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Pilot Study: Effects of Whole Body Vibrational Therapy on Equine Epaxial Muscle Soreness

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Pilot Study: Effects of Whole Body Vibrational Therapy on Equine Epaxial Muscle Soreness

by

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Westerville, Ohio 43081

April 3, 2024

Submitted in partial fulfillment of the requirements

For graduation with Honors

Dr. Sheri Birmingham, DVM	______________________
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Dr. John Tansey, Ph.D.	______________________
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This Honors Thesis was made possible by the Otterbein University Equine Science Department, the help of my advisors, and the help of several friends. I would like to thank Dr. Sheri Birmingham for her help in designing, troubleshooting, and editing this Honors Thesis. Thank you also to Dr. Jeffrey Lehman for your help with the statistical analysis of my data. I would not have been able to complete my data collection without the help of Janet Kautz. I would like to thank the Department of Equine Science for allowing me to use Otterbein's Equivibe plate, pressure algometer, and university-owned horses. Finally, thank you to Molly Casey, Emma Hartzler, and Ellie Linn for allowing your personal horses to be a part of my study.

Abstract

Whole body vibrational therapy (WBV) is well-studied in people, but there is a paucity of research of its effect on horses. It is suggested that WBV use in horses increases performance, aids in recovery, and stimulates nerves, bones, and muscles in ways that normal exercise does not. The purpose of this pilot study was to determine if frequent WBV therapy sessions affect back soreness in horses using pressure algometry. Most sporthorses will experience back soreness in their careers, and it is regarded as one of the most common causes of poor performance in equine athletes. Five horses were measured for mechanical nociceptive thresholds at 8 points along their backs once every 7 days for 8 weeks. Baseline pain scores were established over the first 4 weeks. During the second 4-week period, horses received 5, 30-minute vibration therapy sessions per week. Despite previous research indicating that WBV increases epaxial muscle symmetry in horses, no significant difference was noted between the subjects' average pain thresholds during the baseline period and the trial period. Upon further investigation of the change in sensitivity at the individual sites, 4 out of the 8 sites did show a 0.5-1 kgf difference. This suggests that with further study WBV may increase average pain thresholds. Further experimentation is required to assess whether this difference is biologically meaningful.

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Literature Review

Introduction

Many claims are made about the restorative properties of various emerging therapies for equine athletes despite little research on their actual effects (Bergh et. al., 2021). There is a wealth of studies on the effects of Whole Body Vibrational Therapy (WB) on humans. Studies on WBV in humans have shown that the therapy may contribute to increased bone mineral density and decreased lower back pain in subjects with osteoporosis, reduced essential tremors in adults who did not have a history of substance abuse or other uncontrolled medical issue, and increased rehabilitation in stroke patients (Ruan et. al., 2008; Abramavičius et. al., 2020). The theory behind WBV's efficacy is that the frequency of the vibrations lessens the effects of gravity and stimulates nerve, bone, and muscle as the body adjusts to the vibrations (EquiVibe Website). Companies which market WBV for horses claim that the therapy can increase bone density, improve hoof health, decrease muscle soreness, and enhance recovery, among other benefits (EquiVibe, TheraPlate).

Background on Whole Body Vibrational Therapy

Muscle vibration was first popularized as a performance enhancing tool for athletes in the 1990s. These athletes used local vibration therapy during weightlifting to improve muscle gain (Jordan, 2005). More recently, whole-body vibrational therapy has become a useful tool for athletic performance enhancement and rehabilitation in humans. WBV has become increasingly popular in the equine industry in the last decade despite few conclusive studies on its efficacy in equine athletes. Most studies examining the physical effects of WBV have failed to produce significant results (Bergh et. al., 2021). In the 2016 study by Halsberghe et. al., consistent WBV sessions (30 minutes, twice a day, 5 days per week) significantly increased the left to right symmetry of *m. multifidus* (2016). This muscle runs next to the spine (Figure 2), and in humans, it has been found to affect postural stabilization (García Liñeiro et. al., 2017). The muscle is often weakened in humans with chronic back pain, and human studies on WBV have shown that it both increases *m. multifidus* symmetry and decreases low back pain (Sullivan et. al., 2022). Another study investigating the effects of WBV on adults with non-specific chronic low back pain found that a 12-week treatment period increased participants' postural stability and provided an analgesic effect (Pozo-Cruzet et. al.). The functions of the *m. multifidus* are thought to be similar in horses, though more research needs to be completed to determine whether this increase in muscle symmetry decreases back pain (García Liñeiro et. al., 2017). It is difficult to state whether the muscle serves the same function in horses as it does in humans, as the mechanics of a bipedal spine differ from that of a quadruped. *M. multifidus* asymmetry has been documented in horses with chronic lameness (Sullivan et. al., 2022). Back pain is a common affliction in sporthorses, and there is no strong clinical consensus on an effective therapy (Riccio et. al., 2018).

Use of Pressure Algometry to Evaluate Pain in Horses

Horses cannot verbalize pain; hence, their body language is used as an indicator when evaluating muscle soreness through digital palpation. Pressure Algometry (PA) is a tool used to qualitatively measure the response to palpation by quantifying the amount of force being applied to a specific point. The reading that comes from PA is deemed the mechanical nociceptive threshold (MNT). Typically, the MNT is defined as the minimum amount of force applied to an area before an avoidance behavior is elicited (Haussler, 2020). Therefore, a higher MNT indicates lower sensitivity in the area being palpated. Previously published studies have used MNT as a repeatable measurement of pain in horses when performed in a way that prevents bias (Varcoe-Cocks et. al., 2006; Haussler, 2020). This method has not been shown to cause any adverse effects in horses, though repeated uses of a PA instrument at one site in humans has been recorded to cause bruising (Haussler, 2020). A review article examining 26 studies which used PA to detect equine MNTs concluded that PA is a "repeatable, semi-objective" tool for measuring pain in horses (Haussler, 2020).

Back Pain in Equine Athletes

Research suggests that up to 94% of ridden horses will experience back pain in their careers (Marshall-Gibson et. al., 2023). The pain can be primary or secondary, often caused by underlying lameness or ill-fitting tack. This discomfort can negatively affect a horse's performance, even making it impossible for them to carry out their ridden jobs. Factors that influence a horse's development of back pain include age, duration of activity, correct training, conformation, and degenerative skeletal changes (Mayaki et. al., 2020). One study that investigated the premise of creating a universal equine back pain grading system found that horses with back pain are more likely to have limited hindlimb impulsion, pain and spasming upon muscle palpation, poor epaxial muscle development, muscle stiffness, and resistance to lateral bend (Mayaki et. al., 2020). A smooth, long, stride and strong, but not stiff, back are desirable for horses being used for dressage, hunters, equitation, show jumping, and eventing. Horse owners want their horses to feel comfortable in their backs because they will be happier, more agreeable to ride, move more correctly, and thus will receive better feedback from competition judges and instructors. A study investigating the reasons owners surrender their horses to rescue facilities cited health issues, inability to perform their intended work, and behavioral issues as the main horse-related reasons for surrender (Holcomb, 2010). Unfortunately, some horse owners are less likely to support their horse's care if they are unable to carry out their intended purpose due to pain.

Research Question and Hypothesis

The purpose of this study was to investigate the effects of WBV therapy on equine back soreness using PA-based findings. It was hypothesized that at the end of a 4-week treatment period, the subjects' overall MNTs would be greater than at day zero due to an increase in *m. multifidus* symmetry.

Materials and Methods

Criteria for Horses

Consent was gathered from the horse owners prior to beginning the study, as well as approval from the Otterbein University Animal Care and Use Committee (2019111). All of the horses used in this study were housed at the Austin E. Knowlton Center for Equine Science in Westerville, Ohio. Five horses were chosen based upon their ability to tolerate epaxial muscle palpation with the pressure algometer and comfortably back into and stand on the EquiVibe vibration therapy plate (Figure 3) for 30 minutes. The age range of these horses was 9-17 years, with the median age being 12 years and the average age being 12.6 years. Three subjects were privately owned horses and two were university-owned horses. The group consisted of 4 Warmbloods and 1 Friesian. The selected horses were sound, free of pain medications or non-steroidal anti-inflammatory medications, and in consistent medium work (3-5 days per week, not jumping more than once weekly) during this time period. Two of the horses originally chosen were injured (unrelated to the study) and prescribed daily NSAIDs and/or muscle relaxants during the first 4 weeks of the study. As a result, two new horses meeting the criteria were chosen and the data from the original two horses was discarded. Owners were surveyed at the end of the first and second 4-week periods and asked to note any dates when their horses participated in jumping, competitions, conditioning, or other abnormally exerting exercise so that if there were any outliers in the data the research team could refer to the horse's workload for that week. Horse owners were also asked to note any periods where horses were not ridden for more than three consecutive days.

Whole-body Vibrational Therapy Protocol

Horses did not receive any vibrational therapy during the first 4 weeks of the study. Starting on day 29, horses received WBV sessions 5 days per week. Sessions were performed on a vertically oscillating EquiVibe platform set to 40 Hz for 30 minutes. This frequency and duration was adapted from Halsberghe et. al's study on epaxial muscle symmetry and WBV (2018). Horses were supervised during this time and allowed to stand in any position that placed all four hooves on the vibrating platform.

Measurement of Mechanical Nociceptive Thresholds Alongside the Spine Using a Pressure Algometer

A Wagner Paint Test FPX 50 Algometer with the 1 cm diameter flat circular tip was used to collect MNTs. MNTs were measured at 8 points along each horse's spine once every 7 days for 9 weeks (labeled in this study as Weeks 0-8). MNT was measured 10 cm from the left side of the spine and 10 cm from the right side of the spine at the following sites: 10 cm, 25 cm, 40 cm, and 55 cm cranial of the palpable point of the tuber sacrale (Figure 4). These locations were adapted from a study by Varcoe-Cocks which used MNT to quantify muscle pain in racehorses, specifically the points focused on the muscles of the thoracolumbar spine (2006). These points were measured and marked with chalk at the beginning of each data collection day. MNT data points were collected with the horses restrained in crossties. The pressure algometer was used at the previously documented sites, while a second investigator documented the horse's reaction and noted when an avoidance behavior was displayed. For the purpose of this study, avoidance behavior was defined as local muscle twitching at the measurement site, stepping away from the algometer, back hollowing, hoof stomping, or the horse looking back at the handler. In order to minimize variables which may have elicited unrelated avoidance behaviors, measurements were collected in the same environment each time, with another horse on the cross ties within sight, and with the application of fly spray. When an avoidance behavior was demonstrated, the corresponding pressure reading from the algometer was recorded as the MNT for that point in kilograms of force (kgf) applied. Each point was measured three consecutive times to account for any "false" readings, for a total of 24 MNT readings per horse per week. If one of the three MNT readings was over two kgf above or below the other MNT readings for that point, a fourth MNT value was collected and the inconsistent value was discarded. The investigators handling the algometer and documenting avoidance behaviors remained the same throughout the study to prevent bias and maintain consistency. The algometer was positioned so that both parties were unable to see the force reading until after the avoidance behavior had occurred, as recommended by Haussler to prevent bias (2020). Each horse's behavior was scored on a subjective scale of 1 (quiet) to 5 (agitated) on measurement days, as an agitated horse may be more likely to display avoidance behaviors and therefore make the PA readings inaccurate.

<u>Descriptive Statistics</u>

The average of the 8 MNT measurements from each horse was calculated for weeks 0-8 and were graphed to explore a visual trend. For the purpose of statistical analysis, weeks 0-4 (No

Plate) and weeks 5-8 (Plate) were averaged separately and a repeated measures ANOVA was conducted for the average MNT across all horses at all sites. Similarly, a repeated measures ANOVA was used to analyze differences among individual sites. Student-Newman Keuls (0.05) post hoc student tests were used to determine the significance between means.

Results

Behavior Scores

Each horse scored a 1 or 2 for behavior scoring on each data collection day. Because of this consistency, behavior scores were not factored into the data analysis, as it is unlikely that tension or anxiety affected the MNT values that were collected.

<u>Overall Mechanical Nociceptive Thresholds</u>

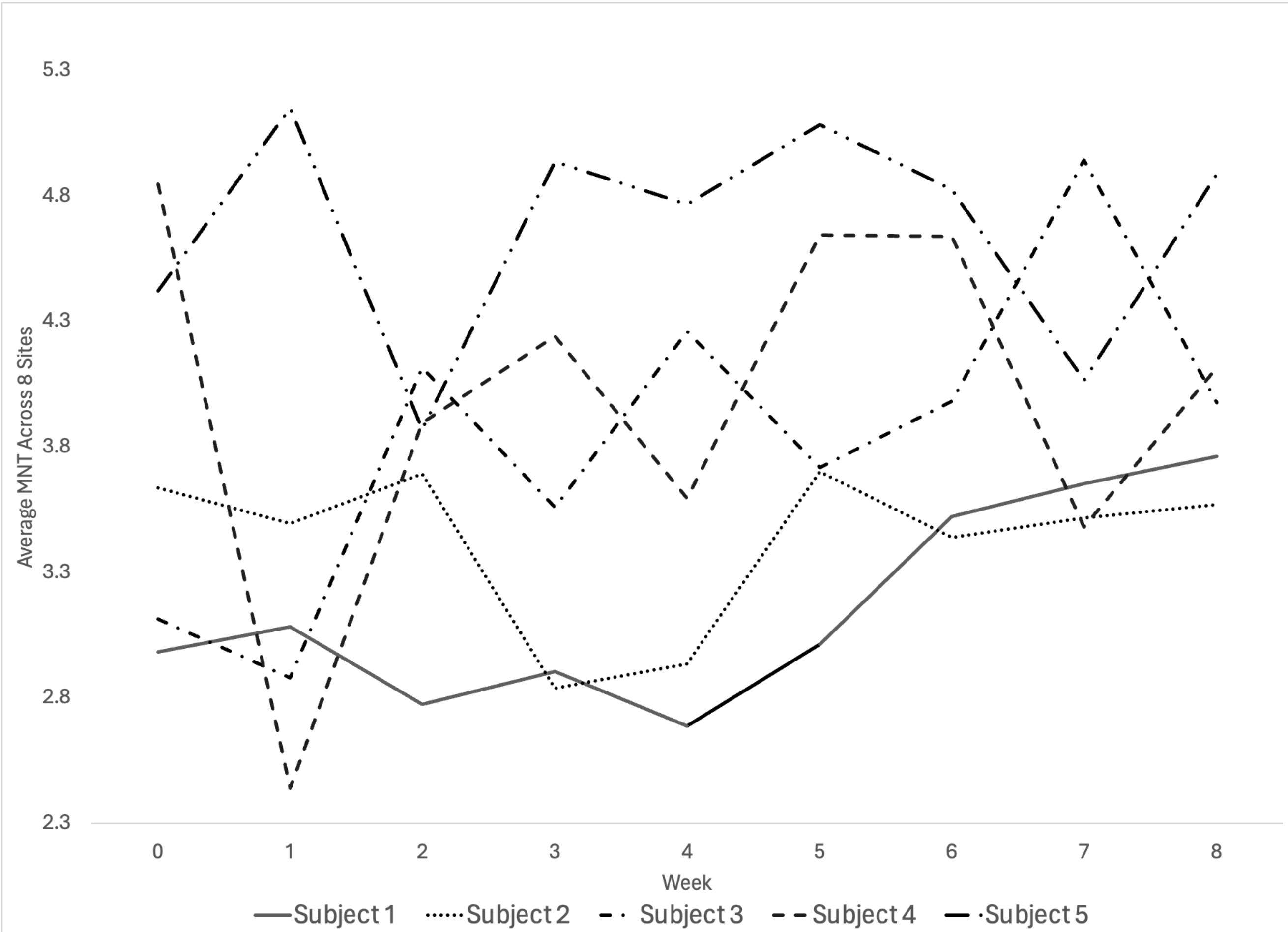

Figure 1: Visual depiction of the average MNT across all 8 sites for each subject. WBV sessions began during week 4. Only Subject 1 displayed a consistent upward trend in average MNT during the treatment period.

Table 1: Mean, standard deviation, difference, and *p*-value for the average MNT values across the 8 sites during the non-treatment (No Plate) and treatment (Plate) periods

Treatment	Mean & Std Dev	Difference	*p* -value
No Plate	3.8 ± 0.72	0.23	0.4467
Plate	4.03 ± 0.51		

Figure 1 was created to visualize the trends in overall MNT across the 5 subjects. Only one subject (Subject 1) displayed an upward trend in overall MNT during the treatment period (weeks 4-8). After visualizing these trends, a one-way ANOVA revealed that across all 5 subjects, there was no significant difference in average MNT across the 8 sites between the first 4-week period and the second 4-week period (p= [p < 0.05]).

Mechanical Nociceptive Thresholds by Site

Table 2. Mean value (in kgf), standard deviation, difference, and *p*-value for the non-treatment (No Plate) and treatment (Plate) MNT values for sites 1-8

Site	Treatment	Mean & Std Dev	Difference	*p* -value
1	No Plate	3.80 ±0.72	0.02	0.8923
	Plate	3.82 ±0.47		
2	No Plate	3.56±0.52	0.07	0.7276
	Plate	3.63±0.32		
3	No Plate	3.58 ±0.99	0.49	0.0339*
	Plate	4.08 ±0.71		
4	No Plate	4.71±1.39	0.71	0.1043
	Plate	5.42±1.26		
5	No Plate	3.41±0.7	0.18	0.1356
	Plate	3.60±0.61		
6	No Plate	3.01 ±0.35	0.62	0.0006*
	Plate	3.63 ±0.34		
7	No Plate	3.54 ±0.64	0.49	0.0141*
	Plate	4.02±0.47		
8	No Plate	3.66 ±0.75	0.5	0.0402*
	Plate	4.16±0.49		

The mean Plate MNT score was higher for each site than the No Plate score. Differences from the No Plate to Plate scores ranged from 0.02 kgf to 0.71 kgf. A one-way ANOVA test for each site's weekly measurements was performed to determine if there was a significant difference in MNT at each site during the treatment and non-treatment periods. Based on this test, sites 3, 6, 7, and 8 did show a statistically significant increase in MNT from the no treatment to the treatment period (p= [$p < 0.05$]). The MNT at these sites increased by 0.49, 0.62, 0.49, and 0.5 kgf respectively. Notably, three out of these four sites were on the right side of the horses' spines. There was no significant change at sites 1, 2, 4, or 5.

Discussion

Clinical Significance

It is difficult to state whether the hypothesis that frequent WBV sessions would increase epaxial MNTs was supported. Based upon the statistical analysis, half of the investigated sites displayed a significant difference in soreness from the nontreatment to treatment period. Three of these four points were on the right side of the horse's spine, indicating that the improvement in MNT was not symmetrical. These statistically significant increases in MNT ranged from 0.49 kgf to 0.62 kgf. When the MNT values across all 8 sites were averaged to create an overall back soreness score, no significant difference was found between the No Plate and Plate periods. Additionally, only one subject displayed an upward trend in average MNT (indicating a decrease in overall back soreness) during weeks 5-8 of the study. It does not appear that WBV caused any harm to the study subjects, as the calculated overall MNT and individual site MNTs all showed at least a minor upward trend from the No Plate to Plate periods.

The distinction between clinical significance and statistical significance is paramount in evidence-based medical practice (Page et. al., 2014). Recent literature regarding this difference states that statistical significance is necessary to interpret a null or directional hypothesis, but fails to tell the complete story in clinical research (Page et. al., 2014). When interpreting clinical research, it is important to consider the "treatment effect", or the magnitude and direction of the results (Page et. al., 2014). Data that is statistically significant may bear no clinical significance.

A standard model for determining treatment effect has yet to be popularized, so it is important that clinicians consider the extent and impact of change, risk, duration of effects, cost, and ease of use of a therapy when considering the true clinical implications of a published study (Ranganathan, 2015).

A paper by Challinor et. al. found that the average body weight of an equestrian out of a surveyed group was (2021). Knowing this information, it seems illogical to say that an MNT increase of less than 1 kg has a significant biological impact on a ridden horse's soreness. Thus, this research supports the current literature that suggests that WBV has little identifiable biological effect on horses.

<u>Limitations and Implications for Future Research</u>

There are several areas where this study could have been enhanced. To begin, the sample size in this study was small. Only 5 horses were used due to the time commitment of the WBV sessions and PA data collection. Another shortcoming in the execution of this study was the need to replace Subject 4 two weeks into the study and Subject 5 three weeks into the study. While the replacement horses underwent the same 8-week study (4 weeks of No Plate, 4 weeks of WBV), it is possible that they may have been exposed to different weekly conditions than the other horses. This study took place in the fall and there was a significant drop in average ambient temperatures over the course of the study, which may have contributed to extra tension or soreness in the subjects.

The Halsberghe et. al. study that initially found WBV effective in increasing *m. multifidus* symmetry performed two 30-minute sessions of WBV therapy per day 5 days per week during the trial period (2016). This study, with one primary undergraduate investigator, did not have sufficient resources to duplicate that methodology, and sessions were limited to once per day. While this may appear to be a design flaw in this study, it is important to consider the feasibility of a treatment plan when evaluating its therapeutic efficacy. Many horse owners may not be able to supervise their horse while it stands on a WBV platform 5 days a week for a total of an hour each day. The methods in this study replicated a more realistic protocol for horse owners to recreate. *M. multifidus* symmetry was not assessed as a part of this study. The Halsberghe study on WBV and *m. multifidus* symmetry performed sessions for 60 days, but noted an increase in symmetry by day 30 (2016). In the future, it may be prudent to perform the MNT testing alongside ultrasonography to measure the widths of the *m. multifidus* muscles to confirm that the muscles are gaining symmetry while measuring change in MNTs. This would provide a definitive answer in regards to the connections between WBV, muscle symmetry, and back soreness.

<u>Implications for Veterinary Practitioners and Horse Owners</u>

Equine back soreness is difficult to diagnose and treat because it has many potential causes and influencing factors. Back pain can be caused by poor saddle fit, incorrect riding, primary lameness, bony or soft tissue lesions on the spine and in surrounding ligaments and musculature, and primary neurologic disorders (Mayaki et. al., 2020). There are many allopathic veterinary techniques used to treat equine back pain as well as complementary therapies. Horses may be treated with systemic NSAIDs, steroids, or muscle relaxants, or platelet-rich-plasma, IRAP, or steroid injections into the intervertebral spaces or the sacro-iliac (SI) region (Riccio, 2018). Ultrasound-guided injection of steroids into the intervertebral facets and sacroiliac region, followed by mesotherapy were perceived to have the greatest efficacy for treating back soreness in a group of surveyed veterinarians in 2016 (Riccio, 2018). Complementary treatments for back pain include PEMF therapy, chiropractic treatment, massage, and acupuncture (Riccio, 2018).

Conclusion

The results of this study suggest that WBV decreases MNT at some sites along the equine epaxial muscles by less than 1 kgf. When considering the overall MNT across all 8 sites, no significant difference in MNT was found between the No Plate to Plate period. Considering the weight of a person sitting atop a ridden horse, it is difficult to state whether this statistical significance translates into clinical significance. Other studies have found that vibrating therapy does little to affect physical parameters. These studies have shown that WBV does not have any significant effect on muscle activity, stride length, baseline lameness score, core temperature, skin temperature, bone mineral content, pulse, or respiratory rate (Buchner et. al., 2016; Nowlin et. al., 2017; Maher et. al., 2017). The study by Nowlin noted that horses receiving WBV do seem to elicit anecdotal signs of relaxation, such as lowering their head and standing more calmly on the vibrating platform than horses in the control group (2017). With this information, Nowlin postulated that the calming effects of WBV may have led to the perception of its benefit in horses today (2017). Further research investigating the effect of WBV on equine salivary cortisol did reveal that cortisol levels were lowered in subjects immediately following, 2 hours, 4 hours, and 24 hours after a 45-minute WBV session (Sugg et. al., 2019). This finding indicates that WBV may lower stress in equine subjects. With so many options for owners to consider for minimizing equine back soreness and enhancing athletic performance, it is useful to note that WBV is not a proven solution, especially with the consideration that the vibrating plates cost upwards of $4,000 (EquiVibe Website). Given the information in the literature review and the results for this study, it would be prudent for horse owners to focus their time and funds on more established treatments if their horse is experiencing back pain.

Appendix A: Animal Care and Use Committee Approval Form

Animal Care and Use Committee Approval Form Date of Approval: 1/16/19 (2019111)

Participant: Riley Leibeck

Faculty: Dr. Sheri Birmingham

Project Title: Effects of Whole Body Vibrational Therapy on Epaxial Muscle Soreness in Horses

Approved By: Animal Care and Use Committee 2022-2023

Committee Chair: Dr. Sheri Birmingham

Appendix B: Figures

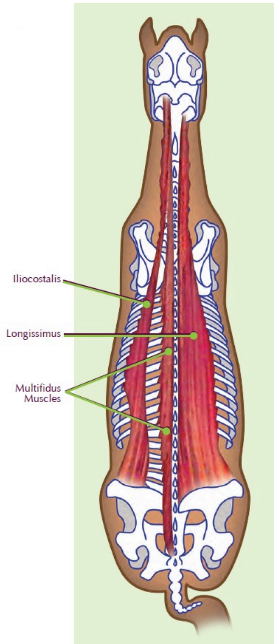

Figure 2. A diagram of the equine epaxial muscles detailing the location of *m. multifidus* (Day, 2020)

Figure 3. The vibrating platform used in the study.

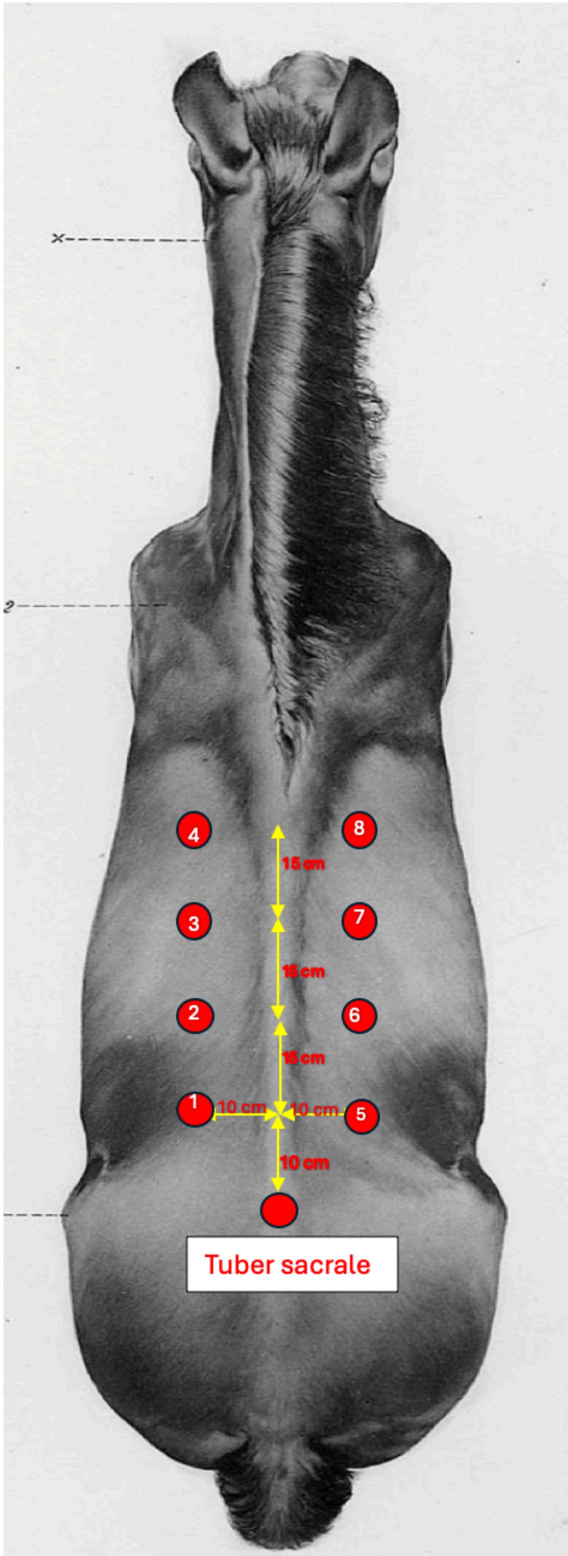

Figure 4. Diagram indicating the locations of the 8 MNT collection sites

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