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To what extent does the prevalence of equine diseases impact the contribution of horses to society and the economy?

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ABSTRACT

There are numerous diseases that can affect horses and reduce their ability to perform tasks that are essential to humans - including horse racing, dressage, and show jumping, as well as their use for transportation and to help with mental health. All of these uses make horses essential for us, therefore it is important to prevent the spread of diseases amongst them. Equine diseases can include neurological diseases which are caused by a disruption in the horse's flow of neurological impulses, that command movement and move through the brain and spinal cord to the effecter, usually a muscle. More specifically, neurological diseases include CVSM, EPM, EDM, and EHM. Fungal diseases is another category that consists of Superficial mycosis, Subcutaneous Mycoses, and Deep mycosis. The final category of diseases discussed is zoonotic diseases, which can be transmitted to humans through either direct or indirect contact, making them all the more dangerous. For this reason, maintaining self-hygiene at the stables is essential. Understanding these diseases will help prevent them and even treat them effectively. This will allow us to continue depending on horses for their various socio-economic uses, even in the future.

INTRODUCTION

The horse is unique and significant not only because of its role in the popular equestrian sport but also because of the financial significance of an individual horse. There has been a transformation in the equine industry over the past 50 to 100 years. For example, horses were initially used as allies at war as well as for hunting purposes. However, as time has gone by, their uses have evolved drastically; they are now an integral part of sports ranging from racing to show jumping and subsequently represent a crucial source of finance for many people.

Unfortunately, the population of horses around the world is continuing to decrease, for example, in 1950 the equine population was over 1.5 million in India, however, the number decreased to 0.3 million in 2019. Whilst the literature and research suggest an array of reasons for the same, the principal cause is evidently the large number of lethal diseases that affect horses and a lack of information that equestrians and horse owners have regarding these diseases. Moreover, the spread of these diseases has become more dangerous and lethal in light of the increase in the global demand for horses requiring them to be transported across the world (Timoney, 2014).

The innumerable uses and importance of horses around the world mean that it is vital to maintain their population. In order to do the aforementioned, the various equine diseases need to be understood thoroughly by all those involved in the industry. This research paper discusses the importance of horses around the world, extending from their importance in sports to society, as well as a source of entertainment and economic inflow (using examples of sports such as racing). The latter half of this paper uncovers some of the most prevalent diseases in horses including those belonging to various categories i.e., fungal diseases, neurological diseases and zoonotic diseases. Ultimately, the research question to be answered is "**To what extent does the prevalence of equine diseases impact the contribution of horses to society and the economy?"**

SOCIO-ECONOMIC IMPORTANCE OF HORSES

Horses have been useful to humans since the beginning. As time has gone by, their role has developed into being a crucial aspect socially as well as economically.

The social significance of horses has progressed with time and is vital to understand and appreciate. Approximately 50,000 years ago, horses played an important role in the war. They would charge into the battlefield, pulling carts of weapons and supplies (Tallis, 2012). It was mainly because of the presence of horses at this time that soldiers could communicate faster which also changed the nature of war altogether. Additionally, before the development of modern-day transport, horses were considered to be the only way to travel faster than humans. With their high stamina, speed and strength, horses could travel long distances in short periods of time. Furthermore, horses were used in agriculture as they had the ability to pull ploughs and other equipment faster than humans. In 1920, there were around 25 million horses in the USA, and most were occupied on farmlands (Stanek, 2021).

Though the social importance of a horse may have changed with time, they are still a crucial aspect of human life. Now, the horse-riding sport has become increasingly popular, ranging from events like show jumping to dressage. Moreover, horses are currently being used to provide aid in therapy and as a source of companionship and support. Horses have the physical and mental ability to not only help those who suffer from physical illness but mental illness and PTSD too (Stanek, 2021). Additionally, a less-known fact is that horses are also being trained as 'seeing-eye' guides for the blind, once again evidencing their social importance.

As per the economic importance of horses, they contribute to around 300 billion dollars and 1.6 million full-time jobs. Horses are most commonly used in equine sports and competitions. This requires a large number of various goods and services, for example, training, therefore adding value to the economy (Lochner et al., 2020). Additionally, horse racing and breeding are responsible for a large sum of money for many individuals.

Horses have transported us, helped us in cultivating food, on the battlefield and to entertain us through the equine sport. For these reasons, there is worldwide importance of horses causing high demand for them in many countries. This means that horses not only have to interact with many others of their kind but with humans too. The role of horses in equestrian sport and racing requires them to be transported internationally. This effectively sets the ground for numerous, harmful diseases which can spread like wildfire among the species but also to humans.

EQUINE NEUROLOGICAL DISEASES

A horse may stumble while walking or drag his toes on the ground and may experience other symptoms, despite having no sores or any noticeable problems in his feet. He could be experiencing one of many neurological diseases ranging from Cervical Vertebral Stenotic Myelopathy (CVSM) and Equine Protozoal Myeloencephalitis (EPM) to Equine Degenerative Myeloencephalopathy (EDM) and Equine Herpesvirus-1 Myeloencephalopathy (EHM). These neurological disorders are dreaded due to the difficulty faced in diagnosing and treating them. However, neurological diseases do not need to be as life-threatening if the correct response is implemented. For this, being able to recognise the disease, get a diagnosis and finally effectively treat the neurological disorder is crucial.

Diagnosis of neurological diseases in horses

There are various neurological diseases, as listed above, which follow similar steps in the identifying stage. Some signs of neurological disorders are unusual behaviour and facial paralysis. According to Debra Sellon, DVM, professor of equine medicine at the Washington State University College of Veterinary Medicine. “The most common neurologic problem equine veterinarians see in the United States is an abnormal gait” (Pascoe, 2011). This may refer to swaying back and forth, staggering or dragging toes while walking or even stumbling frequently. This is caused by a disruption in the horse's flow of neurological impulses, that command movement and move through the brain and spinal cord to the effecter, usually a muscle. This lack of frequency and constant interruptions cause the horse to become imbalanced and confused in its gaits, indicating a neurological disorder. The second step to diagnosing a horse with neurological disease is a physical examination. The most common system used is examining the right side of a horse and contrasting it with the left, to identify irregularities. Numerous physical activities are also conducted to identify injuries such as fractured spinal cord. Veterinarians usually carry out a range of activities such as assessing reflexes such as sight, sound, taste and smell and a horse's response to this stimulus. Additionally, another physical

test, commonly referred to as, on a slope, involves making a horse walk up and down a slope, to see if he stumbles, drags his toes or shows other gait abnormalities. The third and last step is a detailed neurological exam designed to determine the extent of the injury as well as the main nerve affected. By the end of the exam, your veterinarian should know whether your horse's problem is neurologic and, if so, what areas of his nervous system are involved (Pascoe, 2011).

CVSM, EPM and EDM are currently recognised as three of the most common neurologic diseases in U.S. horses, with the latter two conditions being most prevalent in young animals. A detailed analysis of the three is provided below (Bedenice & Johnson, 2022).

Cervical Vertebral Stenotic Myelopathy (CVSM)

One of the most common equine neurological disorders is Cervical Vertebral Stenotic Myelopathy (CVSM), also referred to as 'wobblers disease'. It is believed that the syndrome is caused by genetic predisposition, feeding excessive amounts of energy and other nutrients, rapid growth, physical trauma, decreased copper/increased zinc levels, or a combination of these factors (Camargo & Janes, 2013). Simply, the deformed or unstable vertebrae press against the spinal cord, mixing up the signals from the brain to the limbs or vice versa (Bedenice & Johnson, 2022). CVSM can be detected by noticing general incoordination or stiffness as a horse moves - affected patients may trip, appear to lurch at the canter, have difficulty halting smoothly, and may swing out or collide their limbs while turning. If all four limbs of the horse are not affected, then the disorder can appear unaffected in the forelimbs, with mild signs in the hind limbs. However, not all horses show these clear signs of CVSM. In some cases, the first indications are behavioural changes under a saddle, bucking, bolting, rearing, and losing enthusiasm for the job. Owners must recognise these primary signs to prevent the disorder from dangerously developing. After a diagnosis has been made, CVSM can be treated surgically or medically. The mainstays of medical treatment involve rest or reduction in exercise and systemic or local anti-inflammatory treatment. Young horses are also sometimes treated with dietary modifications to reduce the rate of growth. The most common surgical treatment uses a partially or fully threaded cylindrical implant and a bone graft placed into the body of two adjacent neck bones to reduce movement of the spinal cord (Bedenice & Johnson, 2022).

Equine Protozoal Myeloencephalitis (EPM)

EPM is one of the most common infectious neurological conditions in horses in North America. The protozoan parasites Sarcocystis neurona and Neospora hughesi are known causes of EPM and can be found in certain foods or water contaminated with opossum faeces. EPM is not a transmittable condition, it cannot be passed on from horse to horse. Spinal cord symptoms often predominate, leading to general incoordination, weakness, or muscle mass loss that is often unevenly distributed (asymmetric). Simply, EPM can be diagnosed if the following three criteria are met: compatible clinical signs consistent with neurological disease, exclusion of other likely diseases, and confirmation of exposure to S. neurona or Neospora hughesi. Once diagnosed, EPM can be treated by the following medicine:

Marquis (Merial, Duluth), *ReBalance* (PRN Pharmacal, Pensacola, FL) or *Protazil* (Merck Animal Health, Kansas City, KS). Once treated, approximately 60% of EPM-affected horses are expected to improve at least one grade with treatment regardless of type, while a smaller percentage (10–20%) may return to normal athletic performance (recover completely) (Bedenice & Johnson, 2022).

Equine Degenerative Myeloencephalopathy (EDM)

EDM, Equine Degenerative Myeloencephalopathy, is another neurological disease where affected horses show symmetric incoordination - the forelimbs can be equally or less severely affected than the hind limbs. Horses may also appear "clumsy," showing a two-beat "pacing" gait at walking speed. Essentially, EDM is caused by low dietary vitamin E levels with resultant oxidative damage to select neurones contributing to disease development. Therefore, treatment includes vitamin E supplements. The prognosis for recovery is poor in affected horses, which generally stabilise over time without improvement in their neurological signs or performance, despite treatment (Bedenice & Johnson, 2022).

EQUINE FUNGAL DISEASES

Over the last two decades, the number of fungal diseases in mammals, including horses has drastically increased. This is likely caused by environmental factors. Fungal diseases can cause illnesses in healthy horses but are particularly dangerous and life-threatening in horses with a compromised immune system. A fungus is a parasite that absorbs food from the host on which it grows. Fungal diseases can be acquired by horses in numerous ways such as inhalation of the pathogen, ingestion, or through the skin, for example through a wound or a cut.

Diagnosis of fungal diseases in horses

Fungal infections are commonly known as Mycoses, and their diagnosis follows a series of crucial steps. The primary stage of a definite diagnosis of any fungal infection is to examine the horse's medical history, followed by a thorough physical examination that may include checking the horse's skin and hair, from head to tail, for any abnormalities, such as rashes, that may indicate a fungal disease. Observing the horse's behaviour is also important in this stage, as it may indicate signs of discomfort. This will be followed by an assessment of the horse's weight, height, blood pressure, heart rate, respiration, and body condition score will be recorded. A veterinarian may also use a stethoscope to check the horse's lung sounds. An endoscopy will be done to get a good look at a horse's throat and upper airway and may be used to get a tissue sample for biopsy. To rule out other conditions, some blood tests are needed such as fungal and bacterial cultures, complete blood count (CBC), blood chemistry panel, blood urea nitrogen (BUN), glucose level, and packed cell volume (PCV). Some of the most important tests are imaging, which can show the fungi wherever it is in the tissues and the organs. Regular x-rays can show some of the areas of infection, but it takes an ultrasound and a cross-sectional CT scan to see a much more detailed view (Wag Labs, 2016b). Once these steps

have been carried out, a diagnosis can be made, and the fungal disease can be placed into one of many specific fungal disease categories including Superficial mycosis, Subcutaneous mycoses and Deep mycoses. These are explained further, in debt below.

Superficial mycosis

Superficial mycosis is a fungal disease affecting nails, hair and skin. Two types of superficial mycoses are Dermatophytoses and Candidiasis (Khadka et al., 2016).

Dermatophytosis or 'ringworm' is a fungal infection caused by dermatophytes; a group of fungi which require a source of keratin to grow and reproduce. Since keratin is mainly found in hair, nails and skin, dermatophytosis targets these organs. Dermatophytosis is one of the most common fungal infections in horses, merely due to the ease at which they transit from surface to surface, through saddles or bridles, for example (Hernández, 2020). Dermatophytosis is especially dangerous as it can be zoonotic, transmitted from horse to person, thereby putting horse owners at risk too. Infected animals will develop circular, bald, scaly patches with broken hairs. Common areas for ringworm to occur are the girth and saddle area, but the infection may spread to the neck, flanks, chest, or head (Merchant, 2022). Although the infection does not pose major health risks to horses, ringworm is highly contagious, making it one of the most dangerous.

Candidiasis is a localised fungal disease affecting the mucous membranes and the skin. It is caused by the pathogen *Candida albicans*. Candida albicans are fungi which are present on the body of all animals at all times. However, when an organism's immunity is suppressed, due to an illness such as gastrointestinal, Candida Albicans multiply uncontrollably causing pain and inflammation. It is difficult to prevent Candidiasis as the fungi live in the horse's hair. However, to prevent the risk of acquiring the infection, horse owners should maintain the highest level of hygiene when the horse's immunity is low. The most important way of doing this is by cleaning the horse's mouth frequently (MedBroadcast, 2023).

Subcutaneous mycoses

Subcutaneous mycoses involve the deeper layer of the skin including the cornea, muscles and connective tissues. The causative agents are usually found in the soil, leaves and organic material and can enter horses through traumatic injuries to the skin. An example of a specific disease under the subcutaneous mycoses' category is Pythiosis.

Equine Pythiosis is caused by the pathogen *Pythium insidiosum.* The disease can occur in any anatomical part of a horse's body, however, lesions are most common around the limps, they first come into contact with the environment, for example, grass or soil. Though there is no report of animal-to-animal or animal-to-human transmission of this pathogen, Pythiosis is important to understand as if not treated, usually, through surgical removal of granulomas, it can become life-threatening for horses (Klingler, 2017).

Deep Mycosis

Deep Mycosis is known to be the most threatening form of fungal disease in horses. It usually affects the upper or lower part of the respiratory canal and the fungi usually disseminate through the blood or lymphatic system and if not treated in the early stages, can lead to death. For this reason, it is crucial for horse owners to understand the types of deep mycosis, how they are acquired by horses and how to treat them. Two forms of deep mycosis that horses may suffer from are Blastomycosis and Aspergilloses.

Blastomycosis in horses is extremely rare and for this reason, the disease is frequently overlooked. A main presenting symptom of blastomycosis is lesions. The primary symptom of this disease is in the lungs and could be presented in the form of a dry cough. Horses can come into contact with this fungus if it inhales the spores. Once it inhales the spores, it can spread to the horse's skin, bones, and other organs. This can cause inflammation of the lungs. To diagnose blastomycosis, veterinarians can conduct tests that include X-rays of the lungs and ultrasounds of the chest and abdomen to check for lesions. Microscopic examination will be performed on samples taken from nasal discharge or swabbing of the horse's throat or mouth. A biopsy may also be conducted to allow the horse's veterinarian to directly test the tissue of the lung (Wag Labs, 2017). There are numerous antifungal medications that can be used to treat blastomycosis. These include *Amphotericin B* (given via IV, many more side effects than Ketoconazole and will most likely require hospitalisation for administering and monitoring side effects), *Ketoconazole* (found to be about 75% effective), *Itraconazole*, *Fluconazole*, *Voriconazole*, and *Enilconazole*. Alternate treatments include creating an environment that will not support continued fungus growth, low dairy, low sugars, no honey diet, and vitamins A plus, B, C and E can also help (Wag Labs, 2017).

Aspergillosis in horses is caused by common fungi (moulds), from the aspergillus species. Once infected, a horse may show symptoms such as an inflamed airway and nasal passage. It may also cause bleeding from the nostrils. Aspergillosis in horses comes in many forms; Invasive pulmonary aspergillosis (IPA) is the most common and most dangerous because it spreads rapidly to other parts of the body and vital organs, Allergic pulmonary aspergillosis (ABPA) causes lung and allergy symptoms but no infection, Chronic pulmonary and aspergilloma (CPA) causes same symptoms as ABPA but lasts more than 90 days, Severe asthma with fungal sensitisation (SAFS) can be a serious infection in horses with weakened immune systems. There are many antifungal medications to treat Aspergillosis such as *Posaconazole*, *Itraconazole, and Caspofungin.* Veterinarians should continue to test the horse even after recovery, as aspergillosis commonly resurfaces (Wag Labs, 2016a).

EQUINE ZOONOTIC DISEASES

A zoonotic disease is one which can be transmitted from a non-human organism, i.e. a horse, to a human. They may not make an animal dangerously sick but can cause serious illnesses in humans. The diseases associated with horses include rabies, ringworm and many more. Equine veterinarians must understand the zoonotic potential of certain diseases and organisms affecting horses and both educate their clients about these risks and take appropriate precautions themselves. Children younger than 5, and adults older than 65 are at risk of a zoonotic illness. Additionally, people with weakened immune systems and pregnant women should also be careful of zoonotic diseases when around animals.

Direct contact zoonotic diseases

Zoonotic diseases can be transmitted through direct contact where Rabies, Methicillin-resistant Staphylococcus Aureus (MRSA) and Dermatophytosis are included. Direct contact includes coming into contact with the saliva, blood, urine, mucous, faeces, or other body fluids of an infected animal (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Rabies is a disease in horses that is transmitted directly, by bites and mucus membrane exposure from an infected animal. Horses can be infected with rabies from direct contact with bats, skunks or racoons. Experienced symptoms include unusual and violent behaviour. A clear sign of rabies is foaming in the mouth and loss of tail hair. Hyperaesthesia is also seen with fever and possible paresis of the hindquarters. Rabies is highly fatal, with infected horses dying within 2-10 days of the infection. Exposure to rabies is less common in people handling equines compared with smaller animals or wildlife. Vaccines are available for prevention, however, there is evidence of the disease persisting even with vaccines. For humans frequently dealing with horses, pre-exposure vaccines are available (Kumar et al., 2018).

Methicillin-resistant Staphylococcus Aureus (MRSA) has been identified in both normal horses and those with clinical symptoms of wound infections. It is possible to contract the infection through direct contact with an infected horse. Once infected, people may or may not develop symptoms. If people are not treated, the infection can progress to septicaemia and affect other organs including the lungs. Transmission is unlikely; however, precautions should be implemented to reduce risk. Equine owners should wash their hands frequently and it is recommended to cover any open wounds that are susceptible to infection

Dermatophytosis is a fungal infection that mainly affects the nails, skin and hair of horses. It is commonly known as a ‘ringworm’ and is seen in both horses and humans as scaly, round, hairless patches. Dermatophytes can be transmitted from a horse to a human by direct contact. For prevention, equine workers should wear gloves when handling infected animals and wash their hands after contact (Office of the Campus Veterinarian

& Office of Research Assurances, 2021).

Indirect contact zoonotic diseases

Zoonotic diseases can also be transmitted by indirect contact. Horse owners can be infected by coming into contact with the area where their horse lives and roams, or surfaces that have been contaminated with germs. These could include a horse's girth, bridal or bite. In addition to these surfaces, owners could also be infected while handling their horses' food and water dishes. Zoonotic diseases transmitted indirectly include Leptospirosis, Rhodococcus equi, Salmonellosis, and Anthrax (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Leptospirosis is a disease caused by *Leptospira* and is commonly associated with an eye infection, abortion or kidney disease and is transmitted from a horse to a person through accidental ingestion or contact with contaminated urine, placenta or fetal tissue. People can be infected with leptospirosis through abraded skin. After being infected, people may experience symptoms ranging from vomiting, fever and rashes to haemorrhagic pneumonia, and liver and kidney failure in more severe cases. Leptospirosis can be extremely fatal to humans and could lead to death. Therefore, understanding the risk and its ability to transmit from horses to humans is crucial. To prevent leptospirosis, horse owners should avoid using their hands to clean horses' stables as they could come into contact with contaminated urine. Instead, owners should use gloves off shelves in the stable. Lastly, owners should cover all open cuts with waterproof bandages or dressing (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Rhodococcus equi is a bacterium that causes pneumonia in horses. It is found in the soil around a horse's stable and can be transmitted to humans through inhalation of dust particles that contain the pathogen. This pathogen can cause pneumonia in humans whose immunity is compromised, however, does not cause diseases in healthy people with normal immune functions. Despite this, horse owners should be careful when cleaning stables or arenas that an infected horse has come into contact with. In addition, immunocompromised people should wear a mask around horse stables (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Salmonellosis is a disease in animals caused by a bacterium that is transmitted in the faecal material of infected organisms. Humans can acquire this disease by accidental ingestion of horse faeces through, for example, water that is polluted with faecal matter. Horses with salmonellosis show symptoms of diarrhoea, once transmitted to people, symptoms of fever, abdominal pain and diarrhoea are seen in the person. As a safety precaution, horses with diarrhoea should be suspects of Salmonellosis and should be tested. Additionally, those whose immunity is compromised should stay far from horses with diarrhoea as they are likely to be infected with a zoonotic disease such as salmonellosis (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Anthrax is caused by a bacterium known as *Bacillus anthracis*. Horses can be infected with Anthrax by coming into contact with contaminated water, soil or plants. If passed on to people, Anthrax can be highly dangerous and can cause severe illness, therefore, is a cause of concern. Infection can happen via accidental ingestion of spores or by penetration of bacteria through abraded skin. Fever, chills, severe colic, depression, lack of appetite, weakness, bloody diarrhoea, and swellings can be experienced by the infected horse who is likely to die quickly due to the severity of its symptoms. In humans, Anthrax can cause skin reactions and possibly the formation of blisters. However, if the infection is from ingestion of spores, symptoms predicted are stomach pain diarrhoea (that may contain blood), sore throat and difficulty swallowing, swelling of the neck, fever, chills, and redness in the eyes and face. These fatal symptoms make Anthrax extremely dangerous for humans, therefore, precautions such as washing hands and avoiding touching one's eyes, nose or mouth after handling a horse are crucial. More specifically one must cover all wounds effectively to prevent *Bacillus anthracis* from entering (Office of the Campus Veterinarian & Office of Research Assurances, 2021).

Protection from Zoonotic diseases

The main precautions which should be taken to avoid the transmission of zoonotic diseases from horses to humans are to always wash one's hands after being around animals, even if the animals were not touched. In the instance that soap and water are not readily available, an alcohol-based hand sanitiser that contains at least 60% alcohol may be used. It is also essential that individuals understand how these diseases can be transmitted and ensure the horse stables are cleaned frequently using gloves and PPE (personal protective equipment). Lastly, horses must get tested as soon as they show any symptoms.

CONCLUSION

The increase in equine diseases in horses over time has drastically reduced our ability to depend on them for social and economic uses, for example for equine sports as well as the buying and selling of horses that contributes to the income of numerous people. The major importance horses have in providing us with these essential uses means that we must understand the various diseases that are common in horses and how to effectively prevent as well as treat them to ensure the future survival of horses.

The disease categories that horse owners need to be aware of, as mentioned above, are neurological diseases, fungal diseases and lastly zoonotic diseases (those that can be transmitted to humans, making them all the more dangerous). Symptoms of neurological diseases can mainly be seen in the gait of the horse, and around its ankles. This category of diseases comes in many forms including CVSM, EPM, EDM and EHM. Moreover, superficial mycosis, subcutaneous mycoses and deep mycoses fall under the category of fungal diseases. Lastly, zoonotic diseases are

especially dangerous for horse owners as they can easily be transmitted to humans. The most dangerous zoonotic disease is rabies, which can be transmitted to horses by bites from infected animals.

The number of horses worldwide continues to decrease, consequently reducing our ability to depend on them for both social and economic uses. To prevent this, knowledge of the above diseases is essential. If the diseases are understood, future infections can not only be prevented but efficiently treated too.

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