Practitioner Safety and the Application of Learning Theory related to injury risk in Equine Physiotherapy: a Worldwide Survey

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--Manuscript Draft--

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Abstract:	In the equine physiotherapy profession, similarly to the equine veterinary profession, there may be a high risk of occupational injury and preventive strategies, such as the application of learning theory (LT), may mitigate workplace injury frequency. The purpose of this study was to identify the frequency of occupational injury among equine physiotherapists and investigate the relationship between injury rate and knowledge of LT. An online survey was distributed, receiving 64 valid responses: of these, 51 were qualified veterinary physiotherapists working with equines and their data were taken forward for analysis. The mean injury frequency was 0.59±1 per year, with 36 respondents reporting at least one injury during their career. The most common site of injury for practitioners was the lower limb (n=22) and the most common type of injury was bruising (n=32). Knowledge of LT was poor. There was a moderate positive correlation (r=0.37, 95%CI[0.10,0.58], p<0.01) between veterinary physiotherapists' theoretical knowledge scores and their self-evaluation of LT terminology scores. There was no significant correlation between scenario-based and theoretical LT scores and injury frequency. However, there was a weak negative correlation (r=-0.31, 95%CI[-0.54,- 0.04], p<0.05) between self-evaluation of LT terminology scores and injury frequency. Due to the small number of responses, results from the present study are not representative of the target population. However, results nonetheless highlight a trend of high injury rates and low levels of understanding of equine learning. This indicates the urgent need of research into better prevention and safety-enhancing strategies.
Suggested Reviewers:	Natalie Waran Eastern Institute of Technology nwaran@eit.ac.nz
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Opposed Reviewers:	
Additional Information:	
Question	**Response**

Detailed Response to Reviewers

Practitioner Safety and knowledge of Learning Theory related to injury risk in Equine Physiotherapy: a Worldwide Survey		
Comment	**Addressed**	**Place in the text (lines)**
Overall		
This is an interesting paper that investigates self-reported injuries in equine physiotherapy practitioners. The injury information is the strength of the paper. In my opinion, it is weakened in some ways by attempting to focus on whether a knowledge of learning theory affects frequency injury, which is difficult to test using the study design.	See below	
The frequency of occurrence of injuries in the equine physiotherapy profession is an interesting question, and investigating risk factors for these injuries would be interesting. However this paper reports a small, potentially biased sample and attempts to link one single factor with frequency of injuries within this small sample population when reasons for injuries are likely to be multifactorial, which is not discussed E.g. type of horse/case/client/clinic vs home vs competition/knowledge and experience of handler.	See below	
Why is learning theory the only aspect of horse handling/behaviour that is considered relevant? This needs further justification and rationale in the introduction.	Rationale for this has been added to the introduction	92-105
The hypothesis is not tested by the study as this a questionnaire-based self-reporting retrospective study, not an interventional study that assesses the effect of learning theory on development of injuries, and should be removed or modified.	Hypothesis has been removed	
It is difficult to assess the validity of the manuscript in the absence of the questionnaire. Please could the questionnaire and questions be provided. How are the authors assessing the knowledge of the practitioners at the time of injuries being sustained vs knowledge of learning theory now?	Questionnaire provided as a separate document. Current level of learning theory was measured. This method was chosen due to the difficulty in recalling past levels of knowledge at the time of each injury. 62% of injuries occurred within the past 5 years. Also, based on the literature, teaching of learning theory within professional training is lacking. Practitioners completing the survey would therefore have had to attend specific CPD on learning theory to enhance their knowledge during practice. Questions were aimed at understanding participants' current level of knowledge and how this could be improved with interventions such as those proposed by ISES, from where the explanatory diagram in the survey was taken. The authors understand the limitations to this approach and agree that a different study, not in survey form, may better collect data on knowledge levels at the time of injury vs. now.	
Limiting the manuscript to a report of injuries sustained and a discussion of potential risk factors that could be investigated might present a more useful paper for the reader.	Further rationale has been added to the introduction/literature review to better explain the choice of exploring learning theory as a potential safety aid for equine physiotherapists. The idea was first explored in relation to an MSc level course on Equitation Science with strong ties to work of the International Society for Equitation Science (ISES).	137-152
Intro		
The title does not clearly reflect the content of the manuscript, so I would recommend rewording to reflect that this is largely a questionnaire based report of injuries in the physiotherapy profession.	The title has been changed to: Practitioner Safety and knowledge of Learning Theory related to injury risk in Equine Physiotherapy: a Worldwide Survey	
Reasons for injuries are likely to be multifactorial, which is not raised in the introduction. The introduction should include a short review of literature that has investigated factors influencing injury in equestrian workplaces, veterinary and other horse-related professions to put into context why learning theory was then selected, and then a justification provided for selecting only learning theory as a preventative strategy vs experience and practical handling knowledge, situation, type of horse, horse features, handler knowledge etc.	A more in-depth literature review and justification for the selection of learning theory as a preventative strategy has been provided in the introduction.	129-152 159-171 197-207
Without this background, it seems that taking learning theory as the only factor considered is random, when looking at risk factors for injury might be a more reasonable approach.	---	
The hypothesis cannot be tested by the study described. This should be reworded.	Removed	

Method		
Why did the authors use facebook groups to recruit for the study and not professional organisations? The facebook groups and organisations included should be stated in the paper in order to understand the type and breadth of the sample recruited. How were respondents encouraged to take part if they had both sustained and not sustained injuries during their career, to avoid an over-representation of practitioners who had sustained injuries and therefore might have more buy-in to taking time to complete the questionnaire? Was there any validation of the information provided – eg repeatability of information between injuries reported any other way to this self reporting questionnaire?	After speaking with various professional registers, it was decided to publish the online survey through their Facebook groups rather than have the bodies themselves email all their members. Some bodies refused to email members, others claimed most members were also members of the registers' official Facebook groups and that it would be easier for participants to ask questions directly to the authors in this way. A few registers refused to contact their members in any way, but suggested posting to the "Animal/Veterinary Physiotherapists & Other Professions" Facebook groups which they claimed contained many of their registered members. A table containing information on the Facebook groups selected and the number of members in each has been provided in the Tables document. Participants with and without a history of injury were encouraged to take part by focussing on analysis of the role of experience and knowledge in injury prevention, as well as asking questions about learning theory. The questionnaire was set out so that the first question on injuries (yes/no) determined what set of questions participants would see in the following section (injury section or jump to knowledge section). In this way participants who started the survey were not put off by questions not relevant to them. Repeatability was not possible for this research as it would have required access to medical records/other forms of validation outside the scope and capability of this paper.	249-250
The sample population used does not meet the inclusion criteria as it appears that practitioners that did not meet the inclusion criteria were then added to the final analysis. Any respondents that did not meet the inclusion criteria should be eliminated from the study at this stage.	The authors believe this subgroup to have been erroneously left out of the initial inclusion criteria, due to general lack of information about the number of active equine physiotherapists, the number of animals each therapist actually sees per month (most work with multiple species, not just equines) and a general lack of a unified registering body where such information could be available. This lack of information led to initial assumptions being made regarding inclusion criteria, which were later proven to be incorrect, therefore this subgroup was re-integrated in the study.	
The questionnaire is not provided, and needs to be available to the reviewers and readers (potentially as a supplementary file) to understand the validity of the information.	The questionnaire has now been provided as a separate document.	
How do the questions provided directly relate to ability to handle and react practically vs having a theoretical knowledge of learning theory? Were there also questions about training or qualifications as instructor/rider/trainer/handler, location, horse features and other information about the situation in which the injuries happened?	The questionnaire has now been provided as a separate document.	
How was the questionnaire tested as a direct representation of the respondents' knowledge of learning theory and their ability to apply this practically? What pilot work was done? What validation of questionnaire completion and practical application was done. This should be provided and described.	The questionnaire has now been provided as a separate document. Information about pilot testing has been provided in the Methods section.	225-227
How were years of experience defined? Full time vs part time vs breaks in work? Does this represent age or cumulative experience?	Years of experience were defined from the first year of work after graduation onwards. Full or part time work and breaks in work were not considered relevant in this case as many practitioners treat multiple species, not just equines and therefore there is variation in the actual hours spent on equines each month/year. Years of experience represent cumulative experience. The number of horses treated per month was used in data analysis as it represented a better measurement of contact time with equine patients compared to full vs. part time work.	
This is a retrospective, self-reporting, questionnaire based investigation. How was learning theory knowledge assessed at the time injuries were sustained vs the current time?	Current level of learning theory was measured. This method was chosen due to the difficulty in recalling past levels of knowledge at the time of each injury. 62% of injuries occurred within the past 5 years. Also, based on the literature, teaching of learning theory within professional training is lacking. Practitioners completing the survey would therefore have had to attend specific CPD on learning theory to enhance their knowledge during practice. Questions were aimed at understanding participants' current level of knowledge and how this could be improved with interventions such as those proposed by ISES, from where the explanatory diagram in the survey was taken. The authors understand the limitations to this approach and agree that a different study, not in survey form, may better collect data on knowledge levels at the time of injury vs. now.	

The data analysis is not clear in the absence of the questionnaire. What was classified as level of knowledge and understanding of the principles of LT, work experience and general handling experience? This information should be defined in the methods. How were respondents tested for being likely to apply LT practices in their everyday practice? How was the role that work experience and general handling experience played in injury occurrence tested?	The questionnaire has now been provided as a separate document.	
Results		
The response rate of people opening the facebook link is stated but this is misleading because only a limited and potentially biased population would have had access to or chosen to open the link. How many worldwide physiotherapists are there? And what proportion of these completed the questionnaire? I.e. 51/worldwide population.	This was addressed in the Methods section in the following way: "The free online tool Raosoft [25] was used to calculate a desired sample size with a 5% error margin and 95% confidence interval. As the size of the worldwide population of qualified veterinary physiotherapists working with equines is unknown, estimates of between 500 and 10000 were made. The desired sample size was calculated at 218 to 370 individuals and the choice was made to target 2000 potential respondents through social media distribution"	
Discussion		
The first paragraph makes an assumption that is not justified by the data as far as I can see. It states that 'physiotherapists were generally poorly equipped to deal with behavioural issues, as there was a low level of knowledge and understanding of equine learning theory'. How is this direct link justified by the results? I would suggest removing this sentence.	The resulst section "knowledge and application of learning theory" reports results on participants level of theoretical knowledge and practical application of knowledge to the working environment. Participant scores were generally low, indicating that the level of learning theory knowledge was insufficient. This sentence has been adapted to reflect results, rather than assuming lack of knowledge of learning theory leads to difficulty in dealing with behavioural issues.	326-360
The discussion of injuries is interesting. It would be useful to also add in discussion of literature on injuries in the equestrian industry as well as the veterinary profession. On line 333, it implies that differences between veterinarians and physiotherapists are largely down to ability to chemically restrain (veterinarians) vs physiotherapists. It should also be noted that veterinarians may frequently be required to perform nerve blocks and treatments, painful interventions and diagnostic and imaging procedures which may potentially be of high risk, when a horse may not always be under chemical restraint, so the difference should not just be implied as a difference in ability to sedate a horse. I would suggest elaborating slightly more on this.	This section has been further elaborated on.	402-408
What evidence is there that the questionnaire used was a direct representation of the respondent's knowledge of learning theory and their ability to apply this practically? This should be discussed and justified.	The section on practical application of learning theory in this questionnaire was based on the work by Pearson et al (2020) which followed a similar methodology. This has been acknowledged both in the methods section, table 1, and in the discussion section: "For the present study, it was decided to focus on situational based questions rather than textbook definitions, following a similar methodology to Pearson et al. [8]." The authors acknowledge that such questions may provide some insight into how people may be applying learning theory in practice, but experimental studies, rather than a survey, are needed to confirm findings. Regarding the abilitu to apply LT practically, the study was based on previous reviews by McLean and McGreevy (see reference list).	419-427
The authors should not imply that there is a relationship between learning theory and injury when there was not one shown. Just because of implication in the literature does not mean that this study shows a relationship.	A significant, although weak correlation was found between participants' self-reported knowledge of Learning Theory and their reported frequency of injury. The self-reported knowledge level correlated with the theoretical LT scores for participants. For these reasons, the authors suggest there may be a correlation between knowledge of learning theory and injury frequency, although the present study presents significant limitations which have now been better addressed in the paper.	519-529
What other factors could have influenced injury? None are discussed. A discussion of potential risk factors for injury would considerably strengthen the discussion, and put into context the potential for prevention of injury. This study does not test the effect of any factors (including learning theory) on development of injury, but discussion that includes raising awareness of potential factors that could influence injury might be useful for physiotherapists or for handlers of horses for physiotherapists.	This has now been addressed and expanded upon "Finally, although a trend was found in injury frequency patterns, the severity of injuries appeared much more casual, suggesting that prevention strategies may be the most important type of safety intervention in the profession, with focus on a strong understanding of equine behaviour and the ability to anticipate flight responses and other unwanted or dangerous reactive behaviours (Hawson et al., 2010; McLean and Christensen, 2017; Parkin et al., 2018)."	484-488

The data on number and type of injuries in the sample population are interesting. However, this is limited by a potentially skewed sample population and very small numbers, which needs to be acknowledged in the limitations.	This was addressed in the section "study limitations" as follows: As only 64 valid responses were received, of which 51 from appropriately qualified veterinary physiotherapists working with equines, results from the present study cannot be considered representative of the target population. In addition, as the majority of respondents were based in the UK, the results may not be applicable to other countries which were represented by fewer responses.	515-519
Limitations should be acknowledged much more extensively including: Potential for skewed population as population was sourced from Facebook and facebook group members (need to define which groups used) Low numbers Lack of information Questionnaire based study limitations Self assessment	Information and rationale for the choice of Facebook groups has been given in the methods section and is not considered a limitation compared to emailing register members for the reasons given in this section. Limitations due to small sample size have been addressed in the "study limitations" section. Limitations due to survey data collection, including recall bias and sample bias, have been addressed in the "study limitations" section.	249-250 515-532
The presence of multiple factors that were not assessed which could have significantly affected injury Even if learning theory had an influence, the knowledge of practitioner learning theory at the time of the injuries has not been assessed. This has only been assessed at the current time, so this should be acknowledged in the limitations.	As above	
Conclusion		
Conclusions stated are not all justified by the study or results, but does represent an interesting part of the discussion. I suggest moving some of this section to the discussion and shortening the final conclusions.	This part has been moved to the discussion	502-512
The conclusions might be better limited to a summary of the information about injuries, and the importance of developing strategies to prevent injury, but that practitioner learning theory was not significantly associated with frequency of injury (which may reflect the multifactorial nature of the problem and limitations of the study using retrospective, questionnaire-based assessment).	This part has been revised	536-547
Highlights		
These should report findings in the paper. The first highlight is reasonable. The second and third are not supported by the results of the study and would be better replaced with information about the type of injuries reported, and that learning theory was not associated with injury frequency	Highlights have been revised.	
In-text comment		
The premise of the article is excellent, and the study can offer important insights into the dangers of the profession and strategies for improvement.However, I am unable to review the paper without understanding the details of how knowledge of learning theory was measured. The authors need to supply the survey, including details of how they assessed knowledge of learning theory.	The questionnaire has now been provided as a separate document.	
You could also mention farriery where practitioners also handle and manipulate horses limbs.	This has now been included.	88
This is one cause of horse behaviour, however there are other causes such as fear, separation and novel environments. These are relevant for physiotherapists because horses are often taken to a novel environment and separated from conspecifics for treatment. Acknowledging this will give your paper more rigor.	Added	125-126
Stimulus control might mean a horse is more manageable, but it does not necessarily associated with relaxation. Pain is often used to achieve control, but the horse will not be relaxed.	The term "relaxed" has been removed.	
Hawson et al (2010) discuss a hypothetical relationship between learning theory and safety. Luke et al (2023) Does a working knowledge of learning theory relate to improved horse welfare and rider safety? Anthrozoos - uses a very similar methodology to your study, and showed no relationship. You probably should discuss this paper given the strong similarities between it and your paper.	This paper has now been included. Thank you for suggesting it.	144-146 207-214 429

You could also mention that vets often rely on painful ear- and nose- twitching to shut down horse behaviour (Pearson et al 2020) - which is detrimental to welfare and can exacerbate behavioural problems in the future. A problem for practitioners who see horses repeatedly such as physiotherapists.	This section has been expanded on.	169-171 402-408
A more up to date demonstration of this finding is Luke et al (2023) - see earlier comment.	This paper has now been included.	
It would be more accurate to say "Hawson et al predicted...(their article was a review, they did not test this prediction, so it is not accurate to say they 'found')	Changed	
The survey needs to be provided to complete the peer-review. Also, the survey should be provided so the study can be replicated.	The questionnaire has now been provided as a separate document.	
Maybe provide detail of why you decided to remove them - given you add them back in later, maybe keep them, especially given the low numbers? Not prescribing what you should do, but think about if they are in or out.	As the subgroup was included before starting any data analysis, the sentence about debating whether to include them or not has been removed.	
This contradicts the previous sentence where you tell the reader the data were non-normal - probably better to do the normality tests and report them.	As data was primarily parametric, it was by default non-normal. This section has been adjusted.	
The role of education in changing behaviour is not mentioned in your introduction. It should be mentioned in your introduction.	The role of education has been added to the introduction.	96-99 179-193
This is really important data - excellent!	-	
Please provide details of how learning theory was assessed, as already mentioned.	The questionnaire has now been provided as a separate document.	
I will review the discussion once the other material is provided.	-	

Detailed Response to Reviewers II

Lines	Comment	Correction
49	Suggests there was a practical assessment of LT when there was not. Please rephrase.	Rephrased to "scenario-based" rather than "practical"
126	Delete "These"	Done
132-133	Explain the influence of culture on success/failure of interventions.	Added: "However, as Thompson et al. [1] emphasise, the success of such interventions is heavily influenced by the equestrian culture to which it is applied, with risk being higher in those cultures with low levels of horse ethology, as flight responses are poorly understood and consequently hard to prevent. "
145	for horses or humans or both? Please clarify.	Added: "for both equestrians and horses"
146	Do you mean LT?	Yes, corrected.
479-481	You could add that this is the second study that has failed to identify a significant relationship between knowledge of LT and improved safety. Luke et al was the first. Your study is the second.	Added: "Similar results were obtained in a 2023 study by Luke et al. [24], which also failed to identify a significant relationship between knowledge of LT and improved safety."
481-483	Your data do not support this statement. No significant relationship was found. As previously written (Line 53), you can say that you found injuries were high and knowledge of learning theory was low, however, your data shows these were not related, and suggesting there was a trend is misleading. Rephrase. Could it be that your data suggests that teaching practitioners LT is PART of the solution but not the whole solution to improving safety, hence you didn't find a relationship?	Corrected to: "A direct relationship between reduced injury rates and enhanced understanding of equine learning has been suggested many times in the literature [2,10,14], however, in the present study data show high injury rates and low levels of LT knowledge, but no significant correlation was found. This suggests that better knowledge of LT may play a role in improving practitioner safety, however, it may not be the sole contributing factor, making a significant relationship hard to establish. "
511-512	Repetitive - rephrase (see Line 500)	Fixed

09/07/2023

Dear Editor-in-Chief,

I am writing on behalf of myself, Kirsten Ruffoni, Bryony Lancaster and Dr. Gillian Tabor. We would like to submit our research paper for publication in the Journal of Equine Rehabilitation. This paper is based on research that was carried out in part fulfillment of the degree of Master of Science in Equine Science at the University of Edinburgh between 2021-2022 and focuses on safety and the application of learning theory for qualified veterinary physiotherapists working with equines.

Background information: All equestrian sports and activities that involve riding or handling horses are considered high-risk. From a work perspective, the equine veterinary profession is classified as one of the most dangerous occupations in the UK. Due to similar handling scenarios, the equine physiotherapy profession may also be a high-risk occupation, however, this area of the equine industry has not been researched yet.

Aims: The aim of this research was to identify the incidence of work-related injury and the level of understanding and application of the principles of learning theory among equine physiotherapists in order to investigate whether such knowledge could directly influence injury frequency and severity. To the authors' knowledge, no studies have been carried out to date which directly investigate the possibility of a strong correlation between injury rates and understanding of learning theory, so the present research aims to fill this gap and further enhance our understanding of science-based safety interventions in equestrian occupations.

Data collection: Data was collected through an anonymous online survey made available to
equine physiotherapists worldwide through dedicated Facebook groups between September-December 2021.

Proposed reviewers: Jane Williams, Gemma Pearson, Hayley Randle, Natalie Waran.

A separate Ethics Statement and Declaration of Competing Interest Statement have been uploaded with this submission.

Best wishes,

Kirsten Ruffoni

Declaration of interests

1. Declaration of interests

☒ 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.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

2. Contributions

☒ Each author declares substantial contributions through the following:
(1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data,
(2) drafting the article or revising it critically for important intellectual content,

Please indicate for each author the author contributions in the text field below. Signatures are not required.

Kirsten Ruffoni: primary author
Dr Gillian Tabor: study design, interpretation of data, critical revision of article
Bryony Lancaster: study design, data acquisition, critical revision of article

3. Approval of the submitted version of the manuscript

☒ Please check this box to confirm that all co-authors have read and approved the version of the manuscript that is submitted. Signatures are not required.

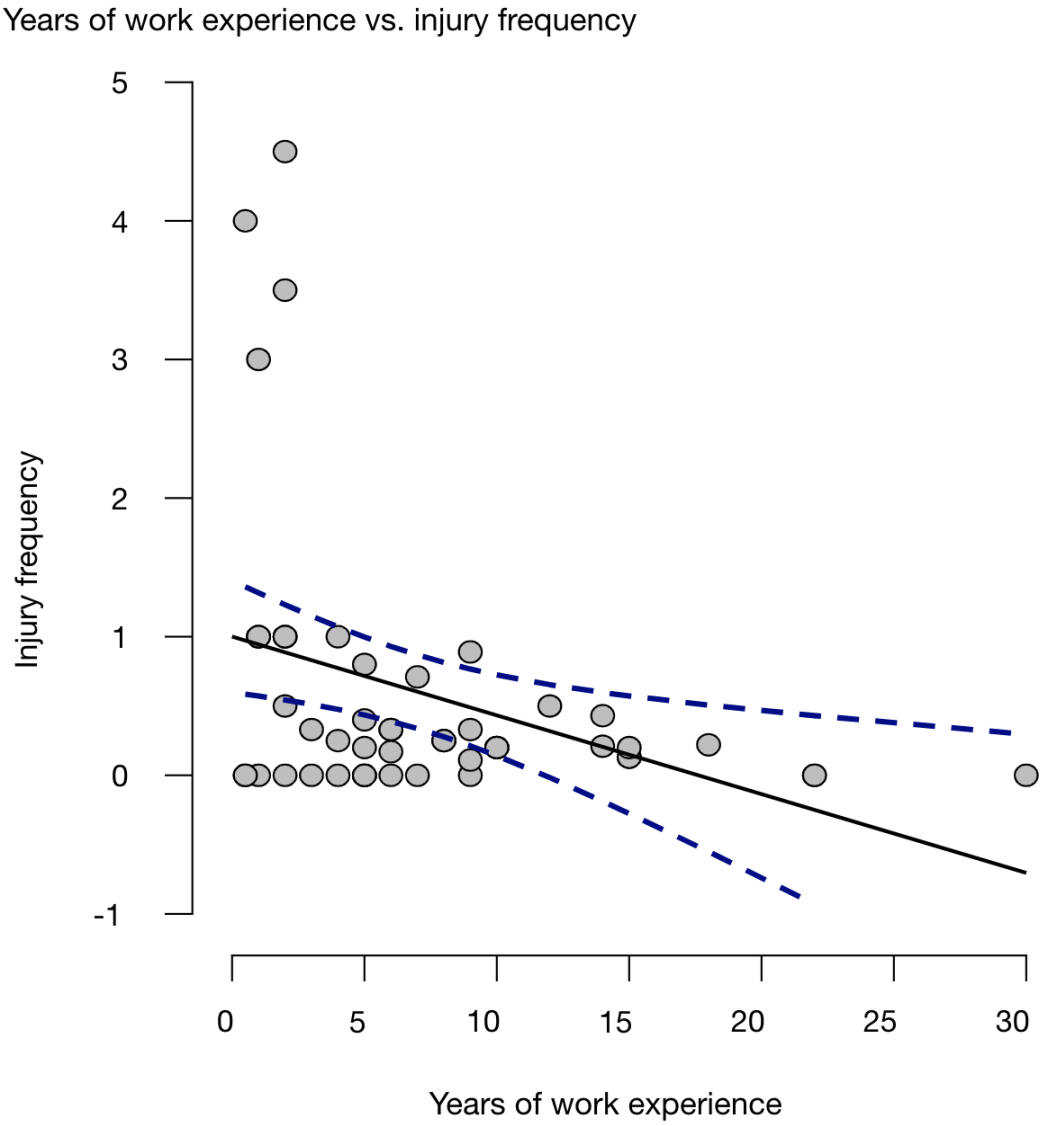

Figure 1

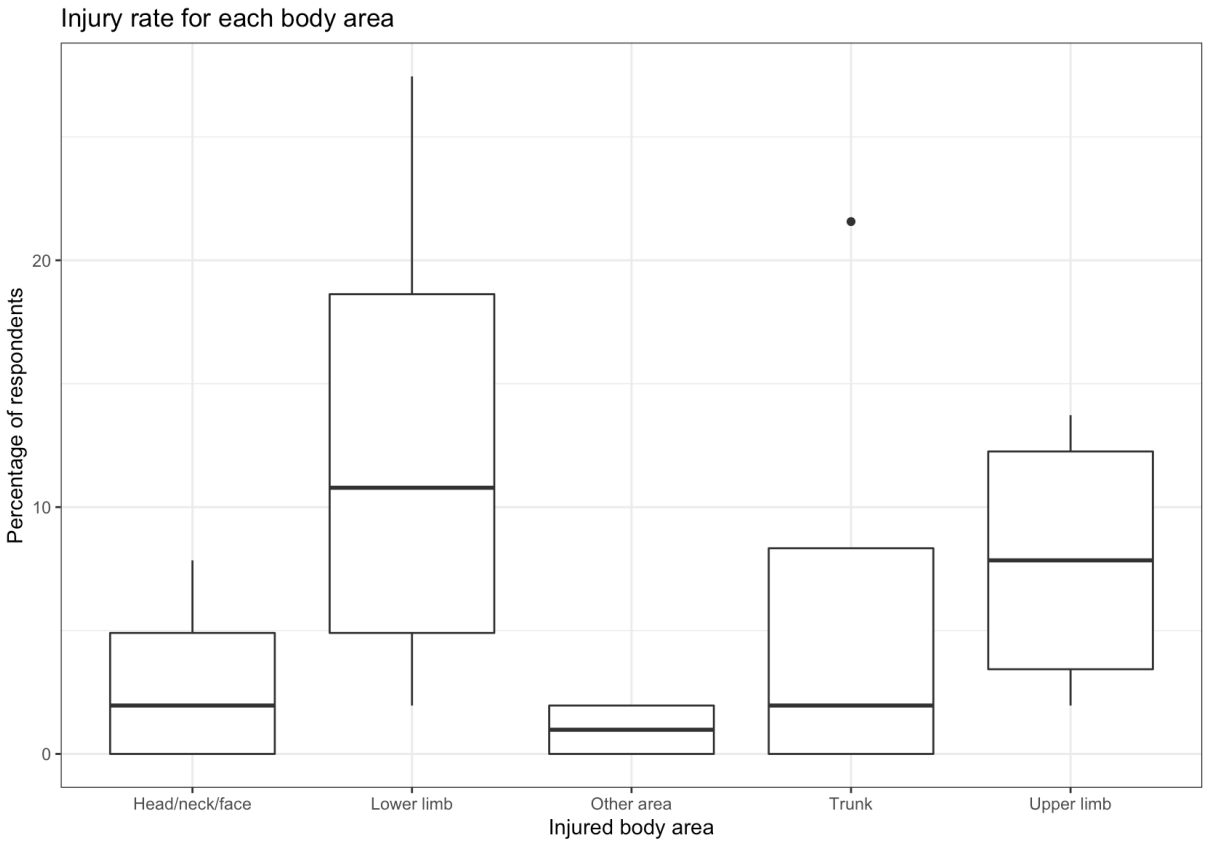
Injury rate for each body area
Percentage of respondents
20
10
0
Head/neck/face
Lower limb
Other area
Trunk
Upper limb
Injured body area

Figure 2

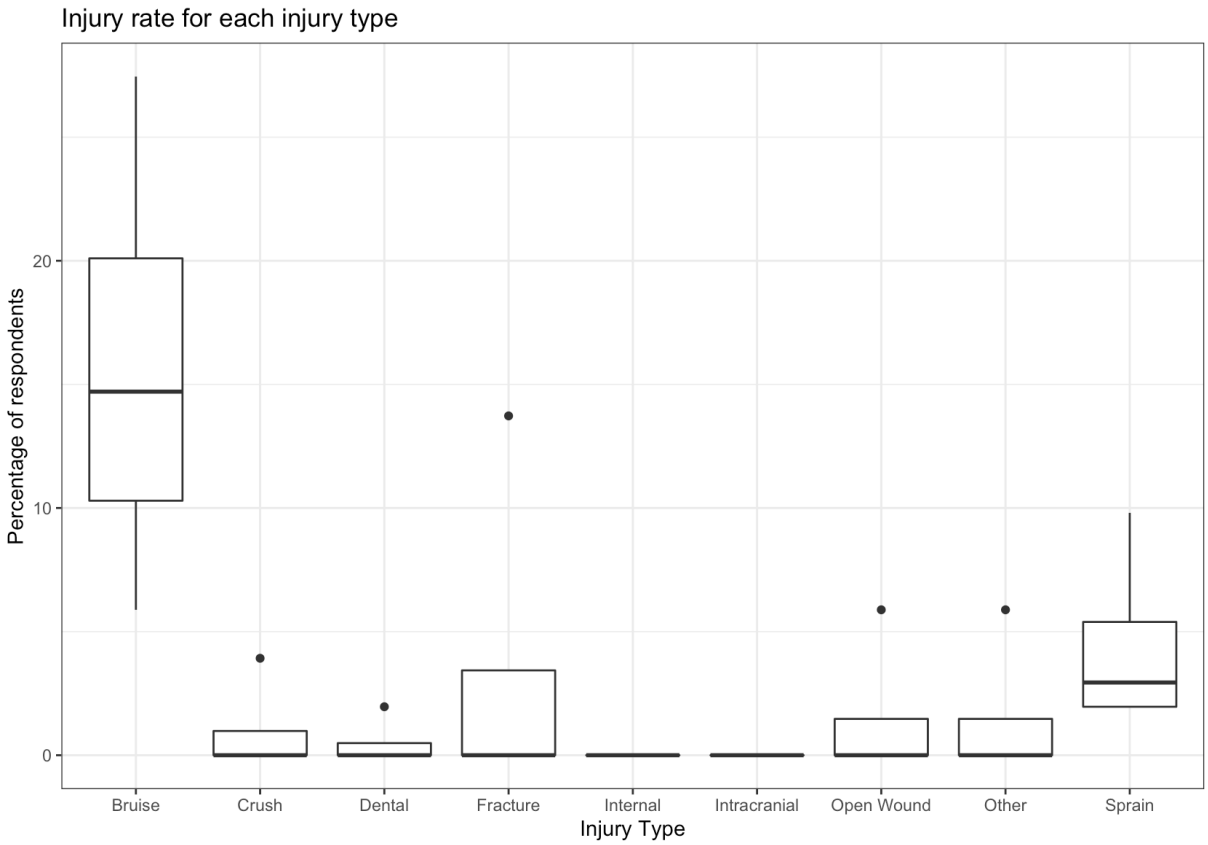
Injury rate for each injury type
Percentage of respondents
20
10
0
Bruise
Crush
Dental
Fracture
Internal
Intracranial
Open Wound
Other
Sprain
Injury Type

Figure 3

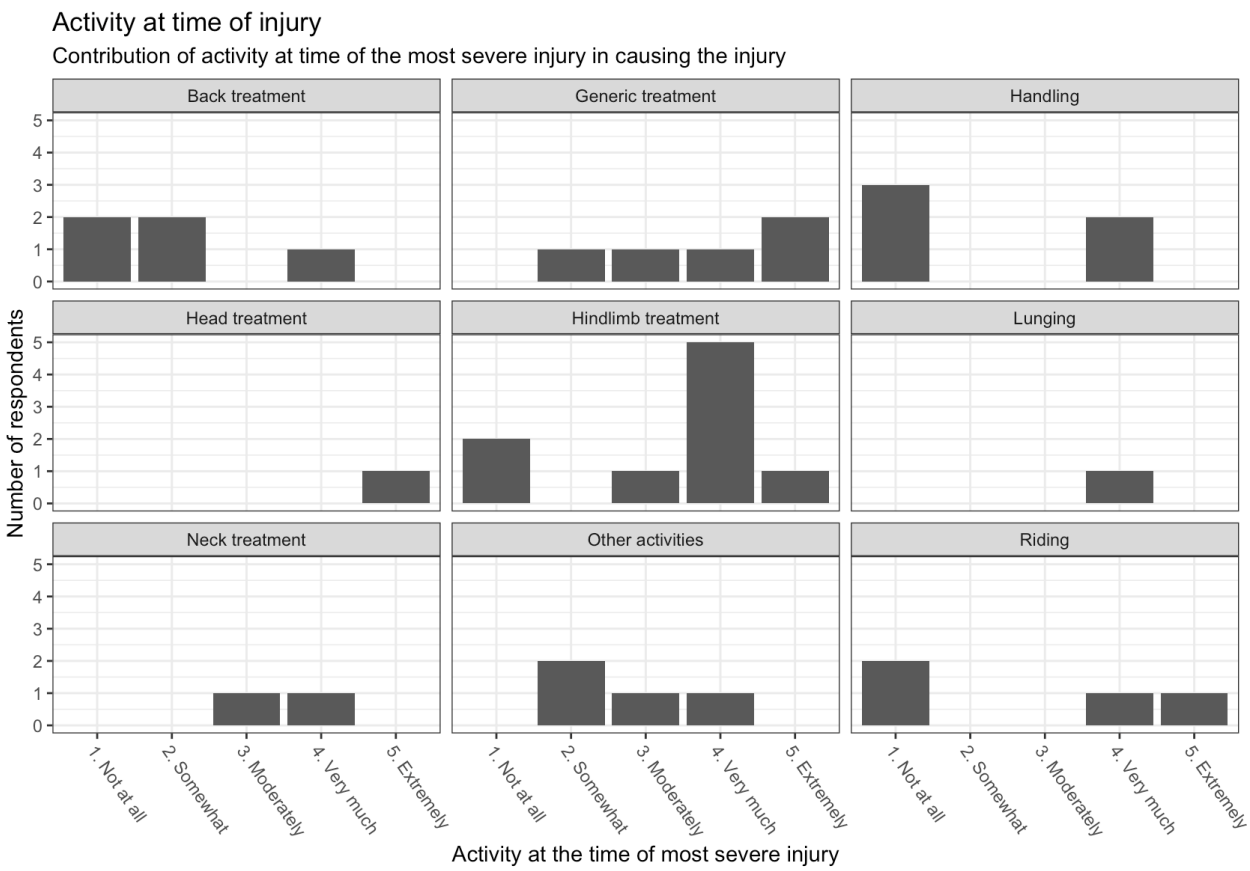
Activity at time of injury
Contribution of activity at time of the most severe injury in causing the injury
Back treatment
Generic treatment
Handling
Head treatment
Hindlimb treatment
Lunging
Neck treatment
Other activities
Riding
Number of respondents
0
1
2
3
4
5
1. Not at all
2. Somewhat
3. Moderately
4. Very much
5. Extremely
Activity at the time of most severe injury

Figure 4

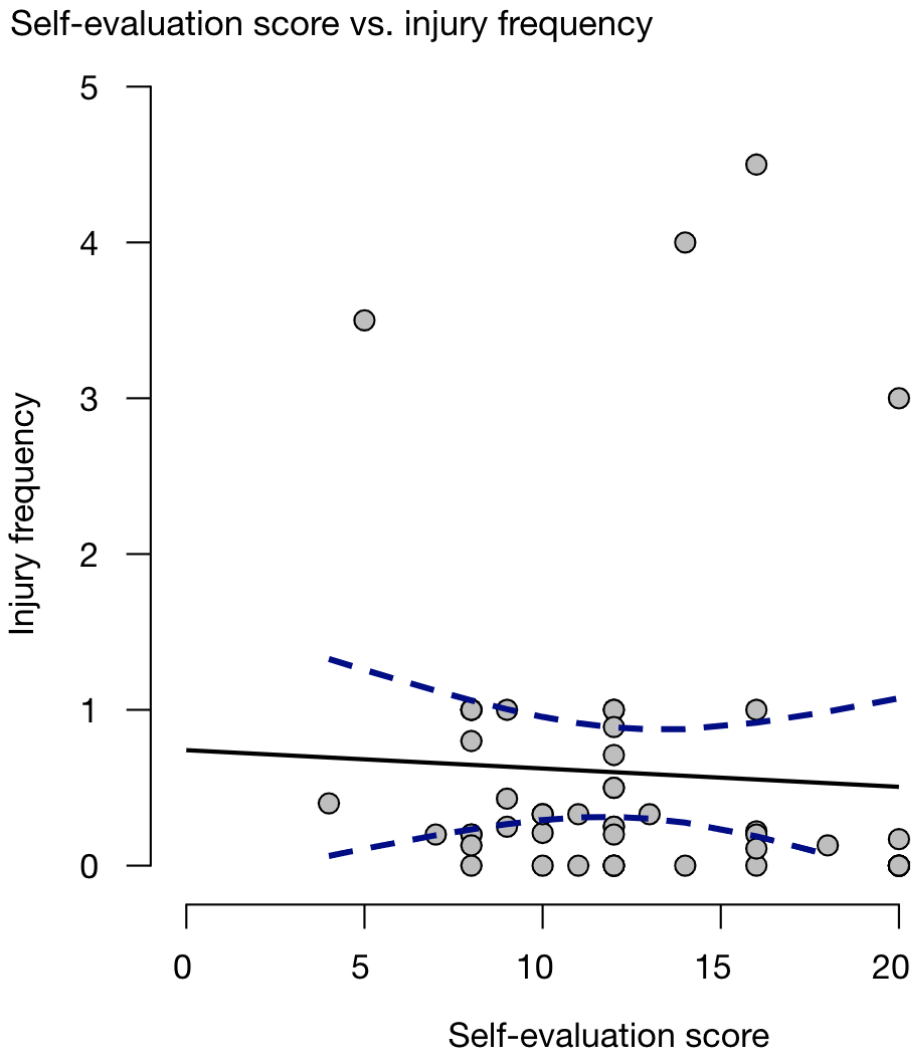
Self-evaluation score vs. injury frequency
Injury frequency
0
1
2
3
4
5
0
5
10
15
20
Self-evaluation score

Figure 5

Table 1: Survey sections, including the rationale for each section and references where questions are based on previous research.

	Main Subject	Rationale for data collection	References
1	Qualification and experience	Provide basic information in order to satisfy the definition of professional equine physiotherapist and be included in the study. Provide information on the number of years in work and years of general experience handling horses.	N/A
2	Occupational injury	Determine injury frequency and overall severity, provide qualitative information on types of injury, body areas affected, hospitalisation and days off work.	Fritschi *et al*. (2006) Lucas *et al.* (2009a, 2009b) Parkin *et al.* (2018)
3	Application of training principles in work practice	Assess the participants' application of the principles of LT in their everyday work - here called "equine training principles".	Warren-Smith and McGreevy (2008) Wentworth-Stanley (2013) Brown and Connor (2017) Pearson *et al.* (2020a)
4	Knowledge and understanding of LT	Evaluate theoretical knowledge of LT. Replicate Brown and Connor (2017) to determine whether making definitions available enhances participants' ability to answer theoretical questions correctly.	Skinner (1953) Warren-Smith and McGreevy (2008) Brown and Connor (2017) McGreevy (2018) Pearson *et al*. (2020a)
5	Demographics	Provide demographic information for descriptive statistical analysis.	N/A

Table 2:

Name of group	**Number of members**
ACPAT discussion group	374
Animal/Veterinary Physiotherapists & Other Professions	2100
IRVAP Private Group	278
IAAT Members	134

Table 3: Mean injury frequency for different years of work experience.

Years of work experience	N. of people in group	Mean injury frequency
0-1 years	8	1.25
2-4 years	12	1.09
5-9 years	16	0.27
10-14 years	4	0.29
15-19 years	2	0.17
20-24 years	2	0
25-30 years	1	0

- The equine physiotherapy profession may be as hazardous as the veterinary profession.
- Equine physiotherapists are most commonly injured to the lower limbs.
- Knowledge of learning theory was poor in the surveyed sample.

Survey Questionnaire

Practitioner Safety and the Application of Learning Theory related to injury risk in Equine Physiotherapy: a Worldwide Survey

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Abstract

In the equine physiotherapy profession, similarly to the equine veterinary profession, there may be a high risk of occupational injury and preventive strategies, such as the application of learning theory (LT), may mitigate workplace injury frequency. The purpose of this study was to identify the frequency of occupational injury among equine physiotherapists and investigate the relationship between injury rate and knowledge of LT. An online survey was distributed, receiving 64 valid responses: of these, 51 were qualified veterinary physiotherapists working with equines and their data were taken forward for analysis. The mean injury frequency was 0.59±1 per year, with 36 respondents reporting at least one injury during their career. There was a moderate negative correlation (r=-0.34, 95%CI[-0.56,-0.07], $p<0.05$) between career length (in years) and injury frequency. The most common site of injury for practitioners was the lower limb (n=22) and the most common type of injury was bruising (n=32). Of the respondents who claimed the work activity they were performing significantly contributed to their most severe injury, six were carrying out equine hindlimb treatment at the time of injury. Knowledge of LT was poor: only 21 of respondents scored 3/9 or higher when tested on practical application of LT and 24 achieved a grade of 6/10 or higher on theoretical knowledge, with one respondent achieving 0/10. There was a moderate positive correlation ($r=0.37$, 95%CI[0.10,0.58], $p<0.01$) between veterinary physiotherapists' theoretical knowledge scores and their self-evaluation of LT terminology scores. There was no significant correlation between scenario-based and theoretical LT scores and injury frequency. However, there was a weak negative correlation ($r=-0.31$, 95%CI[-0.54,-0.04], $p<0.05$) between self-evaluation of LT terminology scores and injury frequency. Due to the small number of responses, results from the present study are not representative of the target population. However, results nonetheless highlight a trend of high injury rates and low levels of understanding of equine learning. This is comparable to other equine-related professions, indicating the urgent need of research into better prevention and safety-

enhancing strategies, which could reduce the rates of occupational injury and safeguard the welfare of both practitioners and equines.

Keywords

Veterinary Physiotherapy

Equine Physiotherapy

Injury

Learning Theory

Safety

1. Introduction

All equestrian sports and activities that involve riding or handling horses are considered high-risk [1]. The equine veterinary profession is classified as one of the most dangerous occupations in the UK [2]. Farriers also experience a high level of occupational injury [3]. Due to handling scenarios similar to veterinary interactions, the equine physiotherapy profession may also be a high-risk occupation. However, although equine physiotherapy is an increasingly popular profession [4], to the authors' knowledge, no studies have been performed to date on the potential risks of this occupation. When assessing and treating equines it is important to have an excellent knowledge of equine behaviour, especially how horses learn [5]. Practitioners who understand and are able to prevent flight responses are more likely to achieve stimulus control of the horse, resulting in a more manageable animal, and a lower risk of accident and injury for all parties. Many veterinary students receive inadequate training in equine behaviour and learning, increasing the risk of injury later in their career [2]. Equine physiotherapists may also be lacking such training, although research is needed to confirm this. The present study aims to identify the frequency and severity of injuries sustained by equine physiotherapists during their career. The current level of behavioural knowledge among equine physiotherapists will be analysed, in order to evaluate whether a greater awareness of equine behaviour and learning could help to better manage occupational risk. In fact, a high level of knowledge of behaviour and learning could potentially reduce occupational risk for professional equine physiotherapists, as well as improving equine welfare by reducing the use of physical or chemical restraints.

1.1. Veterinary injuries

Studies conducted in Australia reported injury rates between 21% to 39% for veterinarians working with equines [6,7,8]. More recently, a survey conducted in the UK found that equine veterinarians were likely to sustain between seven and eight injuries over the course of a 30-year career, with 80% reporting to have sustained one or more equine-related injuries. 49.1%

of injuries were caused by a hindlimb kick and 11.8% by a forelimb strike [9]. Similar results were obtained by Pearson *et al.* [10], who reported that 81% of UK equine veterinarians had sustained at least one injury in the past five years. Some of the main advantages of collecting injury related data through surveys are that information can be gathered from a large sample of the target population [11] and that injuries that did not require hospitalisation can also be included. One disadvantage of this method is that it subjects participants to recall bias, or struggling to remember events as they actually happened [12].

1.2. Equestrian injuries

The majority of equestrian injuries occur during riding, with 65% to 80% reporting being injured as a result of falling or being thrown from a horse, whilst 20%-30% of injuries are reported to have occurred due to being kicked, crushed or bitten when handling a horse from the ground [12,13,14,15]. Such behaviours may arise due to multiple factors, such as fear, separation anxiety, novel environments or when a horse is confused by incorrect or inconsistent signals, losing the ability to control or predict its environment [16]. Handler/rider inconsistencies often lead to unwanted reactions, also known as “conflict behaviours” [2,16,17]. This has led some authors to suggest that, as well as increased use of personal protective equipment [15,18,19], increasing the level of knowledge and understanding of equine behaviour and learning patterns could provide a means of decreasing risk when dealing with horses [1,14]. However, as Thompson *et al*. [1] emphasise, the success of such interventions is heavily influenced by the equestrian culture to which it is applied, with risk being higher in those cultures with low levels of horse ethology, as flight responses are poorly understood and consequently hard to prevent.

1.3. The application of Learning theory as a safety intervention

Knowledge of equine ethology and correct application of LT have often been suggested as potential safety interventions, or injury prevention strategies, when dealing with equines [2,5,10,14,20,21,22,23,24]. In order to apply LT to equine training, it is important to be aware

of the equine ethogram and be capable of reading and interpreting the various behaviours expressed by the horse, such as arousal-level indicators and expressions of aversiveness or conflict [25,26]. During training, correct reinforcement of a given response requires consistency and precise timing so as not to confuse the animal or reinforce undesired behaviours [25]. In a recent study on Australian equestrians, Luke *et al.* [24] suggested that lack of theoretical knowledge may be contributing to poor outcomes for both equestrians and horses when applying LT as an injury prevention strategy. Further, when applying these methods, it is important to acknowledge and avoid the state of learned helplessness, where the animal is confused, no longer knows how to respond in order to avoid a stimulus, and stops reacting [27]. For these reasons, some basic training in the correct application of LT to equines may be beneficial to all amateurs and professionals involved in the equine industry, contributing to reduce behavioural wastage and enhance horse welfare as well as possibly increasing the safety of all parties involved [2,16,25].

1.4 Learning theory and veterinarians

When considering the veterinary profession, Doherty *et al.* [2] found a lack of available research on the practical applications of LT for veterinarians and emphasised the importance of understanding how veterinary procedures can influence equine behaviour manifestations. They concluded that veterinarians should be better equipped to handle potentially dangerous reactive behaviours manifested when carrying out medical procedures. In 2020, Pearson *et al.* [10] conducted a survey of UK equine veterinarians in which 168 respondents subjectively rated their understanding of the theoretical terminology as well as answering a series of situational questions. For respondents who self-reported understanding of the terms positive reinforcement and negative reinforcement, the study found that only 19% and 33% respectively were able to identify the correct scenarios in the situational questions. Fewer participants still were confident of the terms positive punishment and negative punishment, whilst habituation and classical conditioning were more widely understood. Veterinarians in this study reported a total of 579 injuries, indicating that commonly available preventative

measures, such as protective equipment and current workplace safety protocols [28] were either not being applied or not sufficiently effective for this profession [10]. Over-reliance on physical or chemical methods of restraint over behavioural interventions was also highlighted as a risk to both safety and welfare. Both Doherty *et al.* [2] and Pearson *et al.* [10,29] suggested that an improved understanding and application of LT could reduce the risk of injury to veterinarians, reduce the occurrence of litigations, and enhance equine welfare and owner safety by improving handling skills and minimising behavioural conflict. Further, in a two-part informative article on the practical application of LT, Pearson [30,31] reviewed a series of techniques which could prove helpful to the equine veterinarian when assessing and treating animals, such as shaping, counter conditioning and overshadowing. These behavioural interventions may aid in the assessment and diagnosis of equines, which are often affected by stress, as well as improving patients' ability to cope [2]. The importance of teaching LT and ethology to veterinary undergraduates as a means of enhancing knowledge and reducing the risk of occupational injury later in their career was also discussed by Doherty *et al.* [2]. Research by Gronqvist *et al.* [32,33] and Guinnefollau *et al.* [34] looked at veterinary students' handling skills and understanding of equine behaviour and found many to be poorly equipped to deal with equines safely. Pearson *et al.* [29], after conducting a survey of veterinary students' understanding of equine learning and training principles before and after a 45-minute lecture on LT, concluded that a single educational intervention could prove beneficial in changing the attitudes and confidence of undergraduate students when working with difficult horses. Overall, these studies have highlighted how veterinary students are often inadequately prepared to deal with equines in practice, as well as further confirming the importance of adequate teaching in equine behaviour and learning as an appropriate safety-enhancing intervention. Due to the similarity of equine handling situations, such considerations may also be applicable to equine physiotherapists, who could also benefit from enhanced knowledge and the ability to apply LT in their everyday work.

1.5. Learning theory and equestrians

Warren-Smith and McGreevy [20] and Wentworth-Stanley [21] found a poor understanding of LT among equestrian professionals in Australia and Canada, respectively. These studies have emphasised that greater education of equestrian coaches could favour the dissemination of information on correct training practices and potentially improve the human-horse relationship. Improved knowledge and application of LT in training would also limit equine wastage through reduced behavioural conflict and result in improved training outcomes [20,21,35]. Hawson *et al.* [14] predicted that equitation science, incorporating ethology and LT, may be important in reducing the unpredictability of horse-human interactions and could therefore contribute to injury risk reduction. They emphasised that a clear understanding of equine ethology and of the specific behaviour patterns exhibited by horses in handling and riding situations could help to predict and manage responses and reactions, preventing or reducing unwanted flight responses and other conflict behaviours [14]. More recently, Luke *et al.* [24] found the level of knowledge of LT to have slightly improved in the Australian equestrian environment over the past decade, although it is still severely lacking. They looked at the correlation between the theoretical knowledge of LT and the number of equestrian injuries and found no relationship, although they acknowledged that practical application of learning theory was difficult to measure through a survey based study. Further, they emphasised that the improved, but very low current level of knowledge may not be sufficient to achieve improved horse welfare and rider safety benefits [24].

The present study aimed to identify the frequency and severity of injuries sustained by equine physiotherapists during their career. The current level of behavioural knowledge among equine physiotherapists was analysed, in order to evaluate whether a greater awareness of equine behaviour and learning could help to better manage occupational risk.

2. Materials and Methods

2.1. Survey design

The present study used a survey questionnaire comprising 29 questions and administered through the JISC Online Surveys platform, which is GDPR compliant [40]. A pilot was submitted to eight peers prior to commencing the study, and feedback was incorporated into the final version of the questionnaire. The survey received approval from the University of Edinburgh Human Ethical Review Committee (HERC) in August 2021, with reference n. HERC_740-21. The sections of the survey, including the rationale for each section and references where questions are based on previous research, are summarised in Table 1. Theoretical questions were based on self-evaluation and matching of terms with examples rather than the recollection of a complete definition. This choice was made after evaluating that the "partially correct" answers in Warren-Smith and McGreevy [20] and Brown and Connor [35] would be considered sufficiently correct for this study and that knowledge of a full correct definition may not reflect working/applied knowledge of the subject.

2.2. Sampling frame

The sampling frame for this study was all professional equine physiotherapists (or equivalent) working in any country and able to understand and complete a survey in English. Respondents who did not satisfy these criteria were either excluded from the study or included in an "other" group if their qualification and job could be considered similar to that of a veterinary physiotherapist, as was the case with Registered Veterinary Nurses practising physiotherapy.

2.3. Recruitment of participants, response rate and sample size

Participants for the study were recruited through the social media platform Facebook as it is a quick and straightforward way of contacting a large part of the target population. Following agreement by group administrators, a link to the survey was posted, together with a short description, to the official Facebook Groups of the main voluntary Veterinary Physiotherapist Registers (Table 2). The survey was open for eight weeks and two reminder posts were

created; one at three weeks post-opening and one at six weeks post-opening. Respondents were also able to share the survey link with other professionals in their network.

The free online tool Raosoft [41] was used to calculate a desired sample size with a 5% error margin and 95% confidence interval. As the size of the worldwide population of qualified veterinary physiotherapists working with equines is unknown, estimates of between 500 and 10000 were made. The desired sample size was calculated at 218 to 370 individuals and the choice was made to target 2000 potential respondents through social media distribution.

2.4. Survey data scoring

Injury frequency was calculated by dividing the number of reported injuries by the years of work. Overall severity of injuries was determined by calculating the mean of the reported injury severity rates and summative scores were calculated. Up to three answer options could be selected and scoring calculations were automated in the statistical software R. Where respondents selected “other” and detailed their answers, these were scored manually by the researcher.

2.5. Data analysis

Data analysis was performed using R language for statistical computing [42] and graphs made using JASP statistical software [43]. Collected data was either interval or ranked: non-parametric tests were considered stronger for these types of data as many variables did not satisfy the assumption of normal distribution [36]. Spearman’s Rank Correlation Coefficient was used to analyse the correlation between the frequency and severity of injury and the level of knowledge and understanding of the principles of LT; whether respondents who demonstrated a solid theoretical understanding of the principles of LT were also more likely to apply these in their everyday practice; and to investigate the role work experience and general handling experience play in injury occurrence. The correlation between self-perception of knowledge, frequency/severity of injury and actual knowledge of LT was also explored in this way. Finally, the efficacy of providing a short information diagram in

improving respondents' theoretical understanding of the principles of LT was analysed using the Wilcoxon Signed-Rank test. For all tests, significance was set at $p<0.05$.

3. Results

A total of 66 survey responses were received. Two responses were excluded from the study as they did not satisfy the selection criteria, 51 were classified as “veterinary physiotherapists” and 13 were grouped in the category “Other”. Unless otherwise stated, reported results refer to the category “veterinary physiotherapists” only. Response rate was 33% of all people who opened the survey link from Facebook.

3.1. Demographics

Out of the 51 appropriately qualified survey respondents, 36 were female and based in the United Kingdom. Other represented countries included the United States of America, South Africa, Australia, New Zealand, Ireland and Canada. Gender, location or age did not highlight any significant differences within the group. The type of veterinary physiotherapy qualification and register membership was also not significant.

The mean number of years of work experience for veterinary physiotherapists was 7.17 years±6.37 (max=30, min=0.5).

The mean number of horses treated per month was 22.1±12.2 (max=35, min=2).

3.2. Veterinary physiotherapist injury rates

Mean injury frequency was 0.59±1 per year (max=4.5, min=0), with 36 respondents reporting at least one injury during their career, and 32 reporting one or more injuries in the past five years. The mean injury frequency decreased as work experience increased, as summarised in Table 3. This indicates that, on average, equine physiotherapists will experience 5.8 injuries in the first five years of their career, 2.8 injuries in the following 10 years, 0.8 injuries

between 15 and 20 years of work and no further injuries later on in their career, with an average of 9.4 injuries over a 30-year career.

Spearman's rank correlation was computed to assess the relationship between work experience (in years) and injury frequency. There was a moderate negative correlation between the two variables [37] for veterinary physiotherapists (r=-0.34, 95%CI[-0.564, -0.072], p<0.05), as represented in Figure 1. For the "Other" group, there was no significant correlation.

The injury rates for body area and injury type show that lower limb injuries make up the most common site of injury (43%, n=22, Figure 2) and that by far the most common type of injury is bruising (63%, n=32, Figure 3).

Of 36 respondents reporting ≥1 injury, eight required hospitalisation. The average number of working days lost due to injury was 14.5, with six respondents reporting losing ≥30 days.

Respondents reported what activity they were carrying out at the time of injury and rated the contribution of the activity in causing the injury. Overall, 18 respondents claimed the activity they were performing significantly contributed to their most severe injury. Of these, 34% (n=6) were carrying out hindlimb treatment at the time of injury and 17% (n=3) were carrying out generic treatment (Figure 4).

3.3. Knowledge and application of learning theory

Practical application of LT was assessed through three situational based questions with scoring -9/+9. Respondents had the possibility of selecting "Other" and giving a free-text answer. These answers were manually evaluated and scored according to LT principles:

- 21 respondents scored 3/9 or higher (mean=4.5, max=7, min=3).
- 30 respondents scored 2/9 or lower (mean=0.07, max=2, min=-3).

No significant correlation with other parameters, such as injury frequency or theoretical knowledge of LT, was found.

Respondents were asked to self-assess their knowledge of LT, rating each term on a scale from 1 “Poor” - 5 “Excellent”. Knowledge of PR was rated “very good” or “excellent” by 27 respondents, NR by 25 respondents, PP by 14 respondents and NR by 15 respondents. When testing theoretical knowledge of the principles of LT, scores were assigned to each of five scenarios before and after viewing an information diagram. 28% (n=14) of qualified veterinary physiotherapists achieved 4/5 or 5/5 in the first set of theoretical based situational questions, and 37% (n=19) in the second set. The efficacy of providing an information diagram to improve theoretical knowledge of LT was evaluated using the Wilcoxon Signed-Rank test and was significant (p<0.05) for veterinary physiotherapists, but not for the “Other” group.

Spearman’s rank correlation was computed to assess the relationship between self-evaluation scores and theoretical knowledge scores for veterinary physiotherapists. There was a moderate positive correlation between the two variables (r=0.36, 95%CI[0.101,0.583], p<0.01).

Respondents self-evaluated the usefulness of their professional qualification in dealing with behavioural issues, with 18% (n=9) of qualified veterinary physiotherapists considering their professional education sufficient in preparing them for dealing with equine behavioural issues, compared to 54% (n=7) in the “Other” group.

3.4. Correlation between injury frequency and knowledge of learning theory

Spearman’s rank correlation was computed to assess the relationship between self-evaluation of knowledge of LT scores and injury frequency for veterinary physiotherapists. There was a weak negative correlation between the two variables (r=-0.31, 95%CI[-0.542,-0.041], p<0.05), as shown in Figure 5.

There was no significant correlation between injury frequency or injury severity and practical or theoretical LT score for veterinary physiotherapists or the “Other” group. There was also no significant correlation between injury frequency or LT scores and the perceived usefulness of respondents’ professional qualification or equine handling experience.

4. Discussion

Results of the present study indicated that injury frequency in the equine physiotherapists' sample was similar to that of the equine veterinary profession and that participant equine physiotherapists generally showed a low level of knowledge and understanding of equine LT.

4.1. Occupational injury rates

Of the 51 veterinary physiotherapists working with equines who took part in the study, 70% reported at least one occupational injury in the course of their career. The mean injury frequency was 0.59 injuries per year. Injury frequency was significantly reduced by the years of work experience, indicating that practitioners may experience the majority of occupational injuries early on in their career. When factoring in this reduction in injury frequency over time, it was estimated that equine physiotherapists may sustain just over nine injuries over the course of a 30-year career. This is comparable to the results obtained by Parkin *et al.* [9], which found that equine veterinarians sustain on average seven to eight injuries over 30 years and that the majority of these injuries occur during the first five years of veterinary practice, as Pearson *et al.* [29] also reported.

The most common site of injury was the lower limb (n=22), followed by the upper limb, trunk and head. Previous studies on equine veterinarians also found the lower limb to be the most common site of injury. Bruises were the most common type of injury both in the present study and in previous works, followed by sprains and fractures [7,9,14]. 22% of survey respondents reporting one or more injuries required hospitalisation at least once during their career, compared to 33% in the study conducted by Parkin *et al.* [9]. Although direct comparisons between studies are hard to draw, due to the difference in data collection methods and injury categorisation, there are sufficient similarities to indicate that sampled veterinary physiotherapists working with equines show comparable injury patterns to equine

veterinarians [6,8,9,10]. This suggests that proposed safety interventions for equine veterinarians [2,9,14] may also be applicable to the equine physiotherapy profession.

When comparing injuries reported in the present work with equestrian injuries in general, it is interesting to note the 10% to 20% prevalence of hindlimb kicks reported as the second most common cause of equestrian injuries after riding [12,13,14,15]. Respondents in the present study described the activity carried out at the time of their most severe injury and evaluated how much this activity may have contributed to causing the injury. Hindlimb treatment represented 34% (n=6) of all activities that greatly influenced the most severe injury occurring. When looking once again at available data from the equine veterinary profession, hindlimb kicks also feature prominently [7,9].

When comparing data from various professions it is important to consider not only the similarities, but also the differences in everyday work. Veterinarians often work in emergency situations and rely heavily on chemical restraint [10]. Physiotherapists cannot administer drugs [38] and are therefore more inclined to use physical restraint and behavioural interventions, as well as treating the same patient multiple times [4]. Many respondents reported moving to treat a different area of the horse in an attempt to relax the animal, rather than persist with a problematic area: such an intervention may not be an option for a veterinarian working in an emergency situation. Further, equine physiotherapists treat chronic conditions over multiple sessions, enabling them to work at a slower pace whilst allowing the horse to get accustomed to the practitioner and treatment [4], whereas veterinarians will often be called to diagnose and treat acute injuries or pathologies within a single intervention.

4.2. Knowledge and application of learning theory

The overall level of knowledge of LT among study participants was poor, with only 14 qualified veterinary physiotherapists making zero or one mistake in the first set of theoretical based situational questions, and 19 in the second set, which was completed after viewing an information diagram. Similar results were obtained by those respondents who were not qualified veterinary physiotherapists (massage therapists, osteopaths and others). In the

situational questions which tested the practical application of the principles of LT, only about 40% (n=21) of respondents obtained at least 3/9 points over three questions.

Direct comparisons with previous studies are hard to make due to the differences in methodologies, survey questions and terminology used. For the present study, it was decided to focus on situational based questions rather than textbook definitions, following a similar methodology to Pearson *et al.* [10]. As a section for providing alternative answers from those possible was provided, many respondents chose to explain what they would do in each of the given situations in ways that did not consider equine behaviour and learning. Although not all such answers could be considered wrong, they nonetheless suggested that many practitioners did not consider the application of LT as a first choice when dealing with difficult situations, as well as highlighting the complexity of evaluating respondents' practical application of principles through a self-evaluation survey.

Knowledge and understanding of equine learning have been identified by Warren-Smith and McGreevy [20], Wentworth-Stanley [21], Luke *et al.* [24] and Brown and Connor [35] as lacking among equestrian communities worldwide. Interestingly, in the study by Wentworth-Stanley [21], 82.3% of Canadian coaches considered release of pressure (which is negative reinforcement) as the most effective reward - implying the application of the principles of LT, although only 8.6% correctly defined the term Negative Reinforcement in the survey. Such contrasting results suggest that further research is required in order to define a standard for the measure of knowledge in various equine industries and communities, before drawing any definitive conclusions.

The use of an informational diagram explaining the key terminology was found to be useful in increasing the number of correct responses. The aim of this addition was to test whether a minor educational action could prove sufficient in increasing knowledge among equine physiotherapists, and the result was statistically significant. This implies that small, cost-effective interventions could be easily applied to a variety of situations, as demonstrated by Pearson *et al.* [29] in their study of Veterinary Medicine students. The level of training in equine behaviour and learning in veterinary physiotherapy degrees is unknown, however

only nine out of 51 qualified respondents reported their degree/diploma was sufficient in preparing them for dealing with equine behavioural issues. There was no difference in the injury frequency of LT scores for these nine respondents, compared to the main group. This suggests that adequate training may not be occurring in academic institutions.

Overall, results from the surveyed sample indicated a poor knowledge of LT, which also suggested a poor level of application. The free text answers indicated that LT was not something many practitioners would consider as a solution to handling a difficult situation.

4.3. The relationship between injury risk, learning theory and other factors

The aim of this study was to investigate the injury rates and knowledge of LT among equine physiotherapists in order to better understand whether injury frequency and severity may be influenced by the level of education in equine behaviour and learning principles within this profession. Interestingly, although 94% of veterinary physiotherapists reported their handling experience was “very” or “extremely” useful, this did not correlate in any way with the frequency of injury, indicating that the risks incurred when assessing and treating equine patients did not depend on how many years respondents had been around horses. This finding correlates poorly with what was reported by Guinnefollau *et al.* [34], who found that veterinary students who came from horse-owning families were better at correctly interpreting equine behaviour than those that had no prior experience with horses, suggesting that this may help to mitigate the risk of injury when working with equines. However, the study by Guinnefollau *et al.* [34] did not evaluate the injury frequency of surveyed students after joining the workforce and further research would be necessary to test whether students’ prior behavioural understanding may influence occupational injury rates later in their career. Whereas handling experience was not a significant factor in injury rate reduction, the years of work experience were found to influence injury frequency, with the majority of reported injuries occurring early on in practitioners’ careers, similarly to what was reported for equine veterinarians in the UK [9,10]. For this reason, appropriate shadowing of experienced practitioners may be a valuable strategy in injury prevention, which merits further research.

The direct relationship between injury rates and knowledge and application of LT among equine physiotherapists was harder to affirm. Although a statistically significant, negative correlation was found between injury frequency and self-evaluation scores for LT terminology, this correlation was weak and therefore inconclusive. Self-evaluation scores also correlated positively with theoretical understanding scores, indicating a moderate relationship between respondents' perceived and actual level of knowledge. However, when Spearman's Rank correlation coefficient was calculated to assess the relationship between injury frequency and knowledge and application of LT, results were not significant. Similar results were obtained in a 2023 study by Luke et al. [24], which also failed to identify a significant relationship between knowledge of LT and improved safety.

A direct relationship between reduced injury rates and enhanced understanding of equine learning has been suggested many times in the literature [2,10,14], however, in the present study data show high injury rates and low levels of LT knowledge, but no significant correlation was found. This suggests that better knowledge of LT may play a role in improving practitioner safety, however, it may not be the sole contributing factor, making a significant relationship hard to establish. Finally, although a trend was found in injury frequency patterns, the severity of injuries appeared much more casual, suggesting that prevention strategies may be the most important type of safety intervention in the profession, with focus on a strong understanding of equine behaviour and the ability to anticipate flight responses and other unwanted or dangerous reactive behaviours [9,14,17].

The results of the present study are not sufficient to imply that knowledge and correct application of the principles of LT in equine physiotherapy practice are factors that significantly contribute to decreasing the frequency and overall severity of occupational injuries in the profession. However, these results nonetheless highlight a trend of high injury rates and low levels of understanding of equine learning, which is comparable to that of other equine-related professions and for which there is urgent need of research into better

prevention and safety-enhancing strategies, which could reduce the rates of occupational injury and safeguard the welfare of both practitioners and equines.

The underpinning knowledge and the ability to apply the principles of LT to the profession were also found to be insufficient in the surveyed sample, indicating that equine physiotherapists may be facing similar issues to equine veterinarians and equestrians when dealing with horses [2,14].

Based on the results from this study, and currently available research, a few recommendations can be made. First of all, the frequency of injury in the equine physiotherapy profession should be clearly explained to students in training, so that they may seriously consider this aspect of the profession once they are qualified. It is also important to highlight how prior horse handling experience may play a small role in injury prevention, compared to actual work experience, suggesting that ample time should be spent shadowing experienced practitioners when in training and in the early stages of work.

4.4. Study Limitations

As only 64 valid responses were received, of which 51 from appropriately qualified veterinary physiotherapists working with equines, results from the present study cannot be considered representative of the target population. In addition, as the majority of respondents were based in the UK, the results may not be applicable to other countries which were represented by fewer responses. The choice of a survey was made because it was a cost-effective way of reaching a wide number of respondents [11]. However, this methodology is subject to recall bias, or the difficulty in recalling events as they actually happened, social bias, in which respondents choose the most socially acceptable answers rather than the most truthful, and sample bias, where certain categories of respondents may be more willing to respond to a survey because the topic is of particular interest to them [12,34,35,39]. In addition to this, the subjectiveness of what is considered an injury and how severely each injury is rated, as well as the difficulty in remembering minor injuries, are factors which merit consideration when evaluating and interpreting study results. Finally, trying to evaluate the practical application of

the principles of LT through a self-assessment survey proved problematic, as many respondents chose to provide alternative answers which were unrelated to equine learning. Despite these limitations, overall the present study proved useful in investigating injury rates and the knowledge of LT of sampled equine physiotherapists, setting a baseline for further research.

5. Conclusion

This study aimed to investigate the occupational risk of the equine physiotherapy profession and the understanding of the principles of LT, in order to evaluate the effectiveness of such knowledge in preventing or mitigating occupational injury rates. Despite the studied sample size being small and not representative of the worldwide equine physiotherapists' population, the study results nonetheless indicated that the equine physiotherapy profession may be as hazardous as the equine veterinary profession, which is among the most dangerous occupations in the UK [2]. Such a consideration definitely merits further investigation into occupational injury rates and workplace safety interventions for equine physiotherapists.
In conclusion, although the results of the present study cannot be generalised to the entire equine physiotherapy population, the profession may pose a high level of risk and more should be done to address workplace safety, through better education and the development of preventative strategies for dealing with equines.

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Table Captions

Table 1: Survey sections, including the rationale for each section and references where questions are based on previous research.

Table 2: Target Facebook Groups and number of members in each group.

Table 3: Mean injury frequency for different years of work experience.

Figure Captions

Figure 1: Scatter plot showing the negative correlation between the years of work experience and the injury frequency of veterinary physiotherapists. The 95%CI[-0.564,-0.072] is represented by the blue dotted lines.

Figure 2: Boxplot showing the reported injury rates for each body area.

Figure 3: Boxplot showing the injury rate for each type of reported injury.

Figure 4: Respondents' rating of how much the activity they were performing at the time of their most severe injury, contributed to the injury itself. Of respondents who rated the activity as contributing "very much" or "extremely", six were performing hindlimb treatment, three were performing generic treatment, two were handling the horse and two were riding.

Figure 5: Scatter plot showing the weak negative correlation between self-evaluation of knowledge of LT score and the frequency of injury of veterinary physiotherapists. The 95%CI[-0.542,-0.041] is represented by the blue dotted lines.

Human Ethical Review Committee (HERC)

Royal (Dick) School of Veterinary Studies

The University of Edinburgh

Roslin

EH25 9RG

Email HERC.vets@ed.ac.uk

25th August 2021

Dear Kirsten

The research described in your application HERC_740_21 entitled “Safety and Welfare: the Application of Learning Theory in Equine Physiotherapy” now has HERC ethical approval.

You may proceed with this research only on the basis that it conforms to the description you provided and the assurances you made in your application. If you undertake research that deviates in any significant way from the application you submitted, that research does not have the HERC's approval. If, following the receipt of ethical approval, you find that you want or need to change your methods and/or materials in any significant way, you must submit a revised application.

Researchers:

Kirsten Ruffoni

Bryony Lancaster

Gillian Tabor