

Review

Thoroughbred Racehorse Welfare through the Lens of ‘Social License to Operate’—With an Emphasis on a U.S. Perspective

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Abstract: This review addresses the question of whether Thoroughbred horse racing is sustainable in the context of current social values. A recently acknowledged framework, known as ‘Social License to Operate’ (SLO), provides us with a lens through which to view and assess racehorse welfare. In multiple surveys of the general public, the horse owning public, and university students, the primary topics of concern regarding Thoroughbred racing show considerable concordance: concern about catastrophic injuries—particularly as related to track surfaces, concern over the racing of two-year-olds, whip use by jockeys, drug/medication policies, and aftercare opportunities for retired Thoroughbred racehorses. Legitimacy of an industry, consent from industry stakeholders, and trust between the community players, are all essential to have and maintain SLO. In the current era of 24/7 global media access, and the proliferation of social media providing an interactive platform for all interested parties, a dramatic change has occurred in commentary related to racehorse welfare concerns. The situation at Santa Anita (California, USA) from late December 2018 through mid-November 2019 demonstrated just how tenuous the SLO for horse racing is. This article will provide a brief review of what ‘Social License to Operate’ is, along with a brief literature review of five of the areas of primary concern voiced by stakeholders.

Keywords: racehorse welfare; social license; horse racing industry

1. Introduction

Social License to Operate (SLO) is the public or ‘social’ acceptance, which grants permission or a ‘license’ to an organization to undertake its activity; i.e., to ‘operate’ [1] (pp.18–25). While it was first applied in the context of the mining and banking industries, the term has more recently been applied to sport [2–5]. Today, SLO is acknowledged as the public’s approval (or consent) of the activities of an institution [1,6–10].

Even before the spike in fatalities at Santa Anita Park (where over 30 racehorses experienced life-ending catastrophic injuries either during competition or morning exercise sessions in less than 6 months [11] and where a noted sportscaster was televised stating, “I have no idea why horse racing is still a thing . . . ” [12]), Bergmann (2015) articulated the brewing issue: “the principal question emerging from evolving social norms and values . . . [is] whether thoroughbred racing is ethically justifiable, and if so, how it can be conducted so that it is socially acceptable” [13]. The idea that the racing industry is on tenuous footing is not new, but it reached a fever pitch in 2019. Long-term industry sustainability may well depend on the industry’s response to these challenges going forward. The stakes are high. As stated by Ray Paulick in his column, ‘View from the Eighth Pole’, “This is a very real crisis, the likes of which this sport has never seen before” [14].

Any major changes to the future direction of the racing industry stand to have widespread economic impacts. The American Horse Council Foundation’s 2018 Economic Impact of the U.S. Horse Industry report [15] estimates that of the over 1.2 million horses involved in the racing industry, the largest sector is driven by over 500,000 Thoroughbreds. The total “value added” (or contribution to Gross Domestic Product) generated by the racing sector, which includes direct, indirect, and induced effects, is nearly \$36.6 billion. This constitutes about 30% of the overall equine industry impact of \$122 billion in the U.S. However, when considering the future viability and sustainability of the industry, perhaps even more salient is the number of jobs involved—over 241,000 directly, and over 472,000 total (direct, indirect, and induced). While racing is often referred to as the Sport of Kings, many rely on employment within the industry for their primary source of income. The four states with the highest level of total employment in the racing industry include Kentucky (33,735), Florida (25,597), New York (19,704), and California (17,978) [15]. While other states have smaller markets, the presence of Thoroughbred racetracks and related markets are important sources of employment and economic activity in many areas across the U.S.

In 2011, The Jockey Club commissioned McKinsey Consulting to investigate the state of Thoroughbred racing and its growth prospects [16]. The resulting “McKinsey Report” detailed a decline in attendance and wagering over the previous decade, but noted that those trends were not noticeably different from racing in other countries and in other professional sports. However, only 22% of the general public had a favorable impression of horse racing. An update provided by McKinsey at the 2018 Jockey Club Round Table [17] indicated that concerns centered on horse welfare continue to be among the most important issues influencing public perception of racing, even prior to the string of deaths at Santa Anita in late 2018 and early 2019. McKinsey’s update also reported that over 50% of casual fans would stop betting if they knew horses were mistreated, and new fans object to the use of the whip. In a survey of the entire fan base, the top three welfare-related concerns were: treatment of horses after retirement, day-to-day treatment of horses in training, and illegal doping.

The purpose of this paper is to explore racehorse welfare through the lens of the racing industry’s ‘Social License to Operate.’ First, Social License to Operate is defined. Then, with consideration of the scientific literature, we will address and provide a narrative review of five of the primary concerns that consistently have appeared in social media and commentary on news articles: catastrophic breakdown injuries, two-year-old racing, race day medication, whip use, and aftercare [18]. (Two other topics brought up in surveys and commentary during 2019: corruption/greed/integrity issues and lack of a central authority were less horse-centric and deemed to be outside of the scope of this article [19].) A primary goal motivating this exercise was to identify areas where more research investment and effective communication of the existing knowledge would help to address public concerns being raised in a ‘Social License to Operate’ context.

2. What Is Social License to Operate?

The rapid development and adoption of electronic communication technologies within wider society has allowed greater participation than ever by the public in open discourses of common interest; e.g., Thoroughbred horse racing. The impact of increasing access to the Internet and social

media is both globalization and information democratization, which has accelerated changes in human behaviour. Business models once viewed as ‘disruptive’ have transformed into rapidly growing enterprises, such as Airbnb™ and Uber™. These businesses are reliant on citizens unknown to each other accessing crowdsourcing information, sharing personal experiences, and ultimately, recommending the service [20,21]. Crowdsourcing information to form an opinion that facilitates purchasing decisions is a new public skill set and represents a move away from reliance on more institutionalized models of recommendation, like the hotel star rating system.

Disruptive communication technologies have also impacted public perceptions about animal use in sport and have brought to the forefront the importance of recognizing, understanding, and fostering SLO. Shaped by the ‘sharing economy’, the public has redefined the values of legitimacy, credibility, and trust [22,23]. These values are becoming increasingly delegated across society to form the basis of a ‘currency’ of opinion exchange.

While there has long been public opinion about humans and animals in the sporting arena, the Internet has globalized even the smallest local event through smartphone technologies [24,25]. Embracing 24 hours-a-day, seven-days-a-week Internet access increases the exposure of horse sport to a potentially naïve global audience [26]. While this provides the sport with a platform to promote the competition and attract commercial investment, it also enables rapid and wide distribution of other events, including cases which may elicit a negative public response if perceived that the safety and welfare of horses is placed at unwarranted risk.

Access to digital technologies has captured not only citizens seeking to purchase products and services, but also the individual sports follower, who can spectate, comment, and share both online and offline sporting field experiences as a ‘smart fan’ [27]. Similarly, related technologies allow fans to become virtually involved, passionately sharing digital information and resources in all aspects of sport and its administration [21,25,27]. This virtual involvement has the potential to contribute both positively and negatively towards the sport’s overall reputation.

From the social positioning of horses as corporate ‘sporting celebrities’ to the selfie posted from a local horse club, technology is a challenge for the ‘status-quo’ of sports organizations. This new juxtaposition, which blends traditional horse cultures with the new technology-enabled central positioning of individual horses as sports figures, brings a level of public scrutiny and often expected accountability for sport administrators previously only experienced by the business sector [28,29]. The ‘fandom’ includes spectator-fans who collect, share, and comment utilizing digital sport resources but who are not sport fanatics, together with fans of horses who become outraged if it is perceived that their welfare is at risk [26,30]. Fans may be naïve about the intricacies of the sport and equine science, but enhanced by technology, this ‘smart’ global audience is responsive to horse welfare issues and questioning of trust in the organization, both of which may impact long-term business sustainability [27,31,32]. Ultimately, technology accelerates not only the access to crowdsourced knowledge and perceptions, but it impacts societal expectations. Social media is not only an outlet for individuals to share their personal opinions, but also a way to spread information that is published in traditional media. A single article in the Los Angeles Times from March 31, regarding the 23rd fatality at Santa Anita, was shared almost 4800 times [33].

There are different arguments as to what constitutes the prerequisites for achieving or maintaining a social license including legitimacy, consent, and trust [1], or legitimacy, credibility, and trust [2,10,23]. While a community can be seen to award consent, this same community can also seek to withdraw consent. However, there is often no one point at which the decision to withdraw can be seen to occur [1,2,34]. The intangible, dynamic nature of SLO may challenge structured, institutionalized sport governance models.

For this discussion, we will consider legitimacy, credibility, and trust as a pathway for the awarding or removal of public consent [35], which is embodied in the SLO. An established organization has a level of pre-existing legitimacy and historical precedence. However, in the digital age, there is ‘social legitimacy’ that must also be considered. Social legitimacy is created when members of the

public scrutinize crowdsourced information about an organization and evaluate the perceived level of legitimacy held, while using social media to simultaneously influence wider public opinions on factors such as fairness and transparency [1,23,36].

Credibility relates to the public's confidence level that an organization will carry out what it said it will do, and includes a social element similar to legitimacy. Online users can form opinions about the organization's competency before influencing other people's opinions by expressing contempt or sarcasm, claiming an idea or resource as their own, or by dynamically altering their relationship with the issue, by becoming closer to, or more distant from, their own comments posted online at an earlier date [23,37]. An organization's credibility is reinforced when the public can see that the organization is doing what it said it would do.

Trust is emerging to be the most important element of a contemporary SLO, not as a by-product of organizational practices, but as a result of relationships being built/re-built each day [23,32,38]. As discussed earlier, trust is based on the shared economy, where online users rate, review, and comment peer to peer, and businesses or organizations can choose to demonstrate listening skills by responding [39–41]. These multi-authored, real-time public conversations facilitate the shift of trust away from institutions to an outsourced, citizen-curated model, which has the added benefit of building transparency. Therefore, organizations are customizing their viewpoint, ensuring that what they say 'could be done', can in fact actually be done [22,23,42].

Our discussion so far has highlighted that the 'social' part of the Social License to Operate is a new dimension for organizations to grapple with. A potential barrier for the adoption of the SLO concept within an industry is confusion regarding connotation of the term 'license,' which in other applications has linkages to the fields of law and economics and implies a binary agreement [2]. Instead, a SLO operates along a continuum, and at multiple levels, with many valid smaller SLOs at given points [42–44]. The contemporary SLO, particularly where sport and animal use intersects, increasingly sits within the community; therefore, sport cannot 'un-own' the convergent social discourse and walk away.

Ultimately, SLO can be most noticeable within an industry when it is absent [35], causing potential economic impact and the loss of trust, with the risk that political sanctions will follow [31,42]. Further, SLO has a focus on multiple single issues, creating the necessity for organizations to be flexible and adaptable in all aspects of engagement, communication and decision-making in light of the unstable public discourse [1,21,45,46].

We hypothesize that social capital built through a common interest in the welfare of Thoroughbred racehorses is a potential asset to be realized by organizations, arising from a shared protective factor for the sentient equine athlete. This contemporary environment for the SLO challenges traditional institutions to reflect on their self-governance, and to reimagine what previously legitimate business practices might mean in the new operating environment of devolved trust, in which every day business decisions are taken 'with' the community [21,22].

Increasingly, sports organizations are recognizing that the public seeks accountability for the welfare of the horse at multiple touchpoints, including organizational governance, the rules for the conduct of competitive events, and through organizational empowerment of the chief guardians, the human riders and caretakers. The public seeks assurance that the organization is taking horse welfare seriously, in perception and practice (credibility) building long-term relationships (trust) as the pathway to ongoing consent (license) for the activity to continue [1,47].

The next section addresses five key topics that threaten to erode the Thoroughbred racing industry's SLO and, ultimately, the long-term sustainability of the industry. In each topic, we review selections of the available scientific literature.

3. What Are Commonly Expressed Areas of Concern?

Co-author CH has conducted informal surveys of her Horse Behavior and Welfare university students over a seven-year period (2012–2018, n = 154) (2019 was purposely excluded due to increased

media coverage of the topic). Prior to delivering a lecture on the topic of racehorse welfare, students were asked to pick one of the following options to the question: What is your ‘right now’ opinion of the Thoroughbred racing industry? ●A. Very comfortable with the welfare status of the vast majority of Thoroughbreds in the flat racing industry, ●B. Reasonably comfortable with the welfare status of most of the Thoroughbreds in the flat racing industry, ●C. Neutral—neither favorable nor unfavorable opinion, ●D. Somewhat uncomfortable with the welfare status of most horses in the flat racing industry, ●E. Very uncomfortable with the welfare status of most horses in the flat racing industry. Between 25–30% of students selected D. or E. each year.

As the early months of the ‘Santa Anita crisis’ dawned in 2019, we assigned several of our Equine Science and Management interns (noted in Acknowledgements) to search for relevant media articles and social media commentary related to breakdowns at Santa Anita. Co-author CH reviewed their findings and assessed content themes [48]. While recognizing these artifacts may not have been randomly selected, the first 50 selected references related 40% to track surface issues, 24% to perceptions about corruption/integrity/greed, 17% to the age of horses (i.e., too young), 12% toward medication and drug issues, and 7% concerns about the use of the whip/crop. (Concerns/perceptions about “throwaway” horses, and what happens to retired racehorses was less Santa Anita-focused and has been a steady topic in racing-related media coverage for many years. Please see Aftercare section below.)

On September 30, 2019, Fox 11 news station of Los Angeles, California (www.foxla.com) conducted a Facebook poll: “Should Santa Anita Park be shut down (for horse racing)? 18,900 people voted. 54% voted ‘yes, it should be shut down’, 2200 people made comments and 1300 people shared the poll and subsequent results with others. An earlier poll prepared by The Jockey Club asked the following: ‘Generally speaking, do you believe race horses are treated in a humane way?’ 31% of US likely voters said “no,” and 21% of Kentucky likely voters said “no” [19]. Concerns for the well-being of racehorses are not new; the media has been publishing articles voicing similar concerns regarding breakdowns, drug use, and aftercare for decades [49,50]. Though the terminology of ‘Social License to Operate’ is relatively new, similar concerns have been voiced for many years.

A Nexis Uni[®] search with the keywords “Santa Anita” and “Horse Deaths” resulted in 1605 results for the year beginning with January 1, 2019. The keywords “Horse Racing” and “Welfare” elicited 798 articles in North America over the same time period. While keyword searches have their limitations, another Nexis Uni[®] search of “race horses” and “retirement” and “Thoroughbred” and “slaughter” produced over 1000 results. Media articles cited issues such as racing of young horses [51], race track surfaces, the weather, and whipping [52] as possible reasons for these catastrophic injuries. An additional area of concern in the media was the use of medications, such as Lasix [53], in racing horses.

Based on both qualitative and quantitative assessment of the above information [54,55], we have chosen five areas of consistent public concern that seem to be playing a role in horse racing’s SLO. In some of these areas, we will suggest that more public education is needed to help relay what the science tells us (e.g., racing of two-year-olds)

3.1. Racetrack Surfaces and Relationship with Catastrophic Breakdowns

The death of horses directly connected to racing competition is most likely to elicit a public response, and if that public response becomes strong enough, it can threaten racing’s SLO. Typically, these catastrophic injuries are defined as an adverse effect from racing or training that results in death or euthanasia of the horse. In the most important racehorse-affiliated dataset in North America, the Equine Injury Database™, all horses that die or are euthanized within 72 h of injuries sustained from racing are included. In the perception of the general public or many casual race followers, racing surfaces are a central factor in risk of catastrophic injury in horse racing.

The most high profile attempt to eliminate surfaces as a factor in catastrophic injuries is the now reversed edict from the California Horse Racing Board that required synthetic racing surfaces at all of the major racing venues [56]. More careful analysis of the situation suggests that the type of racing

surface may be only one of several risk factors related to the racing surface [57]. However, in the primary study of flat racing in North America, the condition of the track, evaluated for dirt and off-dirt surfaces, was not found to be significant [57]. In contrast, a more recent meta-analysis using studies from a number of different countries suggests that the type of surface may be less of a factor and that the surface's condition is significant [58]. Given the low quality of the data and inconsistent definitions used to define off-dirt versus dirt surfaces, the inconsistency in the significance of outcomes is not surprising. This does not suggest that the question does not need to be considered; however, since along with a few other factors, such as veterinary pre-race examinations, racing surfaces impact every horse in a day of racing. Improved surfaces present an important opportunity to benefit all of the horses in a race. It is also significant that even the perception of a defect in a racing surface can be important since it may distract attention from other factors that should be addressed to enhance the safety of the equestrian surface/footing.

The effect of surfaces on the incidence of catastrophic injury is supported by the literature, while the effect of surfaces on the overall length of a racing career is less well understood [57,58]. In the annual results from the Equine Injury Database™ maintained by The Jockey Club, synthetic surfaces reduce overall injury rates from 2.0/1000 starts on dirt to 1.2/1000 starts on synthetics [59]. The most comprehensive academic paper on the Equine Injury Database™, controlled for all other known variables, found the same result; synthetic surfaces are safer. For the 380,000 starts over the last decade on synthetic surfaces, that difference in injury rates represents 300 fewer horses lost and 300 riders who were not put at serious risk. However, questions remain with synthetic surfaces: synthetic surfaces become difficult to maintain with age, and trainers continue to question if the careers are genuinely longer for horses who race on synthetic surfaces. It has been speculated that a different pattern or distribution of injuries is leading to shorter careers from racing on synthetic surfaces. There is no doubt, however, that catastrophic injuries are a particularly acute risk for horse racing, given that the experience of seeing a horse fatally injured during a race is more visible and emotional [60].

Defects in a racing surface must also become so infrequent that fans and owners will be unlikely to experience a track without an optimal surface. Improved certainty in the track surfaces will also reduce the chance that a fan or participant will ever see a catastrophic injury of a horse and the associated risk to a rider. What may be the biggest challenge is the development of a shared set of criteria that can be tested which also correspond to perception. In this case, efforts in the equestrian sport of show jumping is significantly ahead of racing, with work correlating rider perception of surfaces having been shown to correlate to objective measurements [61].

At the same time, research should be directed toward technologies that make it possible to reduce, or even eliminate, the gap in safety between synthetic and the other surfaces as well as address concerns with synthetic surfaces. Increasing the number of synthetic surfaces and extending the life of current synthetic surfaces will move racing safety in the correct direction. Safe racing must be possible even when the weather is uncertain.

Research by John Bridge at University of Washington, Bothell, USA, has examined the mechanisms of wax degradation in racetracks with synthetic surfaces [62]. This approach has the potential to extend the life of these surfaces to ensure a consistently safe surface over time. Concerns by trainers about the length of equine racing careers must also be addressed. If the biomechanics of these surfaces lead to a different pattern of career ending injuries, a redesigned synthetic may produce better biomechanics. However, the data regarding catastrophic injuries are clear: synthetic surfaces are safer.

The challenge facing the equine industry is to produce a surface that can be consistent both spatially and temporally, while providing biomechanics that are suitable for most horses or provide the opportunity for a horse to adapt. Once a track surface has been developed that provides good biomechanics and consistency over time, objective measurements must be made and communicated in a manner that builds confidence in the consistency of the track for all stakeholders. Development of performance measures from the perspective of the participants may be able to benefit from the criteria developed by the committee associated with the Fédération Equestre Internationale [62]. However,

understanding the effect of these parameters on risk to the horse will require widespread adoption of the testing of racing surfaces. In the interim, the most likely sources of variation can be controlled. For both dirt and turf surfaces, the large variation in injury rate between years is most likely to be a result of differences in moisture content, which result from differences in weather [63]. The simplest approach is to have a consistent method of tracking weather at racetracks as well as measuring moisture content and other critical variables.

It is not only critical that surface research and innovation continues, but that the logic behind decisions to choose different surfaces must be communicated in a transparent fashion. While epidemiology must guide decisions, the data are naturally finite and perceptions and experience of trainers is not always fully represented [64]. Once again, this move toward enhanced transparency is a reminder that SLO components are at hand even when the terminology is not specifically in use. Turf racing continues to grow in popularity and shows significant improvements in safety over dirt. Turf racing needs to be conducted in a manner that more races can be safely held on a consistent surface. Synthetic surfaces will become more of a factor as soon as concerns regarding the career length of the horses are addressed. By innovating to improve the consistency of dirt surfaces, those tracks that continue to race on dirt will need to communicate their efforts to provide more consistency. If dirt surfaces continue to have a higher catastrophic injury rate relative to either synthetic or turf, then the justification for their use in competition or high-speed workouts will become more difficult over time.

3.2. Two-Year-Old Racing

Another highly prevalent criticism of the racing industry centers on the training and racing of two-year-old Thoroughbreds. Critics believe that horses of this age are not yet physically mature enough to withstand the rigors of high-speed exercise. However, research in this area suggests that bone remodeling occurs more efficiently at younger ages, that horses who start their first race later in life have a higher risk of suffering a fatal injury, and that horses who engage in high-speed exercise at a younger age have more successful racing careers [65,66].

Based on research, there are a few critical points relevant to SLO that the industry needs to find ways to better communicate. First, horses enter puberty at 10–15 months of age; consequently, young racehorses starting high-speed exercise around 18–24 months of age are physiologically more analogous to a human in their mid- to late teenage years. Interestingly, in some sports, this is an age where human athletes often start to reach top levels of performance and competition. Second, the structural remodeling of equine limb bones in response to the biomechanical forces of high-speed exercise occurs more efficiently at ages in the range of 18–24 month compared to older horses with developmentally mature bones. Racehorses will need to remodel their limb bone structure whether they start racing as 2–3 year olds or 5–6 year olds, but they can accomplish the remodeling process more easily at the younger ages. Finally, important parameters to consider, both physical and mental, are not always equivalent across different equestrian sports. Horses competing in dressage at elite levels will need to achieve both mental maturity and controlled physical movements in response to rider aids that require many years of training to master. This is not equivalent to the physical capabilities, skeletal parameters, or mental maturity necessary to be a successful and healthy racehorse. Indeed, knowledge in the field of bone biology, as well as the epidemiological data, clearly indicate that delaying high speed exercise until full skeletal maturity is contraindicated.

Critics of the training and racing of two-year-olds come from the outside as well as within the industry. Some of the concern involves the economic incentives associated with “precocious” horses, or youngsters who show early speed [67–69]. Using a sample of horses sold in two-year-old in-training sales in 2013, Robert and Stowe (2016) estimate that each additional 1/5 second reduction in breeze time was worth an average of between \$8000 and \$24,000, depending on the type of sale [70]. Critics of training a young Thoroughbred (often not yet biologically two years old) to run fast “splits,” or a short distance, are concerned about the possible effects of early, intense training on injury rates, longevity, and career performance.

Exercise physiologists have investigated horses' musculoskeletal responses to strenuous physical exercise at a young age. Researchers have discovered that exercise is beneficial for the strength of a young horse's bones, but above some intensity threshold, it becomes damaging. McLellan (2014) analyzed two groups of two-year-old Thoroughbreds trained by the same individual at the same location over a period of about nine months [71]. One group of horses was being prepared for racing, and the other was being prepared for the two-year-old sales. The latter group of horses spent more of their time in intense training in the form of speed work. The two groups did not have a statistically significant difference in injury rates (49% for the racing group and 42% for the sales group). Injuries were similar among both groups, and most injuries were not career-ending. Firth et al. (2005) show that "conventional" training of two-year-old Thoroughbred racehorses has a positive and significant effect on bone size, density and strength index when compared to untrained two-year-old racehorses [72]. Moreover, Boyde and Firth (2005) suggest that "Moderate, industry-standard levels of exercise used to prepare young horses for racing induced the formation of new bone in non-bone spaces in bone tissue, such that the bone organ should better withstand later increased levels of exercise" [73]. However, when exercise exceeds "conventional" training or "industry-level standards," repetitive loading of training and racing produces fatigue injuries [74].

Firth and Rogers (2005) summarize the main findings of an extensive series of studies on the training of young horses by examining tissue responses using a combination of methods [75]. The authors' justification for the study foreshadows the objective in producing this article: "The reason for undertaking the study was that clinically evident musculoskeletal injury in the Thoroughbred racehorse is often acute and in some cases life-threatening or -ending, and provokes negative emotive responses from the public on the issue of training and racing horses." In this study, the authors analyzed tissues from seven horses trained on grass and sand training tracks and compared them to seven horses kept in yards and not formally exercised. The cooperating trainer selected the seven horses to be placed in training from a group of 14 fillies who were born at the same farm, raised identically on pasture, and all except one were by the same sire. The authors found that in general, incidence of clinical injury was negligible, select bones, tendons, and cartilage responded to early training exercise, although some structures responded more than others.

Research suggests that the prevalence of radiographic lesions of Thoroughbreds at two-year-old in-training sales are similar to Thoroughbreds at yearling sales who had not yet started the training process. Among 953 Thoroughbreds at a two-year-old in training sale, 31.4% (299/953) had at least one radiographic lesion [76]. This prevalence is not dissimilar to the prevalence of radiographic lesions found in a retrospective study of 1127 Thoroughbreds at yearling sales [77].

Studies have also investigated the relationship between lesions or other irregularities and future performance. The odds of starting a race and of earning money racing were lower for horses with any lesion and for horses with certain types of lesions [76]. Another study found that while 85% of the sample of 292 two-year-old Thoroughbreds offered for sale at a public auction in 2002 had mild to moderate deviations from straight forelimb conformation at the carpus or fetlock as measured by two separate observers, these deviations had no substantive effect on lifetime racing performance [78].

Breeze time does appear to be a useful predictor of future performance. Horses who breezed one furlong in less than 11 seconds were more likely to have more than the median number of lifetime starts and lifetime earnings [76]. A faster workout time at a two-year-old in-training sale was associated with better short- and long-term racing outcomes [78,79], and starting a race as a two-year-old was a statistically significant predictor of many racing outcomes: more lifetime starts, more wins, more places, higher percentage of placings, more earnings, and a greater number of years raced [78]. In addition to breeze times, breeze distance appears to matter. Horses who breeze two or three furlongs ultimately earn more than horses that breeze only one furlong [79]. One limitation of these studies that attempt to understand the relationship between early training and racing and career performance is that data are insufficient to investigate the effect on longevity; in general, it is not known whether a horse ceases to race because it was more valuable as breeding stock, it was injured, or it was simply too slow.

In 2008, The Jockey Club convened the Thoroughbred Safety Committee. One of the charges to the committee was to collect and analyze data to examine the notion that the training and racing of two-year-old Thoroughbreds predisposed these horses to accelerated rates of injury and prematurely shortened careers. The initial recommendations were presented by Larry Bramlage, DVM, MS, DACVS, at the Jockey Club's 2008 Round Table Conference on Matters Pertaining to Racing. In what follows, the committee's condensed remarks are provided [80]:

"This charge is leveled by some people in and out of the horse industry, especially people outside of racing. It is a very popular theme with animal welfare organizations that are ill-informed on the topic of racing and the horse; it is also parroted frequently in the popular press. . . . To examine these data, The Jockey Club Information Systems extracted one-year windows at five-year intervals, using the years 1975 through 2000 as data sets. Horses were divided into the categories "raced as two-year-olds" and "raced, but not as two-year-olds." . . . The data shows a definitive answer to this charge. . . . The first category of data examined was average starts per starter lifetime. The data shows that horses that raced as 2-year-olds raced many more times in their lifetime in each of the years examined when compared to horses that did not race until after their 2-year-old season . . .

Average lifetime earnings per starter for horses that raced as 2-year-olds are almost twice the amount earned by horses that did not race as 2-year-olds. Career average earnings per start for horses that raced as 2-year-olds exceeded average earnings per start for horses that did not race as 2-year-olds in every one of the years from 1975 to 2000 examined. Lastly, the percent stakes winners in horses that raced as 2-year-olds is nearly three times higher than in horses that did not race until their 3-year-old year or later.

This data is definitive. It shows that horses that began racing as 2-year-olds are much more successful, have much longer careers, and, by extrapolation, show less predisposition to injury than horses that did not begin racing until their 3-year-old year. It is absolute on all the data sets that the training and racing of 2-year-old Thoroughbreds has no ill effect on the horses' race-career longevity or quality . . .

These data strongly support the physiologic premise that it is easier for a horse to adapt to training when training begins at the end of skeletal growth . . . "

The Thoroughbred Safety Committee's research was conducted prior to the establishment of the Equine Injury Database™. However, analyses of the EID provide further support to the committee's findings. Georgopoulos and Parkin (2016) studied the risk factors associated with fatal injuries using the Equine Injury Database™ [57], where a fatal injury due to racing is defined as one that results in death within 72 h of the race. Among the many risk factors studied, one of the risk factors was age at first start. Contrary to public opinion, when analyzed on a population level, each additional year of age at first start beyond the age of two actually increases the risk factor of a fatal injury during a race.

To summarize, extensive research supports the appropriate training and racing of two-year-old Thoroughbreds. Limb bones can remodel in response to the biomechanical forces of racing much more efficiently in the peripubescent period of an 18–24 month old racehorse compared to a skeletally mature older horse [81,82]. Moreover, horses that begin high-speed training at an earlier age are more successful on the racetrack. The SLO variable is primarily one of communicating this knowledge base effectively.

3.3. Medication Used in Racing and Raining of Thoroughbreds

3.3.1. Race-Day Medication (Lasix/Salix/Furosemide)

A consistent area of concern from the general public, as well as social media 'casual race followers', is the issue of Lasix (or Salix or furosemide). Few items are as controversial within the world of horse racing. A review of some of the most relevant literature [83,84] helps us understand why this topic is so

contentious. Administering furosemide does appear to correlate with a reduction in bleeding intensity resulting from exercise-induced pulmonary hemorrhage (EIPH). That is to say, horses that have EIPH will consistently improve by at least one clinical grade score when it comes to bleeding intensity after receiving Lasix. Whether or not ‘bleeders’ should be allowed to race is a separate question, though it should be noted that the majority of Thoroughbreds involved in high level exercise will experience some level of pulmonary hemorrhage. From an animal welfare standpoint, it seems appropriate to provide this medication to horses where the proof is nearly undeniable that it helps. On the other hand, the public and casual race followers overwhelmingly do not support the concept of race day medication. A number of media articles have discussed the issue that Lasix is a diuretic; and because of this, horses urinate a considerable amount after furosemide administration [73,74]. This causes them to lose weight shortly before a race and is seen by many to thus be a performance-enhancing drug. A recent op-ed from Bill Casner [85], Thoroughbred owner and breeder, shares the concern of some stakeholders that, based on human studies, furosemide interferes with calcium homeostasis and has been implicated in human fracture rates [86]. Many industry stakeholders agree that this is one of the most challenging issues in the world of racing; i.e., deciding whether or not race day furosemide should be allowed.

A recent study by Bayly and colleagues demonstrates that furosemide administered 24 h before racing may be equally as effective as the traditional 4 h pre-race dosage [87]. Based on this evidence, the Kentucky Equine Drug Research Council recently reversed its decision related to the phase out of race-day Lasix for 2-year-olds. As of the writing of this article, the Kentucky Equine Drug Research Council is now in agreement with phasing out the use of race-day Lasix in 2-year-olds beginning in 2020 and in stakes races beginning in 2021 [88].

3.3.2. Other Medication Used in Racing and Training—“Doping”

Another concern often voiced on social media is the issue of “doping.” In general, most issues related to drugs and medications, are lumped together in this category. *‘Doping in performance horses is defined as the “illegal application of any substance, except normal diet, that might modify the natural and present capacities of the horse at the time of the race”* [89]. In other words, doping is a concern to the public for a few reasons. First, certain types of medication can mask serious conditions, and by doing so, the horse may be at higher risk for serious injury or catastrophic breakdown. Second, the use of performance enhancing medication creates an uneven playing field. An illustration of this concern is the 340 news articles published in the fall of 2019 related to the positive finding of Scopolamine in a Kentucky Derby winner (e.g., [90,91]). For example, the following quote was presented in the Thoroughbred Daily news, “... But the general public is never going to realize that or get past the headlines, most of which read something along the line ‘Triple Crown winner drugged.’ They won’t understand that scopolamine is a relatively innocuous substance or the difference between environmental contamination and a serious drug being injected ... ” [92].

Though reforms are being proposed to distinguish between ‘therapeutic’ dosages of certain medications (e.g., phenylbutazone) and stricter withdrawal times [93], versus illicit substances and ‘no detectable’ rules, most comments in social media suggest that the general public and casual race followers are not overly concerned about discerning these subtleties. Generally speaking, social commentary strongly suggests that only *no* medications/drugs in the horses’ systems will be acceptable [94]. More nuanced followers of racing are also looking into potential impacts of anabolic steroids (though in theory these have been banned since 2009), off-label use of bisphosphonates [95], potential overuse of joint injections and whether or not ‘needed’ medication, such as omeprazole for the treatment/prevention of ulcers, may be implicated in bone injuries [96].

3.4. Whip Use (or Crop Use, or Stick Use)

3.4.1. Public Perception

Circumspect perceptions of horse racing during the past decade have included public concerns and controversy surrounding whip (crop) use by jockeys. A brief Internet search yields a multitude of public opinion pieces, industry reports, media releases, and research summaries highlighting the whip use debate. The challenges associated with addressing whip use practices and implementing approaches to improve the welfare of horses and sustainability of the sport have also been a significant focus. The whip use debate centers on public opposition to observing jockeys hitting horses to enhance performance, often citing the use of whips as inhumane and archaic. While many riders and industry representatives support appropriate use of the whip to ensure safety by helping to keep horses' attention and guide their movement during races, this does not seem to be the popular public perception. Currently, Norway is the only racing jurisdiction in which whip use has been banned altogether. In other countries including Australia, Great Britain, Ireland, and to a lesser extent the United States, racing authorities and commissions have set forth rules which include type of whip used (most racing jurisdictions have moved to use of the padded whip), number of strikes allowed considering the position of the whip (i.e., forehand or backhand strikes), restrictions on where on the horse's body the whip can be used (e.g., shoulder and hindquarters only), horses should be first shown the whip and given time to respond, etc. (e.g., <https://ua-rtip.org/sites/ua-rtip.org/files/ARCI-010-035-Use%20of%20Riding%20Crop.pdf>). More recently, California has adopted the nation's most restrictive horse racing whip rules in North America (<https://www.latimes.com/sports/story/2019-12-12/chrb-votes-to-adopt-most-restrictive-whip-rule-in-north-america>).

The racing industry inevitably encounters challenges monitoring whip use during racing and also with equitable and consistent enforcement of whip rule violations. In a recent poll conducted by the Paulick Report, 4387 people responded (as of October 29, 2019) to the question, "What policies should be in place regarding the use of riding crops for jockeys?" [97]. Most respondents indicate that there should be policies for crop use including use of the crop for steering and safety only (24.6%), restrictions on the manner in which crops can be used (24.0%) and limiting the number of strokes allowed (16.7%). A smaller percentage of respondents indicate that there should be no restrictions on crop use (25.1%) or that crops should be banned all together (9.6%). From a public SLO perspective, a second poll was less nuanced. Based on a Jockey Club assessment conducted in May, 2019, a full 82% of respondents would have a more favorable opinion of racing if a whip ban was enacted [19].

In August 2019, The Jockey Club announced a recommendation to remove the use of the whip for encouragement. The announcement cited 2019 consumer research demonstrating increased penalties for whip rule violations were a leading concern among current and potential spectators [98]. Additional concerns regarding whip use include: negative perceptions of hitting horses repeatedly, particularly when horses are not in contention; and the possibility that stricter regulations or a complete ban on whip use would only open the door for animal rights groups to place even greater pressure on horse racing. In a recent independent poll (commissioned, but not administered by RSPCA Australia), 74% of respondents indicated that horses should not be hit with a whip during races and 87% of respondents who watch or bet on racing indicated that they would continue to do so if whip use was stopped [99]. A follow-up study was conducted using de-identified data from the RSPCA Australia commissioned poll (n = 1533) to characterize the 26% of Australian respondents who support whip use (113 females and 271 males) and the 10% of racing enthusiasts in the sample (44 females and 63 males) who would stop watching races and wagering on them if whips were banned [99]. The main finding of the secondary study is that men are more supportive of whip use during horse races than women. The authors suggest that female respondents who attended horse races or wagered on races, if they were horse enthusiasts, may be generally more aware and/or knowledgeable about equine welfare compared to their male equivalents.

Graham and McManus (2016) utilized media framing and critical discourse analysis (CDA) to identify perceptions of advocates and opponents of whip use depicted in conventional and social media [100]. Discourse concerning whip use was investigated at three time points in two countries, Australia (2009) and the United Kingdom (2011), following introduction of new whip rules, and during the period August 2014–August 2015 to observe whether perceptions changed over time. The primary area for contention between advocates and opponents was whether the whip is a necessary tool or an instrument of cruelty. The study found this source of contention remained in 2015 following whip use reform. Interviews with and articles written by people involved in the racing industry dominated print media, while the opinions of those outside racing, specifically opponents of the whip, were largely expressed in various social media platforms. The findings demonstrate the important role that social media plays in conveying perceptions and information about equine welfare and the human–horse relationship in sport. Furthermore, it highlights the need, as well as opportunity, for industry representatives, particularly those directly involved in the care of racehorses, to engage in dialogue through social media.

3.4.2. Empirical Research

Scientific investigation of the impacts of whip use on horse performance and on horse and jockey welfare is needed in order to establish reform that addresses both public concerns and industry sustainability. However, at present, the number of evidence-based studies focused on whip use remains limited. Recent research questions (2012–2016) have focused on whip use rule breaches, whether horses find the whip aversive and/or experience pain when they are whipped, forces delivered by jockeys' forehand and backhand strikes, and differences in whip use between experienced and apprentice jockeys. Much of the research to date on whip use has been conducted by a group of Australian researchers led by Professor Paul McGreevy, University of Sydney.

Hood et al., (2017) characterized whip rule violations recorded by Stewards (Stewards Reports and Race Diaries) from 2013–2016 in New South Wales and the Australian Capital Territory [101]. Violations most commonly recorded were forehand whip use on more than 5 occasions before the 100-meter mark (44%) and whip use when the jockey's arm was raised above shoulder height (24%). There were a greater number of recorded breaches by riders of horses that finished first, second, or third than by riders of horses in latter positions.

Evans and McGreevy (2011) investigated associations between racing performance and whip use (as judged by Australian Racing Board stewards) and hypothesized that whippings would be associated with superior performance [102]. Measurements for analysis included whip strikes and sectional times during each of the final three 200-meter sections of five 1200–1250-meter races ($n = 48$ horses). The results of the study showed that jockeys in more advanced placings at the final 400 and 200-meter positions whipped horses more frequently. On average, horses achieved highest velocity in the 600- to 400-meter section of the race when there was no whip use. Increased whip use during the final two 200-meter sections of the race was not associated with significant variation in velocity as a predictor of more favorable placings at the finish. The authors acknowledged limitations to the study which included selection of races on the basis of multiple predetermined criteria (i.e., races were not chosen at random) and the need for sensitive, onboard technologies capable of recording accurate and frequent measurements of velocities, positions, and gait characteristics in a larger number of horses simultaneous with whipping.

One study involving detailed analysis of 109 whip strikes (McGreevy et al., 2012) reported that 83% of whip strikes made a visible indentation into the horse's hide and muscling when viewed in slow motion [103]. Additionally, the unpadded section of the whip made contact on 64% of impacts. Backhand whip strikes have been presumed to generate less force and subsequently have been less scrutinized compared to forehand strikes. Using pressure-detection technology assembled on a static, model horse, McGreevy et al. (2013) examined the force applied with padded whips using forehand and backhand strikes to the gluteal region of the model by six, licensed, Australian jockeys

(4 male and 2 female) [104]. All jockeys were right-handed with a mean age of 33.8 years and had been riding for a mean of 27.7 years. In total, 288 whip strikes were examined (left forehand, left backhand, right forehand, right backhand; $n = 72$ each in batches of 12 consecutive strikes). Significant differences in force were detected between jockeys with interactions between jockey, hand (dominant or non-dominant), and action (forehand or backhand). These differences pose problems for the industry with respect to enforcing equity in whip use. Action (forehand vs. backhand) did not influence force on impact when jockeys used their non-dominant hand. However, jockeys struck with more force in the backhand when using their dominant hand.

Experience of the jockey has also been shown to influence whip use [105]. Apprentice jockeys on average whipped greater than three times compared to non-apprentice jockeys in the 400–200-meter section of 1200–1250-meter distance races, although the total number of whip strikes was not significantly different between the two groups of jockeys when whip counts in 400–200-meter and 200-meter to the finish were combined. In the final 200-meter section of races, apprentice jockeys used backhand strikes significantly more often than non-apprentice jockeys. It is speculated that differences observed in this study between apprentice ($n = 7$) and non-apprentice ($n = 18$) jockeys stem from greater pressure on apprentice jockeys to demonstrate their skill to trainers and to assure their horse performs well and/or to misconceptions among apprentices regarding the influence of whipping on performance with apprentice jockeys going to the whip earlier than more experienced jockeys. These studies have provided insight into the challenges and impacts associated with whip use in horse racing, but more work is warranted, especially within the US horse racing industry. Collaborative, multi-disciplinary studies involving industry representatives and academic researchers should be pursued taking into consideration research questions postulated through the lens of “Social License to Operate”.

3.5. Aftercare

It is unclear when public awareness of what happens to Thoroughbreds after their racing careers are over came into focus, but one high-profile event in the early 2000s certainly stands out. Ferdinand, the 1986 Kentucky Derby winner, died sometime in 2002 in Japan, most likely in a slaughterhouse destined for pet food. After retiring from racing and spending a few years in the U.S. as a breeding stallion, he was sold to Japan in 1994. After his popularity as a breeding stallion waned, it is believed that he was slaughtered late in 2002. Since that time, the public, and the industry, has paid more attention to the fates of Thoroughbreds whose racing careers are over, whether they are Classics winners or were too slow to ever win a race.

While unfortunate endings for retired Thoroughbreds receive a majority of the spotlight, not enough is known about the actual outcome of a retired racehorse’s “first exit” from the racetrack (and even less is known about the “second exit,” such as when a mare or stallion is retired from its breeding career). In some countries, governing bodies of racing have conducted surveys to better understand where retiring racehorses ‘land’ once their racing careers end. For example, Racing Australia recently mandated that owners and trainers immediately report the destination of horses leaving the racetrack via its Retirement and Death Notification Form [106]. In 2015/2016, the reported first-exit destinations are as follows: equestrian (68.3%); breeding (20.5%); died due to natural causes (4.6%); euthanized (3.9%); other (1.3%); livestock sale (0.8%); abattoir (0.4%); and permanent retirement (0.2%). (However, despite the overall positive findings in this study, a very recent expose by ABC Australia suggests that a significantly higher number of Thoroughbreds are sent to slaughter, although it is unclear whether those horses were in first-exit situations [107]). The British Horseracing Authority conducted a similar but voluntary survey in February/March 2018 to allow BHA to better understand the latter stages of racehorses’ lives [108]; however, to our knowledge, the results from this survey have not been publicly reported.

U.S. Department of Agriculture (USDA) export records on U.S. horses shipped to Canadian processing plants in 2002–2005 revealed a small percentage of the horses were likely Thoroughbreds. According to the records, 70% were western type horses, 11% were English or Thoroughbred type horses,

3.6% were draft type horses, and the rest included other breeds or types of horses or mules [109,110]. In a separate study of non-profit organizations (not necessarily breed-specific) that accepted relinquished horses, respondents reported that relinquished horses consisted of mostly light horse breeds (79.3%), with Thoroughbreds (21.6%) and Quarter Horses (18.9%) as the most represented breeds [111]. Taken together, these studies suggest that Thoroughbreds may not be the most prevalent breed present in processing plants or non-profit organizations; however, the public expects the industry to retain the responsibility to ensure humane living circumstances once a horse's racing and breeding careers are over.

Aftercare in the Thoroughbred industry is the result of combined private and industry efforts. Initially, largely decentralized efforts can be credited with turning the attention to proper aftercare for retired Thoroughbred racehorses. The Thoroughbred Retirement Foundation (TRF) was founded in 1983 with a mission of "... sav(ing) Thoroughbred horses no longer able to compete on the racetrack from possible neglect, abuse and slaughter." While some of its horses are ultimately rehomed, most of the horses under TRF care have injuries requiring permanent retirement [112]. The Thoroughbred Charities of America (TCA), established in 1990, provides grant funding to approved non-profit organizations in a handful of different areas, including those that provide rehabilitation, retraining, rehoming, and retirement for Thoroughbred racehorses [113].

Since the early 1990s, a number of independent, non-profit organizations were established to facilitate a successful transition to second careers. Two of the largest organizations filling this void are New Vocations Racehorse Adoption Program, founded in 1992, and the Communication Alliance to Network Thoroughbred Ex-Racehorses (CANTER), established in 1998. These programs, and others like them, are responsible for transitioning thousands of retired racehorses into new homes each year. New Vocations accepts retiring racehorses (both Thoroughbred and Standardbred) donated by owners or trainers. Their staff evaluate the horses, coordinate veterinary care and any necessary rehabilitation, and provide training to teach the horses new skills. Then, horses are offered for adoption. Since they started keeping electronic records in 1998, New Vocations has rehomed nearly 4,181 retired Thoroughbred racehorses as of June 1, 2019 [114]. CANTER, which consists of 18 independent affiliates typically based near racetracks, offers two different avenues to transition retired racehorses to second careers. The primary avenue is offering a listing program, where racehorse owners and trainers can advertise their retiring racehorses; potential buyers contact the owners/trainers privately. The second avenue is a program in which owners and trainers donate retiring horses to CANTER. CANTER then provides veterinary care and rehabilitation as needed, retraining, and finally, rehoming. CANTER has helped over 25,000 retired Thoroughbreds transition into new homes since its inception [115], with about 75% of adoptions through the trainer/owner listings and the remaining 25% from CANTER-owned horses [116].

Due to the proliferation of independent, non-profit aftercare organizations, the Thoroughbred Aftercare Alliance (TAA) was established in 2012 with funding from major industry partners to ensure that aftercare organizations were equipped to appropriately care for the horses in their custody. Accordingly, the main purpose of the TAA is to accredit aftercare organizations. Its Code of Standards [117] and accreditation process were approved by the American Humane Association and the American Association of Equine Practitioners. As of May 2019, the TAA has accredited 70 organizations (up from 23 in 2013, its first year), which oversee about 150 aftercare facilities [118,119].

Around the time that the TAA was being established, the NTRA Safety and Integrity Alliance was proposed as the optimal approach to address a number of issues facing the Thoroughbred racing industry, one of which was Thoroughbred aftercare. Guidelines for aftercare and transition of retired racehorses were provided in the NTRA Safety and Integrity Alliance Code of Standards and placed some of the responsibility on the race tracks. Member race tracks assisted in providing care and retraining by affiliating with approved placement and adoption programs, providing owners and trainers with contact information for these programs, and providing physical and/or human resources to assist in the transfer of horses to these programs [120].

More recent approaches by industry and private participants are focused on addressing the demand side of the market for retired Thoroughbreds by developing incentive programs for individuals to ride and compete retired racehorses. For example, The Jockey Club's Thoroughbred Incentive Program (T.I.P.) allows owners of retired racehorses to register their horses to be eligible for prizes for both competitive and non-competitive riding [121]. An added benefit is that this program allows the industry to track post-racing outcomes of some of its equine athletes, and since 2012, 23,809 T.I.P. numbers have been granted. Additionally, 157 horse shows offered T.I.P. awards in 2012; by 2018, that number had grown nearly tenfold, with 1086 shows offering T.I.P. awards [122].

Finally, in 2017, The Jockey Club Thoroughbred Incentive Program started the T.I.P. Championships, held annually at the Kentucky Horse Park. T.I.P.-eligible Thoroughbreds qualify for the Championships throughout the year and then are eligible to compete for prize money at the Championship show.

A separate, innovative program is the Retired Racehorse Project (RRP), founded in 2010. The focus of the RRP is to increase demand for retired racehorses by showcasing their versatility. This is accomplished in many ways, with the main avenue being the annual \$100,000 Thoroughbred Makeover held annually at the Kentucky Horse Park since 2015. At this event, the breed's versatility is showcased by competition in 10 diverse events, both English and western: barrel racing, competitive trail, dressage, eventing, field hunters, freestyle, polo, ranch work, show hunter, and show jumping. The number of trainers accepted to the \$100,000 Thoroughbred Makeover increased from 293 in 2015 to 794 in 2018, which the number of horses accepted increased from 350 to 748 over the same time period [123]. The event also offers a marketplace to help market and facilitate the private sale of Makeover horses. Reported average sales price per horse has been \$7490, \$9800, and \$10,100 for 2016, 2017, and 2018, respectively [124].

There is little peer-reviewed research investigating issues pertaining to aftercare, and in the future, hopefully increased efforts can be focused here. In order to better understand demand for retired racehorses, one study investigated the relationship between individual horse characteristics and length of stay at an aftercare facility. Stowe and Kibler (2016) collected data from organizations nationwide that provide rescue, retraining, and rehoming for Thoroughbreds retired from racing [125]. The results suggested that adopters preferred horses with fewer activity limitations, gray horses, and younger horses. The authors also analyzed the data to determine whether any individual horse characteristics could predict the likelihood that a horse would be returned to the facility post-adoption; while results were limited here, the authors found that while they were the color in highest demand, gray horses were also more likely to be returned.

A more recent survey was conducted to better understand, from the owner's perspective, the issues retired racehorses come off the track with and how those compare to a control group of non-racehorses, how those issues resolve, and owner satisfaction with their retired racehorse [126]. Compared to controls, results show that Thoroughbreds retired from racing were more likely to suffer from musculoskeletal injuries and gastrointestinal, behavioral, and/or foot/hoof issues. However, a horse's age at first start, age at last start, number of starts, and breaks of 6 months or longer during a horse's racing career did not affect the incidence of any issue. Horses with more than 51 lifetime starts were more likely to experience gastrointestinal issues in the first year after retirement from racing. Ultimately, however, Thoroughbreds retired from racing were as likely as controls to have eventual resolution of issues present at acquisition. Finally, 97% of respondents said they would consider buying or adopting another retired racehorse, 97% said they would recommend a retired racehorse to a friend, and 93% had no regret in adopting or buying a retired racehorse.

Finally, Wickens et al. (2019) conducted a study to investigate whether the presence of stereotypic behaviors (i.e., crib-biting, box-walking, weaving) influences the ability to rehome retired racehorses [127]. Respondents from TAA-accredited Thoroughbred aftercare organizations reported that 17% of the horses in their care in the previous year had at least one stereotypic behavior. 92% of respondents reported that these horses were either "somewhat more challenging" or "much more challenging" to rehome. Furthermore, 33% of respondents indicated that Thoroughbreds with

stereotypic behaviors are more challenging to train for new purposes (this perception was not followed up with actual observational research). This information is important because previous studies suggest that Thoroughbreds, especially those that spent time in a racing career, are more likely to exhibit stereotypic behaviors than other horses [128,129].

The Thoroughbred industry has made great strides over the past 30 years in ensuring that retiring racehorses can find safe new homes, and additional measures continue to develop: for example, in June 2019, the Louisiana state legislature approved HB384, which allocates \$5 per start to a fund for Thoroughbred aftercare [130]. While this progress is to be commended, it remains that accounting for horses upon their first exit from racing is difficult. An added complication is that due to easy identification, the industry remains a target regardless of the stage of its life when a Thoroughbred is discovered in an auction pen. In addition to improving reporting requirements, the section underscores the fact that little scientific research exists regarding Thoroughbred aftercare. Future research efforts should include parties involved in all stages of the horse's life: stallion owners, breeders, racehorse owners and trainers, buyers or adopters of retired racehorses, and aftercare organizations.

4. Discussion

As with many issues, perception is often equated with reality, and horse racing's tenuous SLO should, perhaps, be seen as the new normal. Even for those not using the terminology of 'Social License to Operate', it is clear the industry needs to pay attention to its importance and determine the best way to maintain it and foster it. Scientific research to provide evidence to address real and perceived gaps will continue to play a role, and the topic area reviews in this study help identify where some of these gaps exist. Scientific research can also inform the industry's progress on rebuilding/maintaining its SLO. Finally, where science shows the industry can do better, it must; where science shows that the industry is doing the right thing, better communication is needed. This includes a concerted effort to share information in a way and through a platform that casual fans can access and understand. As recently quoted in an article in *The Paulick Report*, 'What's different this time?', author Natalie Voss states, "Although the shift of public opinion about horse racing this year felt like a rapid evolution, perhaps it was always bound to happen. As society gets further and further from the rural lifestyle, fewer people have any familiarity with horses or racing, but they don't need that familiarity to comprehend the death of Thoroughbreds" [131].

The year of 2019 will likely go down in history as a 'tipping point' [50] in the world of horse racing. A 5 year review of 1,891,483 race starts by 154,527 Thoroughbred racehorses (United States and Canada, 2009–2013) based upon data from the Equine Injury Database™ found 1.9 fatal injuries/1,000 race starts [57]. A more recent meta-analysis of peer-reviewed literature from 1990 to 2017, representing data from six countries, found catastrophic musculoskeletal injury at the rate of 1.2 per 1000 race starts [58]. While these numbers may be seen by some as 'the price of doing business' in a highly demanding, highly athletic equine sport, others recognize that the industry needs to strive harder to achieve as close to zero catastrophic breakdowns as possible. Though the actual number of catastrophic breakdowns nationwide may have experienced only a slight uptick compared to 2018 or 2017 (data not yet complete), the industry was 'put on notice' [14] by intense media scrutiny—attention that increased dramatically in the span of just one year. For example, when looking to Nexis Uni® to help identify how many news/media articles can be identified with the search terms "race horse" and "welfare", in 2019 there have been 2207 hits; in 2018 there were 882 hits for the same key words, and in 2017 there were 586 hits.

In a 2015 article by Bergmann called 'Sustainability, thoroughbred racing and the need for change' [13], the author reported many of the same issues cited in this article; e.g., "... they do not address the principal question emerging from evolving social norms and values of whether thoroughbred racing is ethically justifiable, and if so, how it can be conducted so that it is socially acceptable." ... "the question of the continuation of the use of thoroughbreds requires social negotiations in the interest of social sustainability. This is an ongoing dialogue as society's ethics and values evolve.

It would appear that the thoroughbred industry can expect to greatly benefit from proactively engaging with this process.”

The racing industry has struggled this year (2019) to come together and present a unified front during this time of increased public scrutiny. However, it is notable that attempts at accountability and transparency have been enhanced beyond previous years. Though many relevant stakeholder groups may not be using the term ‘Social License to Operate,’ it appears obvious this concept is in their thought paradigms and their actions. In March of 2019, The Jockey Club prepared their Vision 2025 document titled, “To prosper, horse racing needs comprehensive reform” [112]. Two notable action items are currently taking place: (1) the Horseracing Integrity Act, which sets out to establish a uniform, national standard to prohibit doping and more closely regulate medication for racehorses; to create a new, independent body to oversee the use of drugs and medication, which will be overseen by the US Anti-Doping Agency (USADA) and ban the use of Lasix and other medications deemed to be dangerous to racehorses [132]; and (2) establishment of the Thoroughbred Safety Coalition, which has proposed to combine the resolve, expertise and resources to collectively implement enhanced safety measures within the Thoroughbred racing industry. Representing over 84% of the American graded stakes races, prominent race tracks and racing groups across North America have come together in this Coalition endeavor [133]. Though still contentious, there is a substantial amount of support for a national governing body and the Horseracing Integrity Act of 2019 (H.R. 1754) [112]. Furthermore, there is considerable support to move the reforms that California racing made during 2019 to many of the other tracks in North America [113]. Horse racing in North America is at a critical crossroads; stakeholders have their work cut out for them to maintain sustainability of this longstanding equine sport. As one industry participant says, “This is not the time to be patting ourselves on the back. It is the time to take stock, admit we have a problem, adopt zero tolerance towards anything, anything that can impact safety in any way” [134].

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References

1. Morrison, J. *The Social License: How to Keep Your Organization Legitimate*; Palgrave Macmillan: London, UK, 2014.
2. Black, L. *The Social Licence to Operate: Your Management Framework for Complex Times*; Greenleaf Publishing Ltd.: Sheffield, UK, 2013.
3. English, B. Banking Royal Commission: Foundations of Trust Come Crashing Down. *The Daily Telegraph*. 2019. Available online: <https://www.dailytelegraph.com.au/news/banking-royal-commission-foundations-of-trust-come-crashing-down/news-story/72973e103769edba7f3a7a407ed7f9ca> (accessed on 19 February 2020).
4. Stoddard, E. Harvesting Honey While Thwarting Elephants: Innovative Ways to Earn Mining Social Licence. 2019. Available online: <https://www.miningmx.com/special-reports/mining-indaba/mining-indaba-2019/35897-harvesting-honey-while-thwarting-elephants-innovative-ways-to-earn-mining-social-licences/> (accessed on 19 February 2020).
5. McGreevy, P.D.; McManus, P. Why Horse-Racing in Australia Needs a Social Licence to Operate. *The Conversation*, 3 November 2017.
6. Teh-White, K. Greyhound Bans, Livestock Farming and Social Licence. *The Land*, 13 July 2016.

7. Whyte, J. Qantas Chief Will Stick to His Knitting When Politicians Remember How to Knit. *Financial Review*. 2018. Available online: <https://www.afr.com/business-summit/qantas-chief-will-stick-to-his-knitting-when-politicians-remember-how-to-knit-20180307-h0x5d8> (accessed on 19 February 2020).
8. Paine, N. Weatherill Is Right to Seek a “Social Licence” on Nuclear Industry. 2016. Available online: <http://indaily.com.au/opinion/2016/05/20/weatherill-is-right-to-seek-a-social-licence-on-nuclear-industry/> (accessed on 19 February 2020).
9. Gallois, C.; Ashworth, P.; Leach, J.; Moffat, K. The Language of Science and Social Licence to Operate. *J. Lang. Soc. Psychol.* **2017**, *36*, 45–60. [CrossRef]
10. Boutilier, R.G. Frequently asked questions about the social license to operate. *Impact Assess. Proj. Apprais.* **2014**, *32*, 263–272.
11. Cherwa, J. Special Report: Horse Deaths at Santa Anita May Have Implications for Entire Racing Industry. 2019. Available online: <https://www.latimes.com/sports/more/la-sp-santa-anita-horse-deaths-20190622-story.html> (accessed on 19 February 2020).
12. Staff. ‘I Have No Idea Why Horse Racing Is Still a Thing’: Mainstream Media Responds to Santa Anita Deaths. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/news/the-biz/i-have-no-idea-why-horse-racing-is-still-a-thing-mainstream-public-responds-to-santa-anita-deaths/> (accessed on 19 February 2020).
13. Bergmann, I. Sustainability, thoroughbred racing and the need for change. *Pferdeheilkunde* **2015**, *31*, 490–498. [CrossRef]
14. Paulick, R. View from The Eighth Pole—Horse Racing at the Crossroads: Reform or Die. *Paulick Report*. 15 November 2019. Available online: <https://www.paulickreport.com/news/lay-s-paddock/view-from-the-eighth-pole-horse-racing-at-the-crossroads-reform-or-die/> (accessed on 19 February 2020).
15. *Economic Impact of the U.S. Horse Industry*; American Horse Council Foundation: Washington, DC, USA, 2018.
16. Singer, D.; Lamb, M. Driving sustainable growth for Thoroughbred racing and breeding: Findings and recommendations. In *59th Annual Round Table Conference on Matters Pertaining to Racing*; Springs: Saratoga, NY, USA, 2011.
17. McKinsey Update 2018. 2018. Available online: <http://jockeyclub.com/default.asp?section=RT&year=2018&area=4> (accessed on 19 February 2020).
18. Heleski, C.R. We Shouldn’t Fear the Conversation: A Holistic, Ethics-Based, Welfare Assessment of the Thoroughbred Racing Industry, from Foals to Retirees. In *Proceedings of the 13th International Conference of the International Society for Equitation Science*, Charles Sturt University, Wagga Wagga, Australia, 22–26 November 2017.
19. Green, R.; Rosenblatt, A. Equine Fatality Crisis Insights: Agenda of Key Findings. 2 May 2019. Available online: http://jockeyclub.com/pdfs/horse_racing_poll.pdf (accessed on 19 February 2020).
20. Hamari, J.; Sjöklint, M.; Ukkonen, A. The sharing economy: Why people participate in collaborative consumption. *J. Assoc. Inf. Sci. Technol.* **2016**, *67*, 2047–2059. [CrossRef]
21. Cullen-Knox, C.; Haward, M.; Jabour, J.; Ogier, E.; Tracey, S.R. The social licence to operate and its role in marine governance: Insights from Australia. *Mar. Policy* **2017**, *79*, 70–77. [CrossRef]
22. Rooney, D.; Leach, J.; Ashworth, P. Doing the Social in Social License. *Soc. Epistemol.* **2014**, *28*, 209–218. [CrossRef]
23. Jijelava, D.; Vanclay, F. Legitimacy, credibility and trust as the key components of a social licence to operate: An analysis of BP’s projects in Georgia. *J. Clean. Prod.* **2017**, *140*, 1077–1086. [CrossRef]
24. Stavros, C.; Meng, M.D.; Westberg, K.; Farrelly, F. Understanding fan motivation for interacting on social media. *Sport Manag. Rev.* **2014**, *17*, 455–469. [CrossRef]
25. Cartwright, M. Colosseum. 29 May 2018. Available online: <https://www.ancient.eu/Colosseum/> (accessed on 19 February 2020).
26. Fiedler, J.M.; McGreevy, P.D.; Thompson, K. Reconciling Horse Welfare, Worker Safety, and Public Expectations: Horse Event Incident Management Systems in Australia. *Animals* **2016**, *6*, 16. [CrossRef]
27. Singleton, T.J. Digital Fandemonium: Translating the Sport Experience and Fan Identification through Emergent Technology. Ph.D. Thesis, Fielding Graduate University, Santa Barbara, CA, USA, 1 January 2017.
28. Merritt, J. A fair playing field for sport. *Strateg. Dir.* **2015**, *31*, 23–25.
29. Merritt, J. Don’t look a gift horse in the mouth: Regulating for integrity, what equestrianism can learn from Thoroughbred racing. *Int. Sports Law J.* **2017**, *16*, 198–216. [CrossRef]

30. Breitbarth, T.; Walzel, S.; Anagnostopoulos, C.; van Eekeren, M.F.; van Eekeren, F. Corporate social responsibility and governance in sport: “Oh, the things you can find, if you don’t stay behind!”. *Corp. Gov. Int. J. Bus. Soc.* **2015**, *15*, 254–273. [CrossRef]
31. Hampton, J.O.; Teh-White, K. Animal welfare, social license, and wildlife use industries. *J. Wildl. Manag.* **2019**, *83*, 12–21. [CrossRef]
32. KPMG. *Maintaining the Social Licence to Operate*; Australian Institute of Company Directors: Sydney, Australia, 2018; pp. 1–18.
33. Cherwa, J. Another Horse Fatality at Santa Anita; 23 Thoroughbreds Have Died since Dec. 26. *Los Angeles Times*. 31 March 2019. Available online: <https://www.latimes.com/sports/more/la-sp-santa-anita-horse-death-20190331-story.html> (accessed on 19 February 2020).
34. McHugh, M. Special Commission of Inquiry into the Greyhound Racing Industry in New South Wales. Sydney. 2016, p. 269. Available online: <https://apo.org.au/node/65365> (accessed on 19 February 2020).
35. Duncan, E.; Graham, R.; McManus, P. ‘No one has even seen . . . smelt . . . or sensed a social licence’: Animal geographies and social licence to operate. *Geoforum* **2018**, *96*, 318–327. [CrossRef]
36. Lillqvist, E.; Moisander, J.K.; Fuat Firat, A. Consumers as legitimating agents: How consumer-citizens challenge marketer legitimacy on social media. *Int. J. Consum. Stud.* **2017**, *42*, 197–204. [CrossRef]
37. Lillqvist, E.; Louhiala-Salminen, L. Facing Facebook: Impression Management Strategies in Company-Consumer Interactions. *J. Bus. Tech. Commun.* **2014**, *28*, 3. [CrossRef]
38. Edwards, P.; Fleming, A.; Lacey, J.; Lester, L.; Pinkard, E.; Ruckstuhl, K.; Bezuidenhout, C.; Payn, T.; Bayne, K.; Williams, T. Trust, engagement, information and social licence—Insights from new zealand. *Environ. Res. Lett.* **2019**, *14*, 024010. [CrossRef]
39. Chamorro-Premuzic, T. Reputation and the Rise of the ‘Rating’ Society. 2015. Available online: <https://www.theguardian.com/media-network/2015/oct/26/reputation-rating-society-uber-airbnb> (accessed on 19 February 2020).
40. Coombs, W.T. Strategic Communication, Social Media and Democracy The challenge of the digital naturals. In *Routledge New Directions in Public Relations & Communication Research*; Falkheimer, J., Heide, M., Young, P., Eds.; Taylor and Francis: Hoboken, NJ, USA, 2015.
41. Macnamara, J. Organizational listening. In *The Missing Essential in Public Communication*; Peter Lang Publishing Inc.: New York, NY, USA, 2016.
42. Parsons, R.; Moffat, K. Constructing the Meaning of Social Licence. *Soc. Epistemol.* **2014**, *28*, 340–363. [CrossRef]
43. Dare, M.; Schirmer, J.; Vanclay, F. Community engagement and social licence to operate. *Impact Assess. Proj. Apprais.* **2014**, *32*, 188–197. [CrossRef]
44. Mercer-Mapstone, L.; Rifkin, W.; Moffat, K.; Louis, W. Conceptualising the role of dialogue in social licence to operate. *Resour. Policy* **2017**, *54*, 137–146. [CrossRef]
45. Boutilier, R.G.; Thomson, I. Modelling and Measuring the Social Licence to Operate: Fruits of a Dialogue between Theory and Practice. Social Licence. 2011. Available online: <https://sociallicense.com/publications/Modelling%20and%20Measuring%20the%20SLO.pdf> (accessed on 19 February 2020).
46. Thomson, I.; Boutilier, R. What Is the Social License? 2018. Available online: <https://sociallicense.com/definition.html> (accessed on 19 February 2020).
47. Coddington, M.; Lewis, S.C.; Holton, A.E. Measuring and Evaluating Reciprocal Journalism as a Concept. *Journal. Pract.* **2018**, *12*, 1–12. [CrossRef]
48. Lune, H.; Berg, B.L. *Qualitative Research Methods for the Social Sciences*; Pearson Education Limited: Essex, UK, 2017.
49. Harris, B. *From Ruffian to Charismatic, Racehorse Breakdowns Pack an Emotional Wallop*; The Associated Press: New York, NY, USA, 2006; Available online: <https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:4K1M-K5V0-TW8Y-S25T-00000-00&context=1516831> (accessed on 19 February 2020).
50. Ross, D. ‘The Sport Is at a Tipping Point’: Inside US Horse Racing’s Deadly Crisis; The Future of Horse Racing in America Is at a Crossroads Amid the Headline-Grabbing Rash of Fatalities at Santa Anita Park, Yet the Consequences of a Wholesale Ban Would Be Far-Reaching. *The Guardian*. 2 August 2019. Available online: <https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5WPW-9HK1-JCJY-G3VV-00000-00&context=1516831> (accessed on 2 August 2019).

51. Goertzen, J. The Truth about Horse Racing Deaths. *The Mercury News*. 30 June 2019. Available online: <https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5WFW-8HF1-F0C5-X079-00000-00&context=1516831> (accessed on 19 February 2020).
52. Cherwa, J. HORSE RACING; Horses' Deaths Raise Questions in Race Industry; Santa Anita Toll Hits 30 as Issues with Track Surface and Pressures Put on Stalls Emerge. *Los Angeles Times*. 23 June 2019. Available online: <https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5WDB-MX11-DXXV-314C-00000-00&context=1516831> (accessed on 19 February 2020).
53. Harris, B. *Horse Racing Debates Use of Race-Day Medication*; Canadian Press: Toronto, ON, Canada, 2019; Available online: <https://advance.lexis.com/api/document?collection=news&id=urn:contentItem:5W12-8521-JBVR-31YJ-00000-00&context=1516831> (accessed on 30 April 2019).
54. Thompson, K.; Haigh, L. Perceptions of Equitation Science revealed in an online forum: Improving equine health and welfare by communicating science to equestrians and equestrian to scientists. *J. Vet. Behav.* **2018**, *25*, 1–8. [CrossRef]
55. Thompson, K. Like Apples and Oranges: There are Different Ways to Research Horses and People. *Horses and People*. 7 July 2019. Available online: <https://horsesandpeople.com.au/like-apples-and-oranges-there-are-different-ways-to-research-horses-and-people/> (accessed on 19 February 2020).
56. Norwood, R. Horse Racing Puts Real Hopes for Future on Synthetic Tracks. *Los Angeles Times*. 7 June 2006. Available online: <https://www.latimes.com/archives/la-xpm-2006-jun-07-sp-belmont7-story.html> (accessed on 19 February 2020).
57. Georgopoulos, S.P.; Parkin, T.D.H. Risk factors associated with fatal injuries in Thoroughbred racehorses competing in flat racing in the United States and Canada. *J. Am. Vet. Med. Assoc.* **2016**, *249*, 931–939. [CrossRef]
58. Hitchens, P.L.; Morrice-West, A.V.; Stevenson, M.A.; Whitton, R.C. Meta-analysis of risk factors for racehorse catastrophic musculoskeletal injury in flat racing. *Vet. J.* **2019**, *245*, 29–40. [CrossRef]
59. Equine Injury Database. Available online: <http://jockeyclub.com/default.asp?section=Advocacy&area=10> (accessed on 19 February 2020).
60. Eight Belles' Death Sparks Controversy. *CBS News*. 15 November 2008. Available online: <https://www.cbsnews.com/news/eight-belles-death-sparks-controversy/> (accessed on 19 February 2020).
61. Hernlund, E.; Egenvall, A.; Hobbs, S.J.; Peterson, M.L.; Northrop, A.J.; Bergh, A.; Martin, J.H.; Roepstorff, L. Comparing subjective and objective evaluation of show jumping competition and warm-up arena surfaces. *Vet. J.* **2017**, *227*, 49–57. [CrossRef]
62. Bridge, J.W.; Weisshaupt, K.S.; Fisher, R.M.; Dempsey, K.M.; Peterson, M.L. Chemical degradation of a paraffin wax-based binder used in granular composite sport surfaces. *Sports Eng.* **2017**, *20*, 41–51. [CrossRef]
63. Leste-Lasserre, C. Wave of Horse Deaths on Famed Racetrack Stumps Scientists. *Science Magazine*, 27 March 2019.
64. Larkin, M. Racetrack Surfaces Just One Factor in Horse Racing Fatalities. *JAVMA News*. 18 February 2011. Available online: <https://www.avma.org/javma-news/2011-03-01/racetrack-surfaces-just-one-factor-horse-racing-fatalities> (accessed on 20 January 2020).
65. Firth, E. The response of bone, articular cartilage and tendon to exercise in the horse. *J. Anat.* **2006**, *208*, 513–526. [CrossRef]
66. Tanner, J.; Rogers, C.; Firth, E. The association of 2-year-old training milestones with career length and racing success in a sample of Thoroughbred horses in New Zealand. *Equine Vet. J.* **2013**, *45*, 20–24. [CrossRef]
67. Geor, R. Young Horses in Training and Injury Risks. *The Horse*. 2001. Available online: <http://www.thehorse.com/articles/10065/young-horses-in-training-and-injury-risks> (accessed on 19 February 2020).
68. Miller, P. 2-Year-Old Sale Breeze Shows on Fast Track to Trouble. *Paulick Report*. 2014. Available online: <http://www.paulickreport.com/news/bloodstock/miller-2-year-old-sale-breeze-shows-on-fast-track-to-trouble/> (accessed on 19 February 2020).
69. Dunne, C. No More Gallop-Outs. *Thoroughbred Daily News*. 2014. Available online: <http://www.thoroughbreddailynews.com/no-more-gallop-outs-shared-archive/> (accessed on 19 February 2020).
70. Robert, M.; Stowe, C.J. Ready to Run: Price Determinants of Thoroughbreds from Two-Year-Olds in Training Sales. *Appl. Econ.* **2016**, *48*, 4690–4697. [CrossRef]

71. McClellan, J. Comparison of Training-Related Injury Rates Between Juvenile Thoroughbreds Trained for Two-Year-Old Sales and Those Trained Solely for Racing. In Proceedings of the AAEP Annual Convention, Salt Lake City, UT, USA, 6–10 December 2014.
72. Firth, E.C.; Rogers, C.W.; Doube, M.; Jopson, N.B. Musculoskeletal responses of 2-year-old Thoroughbred horses to early training. 6. Bone parameters in the third metacarpal and third metatarsal bones. *N. Z. Vet. J.* **2005**, *53*, 101–112. [[CrossRef](#)]
73. Boyde, A.; Firth, E.C. Musculoskeletal responses of 2-year-old Thoroughbred horses to early training. 8. Quantitative backscattered electron scanning electron microscopy and confocal fluorescence microscopy of the epiphysis of the third metacarpal bone. *N. Z. Vet. J.* **2005**, *53*, 123–132. [[CrossRef](#)] [[PubMed](#)]
74. Stover, S.M.; Ardans, A.A.; Read, D.H.; Johnson, B.J.; Barr, B.C.; Daft, B.M.; Kindu, H.; Anderson, M.L.; Woods, L.W.; Moore, J.; et al. *Patterns of Stress Fractures Associated with Complete Bone Fractures in Racehorses*; American Association of Equine Practitioners: Lexington, KY, USA, 1993.
75. Firth, E.C.; Rogers, C.W. Musculoskeletal responses of 2-year-old Thoroughbred horses to early training. Conclusions. *N. Z. Vet. J.* **2005**, *53*, 377–383. [[CrossRef](#)] [[PubMed](#)]
76. Meagher, D.M.; Bromberek, J.L.; Meagher, D.T.; Gardner, I.A.; Puchalski, S.M.; Stover, S.M. Prevalence of abnormal radiographic findings in 2-year-old Thoroughbreds at in-training sales and associations with racing performance. *J. Am. Vet. Med. Assoc.* **2013**, *242*, 946–969. [[CrossRef](#)] [[PubMed](#)]
77. Kane, A.J.; Park, R.D.; McIlwraith, C.W.; Rantanen, N.W.; Morehead, J.P.; Bramlage, L.R. Radiographic changes in Thoroughbred yearlings. *Part 1: Prevalence at the time of the yearling sales.* *Equine Vet. J.* **2003**, *35*, 354–365.
78. Santschi, E.M.; White, B.J.; Peterson, E.S.; Gotchey, M.H.; Morgan, J.M.; Leibsle, S.R. Forelimb conformation, sales results, and lifetime racing performance of 2-year-old Thoroughbred racing prospects sold at auction. *J. Equine Vet. Sci.* **2017**, *53*, 74–80. [[CrossRef](#)]
79. Scott, M.; Stowe, C.J.; Plant, E.J. *The Need for Speed: Breeze Times in Thoroughbred Two-Year-Old in Training Sales and Career Performance*; University of Kentucky: Lexington, Kentucky, 2017.
80. Bramlage, L.R. The Thoroughbred Safety Committee—Soundness Issues. In *The Jockey Club's 56th Annual Round Table Conference on Matters Pertaining to Racing*; Springs: Saratoga, NY, USA, 2008.
81. Gilday, R.; Richard, H.; Beauchamp, G.; Fogarty, U.; Lavery, S. Abundant osteoclasts in the subchondral bone of the juvenile Thoroughbred metacarpus suggest an important role in joint maturation. *Equine Vet. J.* **2020**. [[CrossRef](#)]
82. Hyttinen, M.M.; Holopainen, J.; Rene van Weeren, P.; Firth, E.C.; Helminen, H.J.; Brama, P.A. Changes in collagen fibril network organization and proteoglycan distribution in equine articular cartilage during maturation and growth. *J. Anat.* **2009**, *215*, 584–591. [[CrossRef](#)]
83. Hinchcliff, K.W.; Couetil, L.L.; Knight, P.K.; Morley, P.S.; Robinson, N.E.; Sweeney, C.R.; Van Erck, E. Exercise Induced Pulmonary Hemorrhage in Horses: American College of Veterinary Internal Medicine Consensus Statement. *J. Vet. Intern. Med.* **2015**, *79*, 743–758. [[CrossRef](#)]
84. Sullivan, S.L.; Whittem, T.; Morley, P.S.; Hinchcliff, K.W. A systematic review and meta-analysis of the efficacy of furosemide for exercise-induced pulmonary haemorrhage in Thoroughbred and Standardbred racehorses. *Equine Vet. J.* **2015**, *47*, 341–349. [[CrossRef](#)]
85. Casner, B. Casner: Studies Show Some Therapeutic Medications Do More Harm Than Good. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/news/ray-s-paddock/casner-studies-show-some-therapeutic-medications-do-more-damage-than-good/> (accessed on 19 February 2020).
86. Rejnmark, L.; Vestergaard, P.; Mosekilde, L. Fracture risk in patients treated with loop diuretics. *J. Intern. Med.* **2006**, *259*, 117–124. [[CrossRef](#)]
87. Bayly, W.; Lopez, C.; Sides, R.; Bergsma, G.; Bergsma, J.; Gold, J.; Sellon, D. Effect of different protocols on the mitigation of exercise-induced pulmonary hemorrhage in horses when administered 24 hours before strenuous exercise. *J. Vet. Intern. Med.* **2019**, *33*, 2319–2326. [[CrossRef](#)] [[PubMed](#)]
88. Oser, C. In Reversal, KY EDRC Votes for Partial Lasix Phaseout. *BloodHorse*. 2019. Available online: <https://www.bloodhorse.com/horse-racing/articles/237217/in-reversal-ky-edrc-votes-for-partial-lasix-phaseout> (accessed on 19 February 2020).
89. Ungemach, F. Doping Control in Racehorses. *Tierarztl. Prax.* **1985**, *13*, 35–53. [[PubMed](#)]

90. Hayward, C. America's Regulatory and Integrity Structures are Failing Us. *Thoroughbred Racing Commentary*. 17 September 2019. Available online: <https://www.thoroughbredracing.com/articles/americas-regulatory-and-integrity-structures-are-failing-us/> (accessed on 19 February 2020).
91. Hammonds, E. Under the Micro-Scopolamine. *BloodHorse*. 18 September 2019. Available online: <http://cs.bloodhorse.com/blogs/wgoh/archive/2019/09/18/under-the-micro-scopolamine-by-evan-hammonds.aspx> (accessed on 19 February 2020).
92. Finley. Trying to Make Sense of Scopolamine-Gate. *Thoroughbred Daily News*. 16 September 2019. Available online: <https://www.thoroughbreddailynews.com/trying-to-make-sense-of-scopolamine-gate/> (accessed on 19 February 2020).
93. Voss, N. The Whats And Whys Behind Santa Anita's Nightmare Spring Season. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/news/ra-s-paddock/the-whats-and-whys-behind-santa-anitas-nightmare-spring-season/> (accessed on 19 February 2020).
94. Goldman, T. Should Racehorses Be Medicated? *NPR*. 5 June 2019. Available online: <https://www.npr.org/2019/06/05/729344390/should-racehorses-be-medicated> (accessed on 19 February 2020).
95. Ross, D. The Bone Disease Treatment Drugs that may be Putting Young Horses at Risk: Thoroughbred Racing Commentary. *Racing Medication and Testing Consortium*. 3 October 2017. Available online: <https://rmtcnet.com/bone-disease-treatment-drugs-may-putting-young-horses-risk-thoroughbred-racing-commentary-100317/> (accessed on 19 February 2020).
96. Hauss, A.A.; Mann, A.C.; Pagan, J.D.; Petroski, L.A.; Huntington, P.J. Effect of Omeprazole and Calcium Sources on Calcium Digestibility in Thoroughbred Horses. In Proceedings of the 7th Australasian Equine Science Symposium, Gold Coast, Australia, 6–8 June 2018.
97. Yop Poll Archive. 2019. Available online: <https://www.paulickreport.com/yop-poll-archive/> (accessed on 29 October 2019).
98. Voss, N. Jockey Club Committee Calls For Elimination Of Whip Use For Encouragement. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/news/the-biz/jockey-club-committee-calls-for-elimination-of-whip-use-for-encouragement/> (accessed on 19 February 2020).
99. McGreevy, P.D.; Griffiths, M.D.; Ascione, F.R.; Wilson, B. Flogging tired horses: Who wants whipping and who would walk away if whipping horses were withheld? *PLoS ONE* **2018**, *13*, e0192843. [CrossRef] [PubMed]
100. Graham, R.; McManus, P. Changing human-animal relationships in sport: An analysis of the UK and Australian horse racing whips debates. *Animals* **2016**, *6*, 32. [CrossRef]
101. Hood, J.; McDonald, C.; Wilson, B.; McManus, P.; McGreevy, P. Whip rule breaches in a major Australian racing jurisdiction: Welfare and regulatory implications. *Animals* **2017**, *7*, 4. [CrossRef]
102. Evans, D.; McGreevy, P. An investigation of racing performance and whip use by jockeys in Thoroughbred races. *PLoS ONE* **2011**, *6*, e15622. [CrossRef]
103. McGreevy, P.D.; Corken, R.A.; Salvin, H.; Black, C.M. Whip use by jockeys in a sample of Australian thoroughbred races—An observational study. *PLoS ONE* **2012**, *7*, e33398. [CrossRef]
104. McGreevy, P.D.; Hawson, L.A.; Salvin, H.; McLean, A.N. A note on the force of whip impacts delivered by jockeys using forehand and backhand strikes. *J. Vet. Behav. Clin. Appl. Res.* **2013**, *8*, 395–399. [CrossRef]
105. McGreevy, P.D.; Ralston, L. The distribution of whipping of Australian Thoroughbred racehorses in the penultimate 200 m of races is influenced by jockeys' experience. *J. Vet. Behav. Clin. Appl. Res.* **2012**, *7*, 186–190. [CrossRef]
106. Racing Australia. *Annual Report 2016*; Racing Australia: Melbourne, Australia, 2016; p. 8.
107. Meldrum-Hanna, C. The Final Race. *Investigative News Report*. 2019. Available online: <https://www.abc.net.au/7.30/the-dark-side-of-the-horse-racing-industry/11614022> (accessed on 19 February 2020).
108. British Horseracing Authority. Trainer Feedback Wanted As BHA Launches Racehorse Aftercare Survey. *Paulick Report*. 2018. Available online: <https://www.paulickreport.com/horse-care-category/trainer-feedback-wanted-bha-launches-racehorse-aftercare-survey/> (accessed on 19 February 2019).
109. Cordes, T. *Commercial Transportation of Horses to Slaughter in the United States Knowns and Unknowns. The Unwanted Horse Issue: What Now?* USDA: Washington, DC, USA, 2008.
110. Lenz, T.R. The unwanted horse in the United States: An overview of the issue. *J. Equine Vet. Sci.* **2009**, *29*, 253–258. [CrossRef]

111. Holcomb, K.E.; Stull, C.L.; Kass, P.H. Unwanted horses: The role of nonprofit equine rescue and sanctuary organizations. *J. Anim. Sci.* **2010**, *88*, 4142–4150. [CrossRef] [PubMed]
112. Thoroughbred Retirement Foundation. Available online: <https://www.trfinc.org/about-the-trf/> (accessed on 9 October 2019).
113. Thoroughbred Charities of America. Available online: <https://www.tca.org/about/> (accessed on 9 October 2019).
114. Coleman, S.; (New Vocations Racehorse Adoption Program, Lexington, KY, USA). Personal Communication, 2019.
115. CANTER USA. Available online: <https://www.canterusa.org/about/> (accessed on 9 October 2019).
116. Mosholder, R.; (CANTER USA, Redmond, WA). Personal Communication, 2019.
117. Thoroughbred Aftercare Alliance Code of Standards. Available online: <https://www.thoroughbredaftercare.org/code-of-standards/> (accessed on 15 June 2019).
118. Thoroughbred Aftercare Alliance. Available online: <https://www.thoroughbredaftercare.org/about/> (accessed on 9 October 2019).
119. Shea, E.; (Thoroughbred Aftercare Alliance, Lexington, KY, USA). Personal Communication, 2019.
120. Waldrop, A.M.; Nobert, K.M.; Polonis, J.W. Horse Racing Regulatory Reform Through Constructive Engagement by Industry Stakeholders with State Regulators. *Ky. J. Equine Agric. Nat. Resour. Law* **2012**, *4*, 5.
121. The Jockey Club Thoroughbred Incentive Program. Available online: <https://tjctip.com/default> (accessed on 19 February 2020).
122. Werner, K.; (The Jockey Club, Lexington, KY, USA). Personal Communication, 2019.
123. Retired Racehorse Project. Available online: https://www.retiredracehorseproject.org/images/2019SponsorPages_web.pdf (accessed on 4 June 2019).
124. Roytz, J.; (Retired Racehorse Project, Edgewater, MD, USA). Personal Communication, 2019.
125. Stowe, C.J.; Kibler, M.L. Characteristics of Adopted Thoroughbred Racehorses in Second Careers. *J. Appl. Anim. Welf. Sci.* **2016**, *19*, 81–89. [CrossRef] [PubMed]
126. Reed, S.K.; Vander Ley, B.B.; Bell, R.P.; Wilson, D.A.; Wilborn, E.; Keegan, K.G. Survey on Thoroughbred use, health, and owner satisfaction following retirement from racing. *Equine Vet. Educ.* **2019**. [CrossRef]
127. Wickens, C.; Esquivel, A.M.; Hendricks, C.; Heleski, C. Perceptions of Whether Stereotypic Off-the-Track Thoroughbreds are Harder to Rehome Than Nonstereotypic OTTBs—A Pilot Survey Study. *J. Equine Vet. Sci.* **2019**, *81*, 102794. [CrossRef] [PubMed]
128. Wickens, C.L.; Heleski, C.R. Crib-biting behavior in horses: A review. *Appl. Anim. Behav. Sci.* **2010**, *128*, 1–9. [CrossRef]
129. Albright, J.D.; Mohammed, H.O.; Heleski, C.R.; Wickens, C.L.; Houpt, K.A. Crib-biting in US horses: Breed predispositions and owner perceptions of aetiology. *Equine Vet. J.* **2009**, *41*, 455–458. [CrossRef] [PubMed]
130. Staff. Louisiana Legislature Passes Bill Allocating \$5 Per Start To Fund Aftercare. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/horse-care-category/louisiana-legislature-passes-bill-allocating-5-per-start-to-fund-aftercare/> (accessed on 7 June 2019).
131. Voss, N. What's Different This Time? Racing History Shows an Evolution of Attitudes About Fatal Injuries. *Paulick Report*. 2019. Available online: <https://www.paulickreport.com/news/ray-s-paddock/whats-different-this-time-racing-history-shows-an-evolution-of-attitudes-about-fatal-injuries/> (accessed on 19 February 2020).
132. Feinstein to Co-Sponsor Horseracing Integrity Act. *Thoroughbred Daily News*. 2019. Available online: <https://www.thoroughbreddailynews.com/feinstein-to-co-sponsor-horseracing-integrity-act/> (accessed on 19 February 2020).
133. Marquardt, L. Industry Leaders Form Safety Coalition. *Thoroughbred Daily News*. 2019. Available online: <https://www.thoroughbreddailynews.com/industry-leaders-form-safety-coalition/> (accessed on 19 February 2020).
134. Stettin, J. We Have Met the Enemy and It Is Us. *Pastthewire*. 2019. Available online: <https://pastthewire.com/we-have-met-the-enemy-and-it-is-us/> (accessed on 19 February 2020).

