Prevalence of lameness in carriage horses in Yucatan, Mexico

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ABSTRACT

The main objectives of this study were (i) to estimate the prevalence of abnormal findings during a passive examination for detection of musculoskeletal injury (ie, palpation and manipulation of forelimbs, hind limbs, neck and the back) and (ii) to estimate the prevalence of lameness by using a visual examination and a 0 to 5 grade lameness scoring system in carriage horses that work in the city of Merida, Yucatan, Mexico. A secondary objective was to examine the associations between ride distance, ride duration, most common abnormal findings during the passive examination for detection of musculoskeletal injury and lameness in carriage horses in Merida, Yucatan. In the passive examination, the most common abnormal finding was a palpable enlargement of the deep digital flexor tendon (DDFT), superficial digital flexor tendon (SDFT), and suspensory ligament (SL) in fore- and hindlimbs. The frequency of horses with one or more hooves with a high angle (≥ 59o) was higher in hindlimbs (16/41 or 39%), compared to forelimbs (6/41 or 15%) (P = 0.01). In the active examination, prevalence of lameness (grade ≥ 2) was 37/41 or 90%. Prevalence of lameness was higher in hindlimbs (31/41 or 76%), compared to forelimbs (23/41 or 56%); but this difference did not reach statistical significance (P = 0.08). Median distance and median duration per ride were higher in horses affected with focal enlargement of the SDFT in hindlimbs

than in non-affected horses ($P < 0.05$). Study results justify the need to assist carriage horse drivers by promoting education and training programs on farriery, management and prevention of lameness in carriage horses that work in the city of Merida, Yucatan.

INTRODUCTION

Horse-drawn carriage rides are an attraction for national and international tourists who visit Merida, the capital city of Yucatan, Mexico. This activity serves about 100,000 national and international tourists annually. Tourists go for a ride to explore the historic sites of the city, a 45-minute ride for 2 to 4 people. The posted ride price is $200 MXN pesos (~ 15 US dollars) per ride. Some tourists bargain and pay as low as $100 MXN pesos, and the number of passengers including the carriage horse driver can range from 2 to 6. Other tourists decline a ride because some carriage horses may often show a poor physical appearance (eg, poor body condition, skin or foot lesions, lameness).

According to local veterinarians, horse size and overloading and lameness are important animal health and welfare issues of concern in carriage horses in Yucatan. Part of the problem is that the use of veterinary services has been neglected in carriage horses in Yucatan for many years. Carriage horse drivers consider veterinary services to be expensive, so they attempt to treat their own horses. In conversations with the authors of this study, carriage horse drivers recognize their limited knowledge on proper hoof trimming and shoeing techniques for control and prevention of musculoskeletal injury and lameness in their horses. In the scientific literature, knowledge regarding lameness in carriage horses is very limited. Applied research is needed to generate information on the frequency and factors associated with lameness, so that effective education programs can be formulated to control and prevent this condition in carriage horses. The main objectives of this study were (i) to estimate the prevalence of abnormal findings during a passive examination for detection of musculoskeletal injury (ie, palpation and manipulation of forelimbs, hindlimbs, neck and the back) and (ii) to estimate the prevalence of lameness by using a visual examination and a 0 to 5 grade lameness scoring system in carriage horses that work in the city of Merida, Yucatan. A secondary objective was to examine the associations between ride distance, ride duration, most common abnormal findings during the passive examination for detection of musculoskeletal injury and lameness in carriage horses.

METHODS

Study area

The study was conducted in Merida, the capital city of the state of Yucatan, Mexico. The population is ~ 800,000 people.[a]

Study population

At the time of this study, there were 80 carriage horses owned by 49 carriage drivers in the city of Merida. All drivers were registered in a local association of carriage horse drivers. Most drivers own 1 to 2 horses. Most horses are housed in the backyard of carriage drivers' urban homes. On average, each horse works 4 to 8 hours every other day.

Study horses

In May 2007, 29 carriage drivers were randomly selected from a list of 49 drivers to provide a sample of 44 horses. The assumptions used to obtain this sample size were the following: (i) prevalence of horses affected with lameness in one or more limbs = 50%; (ii) accepted error = 10%; (iii) level of confidence = 95%; (iv) power = 80%; and (v) on average, each driver owns 1 to 2 horses. A computer program[b] was used to generate random numbers (ie, select horses) needed in this study. Selected drivers were invited to participate in the study, were offered a compensation of $200 pesos per horse to participate, and were scheduled for a home interview and an examination of the horse(s) during June-July 2007. One of 29 drivers declined to participate; six additional drivers were not found in their homes and were not included in this study. Three drivers (who were not initially selected) were referred by other participants and were included. A total of 43 horses were initially considered for inclusion. Two horses were reported as retired and were excluded. The final enrollment included 25 drivers and 41 horses. Twenty-four drivers accepted and received the compensation of $200 pesos per horse.

Study design

The study was designed as a cross-sectional study. To accomplish the two main objectives, a passive examination for detection of musculoskeletal injury and an active examination for diagnosis of lameness by using a grading system with a scale of 0 to 5 were conducted on each study horse.[1] The approach to the secondary objective included a statistical analysis to evaluate the associations between ride distance, ride duration, most common abnormal findings during the passive examination and lameness in study horses.

Diagnosis of lameness

Passive musculoskeletal examination. Each study horse was examined by one of the authors (SK). The examiner was trained by one of the authors (MPB), using a horse maintained for teaching purposes at the University of Florida. The goal of the training was to standardize the following observations: structures palpated, positioning of the limb for palpation, criteria for categorizing abnormalities, and the results of hoof examinations. The exam used a systematic approach (with the horse standing at rest) and consisted of palpation and manipulation of forelimbs, hindlimbs, neck and the back, as previously described.[2] The hoof was examined for the presence of shoe and nail placement, medio-lateral balance, and sole condition. Tissue enlargements were described by location and as focal or diffuse in regard to the digital flexor tendons. Range of motion was evaluated by passive flexion of the joints in the fore and hindlimbs. Hoof pain was assessed by using hoof testers as previously described.[1] In order to reduce risk of misclassification bias (false sensitivity), hoof tester responses were compared with those obtained from the opposite foot. Responses were recorded as sensitivity present (yes, no); if yes, the anatomic location was recorded. Finally, the hoof angle was determined by using a hoof gaugec as previously described.[1] In forelimbs, angles from 48˚ to 55˚ were classified as normal;[3] in hindlimbs, angles from 48˚ to 58˚ were classified as normal.

Active examination for diagnosis of lameness. Each study horse was examined by one of the authors (SK). The degree of lameness was determined by using the lameness grading system (grade 0 to 5) of the American Association of Equine Practitioners.[1] The horse was exercised in a straight line, on the flattest, paved surface available close to the carriage driver's home. The lameness evaluation of each horse was recorded by using a video-camerad. The limb(s) affected and the grade of lameness was independently evaluated and confirmed by one of the authors (MPB). In this study, perineural or intra-articular analgesia was not used to identify the site or sites of pain associated with lameness. Radiographic or ultrasonographic examinations were not used to confirm the source of lameness.

Data collection

A structured questionnaire was developed for collection of data. Information requested was organized in four sections: (i) owners' information; (ii) horse information; (iii) passive musculoskeletal examination; and (iv) active examination for diagnosis of lameness. The questionnaire was completed during a personal interview (in Spanish) with the carriage driver moments prior to the passive and active examinations during June-July 2007. For each horse, the following data were collected: gender (stallion, gelding, mare); estimated age (years) as reported by the horse owner and confirmed by dental examination; working status (in-work, in-training); presence of shoes; lameness grade (0 to 5); body weight (kg); body condition score; height (cm); purchase price (MXN pesos; US dollars); working days

Table 1. Description of study horses (n = 41).

Variable	Number of horses
Gender	
Stallion	17
Gelding	14
Mare	10
Working status	
In work	39
In training	2
Number of shoes	
Four	23
Three	3
Two (fore pair)	5
Two (hind pair)	6
One	1
Not Shod	3
Age (years)	7 (5, 9)*
Body condition score	5 (4, 5)
Estimated body weight (kg)	295 (266, 317)
Height measured (cm)	135 (132, 140)
Purchase price (MXN pesos)	6,750 (5,000, 7,000)
Purchase price (US dollars)	675 (500, 700)
Working days/week	3 (3, 4)
Years owned	2 (1, 5)
Shoeing frequency (weeks)	4 (4, 4)
Carriage drive services	
Average number of passengers per ride	3 (3, 4)
Distance of ride (km)	4 (2, 6)
Duration of ride (minutes)	45 (40, 45)
Number of rides per day	3 (2, 3)

** Data shown as median (1st quartile, 3rd quartile).*

per week; years owned; shoeing frequency (weeks); average number of passengers per ride; average distance per ride (km); average duration per ride (minutes); and number of rides per day. Body weight was estimated by using a commercially available weigh tapee. The tape was wrapped around the heart girth of the horse, directly behind the elbow. Using the same tape, the height at the withers was measured as previously described.[4] Body condition was determined by using a condition scoring system with a scale 1 to 9, with 5 being ideal, 1 being extremely emaciated, and 9 being extremely fat.[5]

Statistical methods

The prevalence of abnormal findings during the passive examination and the prevalence of lameness were calculated by dividing the number of affected horses by the total number of horses examined. Ninety-five percent confidence intervals (95% CI) were calculated for each point-prevalence estimate. The null hypotheses that the frequencies of horses with one or more hooves with a low angle (i.e., $\leq 47^{o}$), a high angle (fore: $\geq 56^{o}$; hind: $\geq 59^{o}$), palpable enlargement of the SDFT, DDFT, or SL were not different between forelimbs and hindlimbs were tested by using the McNemar's chi-square test. The associations between lameness and hoof angle and palpable enlargement of the SDFT, DDFT, or SL in fore- or hindlimbs were tested by using a chi-square test. Finally, the reported number of passengers per ride, ride distance (km), ride duration (minutes), and number of rides per day were compared between horses classified as lame and non-lame, between horses with and without one or more hooves with a low or high angle, as well as between horses with and without palpable enlargement of the SDFT, DDFT, or SL in fore- or hindlimbs by using the Wilcoxon rank sum test. Values of $P \leq 0.05$ were considered significant. A power analysis was conducted when a relevant difference was observed and the P value > 0.05 and ≤ 0.10.

RESULTS

Study horses

Most horses (17/41) were stallions (Table 1). The median age of study horses was 7 years (1st quartile = 5; 3rd quartile = 9). Median

Table 2. Results of the passive exam in study horses (n = 41).

Variable	Number of horses (%)	95% confidence interval (%)
Forelimbs		
Bottom of hoof: wound present	1 (2)	0, 7
Heel: wound present	3 (7)	0, 15
scar present	2 (5)	0,11
pain elicited	1 (2)	0, 7
Coronary band (scar present)	2 (5)	0, 11
Firm focal enlargement over sesamoids	13 (32)	17, 46
Cannon bone: sensitive dorsal cortex	4 (10)	1, 19
roughened dorsal cortex	2 (5)	0, 11
SDFT: diffuse enlargement	27 (66)	51, 80
focal englargement	6 (15)	4, 25
DDFT: diffuse enlargement	30 (73)	60, 87
focal enlargement	14 (34)	20, 49
Suspensory ligament: body enlargement	16 (39)	24, 54
branch enlargement	8 (20)	7, 32
Superior check ligament: pain elicited	1 (2)	0, 7
Accessory ligament DDFT enlargement	1 (2)	0, 7
Carpus: Capsular thickening	7 (17)	6, 29
Flexion: limited range of motion	8 (20)	7, 32
Fetlock flexion: limited range of motion	6 (15)	4, 25
Back pain elicited	5 (12)	2, 22
Normal hoof angle (48º to 55º)	30 (73)	60, 87
Low hoof angle (≤ 47º)	5 (12)	2, 22
High hoof angle (≥ 56º)	6 (15)	4, 25
Hind limbs		
Bottom of hoof: thrush present	1 (2)	0, 7
Firm focal enlargement over sesamoids	8 (20)	7, 32
SDFT: diffuse enlargement	4 (10)	1, 19
focal enlargement	22 (54)	38, 69
DDFT: diffuse enlargement	5 (12)	2, 22
focal enlargement	38 (93)	85, 100
Suspensory ligament: body enlargement	5 (12)	2, 22
branch enlargement	26 (63)	49, 78
Fetlock flexion: limited range of motion	0	
Churchill hock test: positive (abduc-tion)	21 (51)	36, 67
Patellar fixation test: positive (catch)	4 (10)	1, 19
Trochanteric bursa: pain elicited	20 (49)	34, 64
Gluteal pain elicited	6 (15)	4, 25
Normal hoof angle (48º to 58º)	24 (59)	43, 74
Low hoof angle (≤ 47º)	1 (2)	0, 7
High hoof angle (≥ 59º)	16 (39)	24, 54

height was 135 cm (132, 140). Median body weight was 295 kg (266, 317).

Passive examination findings

In forelimbs, the most common abnormal findings were diffuse enlargement of the DDFT (30/41 horses) and SDFT (27 horses), as well as body enlargement of the SL (16 horses) (Table 2). Similarly, in hindlimbs, the most common abnormal findings were a focal enlargement of the DDFT (38 horses) and SDFT (22 horses), and branch enlargement of the SL (26 horses). All affected horses with a palpable enlargement of the DDFT, SDFT, or SL were not sensitive to palpation. In addition, 33 of 41 horses had all 4 hooves out of balance. The frequency of horses with one or more hooves with a low angle (≤ 47o) was higher in forelimbs (5/41 or 12%) than in hindlimbs (1 or 2%); but this difference was not significant (P = 0.10). The frequency of horses with one or more hooves with a high angle (≥ 59o) was higher in hindlimbs (16 or 39%), compared to forelimbs (6 or 15%) (P = 0.01).

Active examination findings

All 41 horses were identified as affected with lameness (grade ≥ 1) in one or more limbs. Most horses (36/41) had a lameness grade of 2; only 1 horse had a lameness grade of 3. No horses showed lameness grade of 4 or 5. Prevalence of lameness (grade ≥ 2) was 37/41 or 90% (95% CI = 81, 99). Prevalence of lameness (grade ≥ 2) was higher in hindlimbs (31/41 or 76%), compared to forelimbs (23/41 or 56%); but this difference did not reach statistical significance (P = 0.08). Finally, 7 horses had ipsilateral lameness and 9 horses had contralateral lameness (grade ≥ 2).

Association between abnormal findings in the passive examination and lameness

In forelimbs and hindlimbs, palpable enlargement of the SDFT, DDFT, or SL, as well as hoof angle were not associated with lameness in fore- or hind limbs (P ≥ 0.11).

Association between enlargement of the SDFT in hindlimbs and ride distance and ride duration

Median distance per ride was higher in horses affected with focal enlargement of the SDFT in hindlimbs (median = 5 km; 1st quartile = 3, 3rd quartile = 6) than in non-affected horses (3 km; 2, 5) (P = 0.03). In addition, median duration per ride was longer in horses affected with focal enlargement of the SDFT in hindlimbs (45 minutes; 45, 45) than in non-affected horses (40 minutes; 30, 45) (P < 0.01).

DISCUSSION

This study provides new information on the prevalence of lameness in carriage horses that work in the city of Merida, Yucatan. Overall, study results revealed that the most common abnormal findings in the passive examination were a palpable enlargement of the DDFT, SDFT, or SL in fore- and hindlimbs, as well as a high frequency of horses with one or more hooves with a high angle (≥ 59o) in hindlimbs. In the active examination, prevalence of lameness in one or more limbs in study horses was high. Prevalence of lameness (grade ≥ 2) was higher in hindlimbs than in forelimbs. Finally, ride distance and ride duration were longer in horses affected with palpable enlargement of the SDFT in hindlimbs, compared to non-affected horses.

The scope of the present study was descriptive, and its main strength was the random sampling approach used to estimate the prevalence of abnormal findings during the passive examination and the prevalence of lameness in study horses. This study, however, has several limitations. The study used carriage horses that work in Merida, Yucatan. Thus, study results cannot be extrapolated to other carriage horses in Mexico or other countries. The sample size in our study was sufficient to estimate the prevalence of musculoskeletal injury and lameness in the study population, but it was small to adequately examine associations between lameness and abnormal findings during the passive examination. In addition, the study was designed as a cross-sectional study, and this approach limited our ability to properly examine the temporal relationship between lameness and hoof angle, and palpable enlargement of the DDFT, SDFT, or SL. The observed changes in the DDFT, SDFT, and SL were not confirmed by use of ultrasonography, and this was another study limitation. It is possible that the use of ultrasonography could have reduced the potential misclassification of horses as affected or not affected during the passive examination (i.e., in some horses it can be difficult to distinguish a palpable enlargement of the accessory ligament of the DDFT from the SL and DDFT). However, we believe our study results are relevant and can have practical application in the formulation of education programs to reduce the risk of musculoskeletal injury and lameness and to improve the welfare conditions of carriage horses in Yucatan.

Passive musculoskeletal examination

The most common abnormal finding in forelimbs and hindlimbs was enlargement of the DDFT, SDFT, or SL. In this study, all horses affected with a palpable enlargement of the DDFT, SDFT, or SL were not sensitive to palpation; an indication that an old or inactive injury was present. The high frequency of palpable enlargement of the DDFT, SDFT, or SL observed in carriage horses can be attributable to poor hoof trimming and foot balance, and repetitive loading.6-9 In this study, for example, results from the passive examination revealed that 4 of every 5 study horses had all 4 hooves out of balance.

In this study, the frequency of horses with one or more hooves with a high angle (≥ 59o) was higher in hindlimbs than in forelimbs. One explanation for the observed association between high hoof angle and hindlimbs can be poor hoof trimming technique resulting from excessive trimming of the toe and minimal trimming of the heel.6 Another explanation provided by local veterinarians is the use of a wrong shoe size (i.e., too small) and trimming of the hoof to fit the shoe. High hoof angles create a broken-forward appearance of the hoof and pastern. A broken forward hoof-pastern axis is associated with a hoof capsule where the angle of the dorsal hoof wall is higher than the angle of the dorsal pastern.[10] An axis that is broken forward increases pressure on the dorsal section of the hoof and unloads the DDFT,[10] and it also extends the metacarpophalangeal joint slightly.[6]

Active examination for diagnosis of lameness

The prevalence of carriage horses classified as lame (grade ≥ 2) was 37/41 or 90% (95% CI = 81, 99). Even though 1 horse only had a lameness grade of 3, the prevalence of lameness with a grade ≥ 2 is high and justifies the need to educate and train carriage horse drivers on how to control and prevent lameness in their horses. To our knowledge, no other studies have reported prevalence estimates of lameness in carriage horses in Mexico or in other countries.

The prevalence of lameness was higher in hindlimbs (76%), compared to forelimbs (56%). Even though this difference did not reach statistical significance ($P = 0.08$), we believe this result has clinical relevance. It is possible that carriage horses have a higher frequency of lameness in hindlimbs as a result of their occupation gait characteristics, similar to Standardbred racehorses or other horses used for performance events (eg, dressage, cutting, and reining).[1] Carriage horses may place greater stress on hindlimbs making them more susceptible to lameness in hindlimbs, compared to other horses (ie, Thoroughbred racehorses).[1] It is possible that our failure to declare a significant difference of lameness between fore- and hindlimbs was attributable to low statistical power. If the true difference in prevalence of lameness in hind- and forelimbs is 20%, then the power of detecting this difference given the sample sizes used was 43% at the 5% level of significance.

Associations between palpable enlargement of the SDFT in hindlimbs and ride distance and ride duration

The reported ride distance and ride duration were higher in horses affected with focal enlargement of the SDFT in hindlimbs, compared to non-affected horses. Even though the accuracy of these two measurements was not evaluated in this study, these findings justify the need to further examine the relationship between tendon and ligament injury and measurements for repetitive loading in carriage horses in future studies. To our knowledge, studies on the frequency of DDFT, SDFT, or SL injury in carriage horses have not been reported. However, overstrain injuries to the SDFT and SL are among the most common musculoskeletal injuries observed in National Hunt, Thoroughbred, and Standardbred racehorses.[7,11-14] In previous studies, repetitive episodes of cyclic overloading (on a high-speed equine treadmill) resulted in hypertrophy of collagen fibrils for core regions of the SDFT and SL in Thoroughbreds.[7-8] This effect can be attributable to breakdown of larger diameter fibrils, resulting in weakening of the tendon structure, development of further micro-traumatic changes and clinical tendonitis.[7-8]

In summary, study results revealed that a high frequency of horses was affected with a palpable enlargement of the DDFT, SDFT, SL, or lameness. In addition, study results revealed that a high frequency of horses had all 4 hooves out of balance, or had one or more hooves with a high angle ($\geq 59^{o}$) in hindlimbs. These findings justify the need to promote education and training programs for farriery, management, and prevention of lameness in carriage horses. This action may help reduce the incidence of musculoskeletal injury and lameness and improve the welfare conditions of carriage horses in Yucatan.

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