go, or any of that, there's probably more encouragement to go"* (P7). Other staff suggested their employer had not been as supportive: *"You know, once you no good to them, they aren't bothered"* (P12). One participant who had experienced working for several employers during their racing career highlighted the disparity in support offered by employers during periods of injury or illness: *"I think it depends a lot on who you work for as to what you get… [boss 1] would check in, see how I was getting on… [boss 2] he…genuinely looked after you. Whereas [boss 3], they didn't give a **** [poo]. They didn't care if you were dead or alive… The head lads[1] and the people you worked with, they did [care]"* (P5).

Participant 5 above also highlighted the supportive nature of wider members of the staffing teams, such as head lads/lasses[1], or colleagues. Team dynamics also seemed to be a factor in facilitating return to work, with close-knit and well-functioning teams often supporting each other through periods of injury: *"I appreciate I'm very lucky cox it is a smaller yard, erm, and we're very close as a team and they do look out for us and everybody is always present there's no sort of hiding… they very much eased me back into doing the [ridden] work…"* (P2).

3.4. Theme D: Barriers to Help-Seeking

Throughout the interviews, horseracing staff identified several perceived barriers that limited the likelihood of them accessing additional support, whether that was medical provision, rehabilitation or psychosocial support services or even just asking for additional help from social or occupational support networks. Barriers noted most frequently in this study were: 1) trust in medical services; 2) perceptions of injury severity; 3) cultural perceptions of injury within the horseracing industry; and 4) awareness of available resources.

3.4.1. D1: Trust of Medical Services

Horseracing staff in this study had typically negative perceptions of medical services, especially hospital and emergency services, often following prior experiences. There was also a lack of trust in the expertise of National Health Service (NHS) Accident and Emergency departments in treating injured racing staff, with one staff member describing her reason for not visiting a hospital was *"all the horror stories of A & E…"* (P8). Horseracing staff expressed feeling a sense of judgment from medical providers for injuries that were *"self-inflicted"* (P3), and felt medical staff were unlikely to believe the severity of some injuries as

[1]Head lad/lass is the term typically used in horseracing to define a male or female member of the management team within a racing yard **[74]**.

staff often presented walking, talking, driving, and without significant displays of pain or emotional responses.

Horseracing staff felt they were judged by and accident and emergency (A & E) teams for their involvement in horseracing as a dangerous sport, with participant 3, who experienced several major injuries including a kick to the head, suggesting: *"I don't think there's much sympathy involved when it comes to horse related injuries because they kinda look at it and go, it's self-inflicted… you have to have a thick skin…"* (P3).

Within this study, negative perceptions of hospital interactions seemed to stem from a feeling of not being believed about injuries or injury severity, often because the patients' presentation was seen as atypical for that level of injury or pain. Participant 5 described their experiences of A & E when they drove themselves to the hospital following a horse fall which resulted in fractures to the cervical vertebrae and scapula: *"… I will never go back to that hospital 'cause all they do is balls up… I told them this is what's wrong with it, can you please sort it and they said no, no no don't be silly 'cause I wasn't crying and screaming, they've gone there's no way you've done what you're saying you've done. If you're not crying and drove yourself here…"* (P5).

Participant 10 describes their conversation with a doctor about challenges with horsey patients: *"He [hospital doctor] said the worst patient is horsey people, rugby, and farmers. Yeah nothing hurts with them he said"* (P10). Interestingly, one participant reflected that their behavior and dismissal of pain and symptoms during their initial presentation to A & E following an accident at work may have led to their misdiagnosis, which resulted in chronic limitations to the movement of their hand, dexterity, and fine motor movement: *"I was having physio at **** hospital when they realized they had misdiagnosed my finger… they thought it was a fracture, it was actually a full on snap of both ligaments… But like I said, when I went to A & E I was full on rush mode, get me saying get me out of here, I need to get back to work. So I probably pressure, I pressurized them. And I was happy, probably with the diagnosis at the time, because it made it simple break, put a splint on enough to go back to work… I'm not blaming the NHS at all, or anyone else, I was happy with it until the foaling season had finished. Then I thought something's not quite right"* (P7).

Racing staff were more likely to trust the medical judgments of physiotherapists (or equivalent musculoskeletal therapists) with whom they had built long-term relationships, and often sought their expertise in managing and recovering from injuries, with or without medical diagnoses, such as participant 10, who noted: *"I saw my physio three days a week when I got hurt, yeah and then I went to hydropool quite a lot…"* (P10). For participant 11, despite surgical intervention following a fracture during which it can be assumed that prognosis and recovery timelines would have been discussed, the true extent of their injuries was only realized following a conversation with their personal chiropractor, with whom they had a long-standing relationship: *"… I went to see him… he was the person I'd always go [when race riding] to to have a little fix, so I always feel quite reassured when he looks after me… he turned around to me and he said this won't actually properly heal for two years, and again it was sort of like that… the dawn of how long this takes to heal was, erm, was quite shocking really… I trust ***, I actually trust him…"* (P11).

Those staff based in Newmarket, the racing epicenter of the UK, also reported positive experiences of the heath medics where injury resulted from a fall during training: *"… the heath medics are obviously on point and they're very very good at the job. They're worth their weight in gold, bless them…"* (P5). Heath Medics are members of the Newmarket Training Grounds team who have undergone medical training and were introduced in 2016 by the Jockey Club to attend to injured riders prior to the arrival of emergency services while on Newmarket Training Grounds.

3.4.2. D2: Injury Severity

One of the most prevalent factors that influenced horseracing staff's treatment and recovery from injury was their perceptions of what constituted a severe injury, which seemed to be more of an industry-wide viewpoint, than individual perceptions due to similarity in participant responses. Participants expressed a disregard for what others may suggest are medically severe injuries, and this sometimes affected their likelihood of seeking medical attention. Participant 3 described an incident with a colleague at work: *"Yeah, one of the guys at work got kicked in the head yesterday, he just carried on as normal, actually had blood pissing down his head."* When asked what level of injury severity may warrant a visit to Accident and Emergency (A & E), horseracing staff typically responded with *"something's literally hanging off"* (P8), *"dead and dying…"* (P6), or *"if you can walk, if you can breathe, you don't need to go to hospital"* (P12). Participant 8 describes the attitude of racing staff to attending A & E for an injury: *"… unless your heart stopped beating, or something's literally hanging off… it's that underlying attitude…"* (P8).

One participant suggested that any injury that may affect someone's ability to concentrate, or where a broken bone would affect the balance/stability of the rider, would be a safety risk that may result in stopping ridden work. However, when asked about their own injuries, which included a fractured nose, eye socket, and cheekbone, the participant went on to say: *"… my face doesn't affect my riding ability, it hurts, but its not causing me any issues. It doesn't affect the rest of my body that I use to ride so why shouldn't I be here… it doesn't affect my hands or me legs"* (P5).

3.4.3. D3: Horseracing Culture

An underlying theme of the interviews with all injured horseracing staff in this study was that the context of the racing industry had and continued to influence their normative expectations of injury prevalence, severity, treatment options, and help-seeking behaviors within the sector. Staff in this study believed that injuries were an acceptable and accepted part of their roles working with horses, commonplace in nature, *"getting kicked is basically weekly occurrence…"* (P3), and that a level of pain was to be expected, as shown by participant 8: *"We should have to deal with that [aches and pains]. Unfortunately, that's the nature of the game"* (P8).

Staff viewed those working in the industry as *"tough"* (P4), having a *"thick skin"* (P3), being the type of people to *"grin and bear it"* (P2 and P7), or *"just carry on"* (P4 and P12), and

having a *"can-do attitude"* (P11). Several participants used this industry 'persona' to justify their decisions when injured, for example, participant 11 describes how their actions during the injury and recovery period were not dissimilar to what others may have done: *"...people that work with horses and their can-do attitude, yeah, I think everyone's the same in industry, find a way, don't think I'm an exception, I think I am the norm. Everyone's the same, you just do..."* (P11). Those who did not meet these typical characteristics were seen as weak, and several of the participants judged colleagues who took time off or did not immediately return to the saddle: *"If someone is not getting up, the like more the banter you get from other people, ah yeah, she's known for it"* (P5). Participant 4 felt that not everyone was suitable to work in the racing industry based on their ability (or lack thereof) to continue working while injured: *"You either pull your weight or you don't... if you can't do it, you can't do it and then you need to decide, like we're all adults"* (P4).

When asked from where these viewpoints originated, many staff expressed that they had not explicitly heard the negative comments about themselves during periods of injury but had experienced previous examples of other colleagues' injuries so assumed the same was being said about themselves. Participant 3 discussed this at length, stating: *"No, no one told me directly yeah [that they were useless] but you're always thinking if they're saying about others, must be saying about you as well"* (P3). Furthermore, participant 7, who is in a management role within a large stud establishment, suggested that while these shared beliefs are not officially seen, they are ever present in the working environment, and even acknowledged their own role in perpetuating the cycle further: *"I do see it. I don't see it officially. I don't see it from when I go into health and safety meetings. I don't see it from the director. But I do hear it on a day to day basis, I'll probably find myself saying it at times as well"* (P7).

Horseracing staff often identified previous experiences in equine and racing industries as the framework for their current belief system about injury. Participant 7, an older individual in the study, identified a story from their youth that they felt encapsulated how their viewpoints on injury were informed by the industry: *"I can remember getting kicked when I was 17/18... I was there and I thought somebody's going to come and help me, [made me] realize you was never going to come and get an arm around your chair or a sugary cup of tea"* (P7).

Horse riding, in general, holds shared beliefs about returning to riding after a fall, and participant 1 identified that this ethos was something they still considered important in their decisions about returning to the saddle following an accident: *"I think just as a child, its, you always get back on... when I learned to ride and I fell off, it was always don't cry, get back on and you'll end up enjoying it and I think it's just stuck with me"* (P1).

Several of the older participants also note that familial connections to the sport, agriculture, and military industries may have exacerbated their shared beliefs on injury normalization and *"toughness"* of those working in the sector: *"My family on the male side are all military, and we're all horsey farmers, and you just carry on"* (P12), *"my father was a farmer, jockeyed, I grew up with it."* (P10), *"I was born into it [hunting and racing] ..."* (P11). Several staff discussed a generational trend to injury approaches that may have influenced their responses, with participant 12 discussing how carrying on was typical for their generation: *"I think that's just my generation. That's what we do"* (P12), while participant 8, who considered themselves an older participant, felt that their generation had not helped the younger generations in breaking 'old' viewpoints about injury and help-seeking: *"But again, I'm probably the generation that has helped perpetuate this, you know... I'm guessing my generation have not helped the current generation because we've sort of played along with it"* (P8).

3.4.4. D4: Resource Awareness

Some of the horseracing staff in this study were aware of industry resources available to them during recovery, such as the Racing Occupational Health Service (ROHS), Injured Jockeys Fund (IJF), Racing Injury and Accident Benefit Scheme (RIABS), or advice from the National Association of Racing Staff (NARS) who acts as a union for racing grooms. Those participants who were aware of the services provided by Racing Welfare, as the main charity to support the needs of racing staff, were positive, with participant 8 stating: *"They're a great organization, aren't they."* However, despite this awareness, only limited staff had utilized these services previously, *"what little I know of Racing Welfare..."* (P8), and discussions regarding RIABS, and NARS Union support were not always positive for injured staff: *"The Union didn't back me either"* (P12). Furthermore, staff who were aware of these services often highlighted that other staff misunderstood accessibility, with participant 10 stating: *"...there are these places that are supported by charities and fundraiser. And a lot of people think they haven't got access to them"* (P10).

More typically, horseracing staff interviewed in this study were unaware of the extent of opportunities offered by the horseracing industry for injury and illness, most notably the provision of Occupational Health Services by ROHS, Racing Welfare. Some staff believed they should have the same support and facilities as jockeys, comparing the workloads: *"...us guys that produced the horses, work with them every day have no access to that [rehabilitation facility] unless you've had a jockey license. You can't touch it"* (P12).

Those staff who had used one or more services from Racing Welfare, often initially engaged in support services through personal recommendations from trusted sources, such as a friend. Participant 4 identified that their first contact with Racing Welfare was through a support line, during the COVID-19 pandemic to support mental health after a colleague had expressed concern: *"So one day, she just came up...Here's an hour, read this [leaflet from Racing Welfare]. And I just went ok...so we had a chat and she said **** [name] is really worried about you she thinks, she thinks you're not looking after yourself...yeah then that led to having an interview..."* (P4).

Since engaging with other services, participant 4 then felt comfortable seeking additional support for their ongoing back pain as part of the ROHS.

4. Discussion

This study aimed to investigate the psychological responses to occupational injury in British horseracing staff. Staff highlighted the negative impacts on their health and wellbeing, discussing the physical, occupational, and financial consequences of injury as well as the effect injury had on feelings of self-worth and identity. All participants

discussed a range of negative emotional responses upon injury, including denial, frustration, and guilt, which seemed to strongly influence staff decisions to return to work early. Horseracing staff took a proactive management approach in injury recovery, however typically opted for self-medicating or self-managing techniques rather than seeking professional medical support. Finally, several barriers to help-seeking were identified, including a lack of trust in medical services, the normative expectations of injury within the horseracing sector, and limited awareness of the extent of resources available to them to facilitate recovery.

4.1. Psychological Implications of Injury

Primarily, injury results in negative implications for horseracing staff, on their short and long-term health and wellbeing. Injury alters a person's assumptions about the safety of their proximal environment and has far-reaching connotations on self, world, and future viewpoints **[54]**. Following an injury, stable staff experience complex psychological responses to injury, including changes in cognitive appraisal, emotional responses, and behavioral changes, similar to those seen in injured athletes **[39]**. Staff in this study reported both physical and psychological consequences of injury, including pain, limited mobility, altered movement patterns, a range of emotions including frustration, denial, and isolation, and a loss of confidence and reduced sense of self-worth. Frustration is typically reported in injured athletes following injury, due to a sense of loss **[55]**, which could result from an inability to undertake daily working tasks, being unable to manage the horses in their care due to physical limitations, or slow recovery processes and pain **[7]** which has been seen here. Isolation can have detrimental effects on injury recovery **[56]** with racing staff disengaging from their community socially, because of time off work, or through enforced isolation present in some stories in this study due to COVID-19 restrictions at the time of the injury.

Injured horseracing staff interviewed here also reported implications for employment, including concerns regarding job security, and financial concerns, such as loss of earnings or lack of insurance. Insecure job roles or no opportunities for sick leave are some of the reasons that employees in the horseracing sector may not report injuries, or do not take time off **[57]**. Financial losses following injury are well documented, especially for self-employed individuals **[58]**. Working in horseracing, staff may be employed full- or part-time, but several yard roles are also classified as self-employed, which can affect the security and protection offered to staff when injured. Some members of the horseracing industry have access to the Racing Industry Accident Benefit Scheme (RIABS), designed to provide financial assistance to "racing staff who are off work as a result of accidental injury arising out of and while carrying out duties for a licensed trainer," and linked to paid contributions from wages **[59]**. While this opportunity is in place for full- or part-time paid training staff, and far exceeds any support currently offered in the equestrian sector, this financial assistance does not cover those working as self-employed, working in the stud sector, and from the participants in this study, may present some discrepancies in the definition of accidental injury, with one interviewee suggesting payments are not given to chronic injuries, although this perception cannot be verified. Injury benefits from RIABS must also be linked to an accident declared by the claimant's employer **[59]**, presumably reported in Yard Accident Books, a requirement of awarding a Trainers License in Britain **[60]**. These sources of injury data have been found to be notoriously inaccurate in the equine sector **[57,61]** due to both employer and employee underreporting. Staff in this study noted the importance of having personal accident and injury insurance to supplement working life in horseracing, although this was not utilized by all racing staff. Further research should consider a review of the RIABS scheme and sociocultural barriers that may prevent the utilization of vital support services, with consideration to the effects of the racing injury habitus identified here and in previous literature.

4.2. Absentee Guilt

One area of concern for employers in horseracing should be the presence of absentee guilt in injured racing staff, with staff citing lack of cover, understaffing in yards, and not wanting colleagues to 'pick up the slack' as sufficient reasoning to continue working by participants in this study. Guilt has been defined as the emotional response to the perception that one's actions have harmed others, intentionally or otherwise, or that through one's actions, they have failed to meet socially prescribed or personal standards of behavior **[62]**. Guilt has also been associated with judgment from others, for actions or behaviors that do not meet social or cultural norms and within the workforce, may arise from societal pressure around moral obligations to work **[62]**. High levels of guilt have been reported in the ill or injured workforce across multiple sectors, with 29 – 50% of employees feeling guilty about sickness-related absences **[63,64]**. Typical reasons that staff report guilt following absences at work are often attributed to; a sense of letting colleagues or employers down, or leaving them without necessary cover **[65]**, failure to fulfill job demands or personal expectations or associated poor mental health from illness or injury **[64]**, all of which were reported by horseracing staff in this study. Understaffing in the workplace is seen as a contributing factor to absence-related guilt **[66]**, with staff more likely to attend work when they shouldn't due to not wanting to add additional burden on the remaining workforce, which may induce additional guilt responses **[62]**. Furthermore, where staff believe that their attendance to work will be helpful to the workload of their colleagues, and staying at home will induce a level of harm, they often choose to attend work ill or injured, citing guilt as a factor, not wanting to be seen as a burden or letting their colleagues down **[67]**. All these viewpoints were echoed in this study as key influencing factors for returning to work early.

Guilt has been strongly associated with higher levels of sickness presenteeism in multiple occupations **[68]**, defined as attending work despite illness or injury that would provide an adequate reason to stay home **[69]**, resulting in an early return to work **[64]**. While presenteeism is often viewed by employers as less significant to the workforce than absenteeism, research suggests that globally, presenteeism is more costly **[70,71]** and should be avoided. Consequences of presenteeism are well documented; with negative

associations for both the individual (i.e., poor physical health, poor mental health, and poor workability [72]) and the organization (i.e., productivity losses; increased risk of accidents, and higher error rates [73]). More intensive feelings of guilt in injured horseracing staff in this study may have influenced their decisions to return to work early, which could result in longer-term negative consequences for employee health and wellbeing in the future. Poor physical and mental health in injured horseracing staff has already been identified [5,35]; however, the association between guilt, presenteeism, and subsequent accident risk or reinjury in the racing workplace has yet to be explored.

4.3. Injury Culture: Institutional Habitus

While this study has identified the lived experiences of injured horseracing staff, which are individualistic in nature, sociocultural factors developed from the racing habitus [74] were found to have influenced the thoughts and behaviors of injured racing staff. This presented as conformity to the belief that pain and injury are expectations of working with horses [61,75], a cultural deprioritization of safety first principles and safety culture [61], that injury is not sufficient reason to take time off [12,76], and that a presenteeism culture is normalized. Habitus is historically grounded, often reflective of society at large, and develops as part of a long-term belief system [77,78].

Employees within the racing industry are reported to suppress and regulate emotional displays to meet the organization's expectations of the role which Cassidy [79] suggested, creates an organizational culture where employees act, think, and feel in accordance with expectations, and new staff entering are taught to adhere to these cultural norms [78]. Horseracing has previously been suggested to have an institutional habitus [7,77], including reference to injury and injury attitudes [12,80], and in relation to gender norms where masculine traits, such as physical strength are prioritized and pain is ignored [74,78]. Institutional habitus, particularly related to injury expectations, has previously been reported in military personnel, boxing, dancers, veterinary professionals, farmers, and equestrian populations [57,61,76,81–83], whereby the expectation to tolerate pain is part of the social contract [26]. The cultural expectations of the habitus override any prior cultural, religious, or ethnic diversity, and the members now belong solely to the habitus they joined [84]. While all participants in this study echoed the expectations of injury and pain tolerance within the racing sector, none could identify its origin, with most participants generating the *"it's always been like this"* rhetoric [78] or suggesting family connections to the sport and/or farming or military cultures engendered this belief system [74,85]. This poses significant challenges for organizations, such as the Horseracing Industry People Board, to dismantle these norms that may be affecting recruitment, retention, physical and mental health and wellbeing, organizational productivity, and perhaps equine welfare itself [86].

Safety culture is defined as "the product of values, attitudes, competencies, and behavioral patterns at individual and group level, which determine commitment to, and style and competence of, an organization's health and safety program" [87], built and sustained over time [61]. Positive safety culture has been linked to decreased risk of occupational injuries [88], improved employee job satisfaction [89], increased productivity, and lower costs [90]. While other sectors have reduced the risk of injury in the last 10 years, the equine industry has not [91]. Strategies that have been implemented to reduce injuries in the human workforce prioritize technical interventions, such as enhanced safety equipment, which have been shown to have the least effect on workplace health and safety controls [92]. Chapman and Thompson [91] stress the need to review industry perceptions of risk, and factors that influence risk-taking behavior, such as perceptions of injury severity, racing habitus, and cultural and social messaging [75] to create a more positive safety culture within horseracing. Leaders are typically considered the carriers of this culture [61], with the ability to influence employee thoughts and beliefs. Small-scale enterprises (SSEs), businesses with <50 employees such as those seen in horseracing, are more strongly influenced by managerial interests [93], with working practices that may be more guided by personal or cultural beliefs in risk-taking and health and safety practices than national guidelines [94]. Horseracing yards are a hierarchical structure, with employees supervised by 'head' roles (head lad/lass, head traveling groom) with managerial responsibility for colleagues [7]. While the context of leader may initially imply trainers or assistant trainers within a horseracing yard, it is more likely senior racing staff, head lad/lass roles, or long-standing employees who hold the most cultural sway over working practices and normative expectations in training yards. In the equine sector, shared values have also been tied to management, such as where horse wellbeing is prioritized over employee health and safety [93], evidenced by the "horse first" culture adopted by horseracing in 2020 through the BHA Equine Welfare Strategy [95]. This study found that individual yards had different approaches to injured employees regarding communication, support, and signposting, and thus suggests the role of leaders within individual yard managers, trainers, and senior yard staff is imperative to tackle both safety culture within the industry and facilitate positive recovery for injured racing staff to encourage staff retention and positive wellbeing.

Research suggests there are three key demands that increase the presence of presenteeism in the workplace, including excessive workloads, understaffing, and attendance policies [66], although additional factors have also been identified, including job security, personal finances, identity, and professional and moral obligations to work [65]. While attendance policies are not a concern for staff in the horseracing sector, issues pertaining to excessive workloads, understaffing, job security, and professional obligations were all raised by staff in this study following injury. Ideal workers are defined as those with a clear, relentless commitment to paid work [96]. In sports, the ethos of a good worker/athlete is one who embodies "a willingness to make sacrifices; a striving for distinction; an acceptance of risk and the probability of participating while enduring pain; and a tacit acceptance there is no limit to the pursuit of the ultimate performance" [97]. These qualities are echoed in all definitions of the role of stud and stable staff [60,98]. The roles of stud and stable staff are multifaceted, including daily horse care, feeding, and health management, and may include exercise management in horses under training [3].

Racing and stud groom roles have high physical demands with increased workloads, time pressure, and long hours [3,93], that often equate to poor pay, with an unforgiving and arduous regime, which may be attributed, in part, to the current staffing crisis seen within the sector [80]. Brosi and Gerpott [62] suggest that "organizations have developed a powerful norm in favor of presenteeism," and that presenteeism behaviors in employees favor the company, by reducing the need to find staff cover and maintaining numbers. Finding cover was one of the main causes of stress in horseracing trainers [99], and attitudes of trainers and senior staff roles within yards may be influencing the behaviors of horseracing staff, who have previously reported absentee guilt and lack of staff cover [7,12]. Aronsson *et al.* [100] also identified that staff were more likely to work if the institution or organization were already understaffed, as did not want to place additional burden on colleagues, similar to the perspectives voiced by participants interviewed in this study.

Several staff in this study noted that the horses still needed care, and this was a factor for early return to work. Recent research by Bergman Bruhn [101] classified those working in the equine sector as engaging in 'meaningful' work, defined as engagement in personally significant and worthwhile work, often aligning livelihood to lifestyle and hobbies, who find increased enjoyment from work respective of pay or working conditions [102]. Meaningful work has been associated with increased job satisfaction, higher levels of staff commitment, reduced staff turnover, and positive employee wellbeing in wider sectors [103]; however, research has also suggested that there may be negative implications for employee health [104]. Employees, such as those working in horseracing, may be more likely to accept poor working conditions and may engage in overworking practices, such as longer hours without associated compensation, or taking on additional responsibilities [104,105], and by sacrificing their own health and wellbeing for the benefit of others [101]. In human service care work, staff has professional and moral obligations to their patients, and the workload is dictated by urgent client needs, rather than organizational staffing requirements [103]. Service care workers often form close relationships with patients, and typically prioritize their clients' needs over their own. These attitudes increase the likelihood that care workers demonstrate presenteeism, attend work when ill or injured, and choose client wellbeing over their own health [106]. This phenomenon has also been seen in animal caretakers [107,108] and farmers [109] who form meaningful relationships with animals in their care and may prioritize their needs over their own. The interconnection between guilt for the horse and guilt for colleagues was seen in several participants in this study.

4.4. Support Utilization in Horseracing Staff

Despite the plethora of resources that are available to injured horseracing staff, including support for mental and physical health and wellbeing from Racing Welfare and Racing Occupational Health, occupational advice from Racing Welfare, NTF, NARS, and the TBA, and industry-wide financial resources such as RIABS, uptake and awareness of such resources is seemingly low. Reasons for a lack of engagement in support services are complex, with several confounding variables influencing the likelihood of injured horseracing staff to seek out additional resources, such as the relationship to their employer, the habitus of racing, and the sociocultural context of injury and pain within this population, as well as the emotional profiles of injured staff and the influence of those emotions on help-seeking behavior and social stigma.

This study found that where successful relationships with employers existed, horseracing staff typically had a more positive experience of injury recovery and return to work. The relationship between the injured employee and their employer is considered significant to successful recovery and can act as both a facilitator or barrier to accessing support and return to work [110,111]. Positive support from employers may include accessible sick leave, back-to-work schemes, or the implementation of alternative duties which have been seen to facilitate successful recovery and readmittance to the workforce [58], techniques that were discussed by several injured racing staff in this study. However, negative support can include challenges with communication, such as employers not listening or understanding an employee's needs, or setting unrealistic expectations for work capacity, and this can increase feelings of self-devaluation, hostility, and resentment [58,112]. Several participants in this study highlighted challenges with employers expecting a return to work too soon or expecting them to undertake unsuitable tasks without reasonable adjustments. While offering reasonable adjustments for return to work is important, research has also identified that negative reactions from supervisors, such as doubt or anger, are more likely to influence an employee's commitment to the organization in the future, as well as their overall mental health [113,114]. When participants were discussing their interactions with employers, early interactions, such as a check-in phone call or message were positively received, and employees felt valued. Hepburn *et al.* [113] identified that strategies that show concern for the individual, e.g., early contact, are likely to engender commitment and positively influence mental health. Workplace organizations, including those within horseracing, should look to improve training for managers regarding injury communications and employee interactions to complement current return-to-work procedures [113].

Occupational culture and attitudes to workplace safety and risk have previously been found to be significant barriers to the efficacy and uptake of occupational health improvement initiatives in the workplace [61,101]. Shared values within communities are one such barrier [93], and in horseracing, this may include the prioritization of horse welfare over human wellbeing and employee health and safety [7], or the sociocultural racing habitus of an accepted risk of injury and working through pain [12,80]. Recent horseracing research suggests there may be a negative societal stigma associated with injury, and help-seeking behavior within the sector [35,115]. The stigma associated with perceptions of weakness, vulnerability, and incompetence is considered the principal barrier to accessing support [116], and internalizing stigma can decrease a person's sense of worth and self-esteem following injury [55], viewpoints which are echoed in the interviews of injured racing staff within this study. Wider literature also reports additional barriers that were noted by staff in this study including negative past experiences,

lack of mental health literacy [8], lack of time, privacy concerns, financial barriers, and lack of perceived need for help based on injury severity [116]. Previous research in Irish jockeys also identified cultural norms of masculinity and self-reliance as barriers to help-seeking [115], which echoes the work of Butler and Charles [74] and reinforces a gender narrative of physicality and strength associated with masculinity as dominant in horseracing. Given that gender was seen in this study relative to perceptions of weakness in both male and female participants, it could be assumed that gender bias may also be influencing the likelihood of racing staff to access support services.

Furthermore, emotional responses to injury, such as guilt, have also been linked to an increased risk of social isolation in athletes, which can hinder the likelihood of completing any physical or psychological rehabilitation [117]. Guilt has previously been reported in injured horseracing staff [12] and point-to-point jockeys [118], often attributed to either absentee guilt for the impact of their injuries on colleagues and co-workers, such as seen here, or guilt for the horse, whom they are therefore unable to care for, previously reported in animal care workers [107]. Guilt, therefore, may increase the likelihood of isolation, and act as a barrier to accessing help for injured racing staff.

4.5. Recommendations and Future Research

Given the findings of this study, several recommendations and future directions are proposed. Further research should consider the implications of presenteeism in horseracing on organizational productivity, employee retention, subsequent injury risk, and possible implications for standards of equine care, in line with industry strategy to investigate staff retention. In addition, research should investigate the influence of gender norms in horseracing specifically on injury attitudes, and subsequent return-to-work behaviors as research suggests women are more likely to demonstrate presenteeism than men [119]. Finally, researchers should consider the impact of National Health Service (NHS) Accident and Emergency (A & E) Department attitudes in horseracing populations on injury triage and subsequent diagnoses within the NHS, as challenges such as perceived biases, and poor communication, were identified in this study, which may be affecting injured horseracing staff from accessing appropriate medical support. Recommendations from this study include:

1. To conduct an independent review of the Racing Injury Accident Benefit Scheme (RIABS) to consider its application for chronic injuries arising from working in horseracing, and to those workers classified as self-employed.

2. The development, and subsequent implementation, of a national return-to-work procedure for injured stud and stable staff.

3. Employment modifications and workplace adaptations are implemented on an individual basis following discussions with the line manager, considerate of physical limitations, injury type, and pain levels.

4. The creation of educational resources, such as injury narratives, for early contact injury communication training to be made available to employers and senior staff within stud and training yards.

4.6. Limitations

There are limitations to consider within the study. Although this study recruited most participants through purposive sampling and utilized multiple methods of recruitment to achieve a sample representing a wider proportion of injured stable staff in the role, age, gender, and injury type, the voluntary nature of the interviews and use of non-probability and convenience sampling may be subject to self-selection bias [120]. This bias may have increased the likelihood that participants only came forward if they perceived themselves to have experienced significant impacts (physical, mental, or occupational) following a workplace injury. Furthermore, in health psychology research, self-selection bias can lead to difficulties in data interpretation if participants are examples of extremes: subjects who are likely to 'complain about everything' and therefore may exaggerate problems in their own health and environments, and on the other end, subjects who complain about nothing, who are likely to present denial narratives and underreport health, injury or environmental concerns [121]. Examples of both types of individuals have been seen in this study; however, across all participants, a wide range of narratives were identified to counteract the polarizing influences of these extremes.

5. Conclusion

Findings from this study have identified the effects of injury on the horseracing workforce, including consequences to the physical and psychological health and wellbeing of employees, as well as occupational and financial challenges arising from injury. Initial emotional responses, such as frustration and absentee guilt, strongly influenced staff decisions to return to work early within the horseracing sector. Horseracing staff were less likely to utilize professional medical services during recovery, opting for self-medication or self-management techniques. Several barriers to help-seeking were also identified, including a lack of trust in medical services, the normative expectations of injury within the horseracing sector, and limited awareness of the extent of resources available to them to facilitate recovery. With high levels of presenteeism demonstrated by this population, horseracing employers and organizations should be concerned with the potential implications of presenteeism on workforce mental health, recruitment and retention, and employee efficiency. Strategies to improve employee return to work following injury, including phased return-to-work procedures, national guidelines for reasonable adjustments, and early-contact injury training for employers and senior staff, would benefit the sector and align with industry objectives on staff recruitment, retention, and training.

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Authors' Contributions

Conceptualization, E.D., J.M.W. and W.J.M.-P.; methodology, E.D., J.M.W. and W.J.M.-P.; formal analysis, E.D.; investigation, E.D.; resources, E.D. and J.M.W.; data curation, E.D.; writing—original draft preparation, E.D.; writing—review and editing, J.M.W., W.J.M.-P., J.K.P. visualization, E.D.; supervision, J.M.W., W.J.M.-P. and J.K.P.; project administration, J.M.W., W.J.M.-P. and J.K.P. All authors have read and agreed to the published version of the manuscript.

Data Availability

Data are not publicly available since they are confidential.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

This study received ethical approval from the Hartpury University Ethics Committee. The study complied with the guidelines of the Declaration of Helsinki.

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What Does It Take? Changing the Tide on Staffing Issues in the Equestrian Industry

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Abstract

The equine industry faces increasing scrutiny regarding its social license to operate (SLO), with appropriate care for horses at its center. Grooms play a vital role in professional horse care and management, yet their own working conditions often remain poor, resulting in an increasing number leaving the industry. Building on previous research, this study explored grooms' perspectives on the changes needed to improve their profession's long-term viability, and the types of future initiatives they believe would effectively address these issues. An online survey targeting professional grooms received 1,318 valid responses. Thematic analysis was used to analyze qualitative responses to two questions focusing on aspects related to Sustainable Workforce and Future Initiatives. For Sustainable Workforce, 15 unique lower-order themes were grouped into four higher-order themes: Working Conditions, Recognition and Respect, Future Prospects and Personal Development, and Acceptance and Status Quo. For Future Initiatives, 19 lower-order themes were organized into three higher-order themes: Working Conditions, External Recognition, and Change in General. Participants considered improved working conditions—particularly better pay, reasonable working hours, and legal protections—vital to ensuring the sustainability of the grooming profession. Respondents emphasized the importance of initiatives that address such tangible improvements, in addition to aspects such as unionization and health support, rather than symbolic recognition alone. Addressing these issues is critical for improving job satisfaction, retaining grooms, and ensuring horse welfare, ultimately contributing to the industry's SLO and long-term viability.

Keywords

Horse grooms; staffing crisis; equestrian industry; sustainability; working conditions

1. Introduction

Over the past few years, the equine industry has been facing increasing pressure to uphold its social license to operate (SLO) [1–3]. The concept of SLO refers to the informal, ongoing approval granted by the public and key stakeholders for an industry to continue its activities. Unlike legal or regulatory permissions, the SLO is shaped by societal expectations regarding horse welfare, ethical practices, environmental sustainability, and the sport's broader impact on communities [1,4]. As public awareness and scrutiny increase, maintaining this license requires transparency, proactive welfare measures, and responsiveness to evolving ethical standards within the sport.

In 2023, in direct response to these developments, the Fédération Équestre Internationale (FEI) adopted the FEI Code of Conduct for the Welfare of the Horse, requiring all those involved in horse sports to acknowledge that horse welfare is paramount at all times [5]. The way in which horses are managed at home, in training, and in competition is widely acknowledged as essential for ensuring appropriate levels of welfare [6].

In most, if not all, professional or semi-professional equestrian settings, grooms are responsible for the daily management and care of horses. Shortages of sufficiently skilled staff have increasingly been acknowledged to compromise welfare standards [7,8]. Furthermore, financial pressures within the industry exacerbate these challenges, with many establishments struggling to offer competitive wages or adequate working conditions, contributing to high staff turnover and recruitment difficulties [9]. Retaining skilled and motivated grooms is, therefore, essential—not only for maintaining optimal equine welfare but also for preserving the industry's SLO.

In 2024, the Grooms Consultative Group, established by the FEI to allow grooms to contribute to the developments within the FEI, submitted a proposal to prohibit show jumping classes from starting before 7.30 a.m. or ending later than 11.30 p.m., with a minimum of 10 hours between consecutive classes. The FEI, however, decided to postpone a definite decision on the proposal until the full rules revision in 2026 [10]. The proposal primarily aimed to safeguard equine welfare by emphasizing the importance of rest to help horses recover from, and adapt to, exercise-induced stress [11]. Additionally, it highlighted a related concern: the working conditions of grooms.

The impact of late-night jumping on grooms has been the subject of much debate [12], as such competitive schedules extend the length of the groom's working day without the opportunity for compensatory rest. Sleep deprivation becomes an even greater concern, as shows generally conclude on Sundays, with grooms having to load up horses and equipment and take to the wheel themselves to drive back home without the opportunity to sleep beforehand [13]. Several studies have shown that sleepiness at the wheel, poor sleep quality, and sleep deprivation substantially increase the risk of being involved in traffic accidents [14–16]. Requiring grooms to undertake journeys home when overtired, likely poses a considerable safety hazard on public roads, threatening the health and welfare of grooms, horses, and other road users.

Yet late-night shows are only one example of the many challenges faced by grooms. Long, unsociable hours carrying out physically and mentally demanding work with little time to recover, combined with a high degree of responsibility at a minimum wage, all contribute to an increasing number of grooms leaving the industry [17–19].

A previous study [18] investigated the effectiveness of several international initiatives designed to prevent grooms from leaving the equine industry. Perceived barriers for grooms to stay in the industry were categorized using the COM-B model of behavior [20,21], while grooms' perceptions of the different initiatives were aligned with intervention functions according to the Behavior Change Wheel [20,21]. Two of the initiatives—namely, the 2022 ECCO FEI World Championships that highlighted the role of grooms, and the establishment of the International Grooms Association (IGA)—were thought to impact the grooming profession as a whole. However, more than half of the grooms (58.8%) failed to see the relevance of any of the initiatives to them personally, likely because they did not address salient issues such as mental and physical health and the provision of better working conditions. It was argued that, in order to prevent grooms from leaving the industry, future research should focus on what changes or initiatives grooms themselves consider essential to attain a grooming industry equipped to meet current and future societal demands. The current discourse on SLO focuses primarily on equine welfare [1,3]. However, ensuring high welfare standards requires not only ethical practices but also a well-structured, organizational framework of the industry. In such a context, workforce quality and stability are essential, as staffing shortages and poor working conditions have been shown to undermine appropriate levels of horse care [7,8]. Consequently, addressing staffing challenges in the grooming industry is not just a workforce issue but a necessary step in maintaining public trust and securing the equine industry's SLO.

Against this backdrop, the current study builds on the work of Ole and Wolframm [18] by exploring grooms' own perspectives on the changes required in the grooming industry to ensure a stable and capable workforce that supports the equine industry's SLO, as well as the types of future initiatives they consider most effective.

2. Materials and Methods

2.1. Study Design

The study employed a descriptive design using an online survey aimed at professional grooms. The survey, hosted on the Microsoft Forms platform, was available from February 1 to February 26, 2023. Prior to launching the survey, pilot testing was conducted with three professional grooms to ensure clarity and ease of completion. Eligible participants included individuals who were either currently or previously employed as professional grooms. The survey was available in English, open to participants worldwide, and restricted to individuals aged 18 years or older. Participation was voluntary and anonymous, with respondents able to withdraw at any point before submitting their responses. Before starting, participants were provided with detailed information about the study's aims and were required to give explicit consent to participate. The first section of the study focused on demographics, the second section on grooms' familiarity with different initiatives, and the third and final section on the perceived impact of said initiatives, what aspects of the grooming industry should be improved, suggestions for future initiatives, and which stakeholders should lead the change.

The study employed a snowball sampling strategy and was distributed on social media via the university's and the authors' Facebook, Instagram, and LinkedIn accounts; through personal invitations by email and WhatsApp; and via various online equine media outlets. A representative sample size was determined at 357 participants, based on a 95% confidence level, a 50% population proportion, and an estimated population size of 5,000.

Ethical approval for the study was granted by the Hanze Hogeschool Ethics Advisory Committee (dossier number: heac.2023.006), and the research adhered to the principles of the Declaration of Helsinki.

2.2. Survey Design

The survey consisted of 31 questions and combined multiple-choice and open-ended formats to capture a mix of quantitative and qualitative data. Routing options were used to improve navigation. Survey questions included demographic and work-related information, assessments of initiatives aimed at supporting grooms in 2022, and open-ended prompts inviting participants to reflect on necessary changes for the long-term viability and sustainability of the grooming profession. The survey took approximately 10 minutes to complete (see **Supplementary Materials**).

Part of the survey data focusing on the impact of key initiatives aimed at the grooming industry has already been published in **[18]**. The current analysis focused on the qualitative responses provided by grooms employed in the grooming industry at the time of the study in response to the following two questions:

• Q13/28: What type of initiatives, if any, would you like to see to draw attention to the grooming profession ("Future Initiatives")?

• Q15/31: What, if any, changes to the grooming industry would you like to see that would motivate you to stay in the grooming industry long-term ("Sustainable Workforce")?

2.3. Data Analysis

All responses were imported into IBM SPSS Statistics 28.0 for analysis. Quantitative data related to demographics and work environments for all valid responses were analyzed using descriptive statistics (frequencies). Qualitative data were analyzed using thematic analysis **[22]** for each of the two questions ("Future Initiatives" and "Sustainable Workforce" separately). For both questions, the same approach was followed: The first stage of analysis involved immersion in the data, with the first author reading and reviewing the open-ended responses several times to ensure nuanced understanding. In the next step, initial codes were generated by analyzing the data line by line and tagging specific words or phrases relevant to the research questions. These initial codes were refined to reflect lower-order themes and reviewed by the second author. Any discrepancies in understanding were discussed between the first and second authors until a consensus was reached. Similar or related lower-order themes were subsequently grouped into broader, higher-order themes, which were once again refined through discussion between the authors. Finally, each theme was examined thoroughly to ensure coherence and distinctiveness, ensuring that the key areas of concern and improvement suggested by the grooms were captured appropriately.

Descriptive statistics were applied to count the frequency of mentions for each theme to provide a structured overview of the themes and assist with interpreting priorities. Data were managed in compliance with the Research Data Management Policy Framework of the University of Applied Sciences Van Hall Larenstein and adhered to Open Science principles to ensure transparency and long-term accessibility.

3. Results

The survey yielded a total of 1,397 responses, of which 1,318 responded to at least one of the qualitative questions. The demographics of these 1,318 respondents are outlined in **Table 1**.

Table 1: Demographic characteristics of respondents.

Demographic variable	Category	N	Percentage (%)
Gender	Female	1202	91.2
	Male	104	7.9
	Non-binary	6	0.5
	Prefer not to say	6	0.5
Age	18–24	274	20.8
	25–34	566	42.9
	35–44	255	19.3
	45–54	134	10.2
	55–64	66	5.0
	65 and older	23	1.7
Main discipline/ area of work	Show jumping	975	74.0
	Dressage/para-dressage	125	9.5
	Eventing	92	7.0
	Driving/para-driving	7	0.5
	Endurance	1	0.1
	Other (e.g., different discipline, breeding stable, livery yard, riding school, vet clinic, etc.)	109	8.3
	Missing	9	0.7
Type of groom	Home groom	166	12.6
	Show groom	334	25.3
	Both	818	62.1
The most frequent type of shows	National	564	42.8
	International	588	44.6
	Missing	166	12.6
Frequency of shows	Twice a week or more	231	17.5
	Once a week	313	23.7
	Twice a month	437	33.2
	Once a month	106	8.0
	Every two months	25	1.9
	Occasionally	40	3.0
	Missing	166	12.6

3.1. Thematic Analysis – Sustainable Workforce

To improve readability and facilitate understanding, results relating to a Sustainable Workforce are presented first. Thematic analysis of the responses identified 15 unique lower-order themes, which were subsequently organized into four higher-order themes: Working Conditions, Recognition and Respect, Future Prospects and Personal Development, and Acceptance and Status Quo. An additional 59 comments (2.39%) did not fit into any other category and were excluded from further analysis. Explanatory definitions of the lower-order themes are detailed in **Table 2**.

3.2. Thematic Analysis – Future Initiatives

Thematic analysis of responses to the question on Future Initiatives identified 19 unique lower-order themes, which were subsequently organized into 3 higher-order themes: Working Conditions, External Recognition, and Change in General. Explanatory definitions of the lower-order themes are detailed in **Table 3**.

4. Discussion

The aim of the current study was twofold: to investigate grooms' perspectives on the changes required to develop a sustainable grooming industry and to determine which type of future initiatives grooms considered most relevant.

4.1. Higher-Order Theme: Working Conditions

Findings demonstrate that more than three-quarters of participants considered appropriate working conditions by far the most important aspects in achieving a sustainable grooming industry. A better salary and more reasonable working hours were considered vital, followed by improved conditions at shows and home, benefits, working legally, accommodation, and the ability to predict and plan work.

Nearly one-quarter of the grooms pointed out the need for better remuneration, which might be indicative of a lack of financial security, especially considering the economic situation of the past few years, also referred to as the 'cost of living crisis' **[23,24]**. There is very little pay transparency in the equestrian sector, making it difficult to assign exact numbers. However, it can be assumed that participants consider current compensation in relation to the workload insufficient. Lack of overtime pay and other benefits, such as insurance, pension schemes, and scheduling (paid) holidays, likely contribute to such views **[19]**. The nursing sector, which can be considered comparable to the grooming sector in terms of round-the-clock caretaking, has been facing similar issues for years **[25]**, with research suggesting that national social security provisions appropriately reflect the nature of the work. Similarly, while the employment of grooms is subject to national employment laws in most countries if not all, current working conditions often fail to reflect the physical and logistical demands of the profession **[26]**. Studies have shown that poor working conditions **[27]**, high turnover rates, and staffing shortages **[7,8]** negatively impact horse welfare, which, in turn, affect industry legitimacy and SLO. Given that workforce stability is essential for maintaining public trust in the equestrian sector **[3]**, the long-term sustainability of the industry depends on ensuring that grooming remains a viable profession. Sector-wide agreements on appropriate levels of remuneration could help address these challenges, contributing not only to workforce retention but also to the industry's ability to meet evolving societal expectations.

Similar to nursing **[28]**, working hours have also long been a serious concern for grooms and are key in influencing job satisfaction **[19,29]**. Not surprisingly, survey participants identified it as a top priority for improvement. Grooms typically work six days a week, with hours stretching from early morning to late evening **[30]**. While the care for horses must, by definition, be structured differently from office work, grooms should also be able to work within the hours outlined by national employment laws. A good work-life balance has been shown to improve worker health and productivity **[31]**, and workload is a decisive factor for many grooms when questioned about their careers. Being intertwined with staff retention and how the workload is distributed between employees, poor workload management has been identified as leading to burnout and intentions to leave the profession **[28]**. Seeing that for competition grooms, their working environment includes the showground, improving working conditions should extend beyond a groom's home base to competition venues.

Grooms also raised the issue of better accommodation. A groom's contract frequently includes bed and board, which is why paid-out salaries often remain below the national minimum. However, anecdotal evidence has shown that the accommodation provided is at times below par, risking the health and safety of a groom **[32]**. Article 25 of the United Nations Human Rights Declaration states that a person has the right to adequate housing **[33]**. Almost five percent of respondents raised the issue of working legally, indicating that working without a contract continues to exist in the industry. Having the correct paperwork not only helps clarify the responsibilities, rights, and obligations of all parties involved **[34]**, but it also provides at least a modicum of predictability and therefore stability **[26,35]**. A study from 2024 highlighted the psychological impact of unpredictability, stating that constant ambiguity can result in chronic stress, anxiety, and burnout **[36]**. Ensuring that grooms work legally is therefore an essential step toward achieving more transparency and subsequently enhancing levels of trust and credibility in the sector **[3,37]**.

Table 2: Detailed overview of higher- and lower-order themes for sustainable workforce, including the number and percentage of respondents who mentioned the theme.

Higher-order theme: Working Conditions (N = 1940; 80.46%)	
Lower-order theme	Further elaboration by survey participants
Better salary (N = 596; 24.72%)	Salary that reflects the skill/level of experience in the industry, workload, hours worked, and responsibility.
Benefits (N = 263; 10.91%)	Benefits such as pension schemes, (paid) holidays, insurance provided by the employer, access to (mental) health services, and overtime pay.
Better working hours (N = 461; 19.12%)	Fewer working hours per day. Abolishing 6–7 day work weeks and adopting a standard 5-day work week. Overall better work-life balance and the ability to take time off/days off when needed.
Reasonable workload (N = 93; 3.86%)	Increased number of staff to better manage the existing workload; less truck driving to the shows by the grooms themselves (hiring professional drivers instead).
Better working conditions at home (N = 135, 5.60%)	Pleasant work environment, as well as good facilities and equipment to work with.
Better accommodation (N = 35; 1.45%)	Proper living conditions if provided by the employer (enough space, warm water, light, cleanliness).
Working legally (N = 118; 4.89%)	Legal contracts between the employer and the groom follow national employment laws. Presence of human resources (HR) representative. Adhering to labor union rules, if applicable.
Better conditions at horse shows (N = 230; 9.54%)	More reasonable scheduling (no late-night classes, especially if followed by early classes the next day). Strict limits on the number of horses allowed per groom at shows. Providing grooms at all levels (1* to 5*) with the same quality of catering/affordable food, pleasant accommodation, and clean sanitary facilities. More 'groom-friendly' layout (proximity of stables/arenas/parking, enough space for lunging/unloading), and the possibility to stay for an extra night when the show is finished to avoid being tired while driving a truck.
Less pressure and/or uncertainty (N = 9; 0.37%)	More predictability and plannability in terms of work schedules.
Higher-order theme: Recognition and Respect (N = 378; 15.68%)	
Lower-order theme	Further elaboration by survey participants
More respect (N = 291; 12.07%)	Riders and grooms should be seen as equals, and grooms must be heard. Grooming should be taken as a serious profession by all stakeholders. All grooms, regardless of their level or role (home vs. show grooms), should be seen and treated equally. No sexual harassment. More respect among grooms themselves.
More recognition (N = 87; 3.61%)	Continued and increased coverage of grooms on all media platforms by all stakeholders (e.g., FEI, show organizers, employers). Mentioning grooms at shows (named together with rider and horse). More awards both at shows (either financial or material) and in general, including those that highlight the team at home.
Higher-order theme: Future Prospects and Personal Development (N = 72; 2.99%)	
Lower-order theme	Further elaboration by survey participants
Improved future outlook (N = 38; 1.58%)	Opportunities to progress within the industry (e.g., from groom to manager, groom to rider) so that working in the industry could be seen as a long-term career outlet. Possibility to have life after grooming (either retiring with a pension or when moving to another industry, have official qualifications to use at the new job).
Better education (N = 34; 1.41%)	Better education of both incoming/young grooms as well as a possibility to acquire transferable skills that can be later used at other jobs outside of the primary sector in the equestrian industry.
Higher-order theme: Acceptance and Status Quo (N = 21; 0.87%)	
Lower-order theme	Further elaboration by survey participants
It is what it is (N = 17, 0.71%)	Nothing is going to change in the industry and/or this is the nature of the job.
Everything is okay (N = 4, 0.17%)	The current conditions in the industry are acceptable.

Table 3: Detailed overview of higher- and lower-order themes for future initiatives, including the number and percentage of respondents who mentioned the theme.

Higher-order theme: Working Conditions (N = 639; 49.55%)	
Lower-order themes	Further elaboration by survey participants
Better salary (N = 116; 9%)	Salary that reflects the skill/level of experience in the industry, workload, hours worked, and responsibility.
Financial benefits (N = 53; 4.11%)	Benefits such as, but are not limited to: overtime pay including shows and night shifts, monetary awards for grooms at shows, and paid holidays.
Better working conditions at shows (N = 71; 5.50%)	Improved availability of food for grooms (considering the timetable of the show), easier working conditions in terms of proximity of different areas such as parking, water, hay/ shavings, and shuttle for grooms if parking far. Implementation of such initiatives also in the United States and other regions, not just Europe.
Improved working hours at shows (N = 41; 3.18%)	Timetables that allow adequate rest times for both grooms and horses and fewer night classes.
Improved working conditions at home (N = 93; 6.98%)	Primarily related to reasonable workload and better staff management, but also regarding equipment used to work.
Improved working hours (N = 63; 4.88%)	Sustainable working hours would also lead to a better work-life balance.
Better accommodation (N = 10; 0.78%)	Acceptable living conditions both at home and at shows, if the responsibility of arranging it falls on the employer.
Health and safety (N = 53; 4.11%)	Helping grooms who struggle with mental health and providing access to relevant services when needed. Proper insurance would cover healthcare appointments. Assisting grooms who get injured on the job.
Legal contracts (N = 44; 3.41%)	Correct employment contracts that comply with national labor laws, including official salary payments, adherence to set working hours, holiday allowances, and pension schemes.
Collective labor agreement/unionizing (N = 95; 7.36%)	Industry-wide labor regulations and legislations. Protection for mistreated employees and holding employers responsible. Assistance with visas.
Higher-order theme: External Recognition (N = 512; 39.70%)	
Lower-order themes	Further elaboration by survey participants
More respect (N = 73, 5.66%)	Grooms are being listened to by the industry leaders and treated equally as important as the riders. Not to be treated as inferior.
More recognition (N = 229; 17.75%)	Frequent media coverage of grooms; industry awards that also include local/national/ home grooms besides international show grooms. Keep in mind the grooms from outside of Europe. Recognition of the grooms by the sponsors.
Grooms' classes (N = 27, 2.10%)	Organizing classes or incentives for grooms at shows would allow them to showcase their skills and would be rewarded by the organizer/sponsor.
Behind the scenes/awareness (N = 111; 8.60%)	Transparency, showcasing the reality of the job, including salary and hours. Investigating how successful/good employers great positive workplaces.
Education of stakeholders (N = 72; 5.58%)	Education of (new) grooms and employers on horsemanship, labor laws, successful business practices, and life after grooming. Highlighting good experiences in the grooming industry.
Higher-order theme: Change in General (N = 139; 10.78%)	
Lower-order theme	Further elaboration by survey participants
Continuing with ongoing initiatives (N = 73; 5.66%)	More emphasis on already implemented initiatives or their future follow-ups. Even more publicity with emphasis on countries outside of Europe.
Future opportunities (N = 7; 0.54%)	How grooms can evolve within the industry or outside of it.
No initiatives but change in the industry in general (N = 36, 2.79%)	Initiatives will not fix/improve the existing situation, only fundamental change in practices will make the career more sustainable.
Whatever improves the existing situation (N = 23; 1.78%)	Any initiative is welcome if it helps retain more grooms.

4.2. Higher-Order Theme: Recognition and Respect

Fifteen percent of participants consider the industry to be lacking recognition and respect toward grooms, making it difficult for them to see their profession as a long-term career outlet. While steps have already been taken to represent the voice of grooms as a stakeholder by establishing the International Grooms Association (IGA) as well as national organizations such as the British Grooms Association (BGA), these measures have shown to be largely ineffective on an individual level **[18]**.

Employee recognition programs have become increasingly popular in other industries, as they are closely tied to increased employee motivation and engagement **[38]**. Companies implementing verbal or written acknowledgment, performance-based incentives, or material awards have been found to outperform businesses without employee recognition programs **[39]**. In 2024, occasional efforts were made to award grooms at shows **[40]**. It is noteworthy that while grooms often talk about the importance of recognition, their suggestions focus predominantly on financial or material rewards, highlighting the weight extrinsic motivation holds in the grooming sector **[41]**. This emphasis suggests that rather than seeking symbolic acknowledgment, grooms may equate true recognition with tangible improvements to their livelihoods—a perspective likely shaped by their ongoing struggles to make ends meet in an undervalued profession.

4.3. Higher-Order Theme: Future Prospects and Personal Development

In addition to the more tangible aspects of their immediate working environment, grooms also considered their Future Prospects and Personal Development as important to ensure a sustainable grooming industry. Opportunities to move up the ranks within the industry or being able to change careers easily would assist grooms in developing a more sustainable career outlook, as it is vital for maintaining and improving job satisfaction **[42]**. However, according to the survey respondents, the lack of official, widely acknowledged qualifications associated with the grooming profession makes it difficult for most grooms to transition to another industry.

Well-structured onboarding practices to introduce new employees to the business have been proven to positively impact employee retention **[43]**. With the increased desire for better education from grooms, parallels can be drawn between grooming and nursing sectors, as learning opportunities have been brought up in studies on multiple occasions as suggestions to improve the work experience for nurses **[44,45]**.

4.4. Higher-Order Theme: Acceptance and Status Quo

Encouragingly, the vast majority of grooms believe that change in the industry can be initiated by tackling various areas of concern and that a sustainable career is possible. While there are still those who deem the situation to be inevitable and everything happening in the industry to simply be 'the nature of the job,' they are in the minority.

4.5. Future Initiatives

Unsurprisingly, higher-order themes on future initiatives aimed at the grooms mirrored those considered essential to achieving a sustainable workforce. However, additional topics raised included collective labor agreements and unionizing, undoubtedly meant as a means to negotiate better working conditions on behalf of those employed in specific sectors **[46]**. Respondents also highlighted the need for initiatives on health and safety. A survey conducted by BGA in 2024 highlighted that 65% of grooms reported anxiety while 55% reported feeling depressed due to poor working conditions **[47]**, emphasizing the need for initiatives that target mental health topics more effectively.

Current findings highlight a number of important issues that, if not resolved, could lead to the deepening of an already precarious employment crisis in the equestrian industry. Additional staff shortages would not only compromise the sector's operational capacity but also pose a direct threat to equine welfare, a key concern shaping public perception and regulatory scrutiny **[8,27]**. Addressing grooms' concerns is therefore not just about job satisfaction and retention rates; it is integral to maintaining the industry's social license to operate **[4,48]**. Public confidence in equestrianism depends on the industry's ability to demonstrate a genuine commitment to ethical and welfare standards—both for horses and the people responsible for their care. Ensuring that grooms view their profession as a viable long-term career will help stabilize the workforce, guarantee high standards of horse management, and reinforce the industry's legitimacy in the eyes of both the public and key stakeholders **[6,9]**.

Lastly, while current findings provide a comprehensive overview of the most pressing issues as perceived by grooms, certain limitations need to be borne in mind. Almost three-quarters of participants were from the discipline of showjumping, potentially skewing the data toward that particular discipline. However, seeing that showjumping is considered the best-known equestrian discipline under the auspices of the FEI **[49]**, current findings may provide an indicative frame of reference for those disciplines.

5. Conclusion

Current findings underscore the need to improve working conditions for grooms to ensure the long-term sustainability of the equestrian industry. Participants highlighted inadequate pay, long working hours, and poor conditions at both home yards and competitions as the most pressing concerns. While initiatives aimed at raising the profile of grooms have been introduced in recent years, they often fail to address these fundamental issues. Ensuring fair remuneration, legal protections, and better work-life balance would not only enhance career longevity but also contribute to improved equine welfare, reinforcing public trust in the industry.

Importantly, these findings have broader implications for the equestrian sector's social license to operate. As primary caregivers, grooms play an essential role in upholding welfare standards, yet they remain undervalued and underrepresented. Addressing their concerns is not merely a workforce issue but a matter of industry credibility. By

creating a more sustainable career pathway for grooms, the sector can demonstrate a genuine commitment to ethical and welfare standards—both human and equine—thereby strengthening its social license and ensuring its long-term viability in an increasingly welfare-conscious society.

Supplementary Materials

The survey conducted for this study is available as **Supplementary Materials**.

Authors' Contributions

Conceptualization, S.L.O. and I.A.W.; methodology, S.L.O and I.A.W.; formal analysis, S.L.O; writing—original draft preparation, S.L.O. and I.A.W.; writing—review and editing, I.A.W.; visualization, S.L.O. and I.A.W.; supervision, I.A.W.; All authors have read and agreed to the published version of the manuscript.

Data Availability

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The authors declare no conflict of interest.

Ethical Approval

The study received ethical approval from the Hanze Hogeschool Ethics Advisory Committee (dossier number: heac.2023.006), and the study followed the guidelines of the Declaration of Helsinki.

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Evaluation of Collagen Supplements to Reduce the Occurrence of Orthopedic Injuries in Trained Foals

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Abstract

Hydrolyzed collagen is a popular supplement for equine joint health due to its potential role in cartilage metabolism and tissue repair. However, scientific validation of its efficacy remains limited. This study aimed to evaluate the effect of hydrolyzed collagen supplementation in the diet of trained foals on the occurrence of orthopedic injuries and joint changes. Twenty Mangalarga Marchador foals were used and randomly allocated to either a collagen supplementation group (50 g/day for 180 days) or a control group. During this period, the foals were exercised five consecutive days per week. Every 36 days, the hock region was evaluated by radiography and ultrasonography. The concentrations of prostaglandin E2 (PGE2) and glycosaminoglycans (GAGs) in the articular synovial fluid were also measured. For imaging parameters, the data were analyzed using non-parametric Kruskal–Wallis tests. For synovial fluid parameters, the data were subjected to analysis of variance, and the means were compared using Tukey's test, with a significance level set to 0.05. Significant differences ($P < 0.05$) were observed in radiographic, ultrasonographic, and synovial fluid parameters, indicating reduced inflammation and joint degeneration in the supplemented group. It is concluded that hydrolyzed collagen supplementation reduced inflammation and joint degeneration in trained foals without altering joint homeostasis. The significance of this finding is substantial, as it proposes a nutritional strategy to prevent joint disorders while reducing reliance on invasive interventions. However, further research involving extended follow-up and varied supplementation protocols is critical to confirm the sustainability of these outcomes and validate the long-term efficacy of this approach.

Keywords

Foal breeding; glycosaminoglycan; joint; osteoarthritis; prostaglandin E2; training program

1. Introduction

With a sustained demand for high-performance horses, clinical problems in the musculoskeletal system may increase, as sports and training programs influence the prevalence and predisposition to orthopedic injuries and lameness [1,2]. Depending on the workload imposed on specific anatomical structures—which varies according to the type of sport and the level of training—injuries to supporting structures can impair performance. This impact may affect both the foal's development and its future athletic career [2,3].

In this context, it was observed that physical training protocols promote adaptations in the bone and cartilage structure of joints, which can be monitored through physical examination and ultrasonography [4,5]. However, the importance of balancing the benefits of these adaptations with the imminent risk of injuries was emphasized. Although bones and cartilage adjust to training-induced stress, this process can temporarily weaken the joints, increasing the foals' vulnerability to overload and repetitive mechanical stress. Furthermore, there are periods when susceptibility to inflammation and orthopedic injuries is heightened, underscoring the need for preventive measures to reduce their occurrence.

Accordingly, in addition to early detection to minimize new cases, the equine supplements industry has gained prominence by providing dietary supplements and nutritional management techniques to support horses' health [6,7]. Thus, specific ingredients for this purpose, such as collagen, are widely used, although there is a lack of scientific evidence for their efficacy in horses.

Much is known about the naturally occurring physiological functions of collagen in horses, including its role in bone remodeling [8], identification and degradation of collagen in the joint capsule [9], organization of the collagen network in the joint cartilage of young foals [10], histological changes in the equine flexor tendon [11], and its relationship to bone biomarkers [12].

Regarding the use of exogenous collagen in horses, reports suggest that it may be a safe alternative to help protect the non-glandular stomach, preventing gastric mucosal inflammation [13]. In the orthopedic field, horses diagnosed with osteoarthritis may exhibit reduced lameness grades [14]. Additionally, collagen supplementation may serve as an important ally in the treatment of synovitis [15], contribute to collagen synthesis (types I and II), and act as an inhibitor of pro-inflammatory cytokines in vitro [16].

However, the limited research conducted so far presents several constraints, including the short duration of supplementation, variability in collagen sources, small sample sizes, a predominance of in vitro studies, and the lack of complementary assessments such as radiography and ultrasonography—particularly in studies focused on the locomotor system.

Thus, the present study hypothesized that the inclusion of collagen in the diet of foals in training reduces the occurrence of orthopedic injuries and promotes joint homeostasis. Accordingly, the aim was to evaluate the effect of hydrolyzed collagen supplementation in the diet of trained foals on the occurrence of orthopedic injuries and joint changes.

2. Materials and Methods

2.1. Animals, Diets, Treatments, Supplementation, and Experimental Design

All experimental procedures were carried out in accordance with the guidelines established by the Ethics Committee on the Use of Animals – School of Veterinary Medicine and Animal Sciences, University of Sao Paulo (protocol #5595210323). The experiment was conducted at Haras Morada Nova, located in the municipality of Inhaúma, Minas Gerais State, Brazil. Environmental conditions included a temperature range of 19 °C to 27 °C and an average relative humidity of 63%.

Twenty foals of the Mangalarga Marchador breed, born at the experimental site and with a mean body weight of 206 ± 18 kg, were included in the study. There were ten male and ten female foals, all aged seven months. The horses were managed identically from birth in pastures of approximately 3 hectares and weaned at 6 months of age.

Before starting the experiment, all the foals underwent a clinical evaluation to ensure they were healthy (no changes in behavior or manifestation of any clinical signs), and blood samples were collected for a leukogram and an erythrogram to obtain complete blood cell counts.

The foals were kept in individual 16 m² stalls with wood shavings as bedding from weaning until the end of the experimental period. Diets were based on grass hay (*Cynodon* spp. Tifton 85) and concentrate formulated for each animal category. The equivalent of 2.5% of body weight in dry matter was offered, following NRC recommendations [17], with a forage-to-concentrate ratio of 50:50.

To ensure the nutritional quality of the feed (roughage and concentrate), a bromatological analysis was conducted at the beginning of the experimental period. The chemical composition of the feeds is shown in **Table 1**. Water and mineral salt were provided *ad libitum*. The concentrate was provided in individual feeders twice a day, always at the same times (8:00 AM and 4:00 PM), while the hay was placed in a specific manger.

Foals were randomly allocated to one of two groups: a control group (not supplemented with hydrolyzed collagen) and a treatment group (supplemented with hydrolyzed collagen), with ten foals in each group. The experimental period lasted six months. Supplementation occurred over 180 days, during which 50 g of hydrolyzed collagen (Gelco International® – Gelatin and Collagen Excellence) was added daily as a topdress over the concentrate, divided equally between the two feedings.

Table 1: Chemical composition of the concentrate and roughage used for foals (grass hay *Cynodon* spp. Cv. Tifton 85).

Composition	Concentrate (%)	Roughage (%)
Dry matter	87.0	89.3
Crude protein	18.0	9.20
Crude fiber	10.0	38.1
Acid detergent fiber	9.0	42.40
Neutral detergent fiber	14.0	69.34
Ether extract	3.5	1.01
Ash	13.1	6.45
Calcium	1.5	0.19
Phosphorus	0.6	0.19
Starch	20.0	2.80

2.2. Training

All foals underwent weekly training in both the control and the supplemented groups. Training occurred over five consecutive days (Mondays to Fridays) of exercise, followed by two consecutive rest days (Saturdays and Sundays). The training protocol involved a gait exercise combined alternately with aquatic exercises and galloping on an inclined surface.

In the gait exercise, the foals were led with a halter by a handler along a straight path for 50 m, repeated five times, totaling 250 m of walking, on a concrete floor covered by a thick layer of sand. With an average speed of 6 m/second, this exercise was performed daily.

For aquatic training, the animals were placed in a 20-meter-long straight-line pool with a water depth of approximately 1 m and a rubber floor. The foals were individually led with a halter by the handler, walking for 20 minutes. With an average speed of 4.5 m/second, this exercise was performed on Mondays, Wednesdays, and Fridays.

In the galloping exercise on an inclined surface, the animals were led as a group on a flat surface with an approximate incline of 40°, covering 100 m uphill and 100 m downhill. With an average speed of 12 m/second, the foals practiced this activity on Tuesdays and Thursdays.

2.3. Evaluation of Joint Structure by Ultrasonographic Examination

The zootechnical region evaluated was the hock of the left hind limb. The examinations were performed using an ultrasound system (an Esaote® MyLab 70 model) and a 10 MHz linear transducer. The images were obtained in both transverse and longitudinal sections. All exams were performed with the animal in a standing position and without the need for sedation.

Subsequently, the images were sent for further evaluation to three veterinarians specialized in orthopedic diagnostic imaging. The parameters assessed **[5]** were: synovial fluid appearance (SFA), synovial fluid quantity (SFQ), joint capsule thickness (JCT), thickness and appearance of articular cartilage (TAAC), subchondral surface appearance (SSA), and presence of subchondral osteophytes (PSO) **(Table 2)**.

The image acquisition for all periods was performed every 36 days. On the day of imaging collection, no foals were exercised.

2.4. Evaluation of Bone Structure by Radiographic Examination

For the evaluation of bone structure, the zootechnical region we evaluated was also the hock of the left hind limb, corresponding to the tarsal bones. The radiographs were performed using a portable X-ray machine (Eco Ray® model Orange 1060HF) with a power of 100 Kvp and a detector of 37 × 28.5 cm. All examinations were conducted with the animal in a standing position and without the need for sedation. The images were obtained and sent to three veterinary doctors specializing in orthopedic diagnostic imaging for subsequent evaluation. According to the methodology of Machado *et al.* **[18]**, the radiographic projections performed were dorsoplantar and mediolateral. The parameters assessed **[19]** were: increase in soft tissue volume (ISTV), presence of soft tissue mineralization (PSTM), presence of osteophytes and bone proliferations (POBP), enthesophytes (PE), subchondral sclerosis (PSS), subchondral osteolysis (PO), and osteochondral fragments (OF) **(Table 3)**.

The image acquisition for all periods was performed every 36 days. On the day of imaging collection, no foals were exercised.

Table 2: Classification and score of each parameter evaluated in the ultrasound examination.

Variables	Categories	Score
Synovial fluid appearance	Normal	0
	Anechoic	1
	Predominantly anechoic	2
	Predominantly heterogeneous	3
Synovial fluid quantity	Normal	0
	Increased +	1
	Increased ++	2
	Increased +++	3
	Increased ++++	4
Joint capsule thickness	No increase	0
	Mild	1
	Moderate	2
	Severe	3
Thickness and appearance of articular cartilage	Well-defined, continuous, smooth, and easily identifiable chondral line	0
	Chondral line difficult to identify with 50% of the surface preserved	1
	Chondral line difficult to identify, discontinuous, and rough	2
	No identification of the line with the presence of fragments	3
Subchondral surface appearance	Smooth	0
	Regular	1
	Areas with depression	2
Presence of subchondral osteophytes	None	0
	Present	1

Adapted from **[5]**.

Table 3: Classification and score of each parameter evaluated in the radiographic examination.

Variables	Categories	Score
Increase in soft tissue volume	None	0
	Mild	1
	Moderate	2
	Severe	3
Presence of soft tissue mineralization	None	0
	Mild	1
	Evident	2
	Severe	3
Presence of osteophytes and bone proliferations	None	0
	Mild	1
	Moderate	2
	Severe	3
Presence of enthesophytes	None	0
	Mild	1
	Moderate	2
	Severe	3
Presence of subchondral sclerosis	None	0
	Mild	1
	Evident	2
	Severe	3
Presence of subchondral osteolysis	None	0
	Mild	1
	Evident	2
	Severe	3
Osteochondral fragments	None	0
	One	1
	Two	2
	Multiple	3

Adapted from **[19]**.

2.5. Evaluation of Articular Synovial Fluid

The evaluated zootechnical region was the hock of the left hind limb, corresponding to the tibiotarsal joint. All collections were performed with the animal in a standing position and without the need for sedation.

The asepsis of the region consisted of an initial wash with running water and neutral soap, followed by two 5-minute scrubs in a circular motion using 3"×3" gauze sponges soaked in povidone-iodine solution. Excess povidone-iodine was removed with a sterile wipe moistened with 70% isopropyl alcohol. The site was dried with a sterile gauze sponge before sampling **[20]**. The sample was collected via arthrocentesis, where the synovial fluid was aspirated aseptically using a 0.8 × 30 mm needle and syringe, resulting in 4 ml of joint fluid **(Figure 1)**. The samples were immediately transferred to a plain tube (without EDTA).

The tubes were centrifuged at 3000 rpm for 20 minutes at 4 °C, and the supernatant was divided into aliquots, which were immediately stored in a -80 °C freezer within two hours after sample collection for subsequent analysis of PGE2 and GAG **[21]**.

PGE2 was determined using the Prostaglandin E2 ELISA Monoclonal kit (Cayman Chemical, Michigan, USA) **[19]**.

To determine GAG (hyaluronic acid and chondroitin sulfate) concentrations, synovial fluid (SF) samples (50 µL) were subjected to proteolysis using a Maxatase solution (4 mg/mL in 0.05 mol/L Tris-HCl, pH 8.0, 100 µL). After 18 hours of incubation at 50 °C, Maxatase was thermally inactivated (15 minutes at 100 °C), and debris was removed by centrifugation (3000 × g, 15 minutes, 24 °C). The supernatant was lyophilized and resuspended in distilled water (25 µL).

Aliquots (5 µL) were subjected to agarose gel electrophoresis in PDA buffer and stained with 0.1% toluidine blue in 50% ethanol:1% acetic acid (for sulfated glycosaminoglycans), and subsequently in 0.05 M sodium acetate buffer, pH 5 (for HA). Compounds were quantified by densitometry of the agarose gel slides **[22,23]**.

The collection of synovial fluid for all analyses was performed every 36 days. On the day of collection, no foals were exercised.

Figure 1: Arthrocentesis performed on the tibiotarsal joint of a young foal.

2.6. Statistical Analysis

For the imaging parameters, the data were analyzed using non-parametric Kruskal–Wallis tests, considering repeated measures over time, with the significance level set to 0.05, using the PROC NPAR1WAY procedure of SAS 9.0 (SAS Institute, Cary, NC).

For the synovial fluid parameters, the data were initially subjected to the Shapiro–Wilk normality test, and all parameters exhibited a normal distribution. Then, the data were subjected to analysis of variance, and the means were compared using Tukey's test, considering repeated measures over time, with the significance level set to 0.05, using the PROC MIXED procedure of SAS 9.0 (SAS Institute, Cary, NC).

3. Results

It was possible to visualize and record radiographic and ultrasonographic images of all foals without any complications or unexpected findings. In the ultrasound assessment of joint structure, a difference ($P < 0.05$) was observed between groups for several parameters, including SFQ, JCT, SSA, and PSO **(Table 4)**, where collagen supplementation suggests a possible effect on increasing synovial fluid production, associated with a decrease in joint capsule thickness, subchondral surface appearance, and subchondral osteophytes. However, no changes were observed in the appearance of synovial fluid, articular cartilage, or the appearance of periarticular ligaments. Additionally, a difference ($P < 0.05$) was observed between the time points for the variables of SFA, SFQ, JCT, TAAC, and PSO, indicating ultrasonographic changes across the experimental period **(Table 4)**.

Regarding the assessment of bone structure through radiographs, there was a difference ($P < 0.05$) between the treatment and control groups in POBP, PSS, and PSO, but no changes were observed in soft tissues **(Table 5)**. Thus, supplemented foals showed indications of an effect in reducing/preventing osteophytes and bone proliferations, as well as in subchondral sclerosis and osteolysis. Evaluation of the different time periods and variables revealed a significant difference ($P < 0.05$) only for POBP, with the other variables showing no radiographic changes over time **(Table 5)**.

For the assessments of synovial joint fluid, the samples were successfully collected with no unexpected findings. There was a difference ($P < 0.05$) between treatments for PGE2 **(Figure 2)**, with a reduction in the inflammatory grades of supplemented foals. This finding suggests that therapeutic interventions may modulate joint inflammatory responses in young horses.

For GAG analyses, no difference ($P > 0.05$) was observed for HA **(Figure 3)** and CS **(Figure 4)**. This indicates that supplementation did not significantly affect the synthesis or degradation of HA and CS in the extracellular matrix.

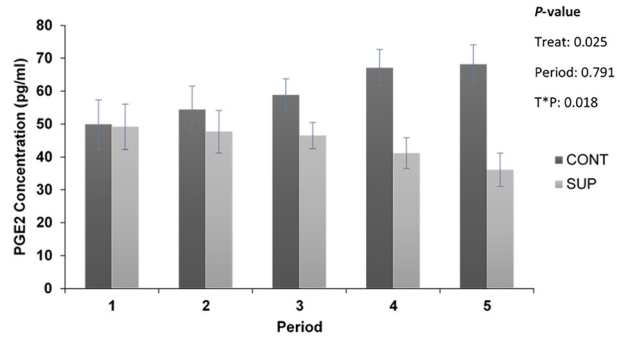

Figure 2: Means and standard error (SE) of PGE2 concentrations (pg/ml) in foals under different treatments and periods.

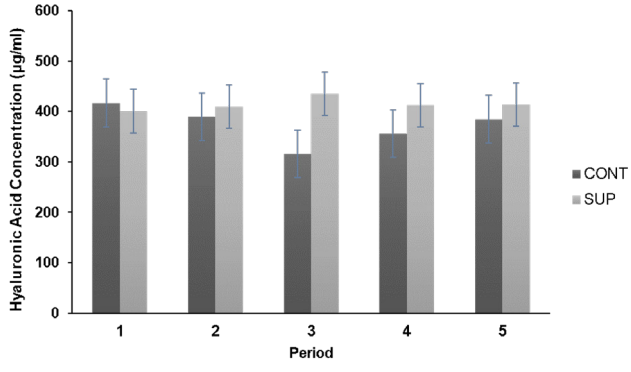

Figure 3: Means and standard error (SE) of HA concentrations (µg/ml) in foals under different treatments and periods.

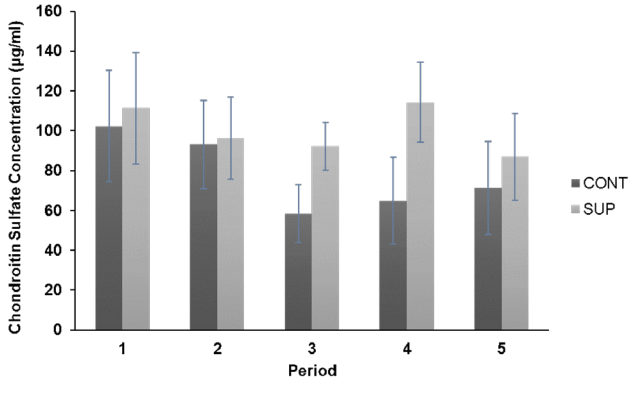

Figure 4: Means and standard error (SE) of CS concentrations (µg/ml) in foals under different treatments and periods.

4. Discussion

Regarding the results for the quantity of synovial fluid, the additional nutritional intake, exclusively derived from peptides present in the supplement, potentially increased the volume of joint fluids. In this context, Shaw *et al.* **[24]** observed that individuals supplemented with gelatin-derived hydrolyzed collagen one hour before engaging in intense exercise showed an increase in circulating levels of glycine, proline, and hydroxyproline—amino acids that constitute the structure of hydrolyzed collagen **[25]**. The authors concluded that adding gelatin to an intermittent exercise program improves circulating and intra-articular collagen synthesis, potentially resulting in increased fluid quantity and playing a beneficial role in injury prevention and tissue repair.

Table 4: Means and standard error of the mean (SEM) corresponding to the ultrasonographic assessments across different treatments, periods, and variables.

Variables	Periods										SEM	*P* value		
	1		2		3		4		5					
	Cont[1]	Supple[2]	Cont	Supple	Cont	Supple	Cont	Supple	Cont	Supple		Treat[3]	Period	T × P
SFA (0–3)	0.90^{B}	0.76^{B}	1.03^{AB}	1.06^{AB}	1.26^{A}	1.06^{A}	1.23^{A}	1.16^{A}	1.00^{AB}	1.03^{AB}	0.2482	0.921	0.026	0.316
SFQ (0–4)	0.53^{aB}	0.56^{bB}	0.63^{aA}	1.30^{bA}	0.63^{aA}	1.40^{bA}	0.53^{aA}	1.41^{bA}	0.60^{aA}	1.41^{bA}	0.1374	<.0001	<.0001	<.0001
JCT (0–3)	0.16^{aC}	0.33^{bC}	0.26^{aBC}	0.33^{bBC}	0.53^{aAB}	0.36^{bAB}	0.73^{aA}	0.46^{bA}	0.63^{aAB}	0.26^{bAB}	0.1330	0.028	0.002	<.0001
TAAC (0–3)	0.60^{A}	0.36^{A}	0.30^{AB}	0.36^{AB}	0.30^{B}	0.16^{B}	0.20^{B}	0.15^{B}	0.20^{B}	0.15^{B}	0.1375	0.261	0.061	0.139
SSA (0–2)	0.83^{a}	0.73^{b}	0.86^{a}	0.83^{b}	0.96^{a}	0.53^{b}	0.96^{a}	0.53^{b}	0.96^{a}	0.33^{b}	0.2281	0.012	0.569	0.002
PSO (0–1)	0.20^{aB}	0.00^{bB}	0.10^{aB}	0.10^{bB}	0.40^{aA}	0.10^{bA}	0.40^{aA}	0.10^{bA}	0.40^{aA}	0.10^{bA}	0.1061	<.0001	0.032	0.000

Synovial fluid appearance (SFA); synovial fluid quantity (SFQ); joint capsule thickness (JCT); thickness and appearance of articular cartilage (TAAC); subchondral surface appearance (SSA); presence of subchondral osteophytes (PSO). Different uppercase letters indicate significant differences over time, and different lowercase letters indicate significant differences among treatments, according to the Kruskal–Wallis test ($P < 0.05$). [1]Control group; [2]Supplement group; [3]Effect of the treatment.

Table 5: Means and standard error of the mean (SEM) corresponding to the radiographic assessments across different treatments, periods, and variables.

Variables	Periods										SEM	*P* value		
	1		2		3		4		5					
	Cont[1]	Supple[2]	Cont	Supple	Cont	Supple	Cont	Supple	Cont	Supple		Treat[3]	Period	T × P
ISTV (0–3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.0105	0.317	0.406	0.408
PSTM (0–3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0970	1.000	1.000	1.000
POBP (0–3)	0.30^{aA}	0.00^{bA}	0.43^{aAB}	0.00^{bAB}	0.55^{aAB}	0.03^{bAB}	0.60^{aAB}	0.03^{bAB}	0.73^{aB}	0.00^{bB}	0.1414	<.0001	0.034	0.460
PE (0–3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0970	1.000	1.000	1.000
PSS (0–3)	0.06^{a}	0.00^{b}	0.06^{a}	0.00^{b}	0.16^{a}	0.00^{b}	0.06^{a}	0.00^{b}	0.04^{a}	0.00^{b}	0.0409	0.007	0.686	0.435
PO (0–3)	0.10^{a}	0.06^{b}	0.06^{a}	0.00^{b}	0.13^{a}	0.03^{b}	0.10^{a}	0.03^{b}	0.04^{a}	0.00^{b}	0.0467	0.038	0.478	0.933
OF (0–3)	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.0191	0.562	0.251	0.844

Increase in soft tissue volume (ISTV); presence of soft tissue mineralization (PSTM); presence of osteophytes and bone proliferations (POBP); presence of enthesophytes (PE); presence of subchondral sclerosis (PSS); presence of subchondral osteolysis (PSO); osteochondral fragments (OF). Different uppercase letters indicate significant differences over time, and different lowercase letters indicate significant differences among treatments, according to the Kruskal–Wallis test ($P < 0.05$). [1]Control group; [2]Supplement group; [3]Effect of the treatment.

Beyond the impact on synovial fluid volume, the thickness of the joint capsule decreased in supplemented foals. This inverse relationship between capsular thickness and inflammation was previously established by Farfaras *et al.* **[26]**, who associated thicker capsules with higher inflammatory levels. Supporting this idea, Van de Water *et al.* **[15]** reported that racehorses supplemented with hydrolyzed collagen for 60 days exhibited lower degrees of synovitis, as indicated by inflammatory markers in synovial fluid (PGE2 and interleukins), and, consequently, reduced joint capsule thickening. In the present study, the decrease in prostaglandin E2 (PGE2) concentrations in the

supplemented group reinforces the hypothesis of a direct anti-inflammatory effect of the supplement in this case.

This anti-inflammatory effect, in turn, appears to be linked to the bioavailability of collagen peptides. As highlighted by **[27]**, these peptides can be absorbed intact, reach systemic circulation, accumulate in cartilage, and stimulate chondrocytes to synthesize extracellular matrix (ECM), promoting joint homeostasis. This mechanism may explain, for instance, the findings of Atayde *et al.* **[28]**, who observed a reduction in inflammatory cell infiltration and pro-inflammatory cytokine production (such as IL-1β and TNF-α) in mice following oral collagen supplementation.

However, beyond inflammation, structural changes such as osteophytes and bone proliferations (POBP), subchondral osteophytes (PSO), subchondral sclerosis (PSS), and osteolysis (PO) were also analyzed. In the present study, these osteoarthritis (OA) markers—particularly POBP—were more prevalent in the control group, where the imposed exercise load likely contributed to increased scores **[29]**. This finding contrasts with Di Filippo *et al.* **[30]**, who, when evaluating the influence of exercise, age, body weight, and growth on the development of tarsal osteoarthritis in gaited foals, observed that only 10% of the control group presented radiographic bone alterations indicative of OA. In contrast, in the present study, 40% of the foals, regardless of treatment, were affected by the presence of POBP. Some of them had already exhibited these radiographic changes even before starting training, suggesting a strong genetic association with the incidence of injuries.

However, in the study by Di Filippo *et al.* **[30]**, the foals followed a training program in which they exercised only three days per week, performing gallop exercises on a straight surface with a gradual increase in speed, with each session lasting 15 minutes. Additionally, as a methodological difference, radiographs were taken only at two-time points during the experimental period—at 18 and 36 months of age.

Still regarding the findings of POBP, Souza **[29]** observed that OA can also affect subchondral bone. The mechanical stimulation of the tarsal bones, caused by repetitive and intense exercises, often leads to microdamage that can eventually result in either normal or excessive bone remodeling, leading to sclerosis and subchondral osteolysis. These findings are consistent with those of our study, where approximately 30% of foals from both treatments exhibited such characteristics. Thus, an increase in subchondral bone sclerosis is related to higher degrees of generalized OA in the joints, justifying the occurrence of these three types of alterations (POBP, PSS, PO).

However, beyond physical load, other factors can influence the development of osteoarthritis (OA) in young horses. While early exercise is often associated with this pathology **[31]**, variables such as genetic predisposition, body weight, foal growth potential (early or late), and nutritional imbalances also play significant roles **[32]**. According to **[31]**, these factors do not all need to be present to contribute to the clinical manifestation of OA, but their interaction can modulate the severity of the condition.

Given this complexity, studies such as **[14]** aim to evaluate interventions that mitigate joint risks. In their research, hydrolyzed collagen was administered to assess its clinical efficacy in horses diagnosed with OA. The collagen was administered orally as a dietary supplement to 38 privately owned horses of various breeds. One group (G25; aged 6 ± 3 years and with a mean body weight of 519 ± 100 kg) received 25 g/day of hydrolyzed collagen, and another group (G50) received 50 g/day for 12 weeks. In a second center, another group of horses (18 ± 4 years; 413 ± 94 kg) did not receive the supplement; they were designated the control group. The evaluation methodology included orthopedic examination (e.g., flexion tests) and lameness assessment without imaging or complementary examinations. In the G25 group, a moderate effect was observed in reducing lameness grades and the incidence of local pain. In the G50 group, a strong effect was observed in reducing lameness grades and the incidence of local pain after six weeks of supplementation. Both groups showed a strong effect on improved mobility and willingness to run compared to the control group.

Corroborating this perspective—but in the context of induced orthopedic conditions—Van de Water *et al.* **[15]** quantified the preventive effects of a dietary supplement on experimentally induced synovitis in horses. Twenty-four Standardbred horses, divided into groups, received 90 g of hydrolyzed collagen for 60 days before undergoing a joint challenge. Synovitis was induced by intra-articular injection of 0.5 ng of lipopolysaccharide into the intercarpal joint. Subsequently, blood and synovial fluid samples were analyzed. The study found that collagen-supplemented animals exhibited significantly lower total protein levels in synovial fluid, total nucleated cell count, and prostaglandin E2 compared to the placebo group (without collagen supplementation). However, no statistically significant differences were observed between treatments regarding interleukins and glycosaminoglycans. The study concluded that hydrolyzed collagen supplementation may reduce inflammation in an experimental model of joint synovitis.

Additionally, investigations such as **[33]** expand the understanding of the effects of combined and comparative supplementation (collagen, glucosamine, chondroitin sulfate, hyaluronic acid, and turmeric) on joint biomechanics. It was found that the supplemented group exhibited a greater range of motion in the hock during gait compared to the control group. This suggested that the hock joint was responsive to biomechanical changes induced by supplementation. However, no changes were observed between treatments regarding serum and plasma biomarkers, including the absence of alterations in collagen metabolite concentrations and no changes in systemic inflammatory markers over the study period, which lasted only 28 days.

Complementing these findings, Bourdon *et al.* **[16]** observed that hydrolyzed collagen downregulates the synthesis of pro-catabolic and pro-inflammatory markers of OA and may ultimately promote collagen production and metabolic activity in equine articular chondrocyte organoids. This mechanism possibly contributes to joint homeostasis, even under intensive load conditions.

However, the response of synovial fluid biomarkers to exercise intensity and duration, based on findings in the literature, is not always clear. Study results vary and often contradict each other, influenced by factors such as exercise type, training period, synovial fluid collection methods, timing between exercise and sampling, joint evaluated, invasive procedures (arthrocentesis and arthroscopy), pathological conditions, and individual biological factors, including breed, age, sex, and temperament [34–39].

Therefore, for the glycosaminoglycan (GAG) findings, exercise did not promote ECM degradation. Over the past decades, several studies on young horses (from neonates to 18 months old) have provided important insights into the role of exercise in articular cartilage maturation [31,40–42]. These authors observed that the absence of physical exercise during the first months of life results in a lack of heterogeneity formation in the joint, eventually leading to negative consequences for the tissue's future resistance to injuries [43].

Moreover, findings by [36] demonstrated that horses subjected to a training regimen with gradually increasing intensity (five days of progressive intensity), alternating between walk, trot, and gallop on an automated treadmill, did not exhibit changes in GAG concentrations in the synovial fluid.

Contrary to the results of the present study, Brown *et al.* [37] reported that exercise influences the composition of synovial fluid, particularly GAGs such as CS and HA. Their study found that training resulted in a modest increase in CS chain length, with the exercised group showing a peak chain length of 15.6 kDa compared to 11.6 kDa in the control group. However, the collections were performed immediately after exercise. In the present study, the foals were not trained on the day of sample collection.

In a temporal evaluation of inflammatory and oxidative markers following high-intensity exercise, MacNicol *et al.* [44] measured GAG concentrations in synovial fluid at distinct time points (0.5, 1, 2, 4, 8, and 24 hours) and observed that within less than 24 hours, the joint environment returned to homeostasis following an 8-hour post-exercise peak in GAG concentrations.

Thus, the results of the present study revealed strong evidence of the beneficial effects of collagen peptides for horses when administered orally as a dietary supplement.

5. Conclusions

We conclude that supplementation with hydrolyzed collagen in trained foals reduces the occurrence of orthopedic injuries and the inflammatory level of synovial fluid without adverse effects on glycosaminoglycan levels. These findings suggest that, from a nutritional perspective, collagen may play a protective role in maintaining joint integrity in horses undergoing training, potentially contributing to enhanced athletic longevity and animal welfare. The clinical relevance of this discovery is significant, as it highlights a viable nutritional strategy for preventing articular orthopedic disorders, thereby reducing reliance on more invasive medical interventions. However, despite the observed benefits, gaps remain in the understanding of collagen's mechanisms of action and its long-term effects. Further studies with extended follow-up periods and varied supplementation protocols are needed to confirm the durability of these effects.

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Authors' Contributions

All authors contributed substantially to the conception, development, writing, and critical revision of the manuscript. Each author affirms their role in ensuring the academic integrity and quality of the work.

Data Availability

All data supporting the findings of this study are included within the article.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Approval

All ethical considerations related to the use of animals were carefully addressed. The study protocol was approved by the Ethics Committee on the Use of Animals – School of Veterinary Medicine and Animal Sciences, University of São Paulo (Protocol #5595210323), São Paulo, Brazil. All applicable international, national, and institutional guidelines for the care and use of animals were followed.

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Exploring Well-Being in Thoroughbred Horse Breeding: A Systematic Narrative Review Applying the PERMA+4 Framework

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Abstract

Background: Staff shortages in the horseracing industry may impact horse and staff well-being. Working conditions such as a high workload, and poor work-life balance are found to influence staff retention. Thoroughbred breeders and staff work long hours with limited job control. However, there is a dearth of research examining breeding staff well-being. **Aims:** This article aims to explore associations between working conditions and well-being in thoroughbred horse breeders and stud farm staff. **Materials and methods:** A search of studies published up to January 2025 and available in PubMed, Scopus, and PsycINFO was performed and is reported in line with PRISMA-S. Included articles were deductively coded into predetermined themes using the PERMA+4 framework for work-related well-being (positive emotions, engagement, relationships, meaning, accomplishment, physical health, work environment, mindset, and economic security). **Results:** A total of 21 studies were included for narrative analysis spanning the United States, United Kingdom, Australia, and Ireland. Results suggest that physical and psychosocial working conditions on stud farms may negatively impact staff well-being and retention through poor work-life balance, employee relations, and training and progression opportunities. Well-being may be influenced through the PERMA+4 dimensions of relationships, accomplishment, physical health, and work environment. **Conclusion:** This review demonstrates that the PERMA+4 model may be used as a theoretical framework to understand associations between working conditions and well-being in thoroughbred breeding work. Further research on the application of positive organizational psychology in this sector may increase understanding of and enhance staff well-being and retention.

Keywords

Mental health; well-being; occupational health; horseracing; stud farm staff; working environment

1. Introduction

Working conditions encompass both the working environment as well as conditions of employment such as training, skills, health and safety, well-being, working time, and work-life balance [1]. Two categories of working conditions are generally agreed upon in the literature; the physical and the psychosocial work environment [2]. The psychosocial work environment refers to the psychological and social influences on well-being including; work time, job control, work demands, job security, as well as

employer-employee relations [2]. An association between working conditions and the well-being of workers has been widely established [3,4]. Specifically, working conditions have been found to significantly contribute to staff retention, job satisfaction, and physical and mental health [5–7].

The horseracing industries of the U.K. and Ireland have long-faced issues around recruitment and retention of staff which may have implications for the welfare and performance of both horses and staff [8]. The horseracing industry encompasses various key stakeholders including jockeys, trainers and stable staff, racecourse staff, and the stud and breeding sector [9]. Staff retention issues in the broader industry have been attributed to a high workload, poor work-life balance, insufficient staff skills, and a lack of career progression [9]. Indeed, almost half of thoroughbred racing and breeding staff plan on leaving their current role in the next two years, while over a fifth plan on leaving the industry in the same timeframe [10]. Among the most common reasons cited by staff were the nature of the work, followed by low pay and lack of career advancement [8].

Attempts to understand the staffing crisis faced by the horseracing industry have highlighted the importance of staff well-being [8]. Well-being encompasses emotional, behavioral, cognitive, and social factors and describes how well an individual feels, functions, and evaluates their life [11]. Well-being in the workplace is increasingly recognized as an important factor in staff retention [12]. Well-being at work is influenced by mental and physical health, occupational hazards, environmental and demographic factors, as well as job satisfaction [13,14]. While there are multiple theories of well-being, the Positive Emotions, Engagement, Relationships, Meaning, and Accomplishment (PERMA) model [15] has been widely adopted in positive psychology research [16]. PERMA offers a multi-dimensional definition of well-being that can be used to evaluate an activity's influence on the key elements of well-being; positive emotions, engagement, relationships, meaning, and accomplishment [17]. Each of these elements is shown to strongly predict well-being and is also associated with improved work performance [18].

PERMA+4 extends the original framework to include four additional elements to explain work-related well-being and performance. These elements are: physical health, mindset, work environment, and economic security [16,18,19]. Previous research on mental health and well-being in horseracing has largely focused on Jockeys [20,21], as well as trainers and stable staff [8,22], research in the breeding sector is lacking. Staff on thoroughbred breeding farms produce horses for racing and work long hours with limited control around time off [9]. Davies *et al.* [23–25] highlighted the significant psychological impact of occupational injuries on stud workers, however little is known about the impact of other occupational factors on stud workers' well-being. While thoroughbred horse breeding is situated within the broader horseracing industry, the occupation shares similarities with farming and the agricultural industry. Farming has been identified as a particularly stressful occupation and farm staff are at an increased risk for mental health problems [26,27]. This perspective article aims to explore associations between working conditions and well-being in horse breeders and stud farm staff. Existing literature on psychosocial working conditions in the thoroughbred breeding industry will be reviewed applying the PERMA+4 model as a theoretical framework to explore their influence on well-being. Specifically, this systematic narrative review aims to answer the following research questions: How do working conditions influence staff well-being in the thoroughbred horse breeding sector? How do working conditions and staff well-being impact staff retention in the thoroughbred breeding sector?

Further empirical evaluation using the PERMA models has the potential to inform policy and intervention development to improve well-being and retention in the breeding sector.

2. Materials and Methods

2.1. Search Strategy

A hybrid systematic-narrative approach was taken whereby search protocols and inclusion/exclusion criteria were informed by systematic review practices, and a narrative approach was applied to the analysis of data [28]. Systematic search strategies prevent bias in literature selection and require a detailed methodology and inclusion criteria that are replicable [29]. The similarity of topic or outcomes between included studies is necessary, therefore a hybrid systematic-narrative approach was deemed most suitable due to the heterogeneity of the research [30]. A review protocol was developed and registered on PROSPERO (CRD42025641832, 23 January 2025). A literature search was conducted in January 2025 across the following databases; PubMed, Scopus, and PsycINFO. Search terms included word variations for working conditions, wellbeing or well-being, and horse breeder or stud farm staff. A full list of search terms can be found in **Table 1**. A manual search of grey literature (industry reports) and reference lists of included papers was also carried out to identify articles for inclusion. A search filter was applied to include full texts and studies in English only.

2.2. Eligibility Criteria

To be included in this systematic narrative review articles must have: (1) included a sample wholly or partially consisting of thoroughbred horse breeding staff; (2) included quantitative or qualitative data on physical or psychosocial working conditions; or (3) assessed mental health or well-being of workers, in line with the aims of this review. Studies were excluded from the review if they met the following criteria: (1) book chapters, or conference abstracts; (2) full text unavailable; (3) not written in English.

2.3. Study Selection

Search results were imported into Covidence, a systematic review manager, and duplicates were removed. Titles and abstracts were screened for inclusion by one researcher (C.M.) using the eligibility criteria. The remaining articles were then screened in full by two reviewers (C.M. & S.N.H.). Any uncertainties were discussed with the research team and a collaborative decision was reached. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection can be found in **Figure 1**. The included studies were then critically appraised for quality using the McGill Mixed Methods Appraisal Tool (MMAT) [31], which is designed for use with reviews including quantitative, qualitative, and mixed methods

studies. All studies met a minimum of 80% of the criteria and were deemed to be of acceptable methodological quality for inclusion.

2.4. Data Extraction

A deductive analytical strategy was employed to apply the theoretical framework to the included data **[32]**. Themes based on components of the PERMA+4 framework (positive emotions, engagement, relationships, meaning, accomplishment, physical health, work environment, mindset, and economic security) were created in the NVivo software. The included articles were then categorized into predetermined themes to extract relevant data. Data on study characteristics are summarized in **Table 2**.

2.5. Data Synthesis

The PERMA+4 framework for work-related well-being was used to guide the synthesis of data. The framework was used to organize the findings and inform how working conditions are associated with and contribute to the well-being of thoroughbred horse breeders and stud farm staff. Interpretation of each of the PERMA+4 constructs is adapted from Donaldson *et al.* **[19]** and is provided in **Table 3**. In line with a systematic narrative hybrid approach, results are discussed in narrative form.

3. Results and Discussion

After title and abstract screening, followed by full-text retrieval, 21 studies were included in this review and are summarized in **Table 2**. Studies were published between 2005 and 2024 and spanned the United States (n = 13), the United Kingdom (n = 4), Australia (n = 3), and Ireland (n = 1). Samples varied but most were representative of thoroughbred horse breeding staff or management. Some studies also included staff from other horseracing industries or veterinarian staff working on stud farms. A variety of study designs were utilized for data collecting including cross-sectional (n = 13), semi-structured interviews and focus groups (n = 4), mixed methods (n = 2), experimental (n = 1), and observational (n = 1).

Table 1: Terms for database search.

Database	Keywords/Boolean
Scopus	work* conditions OR environment OR organizational OR management OR occupational factors OR breed* AND wellbeing OR well-being OR well* OR quality of life OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breed* OR stud farm staff OR stud staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*
PsycINFO	work* conditions OR environment OR organization* OR management OR occupational factors AND wellbeing OR well-being OR well* OR quality of life OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breed* OR horse breeder OR stud farm staff OR stud staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*
PubMed	work* conditions OR work* environment OR organizational conditions OR management OR occupational factors OR breed* AND wellbeing OR well* OR well-being OR quality of life OR wellness OR health OR positive affect OR mental health OR stress OR depression OR injury OR illness AND thoroughbred horse breeding OR horse breeder OR stud farm staff OR horseracing staff OR horse racing staff OR thoroughbred horse farm*

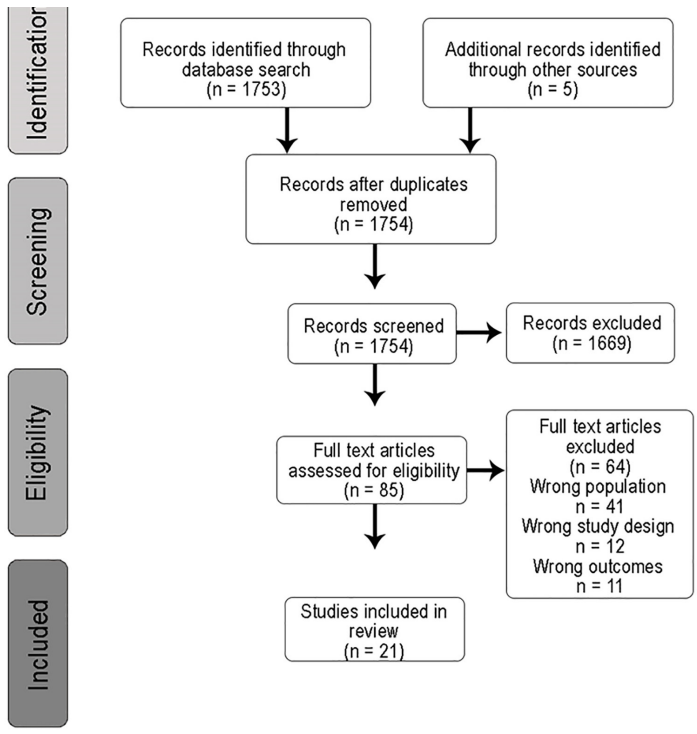

Figure 1: PRISMA flow diagram of study selection.

Table 2: Characteristics of included studies.

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[33]	Hispanic horse workers $N = 225$	$M = 35.4 \pm 9.6$	Male $n =$ 193 (85.8%) Female $n =$ 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (work history, job tasks, working hours, farm size, exposures, work-related stress, health insurance) General health Smoking status Depressive symptomatology	Having children (PR = 1.71, 95% CI {1.03, 2.84}), poor health (PR = 0.72, 95% CI {0.48, 1.08}), work-related stress (PR = 2.58, 95% CI {1.25, 5.32}), and spending time with horses (PR = 1.87, 95% CI {1.15, 3.05}) significantly predicted missed work. Bedding type significantly influenced work-related illness.
[34]	Thoroughbred horse farm managers $N = 35$	N/A	Male $n =$ 26 (74.0%) Female $n = 9$ (26.0%)	United States	Semi-structured interviews	Demographics Working conditions (role, farm size, hazards) Provision of PPE	Horse-related tasks were perceived as the most dangerous. Poor perceptions of PPE efficacy.
[35]	Latino thoroughbred horse farm workers $N = 225$	$M = 35$	Male $n =$ 193 (85.8%) Female $n =$ 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (tenure at current farm, physical demands, work-related stress, supervisor unfairness, supervisor ability to speak Spanish) Work-related injuries	Occupational injury risk was significantly influenced by work stress (OR = 6.70, 95% CI {1.84, 24.31}), supervisor unfairness (OR = 3.34, 95% CI {1.14, 9.73}), longer tenure at farm (OR = 2.67, 95% CI {1.13, 6.34}), and supervisor's inability to speak Spanish (OR = 2.29, 95% CI {1.05, 5.00}).
[25]	British horseracing staff $N = 287$ (breeding sector $n = 18$ (6.3%))	N/A	N/A	United Kingdom	Cross-sectional	Working conditions (employment status, role, job security, employee support) Working practices during COVID-19 lockdown Well-being	Over 87% reported that pandemic-specific work changes were effective, and health and safety were prioritized. Breeding staff were significantly more likely to be working during lockdown compared to jump racing grooms ($p < .05$, 95% CI {2.89, 99.36}). Most sectors reported working the same or fewer hours than before the pandemic, while the breeding sector reported working more hours during lockdown. Over 67% of staff were positive about job security.
[24]	Stable and stud staff $N = 198$ (stud hands $n = 20$)	$M = 34.22 \pm 12.75$	Male $n =$ 37 (18.7%) Female $n =$ 155 (78.3%) Unspecified $n = 6$ (3.0%)	United Kingdom	Cross-sectional	Demographics Working conditions (role, employment status, working hours, pay, job control) Injury details Injury management (attitudes to injury and coping strategies)	Risk factors for injury type included self-perceived job security, working hours, and perceived job control. Consequences of injury included physical limitations, loss of confidence, workplace changes, and lifestyle implications. Attitudes to injury management were influenced by staff shortages, previous injury experiences, and perceived employer expectations.
[23]	British horseracing staff including stable and stud $N = 175$	$M = 34.3 \pm 10.64$	Male $n =$ 29 (16.57%) Female $n =$ 144 (82.29%) Unspecified $n = 2$ (1.14%)	United Kingdom	Cross-sectional	Demographics Working conditions (role, employment status, working hours, pay, job control) Injury details Injury management (attitudes to injury) Social coping behavior Anxiety and depression	A high prevalence of depression and anxiety was found, which was higher for staff who viewed their employer as unhelpful (anxiety $p = .001$; depression $p = .020$).
[36]	Latino thoroughbred horse breeding farm workers $N = 80$	$M = 37.7$, $SD = 10.9$	Male $n =$ 59 (73.8%) Female n = 21 (26.2%)	United States	Cross-sectional	Demographics Job characteristics (duration of employment, hours worked per week, exposures, use of dust masks) Smoking status Respiratory symptoms Pulmonary function	27% showed abnormal pulmonary function. 79% reported any respiratory symptoms, and 94% infrequently used dust masks. Abnormal pulmonary function was associated with shorter durations in the current role (OR = 6.3, 95% CI {1.15, 34.35}) and living in the US (OR = 5.2, 95% CI {1.3, 20.6}).
[37]	Thoroughbred horse farm workers $N = 2276$	N/A	Male $n =$ 1821 (80.0%) Female $n =$ 455 (20.0%)	United States	Cross-sectional	Working conditions (role, contact with horse) Injury details Injury outcomes (i.e. number of days off and injury claims)	Increased risk of high-cost injury for workers with high horse contact jobs (OR = 1.87, 95% CI {1.53, 2.29}).

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[38]	Thoroughbred horse sales stakeholders *N* = 29 (breeders *n* = 11 (37.9%))	N/A	Male *n* = 8 (72.7%) Female *n* = 3 (27.3%)	Australia	Focus groups	Perceptions of yearling sales' endoscopy	Strongly negative perceptions of the yearling sales endoscopy process held across focus groups. The relationship between laryngeal function and future race performance is unclear. A small minority of yearlings with grade three laryngeal function show reduced performance but are earning less generally. Frustration around subjective and inconsistent grading.
[9]	Horseracing staff (focus groups and semi-structured interviews *n* = 131, survey *n* = 1502) including stud sector (focus groups and semi-structured interviews *n* = 7, survey *n* = 143)	N/A	N/A	United Kingdom	Mixed methods (focus groups, semi-structured interviews, and cross-sectional)	Working conditions (role, work hours, work patterns, holidays, benefits, job security) Personal health (injuries, illness, mental health) Mental health services provision Help-seeking Professional development	High rates of stress, anxiety, or depression reported by the stud sector. Poor mental health made worse by their work. Mental health may be influenced by poor communication between management and staff, limited opportunities for development, and tied accommodation.
[39]	Latino horse farm workers *N* = 225	N/A	Male *n* = 193 (85.8%) Female *n* = 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (work-related stress, job security, days missed due to injury, work-related discrimination) Depressive symptomatology	Depression positively correlated with gender (r = .15, p = .04), work stress (r=.15,p=.03),work-relateddiscrimination (r = .27, p < .01), and job insecurity (r = .27, p < .01).
[40]	Latino crop (*n* = 49) and horse breeding workers (*n* = 54) *N* = 103	Horse breeding workers (*M* = 35, *SD* = 9.7) Crop workers (*M* = 32, *SD* = 9.3)	Horse breeding workers (Male *n* = 50 (94.3%) Female *n* = 3 (5.7%)) Crop workers (Male *n* = 48 (97.9%) Female *n* = 1 (2.1%))	United States	Cross-sectional	Demographics Working conditions (farm type, work hours, physical demands, job control, work-related stressors, supervisory practices, supervisory support, safety climate, training, benefits, environmental stressors) General health	Crop workers experienced more physical demands, work-related and environmental stressors, and musculoskeletal and ill-health symptoms. A quarter of both groups reported work-related injury in the last year. Crop workers were significantly more likely to miss work due to work-related illness or injury. A majority of both groups reported exposure to toxic chemicals. A minority received training around toxic chemical use.
[41]	Latino crop (*n* = 49) and horse breeding workers (*n* = 54) *N* = 103	Horse breeding workers (*M* = 35.3, *SD* = 9.7) Crop workers (*M* = 31.9, *SD* = 9.3)	Horse breeding workers (Male *n* = 50 (94.3%) Female *n* = 3 (5.7%)) Crop workers (Male *n* = 48 (97.9%) Female *n* = 1 (2.1%))	United States	Cross-sectional	Demographics Working conditions (working hours, physical demands, work-related stress, supervisor abuse, safety climate) General health	Higher levels of abusive supervision were associated with occupational injury (OR = 2.97, 95% CI {1.0, 8.77}). Awkward postures were associated with occupational illness (OR = 3.85, 95% CI {1.06, 13.98}).
[42]	Horse farm workers *N* = 568	N/A	Male *n* = 476 (83.8%) Female *n* = 92 (16.2%)	United States	Mixed methods (cross-sectional and semi-structured interviews)	Demographics Working conditions (farm size, role, employment status) Injury details	A total of 284 injuries were documented. A large majority of the reported injuries were experienced by men (81.4%) and over half (57.6%) were experienced by non-Latinos. Horse-related tasks were more often associated with general injuries (p = .000), and contusions (p = .033), whereas non-horse-related tasks were more often associated with musculoskeletal sprains, strains, and tears (p = .001), irritations (p = .033), and stings (p = .002).
[43]	Latino thoroughbred horse farm workers *N* = 225	*M* = 35.4 ± 9.6	Male *n* = 193 (85.8%) Female *n* = 32 (14.2%)	United States	Cross-sectional	Demographics Working conditions (tenure, time spent working in barns, exposures, availability of dust masks) Respiratory symptoms	Respiratory symptom prevalence was high. Dust masks may be protective. Women and those with a lower understanding of the English language were at higher risk.

Ref	Sample	Age (years)	Gender	Country	Study design	Measures	Outcomes
[44]	Latino thoroughbred horse farm workers $N = 225$	$M = 35.4$ ($SD = 9.62$)	Male $n = 193$ (85.8%) Female $n = 32$ (14.2%)	United States	Cross-sectional	Demographics General health Working conditions (tenure, working hours, farm size, job tasks, hazards) Injury details	Nearly half of horse farm workers experienced an injury in the last year, often involving a horse. Bruises, sprains, and strains were most common, as were injuries to upper and lower appendages. Head and face injuries more often result in medical care.
[45]	Latino horse farm workers $N = 225$	$M = 35$	Male $n = 193$ (85.8%) Female $n = 32$ (14.2%)	United States	Cross-sectional	Demographics Working conditions (years working on horse farms, hours worked, safety climate, physical demands) Musculoskeletal discomfort (MSD)	85% experienced MSD, which was associated with higher age ($p = .004$), longer tenure on horse farms ($p = .001$), and longer working hours ($p = .004$).
[46]	Thoroughbred breeding industry workers $N = 29$ (Veterinarians/ Laboratory Personnel $n = 10$ (34.0%), Veterinary Nurses $n = 7$ (24.0%), and stud farm staff $n = 12$ (41.0%)	N/A	Male $n = 9$ (31.0%) Female $n = 20$ (69.0%)	Australia	Semi-structured interviews and focus groups	Demographics Perspectives on the use of Personal Biosecurity practices in the Thoroughbred industry	Greater awareness of infectious risks promotes use of Personal Protective Equipment (PPE). PPE is not comfortable, or practical for equine reproductive work in Australia's hot climate. Supportive environments, strong leadership, and policy and economic factors may influence the adoption of biosecurity and personal biosecurity measures in the workplace.
[47]	Thoroughbred breeding industry workers $N = 17$ (stud farm management $n = 8$, equine veterinarians $n = 6$, equine nurse $n = 2$, and stud farm staff $n = 1$)	N/A	Male $n = 5$ (29.4%) Female $n = 12$ (70.6%)	Australia	Experimental	Changes in adoption of personal biosecurity (PBS) practices Reasons for changes in use of PBS	13 PBS adoption strategies were practiced by at least half of the participants. Participants were more likely to use a ready-made foaling box (98.0%), communicate that PPE is a personal responsibility (94.1%), and use ready-made PPE kits (88.2%). Need for strategies to be sensitive to breeding calendar, farm size, and availability of skilled staff.
[48]	Thoroughbred horse breeders $N = 16$	N/A	Male $n = 12$ (75.0%) Female $n = 4$ (25.0%)	Ireland	Semi-structured interviews	Parasite control practices Attitudes toward reducing anthelmintic use	Pasture hygiene is determined by tradition, rather than biosecurity. Advice on parasite control is not viewed as part of veterinarians' role. Anthelmintic resistance is seen as an industry threat, not an on-farm issue.
[49]	Thoroughbred horses ($N = 321$) and staff working in a veterinary hospital ($N = 125$) and a stud farm ($N = 67$)	N/A	N/A	United States	Observational	MRSA screening Human-horse contact	Total identified cases of MRSA in horses $N = 79$, and staff $N = 25$. Cases from the veterinary hospital (horses $n = 27$ (34.0%), staff $n = 17$ (63.0%)). Cases on a stud farm (horses $n = 41$ (51.0%), staff $n = 8$ (12%)). 96% of human cases had previous contact with horse(s) infected with MRSA. Close contact between horses and humans on stud farms, and extensive movement of thoroughbreds may be risk factors for the spread of MRSA.

3.1. Positive Emotions

Research on positive emotions in breeders and stud farm staff is lacking and studies largely focus on negative emotions. Despite none of the included studies specifically assessing the impact of thoroughbred horse breeding on positive emotions, many assess psychosocial experiences that have previously been linked to positive emotions. For example, Juckes *et al.* [8] found that praise and appreciation from employers for a task done well do not occur often within the horseracing industry. Praise is important to staff well-being through increases in the positive emotion of satisfaction [50]. Rewards and incentives have a similar effect on employee satisfaction [51]. Thompson *et al.* [47] investigated strategies used during foaling to encourage the adoption of personal biosecurity, or practices aimed at reducing infection risk which include Personal Protective Equipment (PPE), as well as social and behavioral interventions. A majority of participants disagreed with the use of rewards and incentives to encourage personal biosecurity with 58.8% citing that biosecurity is necessary and does not require rewards and incentives. Although, participants largely used and valued the use of humor to encourage the adoption of biosecurity. The use of humor in the workplace can help to reduce negative emotions such as tension and soften directives and requests [52,53]. Walshe *et al.* [48] assessed attitudes towards sustainable parasite control practices in Irish thoroughbred breeders and found that current behaviors are driven by tradition which elicits

the positive emotion of confidence. Hammersley *et al.* [54] highlighted the importance of tradition to farmers and that changing agricultural policies may reduce farmer confidence through a perceived loss of mastery. For example, an increasing necessity for paperwork has been a challenge to some more traditional farmers [54]. Positive emotions are more than just the absence of negative emotions, and have been associated with improved work-related well-being and staff retention [55].

Research on stud farms has predominantly focused on negative emotions due to a high prevalence of poor mental health reported by breeding staff [9,23]. Rates of stress, anxiety, and depression have been reported to be high in stud farm staff, with almost 50% stating that their mental health was worsened by the nature of their work [9]. Depression and anxiety are associated with increased negative emotions such as sadness, anger, and fear, and a reduction in the positive emotion of happiness [56]. Furthermore, symptoms of work stress are positively associated with staff retention in terms of turnover intention [55]. Davies *et al.* [23] also found high rates of anxiety and depression in stud and stable staff with injuries. However, as pre-injury anxiety and depression were not assessed it is not possible to establish cause and effect between injury and mental health. It is possible that poor sleep mediates this relationship between mental health and injuries in stud and stable staff. Work patterns of farmers are found to negatively impact sleep quality, and sleep issues have previously been associated with mental health problems in farmers [57,58]. Experiencing poor sleep quality puts farmers at an increased injury risk [59]. Future research should assess the influence of occupational factors on sleep quality in breeding staff, as well as associations with positive and negative emotions. Davies *et al.* [24] assessed the impacts of injury on horseracing staff including stud hands and found that injury could elicit negative emotions such as fear, embarrassment, self-consciousness, and vulnerability. Clouser *et al.* [35] found that 71% of Latino thoroughbred farm workers in the U.S. report that their work is stressful. Experiencing stress significantly increases the risk of missing work in this population [33,39]. The association between stress and absenteeism may be due to mental rather than physical health issues. Swanberg *et al.* [41] found no significant relationship between work-related stress and missed work due to physical illness or injury in horse breeding workers. However, Negi *et al.* [39] found significant relationships between days missed due to physical injury and symptoms of depression in Latino horse farm workers. The most significant predictor of depressive symptoms in this study was work-related discrimination due to race or ethnicity. Workplace racism is negatively associated with employee well-being [60]. Negative emotions such as anger, insult, disappointment, and feeling disrespected are most commonly reported in reaction to racial discrimination [61]. Furthermore, emotional distress caused by workplace racism has previously been found to impact employee turnover intention [62,63].

Fredrickson's [64] broaden-and-build theory suggests that positive emotions may improve well-being over time by building physical, intellectual, social, and psychological resources. For example, experiencing a positive emotion like pride may create an urge to achieve more. In the work environment, the building of personal resources such as resilience and optimism through experiencing positive emotions may buffer against setbacks and reduce turnover intentions [65,66]. The included studies demonstrate a high prevalence of poor mental health in the breeding sector, which is associated with increased negative emotions and reduced positive emotions [56]. According to the broaden-and-build theory, experiencing negative emotions narrows thought-action repertoires in order to fight or flight a threat [64,67]. A negative emotion such as fear may create an urge to escape a situation thereby offering short-term, immediate benefits in threatening situations [68]. This could explain the association between work-related stress and turnover intentions as staff may leave their job to escape the experience of negative emotions [55]. Furthermore, experiencing positive emotions at work is thought to decrease stress symptoms, improve job satisfaction, and reduce turnover intentions [55,69]. While there is a lack of research exploring the experience of positive emotions in thoroughbred breeding, an industry report found that 85% of stud workers experience satisfaction in their job, citing their love and passion for horses as the main reason [10]. It is recommended that future research investigate the influence of positive and negative emotions on the well-being and turnover intentions of breeders and stud farm staff. In particular, research on the positive emotions experienced by stud workers through working closely with horses is recommended. Interventions to enhance positive emotions at work such as education programs on positive communication and mindsets may improve breeding staff well-being and retention [55].

Table 3: PERMA+4 interpretation [19].

Construct	Interpretation
Positive emotions	Experiencing positive emotions such as happiness, joy, love, or gratitude in the moment.
Engagement	Being highly absorbed, or experiencing flow while engaged in a task.
Relationships	Maintaining positive relationships with others, characterized by experiences of love and appreciation.
Meaning	Being connected to or serving something larger than oneself, or having a sense of purpose.
Accomplishment	Experiencing mastery or achieving important or challenging work goals.
Physical health	Demonstrating high levels of biological, functional, and psychological assets.
Mindset	Having a growth mindset, characterized by optimism and viewing challenges and setbacks as opportunities for growth.
Work environment	A psychophysical system consisting of both physical factors such as building design and air quality, and subjective experiences including safety and connectedness.
Economic security	Perceived security and stability of finances to satisfy individual needs.

3.2. Engagement

Engagement at work may be negatively affected by staff retention issues in the breeding industry. Horseracing staff shortages means there is sometimes an imbalance between the personal skills of and the demands placed on staff. Juckes *et al.* **[8]** identified a skills gap whereby less experienced staff are lacking practical skills such as riding ability and caring for horses. Recently employed staff who would normally learn from experienced staff may miss out due to a high staff turnover. Engagement refers to being highly absorbed in or experiencing flow while engaged in a task **[15]**. According to Csikszentmihalyi **[70]**, flow occurs at the intercept of personal skills and challenge levels. As horseracing staff including breeders and stud farm staff may be under pressure to work harder and with a higher level of skill than would be normally expected, staff shortages may negatively impact engagement **[8]**. Furthermore, self-determination theory **[71]** suggests that an individual must feel they are competent to perform an activity in order to be motivated to engage in it and to reach a flow state **[72]**. Staff competency may be limited by staff shortages as well as a lack of training and development opportunities reported by some of the included studies **[9,40]**. A recent survey of thoroughbred breeding staff in the U.K. found that job satisfaction was influenced by training, development, and career progression opportunities and that these influence leaving intentions **[10]**. Employees who are satisfied with the training provided by their organization are more likely to be engaged at work and less likely to leave their role which highlights the importance of engagement at work to staff retention **[73]**.

Engagement at work is also related to satisfying the basic need for autonomy, another component of self-determination theory **[74,75]**. Staff autonomy around work shifts, hours, and responsibilities is referred to as job control **[76]**. Stud farm staff have identified a lack of control around taking time off as one of the most significant stressors in the workplace **[9]**. Job control was also previously identified as a risk factor for injury in horseracing staff **[24]**. According to the demand-control model **[77]**, job stress is determined by two parameters; job demands and decision latitude, or autonomy. In addition to offering limited autonomy, jobs in the horseracing industry including the breeding sector place significant physical and mental demands on staff **[78]**. Thus, high job demands coupled with limited job control may impact stud farm workers' well-being through increased stress and low engagement at work **[76,79]**. Swanberg *et al.* **[40]** found that only between one-quarter and one-third of horse farm workers report almost always being able to make decisions about what or how to do their job. Similarly, Davies *et al.* **[24]** found that 36.2% reported having complete or a lot of control over their job, while 35.5% reported little to no job control. McConn-Palfreyman *et al.* **[9]** identified a lack of flexibility on stud farms around taking time off with employees feeling pressure to work seven days per week. While none of the included studies assessed flow or engagement in stud farm staff or breeders, fulfillment of related psychological needs of competence and autonomy at work appears to be low. This may impact staff retention in the breeding sector as engagement at work has previously been found to predict employee intentions to leave in other industries **[73,80]**. Future studies should assess flow states in stud farm workers and their influence on staff well-being and retention.

3.3. Relationships

Relationships between stud farm employees, and between employers and employees appear to have a significant influence on well-being in the horse breeding industry. Within horseracing broadly, Butler *et al.* **[81]** found poor communication, criticism, and a lack of recognition from employers to employees were prevalent. Furthermore, this was found to negatively impact attitudes, behavior, and staff retention which highlights the importance of communication in building positive relationships between horseracing management and employees. In contrast, positive relationships in the workplace were found to mediate the association between organizational support and intentions to leave jobs **[82]**. Studies on the influence of relationships on employee engagement, satisfaction, and learning in the workplace have highlighted the importance of psychological safety **[83]**. In particular, positive leader relations are influential in shaping the work environment and fostering psychological safety **[83]**. In McConn-Palfreyman *et al.* **[9]**, stud managers identified a need for training to enhance their interpersonal skills such as listening to and motivating staff, in order to improve relationships and create a supportive environment. Relationships contribute to well-being through the sharing of positive events, showing interest, emotional engagement, and offering support **[84]**. Stud staff in this study reported a lack of support from employers surrounding injury rehabilitation and time off work for injury **[9]**. Employers can support injured employees through adaptations to job tasks and hours with consideration for injury type and physical limitations **[24]**. A lack of employer support has implications for staff retention, as managers can influence turnover intentions by improving the support provided to employees **[82]**. Davies *et al.* **[24]** also found that over 41% of staff reported their employer as unhelpful during periods of injury. In addition to turnover intentions, a lack of employer support following injury may impact an employee's return to work and mental health **[23,85]**. Davies *et al.* **[23]** found that injured stud and stable staff who perceived their employer and support networks as unhelpful reported higher levels of depression and anxiety. Relationships between supervisors and staff may also impact mental health through discrimination. Negi *et al.* **[39]** found that discrimination at work due to ethnicity was significantly associated with depression in Latino horse farm workers, although Clouser *et al.* **[35]** found that just 11% of Latino horse farmers reported being treated unfairly by their supervisors. However, supervisors' inability to speak their language significantly increased staff risk for occupational injury which highlights the importance of communication between leaders and staff on stud farms. Similarly, Swanberg *et al.* **[41]** found that reported abuse between supervisors and subordinates was low, yet there was a significant relationship between abusive supervision and health outcomes including injury, illness, and missed work, demonstrating the importance of leader relations and support to staff well-being. The physical well-being of staff is also influenced by relationships with leaders. For example, in Australia, managers and supervisors reported a responsibility to staff well-being through promoting the use of PPE **[46]**. Supervisors in this study expressed the need to

lead by example in order to create a workplace culture where everyone adopts PPE. However, in the U.S., many Latino horse workers disagreed that safety practices were prioritized with over half stating that supervisors were just interested in having the work completed quickly and cheaply [40].

In addition to leader relations and influence, peer support between employees is also key to fostering psychological safety in the work environment [83]. The prevalence of workplace bullying in training yards is found to be high and has been identified as a stressor for stable staff [9,22,86]. Rates of workplace bullying is particularly high for female stable staff. Workplace bullying is consistently associated with increased depression, anxiety, and stress [87]. Workplace bullying has not previously been assessed on stud farms. However, stud farm staff report that relations with colleagues are a significant stressor [9]. Furthermore, the long working hours required in the breeding sector impact relationships by causing an imbalance between work and personal life. McConn-Palfreyman *et al.* [9] found that many staff reported feeling isolated from others outside of the stud, and living away from family among their main stressors. In addition to impacting mental health and well-being, relationships on stud farms also impact mental health help-seeking as staff reported a need to appear strong to colleagues as the most significant barrier to engagement with mental health services [9]. However, this study did not use validated measures and as a consequence, further research on mental health and help-seeking in stud farm staff is recommended. The included studies demonstrate the importance of relationships to staff well-being, in particular relations between employees and employers. The findings suggest that a lack of support from employers and peers negatively impacts psychological safety and mental health on stud farms. Workplace bullying incidence is found to be high in stable yards, in particular for female employees [22,86]. However, there is a lack of research assessing the influence of employee relations on well-being. Based on these findings, research on gender differences in workplace relationships and communication within the breeding sector is recommended.

3.4. Meaning

Horseracing jobs are unique in that for many employees working with horses is viewed as a way of life [9]. Breeding staff are motivated to work in the industry by their interest in and love for horses. While pursuing a career centered around leisure interests may provide meaning, it may also demand acceptance of challenging working conditions [88]. This is similar in farming as the occupation is viewed as more than a source of employment but rather a lifestyle, which influences farmers' identity and reduces their likelihood to seek help [89]. Ní Laoire [90] suggests that farmers accept challenging conditions and prioritize farm work over self-care, in the pursuit of a masculine identity. Individuals develop identity through searching for meaning in life, generally in adolescence. Identity continues to develop throughout the lifespan and is subject to change due to development, and interactions with the environment [91]. In the thoroughbred breeding industry, 60% of stud farm staff report living on-site [9]. While this has benefits for employees such as financial security, it may have a significant influence on their identity [92]. McConn-Palfreyman *et al.* [9] suggested that some stud farm staff are at risk of overconforming to their work role to the point that it informs their identity. For example, in sports, athletes are expected to conform to a set of norms such as striving for perfection, choosing sport over personal life, taking risks such as playing through injury and having no limits in the pursuit of excellence [93]. Overconforming athletes may attempt to prove their commitment by exceeding reasonable limits. When an athlete pursues an athletic identity and neglects other life roles it may negatively affect their well-being [94]. Similarly, stud farm staff who overconform to their work identity and neglect other life roles may experience negative impacts on their well-being.

Overworking and difficulties with maintaining a work-life balance have been reported by stud and breeding sector employees [9]. Similarly, farm workers have reported low satisfaction with work-life balance [95]. Racing staff work long hours often including weekends [22]. Swanberg *et al.* [43] found that thoroughbred breeding farms defined full-time work as 48 hours per week, over six days [43]. However, during the breeding season many staff on stud farms reported working in excess of 12 hours a day [9]. Furthermore, staff who live in tied accommodation reported a requirement to be available 24 hours a day should problems arise with the horses overnight [9]. It is suggested that tied accommodation may contribute to the all-encompassing nature of horseracing work and negatively impact staff well-being through poor sleep, nutrition, and social life practices [9]. While meaning in work may positively influence staff well-being, a lack of boundary between work and life due to horse care requirements and the proximity of workers to the farm may negatively impact well-being in the breeding industry. Meaningful work influences work engagement, commitment, and job satisfaction which in turn influences work performance and intentions to leave jobs [55,96]. While industry reports indicate that a poor work-life balance offered by the breeding industry, exacerbated by tied accommodation may negatively influence stud workers' well-being, there is a lack of validated measures to confirm this [9,10]. Further research on the influence of tied accommodation on breeding staff identity and well-being is recommended [9].

3.5. Accomplishment

Accomplishment at work may be hampered by a lack of opportunity for career progression has been reported by stud farm staff [9]. According to Hendry and Kloep's theory of lifespan development [97], life is a series of challenging and routine tasks. If an individual continues to accomplish only routine tasks, this leads to stagnation. Where an individual fails to meet the challenge or to take the risk, this will result in decay. However, when the individual meets the challenge, development occurs having a positive impact on well-being. In the breeding sector, a lack of opportunity for career progression has been reported by stud farm staff [9]. In line with Hendry and Kloep's theory [97], a lack of opportunity to engage in challenging tasks and experience accomplishment may cause stagnation. Described as a 'glass ceiling', the lack of progression offered by the sector is reportedly having a negative impact on employee well-being as well as staff retention [9]. When asked to rank stressors, 29% of stud staff reported that searching for career progression was the

number one source of job stress. Furthermore, a reported skills-gap has been recognised in the wider horseracing industry meaning stud staff may lack competence [9]. Competence is a close relative of accomplishment and is regarded as one of the three basic psychological needs one must fulfill [98]. It is suggested that employees must feel competent in order to be motivated to accomplish at work. Meeting all of these needs can lead to positive outcomes to an individual's well-being such as increased life satisfaction and positive affect, while not meeting one or more needs leads to negative outcomes such as increased negative emotions [98,99]. According to McConn-Palfreyman [9], there is a lack of availability for staff training, and in particular for management. This negatively impacts well-being through increased stress for individuals wishing to progress and pursue managerial opportunities. Similarly, Swanberg *et al.* [40] reported a lack of employee training with 22% of horse workers having received no training whatsoever. This is particularly concerning as Juckes *et al.* [8] identified a lack of employee and management skills as a contributing factor to staff retention issues. Research on the impacts of employee training and career progression on breeding staff well-being is lacking. Future research should consider interventions around increasing training and progression opportunities for individuals in the breeding sector.

3.6. Physical Health

Working in the breeding sector appears to negatively influence physical health through an increased risk of injury and illness [37,40,42,44]. The risk of injury for staff on thoroughbred breeding farms and training yards has been reported to be considerable. Davies *et al.* [23] found that stud and stable staff reported an average of four injuries per year. Swanberg *et al.* [44] found that nearly half of thoroughbred horse farm workers experienced an injury in the last 12 months. Swanberg *et al.* [40] revealed that a quarter of horse farm workers experienced a work-related injury in the previous year. Stud farm jobs that involve high contact with horses carry an increased risk of injury [34,37]. Horses, in particular those bred for racing, are known to be strong and temperamental [42]. Indeed, horses are responsible for over half of the injuries sustained, mainly through kicks, strikes, or being trampled or stepped on [42]. Leading, grooming, and breeding horses were cited among the most dangerous tasks alongside breaking yearlings [34]. The most prevalent injuries to stud and stable staff include bruising, lower back pain, muscle strain, and neck pain [23]. Swanberg *et al.* [45] found high prevalence rates of musculoskeletal discomfort in Latino horse farm workers in the U.S. which was associated with longer tenure on horse farms and longer work hours.

While horses are responsible for a large proportion of injuries sustained, there are other occupational injury risks present on stud farms and training yards. Stud farm work may require heavy lifting of horse feed, hay, or muck which has the potential for injuries [34]. Furthermore, farm equipment such as tractors and hay balers have the potential to cause injury. Individuals engaged in non-horse related tasks are at greatest risk of injuries to the back, knee, and neck as well as musculoskeletal sprains, strains, and tears [42]. Injuries have negative consequences on staff well-being such as physical limitations, loss of confidence, workplace changes, and lifestyle implications [24]. They may also impact mental health as Davies *et al.* [23] found that a majority of injured staff were experiencing mild to severe anxiety, while over half scored over the threshold for depression [23].

In addition to injury, the physical health of stud farm staff may be impacted through work-related illness. Working in horse breeding carries the risk of zoonotic disease through activities such as live breeding and foaling [46]. Weese *et al.* [49] found high rates of MRSA in staff at a thoroughbred stud farm which was likely transmitted during contact with infected horses. Furthermore, thoroughbred horses move frequently between farms for breeding which increases the risk of zoonotic diseases spreading [49]. The bedding type used in barns significantly influences work-related illness in horse workers [33]. Horse farm workers have reported high prevalence rates of respiratory symptoms [36,43]. Physical health is also impacted by staff management of illness and injuries, which may be influenced by staff shortages [24]. A lack of available cover may influence the time staff take to recover from illness and injury. Indeed, the likelihood of stud and stable staff reporting injuries, seeking treatment, or resting for recovery is low [24,42]. This could be attributed to a culture of presenteeism, which obliges staff to show up when ill or injured [9,24]. Sickness presenteeism negatively impacts staff well-being through an increased risk of future absence due to illness and poorer overall health [100]. Furthermore, presenteeism has been found to positively relate to turnover intention [101]. While current research has focused on the negative impacts of horse breeding on physical health, future research may benefit from a positive psychology approach to assessing the influence of this work on physical health with the aim of enhancing staff well-being and retention. For example, working with and owning horses may offer natural opportunities to benefit physical health and well-being such as through reaching recommended physical activity levels, and spending time in nature [102,103]. Indeed, research in farming has identified therapeutic aspects of the work [104]. In particular, being outside in nature and engaging in physical labor offers opportunities for physical and mental well-being that managerial and administrative duties do not.

3.7. Mindset

While mindset was not assessed in any of the included studies, working conditions in the breeding industry may have a negative impact on mindsets. A growth mindset is characterized by future orientation, optimism, and viewing challenges and setbacks as opportunities for growth [105]. Such opportunities may be limited in the breeding sector as a lack of career progression has previously been reported [9]. Specifically, there is a belief in a 'glass ceiling' whereby regardless of effort at work, there is little opportunity for progression. This is an example of learned helplessness, where repeated exposure to uncontrollable events results in the belief that an individual is unable to change their situation and gives up trying [106]. The concept is similar to a fixed mindset as giving up is a common factor [105]. Combined with the lack of progression offered, participants suggested that the hard work required by the breeding sector negatively impacts staff retention [9]. In a fixed mindset, individuals view effort as fruitless and tend to give up easily [105]. Injuries may also elicit a fixed mindset as Davies *et al.* [24] found participants report decreased work

ethic and feelings of redundancy following injury. Fixed mindsets negatively affect well-being through increased negative affect [107]. Furthermore, individuals with a growth mindset show increased well-being and resilience [108,109]. However, there is no current research on the mindset or resilience of breeding staff. Future research on mindset and its influence on resilience and turnover intention in the breeding sector is recommended.

3.8. Work Environment

Breeding sector staff are exposed to various environmental stressors which may impact their well-being through physical health. Air quality in barns may affect stud workers' well-being through respiratory health [34,36,43]. Bush *et al.* [33] found that the bedding type used in barns significantly influenced work-related illness in Hispanic horse workers. Specifically, staff who used straw bedding in barns were over three times more likely to miss work due to work-related illness than those who used sawdust bedding. Furthermore, a majority reported that their symptoms improved when they were away from the barn for more than one day suggesting that dust from straw may cause respiratory symptoms.

Safety climate may also influence well-being in the breeding sector. Safety climate encompasses the provision of safety training and equipment, and information regarding safety hazards [110]. PPE may protect against environmental risk factors on stud farms. On finding a high prevalence of respiratory symptoms in thoroughbred horse farm workers, Swanberg *et al.* [43] recommended the use of dust masks in barns. Flunker *et al.* [36] also found high rates of respiratory symptoms in horse breeding farm workers, with a majority reporting infrequent use of dust masks. PPE may also protect against the risk of zoonotic infections but risk awareness and PPE use in the breeding sector appear to be low [46]. Despite the known injury risks of grooming and leading horses, PPE is rarely used during unmounted horse-related tasks [34]. On many farms, horse-related PPE such as helmets and padded vests are considered necessary only while riding or live-breeding. The provision of PPE may also be low and may be limited by managers' perceptions of their effectiveness [34]. In addition to protective equipment, safety training may be low. Swanberg *et al.* [40] found that a majority of horse farm workers reported being exposed to toxic chemicals, while a minority received training around their use. In Clouser *et al.* [34], most participants were aware that administering medicines to horses required gloves but did not know the reason. The included studies reveal conflicting evidence for the safety climate on stud farms. While Davies *et al.* [25] found that staff health and safety were prioritized during the COVID-19 lockdown, Swanberg *et al.* [45] found that a poor safety climate was associated with elevated musculoskeletal discomfort in U.S. horse farm workers. Further research into the safety climate on stud farms is necessary to establish recommendations on the provision of training and safety equipment.

3.9. Economic Security

Dissatisfaction with wages is not found to be a major contributor to staff retention in the horseracing industry, but this may vary across locations [8]. Davies *et al.* [24,25] found that a majority of stud and stable staff felt secure in their current role. Although staff were statistically more likely to report feeling insecure in their job if they had experienced concussion, or a fracture to the leg, foot, rib, or spine in the last 12 months [24]. This may have implications for injury reporting and taking time off due to injury [24]. Workers have cited finances as the most common reason for coming to work while ill [33]. Although a majority of workers in this study reported receiving compensation for injury or illness acquired at work, just over half receive pay for days missed due to illness. Job insecurity is found to positively correlate with depressive symptoms [39].

In addition to concerns around job security, individuals working in the breeding sector may face financial hardship. Swanberg *et al.* [111] reported that U.S. horse farm workers received an average hourly wage of $10.24. This is low when compared to the national average hourly wage in December 2019 of $28.32 [112]. In the U.K., the majority of the stud and breeding workforce earned between £20,000 and £29,000 per year [9]. This figure is also found to be lower than the U.K. national averages for the same year [113]. Finances may also impact biosecurity practices on stud farms [34,48]. For example, disparities in the provision of PPE are seen between different farm sizes [34]. However, only a small number of farms cited finances as a factor in PPE provision. Similarly, Taylor *et al.* [46] found that while economic factors contributed to the adoption of biosecurity and personal biosecurity measures at work, the cost of PPE was not a major factor. In Walshe *et al.* [48], breeders highlighted cost as one of the main barriers to fecal sampling as a method of sustainable parasite control. Hardwick *et al.* [38] also highlighted the influence of economic security on thoroughbred breeders' well-being. Specifically, this study identified perceptions of endoscopic examinations performed at Australian yearling sales to grade laryngeal function. Despite concerns around Veterinarian subjectivity in grading, and a lack of clarity around whether lower grade laryngeal function predicts future performance, yearlings identified with grade three function sell at reduced prices. Participants identified this as having a significant impact on the livelihood of breeders [38]. Overall, dissatisfaction with wages is not found to be a major contributor to staff retention in the horseracing industry [8]. However, findings suggest that some workers experience job and economic insecurity following absence due to injury or illness [24,33]. This is concerning for staff well-being and further research into job security and satisfaction in the breeding sector is recommended.

4. Recommendations

This exploration is limited by a lack of research in the thoroughbred horse breeding industry. Furthermore, while care has been taken to ensure methodological rigor and transparency, systematic reviews are susceptible to potential biases, such as selection bias and random error [114]. Further empirical research on the dimensions of positive and negative emotions, engagement, and meaning at work is recommended. Research on the application of positive organizational psychology in this sector may increase understanding of and enhance breeding staff well-being and retention. Specifically, the application of the PERMA framework may inform the development of interventions aimed at increasing aspects of well-being in the thoroughbred breeding industry. For example, education programs on positive communication and mindsets may

enhance positive emotions and work and thereby improve breeding staff well-being and retention [55].

5. Conclusion

This systematic narrative review has demonstrated the potential of the PERMA+4 model to increase understanding of the influence of working conditions on breeding staff well-being. This is necessitated by a staffing crisis in the wider horseracing industry, and an established association between work-related well-being and staff retention [55]. Specifically, findings suggest that physical and psychosocial working conditions inherent in the breeding industry may negatively impact well-being through work-life balance, occupational injuries and illnesses, employee relations, and a lack of opportunity for training and progression. Breeding staff are at risk of poor mental and physical health through the PERMA+4 dimensions of relationships, accomplishment, physical health, and work environment. These factors, in particular a poor work-life balance and lack of progression opportunities, may also impact staff leaving intentions. However, validation through empirical research is necessary.

Authors' Contributions

Conceptualization; C.M., methodology; C.M., formal analysis; C.M., validation; S.N.H., writing - original draft; C.M., writing - review and editing; C.M., S.C., S.O.C., G.W., C.N., J.P., A.M., and C.L., All authors have read and agreed to the published version of the manuscript.

Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

Ethical Approval

Not applicable for this study as it involved only previously published data.

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