# CHARACTERISTICS OF COMMON RACEHORSE FRACTURES

By

Maria Guadalupe Esparza

A capstone project submitted for Graduation with University Honors

May 6, 2022

University Honors

University of California, Riverside

APPROVED

Dr. David Reznick

Department of Evolution, Ecology, and Organismal Biology

Dr. Richard Cardullo, Howard H Hays Jr. Chair

University Honors

**Abstract**

Horse racing has been a favorite pastime for many individuals dating back to as early as the first Olympic Games in Greece. It can be a very profitable sport, if your luck is good, and everyone can be a winner, but at whose expense? Horses are often seen as majestic stoic creatures that have always been praised for their usefulness. Their strength and mobility are due to their structure but come at a cost. The leading cause of death for racehorses is fractures. In the racehorse industry horses with fractures are often put down because the likelihood of recovery is slim to none. Musculoskeletal injuries are undergoing research at California Horse Racing Board (CHRB) in the post-mortem examination program as a client of the California Animal Health and Food Safety (CAHFS) Laboratory of the University of California Davis (UCD) in hopes of understanding and providing preventative measures to reduce the injuries. In this paper, we explore the musculoskeletal cases that have come through the CAHFS laboratory in San Bernardino over the past 4 years. We will try to determine if sex, age, and breed have an effect on the type of fractures that occur in these horses. In this research, we cataloged 14 different fractures and focused on the top three fractures: fetlock, humerus, and carpal. Most common injuries seen affected the forelimbs of the horse. Fetlock fractures were 45% of the fractures submitted, and have an even distribution of limbs affected, and age, indicating all can be susceptible to fetlock fractures. Humeral fractures were the second most common about 11% occurring most at ages 2-4 years old and predominantly occurred on the right leg (60%). Carpus fractures were the third most common at 8% all occurring in the right leg, and the majority occurring in ages 2-4-year-olds. These fracture patterns prompted further research on racehorse fractures to reduce the harm to these horses.

**Acknowledgments**

I greatly appreciate the help of those who have guided me throughout this project. I am extremely grateful for the advice and mentorship of Dr. David Reznick throughout this process. With his guidance, we bounced ideas on how to pursue this project and without his help, this project would not be as it is now. I am thankful for his assistance and insight as it helped in the development of this project.

Additionally, I would like to thank CHRB and CAHFS San Bernadino for allowing me to conduct this research based on the necropsied cases. I would like to personally thank the Branch Cheif Dr. Francisco Uzal for the approval to pursue this project, and I would also like to thank him for requesting the CHRB director's permission to use their cases as well. If it wasn't for this I would not have been able to access the data for this project. I would like to acknowledge the work done by the necropsy department that conducted the necropsies and taught me the skills to navigate and access past cases to gather the data. A special thank you to Dr. Monika Samol for helping me understand the data and teaching me the information to fully understand the research, without her I would not have been able to understand the importance of the data and why it is significant.

Lastly, I would like to recognize the Honors Program at UCR for providing me the freedom to pursue a topic I was interested in. I am also thankful for the support provided by the program throughout my years as an Undergraduate. As I graduate and continue pursuing a career in research I will use the experiences and skills this has taught me and implement them as I continue with school.

**Table of Contents**

## Introduction

As a little girl horses were my favorite animal. They were always known to me as Caballos, the Spanish word for horse. I grew up near a racetrack. The city I grew up in was famous for parades. During those parades, horses were my favorite part. I also grew up watching western movies, both in English and Spanish, and fell in love with the magic and loyalty that is the horse. I am not alone for my love of horses.

Horses have always been praised for their usefulness in transportation, hauling, battle, and leisure. Without horses, the history and culture of mankind would have been different. Their strength and swiftness and mobility transformed our existence. In early history, horses symbolized royalty and gave a person status of class and privilege. They are often seen as a symbol of luxury and power. All of these traits also contribute to the imagery of the grandeur of racehorses (Lawrence pg. 223).

Horse racing is one of the oldest sports and has been seen as the "sport of kings" (Britannica). It developed from the diversion of the elite class to a huge public entertainment business for all to enjoy. The history of the first horse racing can be dated as far back as the 700-40 BCE in the Olympic games in Greece. They were also used for entertainment in the Roman Empire. As racing modernized and the sport continued to spread all across the world, they have match advanced to what they are today. Horse racing spread to America in 1665 and continues to be a great pastime for many people.

But what about the horses? What is the harm to the horses? Horses are built differently; they have evolved to walk far distances and to be very fast. Their evolution has led to a unique combination of strength, speed, and endurance. These are the key reasons why they are chosen for racing. However, if they were to be injured, it can cost them their life. In the racehorse

industry horses with catastrophic fractures are often put down because recovery for horses is unlikely. Horses are not meant to lie down, and if they are not on their feet during recovery it often leads to more complications, and sadly they would have outlived their usefulness in the racehorse industry.

Catastrophic musculoskeletal injuries are the predominant cause of euthanasia, and spontaneous death in racehorses (Diab, Stover). Musculoskeletal injuries are still the top issue undergoing research. The post mortem program between Califonia Animal Health Food and Safetly (CAHFS), Univeristy of California Davis (UCD), and California Horse Racing Board (CHRB), works together to catalog and research injuries. This program was developed to determine the cause, and generate the data to develop prevention strategies in hopes of understanding fracture patterns in racehorses. With the continuing research we hope to create preventative measures to reduce the number of injuries for both the horse and the rider. Dr. Monika Samol, in the Journal of Veterinary Diagnostic Investigation (2021) states that musculoskeletal injuries caused about 83% of deaths within the racing industry in California and elsewhere (pg. 788-791).

In this investigation we explore the following question: Does sex, age, breed, and the type of track have an effect on the type of fractures that occur on these racehorses. I predict that those horses of younger age, have a higher tendency of injuries than older horses no matter the sex, breed, and type of track because the impaired maturation of their bones caused by strenuous exercise makes them more susceptible to injury. The importance of this research helps maintain the integrity of the horse, and to prolong their lifespan. To protect the health an safety of these animals, so that they may continue to thrive, and make horse racing a safe space for them as well.

## Methods and Materials:

I work at California Animal Health and Food Safety (CAHFS) diagnostic lab in San Bernardino as a Student Necropsy Technician. It is one of 4 diagnostic labs a part of UC Davis veterinary medicine. It is the backbone of California's warning system that helps to protect the health of California's livestock and poultry. CAHFS runs in partnership with the California Department of Food and Agriculture, UC Davis veterinarians, and livestock and poultry producers. They provide services that protect the animal, public health, and food supply. As a client of CAHFS, the California Horse racing board (CHRB) is a governing body of all California racetracks. According to their law, every horse that dies at any facility under their jurisdiction needs to undergo a mandatory post-mortem examination. This is how post mortem examination program was established in 1990. Its mission statement is to ensure the integrity, viability, and safety of the California horse racing industry. The CHRB diagnostic approach to catastrophic musculoskeletal injuries in racehorses was developed to research and understand the characteristics of injuries in hopes it would shed a pattern and lead to preventative measures and reduction in loss of racehorses to injuries.

For this investigation, I was given approval by the Branch Chief of CAHFS San Bernardino and the Director of CHRB to conduct this investigation using their data from the cases submitted at the San Bernardino branch. In this investigation, I will look into cases from the years 2018 -2021, written by Dr. Samol, from race tracks in Southern California and see if there is a pattern between age-sex breed and the type of track, and the type of fractures that occur. In this, we kept track of the breed of the horse Quarter Horse or Thoroughbred, the type of fracture, which limb it occurred on left/right, front/hind, the type of track dirt/turf, age, and sex male/female. Looking at this information we will put it together and see if any patterns emerge.

In this, we hope to shed light on the patterns, to further promote research, reduce the amount of catastrophic musculoskeletal injuries in racehorses and improve the safety of both the horse and the rider.

## Data Analysis and Results:

Data analysis:

In this research, data collected were the breed of horse, sex, type of fracture, age, type of track, and which leg was affected. In total we did an overall analysis of all 154 cases. In each case we analyzed and catalogged what was the overall distribution of ages, sex, breed, and types of track seeing the percentage of each compared to the whole data set (figures. 1-5). Further analysis was done focusing on the three most common fractures: Fetlock, Humerus, Carpal (highlighted focus fractures in figure 13) . In each of the fractures we further broke down the distributions for ages, sex, breed, and types of track for each individual fracture, seeing the percentages of each, and then comparing and contrasting (seen in figures. 6-9).

Results:

Throughout the timeline, focusing on Southern California racetracks necropsied by Dr. Samol, 154 cases were submitted with musculoskeletal fractures in horses from race tracks in Southern California to CAHFS. These cases report 13 different fractures, plus a separate category of horses with multiple fractures (fig. 1). The most common fracture was the fetlock fracture, which comprised 45% of all fractures. Next came humerus (11%), carpal (8.5 %), and proximal phalanx (6%) fractures. The less common categories of fracture include: pelvic and skull (4.5%), metacarpal, and lumbar (4%), multiple fractures (4 %), ulnar and radius fractures (2.5%), scapula (2.5%), tibia (2%), metatarsal (1%), and sacrum (0.5%).

Within horse racing breeds, 78% of these fractures occurred in thoroughbreds and 22 % in quarter horses (Fig.2). Focusing on the sex of horses, 62% of cases submitted with musculoskeletal fractures were male while 38 % were female (Fig. 3). Between the two types of tracks, 87% of these fractures occurred on dirt tracks and 13% occur on turf tracks (Fig. 5). Age (in years) distribution of the cases is as followed: 36 were age 2, 60 were age 3, 33 were age 4, 12 were age 5, 6 were age 6, 5 were age 7 and one 1 was age 9, and 1 unknown (Fig. 4). Seeing the distribution of numbers in the different types of fractures, we decided to focus only on the 3 most common the following fractures could be seen in comparison in figures 7-9.

Fetlock :

Of the horses submitted and necropsied at CAHFS lab San Bernardino, 45% were fetlock fractures (figure 14 shows a closeup on where fetlock joint is). Of these cases, 67% were male, 33% female. Thoroughbreds comprised 87% of the horses and 13% of Quarter Horse. 55% of the fractures occurred in the right leg and 41% left. The dirt track was the majority where 86 % of these fractures occurred and 14 % on turf. The majority of these horses were age 3 years (29 cases), followed by age 4 years (18 cases) age 5 years (9 cases), age 6 (5 cases), ages 2, and 7, both with 3 cases each and 1 case with age 9, and 1 case of unknown age.

Humerus:

Humerus fractures were the second most common fracture and make up 11% of the cases submitted. Of these 76 % were male and 24% female. All of the cases submitted were thoroughbred horses. All of these fractures occurred on a dirt track. The predominant limb affected was the right leg, comprising 60% of the fractures, 40% occurred on the left. The majority were age 3 (9 cases), and ages 2, and 4 (with 4 cases each).

Carpal:

This fracture comprised 8.5 % of cases submitted. In these fractures 54% were female and 46% male. All of these fractures occurred on the right leg. 92% of these fractures occurred on dirt and 8 % on turf. Of the horses, 69% were Thoroughbred, 31 % Quarter Horse. The majority of horses were 2 and 3 years old, both with 5 cases, and 2 cases were 4 years old.

## Discussion

In this investigation, 154 catastrophic musculoskeletal injuries were necropsied at the CAHFS laboratory in San Bernadino coming from race tracks in Southern California. Catastrophic fractures are defined as "severe acute bone fragments, that carry a poor clinical prognosis" (California Horse Racing Board annual report). Musculoskeletal injuries were found at multiple sites affecting many bones of the axial which comprises the central core of the body and appendicular skeleton which comprises the extremities such as the limbs (figure. 10). There were more Thoroughbreds than Quarter Horses analyzed with 78 and 33 % of cases, respectively. However, it is important to emphasize that generally, Thoroughbred racing is more popular in California, where there is only one racetrack that holds the races for Quarter Horses. Further investigation is to be done to determine fracture specificity between the breeds. More males had been euthanized due to musculoskeletal injuries. However, an important limitation here is that this analysis did not distinguish between castrated males (geldings) and stallions. If that was taken into account, it may alter the reported proportions. The majority of fractures occurred on dirt tracks than on turf tracks. However, this could also be explained by the more frequent use of this surface for both racing and training. Nevertheless, it cannot be excluded that this particular surface carries a higher risk of sustaining musculoskeletal injuries. Looking into different types of racetracks and their effects on biomechanics and subsequent risk for injury is a popular and important area of research. It is a subject of ongoing debate. There are factors such

as climate and surface components that will differ in every country or even in the same region, which makes for continuing research.

The majority of fractures occurred among 2-4 year-olds with the highest cases in horses of age 3. Bone development of the appendicular skeleton has been researched to reach skeletal maturity by 2 years old and the rest of the body continues developing up until age 5 (Rogers). Although the skeletal structure is technically mature, the research states that they have evolved this way to be cursorial animals, meaning they have adapted to run. This is why they are chosen for this sport, and why they are useful animals that have had many roles over the years with humans. Nevertheless, modern horseracing may expose animals in active training to more stress in a short time span. Despite the fact that evolution equipped their ability to run very early on in their development, oftentimes some horses (particularly their skeletons) are not given enough time to adapt to the expected performance. Bones are very dynamic and remodel their stricture constantly in order to adapt to the common stress that they endure every single day. As stated by Wolff's law, bones change in the amount of loading that is applied to them. This process is based on a fine balance between bone resorption and formation. The former and the latter are carried out by a specialized subset of cells that build the bone tissue- osteoclasts, osteocytes, and osteoblasts. Everything in excess is harmful, and so is the exercise. Raising training intensity and frequency too rapidly leads to microdamage accumulation at the particular sites of the skeleton. That in turn affects the balance between bone formation and resorption favoring resorption. Excessive resorption at these sites creates a focus of bone weakening. If the horse is not given enough time to recover, it may progress to complete fractures. This is most likely reflected in the amount horses who have fractured at a young age.

Fetlock breakdowns account for almost half of the musculoskeletal cases that were submitted. fractures were almost half of the fractures that were submitted. The fetlock joint is also known as the metacarpophalangeal joint, in the front limbs and is presented in figure 11. Fetlock joint constitutes of 4 bones: cannon bone, a set of 2 proximal sesamoid bones, and the first phalanx. Additionally, proximal sesamoid bones serve as insertion sites for suspensory ligament, which is an important component of the suspensory apparatus. The fetlock joint supports the majority of the load. It is a hinge joint which means that it is allowed to move in one direction. This minimal to no twisting or other higher ranges of motion, such as intense loading during a canter, gallop, turn and jump can make the joint susceptible to injury. Most injuries can be caused by overloading and are acute and onset, or it is seen as a repetitive strain injury, and often see soft tissue damage (Fitzharris, Busschers). These fetlock fractures occur in horses ranging from 3-to 9 years affecting all ages. The distribution between left and right forelimbs was even. Fetlock breakdowns are the subject of continuing research as veterinary experts are exploring more efficient ways to detect changes that precede complete fractures.

The humerus is the upper bone of the forelegs, that joins the elbow joint, to the shoulder joint (seen in figure 12 horse diagram of the forelimb, highlighted in blue). This joint is a ball and socket joint. This joint is limited in directions of movement for stability and strength. This only allows flexion and extension moving the humerus forward and backward with little sideways movement. When a horse is in motion large movement moves to the bottom length of the horse's legs, and it swings like a pendulum (Stover, Hitchens). All of these fractures occurred on the dirt track. Dr. Stover and Dr. Hitch's research on these humeral fractures in racehorses state that these fractures occur because of bone weakening that is associated with a pre-existing stress fracture.  The clinical challenge that those fractures may pose is the fact that frequently

both humeri have stress fractures and this can be associated with bilateral, often shifting lameness. Also, affected horses may become suddenly lame but the lameness can resolve rapidly despite the bone not being healed. The higher incidence of humeral fractures is associated with periods when training is resumed after a long break from activity. These brakes are often associated with musculoskeletal injuries that required medical attention, longer recovery time, etc. In this cohort, horses predominantly fracture the right humerus. The majority of the fractures were ranging from 2-to 4 years old, supporting the findings that young horses are at higher risk for developing musculoskeletal injuries.

The Carpus (also known as the knee) is arranged horizontally and contains two rows of cuboidal bones between the radius and metacarpus (seen in figure 12, highlighted in pink). It is composed of three main articulations, antebrachioccarpal joint, the middle carpal joint, and the carpometacarpal joint. Interestingly, in examined necropsy cohort this type of fracture occurred more frequently in females than in males. Although we have stated before that total population data couldn't be obtained, to objectively assess the sex preference in relation to the living racehorse population, we consider this finding worth further exploration. Another interesting feature of carpal fractures in the cohort was that all of them affected the right forelimb. This has been confirmed in other studies where they noticed a higher incidence of right carpal breakdowns among Thoroughbred racehorses (Stephens, P R.). In this study, it was also found that those fractures were found predominantly in 2-3-year-olds as was seen in our study group.

In this study, we looked at the breed, sex, limb, and age distribution of the 3 most frequent types of catastrophic musculoskeletal injuries, i.e fetlock, humeral, and carpal fractures. For fetlock breakdowns, we were not able to find any significant correlations. Therefore it can be assumed that there are other factors that lose a higher risk for this type of injury and further

research is needed. In humeral and carpal fractures, the age distribution was centered on horses 2-4 years of age. Accordingly to our results, younger horses seemed more susceptible to fracturing their humerus and carpal bones. This could be due to the amount of stress in training as was discussed earlier. This supports the hypothesis that younger horses are more susceptible to these particular types of fractures. However, this hypothesis is not supported for all injuries. Also in humerus and carpus, we noted that the majority of the fractures occurred in the right limb. We suspect that this finding could be associated with the fact that in America, horses run counterclockwise so the right limb of these horses has to cover more distances than the left being the outside leg. But, this is purely hypothetical speculation. Lastly, females in this cohort appeared to be more prone to carpal fractures. However, this also requires more research in order to draw any further conclusions.

Using Dr. Samol's cases from the years 2018 - to 2021 keeps the reports consistent because it is coming from the same doctor's perspective of how they interpreted the fracture and keeps the reports consistent. Before she started her residency at CAHFS CHRB racehorse fractures were interpreted by the pathologist on call and, although there is a protocol interpreting the cases, individual interpretations could be different. Without knowing for example: the total number of thoroughbreds versus quarter horses, the number ran on dirt versus turf, the number in each age class, or the sex ration of horses, we are not able to say whether or not a given category of horses is more susceptible to fracture or fractures are more common on dirt or turf. With an unknown total of how many of each raced we are unable to say more at this time. What we have been stating in this paper, however, is what fractures have happened most frequently and who get them.

**Figures and Tables:**

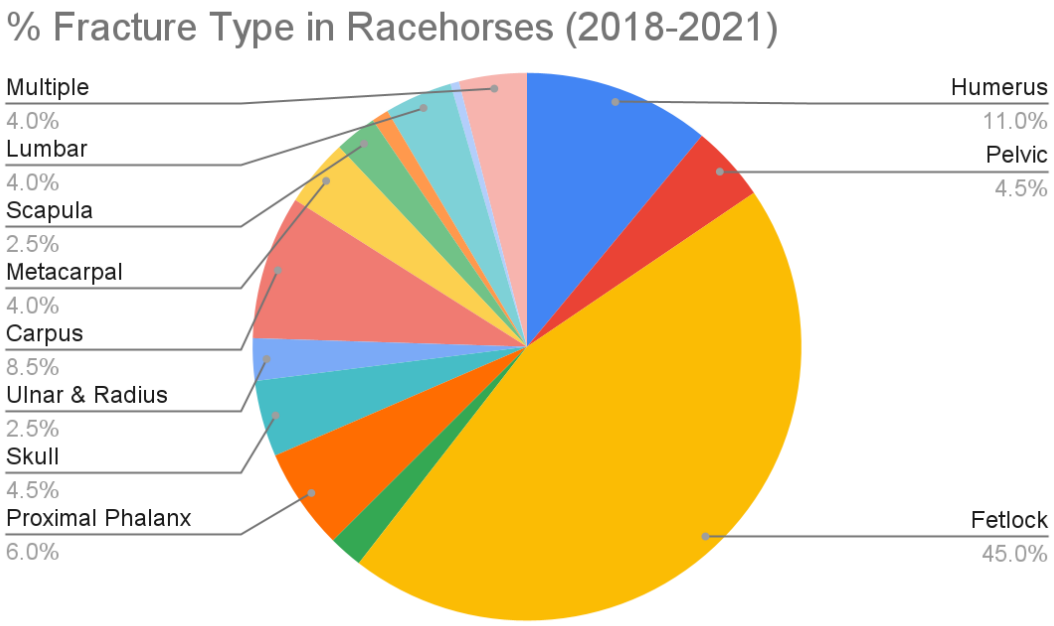



Figure 1. *Distribution of Fractures*

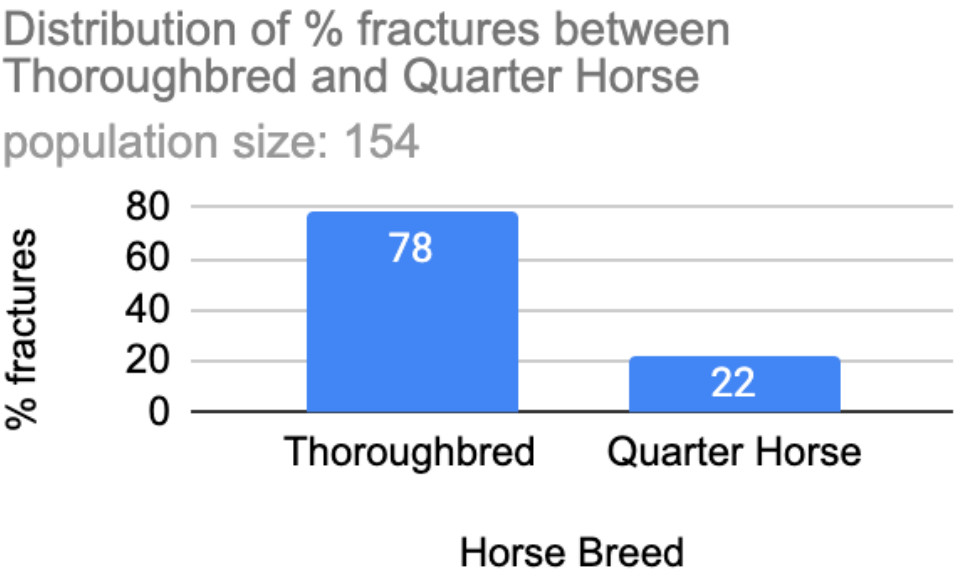



Figure 2. *Distribution of Fractures between horse breeds*

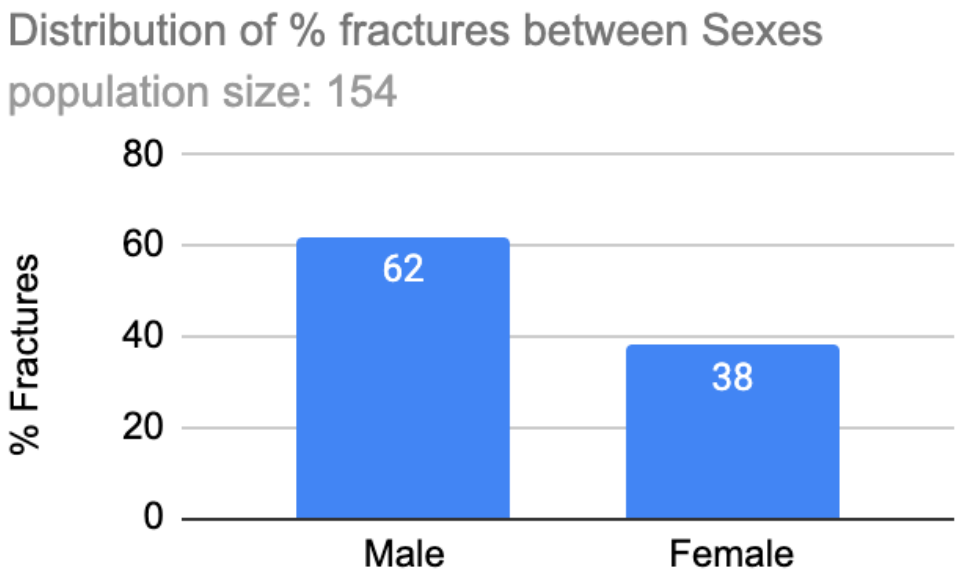



Figure 3. *Distribution of fractures between sexes*

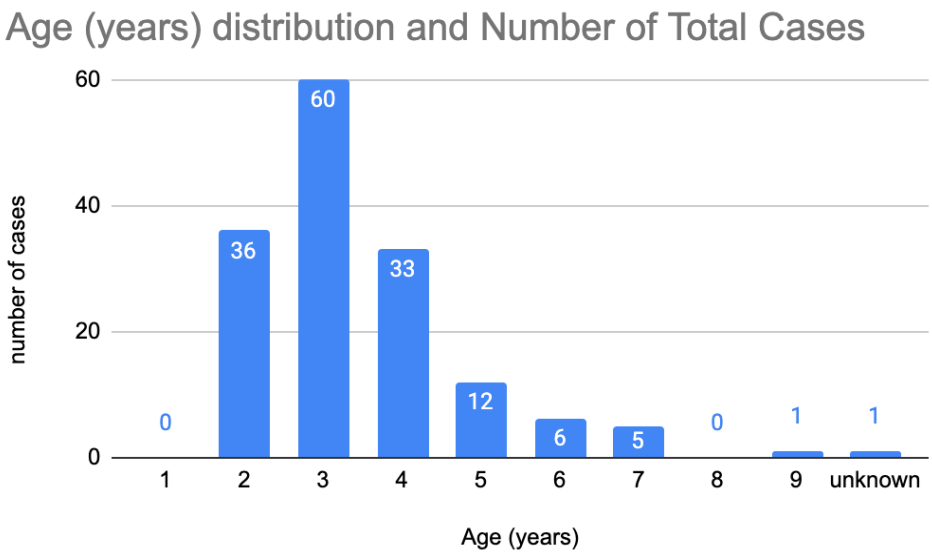



Figure 4. *Distribution of ages of horses submitted with fractures*

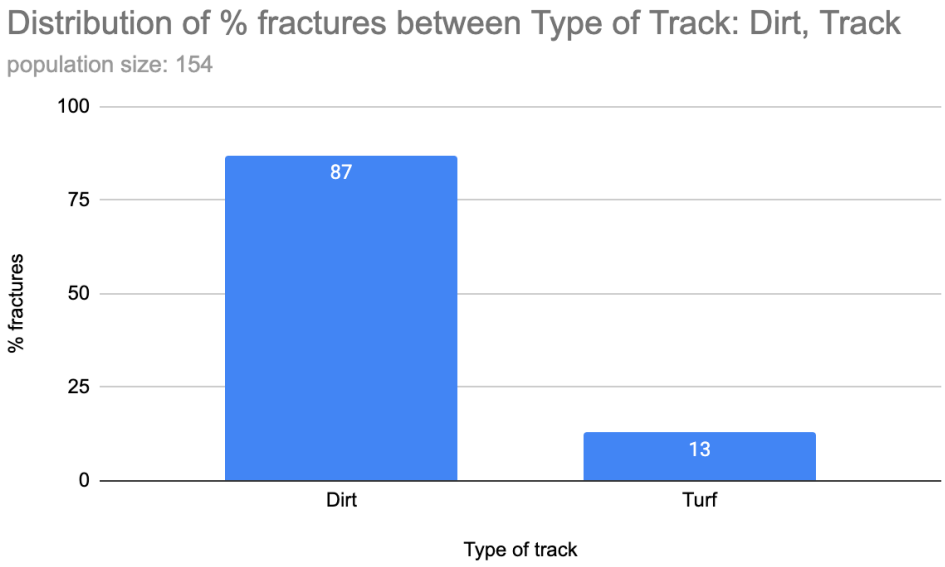



Figure 5. *Percentages of fractures on the different types of track: Dirt and Turf*

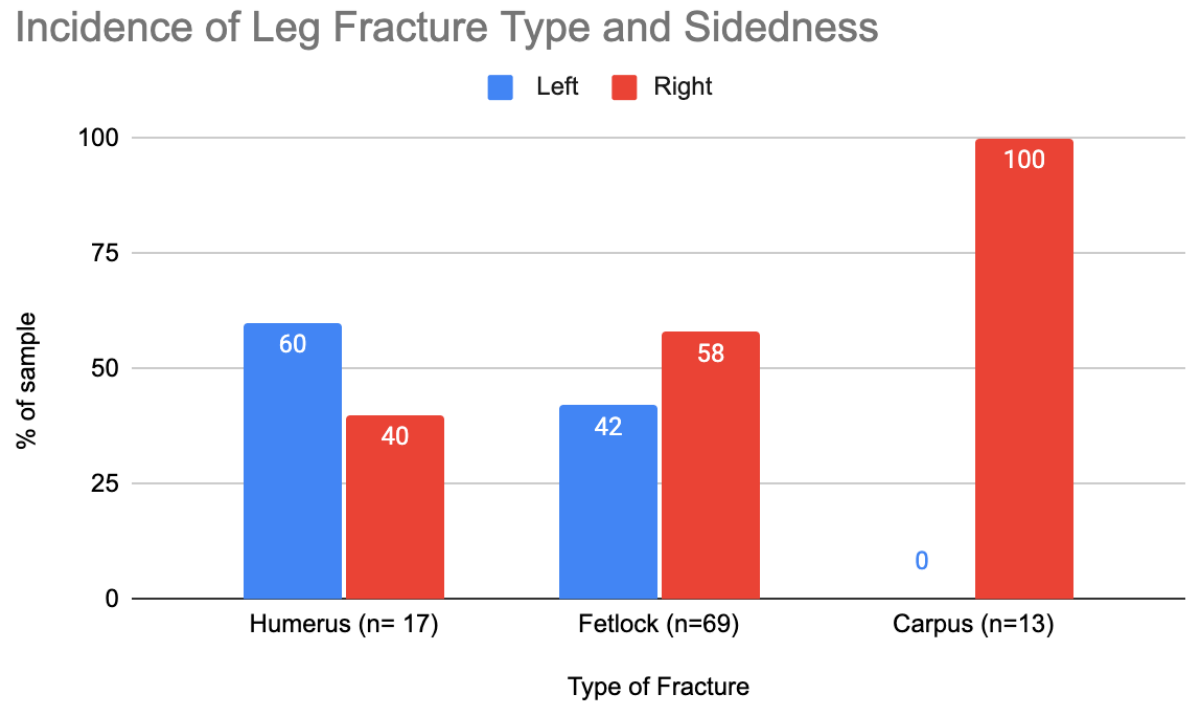



Figure 6. Distribution of fractures on different limbs: left, right

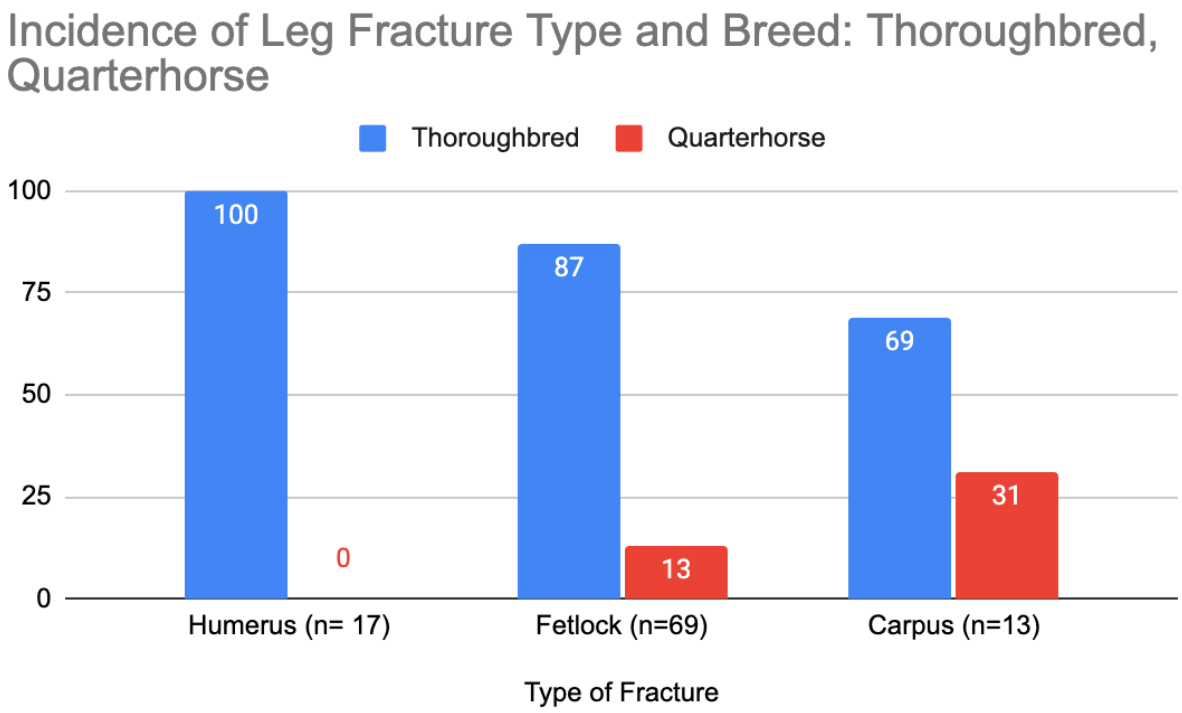



Figure 7. Distribution of fractures between breeds: Thoroughbred, Quarter Horse

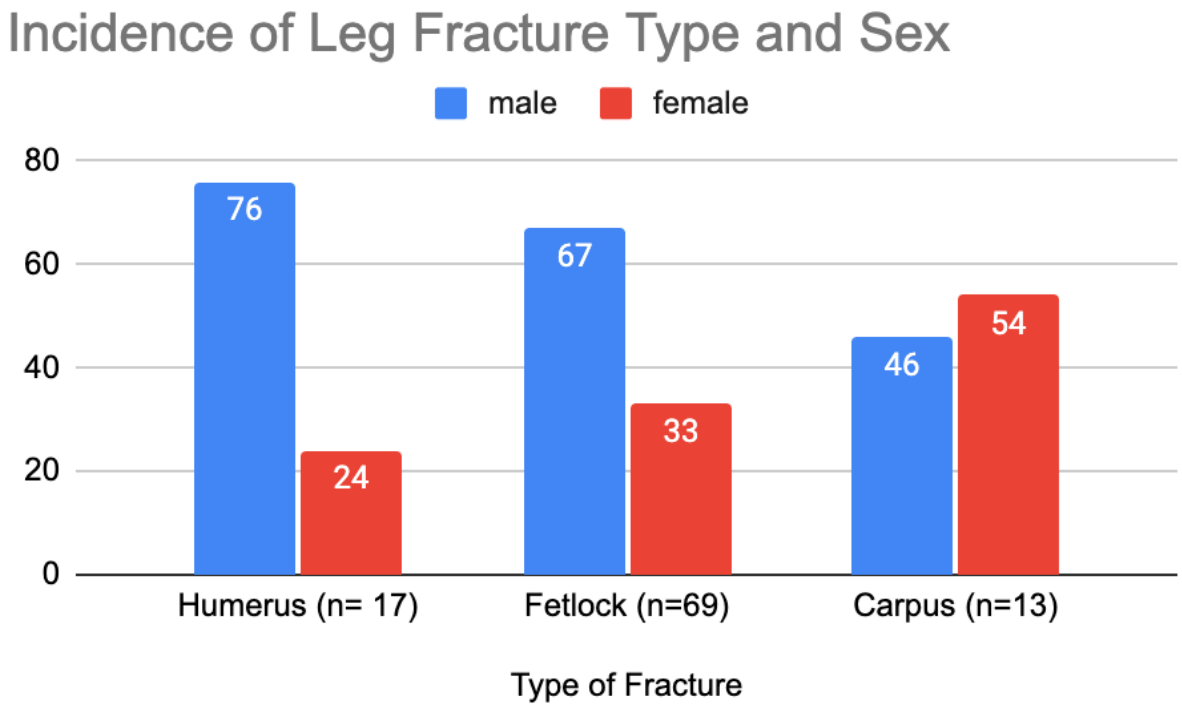



Figure 8. Distribution of fractures between sexes

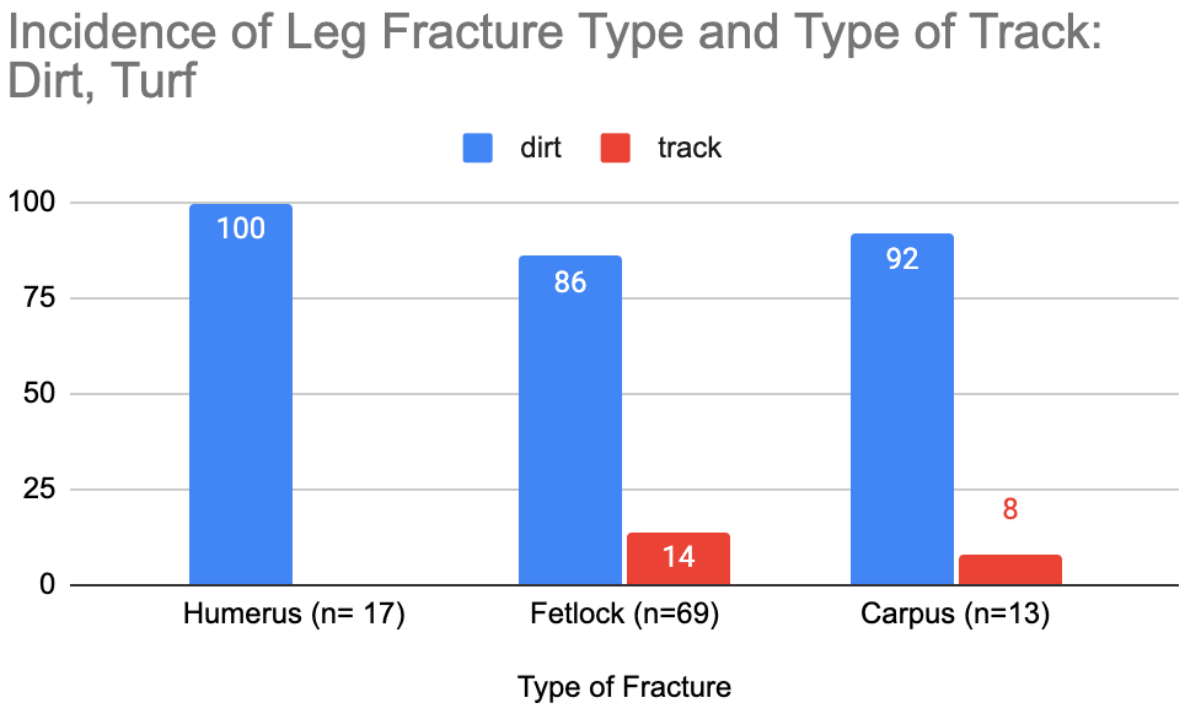



Figure 9. Distribution of Fractures between type of track: dirt, track

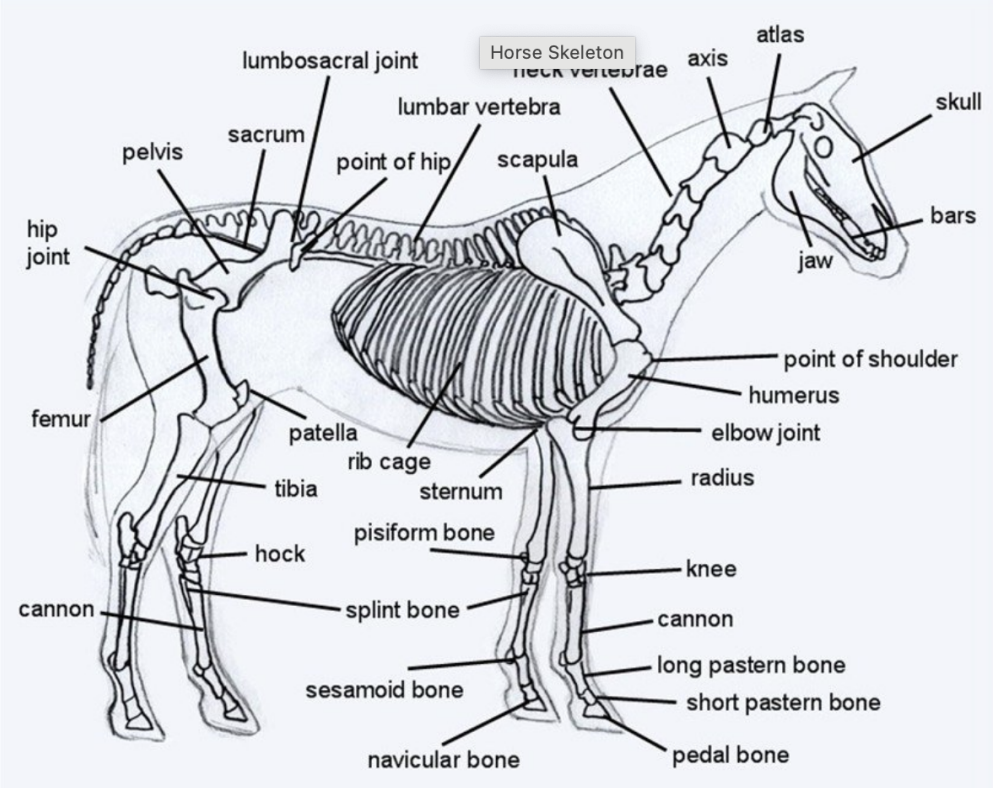
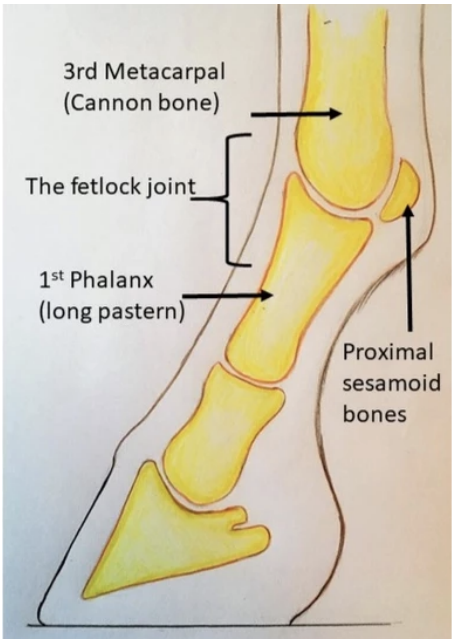



Figure 10. *Horse Diagram*



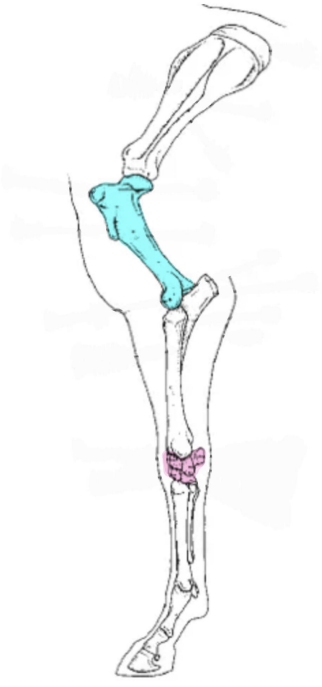



Figure 11.(Left) *Horse diagram, zoomed in on fetlock joint*

Figure 12.(Right) *Horse Diagram of left forelimb highlighting carpus (pink) and Humerus (blue)*

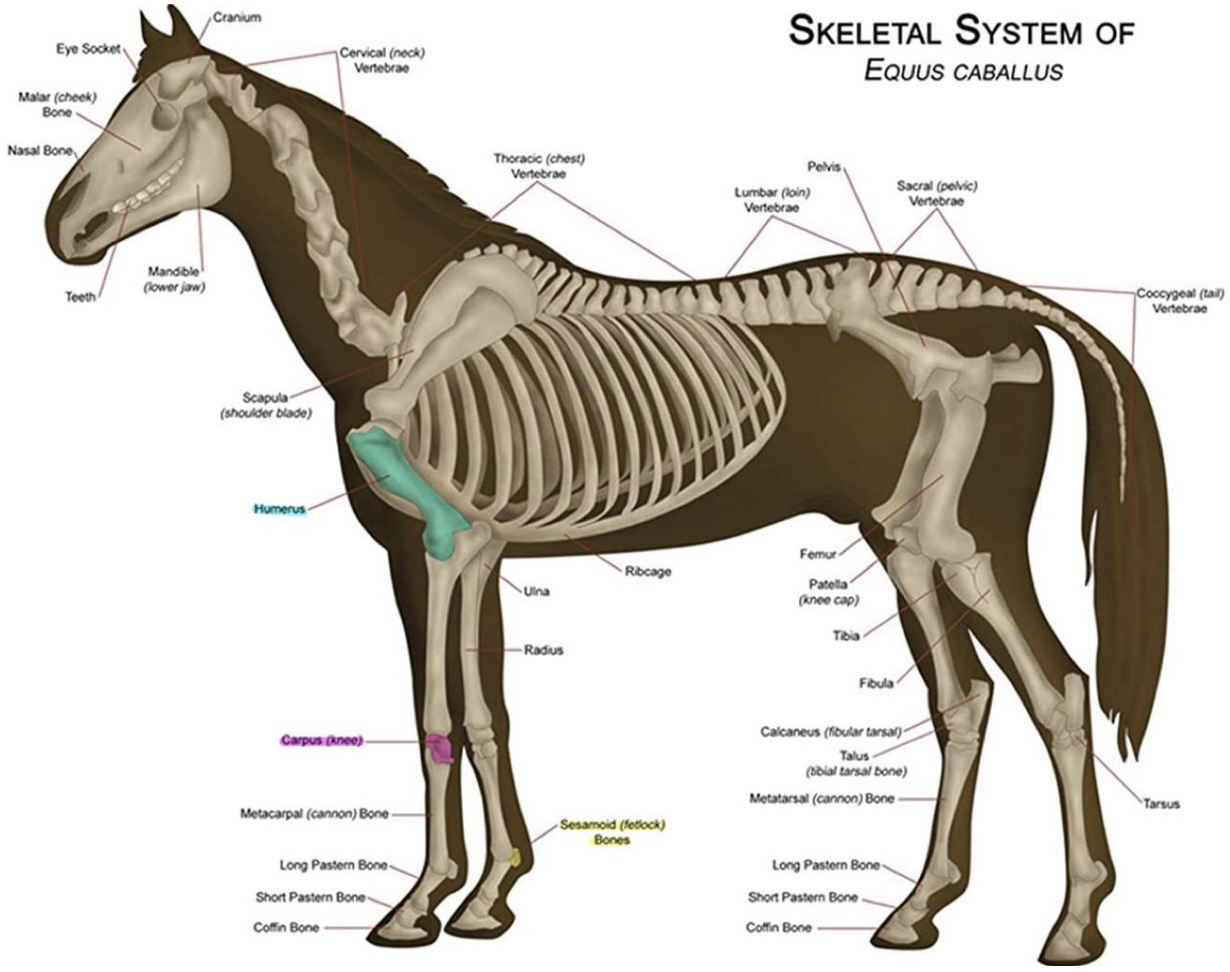



Figure 13. *Horse skeleton with highlighted areas: Blue-humerus, Pink-Carpus, Yellow: sesamoid/fetlock*


Figure 14. *Emphasis on Fetlock*

## References


Britannica, The Editors of Encyclopaedia. "horse racing". *Encyclopedia Britannica*, 24 Mar. 2021, https://www.britannica.com/sports/horse-racing. Accessed 28 April 2022.

California, State of. "Mission Statement." *CHRB*, http://www.chrb.ca.gov/mission.html.

CHRB. "44th Annual Report of the California Horse Racing Board." *California Horse Racing Board*, http://www.chrb.ca.gov/annual_reports/2014_annual_report.pdf.

Diab, Santiago S., et al. "Diagnostic Approach to Catastrophic Musculoskeletal Injuries in Racehorses." *Journal of Veterinary Diagnostic Investigation*, vol. 29, no. 4, July 2017,pp. 405–413, doi:10.1177/1040638716685598.

FWCF, Sarah Logie. "The Fetlock Joint – an Overview of Equine Anatomy." *The Horse Hub*, 11 Apr.2021,https://www.thehorsehub.co.uk/post/the-fetlock-joint-an-overview-of-equine-anatomy.

Horse & Hound 12 November, and Horse & Hound. "The Fetlock: Everything You Need to Know about This Complex Joint *H&H plus*." *Horse & Hound*, 14 Jan. 2021, https://www.horseandhound.co.uk/plus/vet-clinic/the-fetlock-everything-you-need-to-kno

w-about-this-complex-joint-hh-plus-730071#:~:text=The%20fetlock%20is%20a%20hinge,the%20horse%20is%20weight%2Dbearing.

"Horse Skeleton Diagram." *EquineSpot.com*, https://www.equinespot.com/horse-skeleton.html.

Elizabeth A. Lawrence (1988) Horses in Society, Anthrozoös, 1:4, 223-231, DOI: 10.2752/089279388787058407

Samol, Monika A., et al. "Sudden Death Caused by Spinal Cord Injury Associated with Vertebral Fractures and Fetlock Failure in a Thoroughbred Racehorse." *Journal of Veterinary Diagnostic Investigation*, vol. 33, no. 4, July 2021, pp. 788–791, doi:10.1177/10406387211018289.

Stephens, P R et al. "Slab fractures of the third carpal bone in standardbreds and thoroughbreds: 155 cases (1977-1984)." *Journal of the American Veterinary Medical Association* vol. 193,3 (1988): 353-8.

Rogers, Chris W., et al. "Growth and Bone Development in the Horse: When Is a Horse Skeletally Mature?" *MDPI*, Multidisciplinary Digital Publishing Institute, 29 Nov. 2021, https://doi.org/10.3390/ani11123402.