

Review

Health of Polo Horses

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Simple Summary: The sport of polo poses a variety of health risks to polo horses, including lameness injury, joint disease, back problems, exercise-induced pulmonary hemorrhage and infectious disease. The analysis shows that polo horses are exposed to an increased risk of injury and disease due to the demands of the sport, with aspects such as ground conditions, training and genetic factors playing a role. Prevention is the top priority in this growing sport. Both the associations and the players must work continuously to protect the health of horses in polo and minimize injuries.

Abstract: The abstract presents an overview of animal health in polo through a systematic analysis of relevant literature. The sport of polo, which is practiced in around 80 countries, is becoming increasingly popular, drawing attention to animal health and welfare. The literature review examines the history of polo, its organization, the game itself and the breeding, rearing, and training of polo horses. Particular attention is paid to the health aspects and frequently occurring diseases in polo horses. The sport exposes polo horses to a variety of sport-related diseases and injuries, including lameness, back problems, exercise-induced pulmonary hemorrhage (EIPH), myositis and rhabdomyolysis, equine infectious anemia (EIA) and others. Injury to the superficial digital flexor tendon is the most common condition. Effective prevention requires adequate training, adaptation of the ground surface, appropriate shoeing strategies and adherence to animal welfare guidelines and association rules.

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1. Introduction

The introduction should briefly place the study in a broad context and highlight why it is important. It should define the purpose of the work and its significance. The current state of the research field should be carefully reviewed and key publications cited. Please highlight controversial and diverging hypotheses when necessary. Finally, briefly mention the main aim of the work and highlight the principal conclusions. As far as possible, please keep the introduction comprehensible to scientists outside your particular field of research. References should be numbered in order of appearance and indicated by a numeral or numerals in square brackets—e.g., [1] or [2,3], or [4–6]. See the end of the document for further details on references. The sport of polo is growing in popularity worldwide and is currently played in around 80 countries[1]. This is a competitive game of skill, speed, strategy and teamwork. As a result of the increased interest, animal health and welfare issues are also coming more into focus. The aim of this review is to comprehensively overview the existing literature on animal health in polo. Particular attention will be paid to the most common diseases in polo horses.

Through a systematic analysis of the relevant literature, information on the health aspects of polo horses will be compiled and processed. In particular, the identified diseases will be analyzed and possible correlations with training, protective measures and environmental influences on the horses will be investigated.

This review aims to provide a solid basis for further research and recommendations on managing the health of polo horses. The aim is to broaden the understanding of health challenges in polo and thus contribute to improving the welfare and performance of horses.

2. Materials and Methods

The systematic literature search was conducted up to February 2023 in the Primo University Library database Primo and on the Internet at Pubmed and Google Scholar. For the literature search, the keywords "Polo" and "Horse" were used in combination with "Sport", or "Injury" in the Boolean logic for the query. All titles were screened and publications that were not considered relevant after screening were excluded from the results. Studies dealing with the impact of polo on animal health were identified. To determine whether the publications were relevant to the present work, the key aspects and conclusions of each study were read to ensure the comprehensiveness of the underlying research question. When analyzing the health status of polo horses, no inclusion or exclusion criteria were used for the type of studies and documents, as only a few sources were available.

I Additionally, we conducted systematic research on the internet and collected data and information from both the Google search engine and the websites of national and international associations. We recognized that non-peer-reviewed sources may have an increased potential for bias, but they can still contribute to enriching the discussion. Despite the limited availability of publications, a high level of quality could be achieved by primarily utilizing scientific texts. Our research primarily focused on German and English literature.

3. Results

3.1. History of polo

To understand the sport of polo, it is important to examine its history. According to reports, in the earliest history of polo, the Turkmens won the first tournament against the

Persians. Historical records indicate that the origins of polo date back to the 6th century, making polo one of the oldest known equestrian sports in the world [2]. Throughout its history, polo has spread from Asia Minor to India and Europe[3]. The word "polo" comes from the Persian word "Pulu", which means "ball" [4]. The Calcutta Polo Club, located in Calcutta, India, was founded in 1862 by the colonial British and is considered to be the oldest polo club in the world currently in existence [5].

In the 19th century, polo continued to grow in popularity and eventually became a national sport in Great Britain. The modern rules and regulations of polo were established in 1875 by the newly formed Hurlingham Polo Committee. As a pioneering association, it founded the first polo club in Europe in 1878 and drew up a set of rules for the sport that is still recognized today. Since 1925, the association has continued to exist under the name "Hurlingham Polo Association" with 2000 members in Great Britain and is still responsible for the regulation of polo [6].

The characteristics required for polo horses have evolved over time. Initially, small ponies were common, but as polo mallets and striking techniques improved, larger and faster horses became more desirable. However, the HPA's attempt to limit the height of the horses failed [7]. The evolution of polo throughout the years demonstrates the significant growth of the sport and the enduring presence of numerous traditions within it.

3.2. Organisation

The sport of polo is closely networked globally and linked to each other through various organisations. The overarching organisation in this context is the Federation of International Polo (FIP), which was founded in 1987. As an organisation officially recognised by the International Olympic Committee, the FIP includes federations from 82 nations[1].

Argentina is considered the leading nation in polo, followed by the United States and Great Britain. In terms of both horse and player numbers, these nations have a clear lead over others. The associations in these countries are the Asociación Argentina de Polo, the United States Polo Association and the Hurlingham Polo Association. They are largely responsible for the organization, the rules and controls. They are authorised to enforce disciplinary proceedings against players and therefore, play a major role in the area of animal health in the sport of polo. In Germany, the German Polo Association (Deutscher Polo Verband e.V) takes over these tasks. With currently around 400 registered polo players, the association represents an up-and-coming polo nation [8].

3.3. The game

In order to assess the load, it is necessary to understand the course of the sport. In polo, two teams, each consisting of four players, compete against each other on a pitch measuring 150 m × 275 m in order to score goals [9]. Traditionally, polo is played on grass, but in recent years, alternative forms of play such as polo on sand have also become established. A game consists of 4 to 8 chukkers, each lasting a maximum of 7 minutes and 30 seconds, and the winning team is determined by the number of goals scored [3]. A distinctive feature of polo is the handicap system, which quantifies the individual abilities of the players. Handicaps range from -2 (for less experienced players) to +10 (for the best players). This classification allows the division into different polo divisions, with the cumulative handicap of the four players determining the overall handicap of the team [10]. The higher the overall handicap of a team, the more demanding the league in which they compete [1,11].

3.4. Bred

Ideal polo horses are characterized by their speed, agility and endurance. In addition, they have a quick-reacting and intuitive nature [7]. There are no restrictions on breed and size, according to the rules [12]. Polo horses of the German polo horse breed (Deutsches

Polopferd) have been certified according to the Schleswig-Holstein/Hamburg Studbook to have an optimal height of about 156 cm [13].

The main requirements for the health of horses are robust health, good physical and mental resilience, good fertility and freedom from hereditary diseases [13]. Cloning in relation to the breeding of polo horses is also being focused on abroad. Adolfo Cambiasso, the best polo player in the world, is seen as a pioneer, having won the world's most important polo tournament in 2013 with the help of six cloned polo horses [14]. In Argentina, among other countries, cloning is also being focused on in relation to the breeding of polo horses [15]. In Germany, however, cloning is not permitted in the breeding program and clones and their offspring may not be entered in the studbook [13].

Gender is also playing an increasingly important role in the breeding of polo horses. An Argentinian study from 2013 found that preimplantation genetic diagnosis (PGD) can be successfully used for sex determination, which is also cited as a success in the context of polo horse breeding. Mares are preferred because they are considered to be easier to train and more agile [16]. Although some sources emphasize the benefits of female horses in polo horse breeding, there is no scientific evidence to support this. In other areas of equestrian sports, the advantage cannot be shared. An English study from 2018 even shows the opposite, namely that stallions and geldings perform better than mares in most eventing disciplines [17].

3.5. Rearing and training

Comprehensive physical preparation is important to prepare horses for the sport in terms of their health. Breaking in usually takes place between the ages of 3 and 4. Some particularly talented horses take part in high-goal competitions as early as the age of 6. In the course of time, around the age of 12 to 14, the speed often decreases and these horses are then used in lower divisions [18].

For endurance horses, no differences in training intensity are necessary for horses aged 3 to 9 years. Training intensity has a direct impact on the condition of horses, with the rate of recovery after high-speed exercise being a key indicator [19].

Pre-season training is of high importance for more than 98% of polo players interviewed in a survey [20]. In addition, the involvement of experienced riders is very important in the training process [21]. Training games are also used to improve the physical preparation of the horses [22].

Polo horses in training or in regular competition show biochemical variations in lactate, aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl-transferase (GGT), urea, creatinine, phosphorus and potassium. These results suggest that these biochemical variations are due to the physical condition of the animals [23]. The classic training program for polo horses is muscle strengthening. This program increases the oxidative capacity of the muscles, which is very important for the endurance of the horses. In addition to increasing oxidative capacity, the training also tends to increase glycolytic capacity. Glycolytic capacity is important for short-term intense activity, but there is a potential risk of metabolic disorders such as exercise-induced rhabdomyolysis[24]. Blood lactate concentrations in relation to exercise are also used in biochemical studies of polo horses. Lactic acidosis increases after exercise. This is even more pronounced under the stress of outdoor polo compared to indoor polo [22,25]. Before training, plasma lactate concentrations show no differences between well-trained and untrained horses. However, plasma lactate is significantly lower in well-trained horses during and after training [26]. In conclusion, the literature shows that the training of polo horses is a complex matter that requires individual adaptation to the horse's needs. It is important to keep an eye on both the physical fitness and the biochemical aspects to ensure the health and performance of the horses.

3.5. Game

A polo match demands different physiological requirements from horses and riders. The intensity of the games is variable and subject to breaks, which means, that the physiological demands are not continuous [2]. The warm-up of polo horses before the game is usually short but intense, lasting 3-5 minutes. Interestingly, this short warm-up period has positive effects on the horse's ability to achieve a higher maximum oxygen uptake during the game[11,27]. A polo horse can be used for two **chukkas** per match, but it needs at least one chukka of **recovery time** in between. The primary responsibility for the health and welfare of the horses lies with the player, although the referee will also intervene, especially if there are signs of exhaustion, injury or stress in the animals [10,21]. A polo horse gallops between 2500 and 3000 meters during a chukka. The distance covered in chukka and the **average speed** are in direct proportion to a player's handicap. As the level of play increases, the demands on the horse's cardiovascular system and anaerobic fitness increase accordingly [9]. Acute, intense stress during polo tournaments can lead to significant, albeit temporary, physiological changes. For example, a horse's heart rate can reach 210-220 beats per minute during an **intense match**. Despite these changes, most parameters return to the physiological range immediately after exercise[28]. However, studies have also found that polo can lead to cardiac fatigue in horses. The exact causes and long-term effects of this cardiac fatigue have not yet been conclusively clarified and require further research [29].

3.6. Diseases

Polo horses are known for their speed, agility and endurance and are exposed to constant stress during play. This constant strain increases the risk of sport-related illnesses and injuries, especially lameness. An intensive analysis of various sources shows that polo horses frequently suffer from recurring illnesses. The risk of such diseases increases, in particular, with the duration of the risk and the **associated number of starts and competition hours** [20]. There is also a significant correlation between the duration of horse ownership and the risk of injury. Longer periods of ownership correlate with a reduced risk of injury [30].

The main factor that players cite as an important risk for injury to polo horses is the hard ground [20]. One study has already shown, that the interaction between the horse's hoof and the ground plays a crucial role in determining the load on the horse's extremities, which in turn influences injury and performance. As horses have a limited ability to change their limb mobility and gait in response to their environment, veterinarians can have a significant impact on this interaction by initiating ground surface adaptation and adjusting shoeing strategies. This can help to reduce the risk of injury and improve the performance of polo horses [31].

A study indicates that many polo horses exhibit considerable movement asymmetry when trotting on hard surfaces in a straight line. More than half of them can be considered clinically lame. The asymmetries do not appear to be dependent on the age of the horses [32]. The intensive braking maneuvers, especially when accompanied by turns, expose the joints and tendons of the animals to eccentric stresses. This makes them particularly susceptible to musculoskeletal injuries [33]. In fact, such injuries are the most commonly reported injuries in polo horses [20]. In particular, injuries to the superficial digital flexor tendon are the most common [18].

3.6.1. The superficial flexor tendon

The superficial digital flexor tendon plays a central role in the development of lameness. It is the most frequently injured structure of the musculoskeletal system in sport horses and often leads to premature retirement. Using high-speed biplanar fluoroscopic cinematography, it has been shown that tendon tissue, even when visually healthy, is often not fully healed at trot [34]. An ultrasonography study of 40 polo horses also showed that almost half of the horses had ultrasonographic changes in the superficial flexor

tendon [35]. Injuries to ligaments and tendons occurring in polo are not exclusively in the area of the superficial flexor tendon, but also in the collateral ligaments of the distal interphalangeal joints. Polo horses over the age of nine years have an increased risk of diseases of the collateral ligaments of the distal interphalangeal joints [36]. Joint diseases, especially osteoarthritis, are also a common cause of lameness in polo horses. Osteoarthritis of the metacarpophalangeal joint has been identified as the main cause of early retirement. The concentration of chondroitin sulphate in synovial fluid appears to be an early marker of articular cartilage damage, particularly in Polo horses, which are prone to joint disease [37].

Treatment of lameness and injury in polo horses varies depending on severity and cause. Common approaches include hydrotherapy, cold applications, anti-inflammatory medications and local injections. Further attention has been given to the use of filtered platelet concentrates or the use of bone marrow-derived mesenchymal stem cells to treat tendon injuries in horses [38]. According to the study, shockwave therapy also improves the chances of recovery [39].

3.6.2. Trauma in the polo horse

Traumatic injuries are not uncommon in horses and are frequently reported [20]. However, not only in polo, but also in general horse populations, a study shows that the prevalence of injuries is much higher than the 7.7% reported in another study [40]. Recent research has also considered injuries that may not have required veterinary care [30].

An exemplary case study on the extent of injuries in polo describes how a 7-year-old polo horse was hit in the left knee joint by its own rider's polo mallet during a match. This trauma resulted in pronounced lameness [41].

Eye pathologies resulting from previous trauma have also been described in the literature, particularly in polo horses but also in polocrosse horses [42]. It should be emphasized that it is against the rules of the sport to play a polo horse that is "blind in one eye".

Improperly fitted bits and bridles can cause oral trauma such as bone spurs, commissural ulcers and tongue injuries in polo and racehorses. A study examined the most common types of oral injuries in polo and racehorses that can be caused by improperly fitted bits and bridles. Racehorses showed a significantly higher severity and frequency of oral injuries compared to polo horses. Tongue injuries were only observed in polo horses. Racehorses showed more severe injuries in the lip commissures and bone spurs. A positive correlation was found between age and time in the sport. Polo horses played longer before injuries occurred [43].

3.6.3. Back disorder

Back problems in polo horses can cause impairment of the musculoskeletal system. The integrity and functionality of the back are essential for sport horses. Numerous factors can contribute to the development of back problems, some of which have been specifically described in the scientific literature. The various horse breeds that appear predisposed to back problems include thoroughbreds, arabians, polo horses and warmbloods. A gender-specific predisposition to equine back disorders is not yet known. Nevertheless, the literature shows that horses aged five years and older are particularly vulnerable to such affections [43]. With regard to the specific injuries that can occur with back problems, the longissimus muscle and the supraspinous and dorsal sacroiliac ligaments are the most common soft tissue injuries. Impingement and the overlapping of spinous processes are seen as particularly problematic bony lesions. The phenomenon known as 'kissing spines' is considered to be a common major cause of poor performance as it is closely associated with thoracolumbar pain, which can have a significant impact on the horse's welfare and performance[44,45].

3.6.4. EIPH - exercise-induced pulmonary hemorrhage

The prevalence of EIPH in polo horses ranged from 11% to 29.7% in various studies. The horses were examined for exercise-induced pulmonary hemorrhage (EIPH) after intense exercise [46,47].

In one study, neither blood at the nostrils nor below-average performance of the horses were observed [46]. In another study, the prevalence of EIPH was 29.7% (11 out of 37). Despite this significant percentage, the comparison between EIPH-positive and EIPH-negative horses showed no significant difference in tracheal cytology. It was found that polo horses are affected to a relevant extent by IAD and EIPH, so there is a need to consider these respiratory diseases when assessing their health status. In comparison, the incidence of IAD in polo horses is the same as in multiparous horses but not as high as in racehorses [46].

A study from 2003 showed that 46% of the animals examined were EIPH-positive, based on a careful classification of the animals according to polo seasons played and sex, as well as endoscopic examinations of the airways. However, statistical analyses in the study indicated that neither the number of polo seasons played nor the sex of the horse had a significant influence on the occurrence of EIPH [48].

3.6.5. Myositis und Rhabdomyolyse

Rhabdomyolysis is another important stress-induced disease in polo horses. A survey of 423 polo horses revealed an average incidence of rhabdomyolysis of 7.3% [49]. In this context, it is interesting to note that although previous studies suggest that female horses are more susceptible to the disease, polo mares were not significantly more affected than geldings. Genetic factors may play a role. When examining the genome of various horses with rhabdomyolysis due to polysaccharide storage myopathy, a mutation in the glycogen synthetase 1 gene was found in one polo horse. Such genetic markers are an important cause of exertional rhabdomyolysis but are not responsible for all forms of polysaccharide storage myopathy (PSSM1), but they are crucial for the evaluation and management of affected horses [50].

The management of polo horses differs from that of thoroughbreds and is less likely to be a risk factor for certain diseases such as rhabdomyolysis. Although this disease can occur in horses up to 15 years of age, two-year-old horses are at higher risk [51,52]. Polo horses are usually not introduced to the game until they are four years old, which may explain why they do not have a sex predisposition to rhabdomyolysis [18,51]. In thoroughbred mares, however, nervousness and age appear to be potentially more important factors. It has been found that supplementation with the ADE vitamin complex can make muscle metabolism more efficient during exercise, suggesting a possible therapeutic approach [53].

3.6.6. Equine Infectious Anemia (EIA)

Equine infectious anemia (EIA) is a chronic, contagious, and potentially fatal viral disease that attacks the immune system of affected animals [54]. It is of high veterinary relevance and has been reported in polo horses, including a case in 2017 in Switzerland's Aargau canton. Eradication of the EIA virus is proving to be extremely difficult due to the long incubation period and high horse traffic [55]. In a study conducted in Nigeria, 84 sera were collected from racehorses and polo horses in various local regions and tested for antibodies against the EIA virus using an indirect ELISA test. Positive results were found in 1.2% of the samples tested. It is worth noting that the positive horses were adults and had no fever or symptoms associated with EIA [56]. The Hurlingham Polo Association (HPA) focuses on preventing infectious equine diseases such as druse, dermatophytosis,

equine herpesvirus (EHV), and equine influenza. In recent years, equine infectious anemia (EIA) has also become a concern in Germany [10,12].

3.6.6. Heart disease

The first scientific report on the prevalence of heart murmurs in polo horses was conducted in 2019. The study showed a significant incidence of **tricuspid and aortic murmurs**. However, the data was collected by means of detailed chest auscultation and thorough echocardiographic examination and did not reveal any striking differences compared to other horse populations [57].

3.7 Animal welfare in polo

In **Germany, the Animal Welfare Act** is the highest guideline for animal welfare. Compliance with this act is not only a moral obligation but also a legal requirement in polo [58]. The health of the horses is paramount in the sport. The Hurlingham Polo Association has drawn up clear rules that define the health of the horses as a crucial prerequisite for the game. These rules, therefore, stipulate certain conditions under which a polo horse may not be used. These include cases where the horse is blind in one eye, has an open tracheotomy, has been enervated (whether by chemical or surgical means) or is temporarily desensitized. Similarly, polo horses that display unsafe behavior, such as kicking or biting, or show signs of infectious diseases, lameness, spur injuries, or bleeding, should not be used in play.

There are guidelines for extreme heat conditions, known as 'Guidelines for Extreme Heat'. These rules, along with the vaccination regulations of the Hurlingham Polo Association (HPA) and the German Polo Association (DPV), are important for protecting the health of horses. The associations also provide information on current hygiene practices and how to recognize and prevent the spread of diseases in horses. This is crucial for ensuring that horses remain healthy in sport [10].

4. Discussion

Polo horse health is a multifaceted issue that encompasses internal diseases, orthopedic injuries, and ethical aspects. Legal regulations and rules established by various organizations serve as a framework to ensure the protection of horse health in polo. However, the welfare of polo horses also depends on the experience and sensitivity of the players. It is essential for players to recognize the stress limits of their horses and to respond appropriately. They must also consider external factors like temperature and pitch conditions.

Polo horses require demanding athletic skills such as speed, agility, and endurance. During the game, tendons and joints are at constant risk, with the most common orthopedic problem being injury to the superficial digital flexor tendon. Joint diseases, such as osteoarthritis, are particularly common among polo horses and can affect their longevity. Polo horses and racehorses share similar internal diseases. Comprehensive management strategies are required to mitigate the impact of exercise-induced pulmonary hemorrhage (EIPH) and rhabdomyolysis on equine health.

Traumatic injuries to horses in polo, particularly from balls and mallets, raise animal welfare and ethical concerns. To address these concerns, preventative measures should be taken, and prompt medical action should be initiated in the event of injury. It is also essential to comply with regulations established by organizations such as the Hurlingham Polo Association to protect the welfare of horses. The regulations set out the conditions under which polo horses should not be used and emphasize the importance of taking proactive measures to protect the health of the horses. Guidelines for extreme heat conditions, vaccination protocols and hygiene practices help maintain the health of the horses

and prevent the spread of disease. Veterinarians play a crucial role in treating sick horses and preventing injuries. For example, organizations and players receive advice on optimizing ground adjustments and shoeing strategies.

Responsible management practices, compliance with regulations, and ongoing efforts to improve player awareness are crucial to protect the welfare of polo horses. To promote the health and welfare of polo horses, it is crucial for associations, players, organizers, and veterinarians to cooperate.

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