Veterinary pre-purchase examination results as an indicator of subsequent athletic performance in national hunt thoroughbred horses

Emily Maud Elizabeth Barrett

Publication date

01-01-2013

Document Version
1

Citation for this work (HarvardUL)

Barrett, E.M.E. (2013) 'Veterinary pre-purchase examination results as an indicator of subsequent athletic performance in national hunt thoroughbred horses', available: https://hdl.handle.net/10344/3272 [accessed 6 Sep 2022].

Veterinary Pre-Purchase Examination Results as an Indicator of Subsequent Athletic Performance in National Hunt Thoroughbred Horses

Name

Emily Maud Elizabeth Barrett

Supervisor

Professor Sean Arkins

Volume 1 of 2

Submitted for the award of Doctor of Philosophy at the University of Limerick, April, 2013

Abstract

Conformational and other defects can affect the soundness of a horse and impede athletic performance to varying degrees. This study sought to investigate the prevalence of a variety of anatomical defects, to determine heritability estimates for a selection of these defects and to investigate the effect of a variety of these defects on the racing performance in a large sample of young Thoroughbred horses presented for sale. The study population consisted of data from 13,603 pre-purchase veterinary examination certificates for three and four year old Thoroughbred National Hunt (NH) horses. The information was gathered using the Pre-Purchase Veterinary Examination Certificates from eight years of Tattersalls Ireland's Derby Sale, Goffs Ireland June Sale and Doncaster Bloodstock Sales Ltd. (DBS) Spring Sale (2002-2009) and seven years of Tattersalls Ireland's August Sale (2002-2008). All conditions noted by the veterinarian were recorded in order to determine the true prevalence of defects in this National Hunt population.

It was found that 73.58% of the sample population had one or more defects with 12.02% having serious defects likely to prejudice their use for racing. Metacarpal/metatarsal exostoses and tarsal plantar desmitis affected 17.11% and 19.40% of the sample, respectively, while 9.81% of the horses were found to make respiratory noises and 5.26% had recurrent laryngeal neuropathy (RLN). Age, sex and year of birth had a significant effect on the occurrence of many of the defects and panel veterinarians were significantly more likely to diagnose defects than the private veterinarians ($p < 0.001$).

To estimate h^2 values a pedigree file, three generations deep was generated and heritability (h^2) estimates were estimated using an animal model. The h^2 values ranged from 0.01 (±0.008) for calcaneal bursitis to 0.52 (±0.044) for price. Heritability estimates for the defects were highest for tarsal plantar desmitis (0.23 [±0.030]), respiratory noise (0.13 [±0.021]), RLN (0.10 [±0.019]) and metacarpal/metatarsal exostoses (0.10 [±0.020]). The h^2 values were below 0.10 for the remaining defects. Phenotypic correlations were found to range from 0.00 (±0.011) for pelvic asymmetry and being unsold, to 0.65 (±0.006) for respiratory noise and being withdrawn from the sale. The strongest genetic correlation observed was also between respiratory noise and being withdrawn from the sale with a value of 0.99 (±0.298). The strongest genotypic correlations between defects were found between RLN and respiratory noise (0.91 [±0.035]), RLN and prejudicial defects (0.96 [±0.023]) and respiratory noise and prejudicial defects (0.90 [±0.039]). There were also very strong positive genetic correlations between being withdrawn from the sale and the presence of prejudicial defects (0.96 [±0.173]), respiratory noise (0.92 [±0.196]), and RLN (0.99 [±0.298]).

Only horses entered into the sales from 2002-2004 were examined to determine the effect of the anatomical defects on racing performance. At least four years of possible racing results were available for each horse. Sex, selling status and price realised at sale had a large effect on the racing performance of the horses in the sample. Mares had significantly fewer career starts (8.07 ± 0.223 compared to 10.36 ± 0.146), wins (0.49 ± 0.033 compared to 1.03 ± 0.030) and places (1.19 ± 0.060 compared to 1.90 ± 0.045) than geldings ($P < 0.001$). Horses that were sold had significantly more career starts, wins and places (10.04 ± 0.143, 0.96 ± 0.029 and 1.81 ± 0.044, respectively) than horses that were not sold (9.14 ± 0.290, 0.71 ± 0.052 and 1.51 ± 0.083, respectively) or that were withdrawn (8.88 ± 0.452, 0.71 ± 0.089 and 1.41 ± 0.125, respectively) from the sale ($P < 0.05$) and horses that were in the higher price brackets at the

sales had significantly more career starts (10.86±0.234 for horses >€20,001 compared to 8.19±0.276 for horses <€5,000), wins (1.31±0.053 for horses >€20,001 compared to 0.47±0.037 for horses <€5,000) and places (2.15±0.077 for horses >€20,001 compared to 1.14±0.075 for horses <€5,000) than horses in the lower price brackets ($P < 0.001$).

Horses with prejudicial defects were significantly less likely to race (70.4% raced compared to 83.7%) or to win a race (33.8% compared to 41.3%) and had significantly fewer career starts (8.68±0.379 compared to 9.91±0.131), wins (0.69±0.071 compared to 0.92±0.026) and places (1.39±0.115 compared to 1.76±0.040) than horses without prejudicial defects ($P < 0.01$). Horses with RLN were significantly less likely to race (69.4% compared to 83.6%) than those without RLN and had significantly fewer career wins (0.68±0.092 compared to 0.92±0.026) and career places (1.35±0.155 compared to 1.76±0.040) than those without RLN. They also had a significantly higher proportion of non-finished races than those without RLN (34.01%±2.147 compared to 25.29%±0.456). Horses with tarsal plantar desmitis also had a significantly higher proportion of non-finished races than those without tarsal plantar desmitis (29.96%±1.754 compared to 25.71%±0.489). Papillomas significantly adversely affected the number of career starts (8.45±0.470 compared to 9.87±0.128), career wins (0.59±0.079 compared to 0.91±0.025), career places (1.30±0.126 compared to 1.75±0.039) and mean earnings per start (£241.5±41.85 compared to £454.6±21.93). Horses with papillomas had significantly more non-finished races than those without papillomas (33.34%±2.124 compared to 25.85%±0.448) while interestingly, horses with sarcoids had significantly fewer non-finished races than those without sarcoids (19.44%±1.805 compared to 26.58%±0.452).

Overall, the results indicate that a large proportion of Thoroughbred National Hunt horses are affected by defects of some kind. The results show that the prevalence of a large number of defects increases with age and that certain defects are viewed negatively by purchasers, thereby affecting the selling status. There was a heritable component to each of the defects and each defect was found to affect racing performance to some degree. The results indicate that veterinary pre-purchase examinations make a significant contribution in the evaluation of potential racehorses and that buyers' estimates of value appear to correspond with subsequent racing performance. It may be of benefit to the Thoroughbred industry to monitor the prevalence of defects within the population. The low heritability of the more serious defects does suggest that genetic progress in the reduction of these defects in the horse population would be slow.

Declaration

An Analysis of Veterinary Pre-Purchase Examination Results for 3 and 4 Year Old National Hunt Horses

This dissertation is presented in partial fulfilment of the requirements for Doctor of Philosophy in Equine Science. It is entirely my own work and has not been submitted to any other university or higher education institution, of for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledged and fully referenced.

Signature

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Emily Barrett

Acknowledgements

I would like to thank my supervisor, Prof. Sean Arkins, for his continued input, help and guidance throughout the completion of this thesis. His constant support and encouragement helped motivate and keep me on track, even from a distance. I am grateful for all of his help in more ways than I can express.

I would like to acknowledge the assistance of Tattersalls Ireland, Goffs Ireland and Doncaster Bloodstock Sales Ltd., for access to the veterinary pre-purchase examination certificates, without which this project would not have been possible.

Thanks to Soraya, Christine, Catríona and Nick for their help and willingness to listen to any thoughts and ideas about the project and to the staff of the Life Sciences Department for their support and assistance.

Special thanks to my family for their patience and support during the completion of this project and all of my educational endeavours.

Dedication

To my long suffering parents,

Tom and Angela

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List of Abbreviations

Chronic Synovitis of the Talocrural Joint	CSTJ
National Hunt	NH
Osteoarthritis of the Tarsal Joint	OATJ
Recurrent Laryngeal Neuropathy	RLN
Synovial Distension of the Digital Tarsal Sheath	SDDTS
Synovial Distension of the Tarsal Digital Tendon Sheath	SDTDTS

Chapter 1

Literature Review

1.1 Introduction

Thoroughbred breeding is a significant industry in Ireland and the United Kingdom with approximately twelve thousand foals born each year. Unfortunately not all of these horses will ever appear on the racetrack. Approximately one quarter of these foals never race (Minkema, 1975; Pearson, 2006) and of those that do almost half never win a race (More, 1999). Unsoundness (the inability of the horse to perform the function for which it has been purchased) is the primary cause of wastage in the industry both from injuries occurring during training or from predisposing conditions that may lead to a future unsoundness in the horse. It is therefore important that the horse is free from any of these predisposing conditions. It is also important that the extent to which certain conditions or defects may affect the performance of a horse is known within the industry.

Pre-purchase examinations are conducted on thousands of horses in Ireland and the United Kingdom every year. They are compulsory before the sale of a three or four year old National Hunt Thoroughbred horse at public auction such as Tattersalls Ire. or Goffs and are used as a means of identification, for the potential buyer, of conditions of a veterinary nature that may affect the horse's suitability for the buyer's intended use (Mantell, 1998). The defects identified may be of an inconsequential nature; however, it is also possible that they may be of a kind likely to prejudice the horse's intended use by the purchaser.

The defects noted in the pre-purchase examination range from musculoskeletal defects such as metacarpal/metatarsal exostoses and tarsal plantar desmitis, to respiratory defects such as RLN. While pre-purchase examinations represent a very significant amount of effort on the part of equine practitioners (Mantell, 1998), there is a dearth of assembled data on the results of such examinations, either for the equine population at large or for discrete segments of the population. Similarly, it is not precisely understood to what extent these various conditions affect athletic performance.

1.2 Production of National Hunt Foals

Thoroughbred breeding is a significant industry in Ireland with 12,419 foals born at the peak of production in 2008 (HRI Factbook 2008). These foals are purposely bred for different types of races, Flat or National Hunt. A number of them may be dual purpose, that is, they may be bred for either type of race. Although the highest percentage are bred to race in Flat races, the number bred for Jump races has increased steadily, as is evident in Table 1.1 below.

Table 1.1: Number of Flat, Jump and Dual Purpose Horses Born in Ireland and the UK from 2000 to 2010 (Source: Weatherbys' Return of Mares Books 2000-2010)

	Ireland & NI			*UK (exc. NI)*			*Combined*			
Year	Flat	Jump	Dual	Flat	Jump	Dual	Flat	Jump	Dual	Total
2010	4,225	2,217	1,015	3,188	583	757	7,413	2,800	1,762	11,975
2009	5,089	3,213	1,701	3,658	802	859	8,747	4,015	2,560	15,322
2008	5,369	4,033	2,900	3,873	842	847	9,242	4,875	3,747	17,864
2007	5,365	4,342	2,819	3,895	756	892	9,260	5,098	3,711	18,069
2006	5,102	4,849	1,756	3,507	745	921	8,609	5,594	2,677	16,880
2005	5,098	4,587	1,965	3,432	754	902	8,550	5,341	2,867	16,758
2004	4,856	3,898	1,912	3,430	760	812	8,286	4,658	2,724	15,668
2003	4,137	3,553	2,002	3,545	832	849	7,682	4,385	2,851	14,918
2002	3,703	2,752	1,816	3,228	696	701	6,931	3,448	2,517	12,896
2001	3,745	2,304	1,980	3,035	717	754	6,780	3,021	2,734	12,535
2000	3,004	1,687	1,388	2,798	565	681	5,802	2,252	2,069	10,123

The number of Thoroughbreds bred in Ireland and the UK increased by more than 50% from 2000 to 2008 (10,123 – 17,109) with a large proportion of these horses sold at various auction houses before they have raced. However, since 2008 the number of foals has decreased back to figures close to those of 2000 (11,975 in 2010) due to the economic downturn.

1.3 Wastage in the Thoroughbred Industry

While Thoroughbreds are bred to race, not all of them will actually make it to the racetrack. Wastage is discernible in all levels of Thoroughbred racing, both in training and on the track. Varying figures have been quoted with regards to the number of horses that ever reach the racetrack. These figures are dependent on the way in which the authors define wastage. The study by Bourke (1995) encompassed all levels of wastage from breeding to racing. Bourke determined that it required 1,000 Australian Thoroughbred mares to produce 300 horses that race. This figure includes both conception rates and live foal percentages of 73% and 60%, respectively, and also those horses that did not make it to the racetrack (18.8% to 25%). Similarly Jeffcott et al. (1982) investigated wastage from conception to four years of age. Here the Thoroughbred mares that were covered between 1973 and 1979 were analysed and it was found that the total figure for wastage was 72.8%. This figure includes failure to conceive and abortions or non-surviving foals with figures of 22.5% and 10.1%, respectively. It also considers those horses that were not named (13.9%), named but not trained (20.1%) and finally the trained animals that did not race by the age of four years (6.2%). From Jeffcott et al.'s study (1982), it is evident that approximately 40% of foals will never get to the racecourse.

While the majority of studies examine wastage once the horse begins racing, several other studies have investigated the proportion of horses that did not make it to the track. Physick-Sheard (1986) investigated a randomly selected sample of 762 Canadian Standardbreds born in 1972, while Pearson's (2006) sample consisted of 2,000 Thoroughbred horses that passed through the sales ring as Yearlings. These authors reported that 33.5% and 24.5%, respectively, of the horses in their samples did not make it to the track. These figures correspond closely to those of Bourke (1995) and Minkema (1975). Minkema (1975) studied the entire population of Dutch trotters born between 1929 and 1958. It was discovered that of these 2,867 horses, 24.1% never reached the racetrack.

In contrast, an Australian study investigating 553 Thoroughbreds found that a much lower proportion, 14.6%, never raced (Bailey et al., 1999a). This difference however, may be attributed to the fact that the latter study examined horses sold at an elite yearling sale. It could be inferred that these horses were consequently more likely to race than those horses of an inferior quality. There were however similarities between this study and those of Physick-Sheard (1986), Bourke (1995) and Pearson (2006) with regards to wastage differences between the sexes. Each study determined that mares were less likely to race than geldings or stallions.

1.4 Public Auctions

Thoroughbred horses are most commonly sold or purchased in Ireland and the United Kingdom at public auctions. Here, a large number of horses are brought together at specific dates throughout the year for the purpose of trading. The two most significant Bloodstock Auctioneers in Ireland are Tattersalls Ire. and Goffs. Together these auction houses have sold approximately 4,000 Thoroughbred horses annually for the past three years (HRI Factbook 2011), as seen in Table 1.2 below.

Table 1.2: Irish Sales Summary 2002-2008 (Source: HRI Factbook 2005; HRI Factbook 2008; HRI Factbook 2011)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Catalogued	10,802	10,437	11,233	11,307	14,258	15,337	13,071	8,204	7,929	7,315
Offered	8,808	8,535	9,241	9,226	11,625	12,326	10,173	6,867	6,639	6,226
Sold	6,404	6,305	6,575	6,498	8,063	7,684	5,446	4,172	3,987	4,248

These sales results are a combination of both Flat and National Hunt horses. Although both Tattersalls Ire. and Goffs hold sales for both types of horse each specialises in just one particular type of racehorse.

1.4.1 Tattersalls Ireland

Tattersalls Ire. is located in Ratoath, Co. Meath. It is a highly successful sales company known throughout the world. During the year, it holds seven Thoroughbred public auctions (Tattersalls Online, 2012). Tattersalls Ire. is a leading National Hunt sales company holding the largest National Hunt sale in the world every November (Tattersalls Online, 2012). It also holds a select three and four year old sale in June called the Derby Sale and a less select three and four year old sale in August. The following tables show the sales throughput for the Derby and August sales for the past ten years.

Table 1.3: Derby Sale of 3 and 4 Year-Old National Hunt Thoroughbreds Statistics 2003 – 2008 (Source: Tattersalls Online, 2008)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Catalogued	528	521	550	515	531	577	483	461	518	517
Offered	408	407	437	417	426	487	384	377	412	434
Sold	346	322	348	302	343	365	263	237	278	331

Table 1.4: August Sale of 3 and 4 Year-Old National Hunt Thoroughbreds Statistics 2004 – 2008 (Source: Tattersalls Online, 2008)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Catalogued	853	902	825	915	1,091	927	835	591	625	874
Offered	598	635	596	640	746	674	577	449	483	685
Sold	426	467	433	440	495	377	298	207	251	348

1.4.2 Goffs

Goffs is another prestigious Irish bloodstock sales company. It is home to eight Thoroughbred sales each year and specialises in the sale of Flat racehorses. It does however hold National Hunt Sales, most noticeably the December and June National Hunt Sales. The June Sale specialises in three and four year old horses (Goffs Online, 2012). The table below shows the sales results for the June Sale for the years 2003 to 2008.

Table 1.5: June Sale for 3 and 4 Year-Old Thoroughbred National Hunt Horses Statistics 2002 – 2008 (Source: Goffs Online, 2008)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Catalogued	650	613	751	906	888	1,062	843	540	535	455
Offered	650	449	568	684	716	838	690	460	464	390
Sold	322	336	463	497	555	580	451	294	312	283

1.4.3 Doncaster Bloodstock Sales Ltd.

Doncaster Bloodstock Sales Ltd. (DBS) is a British Sales company. It holds twelve Thoroughbred horse auctions each year, selling approximately 3,500 horses annually. DBS hold both Flat and National Hunt sales including the Spring National Hunt Sale and the World's Premier National Hunt Breeze Up Sales in November (DBS Online, 2012). Approximately 200 store horses are sold annually at the Spring Sale, as shown in Table 1.6.

Table 1.6: Spring Sale Statistics for the 3 and 4 Year-Old National Hunt Horse Entries 2002 – 2008 (Source: DBS Online, 2008)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Catalogued	400	405	340	346	310	291	350	306	312	219
Offered	333	320	267	266	257	232	289	249	273	178
Sold	247	218	215	190	200	195	206	170	194	133

All of these sales venues require that three and four year old NH horses presented for sale first have a pre-purchase examination performed.

1.5 Pre-Purchase Examinations

Pre-purchase examinations are performed prior to the sale of a horse, within 14 days of the auction, by a veterinarian, for Tattersalls Ire. and Goffs (Tattersalls Ire Conditions of Sale, 2012; Goffs Conditions of Sale, 2012) and within 28 days of the sale for DBS (DBS Conditions of Sale, 2012). When a young horse is entered into a Sale it is necessary for both the vendor's veterinarian and a member of the Sales Company's veterinary panel to perform separate pre-purchase examinations of the horse. The aim of this is to conduct a comprehensive veterinary examination with the purpose of identifying and assessing any factors of a veterinary nature that may have an effect upon the horses intended use. This then allows the purchaser to make an informed decision on whether or not to purchase the horse (Mantell, 1998).

The typical pre-purchase examination consists of five stages (Chandler, 1998). These are:

1. Preliminary Examination
2. Trotting Up
3. Strenuous Exercise
4. Period of Rest
5. A Second Trot Up and Foot Examination

An additional stage may be added after "strenuous exercise", this is an examination of the horse with an endoscope to determine if there are any laryngeal or pharyngeal defects. Although this is not always included in a pre-purchase examination it is conducted if a horse has been found to have an abnormal respiratory noise during a pre-purchase examination for a Store Horse Sale (three and four year old National Hunt Thoroughbred horses) at an auction house.

During the examination, the veterinary surgeon typically examines every aspect of the horse thoroughly, with the intention of identifying and recording any defects that may be present (Chandler, 1998). Once these defects have been noted the examining veterinarian determines whether or not they are likely to prejudice the horse's use in the purchaser's chosen discipline (Mantell, 1998).

The defects noted can vary greatly from tarsal plantar desmitis, metacarpal/metatarsal exostoses and SDDTS to more serious defects such as RLN and heart murmurs. Even seemingly insignificant defects are noted, for example scars and abrasions. By identifying every defect present, the veterinarian allows the prospective purchaser to make an informed decision on whether or not the horse is suitable for the career they intend it for. As different defects may have more serious implications depending on the discipline in question this allows the potential purchaser to determine whether or not to bid on the horse.

Certificates may be issued on a pass/fail basis or the horse may instead be deemed suitable/unsuitable for the intended career. These declarations are however intended as more of a guide for the potential purchaser than a definite affirmation of the horse's capabilities. A study by Dart et al. (1992) investigated the outcomes of 134 pre-purchase examinations conducted over two years and the future use of those horses. It was found that of the 50 horses deemed suitable upon examination, eight proved to be unsuitable after purchase. In addition, of the 84 judged unsuitable 35 were found to be suitable in the future. The most common reason for horses being deemed unsuitable was lameness which affected 74 horses. Abnormal radiographic findings were the next most common cause, noted for six horses, with ocular problems and respiratory tract infections each affecting two horses (Dart et al., 1992).

Van Hoogmoed et al. (2003) evaluated pre-purchase examination records, over a period of 10 years and also identified lameness as the most common defect identified in the sample with 52% (271/510) of the horses exhibiting lameness. This study also found that the use of endoscopy of the upper respiratory tract of the horse was an increasingly popular procedure. It was performed on 14.1% of the horses, with a marked increase from 1.8% examined in 1991 to 30% examined in 1999 (van Hoogmoed et al., 2003). It was also found that some horses (73.4%) that had been deemed unsuitable at the pre-purchase examination were later found to be suitable for their intended use, with 58/79 in active use. Both of these studies also determined the use of radiography to be beneficial during the pre-purchase examination as a diagnostic aid (Dart et al., 1992; van Hoogmoed et al., 2003) and van Hoogmoed et al. (2003) discovered that the pre-purchase examination had an important impact on the sale, with prices often being reduced if there were negative findings.

1.6 Prevalence of Defects in Clinical Surveys

1.6.1 Most Prevalent Defects

Lameness is widely considered the most prevalent defect present in horses of all disciplines. However, beyond this there is much variation between the prevalences of defects depending on the study examined. For example, it is noted that respiratory defects are in the top five defects for the clinical survey studies by Cook (1965), Traub-Dargatz et al. (1991) and Kaneene et al. (1997) however, the study by Bailey et al. (1999b) determined respiratory defects to be only the ninth most common defect.

An extensive survey carried out by members of the British Equine Veterinary Association investigated a large number of horses throughout Britain and Ireland which had been clinically examined by a number of veterinary surgeons (Cook, 1965). A total of 17,268 horses were examined throughout the study and, of these, 6,278 horses were Thoroughbreds. The sample also contained Hunters, Ponies and Heavy horses. The horses were not exposed to a complete examination; instead the veterinarian recorded the reason why veterinary attention was required. It was found that musculo-skeletal problems were the most commonly observed defects affecting 15% of the sample followed by alimentary and urogenital conditions affecting 10% and 5% of the sample respectively. It was also found that differences in prevalences were observed for different breeds of horses, as can be seen in Table 1.7 below.

Table 1.7: Prevalence of Defects for Different Breeds (Source: Cook, 1965)

	TB	*Hunter*	*Pony*	*Heavy Horse*	*Total*
Number of Horses	8,377	12,463	21,366	1,332	43,538
Musculo-Skeletal	24.7%	24.0%	6.4%	10.5%	15.0%
Alimentary	25.0%	10.5%	4.0%	11.0%	10.0%
Urogenital	12.0%	5.0%	2.9%	2.8%	5.0%
Respiratory	6.0%	6.0%	2.5%	0.6%	4.0%
Skin	2.8%	2.8%	1.5%	1.5%	2.0%
Blood and Lymphatic	1.0%	1.4%	0.1%	0.5%	0.7%
Neoplasia	0.6%	0.8%	0.3%	0.5%	0.5%
Cardiovascular	0.8%	0.6%	0.2%	0.8%	0.4%
Ocular	0.5%	0.5%	0.2%	-	0.3%
Systemic Disease	0.4%	0.5%	0.2%	0.3%	0.3%
Nervous System	0.1%	0.3%	0.1%	0.1%	0.1%
Mammary Gland	0.2%	<0.1%	<0.1%	0.2%	<0.1%
Ear	<0.1%	<0.1%	<0.1%	-	<0.1%
	74.2%	52.6%	18.6%	28.8%	38.5%

The number of horses described in the table refers to the estimated total number of horses of each breed in the veterinary practices. It is evident from Table 1.7 that Thoroughbreds were more likely than any other breed to have clinical problems, with 74.2% of the population affected by at least one defect, while ponies were the least likely to have defects with only 18.6% of the population being affected. Compared to the other breeds of horses, Thoroughbreds were most likely to have alimentary conditions closely followed by musculo-skeletal conditions affecting 25.0% and 24.7%, respectively. All the other breeds were most commonly affected with musculo-skeletal conditions. Thoroughbreds were more likely to have urogenital conditions than any other breed and Thoroughbreds and Hunters were more likely to have respiratory conditions than the others. There was not very much variation at the lower end of the table, with each breed being equally likely to have systemic diseases, nervous conditions, mammary gland conditions and ear conditions (Cook, 1965).

Traub-Dargatz (1991) used questionnaires distributed to 854 veterinary practices in the USA to identify the medical problems of adult horses. Unlike the other studies, lameness was not found to be in the most commonly observed problems. However, this is due to the fact that lameness was not included in the list of diseases on the questionnaire and not to an absence of lameness in the sample. The respondent veterinarians ranked a total of five problems, out of the 36 given, in order of frequency of occurrence in their practice. Colic was found to occur most often, with 43% of the respondents ranking it first, followed by viral respiratory tract disease as ranked by 23% of the respondents. Endometritis was the third most common problem while the fourth and fifth most common problems were found to be dermatitis and parasitism respectively (Traub-Dargatz et al., 1991). This variation in prevalence is probably due to differences in the composition of the population.

The Michigan equine monitoring system was designed in order to determine the prevalence of equine clinical conditions in Michigan State in the USA (Kaneene et al., 1997). It was conducted over two 12 month periods, 1992-1993 and 1993-1994, and examined a sample of 2,469 horses of mixed breeds which was representative of the equine population in the state. This study evaluated the clinical conditions according to their duration and the resulting number of days of performance lost. Recording of the data was carried out monthly by the operator of each establishment included in the study and was collected by trained veterinarians, animal scientists and animal technicians in person in order to clarify any possible problems. According to this form of evaluation it was found that lameness, as a result of leg problems, was the most common defect, followed by dermatological and respiratory defects. The fourth most common defect was lameness due to hoof defects (Kaneene et al., 1997).

The final study included in Table 1.8 below used a postal questionnaire distributed throughout Australia to investigate the clinical conditions present in 3,901 horses (Cole et al., 2005). This study examined a mixed breed sample composed of horses of a variety of ages. It determined the most common defect to be lameness, affecting 13% of the sample. Skin and behavioural conditions affected 6.1% and 4.5% respectively. This was closely followed at 4.2% by ocular disorders and colic at 3.6%. “Other” defects were found to affect 3.3% of the sample. The most common defect classed as other was “back disorders” affecting 0.6% of the sample. It was found that gender had a significant effect on the prevalence of defects with males being more likely to have defects than females ($P < 0.0001$). Age and breed were also seen to have a significant effect on the prevalence of defects ($P < 0.0001$).

Table 1.8: Most Prevalent Defects from Various Studies

Study	*Cook,1965*	*Traub-Dargatz et al., 1991*	*Kaneene et al., 1997*	*Cole et al., 2005*
Geographic Location	Britain & Ireland	USA	Michigan, USA	Australia
Number Examined	17,268 Horses	854 Surveys	2,469 Horses	3,901 Horses
1	Musculo-Skeletal	Colic	Lame: Leg	Lame: Other
2	Alimentary	Viral Respiratory Tract Disease	Dermatological	Lame: Foot
3	Urogenital	Endometritis	Respiratory	Skin
4	Respiratory	Dermatitis	Lame: Hoof and Foot	Behavioural
5	Skin	Parasitism	Reproductive	Ocular
6	Blood and Lymphatic	Dental Problems	Colic	Colic
7	Neoplasia	Pulmonary Haemorrhage	Systemic	Other
8	Cardiovascular	COPD	Lame: Body	Weight Loss
9	Ocular	-	Gastrointestinal	Respiratory
10	Systemic Disease	-	Neurological	Tying-Up
11	Nervous System	-	-	Laminitis
12	Mammary Gland	-	-	-
13	Ear	-	-	-

As is evident in Table 1.8, there are large variations between the frequencies of clinical conditions observed in each study. Most studies determined lameness to be the most prevalent condition with skin conditions consistently amongst the top five most prevalent. However, beyond this there is little similarity. These variations may be due to the fact that the studies were carried out on widely varying sample sizes from 854 veterinary practices (Traub-Dargatz et al., 1991) to 17,268 horses (Cook, 1965). It is also possible that the variation may be due to the different locations in which the studies were performed; two in the USA (Traub-Dargatz et al., 1991; Kaneene et al., 1997), one in Australia (Cole et al., 2005) and one in Britain and Ireland (Cook, 1965), or to the varying methods used; surveys (Traub-Dargatz et al., 1991; Cole et al., 2005) versus recording of cases (Cook, 1965).

1.6.2 Musculoskeletal Defects

There is a dearth of literature regarding the prevalence of musculoskeletal defects. This category encompasses a variety of defects. These include metacarpal/metatarsal exostoses, tarsal plantar desmitis, synovial distension of the digital tendon sheath and calcaneal bursitis.

Musculoskeletal defects affect a large portion of the equine population however, it is difficult to ascertain the actual prevalence because of the virtual absence of relevant literature.

1.6.2.1 Metacarpal/Metatarsal Exostoses

Metacarpal/metatarsal exostoses (more commonly known as splints) are formed as a result of a sprain or tear of the interosseous ligament resulting in proliferative exostosis of the metacarpal/metatarsal II or IV bones and ossification of the interosseous ligament (Baxter, 2011). They are most common in horses undergoing intensive training (Radostits et al., 2007) and are usually located on the fore legs and on the medial aspect (Boening and Wienker, 2005; Radostits et al., 2007; Baxter, 2011). There are multiple causes including hard training, poor conformation, incorrect hoof care or malnutrition (Baxter, 2011). They may also form as a result of a metacarpal/metatarsal bone II or IV fracture (Boening and Wienker, 2005). Poor conformation, such as “in at the knee” combined with “toed out”, has also been reported to increase the likelihood of metacarpal/metatarsal exostoses (McIlwraith et al., 2003; Baxter, 2011).

Metacarpal/metatarsal exostoses can result in lameness of varying degrees during their formation (Baxter, 2011; Ross and Dyson, 2011). However, they usually cause little problem once they mature (Marks, 1999). Although metacarpal/metatarsal exostoses are widely accepted to be a common defect (Marks, 1999) there is no literature available detailing their prevalence in the population. A study investigating wastage in Thoroughbred horses did however find that 4% of the lameness cases observed in the study were as a result of metacarpal/metatarsal exostoses (Rossdale et al., 1985) while another wastage study found metacarpal/metatarsal exostoses to cause 6.5% of the lameness observed (Jeffcott et al., 1982).

1.6.2.2 Tarsal Plantar Desmitis

Tarsal plantar desmitis (commonly known as curb) is located on the hind legs on the plantar aspect of the tarsal bone and is a thickening of the plantar ligament or other local structures. It is reported to be caused by a combination of bad conformation, such as sickle hocks or cow hocks, and a sprain of this ligament (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011). Tarsal plantar desmitis may also form as a result of a trauma from excessive jumping or acceleration and may involve structures other than the plantar ligament (Major and Zubrod, 2006; Radostits et al., 2007). Inflammation and lameness may be present (Ross and Dyson, 2011) and in more severe cases ossification may occur on the fibular tarsal bone (Baxter, 2011). A study investigating the heritability of range of conformational traits in Norwegian trotters found that 18.7% of the 407 horses examined had “curby hocks”, hocks predisposed to tarsal plantar desmitis (Dolvik and Klemetsdal, 1999).

1.6.2.3 Synovial Distension of the Digital Tendon Sheath

Distension of joint capsules, tendon sheaths or bursa, in conjunction with excess synovial fluid, are commonly known as windgalls (Baxter, 2011). They are usually symmetrical in appearance and insignificant with regards to performance (Marks, 1999). Synovial distension of the digital tendon sheath (SDDTS) usually appear as a result of heavy training and once present, do not disappear. Rest, bandaging, cold hydrotherapy and NSAIDs are accepted forms of treatment however, blemishes often persist (Baxter, 2011). There is currently no literature detailing the prevalence of SDDTS.

1.6.2.4 Calcaneal/Carpal Bursitis

Calcaneal and carpal bursitis are bursal enlargements caused by trauma to the area such as from kicking a wall (commonly known as capped hocks and capped knees). They usually do not cause lameness but may display considerable swelling in the area (Radostits et al., 2007; Baxter, 2011; Ross and Dyson, 2011). Similar to SDDTS, treatment in the form of bandaging and cold hydrotherapy may improve the appearance of calcaneal and carpal bursitis (Baxter, 2011), however, blemishes often persist (Baxter, 2011; Ross and Dyson, 2011). It is unknown as to what level they are present in the general population.

1.6.2.5 Chronic Synovitis of the Talocrural Joint

Chronic synovitis of the talocrural joint (CSTJ) or bog spavins can be caused by bad conformation, trauma, osteochondrosis (chip fractures in the joint) or vitamin or mineral imbalances. CSTJ usually does not cause lameness however those formed as a result of trauma may affect the soundness of the horse. CSTJ is primarily located on the dorsomedial aspect of the hock but small swellings may also be present on either side of the hock (Baxter, 2011). There is no literature available regarding the prevalence of CSTJ in the general population.

1.6.2.6 Osteoarthritis of the Tarsal Joint

Continuous strain of the hock joint from activities such as jumping, hard galloping and western reining, roping and cutting can result in osteoarthritis of the tarsal joints (OATJ). This is commonly known as a bone spavin and is most frequently observed in older horses (Baxter, 2011). OATJ often result in lameness and horses are usually observed exhibiting symptoms such as a choppy irregular gait and diminished performance (Brokken, 1978; Moyer et al., 1983; Eksell et al., 1998; Baxter, 2011).

A study investigating 89 Thoroughbred racehorses with OATJ discovered that although OATJ is sometimes found on its own, it is usually accompanied by other problems (Moyer et al., 1983). The average age of onset of OATJ was 3.4 years. Eksell et al. (1998) conducted a study on the prevalence of OATJ in a sample of 379 Icelandic horses. OATJ was found to be present in 23% of the sample and, of the affected horses, 53% were affected bilaterally. This study further investigated the factors affecting the occurrence of OATJ. It was found that hock conformation, age, sex, country of birth and intensity of work all significantly affected the prevalence ($P < 0.05$). Geldings were significantly more likely to have OATJ than mares or stallions and, in contrast to the study by Moyer et al. (1983), it was found that horses between the ages of five and eight years were most likely to have this defect.

1.6.2.7 Synovial Distension of Tarsal Digital Tendon Sheath

Thoroughpins are similar to SDDTS; however, they are a swelling or synovial distension of the tarsal digital tendon sheath (SDTDTS) in the hock. SDTDTS may form as a result of trauma or poor conformation but is considered more as a blemish than as a true musculoskeletal problem and is rarely associated with lameness (Major and Zubrod, 2006; Baxter, 2011). Although SDTDTS is commonly observed (Baxter, 2011), the actual prevalence is unknown.

1.6.3 Hoof Defects

As with musculoskeletal defects, there is an absence of literature regarding the prevalence of hoof defects. However, hoof cracks are defects that occur relatively frequently in horses. Hoof cracks occur in two forms; those starting at the ground and working their way up or those starting at the coronary band and working down towards the ground (Baxter, 2011). They may form as a result of either external or internal trauma (Castelijns, 2008) or they may have predisposing factors such as environment, poor hoof care and nutrition and even conformation and genetics (Eustace, 1994; Suchorski-Tremblay et al., 2001; Baxter, 2011).

Vertical cracks that occur from the coronary band downwards are the more serious of the two varieties and are caused by an injury to the coronary band. This damage can be temporary or permanent and can result in loss of part of the hoof wall if the crack reaches the ground. Cracks extending from the bottom of the hoof upwards are usually a result of the hoof being overgrown and breaking (Baxter, 2011).

Hoof cracks can have varying degrees of significance. They may be of an insignificant, superficial nature, or more serious, affecting the sensitive laminae of the hoof. Although hoof cracks do not usually cause lameness, if they are of the deeper type they can result in acute lameness due to movement of the hoof wall or infection (Baxter, 2011). Hoof cracks can be seen in all types of horses; however they are most common in racehorses (Moyer, 2005).

A study investigating the relationship between hoof cracks and a number of variables found that there were several factors that were associated with the occurrence of hoof cracks (Suchorski-Tremblay et al., 2001). The most important variable was found to be the presence of a musculoskeletal stereotypy, for example box walking or weaving, while time spent in stall during summer, bedding surface type, field/paddock footing type, speciality feed type and hoof conditioner application, were also found to be significant.

1.6.4 Lameness

Lameness is a common problem in horses (Jeffcott et al., 1982; Rossdale et al., 1985; Dart et al., 1992; Ross and Kaneene, 1996; Kaneene et al., 1997; Kane et al., 2000; Knight and

Evans, 2000; Vigre et al., 2002; van Hoogmoed et al., 2003; Cole et al., 2005). It can be caused by injury or by a variety of defects; leg, hoof and back problems can all result in lameness. It has also been found that poor conformation may predispose the horse to, and may in some cases even cause, lameness (Baxter, 2011). Lameness is disadvantageous to the horse's career and is therefore highly undesirable.

A study by Cole et al. (2005) determined lameness to be the most commonly reported health disorder by owners, affecting 13% of the sample population. Other studies determined lameness to be the most frequent defect to interrupt training (Vigre et al., 2002) and the most frequently observed health problem (Kaneene et al., 1997), while a study by Knight and Evans (2000) determined lameness to be the second most common defect observed in poorly performing Standardbred horses, affecting 11.1% of the sample.

Retrospective studies examining pre-purchase examination results found that lameness was quite a common clinical condition (Dart et al., 1992; van Hoogmoed et al., 2003). It was observed in a sample of 510 horses, of mixed breeds and a mean age of eight years, examined between 1991 and 2000, that 52.8% of the horses were lame (van Hoogmoed et al., 2003) while a study by Dart et al. (1992) examining 134 mixed breed horses found a similar proportion of 55.2% to be lame. Lameness was the most common reason for a horse being deemed unsuitable for use during pre-purchase examinations (Dart et al., 1992). These figures are much higher than those quoted in other studies (Knight and Evans, 2000; Cole et al., 2005) however, this may be because the horses undergoing a pre-purchase examination could have been examined more thoroughly than those in the other studies.

A number of studies have investigated some of the factors predisposing horses to lameness. One such study, investigating the factors affecting lameness in Danish Standardbred trotters, determined that age and gender had an influence on the prevalence of lameness. It was found that geldings were more likely to be affected by lameness than mares and also that three year olds were more likely to be affected than four year olds (Vigre et al., 2002). Another study, using the Michigan Equine Monitoring System over a period of two years, found that horses that competed in racing and those whose exercise intensity increased were more likely to suffer from lameness (Ross and Kaneene, 1996).

An owner reported based study found that approximately 50% of horse operations with at least three horses had at least one lame horse a year and that horses were more likely to be lame in the spring and the summer than during the winter (Kane et al., 2000). It was also discovered that leg and joint problems accounted for approximately half of the lameness during the spring and winter while foot problems such as laminitis, navicular disease, bruises and abscesses were the cause of half of the cases observed during the summer.

Lameness was found to be the most common reason for horses to miss training days in a study investigating wastage among racehorses (Rossdale et al., 1985). This work also documented the most common sites of lameness. Lameness of the foot was most common with 19% of all cases located here. This was closely followed by the muscles which were the location for 36 of the 198 cases (18%). Rossdale et al. (1985) also found the foot to be the most common site of lameness. However they found the fetlock to be the second most common site with 15.4% and 15% of all cases of lameness located in these sites respectively.

1.6.5 Ocular Defects

Ocular defects are rare in horses compared to other domestic animals. This is largely due to their high head carriage and strongly developed ocular anatomy, especially the third eyelid (Craven, 1971). In spite of this, ocular defects do occur. A study by Cole et al. (2005) identified ocular defects as the fourth most common defect in horses affecting 4.2% of the 3,901 horses in a mixed breed sample. Corneal ulcers are frequently held to be one of the most common ocular defects in horses (Brooks, 2002; Kallberg, 2005; Brooks, 2007) ranging from simple abrasions to more severe perforations (Brooks, 2002; Brooks, 2007). The more serious of these may result in loss of vision (Brooks, 2002; Kallberg, 2005; Brooks, 2007).

Another common ocular defect is opacity of the lens, known as a cataract. Cataracts are the most frequently observed congenital ocular defect in foals (Brooks, 2002) and a study by Priester (1972) looking at a mixed animal sample affected with ocular conditions determined cataracts to be the most common ocular defect in the horses, contributing 12 of the 34 cases of ocular defects. As Priester (1972) only included animals with an ocular defect, the study did not determine the prevalence of any of the defects in the population however, Matthews (2000) states that lens opacities are present in between 5% and 7% of horses. The majority of cataracts do not cause blindness, however, as they become more opaque, and cover a greater area of the eye they may impair vision and even cause blindness (Brooks, 2002).

An intensive study conducted on 514 Rocky Mountain horses found the prevalence of ocular defects to be quite high, with 48% of the studied sample found to have ocular cysts (Ramsey et al., 1999). A large percentage of the horses were also found to have retinal dysplasia (24%). This study also investigated the associations between the ocular defects and coat colour. It was determined that there was a significant association ($P < 0.001$), with chocolate coloured horses with white manes and tails significantly more likely to have a defect than horses of any other colour. They further concluded that the environment had very little influence on the occurrence of these defects.

A more recent study looked at the ophthalmic examination findings of 204 Australian Thoroughbred racehorses (Hurn and Turner, 2006). Ocular defects were present in 138 or 67.6% of the horses while the remaining 66 were free from defects. Of the 204 horses in the study, 7.4% had potential vision-threatening defects. The retina and the lens were the most frequently affected areas, with 117 horses (57.4%) affected by defects of the retina and 40 horses (19.6%) affected by lens defects.

1.6.6 Dental Defects

Dental defects can have a detrimental effect on the health and performance of horses. Painful teeth may result in a reduction in feed consumption, cause behavioural problems and may also interfere with the action of a bit (Lane, 1994; Scoggins, 2001; Bryant, 2004; Dixon and Dacre, 2005; Linkous, 2005). Clinical dental defects occupy 10% of veterinary practice time in the UK (Cook, 1965) and are the third most common problem observed by large animal practitioners in the USA (Traub-Dargatz et al., 1991). The prevalence of overall dental defects reported varies greatly. Uhlinger (1978) found that 38.6% of the sample of 233 young horses were affected by dental defects whereas Pimentel et al. (2007) found that incisor defects alone affected 45% of the 607 horses in his sample and Kirkland et al. (1994), investigating 500 skulls at an abattoir, determined that more than 80% showed defects. Many of the defects in the latter study would not have resulted in symptoms.

Dental defects are more likely to be present in the cheek teeth (Dixon, 2003). Dental problems may be present as a result of trauma or behavioural problems such as crib biting or windsucking (Dixon and Dacre, 2005). Such defects include fractures and missing teeth. Several studies have investigated the prevalence of dental defects in horses (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000; Broeze-ten Voorde et al., 2006; Pimentel et al., 2007). Defects of the cheek teeth were the most common defect in each of the studies.

A long term study of 400 horses identified the most common defects affecting the incisor, canine, premolar and cheek teeth (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000). The study was separated into three parts and examined horses that were referred to a veterinary hospital due to dental defects and therefore was not representative of the entire equine population. The most common dental defects were found to be defects of wear, affecting 11% of the horses, traumatic damage affecting 6.5%, idiopathic fractures affecting 6% and cheek teeth displacement affecting 5.8% of the horses (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000). Defects of the cheek teeth were more common than those of the incisors with only 11% of the sample (44 horses) identified as having incisor defects. Traumatic fractures and retained deciduous incisors were the most common incisor defect affecting 2.8% and 1.3% of the horses respectively (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000).

Dixon and Dacre (2005) state that enamel points are the most prevalent dental defect which is in agreement with the study by Broeze-ten Voorde et al. (2006) where 58.3% of the 483 horse sample had this problem. Broeze-ten Voorde et al. (2006) examined horses that were anaesthetised for surgeries other than dental surgery. Cheek teeth hooks were another common defect affecting 33.5% of the sample. Overjet, a mild form of parrot mouth where the upper incisors are protruding in front of the lower incisors but without overlapping them, was the third most common defect, affecting 29.2% of the sample and if combined with the prevalence of overbites (12 horses) would see 31.7% of the sample experiencing varying forms of parrot mouth (Broeze-ten Voorde et al., 2006). This is a much larger proportion than was observed in the other studies described above, 7.6% (Pimentel et al., 2007) and 1% (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000). Pimentel et al. (2007) also found a high proportion of horses to have wolf teeth (20.6%); this feature was not mentioned in the other studies.

Uhlinger (1978) investigated the prevalence of dental defects using a slightly different approach. This author compared the prevalence of dental defects of two groups, totalling 233 horses, group 1 displaying no clinical signs of dental problems and group 2 displaying clinical signs. It was found that horses displaying clinical signs of dental disorders were more likely to have defects than those without, 65% compared to 24%. Similar to other studies (Dixon et al., 1999a; Dixon et al., 1999b; Dixon et al., 2000; Broeze-ten Voorde et al., 2006; Pimentel et al., 2007), defects of wear of the cheek teeth were the most common defect. However, in contrast to these studies, oral lacerations were observed in a large proportion of the horses, 8% in group 1 and 27.7% in group 2. It was interesting to note that although all of the horses in group 2 exhibited signs of dental problems, 35% of these horses had no defects.

1.6.7 Respiratory Defects

Laryngeal paralysis, more correctly termed recurrent laryngeal neuropathy (RLN), is the most important respiratory condition in horses (Dixon and Robinson, 2003) and has been found to affect between 0.96% (Lane et al., 1987) and 3.3% (Raphel, 1982) of the equine population. While this is a relatively small proportion of horses it does have an impact upon the performance of the horse (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006) and may also affect the price at auction (Pierce and Embertson, 2005). It is therefore receiving increased emphasis during the equine pre-purchase examination. Van Hoogmoed et al. (2003) found that the proportion of horses undergoing endoscopic examination increased from 1.8% in 1991 to 58.3% of horses between 1997 and 2000. RLN is caused by the degeneration of the recurrent laryngeal nerve resulting in paralysis of the larynx (Dixon et al., 2001). It usually occurs on the left hand side of the larynx, but has been noted, very infrequently, on both sides. Dixon et al. (2001) found that in a sample of 375 cases of RLN 96% of the cases occurred on the left side of the larynx, 2% occurred on the right side and 2% occurred bilaterally. This was similar to the results found by Hobo et al. (1995) with 99.6% of the cases affecting the left side of the larynx and only 0.4% affecting the right side.

The cause of the majority of RLN cases is unknown and it is therefore usually referred to as idiopathic RLN. There are, however, thought to be several predisposing factors; breed, age, sex, size, conformation, heredity, management, climate and geography (Cahill and Goulden, 1987).

Many studies researching respiratory problems are carried out on horses with already diagnosed laryngeal defects. While this gives no indication of the prevalence of these conditions in the population, these studies are very important in determining which factors may predispose the horse to the development of these defects. One such study (Dixon et al., 2001), examining a mixed breed sample of 375 horses, found that 81% of the cases of RLN affected geldings with only 18% affecting mares. This study also determined that taller horses were more likely to be affected by respiratory defects (Dixon et al., 2001). These results are similar to those of an earlier study by Goulden and Anderson (1981) which investigated a sample of 127 horses affected by RLN. The authors found that colts and geldings were more likely to be affected than mares and that taller and heavier horses were significantly more likely to be affected than smaller or lighter horses ($P < 0.05$). It was also determined that there was no difference between the prevalence of RLN in Thoroughbreds and Standardbreds and that the onset of the condition was most likely to occur by the age of three years (Goulden and Anderson, 1981). This finding is at variance to those of Dixon et al. (2001) and Hobo et al. (1995). Dixon et al. (2001) concluded that the median age of horses to be first presented with the disease was six years while Hobo et al. (1995) found that of the 67.6% of horses affected with RLN, in their sample of 350 racehorses exhibiting signs of a clinical defect, the prevalence was significantly higher in four and five year olds than in three year olds.

Tan et al. (2005) reported a very high prevalence of RLN (38.5%) in 291 horses in a mixed breed sample. However, this sample was composed of all the horses that had been examined using high speed treadmill video-endoscopy. It is very likely that a number of these horses were examined to check for a problem due to poor performance or an abnormal respiratory noise and therefore were more likely to have a respiratory condition. Much lower prevalences were found by Raphel (1982), Lane et al. (1987), Sweeney et al. (1991) and Lane (2003).

Raphel (1982) investigated a sample of 479 randomly selected mixed breeds and found that 3.3% of these horses were affected by RLN. Unlike the studies discussed above (Goulden and Anderson, 1981; Hobo et al., 1995; Dixon et al., 2001) the author found no association to exist between age and the presence of the condition. A very low prevalence was established by Lane et al. (1987) who found that only 1% of the 6,860 Thoroughbreds examined at a Sales venue were affected by RLN. However this low figure may be attributed to the young age of the sample which was composed exclusively of yearlings and also to the fact that these yearlings were being sold at Sales and therefore horses that were known to have RLN might have been withdrawn before the author had a chance to examine them. A more recent study by Lane (2003) also looking at Thoroughbred yearlings, this time a sample of 3,497 examined over a 15 year period, found a much larger proportion of horses to be affected. In total the author found that 77.6% of 3,497 unbroken yearlings had some degree of RLN but that not every case was of clinical significance. A smaller proportion, 2.3%, was deemed to be clinically significant. This is quite similar to the figure of 1.8% found by Sweeney et al. (1991) in their sample of 678 randomly selected Thoroughbred racehorses. Unlike the other studies (Lane et al., 1987; Lane, 2003) this sample was not composed of yearlings but instead examined older horses with a mean age of three years.

1.6.8 Cardiac Defects

Cardiac defects, or more specifically heart murmurs or arrhythmias, have been found to be very common in Thoroughbreds with various studies reporting prevalences ranging from 57.7% to 81.1% (Patteson and Cripps, 1993; Kriz et al., 2000; Buhl et al., 2005). They may vary in degrees of severity and some may disappear during exercise. Murmurs are abnormal sounds made during the different stages of the heartbeat, systolic or diastolic, or when regurgitation occurs in valves in the heart. They are classified according to the valve affected and can be heard as a result of mitral regurgitation, tricuspid regurgitation or aortic regurgitation.

Patterson and Cripps (1993) analysed a sample of 545 horses believed to be “Normal” to determine if there was a difference in the prevalence of heart murmurs between different breeds and uses. The sample included Thoroughbreds involved in National Hunt (Group 1) or Flat (Group 2) racing and competition and pleasure horses (Group 3). It was found that 68% of the horses in the sample had murmurs, with left sided systolic murmurs being the most common type of murmur in all three groups, affecting 51.7%, 55.3% and 45.2% respectively. Flat racers were most likely to have a systolic or diastolic murmur while

National Hunt horses were more likely to have valvular regurgitation. Competition and Pleasure horses were least likely to have murmurs with 43.9% free from any type of murmur. The proportion of horses affected by each type of murmur is presented in Table 1.9.

Table 1.9: Prevalence of Cardiac Murmurs and Arrhythmias in Different Breeds and Uses of Horse (Source: Patteson and Cripps, 1993)

	National Hunt Horses	*Flat Racing Horses*	*Competition and Pleasure Horses*	*All*
Number of Horses	232	85	228	545
No Murmur	22.4%	24.7%	43.9%	31.7%
Left Early Systolic Murmur	51.7%	55.3%	45.2%	49.5%
Right Early Systolic Murmur	10.3%	14.1%	4.4%	8.4%
Left Early Diastolic Murmur	22.4%	23.5%	4.4%	15.0%
Right Early Diastolic Murmur	21.6%	21.2%	2.2%	13.4%
Mitral Regurgitation	5.6%	1.2%	2.2%	3.5%
Tricuspid Regurgitation	16.4%	4.7%	3.1%	9.0%
Atrial Regurgitation	2.2%	0.0%	3.1%	2.2%
Pre Systolic Murmur	2.6%	3.5%	0.9%	2.2%
2° Atrio-Ventricular Block	28.0%	9.4%	14.9%	19.6%
Atrial Fibrillation	0.0%	0.0%	2.0%	0.6%

Kriz et al. (2000) determined the prevalence of heart murmurs to be 81.1% in a sample of 846 racehorses. It was found that a high proportion of horses had more than one murmur, 48.1% had one murmur, 24.8% had two murmurs, 6.7% had three murmurs and 0.8% had four murmurs.

It was also found that there was a significant difference between the number of affected three year olds and four year olds ($P < 0.05$). Four year olds were significantly more likely to have a heart murmur than three year olds with 28.4% and 16.1% affected respectively (Kriz et al., 2000).

In 2005, Buhl et al. examined the development of heart murmurs over an 18 month period. A sample of 103 Standardbred trotters born in 1999 was examined. The authors determined that there was a significant increase in the prevalence of this defect over the study period. It was seen to grow from 15% to 64%, however, the researchers were unable to determine if this increase was due to age or an increase in the level of training which the horses were undergoing (Buhl et al., 2005).

Young and Wood (2000) also investigated the effect of training on murmurs in 55 two year old Thoroughbreds. It was found that the prevalence of mitral valve regurgitation increased from 4/55 to 12/55, while tricuspid valve regurgitation and aortic regurgitation increased from 7/55 to 14/55 and from 0/55 to 1/55 respectively. It was possible for the authors to determine that the changes were a result of training and not age.

1.6.9 Behavioural Defects

There are a large variety of behavioural defects or stereotypies present in the equine population. A stereotypy is a repetitive behaviour which appears to have no apparent function (Waters et al., 2002). The more common ones are weaving, crib biting and box walking, however the term also encompasses defects such as self-mutilation and stall or door kicking. Stereotypies are thought to be caused by dietary deficiency, lack of stimulation, being confined to stables and being isolated from other horses (Kiley-Worthington, 1983; Luescher et al., 1991).

A number of studies have investigated the cause and prevention of behavioural defects. However, the majority of these studies are more concerned with the effects of environmental factors upon the prevalence of the defects than the actual prevalence of the defects themselves. There is considerable variation in the literature with regards to the prevalence of stereotypies. An unpublished study by McKeown and Luescher found that over 15% of domesticated horses carry out behavioural stereotypies (cited by Luescher et al., 1991). Kiley-Worthington (1983), however, estimated a much higher prevalence after observing 26% of the horses in a stud farm exhibiting stereotypies within the space of half an hour. A long term study of 225 young Thoroughbred and half bred horses found that 34.7% of the sample demonstrated behavioural defects (Waters et al., 2002).

Large variations have been observed among horses in different careers. Whereas 34.7% of racehorses have been observed to demonstrate stereotypic behaviours (Waters et al., 2002), a study on the prevalence of abnormal behaviours in dressage, eventing and endurance horses recorded prevalences of 32.5%, 30.8% and 19.5% respectively (McGreevy et al., 1995). This is in agreement with the observation of Kiley-Worthington (1983) that stereotypies are more commonly observed in Thoroughbreds than in warm-bloods. These variations are evident in Table 1.10.

Table 1.10: Prevalence of Behavioural Defects in Horses in Different Competitive Disciplines (Sources: Waters et al., 2002 and McGreevy et al., 1995)

Type of Horse	*Prevalence*	*Authors*
Racehorses	34.7%	Waters et al., 2002
Dressage Horses	32.5%	McGreevy et al., 1995
Eventing Horses	30.8%	McGreevy et al., 1995
Endurance Horses	19.5%	McGreevy et al., 1995

The most commonly observed types of behavioural defects in Thoroughbred horses are wood chewing, crib biting, weaving, box (stall) walking and box kicking (Luescher et al., 1998; Waters et al., 2002). A study based in Ontario, Canada found that approximately 12.3% of the sample demonstrated stereotypies. Crib biting was the most commonly observed stereotypy, performed by 6.8% of the Thoroughbred sample used in the study. Weaving was observed in 4.2% and box walking in 3.0% (Luescher et al., 1998).

The results of Waters et al.'s (2002) study were slightly different. They found an overall prevalence of stereotypies of 34.7%. Wood chewing was discovered to be the most common defect affecting 30.3% of the horses in the sample. Crib Biting was the second most common stereotypy, affecting 10.5% of the horses, followed by weaving and box walking.

Of particular interest to this study are the results of the research by Mills et al. (2002) who investigated the effect of age, gender and colour on the prevalence of behavioural defects in a sample of 4,061 Thoroughbred horses that passed through public auction sales. These authors found the prevalence of behavioural defects to be 5.1%. It was determined that age and gender had a significant effect on the occurrence of these defects ($P < 0.05$); however colour was not found to have a significant effect ($P > 0.05$). The age of the horses in the sample ranged from one year old to more than seven years. Two year olds were found to be the most susceptible age with 16.4% affected, while geldings more likely to be affected than either entire males or females. It was also discovered that of the horses affected with a stereotypy, 9.1% were found to suffer from two or more behavioural defects (Mills et al., 2002). The diagnosis of behavioural defects was however, on the basis of the owner's declaration, which may have affected the prevalence reported.

Luescher et al. (1998) also investigated the association between the occurrence of stereotypies and the age and sex and breed of the horses. Certain breeds were significantly more likely to have specific defects than others. Thoroughbreds were significantly more likely to be crib biters and weavers than other breeds, while Arabians were more likely to be stall walkers and Warmbloods were more likely to be stall kickers. Sex was also found to have a significant effect on the occurrence of cribbing and weaving with mares least likely to crib bite and geldings least likely to weave. It was also discovered that the prevalence of both crib biting and stall walking increased with age (Luescher et al., 1998).

1.6.10 Neurological Defects

There is currently a lack of information concerning the prevalence of defects of the nervous system such as stringhalt or wobbler syndrome in horses, with most studies available discussing the aetiology and pathogenesis of these particular defects. Several post mortem studies have however, been carried out to determine the prevalence of neurologic disease. Baker and Ellis (1981) determined a prevalence of neurologic disease of 15.8% in their sample of 480 horses and Laugier et al (2009) determined a prevalence of 12.6% in their sample of 4,319 horses.

Three variations of stringhalt have been noted in horses. One type is thought to be a result of injury or trauma to the hind legs. It has been observed worldwide and its characteristic sign is exaggerated movement of the hind legs. Another, known as Australian stringhalt, is observed in outbreaks and has been connected with the ingestion of high quantities of certain weeds containing neurotoxins. This variant of the disease has been identified in locations such as Australia, New Zealand and California. The clinical signs include, once again, exaggerated movement of the legs but also stumbling and occasionally laryngeal dysfunction (Cahill et al., 1985; Cahill and Goulden, 1992; Mayhew, 2003). A study by Cahill et al. (1985) investigating Australian stringhalt discovered that 8 out of 12 horses observed to have stringhalt were also found to have laryngeal defects. The final type, which is rarely observed, affects the fore limbs as well as the hind limbs and is possibly just a more severe form of Australian stringhalt (Mayhew, 2003). All cases are thought to be associated with damage to the peripheral nerves. There is currently no literature available detailing the prevalence of stringhalt in the population, however, a study by Tyler et al (1993) determined that 15.6% of their sample of 450 horses presented to the University of Sydney veterinary centre due to neurologic disease were affected with stringhalt.

There is also very little literature regarding the prevalence of cervical vertebral stenotic myelopathy (wobbler syndrome) in the horse. Wobbler syndrome is a disease caused by narrowing of the cervical vertebral canal which compresses the spinal cord resulting in ataxia and muscle weakness (Nout and Reed, 2003) and contributed 15.3% of the total neurological cases identified by Laugier et al. (2009) and 18.4% of the cases identified by Tyler et al (1993). The majority of studies focus on the aetiology and pathogenesis rather than the prevalence, however, Laugier et al. (2009) found that 2% of the 4,319 horses examined in their necropsy survey in France were affected. Several studies have found that males are more commonly affected than females and, that young horses are more commonly affected than older horses (Tyler et al., 1993; Levine et al., 2007; Levine et al., 2008; Laugier et al., 2009; Levine et al., 2010).

1.6.11 Papillomas and Sarcoids

1.6.11.1 Papillomas

Papillomas are the most common tumour found in young horses, usually between ages one and three years (Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Postey et al., 2007; Barrelet et al., 2010). They are caused by Equine papillomavirus 1 and 2 (Murphy et al., 1999; Barrelet et al., 2010) and usually regress spontaneously within approximately nine months as the animal builds up immunity to them (Murphy et al., 1999; Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Postey et al., 2007; Barrelet et al., 2010). Papillomas can be found anywhere on the body, however, the most frequent sites are around the nose and lips (Murphy et al., 1999; Barrelet et al., 2010). Papillomas can cause problems if they are located in an area that interferes with tack; otherwise they are perceived as primarily an aesthetic problem.

1.6.11.2 Sarcoids

Sarcoids are common, locally aggressive fibroblastic skin tumours (Murphy et al., 1999; Knottenbelt, 2005; Postey et al., 2007; Barrelet et al., 2010). They occur predominantly on the head, neck, legs and ventral body (Angelos et al., 1988; Postey et al., 2007; Barrelet et al., 2010). Unlike papillomas, sarcoids do not spontaneously regress and usually persist for life, having a high rate of recurrence after removal (Angelos et al., 1988; Murphy et al., 1999; Postey et al., 2007; Barrelet et al., 2010). They are believed to be caused by Bovine papillomavirus 1 and 2 (Murphy et al., 1999; Barrelet et al., 2010) and can appear similar to papillomas, sometimes making it difficult to differentiate between the two (Postey et al., 2007). Similar to papillomas, sarcoids can cause problems if they are located in an area that interferes with tack. The exact prevalence of sarcoids is unknown however, it is reported that the prevalence ranges from 1–8% worldwide (Knottenbelt, 2005). Angelos et al. (1988) determined a prevalence of 0.7% in Thoroughbred horses in their mixed breed sample of 16,242 horses in New York. They also determined that Thoroughbreds had a significantly higher risk of developing sarcoids than Standardbreds, but a significantly lower risk than Quarter Horses and Appaloosas. It is unclear how sarcoids affect the horse, however, it has been noted that the successful removal of sarcoids can lead to improved behaviour and performance in the horse (Knottenbelt, 2005).

1.7 Effect of Commonly Reported Defects on Performance

Racehorses are bred to win races. Therefore it is important that they perform to the best of their ability. Musculoskeletal defects may impede their performance to varying degrees. As stated previously, pre-purchase examinations are provided as a means of identification of the defects present in the horse for the prospective purchaser. However, it is not clear whether some of the defects that may be listed on the certificate are likely to affect the performance of the horse. A number of studies have been performed investigating the connection between various defects and performance. However there is a large dearth of information still, regarding the effect, if any, on the impact of defects on athletic performance.

1.7.1 Most Common Performance Affecting Defects

Many of the studies regarding performance affecting defects are general studies investigating the causes of poor performance rather than whether or not specific defects cause poor performance. As is evident from Table 1.11 below, Jeffcott et al. (1982) found lameness, respiratory problems, colic and dermatological conditions to affect racing performance in a study on 314 Thoroughbred horses aged between two and six years during 1980. Unfortunately it is not possible to establish the full extent of horses affected by respiratory problems or colic as prevalences were not recorded for the entire study sample. However, lameness was found to affect 163 of the 314 horses in the sample and dermatological problems were found to affect 28 of the horses.

Table 1.11: 10 Most Common Reasons for Interruption to Training/Days Lost as Discovered in a Variety of Studies

Study	*Jeffcott et al., 1982*	*Bailey et al., 1999*	*Knight and Evans, 2000*	*Hernandez and Hawkins , 2001*
N	314	160	541	40
1	Lameness	Lacerations or Traumatic Injury	Fresh Leg and Foot Injuries	Lameness
2	Respiratory Problems	Coughs and Nasal Discharge	Lameness	Planned Training Failure
3	Retired or Sold	Increased Metacarpal/ Metatarsal III Sensitivity	Sacroiliac Pain	Respiratory Disease
4	Convalescence	Carpal Problems	Poor Recovery	Equine Protozoal Myeloencephalitis
5	Colic	Fetlock Problems	Exercise Induced Pulmonary Haemorrhage (EIPH)	Ringworm
6	Dermatological Problems	Miscellaneous Lameness	Respiratory Infection/ Discharge	Rain
7	-	Foot Problems	Gluteal Pain	Cribbing Surgery
8	-	Pyrexia	Unilateral Nasal Haemorrhage	Girth Injury
9	-	Ligament Sprain	Mouth Injuries	Other Causes
10	-	Sesamoid Problems	Synchronous Diaphragmatic Flutter	Colic

An Australian study investigated a sample of Thoroughbred horses in training (Bailey et al., 1999b). During the period studied, 2.7% of the total available training days were lost due to injuries or disease. Of the 160 horses examined, 42% were found to have increased sensitivity on the dorsal aspect of the metacarpal or metatarsal III bone. This was the most commonly observed defect, followed by fetlock problems (25%), coughs and nasal discharges (16%), lacerations or traumatic injuries (13%) and foot defects (9%).

Knight and Evans (2000) conducted a study on 541 poorly performing Standardbred horses in Australia. Defects were found to be present in 264 of these horses. Fresh leg and foot injuries were the most common reason for poor performance and represented 26.6% of all defects detected. Lameness was the second most common reason for poor performance affecting 11.1% of the horses and representing 21.8% of all defects detected. Other defects such as exercise induced pulmonary haemorrhage (EIPH), respiratory infections, mouth injuries and fractures were also found to affect the performance of the horses (Knight and Evans, 2000).

Lameness was also the most common reason for lost training days in a study investigating training failure among a relatively small sample of 40 Thoroughbred yearlings, with a total of 518 days lost (Hernandez and Hawkins, 2001). The second most common reason for lost training days was planned training failure, that is, defects detected on pre-purchase examinations that required surgery to correct. Respiratory disease was the third most common reason with 126 days lost while other defects such as ringworm and colic were also causes of lost training days.

Morris and Seeherman (1991) conducted a study investigating the poor performance of 275 racehorses. This study only investigated two different categories of defects, respiratory and musculoskeletal. Anything that did not fall into these categories was simply termed “other”. It was found that the majority of horses (202) were affected with musculoskeletal defects and, of these, more than two thirds were affected in two or more locations. Respiratory defects were found to affect 66 of the horses in the sample while 15 of the horses were found to have other defects. The study found that 84% of the horses were found to be suffering from more than one defect which they felt implied that poor performance is caused more so by a combination of factors rather than a single defect (Morris and Seeherman, 1991).

Rossdale at al.’s (1985) study also examined Thoroughbred racehorses; however, their study examined loss of training days rather than poor performance. Five hundred and eighty one horses with a total of 114,919 training days were examined in this study. Of these 9,826 were lost as a result of injury or disease. Lameness accounted for the loss of 6,649 days and respiratory problems were responsible for 2,016 days. The remaining 1,161 lost training days were from a combination of defects including wounds, infections and ocular injuries.

Vigre et al. (2002) examined the reasons for interruption in training in a sample of 265 Danish Standardbred trotters. The study focused primarily on lameness, but also included information on other defects. The conditions most likely to interrupt the horses' training were lameness, respiratory diseases and muscular problems. These were found to occur in 31.7%, 6% and 2.6% of the sample respectively (Vigre et al., 2002).

Other studies have investigated the effect of specific defects on performance. While these studies are useful, they have a number of shortcomings. They study a relatively small sample of horses in unique training environments. Secondly, they report on a variety of infectious and traumatic conditions that may have arisen as a result of the training environment rather than from any inherent defects (Jeffcott et al., 1982; Reef, 1995; Bailey et al., 1999b; Knight and Evans, 2000; Strand et al., 2000; Hernandez and Hawkins, 2001; Stick et al., 2001; Brown et al., 2005; Marr, 2005; Kikuta et al., 2006). Although these studies found that various defects affected the training of the horses they did not ascertain whether or not horses with certain defects were less likely to perform well than horses without these defects. Nor did they determine if musculoskeletal defects contributed to these defects.

1.7.2 Effect of Musculoskeletal Defects on Performance

Lameness is a frequently observed problem that affects the performance of horses (Kaneene et al., 1997; Bailey et al., 1999; Vigre et al., 2002). Lameness may be as a result of trauma, it may also be due to bad conformation or a variety of musculoskeletal defects. Unfortunately there is very little literature available concerning the association between these musculoskeletal defects and poor performance in the horse. Nevertheless it is believed that defects such as tarsal plantar desmitis (Brokken, 1978; Ross et al., 2002; Major and Zubrod, 2006), metacarpal/metatarsal exostoses (Rossdale et al., 1985), OATJ (Brokken, 1978; Moyer et al., 1983) and hoof cracks (Wilson and Pardoe, 1998; Pardoe and Wilson, 1999; O'Grady, 2001a; O'Grady, 2001b) can cause lameness and may be performance limiting. Although these authors invariably state that these defects can be performance limiting, no proof of this is offered.

There are however, many studies that associate lameness with poor performance (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002; Ross, 2003). Lameness is widely reported to be the most common reason for poor performance (Ross, 2003) and loss of training (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002).

1.7.3 Effect of RLN on Performance

RLN is recognised as a performance limiting defect (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006). A number of studies have investigated the effect of RLN on athletic performance (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006; Garrett et al., 2010). Racing performance was found to be significantly affected by the severity of RLN in a study examining 294 affected Thoroughbred racehorses (Kikuta et al., 2006). The degree of paralysis was categorised into three groups, with 1 being slight paralysis and 3 being total paralysis. There was found to be significant differences between groups 1 and 3 and groups 2 and 3 with group 3 horses less likely to return to racing after diagnosis, running fewer races and being more likely to finish 4/5 seconds or more behind the winning horse ($P < 0.05$).

Stick et al. (2001) also investigated the effect of RLN on performance. The study examined the racing results of 427 Thoroughbred yearlings that were examined endoscopically at the Keeneland 1996 September Yearling Sales. Laryngeal function was graded from 1 to 4, with grade 1 being no paralysis and 4 representing total paralysis. It was found that there was no significant difference between the groups with regards to starting a racing career, however, there were significant differences ($P < 0.05$) between grades 1 and 2 versus grades 3 and 4 for several of the analysed performance variables, indicating that the more severe levels of RLN had a negative impact on performance. Unfortunately, the study does not state which of the variables were significantly affected. A similar study, investigating a large sample of Thoroughbred yearlings (n = 2,954) using a similar grading scheme, was undertaken in 2010 (Garrett et al., 2010). It was found that horses with grade 3 paralysis had significantly fewer starts and significantly less earnings than horses with grades 1 or 2.

As is evident from the above studies, the more pronounced levels of RLN have a negative effect on performance. For this reason a number of surgical techniques have been developed in order to attempt to alleviate this problem such as nerve transplants, nerve anastomosis and neuromuscular grafts. However, the most commonly used procedure is still prosthetic laryngoplasty (Strand et al., 2000). Several studies have been conducted to investigate if prosthetic laryngoplasty improves the racing performance of horses with RLN (Strand et al., 2000; Kikuta et al., 2006; Barakzai et al., 2009), each with similar findings. Strand et al. (2000) conducted a study investigating the difference in performance before and after laryngoplasty surgery was performed. It was found that there was a significant difference between the racing speed in the race immediately before surgery and the races after surgery ($P < 0.001$). It was also found that there was no difference between the racing performance six months before surgery and the racing performance after surgery (Strand et al., 2000). Kikuta et al. (2006) also investigated the effect of laryngoplasty surgeries. This study analysed the difference between horses with Grade 3 RLN which did, or did not, have a laryngoplasty performed. It was found that horses which had a laryngoplasty performed were significantly more likely to return to racing ($P < 0.05$), ran significantly more races ($P < 0.05$) and had significantly better race results ($P < 0.05$) than those which did not have surgery (Kikuta et al., 2006).

Barakzai et al. (2009) used a different procedure to determine the effect of prosthetic laryngoplasty on racing performance. Horses with laryngoplasty were matched for age and sex with control horses that were not operated on. It was discovered that prosthetic laryngoplasty improved the racing performance of RLN affected horses. Controls were more than ten times as likely to race as horses with RLN before surgery, however, after prosthetic laryngoplasty both groups were just as likely to race. Similarly, controls earned significantly more than affected horses before surgery, while after surgery there was no significant difference between the groups.

1.7.4 Effect of Cardiac Defects on Performance

Heart murmurs, or valvular regurgitation, can be present in varying degrees of severity and in different regions in the heart. The more severe murmurs can be performance limiting.

However horses affected with less severe murmurs may have no clinical signs beyond the murmur itself (Reef, 1995; Marr, 2005).

Kriz et al. (2000) divided a sample of 846 Thoroughbred racehorses into groups according to the presence or absence of murmurs, and also according to the degree and location of the murmur. There was no significant difference for starts per horse per race season, mean weight carried, mean distance raced, mean number of wins, mean win score, mean number of points and mean point score between any of the groups. These results are in agreement with the findings in Standardbred horses. Buhl et al (2005) examined a sample of 132 two-year old Standardbred trotters in training over a period of 18 months and found that valvular regurgitation had no effect on the racing performance, kilometre time, total earnings or percentage of wins. Although no effect was observed in this age group the authors were unwilling to rule out the possibility of valvular regurgitation decreasing the performance of older horses (Buhl et al., 2005). Similarly, Young et al. (2008) found no significant associations between murmurs or valvular regurgitation and performance. These authors investigated the performance of 526 Thoroughbred racehorses of varying ages. Interestingly, it was discovered that there was a positive correlation between aortic regurgitation and performance in hurdle races and in steeplechases. This indicates that horses with more severe aortic regurgitation were more likely to perform well than those with lower grades of regurgitation.

As discussed in a previous section, Young and Wood (2000) investigated the effect of training on murmurs in young Thoroughbreds. As there was in increase in the prevalence of murmurs in the sample undergoing training and no change in the prevalence of murmurs in the control group it was apparent that the noted changes were as a result of training and not of age.

1.7.5 Effect of Other Defects on Racing Performance

Very little research has been conducted to determine the effect of dental or ocular defects on racing performance. It is however commonly accepted that they do negatively affect performance. Dental defects can affect performance in two ways. They can cause oral discomfort or pain, resulting in head shaking or bit evasion, which takes the horses concentration away from performance (Lane, 1994; Scoggins, 2001; Bryant, 2004) and they can also result in mastication problems which may result in inadequate nutrition and loss of condition (Ford, 1960; Lane, 1994; Linkous, 2005). Wolf teeth are an example of a dental defect which is seen as undesirable in horses. They can interfere with the action of the bit causing pain to the horse (Linkous, 2005), resulting in reduced performance.

Vision is very important in a racehorse allowing them to see the fences, railings and other horses. If the vision is impaired this could be detrimental to their success. Rossdale et al. (1985) found that ocular injuries caused lost training days, which may in turn have affected the likelihood of the horses racing.

1.7.6 Association between Purchase Price and Racing Performance

Thoroughbred horses with good pedigrees and conformation routinely achieve higher prices at sales. It is therefore to be expected that the more expensive horses are better race horses; however, this is not always the case. Some of the most expensive horses ever purchased have proven to be poor performers on the track, while others bought for relatively low prices at sale have gone on to win some of the toughest races. Several studies have therefore been conducted in order to investigate the association between racing performance and purchase price (Robbins and Kennedy, 2001; Jackson et al., 2011). It was found that as price increased so too did the probability of winning a stakes race (Robbins and Kennedy, 2001), the number of starts, and the prize money earned (Jackson et al., 2011).

Jackson et al. (2011) studied a relatively large sample of 2,773 Thoroughbred yearlings in Australia to investigate the association between purchase price and performance. They found that as purchase price increased so too did the likelihood of horses racing, the number of starts and the number of places ($P < 0.001$). An earlier study by Robbins and Kennedy (2001) investigated a sample of 1,316 Thoroughbred horses in British Columbia. It was found that as price increased so too did the probability of winning a stakes race. These results indicated that while price is not always an accurate predictor of racing potential, buyers do, in general, know what kind of horse is more likely to prove successful on the racetrack and therefore the price increases accordingly.

1.8 Heritability

Heritability can be defined as the "degree to which a given trait is controlled by genotype or the proportion of total phenotypic variation that is attributable to additive genetic variation" (Bowling and Ruvinsky, 2000). Currently, the majority of studies regarding equine heritability traits focus on conformation traits or performance traits with very little research available concerning abnormal conditions or defects in the equine population. Conformation and performance traits are used to select horses for breeding and racing (Dolvik and Klemetsdal, 1999). If more was known about the heritability of defects these too could be used to select mares and stallions for breeding purposes.

1.8.1 Heritability of Anatomical or Conformational Defects

As stated previously, few studies have focused on the prevalence of defects or conditions present in horses; and of these, very few have undertaken to estimate heritability values. Instead, they have compared the prevalences of conditions observed in the progeny of stallions affected by the condition, with the prevalences observed in the progeny of unaffected stallions.

RLN has long been suspected to be a genetically influenced condition (Quinlan and Morton, 1957; Poncet et al., 1989). Several studies have been conducted to investigate this hypothesis. While it has been somewhat established that it is genetically linked it has also been proposed that it may be a predisposing conformation, such as a long neck, that is inherited rather than the condition itself (Quinlan and Morton, 1957).

An early study (Quinlan and Morton, 1957) investigating the heredity of RLN in horses aimed to breed horses from two groups of sires, those affected with RLN (n=9) and those which were unaffected and did not, bar one, have affected ancestors within the 4th generation (n=14). Unfortunately, this study was interrupted before completion. However, some conclusions could still be drawn from it. It was found that the progeny of the suspected sires were more likely to be affected than the progeny of the control sires, with average saturations of 50 and 12.375 respectively. More recent studies have since been conducted using similar methods, however, without the use of a specialised breeding programme as was used by Quinlan and Morton (1957).

Poncet et al. (1989) conducted a study to investigate the possible genetic basis of RLN in horses. Their study compared the prevalence of RLN between two groups, one group containing 47 progeny of a sire known to be affected with RLN and the other containing a control sample of 50 horses. It was found that there was a significant difference between the numbers affected in each group ($P < 0.05$) with 47% of the first group having asymmetry or paralysis of the larynx compared to only 10% of the control group (Poncet et al., 1989). Ohnesorge et al. (1993) used a similar method and produced similar results during their examination of 1,046 horses. This sample was composed of 24 stallions, their offspring, which included 240 foals and 474 adult horses, and 308 dams of horses in the sample. It was found that the progeny of affected parents were significantly more likely to have RLN than the progeny of the unaffected parents. Forty-one percent of the foals and 60.9% of the adult horses with affected parents were affected with RLN compared to 8.9% of the foals and 39.6% of the adult horses with unaffected parents. Ohnesorge et al. (1993) also found positive correlations to exist between the occurrence of respiratory noise and RLN. The authors examined 120 horses laryngoscopically and found that 54.3% of the horses affected with RLN produced an respiratory noise and that 80.9% of the horses producing an respiratory noise had RLN.

More recent studies have been conducted using more advanced methods and have been successful in determining heritability estimates (h^2) for RLN (Miesner, 1996; Ibi et al., 2003). There is, however, huge variation between the results generated. Miesner (1996) estimated a heritability value of 0.61 with a standard error of 0.17 using the same sample set as Ohnesorge et al. (1993). This is much higher than the values calculated by Ibi et al. (2003) of 0.23 and 0.20 for the binary and categorical RLN traits. A sample of 706 Thoroughbreds aged between two and five years old were analysed in this study. While these studies do indicate that RLN is heritable, it is evident by the disparity in the results that further research is necessary in this area.

While a number of studies have been conducted investigating the heritability of RLN, several studies have also been conducted investigating the heritabilities of a number of other conditions. A Norwegian study on the heritability of lameness examined a random sample of 265 horses (Dolvik and Gaustad, 1996). All of the horses were three year old Standardbred trotters. Analysis was performed comparing the prevalence of lameness among the groups of progeny of different stallions and it was determined that a significant difference existed between the groups of progeny (P = 0.05). Further analysis determined that the heritability estimate of the bivariate variable lame/sound was 0.33 (Dolvik and Gaustad, 1996). As stated previously, there are certain predisposing factors that may result in lameness such as metacarpal/metatarsal exostoses, tarsal plantar desmitis and OATJ. It is believed that these defects also have a heritable component (Quinlan and Morton, 1957), however, this has not yet been demonstrated.

Behavioural defects have also been found to have a heritable component. Galizzi Vecchiotti and Galanti (1986) compared the prevalence of cribbing, weaving and box-walking in a sample of 1,035 Thoroughbred horses with the prevalences observed in families containing horses known to be affected. The prevalence of each defect was much higher in the families containing the affected horses than in the sample population. Cribbing was present in 2.4% of the sample compared to 30% for the relatives of the known affected horses, weaving affected 2.5% of the sample compared to 26% of the known affected horses families and box-walking affected 2.5% of the sample compared to 13% of the known affected horses relatives. Although the authors did not estimate any heritability values for these conditions, it is apparent from their results that behavioural conditions are, at least, in some part heritable.

1.8.2 Heritability of Conformation

The heritability of conformation traits has been looked at extensively in recent years (Preisinger et al., 1991; Dolvik and Klemetsdal, 1999; Gerber Olsson et al., 2000; de Groot et al., 2002; Wallin et al., 2003; Love et al., 2006; Stock and Distl, 2006; Ducro et al., 2007; Albertsdóttir et al., 2008; Olsson et al., 2008; Ducro et al., 2009). A wide range of heritability estimates have been found within these studies ranging from 0.0 to 1.0. The majority of the estimates ranged from 0.2 to 0.4.

The reason for the wide range of estimates is possibly due to the differing samples and methods used to generate these values. Many of the studies were carried out using data from Studbook Inspections or Stallion Tests (Gerber Olsson et al., 2000; de Groot et al., 2002; Wallin et al., 2003; Stock and Distl, 2006; Ducro et al., 2007; Olsson et al., 2008; Ducro et al., 2009) while others selected the horses to be examined for the study (Preisinger et al., 1991; Dolvik and Klemetsdal, 1999; Love et al., 2006). The heritability estimates for conformation in those studies examining data generated at Stallion Tests and Studbook Inspections were more similar than those in the other studies. They also generally estimated values for conformation as a whole rather than for individual conformation traits.

Those studies generating estimates for conformation as a whole (Gerber Olsson et al., 2000; Wallin et al., 2003; Stock and Distl, 2006; Olsson et al., 2008) found a range of values between 0.23 and 0.33. The range of heritability estimates was more extensive when individual traits were examined. Albertsdóttir et al. (2008) collected data from breeding field tests for Icelandic horses. The authors examined a range of conformational traits including head, mane and tail, back and withers and leg stance (posture/position of leg). The highest heritability estimate was 0.67 for height of withers while the lowest was for leg quality, 0.22. A more recent study (Ducro et al., 2009), this time examining Dutch Warmblood horses, also found a heritability estimate of 0.67 for wither height. Lower estimates were found for the traits relating to leg and hoof, these ranged from 0.12 to 0.24.

Dolvik and Klemetsdal (1999) examined a sample of 508 Standardbred Trotters born in 1980. All were examined by one veterinarian for a range of conformation traits. The heritability estimates of these traits ranged from 0.00 to 0.73. Similar to the previously discussed studies the highest estimate (0.73) was for height at withers. Various other conformational traits were examined with some proving to have no heritable components (h^2=0.00), such as toed in forelimbs, while others such as "curby hocks" proving to be in some part heritable (h^2=0.40). A study examining the heritability of musculoskeletal conformation traits in 3,916 Thoroughbred yearlings found a very high heritability estimate of 1.0 for the conformational trait "tied below knee" (Love et al., 2006). This value indicates that this trait is very strongly genetically influenced. Love et al. (2006) also found high heritability estimates for the "trait back at the knee", 0.66. Unlike the previously discussed studies, Love et al. (2006) and Dolvik and Klemetsdal (1999) estimated the heritability of conformational defects rather than just conformational traits.

An earlier study, by Hintz et al. (1978) investigated heritability estimates for weight, height and front cannon bone circumference in horses at different ages. The sample used measurements, taken monthly, from 1,992 foals born on a Thoroughbred stud farm over a 19 year period, until they were approximately 715 days old. It was found that as the age of the horses increased so did the values of the heritability estimates. The h^2 value for weight was found to be 0.21 when the animals were between 0 and 44 days, however, this increased to 0.90 when they were aged between 450 and 715 days. The same was seen to apply for height at withers and for cannon bone circumference.

1.8.3 Heritability of Performance

During performance testing, values are commonly awarded to the animal for their different gaits, walk, trot and canter/gallop. Several studies have used these values to determine heritability estimates for these traits (Gerber Olsson et al., 2000; Wallin et al., 2003; Ducro et al., 2007; Albertsdóttir et al., 2008; Olsson et al., 2008). Studies by Gerber Olsson et al. (2000) and Wallin et al. (2003) both estimated heritability values for gaits as a single trait. The authors estimated values of 0.43 and 0.27 respectively. More specific heritability estimates were generated for each of the gaits individually. Heritability estimates (h^2) for walk ranged from 0.20-0.46, h^2 values for trot ranged from 0.23 to 0.50 and h^2 values for canter or gallop from 0.17 to 0.42 (Gerber Olsson et al., 2000; Wallin et al., 2003; Ducro et al., 2007; Albertsdóttir et al., 2008; Olsson et al., 2008).

Several of these studies have also estimated heritability values for jumping (Gerber Olsson et al., 2000; Wallin et al., 2003; Ducro et al., 2007; Olsson et al., 2008). Values ranged from 0.18 to 0.65. Gerber Olsson et al. (2000) and Wallin et al. (2003) looked at jumping as a single trait. Gerber Olsson et al. (2000) estimated a heritability of 0.43 for the jumping trait scored during the stallion performance test but a much lower estimate of 0.17 for the jumping trait scored during the riding horse quality test while Wallin et al. (2003) found a similar estimate of 0.18 for the trait scored during the field testing of four year old Swedish Warmblood riding horses. Gerber Olsson et al. (2000) and Olsson et al. (2008) investigated several different types of jumping traits: free jumping, jumping under rider and the temperament and general appearance of the horse during free jumping and jumping under rider. Free jumping (h^2=0.47), and jumping under rider (h^2=0.32) had the highest heritability estimates respectively. Ducro et al. (2007) investigated jumping related traits: balance, take off, technique and power. Power was found to have the highest heritability estimate with a value of 0.61.

Heritability estimates have also been determined for a range of other performance related traits including earnings, race times and rankings in both Arabian (Belhajyahia et al., 2003; Ekiz and Kocak, 2005; Ekiz et al., 2005a) and Thoroughbred horses (Ekiz et al., 2005b). The heritability of race times was estimated by Ekiz and Kocak (2005) and Ekiz et al. (2005b) to be 0.28 and 0.32, respectively. The heritability of race times was also found to vary from 0.18 to 0.30 depending on the length of the race with shorter distance races having higher heritability values (Ekiz et al., 2005a). There was a large variation between the heritability estimates for earnings reported by Ekiz et al. (2005b) and Belhajyahia et al. (2003). The authors found the heritabilities to be 0.19 and 0.09 respectively. Their heritability estimates were closer with regards to ranking, 0.13 and 0.12 respectively, however this was at variance with the estimate from the study by Ekiz and Kocak (2005) which reported a value of 0.07.

1.8.4 Genetic Correlations

Albertsdóttir et al. (2008) and Ducro et al. (2009) calculated genetic and phenotypic correlations to determine if relationships existed between the various conformational traits examined in their studies. Albertsdóttir et al. (2008) examined the conformation traits of a sample of Swedish Warmblood horses. The authors determined that a positive genetic correlation of 0.69 was present between the "proportions" of the horse and the neck, withers and shoulders. The strongest phenotypic correlation existed between the same traits with a value of 0.47. Ducro et al. (2009) examined a variety of hoof conformation traits in a sample of Icelandic horses and established a range of genetic correlations between -0.58 and 0.50 and a range of phenotypic correlations between -0.25 and 0.25. Limb quality and bone circumference were negatively correlated with a value of -0.58 while the strongest positive genetic correlation existed between hoof shape and bone circumference with a value of 0.50. Correlations between the various conformation traits and the horses' rankings in competition were also examined by Ducro et al. (2009). Jumping ranking was found to be most strongly genetically correlated with limb quality (0.20) and most strongly phenotypically correlated with heel height (0.20). The traits with the strongest genetic and phenotypic correlations for the dressage ranking were limb quality (0.36) and height at withers (0.14), respectively.

In addition to investigating correlations between the different conformational traits Albertsdóttir et al. (2008) also investigated the relationship between conformational traits and the gaits of the horses. Walk was most strongly genetically correlated with leg quality with a value of 0.26 while trot was most strongly genetically correlated with "back and hindquarters" and hooves, both with a value of 0.20. The trait with the strongest genetic correlation with gallop was "neck, withers and shoulders" with a correlation of 0.44.

Not only are gaits correlated with conformational traits, they have also been shown to be correlated with each other (Gerber Olsson et al., 2000; Albertsdóttir et al., 2008; Olsson et al., 2008). Trot and canter/gallop were found to be more strongly correlated than walk and trot or walk and canter with values ranging from 0.62-0.71. This was followed by walk and trot with correlations ranging between 0.29 and 0.34. Walk and canter/gallop had the lowest correlations, with values ranging from 0.11-0.30, which is interesting as buyers at Thoroughbred yearling auctions look at the animal's walk as it is felt that the walk is a good indicator of the gallop.

Gerber Olsson et al. (2000) also investigated the relationship between gaits and jumping ability. Gallop was found to be most strongly genetically and phenotypically correlated with both loose jumping and jumping with a rider. Genetic correlation values of 0.40 and 0.54 were found for each of these traits, respectively, while phenotypic values of 0.31 and 0.37 were observed, respectively. Interestingly, walk was found to be more genetically correlated with jumping than trot (0.27 and 0.21 versus 0.24 and 0.14). These figures are at variance with those calculated by Ducro et al. (2007) who found walk and trot to be negatively correlated with jumping with values of -0.45 and -0.36, respectively. Canter was found to be positively correlated with jumping; however, the correlation was very low (0.06). Take-off was the most strongly correlated trait with jumping while technique and power were also found to be highly genetically correlated with jumping, with all falling within the range of 0.81 and 0.92. Ducro et al. (2007) also investigated the relationship between dressage and the different gaits. Walk was the trait most strongly correlated with dressage, with a genetic correlation value of 0.72. Trot, canter and balance were all positively correlated with dressage whilst each of the jumping traits mentioned above were negatively correlated with dressage.

Wallin et al. (2003) also investigated correlations between various traits and dressage and show jumping. The authors determined that the strongest correlation with dressage was the temperament of the horse on the flat, 0.75, followed closely by the gaits of the horse, 0.74.

Very strong genetic correlations were found to exist between show jumping and temperament while jumping, and show jumping and jumping, with values of 0.93 and 0.88, respectively.

1.9 Summary

1.9.1 Musculoskeletal Defects

There is currently no information available regarding the prevalence of musculoskeletal defects such as metacarpal/metatarsal exostoses, tarsal plantar desmitis, SDDTS, calcaneal, olecranon and carpal bursitis, CSTJ, OATJ and SDTDTS. It is believed that metacarpal/metatarsal exostoses, tarsal plantar desmitis and OATJ may have a heritable component (Quinlan and Morton, 1957), however, this has not yet been demonstrated. It is also believed that tarsal plantar desmitis (Brokken, 1978; Ross et al., 2002; Major and Zubrod, 2006), metacarpal/metatarsal exostoses (Rossdale et al., 1985), OATJ (Brokken, 1978; Moyer et al., 1983) and hoof cracks (Wilson and Pardoe, 1998; Pardoe and Wilson, 1999; O'Grady, 2001a; O'Grady, 2001b) may be performance limiting, however, no proof of this is offered.

1.9.2 Lameness

There are many studies that associate lameness with poor performance (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002; Ross, 2003). Lameness is widely reported to be the most common reason for poor performance (Ross, 2003) and loss of training (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002). Several studies have investigated the prevalence of lameness using varying techniques. A range of 11-13% was found in surveys of health problems in horses (Cole et al., 2005; Knight and Thomson, 2011) while a much higher range of 52.8-55.2% was found in pre-purchase examination studies (Dart et al., 1992; van Hoogmoed et al., 2003). A Norwegian study on the heritability of lameness examined a random sample of 265 three year old Standardbred trotters (Dolvik and Gaustad, 1996) and determined that the heritability estimate of the bivariate variable lame/sound was 0.33. There appears to be no more recent literature available regarding the heritability of lameness.

1.9.3 Ocular Defects

Ocular defects have been found to affect 4.2% of the sample in a general study of owner reported health disorders (Cole et al., 2005), however, much higher prevalences were discovered when horses were examined specifically for ocular defects with prevalences ranging from 48% to 67.6% (Ramsey et al., 1999; Hurn and Turner, 2006). Rossdale et al. (1985) found that ocular injuries caused lost training days, which may in turn have affected the likelihood of the horses racing, however, beyond this very little is known regarding the extent of the effect of ocular defects on racing performance. There are currently no heritability estimates for ocular defects in the horse.

1.9.4 Dental Defects

A range of prevalences for dental defects, 38.6% to 80%, have been documented to date (Uhlinger, 1978; Kirkland et al., 1994; Pimentel et al., 2007), however, very little research has been conducted to determine the extent of the effect of dental defects on racing performance. It is however, commonly accepted that they do negatively affect performance (Lane, 1994; Scoggins, 2001; Bryant, 2004; Linkous, 2005). There are currently no heritability estimates for dental defects in the horse.

1.9.5 Recurrent Laryngeal Neuropathy

RLN has been found to affect between 1.0% and 3.3% of horses (Raphel, 1982; Lane et al., 1987; Sweeney et al., 1991) and is recognised as a performance limiting defect (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006). Horses with RLN have been found to run in fewer races (Kikuta et al., 2006; Garrett et al., 2010) and to have significantly less earnings than horses without RLN (Garrett et al., 2010). Widely varying h^2 values have been estimated for RLN by Miesner (1996) and Ibi et al. (2003). Meisner (1996) estimated a h^2 value of 0.61 while Ibi et al. (2003) estimated h^2 values of 0.23 and 0.20 for the binary and categorical RLN traits.

1.9.6 Heart Murmurs

Heart murmurs have been found to be present in between 57.7% and 81.1% of horses (Patteson and Cripps, 1993; Kriz et al., 2000; Buhl et al., 2005) and to have no negative effect on racing performance (Kriz et al., 2000; Buhl et al., 2005; Young et al., 2008). There are currently no heritability estimates for heart murmurs in the horse.

1.9.7 Behavioural Defects

Behavioural defects have been found to affect between 5.1% and 34.7% of horses (Kiley-Worthington, 1983; McKeown and Luescher, 1989; McGreevy et al., 1995; Luescher et al., 1998; Mills et al., 2002; Waters et al., 2002). Although there are no known heritability estimates for behavioural defects it has been found that families of affected horses showed higher prevalences of behavioural defects than were found in the sample population (Galizzi Vecchiotti and Galanti, 1986). The level to which behavioural defects affect racing performance in horses is currently unknown.

1.9.8 Neurological Defects

Defects of the nervous system have been found to affect 12.6-15.8% of horses (Baker and Ellis, 1981; Laugier et al., 2009). The prevalence of stringhalt is currently unknown, however, wobbler syndrome was found to affect 2% of horses in a large sample in France (Laugier et al., 2009). No studies have been conducted to determine the effect of stringhalt or wobbler syndrome on racing performance or to determine heritability estimates for these defects.

1.9.9 Papillomas and Sarcoids

The prevalence of papillomas is currently unknown, however, sarcoids are reported to have a prevalence of 1-8% worldwide (Knottenbelt, 2005). No studies have been conducted to determine the effect of papillomas or sarcoids on racing performance or to determine heritability estimates for these defects. It has however, been noted that the successful removal of sarcoids can lead to improved behaviour and performance in the horse (Knottenbelt, 2005).

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Chapter 2

Anatomical Defects in National Hunt Horses Presented at Sale

Abstract

This study investigated the prevalence of some anatomical defects in a large sample of horses presented for sale. The study comprised information concerning 13,603 three and four year old Thoroughbred National Hunt horses. The information was gathered using the pre-purchase veterinary examination certificates from eight years of Tattersalls Ireland's Derby Sale, Goffs Ireland June Sale and Doncaster Bloodstock Sales Ltd. (DBS) Spring Sale (2002-2009) and seven years of Tattersalls Ireland's August Sale (2002-2008). All conditions noted by the veterinarian were recorded in order to determine the true prevalence of defects in this National Hunt population.

It was found that 73.58% of the sample population had one or more defects recorded with 12.02% having defects likely to prejudice their use for racing. Metacarpal/metatarsal exostoses and tarsal plantar desmitis affected 17.11% and 19.40% of the sample, respectively, while 9.81% of the horses were found to make abnormal respiratory noises and 5.26% had recurrent laryngeal neuropathy (RLN). Age had a significant effect upon the prevalence of many of the defects, with four year olds being significantly more likely to have defects, prejudicial defects, respiratory noises and metacarpal/metatarsal exostoses than three year old horses ($P < 0.05$). Year of birth had a significant effect on the prevalence of certificates with no defects, prejudicial defects, respiratory noise, RLN and metacarpal/metatarsal exostoses ($P < 0.05$). The proportion of certificates with no defects rose significantly ($P < 0.05$) from 1998 to 2006, while prejudicial defects, respiratory noise and RLN decreased significantly over the same period. Sex also had a significant effect on the prevalence of several of the defects with fillies more likely to have synovial distension of the digital tendon sheath (SDDTS), calcaneal bursitis and sand cracks than geldings ($P < 0.05$). Geldings were more likely to have tarsal plantar desmitis and dental defects than fillies. Geldings were also significantly more likely to be sold than fillies ($P < 0.05$).

There was also a significant difference in the prevalence of horses with defects between the horses which were sold and unsold with the unsold horses significantly more likely to have prejudicial defects, respiratory noise, RLN and cardiac defects ($P < 0.05$). Six per cent of the sample were withdrawn prior to sale. These horses had been examined by the veterinary panel and had pre-purchase examination certificates. It was found that 83.56% of these withdrawn horses had prejudicial defects, with 55.09% having abnormal respiratory noises and 41.72% having RLN. Lameness was noted in 13.01% of these horses and 7.24% were found to have cardiac defects. By comparison only 6.3% of horses that were sold had prejudicial defects and 6.7% and 5.9% had abnormal respiratory noises and RLN, respectively. The prevalence of horses with defects and prejudicial defects significantly decreased from 1998 to 2006. Overall defects decreased from 80.7% to 64.4% and prejudicial defects decreased from 17.3% to 7.2%. There was a significant difference between the frequency of defects noted by the private veterinarians and the panel veterinarians. Panel veterinarians were significantly more likely to diagnose defects than the private veterinarians ($P < 0.001$). They were also significantly more likely to diagnose prejudicial defects than the private veterinarians ($P < 0.001$).

Overall, the results indicate that a large proportion of Thoroughbred National Hunt horses are affected by defects of some kind. They also indicate that the prevalence of a large number of defects increases with age and that certain defects are viewed negatively by purchasers thereby affecting the selling status. It may be of benefit to the Thoroughbred industry to monitor the prevalence of these defects in young horses as an aid to reduce their prevalence in the population.

2.1 Introduction

Thoroughbred breeding is a significant industry in Ireland and the United Kingdom with approximately twelve thousand foals born each year. Unfortunately not all of these horses will ever appear on the racetrack. Approximately one quarter of these foals never race (Minkema, 1975; Pearson, 2006) and of those that do almost half never win a race (More, 1999). Unsoundness (the inability of the horse to perform the function for which it has been purchased) is the primary cause of wastage in the industry both from injuries occurring during training or from pre-existing predisposing conditions that may lead to a future unsoundness in the horse. It is therefore important that the horse is free from any of these predisposing conditions. It is also important that the extent to which certain conditions or defects may affect the performance of a horse is known within the industry.

Veterinary pre-purchase examinations of horses provide an opportunity to identify pre-existing or potential problems that might affect the future performance of the horse. Pre-purchase examinations are conducted on thousands of horses in Ireland and the United Kingdom every year. They are compulsory before the sale of a three or four year old National Hunt (NH) horse at public auction (Tattersalls Ire Conditions of Sale, 2012; Goffs Conditions of Sale, 2012; DBS Conditions of Sale, 2012). The objective is to conduct a comprehensive veterinary examination with the purpose of diagnosing and thence assessing any factors of a veterinary nature that may have an effect upon the horse's intended use. This then allows the purchaser to make an informed decision on whether or not to purchase the horse (Mantell, 1998). While the components of the pre-purchase examination have been described comprehensively, there is little data on the results arising from these examinations. Some authors have reported on radiographic findings (Howard et al., 1993; McIlwraith et al., 2003) or respiratory endoscopic examinations (Lane et al., 1987) from Thoroughbred yearling sales but there is a paucity of studies on general aspects of pre-purchase examinations or on retrospective evaluations from these examinations (van Hoogmoed et al., 2003).

Examination of Thoroughbred horses at public auction is a special form of pre-purchase examination, since the clinician cannot be as thorough as in clinical situations, due to limitations such as time, number of horses and availability of resources (Ellis, 1998).

However, throughout the examination the veterinarian examines every aspect of the horse thoroughly with the intention of identifying and recording any defects that may be present (Chandler, 1998). The examination includes a physical examination including walking in hand, limb palpation, lunging and an upper respiratory tract endoscopic examination if the horses make an abnormal respiratory noise. The defects noted in the pre-purchase examination range from musculoskeletal defects such as metacarpal/metatarsal exostoses and tarsal plantar desmitis, to respiratory defects such as RLN. Once these defects have been noted the examining veterinarian determines whether or not they are likely to prejudice the horse's use in the purchasers chosen discipline (Mantell, 1998).

There is currently relatively little research data available concerning the prevalence of defects in the general Thoroughbred horses. The majority of studies have focused on a single type of defect or else on mixed breed populations. For example, studies by Cole et al. (2005) and Kaneene et al. (1997) reported on the results of a survey of owner reported health disorders for 3,901 horses, and a survey of equine health problems of 2,469 horses in Michigan, respectively. Both of these studies however examined samples of mixed breeds and ages. Lane et al. (1987) investigated the prevalence of idiopathic RLN in the Thoroughbred yearlings that were referred to the Tattersalls UK wind panel over a period of six years. Their study found that approximately 0.8% of the horses sold were found to be returnable because of RLN under the Tattersalls conditions of sale. Another study which focused solely on RLN was that of Dixon et al. (2001) which studied 375 cases of RLN referred to a veterinary hospital in order to examine the diagnostic details and to determine the possible causes of this disease. Conversely in a general population, Buhl et al. (2005) investigated the prevalence and development of valvular regurgitation or heart murmurs in Standardbred trotters, finding that 15% of the sample was affected with this defect, rising to 64% after an 18 month period. There is however, currently no literature detailing the prevalence of defects such as metacarpal/metatarsal exostoses, tarsal plantar desmitis or papillomas in the equine population.

The present study aimed to determine the prevalence of a wide range of defects in an elite Thoroughbred population using the results of pre-purchase examinations conducted at a number of Thoroughbred sales venues over a number of years.

2.2 Materials and Methods

Pre-purchase examination certificates from a sample of 13,603 three and four year old NH horses that were presented for sale at Tattersalls Ireland, Goffs Ireland and Doncaster Bloodstock Sales Ltd. (DBS) from 2002 to 2009 were analysed. Certificates for Tattersalls 2009 August Sale were not included in the analysis as the pre-purchase examination procedure was changed. In cases where a horse was entered into multiple sales, only the most recent veterinary pre-purchase examination certificate was used for analysis. The number of horses from each sale is shown in Table 2.1 below. The information gathered from these certificates was used to determine the prevalence of each defect. The data were then used to investigate any associations between the prevalence of the defects and the age, year of birth and sex of the horses.

Table 2.1: Number of Horses Analysed from Each Sale for Each Year of Study

	Tattersalls Ire.		*Goffs Ire.*	*Doncaster Bloodstock*	*Total*
Year	Derby	August	June	Spring	
2009	552	0	478	257	1,287
2008	508	561	472	280	1,821
2007	433	631	469	244	1,777
2006	409	748	474	250	1,881
2005	387	620	454	267	1,728
2004	398	558	459	259	1,674
2003	371	593	442	330	1,736
2002	373	597	404	325	1,699
Total	3,431	4,308	3,652	2,212	13,603

When a young NH horse is entered into a sale it is sold subject to a pre-purchase examination certificate. It is compulsory for the owner or vendor to have a pre-purchase examination carried out on the horse by a privately appointed veterinarian within a certain number of days before the sale (14 for Tattersalls and Goffs, 28 for DBS), which is stipulated in the Conditions of Sale of the company. The certificate from this examination is then brought, with the animal, to the sales complex whereupon the animal is examined again, this time by a member of the veterinary panel appointed by the sales company. The allocation of the veterinarians from the panel is random with the first free veterinarian taking the next horse in line. Once this examination has been completed the panel veterinarian either agrees or disagrees with the original certificate as to whether or not any defects present are likely to prejudice the horse's use for racing. The panel veterinarian may then make changes to the certificate, such as the inclusion of additional defects discovered or the omission of defects that were not found to be present. The defects discovered by both veterinarians are disclosed during the sale and the certificates are available for inspection by purchasers. The decision of whether or not a defect is deemed prejudicial to future use or not is at the discretion of the examining veterinarians. Behavioural defects are not identified on either veterinary certificate but are disclosed separately in a vendor's declaration. As these vendor declarations were not available for analysis, behavioural defects were not included in this study.

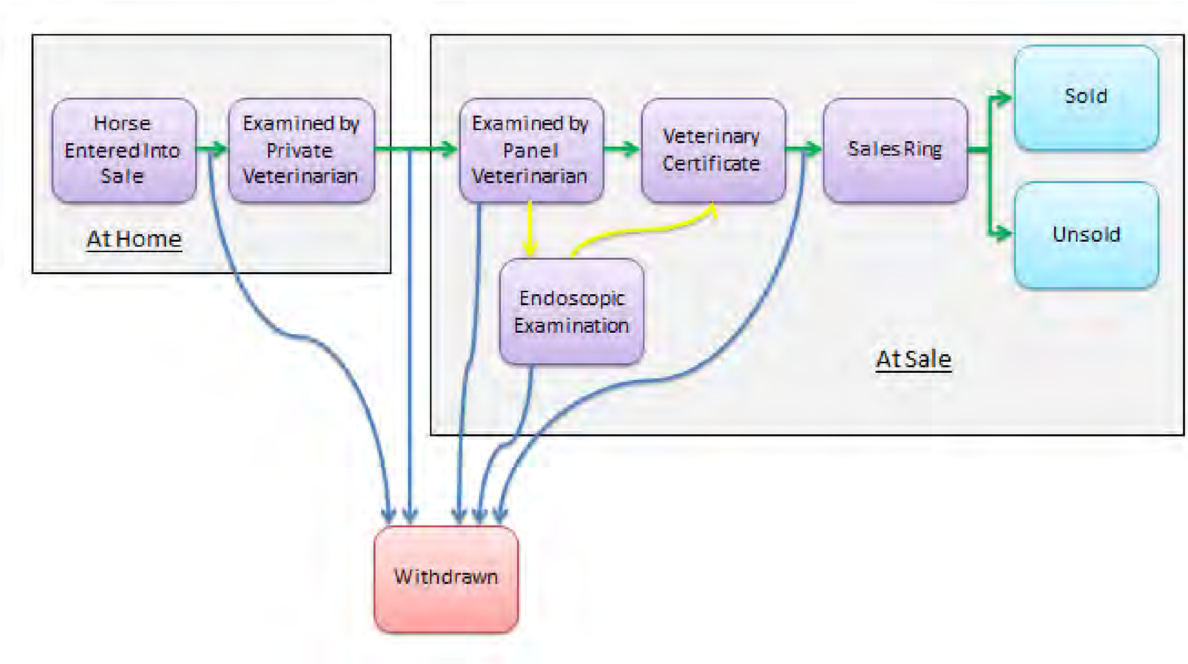


Figure 2.1: Flowchart Showing Progress Through the Pre-Purchase Examinations

Horses can be withdrawn by the vendor at any stage from the sale (Figure 2.1), either before or after the pre-purchase examinations have taken place. Certificates were only available for the horses that were presented at the sales venue, that is, those which underwent the panel pre-purchase examination. The sales used in this study are considered "select" sales. Horses entered into select sales have to undergo pre-screening in order to determine if they are of a high enough quality, with respect to pedigree and conformation, to be sold at these sales.

2.2.1 Respiratory Examination

Only the horses identified as producing abnormal respiratory noises were subjected to endoscopic examination. This stage of the examination was carried out in enclosed lunging arenas which allowed the examining veterinarians to hear any abnormal noises. Once the examining panel veterinarian identified an abnormal respiratory noise, another member of the veterinary panel was asked to verify this finding. The examining veterinarian then made the determination that the horse had a defect likely to prejudice its use for racing and the horse was sent for an endoscopic examination in order identify any laryngeal or pharyngeal defects that may be present. This was carried out by a group of three panel veterinarians who had been assigned to this task, in a quiet room away from the other horses. The horse was examined using a video endoscope and all three veterinarians observed the larynx together. If paralysis was observed, the horse was recorded as having RLN. If there was no paralysis (or any other laryngeal or pharyngeal defect) present, the horse was still considered to have a defect likely to prejudice its use for racing on the basis of the abnormal respiratory noise.

2.2.2 Statistical Analysis

The pre-purchase examination certificates provided data regarding the existence and location of any defects, and information such as the age, year of birth and sex of the horses was obtained from the sales catalogues. The information gathered from the pre-purchase certificates was used to determine the prevalence of each defect. Associations between the occurrence of the defects and the age, year of birth and sex of the horses were then determined. The Euro was the currency used to analyse sales prices. Where the price was in Pound Sterling, all values were converted to Euro using the exchange rates for the date of sale provided by the European Central Bank. For horses that were unsold, the highest bid value was determined to be the price realised at sale as this indicated the perceived value of the horse by the industry.

SPSS version 19.0 for Windows was used to analyse the data. Frequencies were used to determine the prevalences of the defects, while Chi-square tests were used to analyse the effect of age and sex. Chi-square tests were also used to analyse the effect of selling status, year of birth and to determine if differences existed in the location of some of the defects. T-tests were used to analyse sale price while chi-square tests were used to determine the proportion of horses affected with defects within the different sale price categories.

2.3 Results

2.3.1 Population Profile

Although 16,321 horses were entered into the various sales used in the analysis, pre-purchase veterinary examination certificates were only available for 13,603 of the horses as 2,718 horses were not brought to the sales grounds. Of the 13,603 horses in the sample 9,915 or 72.89% were sold, 2,873 (21.12%) were not sold and 815 (5.99%) were withdrawn from the sales.

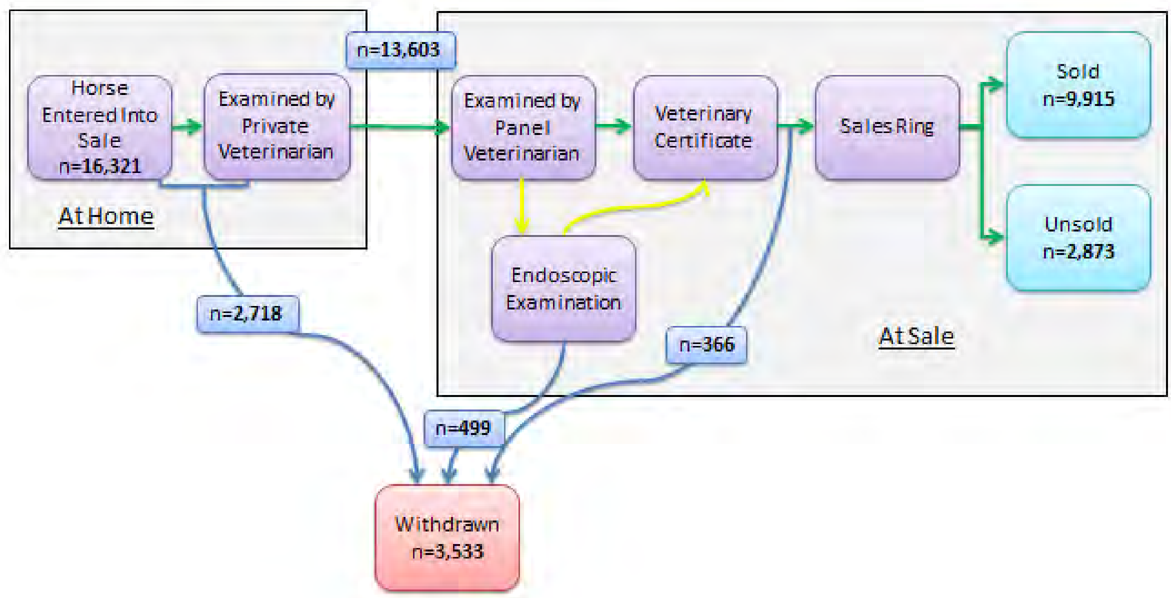


Figure 2.2: Flowchart Showing Number of Horses that Progressed Through the Sales

Geldings represented 74.81% (10,177) of the sample, while only 24.93% of the horses entered were fillies (3,391). There were also 28 (0.21%) colts and six (0.04%) mares entered into the sales. As there were so few colts and mares in the sample, these were excluded from analyses to determine the effect of sex throughout the study, leaving 13,568 horses (10,177 geldings and 3,391 fillies) in the analysis.

Table 2.2: Age of Horses

Age (Years)	*Number*	*Proportion*	*Age (Years)*	*Number*	*Proportion*
2	45	0.33%	6	4	0.03%
3	6,866	50.47%	8	1	0.01%
4	6,655	48.92%	Unknown	1	0.01%
5	31	0.23%			

Three and four year old horses were predominant at the sales (Table 2.2) and they represented 50.47% (6,866) and 48.92% (6,655) of the entries respectively. The majority of the horses were born between 1998 and 2006 with only 19 horses born in other years. The largest proportion of horses, 13.17% of the sample, was born in 2003 (see Appendix 1, Table A.1). Only the data from horses aged three and four years (13,521 horses) were analysed to determine the effects of age (6,866 three year olds and 6,655 four year olds) throughout the study.

2.3.2 Most Prevalent Defects

A variety of defects were identified on the certificates examined in the study. The ten most prevalent are listed in Table 2.3 below (See Appendix 2, Table A.2 for full list of defects).

Table 2.3: Ten Most Common Defects

Defect	*Number*	*Prevalence*
Skin Scar	2,953	21.71%
Tarsal Plantar Desmitis	2,639	19.40%
Metacarpal/Metatarsal Exostosis	2,327	17.11%
Respiratory Noise Requiring Endoscopic Examination	1,335	9.81%
Wounds	986	7.25%
Sarcoid	795	5.84%
Recurrent Laryngeal Neuropathy (RLN)	716	5.26%
Papilloma	716	5.26%
Calcaneal Bursitis	521	3.83%
Swelling	442	3.25%

Skin scars were the most common defects noted and were present on 2,953 (21.71%) horses in the sample. Tarsal plantar desmitis and metacarpal/metatarsal exostoses were the next most prevalent occurring in 2,639 (19.40%) horses and 2,327 (17.11%) of the horses in population, respectively. Respiratory noise was also highly prevalent in the sample affecting 1,335 (9.81%) horses, with RLN affecting 716 (5.26%) horses.

2.3.3 Prejudicial and Non Prejudicial Defects

The veterinary certificates were initially grouped into two categories; those with defects and those without defects. Certificates with one or more defects were classed together. There were 3,594 (26.42%) horses with no defects, while the remaining 10,009 (73.58%) horses had comments on their certificates noting one or more defects. The defects were then considered in two categories, those that were likely to prejudice the horse's use for racing and those not likely to prejudice the horse's use for racing.

In all, 1,635 horses (12.02%) were found to have defects likely to prejudice their use for racing. These defects included RLN, heart murmurs and lameness. The remaining 11,968 (87.98%) horses were found to be free from these types of defects, with 8,374 (61.56%) horses deemed to have non prejudicial defects and 3,594 (26.42%) reported to have no defects.

There was no significant difference between the numbers of fillies and geldings with either no defects or with prejudicial defects ($P > 0.05$). Fillies and geldings were equally likely to have defects (74.8% and 73.2%, respectively). They were also equally likely to have prejudicial defects, with 12.3% of the fillies and 11.9% of the geldings having defects likely to prejudice their use for racing.

Table 2.4: Comparison of the Prevalence of Horses with Defects and Prejudicial Defects among Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Defects	2,536 74.8%	7,451 73.2%	3.236	0.072
Prejudicial Defects	416 12.3%	1,216 11.9%	0.245	0.621

Four year olds were significantly more likely to have defects than three year olds ($P < 0.001$) with 5,180 (77.8%) of the four year olds having defects compared to 4,772 (69.5%) of the three year olds. Four year olds were also more likely to have prejudicial defects than three year olds, with 915 (13.7%) and 707 (10.3%) affected respectively.

Table 2.5: Comparison of the Prevalence of Horses with Defects and Horses with Prejudicial Defects among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
No Defects	4,772 69.5%	5,180 77.8%	120.821	< 0.001
Prejudicial Defects	707 10.3%	915 13.7%	38.144	< 0.001

2.3.4 Analysis of Prejudicial Defects

Prejudicial defects encompassed a variety of defects including respiratory defects, cardiac defects, neurological defects and lameness. Defects were deemed prejudicial to future use at the discretion of the examining veterinarians.

2.3.4.1 Respiratory Defects

Four types of respiratory noise were identified in the study with horses being classified as having an abnormal respiratory noise, being a whistler, thick winded or a high blower. Figure 2.3 shows the numbers of each of these defects that were classified as prejudicial or non-prejudicial and the number of horses that went on to be examined endoscopically.

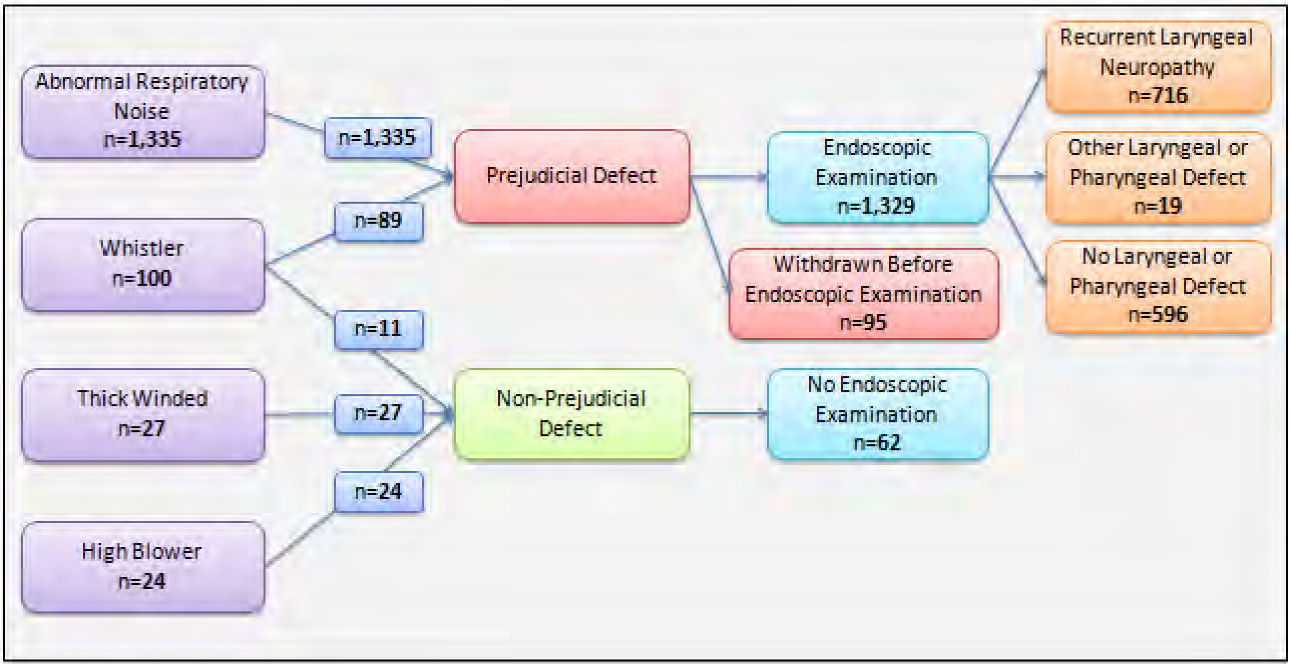


Figure 2.3: Flowchart Showing Respiratory Defects Classified as Prejudicial or Non-Prejudicial

Respiratory defects were present in 1,487 horses or 10.93% of the sample. Abnormal respiratory noises were noted in 9.81% of the sample population. This represented a total of 1,335 horses. Of these, 716 were found to have recurrent laryngeal neuropathy (RLN) as can be seen in Table 2.6. This was 5.26% of the total sample and represented 53.63% of all the horses with respiratory noises. A further 1.11% (151 horses) were declared to be whistlers, high blowers or thick winded and 0.14% (19 horses) had other laryngeal or pharyngeal defects.

Table 2.6: Respiratory Defects

Defect	*Number*	*Prevalence*	*Prejudicial*
Respiratory Noise Requiring Endoscopic Examination	1,335	9.81%	100%
- RLN	665	57.30% of horses with noise that were scoped (n=1,245)	100%
Whistler	100	0.74%	89.0%
- RLN	44	52.4% of whistlers that were scoped (n=84)	100%
RLN (Total)	716	5.26%	100%
Thick Winded	27	0.20%	0%
High Blower	24	0.18%	0%
Hobday Operation	7	0.05%	42.9%
Pharyngeal Hyperplasia	8	0.06%	100%
Pharyngeal Growth	1	0.01%	100%
Rostral Displacement of the Palato-Pharyngeal Arch	1	0.01%	100%
Epiglottic Entrapment	1	0.01%	100%
Collapsed Alar Folds	1	0.01%	100%

Of the horses with respiratory noises, 107 (0.79%) were not examined endoscopically for RLN for unknown reasons. Seven horses were examined endoscopically even though the panel veterinarians did not hear an abnormal respiratory noise, because the private veterinarian diagnosed a noise, and were subsequently found to have RLN. The prevalence of respiratory noise and RLN was similar in geldings and fillies (Table 2.7).

Table 2.7: Comparison of the Prevalence of Respiratory Noise and RLN among Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Respiratory Noise	352 10.4%	980 9.6%	1.620	0.203
RLN	188 5.6%	526 5.2%	0.670	0.413

Four year olds were significantly more likely to have respiratory noises and RLN than three year olds ($P < 0.05$), as shown in Table 2.8.

Table 2.8: Comparison of the Prevalence of Respiratory Noise among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Respiratory Noise	596 8.7%	733 11.0%	20.768	< 0.001
Thick Winded	6 0.1%	21 0.3%	8.828	0.003
RLN	326 4.8%	388 5.9%	8.016	0.005

2.3.4.2 Cardiac Defects

Of the horses examined, 166 (1.22%) were found to have cardiac defects. Heart murmurs were the most common cardiac defects noted in the study, affecting 157 (1.15%) horses, while irregular heartbeat/arrhythmias affected nine (0.07%) horses. Not all of the heart murmurs were found to be prejudicial to future use as a racehorse as many disappeared with exercise. The majority of cases of heart murmur were found to be prejudicial (62.4%), however, this may not be entirely accurate as 12.7% of the cases (20 horses) occurred in horses with an abnormal respiratory noise which would also have resulted in the horse being determined to have a prejudicial defect. There was no significant difference in the prevalence of cardiac defects between fillies and geldings, 1.1% compared to 1.3%, respectively ($\chi^2 = 0.980$, df = 1, $P = 0.322$). There was however a significant difference in the prevalence of cardiac defects, and more specifically heart murmurs, between three and four year old horses ($P < 0.05$). Four year olds were significantly more likely to have these defects (1.7% and 1.5%) than the three year old horses in the sample (0.8% and 0.8%), respectively.

Table 2.9: Comparison of the Prevalence of Cardiac Defects among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Cardiac Defects	55 0.8%	110 1.7%	20.343	<0.001
Heart Murmur	53 0.8%	103 1.5%	17.834	<0.001

2.3.4.3 Neurological Defects

Neurological defects affected 47 (0.35%) horses in the sample. The most commonly observed neurological defect was stringhalt, affecting 18 (0.13%) horses or 38.30% of all those with neurological defects. This was followed by incoordination of the hind legs affecting 14 (0.10%) horses and exaggerated hind leg movement affecting seven (0.05%) horses. These defects are outlined in Table 2.10 below. Hind limb incoordination, shiverers and wobblers were classified as likely to prejudice use for racing while stringhalt and muscle tremors were classified as non-prejudicial. There was no significant difference in the prevalence of defects affecting the nervous system according to age or sex (data not shown).

Table 2.10: Neurological Defects

Defect	*Number*	*Prevalence*	*Prejudicial*
Stringhalt	18	0.13%	0%
Hind Limb Incoordination	14	0.10%	78.6%
Exaggerated Hind Limb Movement	7	0.05%	28.6%
Shiverer	4	0.03%	100%
Muscle Tremor	2	0.01%	0%
Wobbler	2	0.01%	100%

2.3.4.4 Lameness

One hundred and thirty of the horses presented to the veterinary panel were lame. This represented 0.96% of the sample. Horses were more likely to be lame in a hind leg than in a front leg (80 vs. 34 cases) ($\chi^2 = 18.640$, df = 1, $P < 0.001$) and in a right leg than in a left leg (75 vs. 39 cases) ($\chi^2 = 11.416$, df = 1, P = 0.001). There was also a significant difference between the prevalence of lameness in the left hind (25) and in the right hind limbs (51) ($\chi^2 = 8.925$, df = 1, P = 0.003), however, there was no significant difference in the prevalence of lameness in the left front (14) and in the right front limbs (21) ($\chi^2 = 1.403$, df = 1, P = 0.236). There was no significant difference in the prevalence of lameness at the time of sale between fillies and geldings ($\chi^2 = 2.336$, df = 1, P = 0.126). There was however, a significant difference between three and four year olds, 0.6% compared to 1.3% ($\chi^2 = 16.319$, df = 1, $P < 0.001$)

2.3.5 Analysis of Non-Prejudicial Defects

2.3.5.1 Musculoskeletal Defects

2.3.5.1.1 Metacarpal/Metatarsal Exostoses

Of the horses presented for examination 2,327 (17.11%) horses were found to have metacarpal/metatarsal exostoses. These were most likely to occur on the front legs as seen in Table 2.11 with the left front affected most frequently (60.38% of all metacarpal/metatarsal exostoses). Six hundred and fifty-four horses had more than one metacarpal/metatarsal exostosis resulting in 3,027 metacarpal/metatarsal exostoses, with 534 horses (3.93% of the sample and 22.95% of affected horses) having bilateral front leg metacarpal/metatarsal exostoses.

Table 2.11: Location of Metacarpal/Metatarsal Exostoses

Location	*Number*	*Prevalence*
Left Front	1,405	10.33%
Right Front	1,184	8.70%
Left Hind	191	1.40%
Right Hind	231	1.70%
Unknown	16	0.12%

There was a significant difference between the occurrence of metacarpal/metatarsal exostoses on the front legs and metacarpal/metatarsal exostoses on the hind legs (χ^2 = 1,263.629, df = 1, P < 0.001) with metacarpal/metatarsal exostoses being more likely to occur on the front legs than on the hind legs. Metacarpal/metatarsal exostoses were also significantly more likely to occur on the left front leg than the right front leg (χ^2 = 20.887, df = 1, P < 0.001) and on the right hind leg than the left hind leg (χ^2 = 3.845, df = 1, P = 0.050). Metacarpal/metatarsal exostoses were also significantly more likely to occur medially than laterally (χ^2 = 1,122.908, df = 1, P < 0.001), with 1,717 occurring medially and only 178 occurring laterally. The majority of horses (82.89%) had no metacarpal/metatarsal exostoses, 12.23% had one metacarpal/metatarsal exostosis, 4.30% had two metacarpal/metatarsal exostoses and 0.50% had more than two metacarpal/metatarsal exostoses (Table 2.12).

Table 2.12: Number of Metacarpal/Metatarsal Exostoses

Number of Metacarpal/ Metatarsal Exostoses	*Number of Horses*	*Prevalence*	*Number of Metacarpal/ Metatarsal Exostoses*	*Number of Horses*	*Prevalence*
0	11,276	82.89%	4	15	0.11%
1	1,664	12.23%	5	2	0.01%
2	585	4.30%	6	1	0.01%
3	51	0.37%	Unknown	9	0.07%

Metacarpal/metatarsal exostoses were found to be equally likely to appear on fillies and geldings (χ^2 = 1.638, df = 1, P = 0.201), with 16.4% of the fillies (557 horses) and 17.4% of the geldings (1,769 horses) affected. There was however a significant difference between three year olds and four year olds. Four year olds were significantly more likely to have metacarpal/metatarsal exostoses than three year olds, 20.3% (1,349 horses) compared to 14.1% (966 horses) (χ^2 = 91.580, df = 1, P < 0.001).

2.3.5.1.2 Tarsal Plantar Desmitis

Of those horses submitted for examination, 2,639 (19.40%) were found to have tarsal plantar desmitis with 832 (6.12%) of those affected having tarsal plantar desmitis on both hind legs. Tarsal plantar desmitis were significantly more likely to be located on the left hind leg 2,091 (60.49%) than on the right hind leg 1,366 (39.41%) (χ^2 = 174.200, df = 1, P < 0.001). Geldings were significantly more likely to have tarsal plantar desmitis than fillies, 21.0% compared to 14.6%, (χ^2 = 67.657, df = 1, P < 0.001) however, there was no significant difference between three and four year old horses, 19.9% and 19.0% respectively (χ^2 = 2.053, df = 1, P = 0.152).

2.3.5.1.3 Synovial Distension of the Digital Tarsal Sheath

Synovial distension of the digital tendon sheath (SDDTS) were noted in 425 (3.12%) of the horses in the sample. These most commonly affected both hind fetlocks; 65.18% of all horses observed to have SDDTS were found to have SDDTS on both hind legs. SDDTS were found to be significantly more likely to occur on hind legs than on the front legs (χ^2 = 267.806, df = 1, P < 0.001). However, there was no significant difference between the occurrence of SDDTS on the left and right legs (χ^2 = 1.316, df = 1, P = 0.251). Similarly, there was no significant difference between the prevalence of SDDTS on the left front and the right front or on the left hind and the right hind leg ($P > 0.05$).

Table 2.13: Location of SDDTS

Location	*No.*	*%*	*Location*	*No.*	*%*
Left Front Fetlock	47	0.35%	Both Front Fetlocks	36	0.26%
Right Front Fetlock	40	0.29%	Both Hind Fetlocks	277	2.04%
Left Hind Fetlock	347	2.55%	All Four Fetlocks	25	0.18%
Right Hind Fetlock	323	2.37%			

The majority of horses that had SDDTS had them on two limbs. This was the case in 260 horses or 1.91% of the sample.

Table 2.14: Number of SDDTS

Number of SDDTS	*Number of Horses*	*Prevalence*	*Number of SDDTS*	*Number of Horses*	*Prevalence*
0	13,177	96.87%	4	25	0.18%
1	126	0.93%	6	1	0.01%
2	260	1.91%	Unknown	9	0.07%
3	5	0.04%			

Fillies were significantly more likely to have SDDTS than geldings, 4.2% (144 fillies) compared to 2.8% (280 geldings) ($\chi^2 = 18.784$, df = 1, $P < 0.001$) and four year olds were significantly more likely to have SDDTS than three year olds, 4.2% (278 horses) compared to 2.1% (147 horses) ($\chi^2 = 46.029$, df = 1, $P < 0.001$).

2.3.5.1.4 Calcaneal Bursitis

Calcaneal bursitis were reported in 3.83% of the sample or on 521 horses with 143 horses having two calcaneal bursitis. Calcaneal bursitis were distributed evenly over both legs; 333 on the left and 323 on the right. There was no significant difference between the occurrences of calcaneal bursitis on either leg ($\chi^2 = 0.156$, df = 1, $P = 0.693$). They were however more frequently observed on just one leg than on both simultaneously as described above. Fillies were significantly more likely to have calcaneal bursitis than geldings, 4.6% compared to 2.6% ($\chi^2 = 32.807$, df = 1, $P < 0.001$) but there was no significant difference in the prevalences between three and four year old horses ($\chi^2 = 0.398$, df = 1, $P = 0.528$).

2.3.5.1.5 Other Musculoskeletal Defects

Unspecified synovial distensions affected 99 (0.73%) horses of the sample, unfortunately it was not noted which joint was affected. CSTJ affected 18 (0.13%) horses, followed closely by SDTDTS and carpal bursitis affecting 23 (0.17%) and 10 (0.07%) horses, respectively. Two horses (0.01%) had ringbone, while only one horse had olecranon bursitis (0.01%).

Table 2.15: Other Musculoskeletal Defects

Defect	*Number*	*Prevalence*
Unspecified Synovial Distension	99	0.73%
Chronic Synovitis of the Talocrural Joint (CSTJ)	18	0.13%
Synovial Distension of the Tarsal Digital Tendon Sheath (SDTDTS)	23	0.17%
Carpal Bursitis	10	0.07%
Ringbone	2	0.01%
Olecranon Bursitis	1	0.01%
Osteoarthritis of the Tarsal Joint (OATJ)	1	0.01%
Sidebone	1	0.01%

Four year old horses were significantly more likely to have unspecified synovial distension than three year old horses, 0.9% compared to 0.6% ($\chi^2 = 4.296$, df = 1, P = 0.038). There was no significant difference between fillies and geldings or between three and four year olds for the other musculoskeletal defects (data not shown).

2.3.5.1.6 Asymmetry of Conformation

Two hundred and eighty-six horses (2.0%) in the sample were determined to suffer from some form of asymmetry of conformation. Forty-five (0.33%) had asymmetric feet, while the other 241 (1.77%) had pelvic or hind quarter asymmetry. None of these were deemed to be prejudicial to future performance. Four year old horses were significantly more likely to have pelvic asymmetry than three year old horses, 2.5% (166 horses) compared to 1.0% (72 horses) ($\chi^2 = 40.847$, df = 1, P < 0.001) and to have asymmetric feet than three year olds, 0.5% (31 horses) compared to 0.2% (13 horses) ($\chi^2 = 7.964$, df = 1, P = 0.005).

2.3.5.2 Hoof Defects

2.3.5.2.1 Sand Crack

Sand cracks were defined as cracks in the hoof which begin at the top of the hoof or at the coronary band and work down towards the toe. Of the 13,603 horses in the sample, 332 had sand cracks (2.44%).

Table 2.16: Location of Sand Cracks

Location	*Number*	*Prevalence*
Left Front	133	0.98%
Right Front	125	0.92%
Left Hind	119	0.87%
Right Hind	105	0.77%
Unknown	7	0.05%

Sand cracks were equally distributed across all limbs ($P > 0.05$) and were more likely to occur on a single hoof than on multiple hooves of the affected horses. Two hundred and seven horses (1.52%) had a sand crack on one hoof compared to 89 (0.65%) having them on two hooves. Only 15 horses (0.11%) in the sample had sand cracks on three hooves and 13 (0.10%) were affected with sand cracks in all four hooves.

Fillies were significantly more likely to have sand cracks than geldings with 3.6% of the fillies (123) having sand cracks compared to 2.0% of the geldings (203) ($\chi^2 = 26.794$, df = 1, $P < 0.001$). Four year olds were also significantly more likely to have sand cracks than three year olds, 3.2% compared to 1.7% ($\chi^2 = 34.351$, df = 1, $P < 0.001$).

2.3.5.2.2 Hoof Crack

Hoof cracks were also noted in the form of grass cracks or horizontal cracks, with grass cracks beginning at the toe and working upwards and horizontal cracks forming horizontally across the hoof wall. Hoof cracks were found to affect 243 (1.79%) horses in the sample.

Table 2.17: Location of Hoof Cracks

Location	*Number*	*Prevalence*
Left Front	78	0.57%
Right Front	80	0.59%
Left Hind	71	0.52%
Right Hind	66	0.49%
Unknown	17	0.12%

Hoof cracks appeared to be equally distributed across all limbs ($P > 0.05$). Like sand cracks, hoof cracks were most likely to occur on a single hoof than on multiple hooves. Of the horses affected with hoof cracks, 168 (69.14%) had a hoof crack on one hoof compared to 53 (21.81%) having them on two hooves. Only four (1.64%) horses had hoof cracks on three hooves and three (1.23%) had them on every hoof. It was not noted how many hoof cracks the other 15 horses (6.17%) had.

There was no significant difference in the proportion of fillies and geldings with hoof cracks with 1.8% of both groups affected ($\chi^2 = 0.052$, df = 1, $P = 0.820$). There was however, a significant difference between three and four year olds. Four year olds were significantly more likely to have hoof cracks, 2.2% compared to 1.4% ($\chi^2 = 13.519$, df = 1, $P < 0.001$).

2.3.5.3 Ocular Defects

Two hundred and thirty-three horses were described as having ocular defects. This represented 1.71% of the animals in the sample. Some horses were affected by more than one ocular defect. While the majority of the ocular defects were considered non-prejudicial, impaired vision was classified as likely to prejudice use for racing.

The most prevalent ocular defect was found to be corneal opacity, with 79 (0.59%) horses affected. The second most prevalent ocular defect was corneal scarring affecting 56 horses (0.41%) followed by lens opacities affecting 30 horses (0.22%). Three horses had impaired vision (0.02%) and one horse had had an eye surgically removed (0.01%).

Table 2.18: Ocular Defects

Defect	*No.*	*%*	*Defect*	*No.*	*%*
Corneal Opacity	79	0.58	Circular Lens Defect	1	0.01
Corneal Scar	56	0.41	Lens Sclerosis	1	0.01
Lens Opacity	30	0.22	Blocked Tear Duct	1	0.01
Cataract	17	0.12	Retinitis/Uveitis	1	0.01
Irregular Pigmentation	7	0.05	Retinal Changes	1	0.01
Mark on Lens/Cornea	15	0.10	Prominent Onion Rings	1	0.01
Keratopathy	6	0.04	Detached Portion of Corpus Nigrans	1	0.01
Enlarged Corpus Nigrans	5	0.04			
Refractive Lens	5	0.04	Prominent Lens Facet	1	0.01
Corneal Oedema	4	0.03	Surgically Removed Right Eye	1	0.01
Impaired Vision	3	0.02			
Eye Ulcer	3	0.02	Irregular Iris	1	0.01
Missing Part of Eyelid	2	0.01	Corneal Blemish	1	0.01
Eye Distension	1	0.01	Vitreous Floater	1	0.01
Conjunctivitis	1	0.01	Iris Tag	1	0.01
Corneal Cloud	1	0.01			

There was no significant difference in the prevalence of ocular defects between fillies and geldings (data not shown), however, ocular defects occurred at significantly higher prevalences in four year olds than in three year olds ($P < 0.05$). Four year olds were also significantly more likely to have corneal scars than the three year olds in the sample ($P < 0.05$) (0.6% compared to 0.2%, respectively). There was no significant difference for the remaining ocular defects (data not shown).

Table 2.19: Comparison of the Prevalence of Horses with Ocular Defects among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Ocular Defects	86 1.3%	145 2.2%	17.266	< 0.001
Corneal Scar	17 0.2%	38 0.6%	8.725	0.003
Keratopathy	0 0.0%	6 0.1%	6.193	0.013

2.3.5.4 Oral and Dental Defects and Features

Two hundred and thirty-nine of the horses (1.76%) in the sample were found to have oral or dental defects and features stated on their pre-purchase certificate. Wolf teeth were the most common dental feature noted in the study, affecting 75 (0.55%) of the horses. Parrot mouth was found to be the second most frequently observed oral defect in the sample with missing teeth the third most common as shown in Table 2.20. These affected 63 (0.46%) and 33 (0.24%) horses respectively. Some horses were affected by more than one oral or dental defect.

Table 2.20: Oral and Dental Defects and Features

Defect	*Number*	*Prevalence*
Wolf Teeth	75	0.55%
Parrot Mouth	63	0.46%
Missing Tooth	33	0.24%
Undershot	15	0.11%
Irregular/Uneven Front Teeth	11	0.08%
Broken Tooth	10	0.07%
Dislodged/Displaced Tooth	5	0.04%
Damaged Incisor	4	0.03%
Teeth Age Different to Passport Age	4	0.03%
Additional Tooth	3	0.02%
Sharp Molars	2	0.01%
Tooth Injury	2	0.01%
Retained Tooth	2	0.01%
Abnormal Wear	2	0.01%
Teething Bump	2	0.01%
Tooth Irregularity	1	0.01%
Erupting Teeth	1	0.01%
Prominent Incisor Tooth	1	0.01%
Tooth Scar	1	0.01%
Mal-erupted Tooth	1	0.01%
Black Incisors	1	0.01%
Changing Incisors	1	0.01%
Crowded Incisors	1	0.01%
Elongated Incisors	1	0.01%
Gap in Incisors	1	0.01%
Irregular Eruption	1	0.01%
Non-erupted Tooth	1	0.01%
Tushes Erupting	1	0.01%
Molar Caps Grinded Down with Swiss Float	1	0.01%
Damaged Lower Gum	1	0.01%

Sex was found to have a significant effect on the prevalence of horses with oral or dental defects and features ($P < 0.05$). As is evident in Table 2.21, geldings were significantly more likely to have oral or dental defects and features, specifically parrot mouth and missing teeth, than fillies. There was no significant difference between fillies and geldings for any other oral or dental defects and features (data not shown).

Table 2.21: Comparison of the Prevalence of Horses with Oral or Dental Defects and Features among Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Oral or Dental Defects and Features	36 1.1%	202 2.0%	12.580	<0.001
Parrot Mouth	6 0.2%	57 0.6%	8.079	0.004
Missing Tooth	3 0.1%	30 0.3%	4.462	0.035

There was a significant difference observed in the prevalence of horses with overall oral or dental defects and features between three and four year olds (P > 0.05) as can be seen in Table 2.22. However, there was no significant difference within any of the individual defects (data not shown).

Table 2.22: Comparison of the Prevalence of Horses with Oral or Dental Defects and Features among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Oral or Dental Defects and Features	103 1.5%	131 2.0%	4.358	0.037

2.3.5.5 Skin and Tissue Defects

2.3.5.5.1 Sarcoids and Papillomas

Sarcoids affected 795 horses (5.84%) of the sample, while papillomas affected 716 (5.26%) horses. Geldings were significantly more likely to have sarcoids than fillies (P = 0.009), 6.1% (625) of geldings compared to 4.9% (167) of fillies. There was no significant difference in the proportion of fillies and geldings with papillomas (P > 0.05).

Table 2.23: Comparison of the Prevalence of Horses with Sarcoids and Papillomas among Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Sarcoids	167 4.9%	625 6.1%	6.848	0.009
Papillomas	162 4.8%	551 5.4%	2.072	0.150

There were significant differences in the prevalences of horses with sarcoids and papillomas between three year olds and four year olds ($P < 0.001$). Four year olds were significantly more likely to have both of these defects with 7.5% of the four year olds having sarcoids compared to only 4.2% of the three year olds and with 6.1% of the four year olds having papillomas compared to only 4.5% of the three year olds.

Table 2.24: Comparison of the Prevalence of Horses with Sarcoids and Papillomas among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Sarcoid	291 4.2%	499 7.5%	65.278	< 0.001
Papilloma	307 4.5%	405 6.1%	17.655	< 0.001

2.3.6 Effect of Sex on Prevalence of Some other Defects

Sex was also found to have a significant effect on the prevalence of other defects ($P < 0.05$). Geldings were significantly more likely be toed out and to have ringworm and overreaches than fillies, while fillies were significantly more likely to have muscle wastage, umbilical hernias, wounds and haematomas than geldings ($P < 0.05$; Table 2.26).

Table 2.25: Comparison of the Prevalence of Several Other Defects among Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Toed Out Conformation	0 0.0%	22 0.2%	10.341	0.006
Ringworm	4 0.1%	51 0.5%	9.250	0.002
Muscle Wastage/Depression	9 0.3%	8 0.1%	7.092	0.008
Umbilical Hernia	23 0.7%	33 0.3%	7.755	0.005
Wounds	272 8.0%	712 7.0%	3.973	0.046
Haematoma	18 0.5%	24 0.2%	7.172	0.007
Overreach	7 0.2%	47 0.5%	4.185	0.041
Sunburn	3 0.1%	0 0.0%	9.006	0.003
Skin Scar	787 23.2%	2,157 21.2%	6.070	0.014
Bony Scar	4 0.1%	2 0.0%	5.561	0.018

2.3.7 Effect of Age on Prevalence of Some other Defects

The prevalences of horses with some conformational defects differed significantly between three and four year olds ($P < 0.05$). As shown in Table 2.26, four year olds were significantly more likely to have conformational defects than three year olds. They were also significantly more likely to dish or to be pigeon toed ($P < 0.05$) with 0.8% compared to 0.4%, found to dish, and with 1.0% compared to 0.4%, being pigeon toed.

Table 2.26: Comparison of the Prevalence of Horses with Conformational and Gait Defects among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Dishes	30 0.4%	50 0.8%	5.679	0.017
Toed In	24 0.3%	62 0.9%	18.123	<0.001
Boxy Feet	4 0.1%	0 0.0%	3.878	0.049
Poor Hind-Limb Conformation	0 0.0%	4 0.1%	4.128	0.042
Offset Knees/Cannons/Feet	9 0.1%	21 0.3%	5.195	0.023
Poor Pastern Conformation	0 0.0%	6 0.1%	6.193	0.013

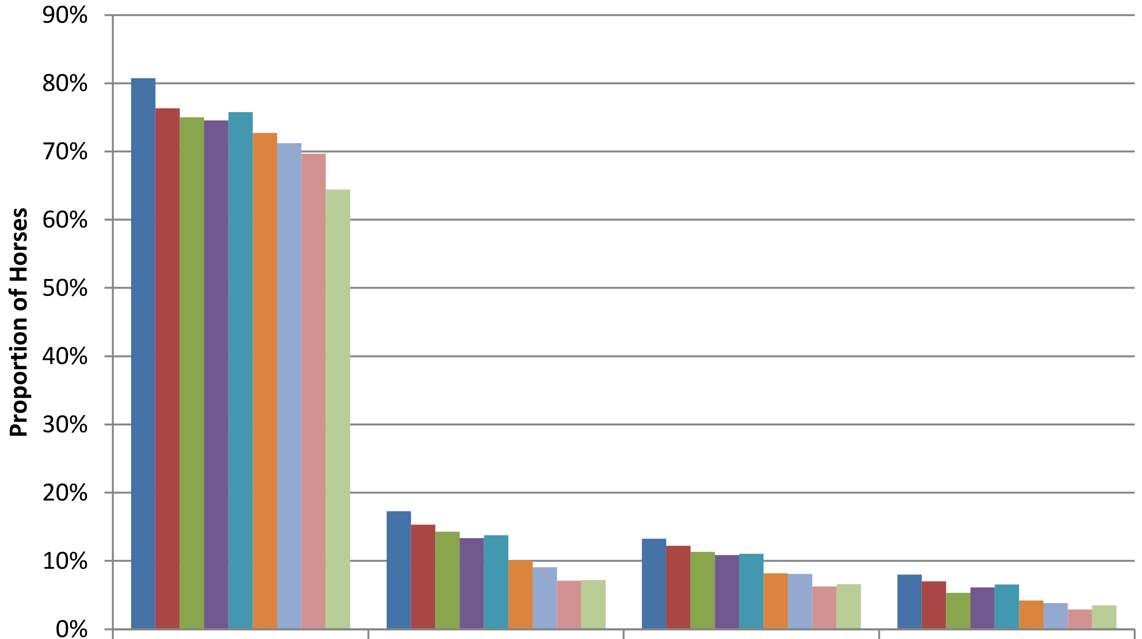
Table 2.27 lists the other defects in which the prevalence rate differed significantly between three and four year old horses. The majority were significantly more likely to occur in four year olds ($P < 0.05$) however three year olds were found to be significantly more likely to have inflammation, lacerations, stitches and cysts ($P < 0.05$).

Table 2.27: Comparison of the Prevalence of Horses with Some Other Defects among 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Hoof Defect	28 0.4%	47 0.7%	5.456	0.019
Bony Growth	82 1.2%	166 2.5%	31.723	<0.001
Fibrous Growth	11 0.2%	22 0.3%	4.029	0.045
Nodule	45 0.7%	64 1.0%	3.964	0.046
Dermatitis	8 0.1%	18 0.3%	4.174	0.041
Inflammation	8 0.1%	1 0.0%	5.233	0.022
Stitches/Staples	12 0.2%	2 0.0%	6.843	0.009
Skin Scar	1,362 19.8%	1,572 23.6%	28.486	<0.001
Coronet/Heel/Overreach Scar	98 1.4%	143 2.1%	10.047	0.002
Scar Tissue	16 0.2%	30 0.5%	4.726	0.030
Knock	12 0.2%	27 0.4%	6.266	0.012

2.3.8 Effect of Year of Birth on the Prevalence of Selected Defects

Only those horses born between the years 1998 and 2006 were examined in this section of the study, representing 13,584 horses. There were significant differences in the prevalences of horses with a variety of defects for the different years as can be seen in Table 2.28. There was a significant difference in selling status throughout the years ($P < 0.005$) with the proportion of horses sold increasing, while the proportion of horses not sold or withdrawn decreased in the more recent years. As shown in Figure 2.4, the proportion of horses with defects, prejudicial defects, respiratory noises and RLN all decreased between those born in 1998 and 2006 ($P < 0.05$).



	Defects	Prejudicial Defects	Respiratory Noise	Laryngeal Paralysis
1998	80.72%	17.30%	13.24%	8.02%
1999	76.34%	15.34%	12.24%	7.02%
2000	75.00%	14.28%	11.34%	5.33%
2001	74.55%	13.36%	10.88%	6.11%
2002	75.76%	13.76%	11.07%	6.56%
2003	72.70%	10.11%	8.21%	4.19%
2004	71.21%	9.06%	8.08%	3.82%
2005	69.66%	7.12%	6.27%	2.90%
2006	64.40%	7.23%	6.59%	3.51%

Figure 2.4: Changes in the Proportion of Horses with Defects, Prejudicial Defects, Respiratory Noise and RLN from 1998 to 2003

Table 2.28 lists some of the various factors that were significantly different for the different years of birth (See Appendix 3, Table A.3 for full list of defects significantly different for different years of birth).

Table 2.28: Some Defects Significantly Affected by Year of Birth

	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*Chi-Square*	*Sig.*
Defects	896 80.7%	1,229 76.3%	1,224 75.0%	1,233 74.5%	1,294 75.8%	1,302 72.7%	1,155 71.2%	1,056 69.7%	606 64.4%	100.278	<0.001
Prejudicial Defects	192 17.3%	247 15.3%	233 14.3%	221 13.4%	235 13.8%	181 10.1%	147 9.1%	108 7.1%	68 7.2%	136.071	<0.001
Respiratory Defect	171 15.4%	226 14.0%	202 12.4%	202 12.2%	210 12.3%	165 9.2%	146 9.0%	101 6.7%	62 6.6%	106.567	<0.001
Respiratory Noise	147 13.2%	197 12.2%	185 11.3%	180 10.9%	189 11.1%	147 8.2%	131 8.1%	95 6.3%	62 6.6%	78.222	<0.001
RLN	89 8.1%	113 7.1%	87 5.4%	101 6.2%	112 6.6%	75 4.2%	62 3.8%	44 2.9%	33 3.5%	70.403	<0.001
Metacarpal/ Metatarsal Exostosis	223 20.1%	321 19.9%	322 19.7%	304 18.4%	283 16.6%	302 16.9%	245 15.1%	220 14.5%	104 11.1%	62.408	<0.001
Sarcoid	80 7.2%	81 5.0%	60 3.7%	94 5.7%	117 6.9%	106 5.9%	114 7.0%	94 6.2%	48 5.1%	28.279	<0.001
Papilloma	87 7.8%	71 4.4%	72 4.4%	78 4.7%	93 5.4%	104 5.8%	87 5.4%	71 4.7%	50 5.3%	22.762	0.004

2.3.9 Effect of Sex, Age and Defects on Selling Status

There was a significant difference between the selling status of fillies and geldings ($P < 0.05$). Geldings were significantly more likely to be sold than fillies, with 74.7% of the geldings in the sample sold compared to 67.4% of the fillies. Fillies were significantly more likely to be unsold than the geldings (Table 2.29). Similar proportions of fillies and geldings were withdrawn from the sales.

Table 2.29: Comparison of the Selling Status for Fillies and Geldings

	Filly	*Gelding*	*Chi-Square*	*Significance*
Sold	2,286 67.4%	7,603 74.7%		
Not Sold	899 26.5%	1,967 19.3%	80.753	< 0.001
Withdrawn	206 6.1%	607 6.0%		

There was a significant difference between the selling status' of the three and four year old horses (P < 0.05). A higher proportion of three year olds were sold than four year olds, while higher proportions of four year olds were unsold and were withdrawn than three year olds as shown in Table 2.30 below.

Table 2.30: Comparison of Selling Status of 3 and 4 Year Old Horses

	3 Year Olds	*4 Year Olds*	*Chi-Square*	*Significance*
Sold	5,167 75.3%	4,702 70.7%		
Not Sold	1,333 19.4%	1,514 22.7%	36.753	< 0.001
Withdrawn	366 5.3%	439 6.6%		

There was a significant difference in the prevalences of some of the defects noted between the horses that were sold and those that were not sold. As can be seen in Table 2.31 below, 71.0% of the horses sold had defects compared to 76.1% of the horses which were not sold. Horses with defects were significantly less likely to be sold than not sold (P < 0.001). Only 6.3% of the horses sold had defects likely to prejudice their use for racing compared to 11.5% of the horses which were not sold. Horses with prejudicial defects were significantly more likely to be not sold than sold (P < 0.001).

Table 2.31: Comparison of the Prevalence of Horses with Defects and Prejudicial Defects for Those Sold and Not Sold

	Sold	*Not Sold*	*Chi-Square*	*Significance*
Defects	7,040 71.0%	2,187 76.1%	29.051	< 0.001
Prejudicial Defects	623 6.3%	331 11.5%	88.516	< 0.001

Both respiratory noise and RLN were significantly more likely to be found in the horses that were not sold than those which were sold (P < 0.001). Respiratory noise was present in 5.9% of the horses which were sold with 2.4% affected with RLN compared to 10.6% and 4.7% in the horses which were not sold, respectively.

Table 2.32: Comparison of the Prevalence of Respiratory Noise and RLN for Those Sold and Not Sold

	Sold	*Not Sold*	*Chi-Square*	*Significance*
Respiratory Defect	660 6.7%	331 11.5%	73.732	< 0.001
Respiratory Noise	582 5.9%	304 10.6%	76.678	< 0.001
RLN	242 2.4%	134 4.7%	38.695	< 0.001

There was no significant difference between the prevalences of cardiac defects in horses that were sold or unsold ($\chi^2 = 0.849$, df = 1, P = 0.357), with 0.8% of the horses which were sold affected by cardiac defects compared to 1.0% of the horses which were not sold. There was also no significant difference in the prevalence of lameness between horses sold or not sold ($\chi^2 = 3.120$, df = 1, P = 0.077), 0.2% compared to 0.3%.

As can be seen in Table 2.33 below there was no significant difference between the prevalences of horses with metacarpal/metatarsal exostoses or tarsal plantar desmitis between horses sold and not sold (P > 0.05). There was however a significant difference between the prevalences of horses with carpal bursitis and ringbone (P < 0.05), with both defects being more common in horses that did not sell than in horses that did.

Table 2.33: Comparison of the Prevalence of Horses with Metacarpal/Metatarsal Exostoses and Tarsal Plantar Desmitis for Those Sold and Not Sold

	Sold	*Not Sold*	*Chi-Square*	*Significance*
Metacarpal/Metatarsal Exostosis	1,665 16.8%	518 18.0%	2.408	0.121
Tarsal Plantar Desmitis	1,893 19.1%	585 20.4%	2.299	0.129
Carpal Bursitis	5 0.1%	5 0.2%	4.356	0.037
Ringbone	0 0.0%	2 0.1%	6.903	0.009

Appendix 4, Table A.4 lists the other defects in which the prevalence rate differed significantly between horses that were sold or unsold. Each of the defects was significantly more likely to occur in unsold horses than horses that were sold (P < 0.05).

2.3.10 Effect of Sex, Age and Defects on Price at Sale

These data were obtained from elite sales results and the average price achieved (€17,239.4±185.27) reflects the high quality of the horses offered for sale. Geldings achieved significantly higher sale prices than fillies (Table 2.34) and three year old horses achieved significantly higher sale prices than four year old horses ($P < 0.001$), €21,560.7±308.75 compared to €16,049.4±236.32.

Table 2.34: Effect of Age and Sex on Price at Sale

Variable		*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Sex	Filly	3,078	11,138.4±286.30	-27.506	<0.001
	Gelding	9,339	21,385.0±238.34		
Age	3	6,329	21,560.7±308.75	14.175	<0.001
	4	6,048	16,049.4±236.32		

The presence of defects significantly affected the selling status and the price achieved. Horses without defects achieved significantly higher sale prices than horses with defects and horses without prejudicial defects achieved significantly higher sale prices than horses with prejudicial defects ($P < 0.001$).

Table 2.35: Effect of Defects and Prejudicial Defects on Price at Sale

Variable	*Defect*	*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Defects	No	3,486	22,294.2±432.06	9.965	<0.001
	Yes	8,962	17,493.3±213.21		
Prejudicial Defects	No	11,567	19,693.0±207.81	-31.684	<0.001
	Yes	881	7,609.5±319.78		

Respiratory defects also had a significant effect on the price achieved at sale ($P < 0.001$). Horses with abnormal respiratory noises, whistlers and horses with RLN achieved significantly lower prices at sale than horses without these defects, as shown in Table 2.36.

Table 2.36: Effect of Respiratory Defects on Price at Sale

Variable	*Defect*	*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Respiratory Defect	No	11,528	19,705.4±208.57	-31.844	<0.001
	Yes	920	7,966.1±303.97		
Respiratory Noise	No	11,628	19,659.3±207.15	-35.111	<0.001
	Yes	820	7,188.6±288.52		
Whistler	No	12,397	18,883.2±197.04	-9.370	<0.001
	Yes	51	7,803.4±1,165.93		
RLN	No	12,079	19,298.5±200.80	-50.895	<0.001
	Yes	348	3,695.6±231.66		

Cardiac defects also significantly affected the price achieved at sale (P < 0.001). Horses without cardiac defects achieved significantly higher prices at sale than horses with cardiac defects, €18,903.0±197.72 compared to €11,024.6±1,098.93.

Table 2.37: Effect of Cardiac Defects on Price at Sale

Variable	*Defect*	*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Cardiac Defects	No	12,345	18,903.0±197.72	-7.056	<0.001
	Yes	103	11,024.6±1,098.93		
Heart Murmur	No	12,351	18,900.3±197.63	-6.904	<0.001
	Yes	97	10,877.0±1,145.26		

Horses without metacarpal/metatarsal exostoses achieved a sale price of €19,113.0±223.55 which was significantly higher than that of horses with metacarpal/metatarsal exostoses, €17,498.3±378.22 (P < 0.001). Similar results were seen for tarsal plantar desmitis, calcaneal bursitis, sand cracks and hoof cracks (Table 2.38).

Table 2.38: Effect of Some Musculoskeletal Defects on Price at Sale

Variable	*Defect*	*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Metacarpal/Metatarsal Exostosis	No	10,326	19,113.0±223.55	-3.675	<0.001
	Yes	2,122	17,498.3±378.22		
Tarsal Plantar Desmitis	No	10,032	19,436.3±227.27	-7.230	<0.001
	Yes	2,416	16,352.5±360.93		
Calcaneal Bursitis	No	11,975	18,973.1±201.97	-4.662	<0.001
	Yes	473	15,412.1±736.70		
Sand Cracks	No	12,149	19,035.8±200.27	-12.167	<0.001
	Yes	299	10,792.6±647.20		
Hoof Cracks	No	12,227	18,884.8±198.83	-2.256	0.025
	Yes	221	16,234.9±1,157.58		

Table 2.39 lists the other defects which affected the price achieved at sale. The majority were found to significantly lower the price achieved at sale, however, surprisingly, sarcoids were found to have a positive effect on price. Horses with sarcoids achieved significantly higher prices at sale than horses without sarcoids (P = 0.014), €20,765.4±824.14 compared to €18,716.6±202.17.

Table 2.39: Effect of Some Miscellaneous Defects on Price at Sale

Variable	*Defect*	*N*	*Mean ± S.E. (€)*	*t-value*	*Sig.*
Sarcoid	No	11,712	18,716.6±202.17	2.461	0.014
	Yes	736	20,765.4±824.14		
Wounds	No	11,551	19,048.2±207.22	-5.003	<0.001
	Yes	899	16,108.7±549.84		
Swelling	No	12,066	18,902.3±200.73	-2.365	0.018
	Yes	382	16,799.8±865.95		
Bone Thickening	No	12,161	18,922.9±199.70	-3.782	<0.001
	Yes	287	15,228.8±956.21		
Muscle Wastage	No	12,371	18,883.7±197.41	-6.023	<0.001
	Yes	77	11,456.8±1,217.24		
Parrot Mouth	No	12,392	18,862.4±197.10	-3.115	0.003
	Yes	56	13,379.7±1,748.94		
Umbilical Hernia	No	12,394	18,862.3±197.14	-4.147	<0.001
	Yes	54	13,197.8±1,351.72		
Mud Rash	No	12,397	18,864.7±197.08	-4.375	<0.001
	Yes	51	12,297.0±1,488.28		
Fibroma	No	12,446	18,831.9±196.37	2.367	0.018
	Yes	2	55,500.0±19,500.00		

There were significant differences in the prevalences of a range of defects between horses in the different price categories. Horses in the under €5,000 price category had a higher proportion of prejudicial defects and a lower proportion of these horses were free of defects compared to horses in the higher price categories. Prejudicial defects affected 18.3% of the horses in the under €5,000 price category compared to 1.7% of the horses in the over €20,000 price category. Similar trends were observed for all other defects in Table 2.40 below. The only exception was for sarcoids where a higher proportion of horses in the over €20,000 price category had sarcoids than in the under €5,000 price category, 7.0% compared to 3.9%.

Table 2.40: Proportion of Horses Affected with Defects within the Different Price Achieved at Sale Categories

Variable	*€1 – €5,000*	*€5,001 – €10,000*	*€10,001 – €20,000*	*> €20,001*	*df*	χ^2	*Sig.*
No Defects	22.1%	24.7%	29.1%	33.7%	3	124.703	<0.001
Prejudicial Defects	18.3%	7.1%	3.9%	1.7%	3	741.617	<0.001
Respiratory Defect	18.3%	7.7%	4.1%	2.1%	3	687.608	<0.001
Respiratory Noise	17.3%	6.8%	3.5%	1.4%	3	727.003	<0.001
Thick Winded	0.0%	0.2%	0.2%	0.3%	3	8.427	0.038
Whistler	0.9%	0.5%	0.3%	0.1%	3	31.516	<0.001
RLN	10.4%	1.7%	0.3%	0.2%	3	765.475	<0.001
Hobdayed	0.2%	0.0%	0.0%	0.0%	3	10.342	0.016
Cardiac Defects	1.6%	0.7%	0.7%	0.4%	3	29.309	<0.001
Heart Murmur	1.6%	0.7%	0.7%	0.4%	3	29.629	<0.001
Tarsal Plantar Desmitis	21.5%	21.3%	19.8%	16.2%	3	38.413	<0.001
Calcaneal Bursitis	5.2%	3.7%	3.5%	3.1%	3	21.148	<0.001
Sand Cracks	4.6%	2.7%	1.7%	1.2%	3	86.291	<0.001
Sarcoids	3.9%	5.2%	6.9%	7.0%	3	38.332	<0.001

2.3.11 Prevalence of Defects in Withdrawn Horses

A total of 815 horses were withdrawn from the sales, following examination by the veterinary panel. It is interesting to note that the vast majority of these horses (83.56%) had some prejudicial defect recorded, suggesting that this was the primary reason for withdrawal. Only 4.05% of the horses that were withdrawn were free from defects, while 55.09% of withdrawn horses were diagnosed with respiratory noises and 41.72% were found to have RLN. A further 10.06% of the horses were withdrawn before the endoscopic examination so it was impossible to declare these horses free from laryngeal or pharyngeal defects. The remaining prejudicial defects included cardiac defects, lameness, hind limb in-coordination, stiffness after the flexion test, obstructed vision and sarcoids which would interfere with tack placement. The prevalence of non-prejudicial defects such as metacarpal/metatarsal exostoses and tarsal plantar desmitis was similar to those observed in the whole sample affecting 17.67% and 19.75% respectively. The prevalences for some of the defects affecting the withdrawn horses are shown in Table 2.41 below.

Table 2.41: Defects Affecting Withdrawn Horses

	Number	*Prevalence*
No Defects	33	4.05%
Prejudicial Defects	681	83.56%
Respiratory Defect	496	60.86%
Respiratory Noise	449	55.09%
Whistler	45	5.52%
RLN	340	41.72%
Rostral Displacement of the Palato-Pharyngeal Arch	1	0.12%
Epiglottic Entrapment	1	0.12%
Pharyngeal Hyperplasia	5	0.61%
Collapsed Alar Folds	1	0.12%
Endoscopy Not Performed	82	10.06%
Cardiac Defects	59	7.24%
Heart Murmur	56	6.87%
Irregular Heartbeat	4	0.49%
Lameness	106	13.01%
Hind Limb In-Coordination	10	1.23%
Suspected Fracture	1	0.12%
Metacarpal/Metatarsal Exostosis	144	17.67%
Tarsal Plantar Desmitis	161	19.75%
SDDTS	28	3.44%
Calcaneal Bursitis	29	3.56%
Sand Crack	25	3.07%
Hoof Crack	14	1.72%
Sarcoid	44	5.40%
Papilloma	34	4.17%
Pelvic Asymmetry	21	2.58%
Oral and Dental Defect	19	2.33%
Ocular Defect	17	2.09%
Impaired Vision	1	0.12%
Swelling	52	6.38%
Pain/Stiffness after Flexion Test	3	0.37%
Enlarged Joint	22	2.70%
Tendonitis	2	0.25%
Bowed Tendons	1	0.12%
Tendon Thickening	32	3.93%
Abnormal Tendons	2	0.25%
Neurological defect	16	1.96%
Wobbler	1	0.12%
Shiverer	2	0.25%
Exaggerated Flexion	1	0.12%
Ringworm	9	1.10%
Muscle Wastage	13	1.60%
Wounds	66	8.10%
Stage Skipped in Exam/Discontinued	32	3.93%

2.3.12 Comparison of Observations of Private and Panel Veterinarians

All horses presented for sale had to have a veterinary certificate arising from an examination by the vendor's veterinarian within 14 or 28 days of the sale (Conditions of Sale). The horses were then re-examined by a panel veterinarian and a combined certificate was then issued. The following tables show the comparison of comments for some of the defects from the two groups.

2.3.12.1 No Defects and Prejudicial Defects

The panel veterinarian was highly significantly more likely to diagnose both non-prejudicial and prejudicial defects ($p<0.001$), as can be seen in Table 2.42 below. The panel veterinarians diagnosed six times the number of prejudicial defects diagnosed by the private veterinarians.

Table 2.42: Comparison of the Prevalence of Horses with Defects and Prejudicial Defects Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Defects	8,189 60.2%	10,009 73.6%	549.738	<0.001
Prejudicial Defects	282 2.1%	1,635 12.0%	1,027.322	<0.001

2.3.12.2 Respiratory Noise and Recurrent Laryngeal Neuropathy

The panel veterinarians were significantly more likely to diagnose horses with respiratory noise and to identify those with RLN ($p<0.001$). As can be seen in Table 2.43 the panel veterinarians identified more than three times as many horses which produced a respiratory noise compared to the private veterinarians.

Table 2.43: Comparison of the Prevalence of Respiratory Noise and RLN Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Respiratory Noise	368 2.7%	1,335 9.8%	585.749	<0.001
RLN	254 1.9%	716 5.3%	228.319	<0.001

2.3.12.3 Heart Murmurs

The panel veterinarians were significantly more likely to diagnose a heart murmur than the vendor's private veterinarians (p<0.001), identifying more than double the number of murmurs diagnosed by the first examining veterinarians.

Table 2.44: Comparison of the Prevalence of Heart Murmurs Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Heart Murmur	68 0.5%	157 1.2%	35.498	<0.001

2.3.12.4 Musculoskeletal Defects

Significantly more metacarpal/metatarsal exostoses, tarsal plantar desmitis, calcaneal bursitis and SDDTS were diagnosed by the panel veterinarians than by the private examining veterinarians (p<0.001, p<0.001, P = 0.001 and P = 0.002 respectively) as can be seen in the following table.

Table 2.45: Comparison of the Prevalence of Horses with Some Musculoskeletal Defects Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Metacarpal/Metatarsal Exostoses	1,904 14.0%	2,327 17.1%	50.078	<0.001
Tarsal Plantar Desmitis	2,083 15.3%	2,639 19.4%	79.216	<0.001
Calcaneal Bursitis	420 3.1%	521 3.8%	11.229	0.001
SDDTS	341 2.5%	425 3.1%	9.478	0.002

2.3.12.5 Hoof Defects

Sand cracks and hoof cracks were both diagnosed significantly more often by the panel veterinarians than by the private examining veterinarians ($P < 0.001$) as can be seen in the following table.

Table 2.46: Comparison of the Prevalence of Horses with Some Hoof Defects Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Sand Cracks	223 1.6%	332 2.4%	21.853	<0.001
Hoof Cracks	147 1.1%	243 1.8%	23.974	<0.001

2.3.12.6 Sarcoids and Papillomas

The private veterinarians were significantly less likely to diagnose sarcoids and papillomas than the panel veterinarians ($p<0.001$). As can be seen in table 2.47 below, the panel veterinarians diagnosed more than double the number of horses with sarcoids as the private examining veterinarians. It is sometimes difficult to distinguish between sarcoids and papillomas so this may have resulted in occasional incorrect diagnosis.

Table 2.47: Comparison of the Prevalence of Horses with Sarcoids and Papillomas Recorded by Private and Panel Veterinarians

	Private Veterinarian	*Panel Veterinarian*	*Chi-Square*	*Significance*
Sarcoids	371 2.7%	795 5.8%	161.086	<0.001
Papillomas	474 3.5%	716 5.3%	51.465	<0.001

2.4 Discussion

2.4.1 Prevalence of Defects

This study describes one of the largest sample sizes that have been examined in order to establish the prevalence of defects in one breed of horses, examining 13,603 elite young Thoroughbred NH horses. Cole et al. (2005) examined 3,901 horses in their study of owner reported health disorders and Kaneene et al. (1997) examined 2,469 horses in a study on equine health problems in Michigan; however both of these studies examined a sample of mixed breeds of a variety of ages. These studies also reported on clinical conditions rather than anatomical defects in an apparently healthy population. The studies conducted by Vigre et al. (2002) and Bailey et al. (1999) which looked at the risk factors of lameness in Standardbreds (Vigre et al., 2002) and the impact of injuries and disease on young Thoroughbred horses in training (Bailey et al., 1999), examined horses of a specific breed, however their sample sizes were much smaller at 265 and 160 horses respectively. The large sample size in the present study was beneficial as it contributed to a more accurate result statistically and was focused on a specific breed and age range. Another useful attribute of this study is that it analysed all defects that were present in the sample unlike the majority of studies which deal with only one particular type of defect, such as RLN or heart murmurs. It also dealt with an otherwise healthy sample of horses, unlike studies that examined horses pre-diagnosed with the condition in question.

The defects reported in the present study were largely asymptomatic and non-clinical. However, they represent a number of important conditions which can in some instances prejudice the animal's long term racing career. There were, however, some limitations to the study. This study only analysed horses that were entered into the Derby and August Sales in Tattersalls Ireland, the June sale in Goffs Ireland and the Spring and November Sales in DBS. This is therefore a select sample of horses and does not include any horses that were kept for racing or breeding purposes by their owners. It also does not include any horses that were deemed to be of an inadequate quality to be entered into the sales. This automatically rules out many horses that may have conformational or other defects. As it is only the higher quality horses that are permitted to enter the sales it is quite possible that the prevalences of the defects noted in this study are conservative values and that the true prevalences may in fact be much higher. However, as the sample includes both high and low priced horses, it is felt that the sample examined is broadly representative of the population. This study also only includes horses that were presented at the sales. Any horses that were withdrawn prior to the pre-purchase examination conducted by the panel veterinarians (2,718 horses) had to be omitted from the study as the pre-purchase examination certificates were not available for analysis. These horses may have been withdrawn for a variety of reasons; they may have been withdrawn due to being sold prior to the sale or due to injuries such as cuts or lameness. They may also have been withdrawn due to the discovery of a serious defect such as RLN or simply due to external factors making it impossible for the vendor to bring them to the sale. It is possible that the absence of these horses from the sample may have affected the results.

It must also be considered that it is possible that not all of the defects present on each horse were noted. Since only the horses identified as having a respiratory noise were examined for RLN, it is therefore possible that not all of the horses with RLN were identified. It must also be noted that diagnostic specificity is subject to the terminology used by the examining veterinarians.

A large percentage of horses were found to have defects in this study, with 73.58% of the sample exhibiting at least one defect. This figure did, however, include defects such as skin scars and abrasions which greatly increased the proportion of horses with defects. This is quite a high proportion considering that the Thoroughbred industry is striving to attain biological or at least athletic perfection in the horses that are being bred. A substantial proportion of the sample (12.02%) had serious defects likely to prejudice their use for racing. The remaining defects were found to be unlikely to prejudice the horses use for racing and to therefore be less serious, possibly even inconsequential in nature. It is however, a cause for concern that more than one in every 10 supposedly healthy horses is affected with defects known to be prejudicial to future use as a racehorse. Although the majority of defects present on the horses in the study were considered non prejudicial, it is possible that some of these defects are also potentially deleterious to racing performance (Brokken, 1978; Moyer et al., 1983; Rossdale et al., 1985; Ross et al., 2002; Major and Zubrod, 2006). However, the extent to which these other conditions affect racing performance has not yet been defined.

The most prevalent defects in this study were found to be leg defects, dermal defects and respiratory defects, respectively. This coincided with the results found by Kaneene et al.

(1997) in the Michigan horse study. However, it is at variance with the results noted in the studies by Cole et al. (2005), Vigre et al. (2002) and Bailey et al. (1999). These differences may be attributed to differences in data collection and to the different population groups studied. All defects in the present study were diagnosed by veterinarians, however, the studies by Vigre et al. (2002) and Bailey et al. (1999) examined trainer reported conditions, while Cole et al. (2005) examined owner reported conditions. The results, however, differ from Kaneene et al.'s (1997) study in that the leg defects identified by the latter were those found to actually cause lameness in the horses. The leg defects identified in this study did not always result in lameness at the time of the sale in the horses but consisted primarily of defects such as metacarpal/metatarsal exostoses, tarsal plantar desmitis and SDDTS. These are considered to be a reflection of poor conformation and may indicate a predisposition to lameness.

The differences observed between this study and those by Cole et al. (2005), Vigre et al. (2002) and Bailey et al. (1999) may also be explained by the difference between the level of training or work being performed by the horses in the samples. This study looked at young horses not yet in training, whilst Vigre et al. (2002) and Bailey et al. (1999) looked at Standardbreds and Thoroughbreds in training. Cole et al. (2005) also looked at older horses which were involved in work of some kind. The horses that were involved in training may have been exposed to additional factors that may cause alternative defects to those identified in this study such as increased sensitivity on the dorsal aspect of the metacarpal or metatarsal III bone, which was identified as the most prevalent problem by Bailey et al. (1999).

2.4.2 Respiratory Defects

This study determined the prevalence of respiratory defects to be 10.93%. This is within the range of 6.3% to 10.9% identified by various studies (Raphel, 1982; Sweeney et al., 1991; Brown et al., 2005). The prevalence of RLN identified in this study (5.26%) is also in agreement with the range of 2.03% to 8.3% reported in previous studies (Pascoe et al., 1981; Raphel, 1982; Hillidge, 1986) but is much higher than the 0.80% identified by Lane at al. (1987) in horses presented for auction. This may however be attributed to the fact that the Lane et al. (1987) study looked at Thoroughbred yearlings. It is possible that many of the yearlings might not yet have developed this defect but might still do so as they age, as it was shown in this study that older horses were significantly more likely to have RLN ($P < 0.05$). The prevalence in the current study is quite high with one in 10 horses producing respiratory noises and one in 20 exhibiting RLN. However, the actual figure may in fact be higher. Only horses that were diagnosed with an abnormal respiratory noise were sent for an endoscopic examination to determine the presence of RLN and the horses were only examined at rest. A study by Dixon et al. (2001) found that approximately 90% of the horses affected with RLN produced an abnormal respiratory noise, while Marti and Ohnesorge (2002) found that only 54.8% of the horses found to have RLN in their sample were found to produce an respiratory noise. Tan et al. (2005) found that 49% of the horses in their mixed breed sample which had normal airways when examined at rest had respiratory defects identified when examined during exercise. This indicates that some cases of RLN in the sample may have been overlooked. These high prevalences indicate that it may be necessary to investigate ways in which to reduce the occurrence of these defects in the Thoroughbred in order to improve the quality and the health of the population. However, as the prevalence of respiratory defects was seen to fall from horses born in 1998 to 2006 it appears that breeders may already be attempting to reduce the occurrence of these defects.

Previous studies have reported that geldings were more likely to have RLN (Dixon et al., 2001) than fillies. This study however found sex to have no significant effect on this defect ($P > 0.05$). This may be because many horses affected by RLN may have been withdrawn before reaching the sales and therefore would not have been available for inclusion in the analysis.

2.4.3 Cardiac Defects

Cardiac defects were found to affect 1.22% of the sample with the most common defect being heart murmurs. This is in marked contrast to previous studies such as that of Kriz et al. (2000) who determined the prevalence of heart murmurs to be 57.7% and Buhl et al. (2005) who determined it to be 15% rising to 64% after an 18 month period. These variations may be due to the differences in age and level of training of the horses in the samples. Buhl et al. (2005) found that the prevalence of heart murmurs in a sample increased over time, although they were unable to determine if age or the level of training was the cause of this change. This study however found that age affected the prevalence of heart murmurs with four year olds significantly more likely to have a heart murmur than three year olds ($P < 0.05$). It is therefore possible that this variation is due to the age of the horses in the sample and that the prevalence of heart murmurs will increase as the horses grow older and start racing. It may also be due to the different methods of diagnoses used in the different studies. The horses in this study were examined only using stethoscopes whereas Kriz et al. (2000) used a combination of stethoscopes and echocardiograms and Buhl et al. (2005) used Doppler echocardiography.

2.4.4 Neurological defects

Neurological defects were found to affect 0.35% of the sample with the most prevalent type being stringhalt affecting 0.13% of the sample, followed by hind leg in-coordination affecting 0.10% of the sample. This is quite a low prevalence which bodes well for the industry suggesting that neurological defects are not common in young NH horses.

2.4.5 Musculoskeletal Defects

Lameness was found to affect only 0.96% of the sample population. Previous studies found the prevalence of lameness to be 13% (Cole et al., 2005) and 11.1% (Knight and Evans, 2000). This variation can be explained by two things. Firstly it is possible that because the horses in this study had not yet begun training they had not been exposed to as many factors which may produce injuries resulting in lameness as horses in training would have been exposed to. Secondly, it is also probable that any horses exhibiting signs of lameness were withdrawn from the sale to prevent them being sold for less than they were considered to be worth or to prevent them failing to sell.

Vigre et at. (2002) previously reported that geldings were more likely to be lame than fillies. This study however found sex to have no significant effect on the prevalence of lameness at sale ($P > 0.05$). This may again be because horses affected by lameness may have been withdrawn before reaching the sales and therefore would not have been available for inclusion in the analysis or because of the relative uniformity of age and work status of the population.

Musculoskeletal defects were the most common defects noted on the pre-purchase examination certificates with tarsal plantar desmitis and metacarpal/metatarsal exostoses the second and third most common defects noted in the study, respectively. They were found to affect 19.40% and 17.11% of the sample, respectively. Until now there have been no studies documenting the prevalence of these defects, however they have always been considered to be prominent among the Thoroughbred population. Metacarpal/metatarsal exostoses and tarsal plantar desmitis can cause lameness during their formation and can result in horses having to be rested until the defects have settled (Baxter, 2011). This is obviously undesirable for owners and indicates that they have implications for the soundness of the Thoroughbred horse. Poor conformation can be a predisposing factor for these defects and may need to be addressed in order to remedy this problem. It might prove beneficial to the industry to attempt to reduce these defects in the population and selective breeding might possibly aid in this endeavour. While the prevalence of metacarpal/metatarsal exostoses was seen to halve between 1998 and 2006, there was no significant reduction in the prevalence of other musculoskeletal defects, indicating that breeders are currently making little effort to reduce the occurrence of these defects.

Metacarpal/metatarsal exostoses have been associated with bench knee or offset knee conformation (Anderson and McIlwraith, 2004; Weller et al., 2006) and tarsal plantar desmitis with sickle hock conformation (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011). The high prevalences of horses with metacarpal/metatarsal exostoses and tarsal plantar desmitis may therefore be indicators of the level of poor conformation present in the population. Love et al. (2006) found a prevalence of 12.94% for offset knees in a sample of 3,916 Thoroughbred yearlings. This was similar to the prevalence of metacarpal/metatarsal exostoses found in the current study (17.11%) indicating that the two may indeed be related. Poor limb conformation is undesirable in a high performance Thoroughbred as it puts extra pressure on the joints and may result in the horse breaking down earlier in its career. While metacarpal/metatarsal exostoses and tarsal plantar desmitis are not always held to be performance limiting conditions they may be indicators that a deeper problem may be present and may be useful indicators to potential purchasers with regards to how well the horse may stand up to training and racing stresses. The relative longevity of the racing careers of horses with these musculoskeletal defects is not known.

Metacarpal/metatarsal exostoses and SDDTS were both significantly more likely to occur in four year olds than three year olds ($P < 0.001$). This can be explained by the fact that the older the horse is the greater the opportunity they have had to acquire these defects. The horse will have had more concussion on the limbs which may result in the formation of metacarpal/metatarsal exostoses and SDDTS.

2.4.5.1 Location of Musculoskeletal Defects

There were significant differences between the distributions of certain defects on different limbs ($P < 0.05$). Horses were more likely to be lame on a hind limb than on a front limb. Metacarpal/metatarsal exostoses were significantly more likely to occur on the front legs than on the hind legs and more likely to occur on the left front than on the right front. They were also found to be significantly more likely to be on the medial aspect of the limb than the lateral aspect. This is in agreement with Ford (1960) and Stashak (2011) who state that metacarpal/metatarsal exostoses are most common on the medial front limb. Tarsal plantar desmitis were significantly more likely to occur on the left hind leg and SDDTS were more likely to occur on the hind legs. Hoof cracks however were significantly more likely to occur on the front legs than on the hind legs and on the right front than on the left front ($P < 0.05$).

The predilection of the metacarpal/metatarsal exostoses and tarsal plantar desmitis for the left hand side compared to the right hand side is a novel finding and may be due to a variety of factors. Horses are known to be more commonly left lateralised than right lateralised (Deuel and Lawrence, 1987) unlike humans who are predominantly right handed. It is possible that the horses therefore place more stress on this side of their body causing an increase in the prevalence of defects on this side. It is also possible that when the horses were being lunged in preparation for the sales the handlers allowed them to work more on the left rein, the horse's favourite rein, than on the right, putting more stress on the inside or left legs. This increased level of stress on the left legs may have resulted in the increased number of defects on these legs.

2.4.6 Oral and Dental Defects and Features

The prevalence of dental defects and features was 1.76%, with wolf teeth being the most common feature affecting 0.55% of the sample. The second most common defect or feature was parrot mouth affecting 0.46%, while 0.24% of the sample had missing teeth. This is at variance with the results of Dixon et al. (1999a) which found that the most common incisor defect was traumatic fractures followed by retained deciduous incisors and developmental displacement. However Dixon et al.'s (1999a) study investigated horses referred with dental defects, while this study investigated a sample of otherwise healthy horses. All of the dental defects present affected the incisors, with no defects of the cheek teeth observed. However this does not ensure that such defects were not present. The horses' teeth were examined without the use of a gag which makes it impossible to examine the cheek teeth fully and therefore the incisors may have been examined more thoroughly than the cheek teeth.

2.4.7 Ocular Defects

Ocular defects affected 1.71% of the sample in this study. The most prevalent ocular defect was corneal opacity, affecting 0.58%. This is a low prevalence which contradicts Craven (1971) who stated that corneal opacity is a commonly observed defect. However it may be that as the horses in this study are young Thoroughbreds which were being brought to auction they may have been more shielded from injuries than the general mixed breed population resulting in fewer corneal opacities.

2.4.8 Effect of Sex on Prevalence of Defects

There was an uneven distribution of geldings and fillies in the sample (n = 13,568) with 75.01% geldings and 24.99% fillies. The sex of the horse was found to have a significant influence on the occurrence of a range of defects. The defects in question included tarsal plantar desmitis, SDDTS, calcaneal bursitis, sand cracks, dental defects, sarcoids and muscle wastage to name a few ($P < 0.05$). Sex was also found to have an effect on selling status ($P < 0.05$). Previous studies have reported that geldings were more likely to have RLN (Dixon et al., 2001) and lameness (Vigre et al., 2002) than fillies. This study however found sex to have no significant effect on either of these defects ($P > 0.05$). This may be because horses affected by these defects may have been withdrawn before reaching the sales and therefore would not have been available for inclusion in the analysis or because of the relative uniformity of age and work status of the population.

Geldings were significantly more likely to be sold than fillies, probably reflecting purchaser preferences. They were also significantly more likely to have tarsal plantar desmitis, sarcoids and dental defects ($P < 0.05$) whereas fillies were more likely to have calcaneal bursitis, SDDTS, sand cracks and muscle wastage ($P < 0.05$).

2.4.9 Effect of Age on the Prevalence of Defects

Age had a significant effect on the occurrence of respiratory noise, RLN, heart murmurs, lameness, metacarpal/metatarsal exostoses and SDDTS ($P < 0.05$). This is in accordance with the study by Cole et al. (2005) which found that age had a significant effect on the occurrence of defects. The majority of the defects identified as being affected by age increased in prevalence from age three to age four years. This can be explained by the fact that the older the horse is the greater the opportunity they have had to acquire these defects. The horse will have had more concussion on the limbs resulting in metacarpal/metatarsal exostoses and SDDTS. The increase in the prevalence of heart murmurs is in agreement with the results of the study by Buhl et al. (2005) who found that the prevalence of heart murmurs in their sample increased over the period of the study. Although at the time they were unsure whether to attribute this change to age or the increase in training, it would appear from this study that the ageing of the horses may have contributed to it.

2.4.10 Effect of Year of Birth on the Prevalence of Defects

The year of birth had a significant effect on the prevalence of a variety of defects, both prejudicial and non-prejudicial ($P < 0.05$). The prevalence of respiratory defects was seen to fall from horses born in 1998 to 2006, while the prevalence of tarsal plantar desmitis and calcaneal bursitis did not significantly vary between 1998 and 2006. This may indicate that breeders are becoming more selective in their breeding and are trying to eliminate respiratory defects which have serious effects on the performance of a race horse. However, it is highly unlikely that a period of eight years should see a reduction in RLN by more than 50%, it is therefore possible that as more emphasis has been placed on RLN and its detrimental effect on performance, owners are less likely to present a horse with this defect at the sales. Alternatively, it is possible that this could be due to a change in emphasis by the veterinarians during the examination, however, as practices and procedures in the pre-purchase examination did not change during this period this is not likely. The lack of change in most musculoskeletal defects may indicate that it is only horses with prejudicial defects that owners are reluctant to enter into the sale. Although there was no significant change for the majority of musculoskeletal defects, a dramatic reduction was observed in metacarpal/metatarsal exostoses from 1998 to 2006. The prevalence for metacarpal/metatarsal exostoses almost halved in this time period, from 20.1% to 11.1%. While possible that this decrease was due to changes in breeding, it is more likely due to changes in management practices.

2.4.11 Prevalence of Defects in Sold and Unsold Horses

The prevalences of several of the defects were found to be significantly different for the horses that were sold or unsold ($P < 0.05$). The proportions of horses with no defects, prejudicial defects, respiratory noise and RLN were significantly different between these two categories ($P < 0.05$), with horses that were sold being more likely to have no defects and horses that were not sold likely to have more prejudicial defects, respiratory noise and RLN. This indicates that purchasers are more reluctant to purchase horses with these defects and implies that these defects are felt to be undesirable in a racehorse. RLN has frequently been associated with poor racing performance (Morris and Seeherman, 1991; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005) therefore it is unsurprising that horses with this defect were less likely to be sold. Interestingly, there was no significant difference between the prevalences of cardiac defects in the sold and unsold groups, with horses affected by this type of defect just as likely to be sold as unsold. However this may be because some of the defects, such as murmurs that disappear on exercise, were classed as not likely to prejudice the horses use for racing therefore purchasers would have less hesitation in buying a horse affected with this type of defect.

2.4.12 Effect of Defects on Price

The presence of many of the defects investigated in the study had an effect on the price realised at sale ($P < 0.05$). Horses with prejudicial defects, abnormal respiratory noises, RLN or cardiac defects, all achieved significantly lower prices at sale than horses without these defects. Higher proportions of horses in the lower price categories were also found to be affected with each of these defects than horses in the higher price categories. This indicates that purchasers believe these defects will negatively impact racing performance and therefore are not willing to pay as much as for unaffected horses. A large number of non-prejudicial defects were also seen to have an effect on price. Horses with metacarpal/metatarsal exostoses, tarsal plantar desmitis, sand cracks, hoof cracks or wounds and lacerations were significantly less expensive at sale than horses without these defects. This may indicate that purchasers also find these defects undesirable in a racehorse. Metacarpal/metatarsal exostoses, tarsal plantar desmitis and hoof cracks are all associated with pain and lameness at various stages in their formation, which in turn may affect performance (Rooney, 1981; Rossdale et al., 1985; Wilson and Pardoe, 1998; Pardoe and Wilson, 1999; O'Grady, 2001; Ross et al., 2002; Major and Zubrod, 2006; Baxter, 2011). Therefore, they would be unattractive to potential purchasers, resulting in lower prices.

2.4.13 Prevalence of Defects in Horses Withdrawn from Sale

A total of 815 horses were withdrawn from the sale, following examination by the veterinary panel. While 4.05% had no defects, 83.56% of these had some prejudicial defect recorded. This is a strong indication that the main reason for withdrawal from the sale was the presence of a prejudicial defect. The majority of these horses, (55.09% of the withdrawn horses) were diagnosed as making a respiratory noise, while 41.72% were found to have RLN. A further 10.06% of the horses were withdrawn before the endoscope examination so they may or may not have had RLN. Although the prevalences of prejudicial defects were much higher in the withdrawn sample than the sample as a whole, there was little difference in the prevalences of non-prejudicial defects, such as metacarpal/metatarsal exostoses and tarsal plantar desmitis, which were found to affect 17.67% and 19.75% respectively. This suggests that the horses were withdrawn upon the discovery of a prejudicial defect, because they might not attain a high price in the sale, or in the hopes of treating the problem and therefore selling the horse for a greater price, privately, or at a later sale.

2.4.14 Differences between Private and Panel Veterinarians

There were significant differences between the prevalences of defects diagnosed by the first examining veterinarians and the panel veterinarians, with the panel veterinarians more likely to diagnose all defects. This could be due to a number of reasons, including a lack of specialist equine knowledge on the part of the first examining veterinarians. Many of these may be general practitioners that do not specialise in equine practice and therefore may have a more limited expertise of the defects affecting horses or may have some difficulty diagnosing them. It is also possible that the conditions in which the horses were examined at the home venue were less than ideal compared to the purpose-built facilities at the sales complexes. If a wind examination is being conducted in an open field on a windy day it is more difficult to diagnose an abnormal respiratory noise than in an enclosed lunging arena at the sales. A further reason may be that the private veterinarian might feel compromised by the relationship with the owner and feel that identifying defects might not be in his/her commercial interests, particularly since the opinion of the panel veterinarian is still to come and is to be taken as the final decision.

2.5 Conclusions and Recommendations

The results highlight the high prevalence of defects in the general Thoroughbred NH population sent for sale. Nearly three quarters of the sample (73.58%) were affected by defects of some kind and more than one tenth (12.02%) were affected by defects likely to prejudice their use for racing. It is worrying that more than one in every 10 supposedly healthy horses were affected with defects known to be prejudicial to future use as a racehorse and it therefore may be of benefit to the Thoroughbred industry to consider stricter breeding guidelines, in an effort to reduce the prevalence of these defects.

Year of birth had a significant effect on the prevalence of a variety of defects. The prevalence of overall defects, prejudicial defects, respiratory noise and RLN showed a downward trend from 1998 to 2006. This may indicate that breeders are becoming more selective. If tighter breeding regulations existed, including monitoring of progeny, those horses affected with or passing on prejudicial defects such as RLN to their progeny could potentially be withheld from breeding. This could further assist in decreasing the prevalence of these defects.

Horses with defects achieved significantly lower prices at sale than horses without defects and the prevalences of horses with a variety of defects were much higher in the lower sale price categories than in the higher price categories. This indicates that buyer perception may be influenced by the defects present, resulting in lower prices. It also indicates that the veterinary examination is considered by buyers to be an important assessment of the animals work and commercial value.

Overall, the results show the usefulness and importance of veterinary pre-purchase examination certificates. Without this examination purchasers would be unaware that more than 10% of the horses offered were potentially unsuitable for their intended career and without the examinations by the panel veterinarians five out of every six prejudicial defects would be overlooked. This indicates that the current system implemented by the sales companies is very useful to the purchasers and plays an important role in their selection of horses for purchase.

Recording of defects in a public database would allow monitoring of conformation within the industry and could also prove to be a useful form of progeny evaluation. Veterinary pre-purchase examination certificates from sales could serve as official information to populate this database. This would then provide valuable information to breeders when selecting stallions, indicating the potential quality of the resulting progeny.

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Chapter 3

Estimation of Heritability Values for a Range of Anatomical Defects in Young Thoroughbred National Hunt Horses

Abstract

The objective of this study was to estimate heritability values for a range of anatomical defects in young Thoroughbred National Hunt horses. Heritability values were also estimated for price and selling status and genetic and phenotypic correlations were estimated between the variables. Data were obtained from the pre-purchase veterinary examination certificates and sales catalogues for 8,933 young Thoroughbred National Hunt horses that attended Tattersalls Ireland's Derby and August Sales, Goffs Ireland June Sale and Doncaster Bloodstock Sales Ltd. (DBS) Spring Sale, from 2002-2006 and for the three year olds presented for sale at the DBS 2001 Spring Sale. A pedigree file, three generations deep was generated and heritability (h^2) estimates were estimated using an animal model and ranged from 0.01 (±0.008) for calcaneal bursitis to 0.52 (±0.044) for price. Heritability estimates for the defects were highest for tarsal plantar desmitis (0.23 [±0.030]), respiratory noise (0.13 [±0.021]), recurrent laryngeal neuropathy (RLN) (0.10 [±0.019]) and metacarpal/metatarsal exostoses (0.10 [±0.020]). The h^2 values were below 0.10 for the remaining defects.

Genetic and phenotypic correlations between defects and between defects and the selling status were also investigated. The majority of the genetic and phenotypic correlations between the defects were very weak, however, some strong correlations were observed. Phenotypic correlations were found to range from 0.00 (±0.011) for pelvic asymmetry and being unsold, to 0.65 (±0.006) for respiratory noise and being withdrawn from the sale. The strongest genetic correlation observed was also between respiratory noise and being withdrawn from the sale with a value of 0.99 (±0.298). The strongest genetic correlations between defects were found between RLN and respiratory noise (0.91 [±0.035]), RLN and prejudicial defects (0.96 [±0.023]) and respiratory noise and prejudicial defects (0.90 [±0.039]). There was also a very strong positive genetic correlation between being withdrawn from the sale and the presence of prejudicial defects (0.96 [±0.173]), respiratory noise (0.92 [±0.196]), and RLN (0.99 [±0.298]). The results indicate that while some defects have a heritable component and selective breeding may help reduce the prevalence of these defects in the National Hunt population, given the relatively low heritability values genetic progress would be slow.

3.1 Introduction

Thoroughbred breeding is a significant industry in Ireland and the United Kingdom with approximately twelve thousand foals born each year. Unfortunately not all of these horses will ever appear on the racetrack. Approximately one quarter of these foals never race (Minkema, 1975; Pearson, 2006) and of those that do almost half never win a race (More, 1999). Unsoundness (the inability of the horse to perform the function for which it has been purchased) is the primary cause of wastage in the industry, both from injuries occurring during training, or from predisposing conditions that may lead to a future unsoundness in the horse. It is therefore important that the horse is free from any of these predisposing conditions. It is also important that the extent to which certain conditions or defects may affect the performance of a horse is known within the industry.

Horses may be affected by many diverse anatomical defects throughout their life, of varying significance. While some defects may not have a detrimental effect on the horse, others, such as recurrent laryngeal neuropathy (RLN) or cardiac defects, may have a prejudicial effect on the racing performance of the horse. Some defects are generally considered to be heritable; however, there is currently very little literature available concerning the heritability of these defects, and most equine heritability studies to date have examined conformational traits or performance traits (Dolvik and Klemetsdal, 1999; Albertsdóttir et al., 2008; Ducro et al., 2009; Suontama et al., 2011).

Several studies have, however, investigated the heritability of RLN (Hillidge, 1985; Poncet et al., 1989; Ohnesorge et al., 1993; Miesner, 1996; Ibi et al., 2003) using a variety of methods. Studies by Ohnesorge et al. (1993), Poncet et al. (1989) and Hillidge (1985) investigated samples of horses bred by specific sires comparing the prevalence of RLN in the progeny of affected sires with the prevalence in the progeny of unaffected sires. The prevalence of the condition in the progeny of affected sires was significantly higher than that in the progeny of unaffected sires in each study. Miesner (1996) and more recently Ibi et al. (2003) have estimated h^2 values for RLN. Miesner (1996) estimated an h^2 value of 0.61, which was much higher than the values of 0.23 and 0.20 for the binary and categorical RLN traits estimated by Ibi et al. (2003). While these studies do indicate that RLN is heritable, it is evident by the disparity in the results that further research is necessary in this area. Lameness was also found to be heritable in a study by Dolvik and Gaustad (1996) which estimated a heritability value of 0.33. Further defects such as tarsal plantar desmitis and metacarpal/metatarsal exostoses have previously been reported to be heritable (Quinlan and Morton, 1957), however this has not been reliably demonstrated and no estimates of heritability are currently available.

While no direct research into the heritability of defects such as metacarpal/metatarsal exostoses and tarsal plantar desmitis has been conducted to date, there has however been research regarding the heritability of conformational traits which are commonly associated with these defects. Metacarpal/metatarsal exostoses are often associated with bench knee or offset knee conformation (Anderson and McIlwraith, 2004; Weller et al., 2006) and tarsal plantar desmitis with sickle hock conformation (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011). RLN has also been associated with larger/taller horses and those with long necks (Goulden and Anderson, 1981; Goulden et al., 1985; Dixon et al., 2001; Hawe et al., 2001). The heritability of these and other conformation traits has been examined extensively in recent years (Dolvik and Klemetsdal, 1999; Love et al., 2006; Albertsdóttir et al., 2008; Ducro et al., 2009; Albertsdóttir et al., 2011; Suontama et al., 2011).

Heritability estimates for wither height have been found to range from 0.67 to 0.84 (Dolvik and Klemetsdal, 1999; Albertsdóttir et al., 2008; Ducro et al., 2009; Suontama et al., 2011), while neck length had a h^2 value of 0.23 (Ducro et al., 2009). Increased wither height has been associated with a predisposition to RLN. Leg stance (posture and position of leg) has been estimated to have a h^2 value of between 0.12 and 0.23 (Albertsdóttir et al., 2011; Suontama et al., 2011) while more specifically, offset knees, which are associated with metacarpal/metatarsal exostoses, and "curby hocks", hocks predisposed to tarsal plantar desmitis, have been estimated to have h^2 values of 0.42 (Love et al., 2006) and 0.40 (Dolvik and Klemetsdal, 1999), respectively. As these conformational traits/faults have proven to be heritable, it is therefore likely that the associated anatomical defects are also, in some part, heritable.

If the heritability of more anatomical defects were known, it might be possible to reduce their prevalence in the population by using more selective breeding, similar to that used in Quarter Horses to reduce the occurrence of hyperkalemic periodic paralysis (HYPP). Currently, all horses in a known affected line must be genetically tested and those that are homozygous for HYPP are no longer permitted to be registered for breeding (Secombe and Lester, 2011). The present study therefore aimed to determine the heritability of a range of defects using the pre-purchase examination certificates produced, for an elite Thoroughbred population, at a number of Thoroughbred sales venues over a number of years.

3.2 Materials and Methods

The study investigated veterinary pre-purchase examination certificates for a sample of 8,933 Thoroughbred National Hunt (NH) horses which were presented for sale at Tattersalls Ireland and Goffs Ireland from 2002 to 2006 and Doncaster Bloodstock Sales Ltd. (DBS) from 2001 to 2006. The data were obtained from a combination of the veterinary pre-purchase examination certificates that were produced for each horse, by members of the appointed panel of veterinarians, and the sales catalogues. All horses in the sample were either three or four years old, all other ages were not included in the analysis.

3.2.1 Defects

The prevalences of the defects were determined from the veterinary pre-purchase examination certificates obtained from the sales companies (chapter two). The pre-purchase examinations were carried out on each horse (8,933), by a private veterinarian, within 14 days of the sale for Tattersalls Ire. and Goffs Ire. (Tattersalls Ire Conditions of Sale, 2012; Goffs Conditions of Sale, 2012) and within 28 days of the sale for DBS (DBS Conditions of Sale, 2012) and then again at the sales venue by a randomly chosen member of the approved veterinary panel appointed by the sales company. The results from both examinations were combined (if agreed upon by the panel veterinarian) and put onto a final veterinary certificate which was available to the public for viewing and which was read out while the horse was in the sales ring. The panel veterinarians' decision was considered the final decision in the event of any discrepancy between the two veterinarians. In cases where a horse was entered into multiple sales, the most recent veterinary pre-purchase examination certificate was used for analysis. Information regarding the prevalence of investigated defects can be seen in Table 3.1 below.

Table 3.1: Number of Observations and Prevalence of the Defects Investigated

Trait	*No. of Observations*	*Prevalence*	*% Prejudicial*
No Defects	2,201	24.6%	0.00%
Prejudicial Defects	883	9.9%	100%
Respiratory Noise	1,112	12.4%	100%
Recurrent Laryngeal Neuropathy (RLN)	554	6.2%	100%
Cardiac Defects	129	1.4%	50.39%
Pelvic Asymmetry	185	2.1%	3.24%
Metacarpal/Metatarsal Exostosis	1,614	18.1%	0.00%
Tarsal Plantar Desmitis	1,755	19.6%	0.00%
Synovial Distension of the Digital Tendon Sheath (SDDTS)	306	3.4%	0.00%
Calcaneal Bursitis	361	4.0%	0.00%
Hoof Cracks	451	5.0%	0.00%
Sarcoids	487	5.5%	3.28%
Papillomas	468	5.2%	1.28%
Dental Defects	154	1.7%	0.65%
Ocular Defects	145	1.6%	6.90%
Selling Status			
- Sold	6,611	74.0%	–
- Unsold	1,679	18.8%	–
- Withdrawn	643	7.2%	–

3.2.2 Pedigree Information

All of the horses in the study were registered Thoroughbreds. The sales catalogue provided a full three generation pedigree for the majority of the horses in the sample. Missing ancestry details were obtained from the Weatherbys database (weatherbys.ie). Three complete generations of ancestry were available for 99.93% of horses included in this sample.

3.2.3 Statistical Analysis

All analyses were undertaken using an animal model in ASReml3 (Gilmour et al., 2009). Throughout the analyses the statistical significance of all fixed effects was based on the F-test.

Data were analysed using the following model:

$$y_{ijklmnop} = \mu + SEX_i + AGE_j + SALE_k + SALEYEAR_l + VET_m + a_n + vendor_o + e_{ijklmnop}$$

where

$y_{ijklmnop}$ = the trait,

μ = the population mean,

SEX_i = the fixed effect of sex,

AGE_j = the fixed effect of age at sale,

$SALE_k$ = the fixed effect of sale,

$SALEYEAR_l$ = the fixed effect of year of sale,

VET_m = the fixed effect of examining veterinarian,

a_n = the random effect of the horse,

$vendor_o$ = the random effect of vendor

$e_{ijklmnop}$ = the random residual effect

Bivariate analysis was performed on all possible combinations of traits in order to obtain genetic and phenotypic correlations. The same fixed and random effects were included in the bivariate model.

Only data from horses that went through the sales ring (sold or unsold) were correlated with price, the data from horses that were withdrawn from sale were not correlated with price as no selling price was realised. For horses that were unsold, the highest bid value was used as this indicated the perceived value of the horse by the industry.

3.3 Results

3.3.1 Heritability Estimates

The heritability estimates for the traits analysed are shown in Tables 3.2 and 3.3 below. Very low h^2 values were found for each of the selling statuses; sold, unsold and withdrawn, however, the heritability estimate for price was 0.52 (±0.044).

Table 3.2: Heritability (h^2) with Standard Error (s.e.) for Selling Status and Price

	h^2 (s.e.)
Sold	0.02 (0.009)
Unsold	0.02 (0.010)
Withdrawn	0.01 (0.008)
Price	0.52 (0.044)

The heritability estimates for the defects ranged from 0.003 (±0.0059) for ocular defects to 0.23 (±0.030) for tarsal plantar desmitis. Heritability estimates for the defects were highest for tarsal plantar desmitis (0.23 [±0.030]), respiratory noise (0.13 [±0.021]), RLN (0.10 [±0.019]) and metacarpal/metatarsal exostoses (0.10 [±0.020]). The h^2 values were below 0.10 for the remaining defects (Table 3.3).

Table 3.3: Heritability (h^2) with Standard Error (s.e.) for the Traits Analysed

Defect	*h^2 (s.e.)*
No Defects	0.02 (0.010)
Prejudicial Defects	0.09 (0.019)
Respiratory Noise	0.13 (0.021)
RLN	0.10 (0.019)
Cardiac Defects	0.06 (0.017)
Pelvic Asymmetry	0.03 (0.012)
Metacarpal/Metatarsal Exostosis	0.10 (0.020)
Tarsal Plantar Desmitis	0.23 (0.030)
SDDTS	0.04 (0.012)
Calcaneal Bursitis	0.01 (0.008)
Hoof Cracks	0.05 (0.015)
Sarcoids	0.06 (0.018)
Papillomas	0.04 (0.012)
Dental Defects	0.03 (0.013)
Ocular Defects	0.003 (0.0059)

3.3.2 Genetic and Phenotypic Correlations between the Defects

Bivariate analysis was performed on all possible combinations of traits in order to obtain genetic and phenotypic correlations. Phenotypic correlations ranged from 0.00 (±0.011) for pelvic asymmetry and being unsold to 0.65 (±0.006) for respiratory noise and being withdrawn from the sale, while genetic correlations ranged from 0.001 (±0.1467) for price and cracked hoofs to 0.99 (±0.298) for respiratory noise and being withdrawn from the sale.

The majority of the genetic and phenotypic correlations between the defects were very weak, however, some strong correlations were observed. The strongest genotypic correlations between defects were found between RLN and respiratory noise (0.91 [±0.035]), RLN and prejudicial defects (0.96 [±0.023]) and respiratory noise and prejudicial defects (0.90 [±0.039]). Each was a very strong positive correlation as was expected. There was also a very strong positive genetic correlation between being withdrawn from the sale and the presence of prejudicial defects (0.96 [±0.173]), respiratory noise (0.92 [±0.196]), and RLN (0.99 [±0.298]). Cardiac defects were found to be strongly positively correlated with calcaneal bursitis (0.79 [±0.334]) and negatively genetically correlated with hoof cracks (-0.45 [±0.186]), meaning that horses with cardiac defects were more likely to have calcaneal bursitis and less likely to have hoof cracks than horses without cardiac defects. Sarcoids and papillomas were found to be strongly positively genetically correlated (0.73 [±0.151]) (but very weakly phenotypically correlated, 0.04 [0.011]) and, surprisingly, sarcoids and being unsold were very strongly negatively correlated (-0.90 [±0.116]) meaning that horses with sarcoids were less likely to be unsold.

Phenotypic correlations were found to range from 0.00 (±0.011) for pelvic asymmetry and being unsold to 0.76 (±0.005) for prejudicial defects and RLN. The strongest phenotypic correlations between defects were found between RLN and prejudicial defects (0.76 [±0.005]), RLN and respiratory noise (0.66 [±0.006]) and respiratory noise and prejudicial defects (0.60 [±0.007]). Cardiac defects also showed a weak correlation with prejudicial defects (0.22 [±0.010]). Prejudicial defects, respiratory noise and RLN all showed weak negative phenotypic correlations with being sold and modest positive phenotypic correlations with being withdrawn, as shown in Table 3.4. They also showed very weak negative phenotypic correlations with price, -0.14 (±0.014), -0.13 (±0.013) and -0.11 (±0.014), respectively.

The defects with the strongest negative phenotypic correlation with price included prejudicial defects, RLN and respiratory noise. These defects were also strongly negatively correlated with being sold, whilst the absence of defects was the strongest positive correlation (both genetic and phenotypic) with being sold.

Table 3.4: Heritability Estimates (on the Diagonal), Phenotypic Correlations (above the Diagonal) and Genetic Correlations (below the Diagonal) for a Range of Traits with their Standard Errors (in Brackets)

	None	Prejudicial Defect	Respiratory Noise	RLN	Cardiac Defect	Tarsal Plantar Desmitis	Metacarpal/ Metatarsal Exostosis	Calcaneal Bursitis	SDDTS	Cracked Hoof	Sarcoids	Papillomas	Pelvic Asymmetry	Oral/Dental Defects and Features	Ocular Defect	Price	Sold	Unsold	Withdrawn
None	**0.02 (0.009)**															0.06 (0.012)	0.10 (0.011)	-0.02 (0.011)	-0.13 (0.011)
Prejudicial Defect		**0.09 (0.019)**	0.90 (0.039)	0.96 (0.023)	-0.01 (0.175)	0.01 (0.123)	-0.01 (0.0110)	0.41 (0.306)	-0.01 (0.011)	0.07 (0.178)	0.004 (0.0110)	-0.03 (0.011)	-0.02 (0.222)	-0.004 (0.0110)	-0.33 (0.724)	-0.14 (0.014)	-0.33 (0.010)	-0.06 (0.011)	0.65 (0.006)
Respiratory Noise		0.60 (0.007)	**0.13 (0.021)**	0.66 (0.006)	-0.01 (0.155)	-0.11 (0.108)	-0.003 (0.0111)	0.19 (0.252)	-0.003 (0.0109)	0.04 (0.159)	0.009 (0.0110)	-0.01 (0.011)	-0.07 (0.199)	-0.001 (0.0110)	0.47 (0.674)	-0.13 (0.013)	-0.24 (0.011)	-0.003 (0.0112)	0.41 (0.009)
RLN		0.76 (0.005)	0.91 (0.035)	**0.10 (0.019)**	-0.12 (0.166)	-0.17 (0.115)	-0.001 (0.0110)	0.18 (0.279)	-0.01 (0.011)	0.10 (0.168)	0.003 (0.0109)	-0.02 (0.011)	0.07 (0.209)	-0.00 (0.011)	-0.46 (0.766)	-0.11 (0.014)	-0.22 (0.011)	-0.03 (0.011)	0.42 (0.009)
Cardiac Defect		0.22 (0.010)	0.005 (0.0109)	0.01 (0.011)	**0.06 (0.017)**	0.15 (0.143)	0.004 (0.0109)	0.79 (0.334)	-0.003 (0.0108)	-0.45 (0.186)	-0.003 (0.0109)	-0.02 (0.011)	0.13 (0.261)	0.01 (0.011)	0.12 (0.598)	-0.04 (0.013)	-0.07 (0.011)	-0.01 (0.011)	0.14 (0.011)
Tarsal Plantar Desmitis		-0.002 (0.0113)	-0.02 (0.012)	-0.01 (0.011)	0.01 (0.011)	**0.23 (0.030)**	0.003 (0.0114)	-0.02 (0.259)	-0.01 (0.011)	0.13 (0.147)	-0.03 (0.011)	-0.01 (0.011)	-0.14 (0.185)	-0.01 (0.011)	0.01 (0.011)	-0.04 (0.014)	-0.02 (0.011)	0.02 (0.011)	0.002 (0.0108)
Metacarpal/ Metatarsal Exostosis		-0.12 (0.147)	-0.03 (0.132)	-0.16 (0.139)	0.02 (0.172)	-0.16 (0.120)	**0.10 (0.020)**	0.15 (0.268)	0.01 (0.011)	0.13 (0.174)	-0.25 (0.167)	0.01 (0.011)	0.12 (0.219)	-0.01 (0.011)	0.10 (0.475)	-0.01 (0.013)	0.002 (0.0109)	-0.002 (0.0110)	-0.001 (0.0107)
Calcaneal Bursitis		-0.001 (0.0107)	0.01 (0.011)	0.01 (0.011)	0.01 (0.011)	-0.01 (0.011)	0.02 (0.011)	**0.01 (0.008)**	0.01 (0.011)	-0.01 (0.011)	0.02 (0.011)	-0.002 (0.0107)	0.21 (0.452)	-0.01 (0.011)	0.01 (0.011)	-0.02 (0.012)	0.003 (0.0108)	-0.00 (0.011)	-0.005 (0.0107)
SDDTS		0.13 (0.182)	0.24 (0.158)	0.09 (0.176)	0.16 (0.211)	-0.38 (0.150)	0.18 (0.182)	-0.40 (0.376)	**0.04 (0.012)**	-0.09 (0.219)	-0.10 (0.215)	-0.02 (0.224)	0.27 (0.261)	-0.31 (0.244)	0.06 (0.602)	0.01 (0.012)	0.01 (0.011)	-0.01 (0.011)	-0.01 (0.011)
Cracked Hoof		0.002 (0.0110)	0.01 (0.011)	0.01 (0.011)	-0.004 (0.0109)	0.001 (0.0112)	0.01 (0.011)	-0.33 (0.362)	0.01 (0.011)	**0.05 (0.015)**	0.03 (0.011)	-0.01 (0.011)	-0.68 (0.262)	-0.01 (0.011)	-0.01 (0.011)	-0.02 (0.012)	-0.01 (0.011)	0.01 (0.011)	0.004 (0.0108)
Sarcoids		0.04 (0.172)	0.06 (0.153)	0.08 (0.163)	-0.34 (0.181)	-0.15 (0.138)	-0.004 (0.0109)	0.24 (0.333)	0.004 (0.0108)	0.36 (0.200)	**0.06 (0.018)**	0.04 (0.011)	-0.14 (0.265)	0.01 (0.011)	0.99 (1.046)	0.01 (0.013)	0.002 (0.0110)	0.004 (0.0111)	-0.01 (0.011)
Papillomas		-0.10 (0.184)	0.07 (0.165)	0.09 (0.175)	-0.15 (0.214)	0.002 (0.1579)	-0.05 (0.182)	0.11 (0.344)	-0.01 (0.011)	0.35 (0.216)	0.73 (0.151)	**0.04 (0.012)**	-0.07 (0.267)	0.09 (0.252)	0.25 (0.694)	0.02 (0.012)	0.01 (0.011)	0.01 (0.011)	-0.02 (0.011)
Pelvic Asymmetry		-0.002 (0.0108)	-0.002 (0.0108)	-0.01 (0.011)	0.02 (0.011)	0.03 (0.011)	0.01 (0.011)	-0.01 (0.011)	-0.02 (0.011)	0.001 (0.0108)	0.003 (0.0107)	0.004 (0.011)	**0.03 (0.012)**	-0.01 (0.011)	-0.01 (0.011)	-0.03 (0.012)	0.003 (0.0108)	0.00 (0.011)	-0.003 (0.011)
Oral/Dental Defect & Features		-0.10 (0.206)	-0.21 (0.177)	-0.19 (0.189)	0.12 (0.242)	-0.40 (0.151)	0.56 (0.201)	0.44 (0.373)	0.003 (0.0109)	-0.03 (0.253)	-0.18 (0.243)	0.01 (0.011)	0.26 (0.298)	**0.03 (0.013)**	-0.98 (1.186)	-0.03 (0.012)	-0.01 (0.012)	0.01 (0.012)	0.01 (0.011)
Ocular Defect		0.01 (0.011)	-0.02 (0.011)	-0.02 (0.011)	0.01 (0.011)	0.31 (0.442)	0.001 (0.011)	0.39 (0.895)	-0.01 (0.011)	0.79 (0.997)	0.01 (0.011)	-0.004 (0.0106)	0.40 (0.790)	0.05 (0.011)	**0.003 (0.0059)**	-0.02 (0.012)	-0.01 (0.011)	0.00 (0.011)	0.02 (0.0107)
Price	0.24 (0.204)	-0.03 (0.117)	0.02 (0.102)	0.02 (0.112)	-0.15 (0.138)	-0.01 (0.087)	-0.04 (0.117)	-0.18 (0.262)	0.10 (0.157)	0.001 (0.1467)	0.25 (0.128)	0.41 (0.14)	0.01 (0.189)	-0.31 (0.161)	-0.06 (0.473)	**0.52 (0.044)**	0.12 (0.013)	-0.12 (0.012)	
Sold	0.58 (0.283)	-0.56 (0.193)	-0.31 (0.201)	-0.39 (0.210)	-0.47 (0.267)	-0.07 (0.211)	-0.36 (0.231)	-0.62 (0.363)	-0.26 (0.280)	-0.35 (0.269)	0.01 (0.283)	0.26 (0.283)	0.08 (0.352)	0.18 (0.327)	0.13 (0.772)	0.76 (0.17)	**0.02 (0.009)**		
Unsold	-0.55 (0.28)	0.11 (0.227)	-0.14 (0.205)	-0.05 (0.217)	0.47 (0.259)	0.19 (0.196)	-0.15 (0.257)	0.57 (0.341)	-0.40 (0.264)	0.27 (0.259)	-0.90 (0.116)	-0.27 (0.298)	-0.02 (0.329)	0.36 (0.223)	-0.37 (0.784)	0.26 (0.272)		**0.02 (0.010)**	
Withdrawn	-0.07 (0.465)	0.96 (0.173)	0.92 (0.196)	0.99 (0.298)	0.05 (0.392)	-0.24 (0.280)	-0.11 (0.336)	0.23 (0.644)	-0.12 (0.426)	0.24 (0.395)	0.32 (0.410)	0.36 (0.441)	-0.22 (0.478)	0.19 (0.453)	0.52 (1.118)				**0.01 (0.008)**

3.4 Discussion

3.4.1 Limitations

This study investigated a select sample of horses. Only horses that were entered into the sale and which underwent the veterinary panel pre-purchase examination were analysed. The sample therefore did not include any horses that were retained for breeding or racing purposes or that were of an insufficient quality to be entered into the sales. Nor did it include any horses that were withdrawn prior to the panel examination. These horses may have been withdrawn for a variety of reasons including the identification of a prejudicial defect by the private examining veterinarian, being sold before the sale, injuries such as lameness, or circumstances making it impossible for the vendor to attend the sale. It must also be noted that defects may have been overlooked during the examinations and that only the horses identified as having a respiratory noise were examined for RLN by endoscopic examination.

3.4.2 Heritability Estimates

The h^2 values estimated in this study indicate that there is a weak genetic influence on selling status and on a range of anatomical defects. Papillomas, SDDTS, dental defects, pelvic asymmetry, calcaneal bursitis and ocular defects all had h^2 values below 0.05 while the highest h^2 value was 0.23 for tarsal plantar desmitis. Only four defects had h^2 values over 0.10, abnormal respiratory noise, RLN, tarsal plantar desmitis and metacarpal/metatarsal exostoses. The h^2 values of 0.23 for tarsal plantar desmitis and 0.10 for metacarpal/metatarsal exostoses lends credence to the suggestion by Quinlan and Morton (1957) that these defects have a heritable component.

The h^2 value of 0.10 for RLN found in this study is lower than those found in previous studies, 0.61 (Miesner, 1996) and 0.20 – 0.23 (Ibi et al., 2003). However, every horse in the studies by Miesner (1996) and Ibi et al. (2003) was examined endoscopically whereas, in the current study only those identified as having an abnormal respiratory noise were examined with an endoscope to determine the presence of RLN. It is therefore possible that some cases of RLN in the sample may have been overlooked. A study by Dixon et al. (2001) found that only approximately 90% of the horses affected with RLN produced an abnormal respiratory noise, while Marti and Ohnesorge (2002) found that only 54.8% of the horses found to have RLN in their sample were found to produce an respiratory noise. If every horse in the current study had been examined endoscopically it is possible that a higher prevalence of RLN may have been found and this may have contributed to a higher and potentially more accurate heritability estimate.

It was interesting that the heritability estimates for defects that are associated with poor conformation were not higher. Metacarpal/metatarsal exostoses are often associated with bench knee or offset knee conformation (Anderson and McIlwraith, 2004; Weller et al., 2006) and tarsal plantar desmitis with sickle hock conformation (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011) which have previously been estimated to have h^2 values of 0.42 (Love et al., 2006) and 0.40 (Dolvik and Klemetsdal, 1999), respectively. It was therefore expected that h^2 values of greater than 0.10 for metacarpal/metatarsal exostoses and 0.23 for tarsal plantar desmitis would be estimated. These low estimates may be a result of the composition of the sample population. As the majority of the horses in the sample were preselected for entry into the sales, based on conformation and pedigree, only those with better conformation were accepted. This bias towards horses with more correct conformation may have resulted in an inaccurate heritability estimate for these defects. Alternatively, tarsal plantar desmitis and metacarpal/metatarsal exostoses may be a severe manifestation of poor conformation and may only appear in a fraction of this population.

Both sarcoids and papillomas had quite low h^2 values, 0.06 and 0.04, respectively. This was unsurprising as both sarcoids and papillomas are known to be caused by viruses (Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Radostits et al., 2007; Bogaert et al., 2008). Therefore, it would not be expected that there would be a strong genetic influence on the occurrence of either defect. Previous studies have found that the occurrence of sarcoids is associated with the expression of equine leukocyte antigens found predominantly in certain breeds of horses (Lazary et al., 1985; Meredith et al., 1986; Broström et al., 1988), however, there is very little known about the effect of sire within a specific breed. The very low h^2 value for ocular defects (0.003) was also unsurprising as this covered a wide range of defects, the most common of which was corneal scars. As this defect is a result of environmental factors it would not be expected to have a genetic influence.

The overall low values found for the defects in this study may indicate that there is a very weak genetic influence on these defects; however, it is possible that in the general population the values may be higher. The sample in the current study is somewhat select. Records were only available for horses deemed of a high enough quality for the sale. The sample therefore does not include any horses that were of an insufficient quality to be entered into the sales or those that were retained for breeding or racing purposes. Nor does it include any horses that were withdrawn prior to the panel examination. These horses may have been withdrawn for a variety of reasons including the identification of a prejudicial defect by the private examining veterinarian. As the sample is composed of horses selected for the sale, the prevalence of each defect is potentially much lower than in the actual population which may have affected the estimation of accurate heritability values. It would have been informative, albeit not possible, to analyse all horses entered for sale and not just those presented for sale.

Very low heritability estimates of 0.02 or less were found for the selling statuses sold, unsold and withdrawn. This indicates that conformation plays more of a role in whether or not a horse will be sold than the pedigree of the horse or that there is little variation in these parameters. There was however, a high h^2 value for price (0.52). This was not surprising as price at sale is largely based on the pedigree of the horse.

3.4.3 Genetic and Phenotypic Correlations between the Defects

3.4.3.1 Defects

The majority of the genetic and phenotypic correlations were weak, showing that there was very little connection between the defects analysed. There were however, some strong correlations observed between defects. Prejudicial defects and respiratory noise, and prejudicial defects and RLN were found to be strongly positively phenotypically correlated and modestly to strongly positively genetically correlated. Every case of respiratory noise and RLN was classified as prejudicial to racing which would result obviously in a strong correlation with prejudicial defects.

Respiratory noise and RLN were also very strongly positively phenotypically correlated and modestly positively genetically correlated. Again, this is not surprising as all of the horses identified with RLN in the study were first identified with respiratory noise. Only horses with an abnormal respiratory noise were examined endoscopically to determine the presence of RLN. RLN was very weakly positively correlated with calcaneal bursitis and very weakly negatively correlated with tarsal plantar desmitis.

Cardiac defects were found to be weakly positively phenotypically correlated with prejudicial defects. This was as expected, as only a small proportion of cardiac defects were considered likely to prejudice use for racing. Cardiac defects were also strongly positively genetically correlated with calcaneal bursitis and modestly negatively phenotypically correlated with hoof cracks. There is no apparent reason why this should be the case.

Tarsal plantar desmitis were found to be weakly negatively genetically correlated with SDDTS. As certain types of hock conformation, such as sickle or cow hocks, predispose horses to the development of tarsal plantar desmitis (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011) it is possible that this conformation of the hock takes pressure off the fetlocks resulting in fewer SDDTS on the hind limbs. A modest negative genetic correlation was observed between oral or dental defects and features and tarsal plantar desmitis and a modest positive genetic correlation was observed between oral or dental defects and features and metacarpal/metatarsal exostoses. There is no apparent biological reason why this should be the case.

It was interesting that the correlations between various types of limb defects were quite low. As the majority of these defects are associated with poor conformation it was assumed that defects such as metacarpal/metatarsal exostoses and SDDTS might therefore be more strongly correlated. Metacarpal/metatarsal exostoses are commonly associated with offset knee conformation (Anderson and McIlwraith, 2004; Weller et al., 2006) which may put more strain on the fetlock joints, potentially resulting in SDDTS. While a genetic correlation of 0.18 was found between metacarpal/metatarsal exostoses and SDDTS, the value was not significant (s.e. = $\pm$0.182). It was unfortunate that the conformation of the horses was not routinely noted as it would have been useful to investigate the correlations between conformation and anatomical defects.

Sarcoids and papillomas were strongly genetically positively correlated. It is possible that they may have been misidentified by the examining veterinarians as they can look quite similar, resulting in both being identified when only one was present. However, as both are caused by viruses, Bovine Papilloma Virus 1 and 2 and Equine Papilloma Virus 1 and 2 respectively (Murphy et al., 1999; Barrelet et al., 2010), this may indicate that the affected horses might have an impaired immune function making them more susceptible to both viruses.

Ocular defects were very strongly positively phenotypically correlated with sarcoids and very strongly negatively phenotypically correlated with oral or dental defects and features. The standard errors however were very large, indicating that it may be advisable to do further analysis with a larger sample size. A very small proportion of horses in the sample were affected with ocular defects (1.6%), therefore the values may not be as accurate as desired.

3.4.3.2 Price

Weak positive genetic correlations were found between price and the absence of defects and price and sarcoids while a modest positive genetic correlation was found between price and papillomas. It was very surprising that the presence of sarcoids and papillomas increased sale price as both of these defects are caused by viral infections (Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Radostits et al., 2007; Bogaert et al., 2008) and the common perception within the industry would be to advise against purchasing a horse with sarcoids. The strongest negative genetic correlation with price was for oral or dental defects and features while prejudicial defects, respiratory noise and RLN also recorded very weak genetic correlations with price. This was unexpected as prejudicial defects are those likely to have a negative effect on racing performance and RLN is known to affect performance (Lane et al., 1987; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006). It was anticipated that horses with these defects would have significantly lower prices than those without these defects. Stronger phenotypic correlations were found between price and prejudicial defects, respiratory noise and RLN; however, they were still very weak, between -0.11 and -0.14.

3.4.3.3 Selling Status

There was a positive genetic correlation between being sold and the absence of defects, and a negative genetic correlation between being sold and the presence of prejudicial defects (-0.56 ± 0.193). This result was as expected, as it is unlikely that purchasers wish to purchase horses with defects likely to prejudice their use as a racehorse. This reinforces the findings discussed previously in chapter two where higher proportions of prejudicial defects were present in horses that were not sold than those that were sold and higher proportions of horses without defects were present in horses that were sold than in unsold horses. It was also anticipated that there would be negative phenotypic and genetic correlations between sold and respiratory noise and sold and RLN. As mentioned previously, these defects are known to have a negative effect on performance (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006) therefore, it would be expected that horses with these defects would be less likely to be sold and be more likely to be unsold. Strangely, cardiac defects had stronger genetic correlations with being sold and being unsold than respiratory noise or RLN, even though the majority of the cases of cardiac defects were found by the examining veterinarians to be unlikely to prejudice use for racing. It was interesting to note that sarcoids were strongly negatively genetically correlated with being unsold. It was anticipated that sarcoids would be positively correlated with being unsold as they are locally invasive skin tumours which can persist for life (Murphy et al., 1999; Knottenbelt and Kelly, 2000) and which may become more aggressive over time (Knottenbelt, 2008); however, it appears that they are not viewed very negatively within the Thoroughbred industry.

Very strong positive genetic correlations and modest positive phenotypic correlations were found between being withdrawn from sale and prejudicial defects, respiratory noise and RLN. This was expected as horses with these defects are commonly withdrawn from sale. As horses with these defects usually achieve much lower prices at sale (see chapter 2) owners often withdraw them from the sales in the hopes of selling them at a later date when the defect may have disappeared or may have been treated in the interim.

3.5 Conclusion

A number of the conditions affecting Thoroughbred horses at veterinary examination have a modest heritable component. For these conditions a reduction in their prevalence might be achieved by selective breeding within the industry, similar to that used by other horse breeders. However, given the relatively low heritability of the defects calculated in this study, the rate of genetic progress arising from selection would be expected to be slow.

Due to the heritable component of these defects it might be useful to record defects in a public database to allow monitoring of the occurrence of defects within the industry. This may also prove to be a useful form of progeny evaluation. The database could provide valuable information to breeders when selecting stallions, indicating the potential quality of the resulting progeny. Such a database would benefit greatly if the data from all animals entered into the sale were available.

The majority of defects were very weakly genetically and phenotypically correlated. Prejudicial defects were strongly positively correlated with being withdrawn from sale and sarcoids were strongly negatively correlated with being unsold, however, no other strong positive or negative correlations were observed between being sold or unsold and any of the defects.

While the correlations between the anatomical defects were very weak it may be of benefit in the future to investigate the genetic and phenotypic correlations between conformation and anatomical defects. This may contribute to the understanding of whether it is the defect or the underlying conformation that plays a role in poor performance.

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Chapter 4

Effect of Sex, Selling Status and Price Realised at Sale on the Racing Performance of Thoroughbred National Hunt Horses

Abstract

This study sought to investigate the effect of sex, selling status and price realised at sale on the subsequent racing performance of a large sample of horses. The study population consisted of information concerning 5,282 Thoroughbred National Hunt horses that were presented for sale at ages three and four years. The information was gathered from the pre-purchase veterinary examination certificates from three years of Tattersalls Ireland's Derby and August Sales, Goffs Ireland June Sale and Doncaster Bloodstock Sales Ltd. (DBS) Spring Sale, from 2002-2004. At least four years of possible racing data were available for each horse.

Overall, 82.24% (4,344) of the sample raced at some stage in their life, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five years. Only 40.64% (1,700) ever won a race, while 56.28% (2, 354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample (2,564 horses) won or were placed in a race. Sex, selling status and price realised at sale were seen to have a large effect on the racing performance of the horses in the sample. Mares had significantly fewer career starts (8.07±0.223 compared to 10.36±0.146), wins (0.49±0.033 compared to 1.03±0.030) and places (1.19±0.060 compared to 1.90±0.045) than geldings ($P < 0.001$). Horses that were sold had significantly more career starts, wins and places (10.04±0.143, 0.96±0.029 and 1.81±0.044, respectively) than horses that were not sold (9.14±0.290, 0.71±0.052 and 1.51±0.083, respectively) or that were withdrawn (8.88±0.452, 0.71±0.089 and 1.41±0.125, respectively) from the sale ($P < 0.05$) and horses that were in the higher price brackets at the sales had significantly more career starts (10.86±0.234 for horses >€20,001 compared to 8.19±0.276 for horses <€5,000), wins (1.31±0.053 for horses >€20,001 compared to 0.47±0.037 for horses <€5,000) and places (2.15±0.077 for horses >€20,001 compared to 1.14±0.075 for horses <€5,000) than horses in the lower price brackets ($P < 0.001$).

Mares, unsold horses and horses in the lower price categories had significantly fewer National Hunt starts (2.28±0.064 compared to 2.61±0.036, $P < 0.001$; 2.22±0.075 compared to 2.63±0.036, $P < 0.001$ and 1.87±0.074 for horses <€5,000 compared to 3.09±0.054 for horses >€20,001, $P < 0.001$, respectively) and significantly more Irish Point-to-Point starts (1.07±0.049 compared to 0.86±0.023, $P < 0.001$; 1.11±0.053 compared to 0.83±0.023, $P < 0.001$ and 1.40±0.060 for horses <€5,000 compared to 0.43±0.027 for horses >€20,001, $P < 0.001$, respectively) per year raced than geldings, sold horses and horses in the higher price categories respectively, indicating that the poorer quality horses were directed towards the Irish Point-to-Point circuit while the more expensive or higher quality horses were directed towards the higher stakes races. The results indicate that price realised at sale does indicate the quality and potential of the horse, and that buyer's monetary appraisal may be a useful indicator of athletic potential.

4.1 Introduction

Thoroughbred horse breeding and racing are significant industries in Ireland and the UK, with approximately twelve thousand foals born each year. Not all of the foals bred will make it to the racetrack, approximately one quarter will never race (Minkema, 1975; Pearson, 2006) and of those that do almost half never win a race (More, 1999). Conformational and other abnormalities can affect the soundness of a horse and can impede its performance to varying degrees. It is therefore important that the horses produced have as few performance limiting conditions as possible. Pre-purchase examinations are conducted on all three and four year old National Hunt (NH) horses that are sold at public auction in Ireland and the UK. These serve to identify some of the abnormalities present in the horse for the prospective purchaser. However, it is not clear whether all of the abnormalities that may be listed on the certificate are likely to affect the performance of the horse.

In addition to desiring a horse free from performance limiting conditions purchasers predominantly base their purchasing decisions on pedigree and conformation (Parsons and Smith, 2008). However, as Thoroughbred horses are usually purchased at auction, before training and racing have commenced, it can be difficult to determine if a horse is a potential winner or not. Previous studies have determined the association between purchase price and future racing performance; however, these invariably investigate samples of yearlings destined to run on the flat (Heckerman, 1996; Robbins and Kennedy, 2001; Jackson et al., 2011). As the price of Thoroughbred yearlings increased so too did the probability of winning a stakes race (Heckerman, 1996; Robbins and Kennedy, 2001) and the prize money earned also increased (Heckerman, 1996; Jackson et al., 2011). Jackson et al. (2011) also determined that as purchase price increased so too did the likelihood of horses racing, the number of starts and the number of places ($P < 0.001$). While this information is available regarding Thoroughbred yearlings, there is currently no information regarding the association between sale price and racing performance in Irish and British NH Thoroughbred horses.

In chapter two it was determined that fillies realised significantly lower mean prices at sale than geldings (€11,138.36$\pm$286.30 compared to €21,384.96$\pm$238.34, $P < 0.001$) indicating that purchasers believed that fillies made inferior racehorses to geldings. Additionally, Jackson et al. (2011) found that male horses significantly outperformed female horses in every flat racing performance variable. Previous studies have also found that male horses are physiologically more suited to high performance than female horses. Female horses have higher heart rates at submaximal exercise than male horses, suggesting they may have a lower aerobic capacity than males (Mukai et al., 2003) and training significantly increases the V_{200} of male horses while having no significant effect on the V_{200} of female horses (Ohmura et al., 2002). Geldings are often larger than mares and have a longer stride length (Seder and Vickery, 2003) and as the level of competition increases, the proportion of mares performing decreases (Whitaker et al., 2008). As NH racing is made more difficult by the addition of obstacles, it is therefore even more likely that male horses will outperform female horses; however, there are currently no studies available regarding this. The aim of this study was therefore to investigate the effect of sex on NH racing performance and also to investigate the association between sale price and racing performance and selling status and racing performance.

4.2 Materials and Methods

The sample consisted of data from 5,282 three and four year old NH horses that were presented for sale at Tattersalls Ireland, Goffs Ireland and Doncaster Bloodstock Sales Ltd. (DBS) from 2002 to 2004. The number of horses from each sale is shown in Table 4.1 below. These years were chosen as they allowed at least four years of possible racing per horse. The cut-off date for the races included in the analysis was the 31st of December 2009. Any race ran after this date was excluded from the study. The effects of sex, selling status and price realised at sale on racing performance were then analysed to determine if these had an effect on the performance of the horse.

Table 4.1: Number of Horses Analysed from Each Sale for Each Year

	Tattersalls Ire.		*Goffs Ire.*	*Doncaster Bloodstock*	*Total*
	Derby	August	June	Spring	
2004	452	643	459	267	1,821
2003	382	636	416	314	1,748
2002	380	609	402	322	1,713
Total	1,214	1,888	1,277	903	5,282

Information used to identify the horses, including dam, sire and year of birth was taken from the sales catalogues. The names of the horses were then acquired from the Weatherbys' database using this information and the performance results were then taken from the racing post website and the Irish Point-to-Point website. All results were from individual horses. If horses were entered into multiple sales only the last sales results were analysed. The Euro was the currency used to analyse sales prices. Where the price was in Pounds Sterling, all values were converted to Euro using the exchange rates for the date of sale provided by the European Central Bank. Earnings were analysed in Pounds Sterling as this was the currency used by the racing post website. Although the female horses in the sample were sold as fillies (female horses four years and younger) the majority of their racing careers took place after the age of five, therefore they will be referred to as mares throughout this chapter.

4.2.1 Pre-Sale Procedure

When a young untrained NH horse is entered into a sale, it must undergo certain pre-sales procedures in the form of veterinary pre-purchase examinations, the first completed by the vendor's private veterinarian at home and the second by a member of the sales appointed veterinary panel. As illustrated in Figure 4.1 below, horses can be withdrawn from the sale at any point during this pre-sale procedure. Once the horse goes through the sales ring, it can be either sold or unsold. Only data for those horses that were presented at the sales venue were analysed to determine the effect of sex, selling status and price realised at sale on future racing performance. For horses that were unsold, the highest bid value was determined to be the price realised at sale as this indicated the perceived value of the horse by the industry.

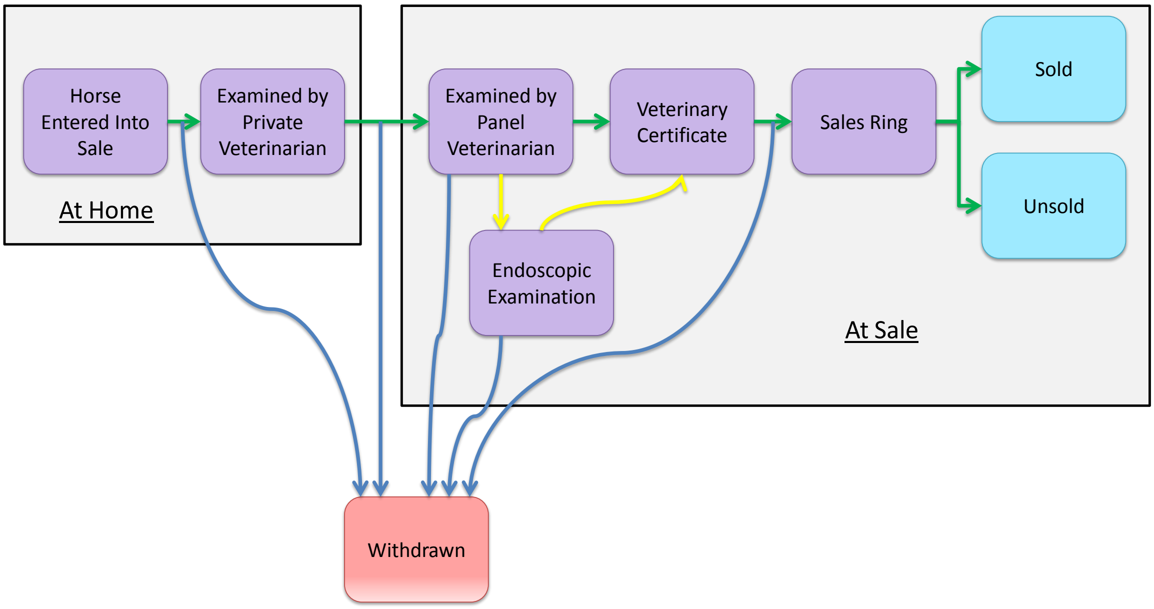


Figure 4.1: Flowchart Showing Progress Through the Pre-Sale Procedures

4.2.2 Statistical Analysis

SPSS version 19.0 for Windows was used to analyse the data. ANOVAs were used to determine the variance of the mean for selling status and price achieved at sale while t-tests were used to analyse sex. Chi-squared tests were used to analyse several of the racing parameters (signified with * below).

The variables that were analysed were:

- Sex
- Selling Status
- Price Realised at Sale

The racing parameters that were analysed were:

1. Raced vs. Unraced *
2. Raced by Age 4 Years vs. Unraced by Age 4 Years*
3. Raced by Age 5 Years vs. Unraced by Age 5 Years*
4. Win vs. No Wins *
5. Placed vs. No Places *
6. Second Placed vs. No Second Places *
7. Third Placed vs. No Third Places *
8. Win or Place vs. No Win or Place *
9. Type of Racing Career*
10. Age at 1st Race
11. Starts per Year Raced
12. National Hunt Starts per Year Raced
13. Hurdle Starts per Year Raced
14. Steeplechase Starts per Year Raced
15. Irish Point-to-Point Starts per Year Raced
16. Starts at Age 4 Years
17. Starts at Age 5 Years
18. Starts at Age 6 Years
19. Starts at Age 7 Years
20. Starts at Age 8 Years
21. Starts up to Age 8 Years
22. Raced at Age 7 Years vs. Unraced at Age 7 Years
23. Raced at Age 8 Years vs. Unraced at Age 8 Years
24. Non-Finished Races per Start
25. Win Strike Rate
26. Place Strike Rate
27. Second Place Strike Rate
28. Third Place Strike Rate
29. Overall Win and Place Strike Rate
30. National Hunt Win Strike Rate
31. National Hunt Place Strike Rate
32. Irish Point-to-Point Win Strike Rate
33. Irish Point-to-Point Place Strike Rate
34. Earnings per Start
35. Wins at Age 4 Years Strike Rate
36. Places at Age 4 Years Strike Rate
37. Wins at Age 5 Years Strike Rate
38. Places at Age 5 Years Strike Rate
39. Wins at Age 6 Years Strike Rate
40. Places at Age 6 Years Strike Rate
41. Wins at Age 7 Years Strike Rate
42. Places at Age 7 Years Strike Rate
43. Wins at Age 8 Years Strike Rate
44. Places at Age 8 Years Strike Rate
45. Wins up to Age 8 Years Strike Rate
46. Places up to Age 8 Years Strike Rate
47. Wins up to Age 8 Years
48. Places up to Age 8 Years

The data selected for analysis varied depending on the racing parameter. All horses were included for analysis of parameter 1. For the rest of the variables, only horses that raced were included in the analysis, however, 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

Only horses that raced were included for analysis of parameters 2-29, 32 and 45-48 inclusive. Only horses that raced by age four years were included for parameters 35 and 36, horses that raced at age five years for 37 and 38, at age six years for 39 and 40, at age seven years for 41 and 42 and at age eight years for 43 and 44. Only horses that raced in NH races were included for parameters 30 and 31 and only horses that raced in Irish Point-to-Point were included for parameters 32 and 33. Parameters 11-15 were calculated by determining the total number of starts that the animal had before the 31st of December, 2009 and dividing by the number of years raced. Parameters 24 and 34 were calculated by determining the total number of non-finished races and the total earnings that the animal had before the 31st of December, 2009 and dividing by the number of starts for that animal. Parameters 16-20 and 35-44 include every start, win or place which the animal had from the 1st of January to the 31st of December of the appropriate year for that particular animal. Every start, win and place the animal had up to and including the age of eight years was included for parameters 21 and 45-48. Parameter 25-29 were calculated by determining the total number of wins, places and total wins and places each animal had up to and including the age of eight years and expressing it as a percentage of the number of starts that animal had up to and including age eight years. Parameters 30-33 were calculated by determining the total number of NH (30-31) wins and places and Irish Point-to-Point (32-33) wins and places each animal had before the 31st of December, 2009 and expressing it as a percentage of the total number of NH or Irish Point-to-Point starts for that animal. Parameters 35-46 were calculated by determining the total number of wins and places each animal had in the relevant year(s) and expressing it as a percentage of the number of starts that animal had in the relevant year(s). Parameter 24 included races where the horse was pulled up, fell, retired, refused, ran out, slipped up and refused to run. It did not include races where the rider was unseated or where the horse was brought down because it was considered that these occurrences did not reflect on the athletic ability of the horse.

4.3 Results

4.3.1 Sample Description

4.3.1.1 Proportion of Horses that Raced, Won and Placed

Of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life. One hundred and sixty one of these horses (3.05% of the sample) raced in only British Point-to-Point races and due to the unavailability of data were excluded from further analysis. Of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 3,240 horses or 77.46% had raced by the age of five years. Only 40.64% (1,700) ever won a race, while a larger proportion, 56.28% (2,354) were placed in a race, with 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample (2,564 horses) won or were placed in a race.

The majority of horses, 53.07% (2,220), raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. The mean earnings per start were £443.0±1,350.34 and the mean percentage of non-finished races per start was 26.25%±28.454.

4.3.1.2 Age at First Race

The majority of the horses, 54.24%, began their racing career at age five years while 22.69% first raced at age four years and 17.93% first raced at age six years. Only 5.14% began racing at any other age, as shown in Table 4.2 below. The mean age at first race was 5.04±0.818 years.

Table 4.2: Age at First Race

Age at First Race	*N*	*Proportion*	*Cumulative Proportion*
2 Years	2	0.05%	0.05%
3 Years	20	0.48%	0.53%
4 Years	949	22.69%	23.22%
5 Years	2,269	54.24%	77.46%
6 Years	750	17.93%	95.39%
7 Years	146	3.49%	98.88%
8 Years	47	1.12%	100.00%

4.3.1.3 Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that the horse raced. Only horses that raced were included in the analysis. The mean number of starts per year raced in the sample was 3.48$\pm$1.821 and the most starts any horse averaged in one year was 14.25. Horses participated in significantly more hurdle races than any other type of race (1.79$\pm$1.565) followed by Irish Point-to-Points and then steeplechase races (0.91$\pm$1.376 and 0.74$\pm$1.249 starts respectively). Further details are outlined in Table 4.3 below.

Table 4.3: Mean Number of Starts per Year Raced

	n	*Mean $\pm$ S.D.*	*Min*	*Max*
Mean Number of Starts per Year Raced	4,183	3.48$\pm$1.821	1	14.25
Mean Number of NH Starts per Year Raced	4,183	2.53$\pm$2.037	0	13.75
- Mean Number of Hurdle Starts per Year Raced	4,183	1.79$\pm$1.565	0	11.00
- Mean Number of Steeplechase Starts per Year Raced	4,183	0.74$\pm$1.249	0	10.17
Mean Number of Irish Point-to-Point Starts per Year Raced	4,183	0.91$\pm$1.376	0	9.00

4.3.1.4 Win and Place Strike Rates

The win strike rate was calculated as the number of wins relative to the total number of races ran, expressed as a percentage and the place strike rate was calculated as the number of places relative to the number or races ran, also expressed as a percentage. The strike rates ranged from zero to 100, with mean win, place and overall win and place strike rates of 6.75%±11.689, 13.37%±16.319 and 20.11%±21.999, respectively.

Table 4.4: Mean Win and Place Strike Rates

	n	*Mean%±S.D.*	*Min*	*Max*
Win Strike Rate	4,183	6.75±11.689	0	100
Place Strike Rate	4,183	13.37±16.319	0	100
Second Place Strike Rate	4,183	6.30±10.232	0	100
Third Place Strike Rate	4,183	5.94±9.517	0	100
Overall Win and Place Strike Rate	4,183	20.11±21.999	0	100

4.3.1.5 Number of Starts at Various Ages

Six year olds showed the highest number of starts and the highest mean number of starts, 22 and 2.94±3.01, respectively. The lowest number of starts was observed in four year old horses, with a maximum number of 12 starts and a mean number of 0.57±1.34 starts. When examining the total number of starts up to age eight years it was found that one horse had raced 59 times while the mean number of starts was 9.80±8.00.

Table 4.5: Number of Starts from Ages Four to Eight Years

	n	*Mean ± S.D.*	*Min*	*Max*
Starts at Age Four Years	4,183	0.57±1.344	0	12
Starts at Age Five Years	4,183	2.46±2.448	0	16
Starts at Age Six Years	4,183	2.94±3.007	0	22
Starts at Age Seven Years	4,183	2.22±2.986	0	17
Starts at Age Eight Years	4,183	1.59±2.805	0	21
Starts up to Age Eight Years	4,183	9.80±8.003	0	59

4.3.1.6 Mean Number of Wins and Places per Year Raced

The maximum number of wins and places per year raced was 5.57, while the mean number was 0.79±0.92 wins and places. Separately, the mean number of wins per year raced and the mean number of places per year raced were 0.54±0.66 and 0.25±0.40 respectively. Interestingly, the maximum number and the mean number of second places was higher than those for either first or third places, as shown in Table 4.6 below. The mean numbers of both wins and places per year raced were higher for NH races than Irish Point-to-Point races. The mean number of wins for NH was 0.23±0.38 compared to 0.14±0.25 for Irish Point-to-Point, while the mean number of places was 0.47±0.62 compared to 0.30±0.49.

Table 4.6: Mean Number of Wins and Places per Year Raced

	n	*Mean ± S.D.*	*Min*	*Max*
Mean Number of Wins per Year Raced	4,183	0.25±0.397	0	3.00
Mean Number of Places per Year Raced	4,183	0.54±0.660	0	4.40
Mean Number of Second Places per Year Raced	4,183	0.27±0.415	0	4.00
Mean Number of Third Places per Year Raced	4,183	0.26±0.382	0	3.00
Mean Number of Wins or Places per Year Raced	4,183	0.79±0.916	0	5.57
Mean Number of NH Wins per Year Raced	3,440	0.23±0.383	0	3.00
Mean Number of NH Places per Year Raced	3,440	0.47±0.624	0	4.40
Mean Number of Irish Point-to-Point Wins per Year Raced	1,955	0.14±0.247	0	2.20
Mean Number of Irish Point-to-Point Places per Year Raced	1,955	0.30±0.485	0	4.00

4.3.1.7 Number of Wins and Places at Various Ages

Only horses that raced at a specific age were used in the analysis for the wins and places at that age. The minimum number of wins and places for each year was zero. The highest number of wins was observed in seven and eight year olds which had the highest maximum number of wins, 7 each, and the highest means, 0.43±0.82 and 0.41±0.81, respectively. The lowest number of wins was observed in four year olds with a maximum number of 3 and a mean of 0.18±0.46. Seven and eight year olds also had the largest mean number of places, 0.82±1.21 and 0.82±1.17 respectively, and seven year olds had the highest number of places which was 10. When looking at all of the horses that raced, means of 0.90±1.566 wins and 1.73±2.431 places were observed from the start of their racing careers up to the age of eight years. The maximum number of wins was 15 while the maximum number of places was 18.

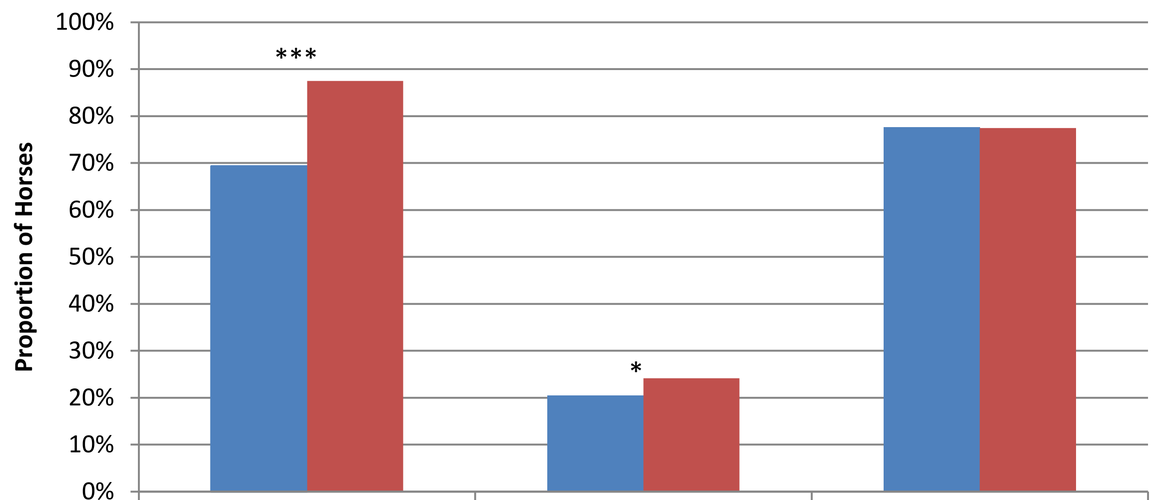
Table 4.7: Number of Wins and Places from Ages Four to Eight Years

	n	*Mean ± S.D.*	*Min*	*Max*
Wins at Age Four Years	970	0.18±0.460	0	3
Places at Age Four Years	970	0.41±0.779	0	6
Wins at Age Five Years	3,050	0.29±0.629	0	5
Places at Age Five Years	3,050	0.53±0.904	0	7
Wins at Age Six Years	2,941	0.40±0.767	0	6
Places at Age Six Years	2,941	0.75±1.126	0	9
Wins at Age Seven Years	2,169	0.43±0.819	0	7
Places at Age Seven Years	2,169	0.82±1.208	0	10
Wins at Age Eight Years	1,505	0.41±0.810	0	7
Places at Age Eight Years	1,505	0.82±1.175	0	8
Wins up to Age Eight Years	4,183	0.90±1.566	0	15
Places up to Age Eight Years	4,183	1.73±2.431	0	18

4.3.2 Effect of Sex on Racing Performance

4.3.2.1 Effect of Sex on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five years. Of the 5,282 horses in the sample five were colts (0.09%) and were excluded from the analysis for the effect of sex on racing performance. Of the remaining 5,277 horses, 1,525 or 28.9% were mares and 3,752 or 71.1% were geldings. Of these 3,752 geldings, 87.5% raced compared to only 69.3% of the 1,525 mares. This difference was significant (χ^2 = 244.708, df = 1, P < 0.001) with geldings significantly more likely to race than mares. For the rest of the variables, only horses that raced were included in the analysis, however, 161 of these horses raced in only British Point-to-Point races and due to lack of data were excluded from further analysis. Of the remaining horses that raced, geldings were significantly more likely to race at age four years than mares (χ^2 = 6.135, df = 1, P = 0.013). There was however no significant difference between the proportion of mares and geldings that raced by age five years (χ^2 = 0.007, df = 1, P = 0.933) with both being equally likely to race (Figure 4.2).



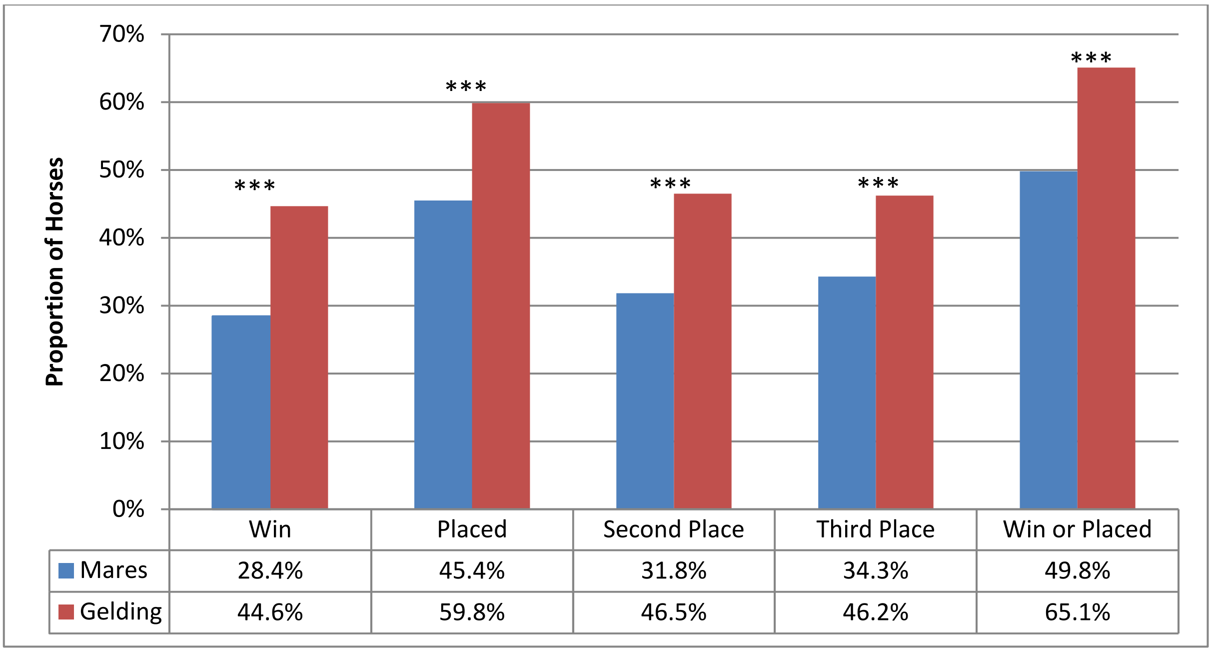
	Raced	Raced at Four	Raced by Five
Mares	69.3%	20.4%	77.6%
Gelding	87.5%	24.1%	77.4%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.2: Proportion of Mares and Geldings that Raced

4.3.2.2 Effect of Sex on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Overall, 61.30% of the sample population (2,564 horses) won or were placed in a race. Geldings were significantly more likely to win a race than mares (44.6% vs. 28.4%, $\chi^2 = 84.270$, df = 1, $P < 0.001$). They were also significantly more likely to place in a race (59.3% vs. 45.4%, $\chi^2 = 65.208$, df = 1, $P < 0.001$), to place second in a race (46.5% vs. 31.8%, $\chi^2 = 68.102$, df = 1, $P < 0.001$) and to place third in a race (46.2% vs. 34.3%, $\chi^2 = 45.132$, df = 1, $P < 0.001$) than mares. Further information can be seen in Figure 4.3.



*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.3: Proportion of Mares and Geldings that Won or Placed in a Race

4.3.2.3 Effect of Sex on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for mares and geldings ($\chi^2 = 25.644$, df = 2, $P < 0.001$). A higher proportion of geldings raced in a combination of NH races and Irish Point-to-Point races than mares (30.6% vs. 24.9%) while a higher proportion of mares raced in only Irish Point-to-Point races compared to geldings (22.2% vs. 16.0%) (Figure 4.4).

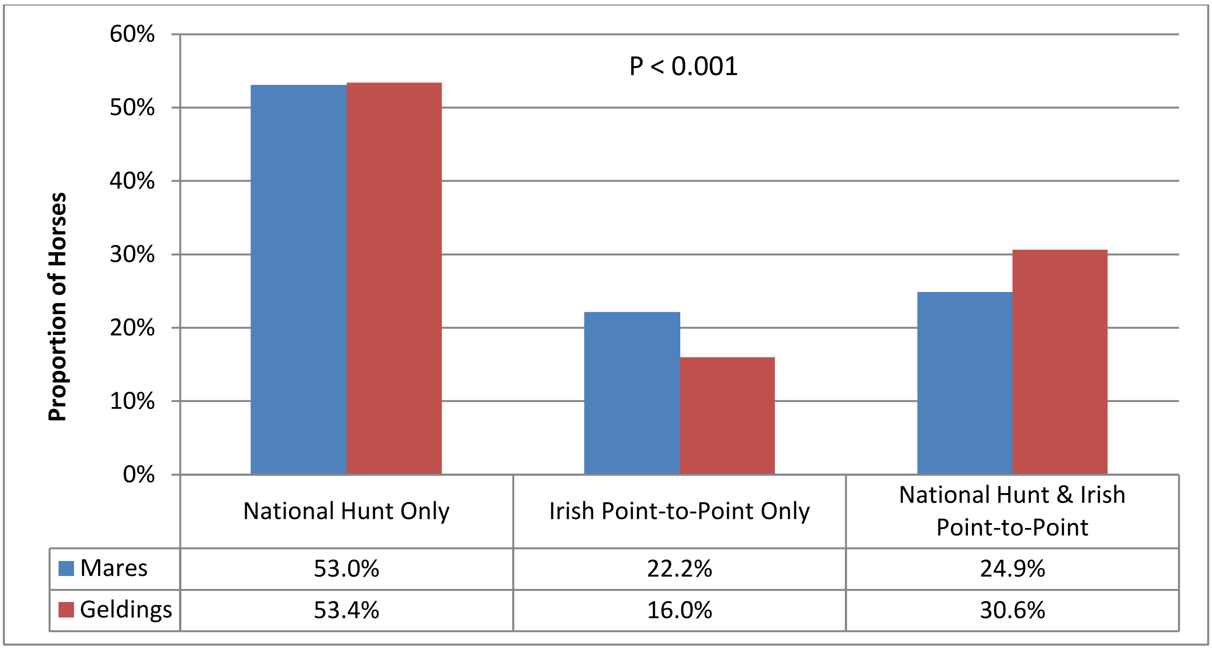


Figure 4.4: Proportion of Mares and Geldings that Raced in Only NH Races, Only Irish Point-to-Point Races or a Combination of NH and Irish Point-to-Point Races

4.3.2.4 Effect of Sex on the Age in Years at First Race

There was no significant difference in the age at first race for mares and geldings (data not shown, see Appendix 5, Table A.5).

4.3.2.5 Effect of Sex on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that the horse raced during the sample period. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48 ± 1.821, with horses participating in significantly more hurdle races than any other type of race (1.79 ± 1.565), followed by Irish Point-to-Points (0.91 ± 1.376) and then steeplechase races (0.74 ± 1.249). There was no significant difference between the mean number of overall starts per year raced for mares and geldings, 3.40 ± 0.059 and 3.51 ± 0.032 respectively ($P = 0.096$); however, there were highly significant differences between the mean numbers of NH starts, hurdle starts, steeplechase starts and Irish Point-to-Point starts per year raced ($P < 0.001$) as seen in Table 4.8 below. Mares raced in significantly more hurdle races and Irish Point-to-Point races while Geldings had significantly more NH starts overall and more steeplechase starts.

Table 4.8: Mean Number of Starts per Year Raced for Mares and Geldings

Variable	*Sex*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of NH Starts per Year Raced	Mare	1,030	2.28±0.064	-4.450	<0.001
	Gelding	3,148	2.61±0.036		
Mean Number of Hurdle Starts per Year Raced	Mare	1,030	2.01±0.057	4.616	<0.001
	Gelding	3,148	1.72±0.026		
Mean Number of Steeplechase Starts per Year Raced	Mare	1,030	0.28±0.025	-17.528	<0.001
	Gelding	3,148	0.89±0.024		
Mean Number of Irish Point-to-Point Starts per Year Raced	Mare	1,030	1.07±0.049	3.893	<0.001
	Gelding	3,148	0.86±0.023		

4.3.2.6 Effect of Sex on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Geldings had significantly more starts at ages six, seven, eight and up to age eight years ($P < 0.001$) than mares, as shown in Table 4.9 below. There was no significant difference in the number of starts, between mares and geldings, at any other age (data not shown, see Appendix 5, Table A.5).

Table 4.9: Number of Starts at Various Ages for Mares and Geldings

Variable	*Sex*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age Six Years	Mare	1,030	2.60±0.093	-4.272	<0.001
	Gelding	3,148	3.06±0.054		
Starts at Age Seven Years	Mare	1,030	1.55±0.083	-8.989	<0.001
	Gelding	3,148	2.44±0.054		
Starts at Age Eight Years	Mare	1,030	0.87±0.068	-11.110	<0.001
	Gelding	3,148	1.83±0.052		
Starts up to Age Eight Years	Mare	1,030	8.07±0.223	-8.625	<0.001
	Gelding	3,148	10.36±0.146		

4.3.2.7 Effect of Sex on Career Length

Geldings were significantly more likely to race at ages seven (56.3% compared to 38.3%, $\chi^2 = 100.052$, df = 1, $P < 0.001$) and eight years (41.1% compared to 20.4%, $\chi^2 = 144.173$, df = 1, $P < 0.001$) than mares.

4.3.2.8 Effect of Sex on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start between mares and geldings (data not shown, see Appendix 5, Table A.5).

4.3.2.9 Effect of Sex on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rate. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. Geldings were found to have significantly higher win strike rates, place strike rates and overall win and place strike rates than mares.

Table 4.10: Win and Place Strike Rates for Mares and Geldings

Variable	*Sex*	*n*	*Mean±S.E. (%)*	*t-value*	*Sig.*
Win Strike Rate	Mare	1,030	4.16±0.296	-9.317	<0.001
	Gelding	3,148	7.59±0.218		
Place Strike Rate	Mare	1,030	10.50±0.474	-6.815	<0.001
	Gelding	3,148	14.30±0.295		
Second Place Strike Rate	Mare	1,030	5.09±0.331	-4.275	<0.001
	Gelding	3,148	6.70±0.180		
Third Place Strike Rate	Mare	1,030	5.12±0.289	-3.183	<0.001
	Gelding	3,148	6.21±0.171		
Overall Win and Place Strike Rate	Mare	1,030	14.66±0.606	-9.945	<0.001
	Gelding	3,148	21.88±0.401		

4.3.2.10 Effect of Sex on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Geldings had significantly higher NH win and place strike rates than mares ($P < 0.001$) while mares had significantly higher Irish Point-to-Point win and place strike rates than geldings (Table 4.11).

Table 4.11: NH and Irish Point-to-Point Win and Place Strike Rates for Mares and Geldings

Variable	*Sex*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Win Strike Rate	Mare	799	3.27±0.303	-8.698	<0.001
	Gelding	2,638	6.47±0.206		
NH Place Strike Rate	Mare	799	9.02±0.512	-7.029	<0.001
	Gelding	2,638	13.22±0.310		
Irish Point-to-Point Win Strike Rate	Mare	1,469	12.64±0.621	-3.791	<0.001
	Gelding	483	8.64±0.851		
Irish Point-to-Point Place Strike Rate	Mare	1,469	16.82±0.648	-3.649	<0.001
	Gelding	483	12.78±0.898		

4.3.2.11 Effect of Sex on the Mean Earnings per Start

Overall, the mean earnings per start in the sample population were £443.0±1,350.34. Geldings earned significantly more money per start than mares ($P < 0.001$), £516.5(±26.85) compared to £218.8(±19.75), as shown in Table 4.12 below.

Table 4.12: Mean Earnings per Start for Mares and Geldings

Variable	*Sex*	*n*	*Mean ± S.E.(£)*	*t-value*	*Sig.*
Mean Earnings per Start	Mare	1,030	218.8±19.75	-8.932	<0.001
	Gelding	3,148	516.5±26.85		

4.3.2.12 Effect of Sex on the Win and Place Strike Rates at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. The win strike rates, at ages four, five, six, seven and up to age eight years, were significantly different with geldings having higher win strike rates than mares ($P < 0.05$), as seen below. Geldings also had significantly higher place strike rates at ages four, five, six and up to age eight years than mares ($P < 0.001$). There was no significant difference in the win strike rates at age eight years or in the place strike rates at ages seven or eight years between mares and geldings (data not shown, see Appendix 5, Table A.5).

Table 4.13: Win and Place Strike Rates at Various Ages for Mares and Geldings

Variable	*Sex*	*n*	*Mean±S.E. (%)*	*t-value*	*Sig.*
Wins at Age 4 Years Strike Rate	Mare	210	3.32±0.936	-4.207	<0.001
	Gelding	759	8.52±0.810		
Places at Age 4 Years Strike Rate	Mare	210	10.58±1.550	-2.389	0.017
	Gelding	759	15.01±1.016		
Wins at Age 5 Years Strike Rate	Mare	744	4.58±0.501	-6.805	<0.001
	Gelding	2,303	9.09±0.434		
Places at Age 5 Years Strike Rate	Mare	744	9.56±0.665	-6.756	<0.001
	Gelding	2,303	15.28±0.523		
Wins at Age 6 Years Strike Rate	Mare	647	5.78±0.581	-5.079	<0.001
	Gelding	2,289	9.34±0.394		
Places at Age 6 Years Strike Rate	Mare	647	12.48±0.817	-3.598	<0.001
	Gelding	2,289	15.88±0.477		
Wins at Age 7 Years Strike Rate	Mare	395	4.51±0.675	-5.843	<0.001
	Gelding	1,772	9.23±0.442		
Wins up to Age 8 Years Strike Rate	Mare	1,030	3.99±0.285	-7.621	<0.001
	Gelding	3,148	6.62±0.193		
Places up to Age 8 Years Strike Rate	Mare	1,030	10.08±0.463	-4.990	<0.001
	Gelding	3,148	12.86±0.281		

4.3.2.13 Effect of Sex on the Number of Wins and Places up to Age Eight Years

Only horses that raced by age eight years were included in the analysis for the number of wins and places at age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight years. Geldings had significantly more wins and places up to age eight years than mares ($P < 0.001$) as shown in Table 4.14 below.

Table 4.14: Number of Wins and Places up to Age Eight Years for Mares and Geldings

Variable	*Sex*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Wins up to Age 8 Years	Mare	1,030	0.49±0.033	-12.231	<0.001
	Gelding	3,148	1.03±0.030		
Places up to Age 8 Years	Mare	1,030	1.19±0.060	-9.509	<0.001
	Gelding	3,148	1.90±0.045		

4.3.3 Effect of Selling Status on Racing Performance

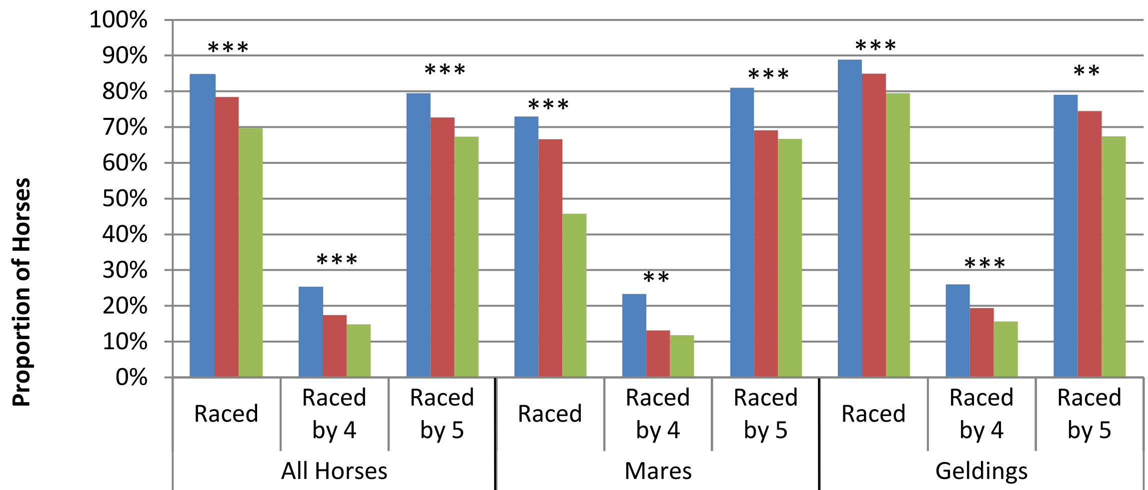
Of the 5,282 horses in the sample, only 4,876 or 92.3% went through the sales ring. The other 7.7% or 406 horses were withdrawn before the sale. The sold horses numbered 3,845 (72.8%) and the unsold horses numbered 1,031 (19.5%).

4.3.3.1 Effect of Selling Status on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five years. There was a significant difference in the proportions of horses that raced between those sold, not sold or withdrawn at sale (χ^2 = 68.959, df = 2, P < 0.001). The highest proportion of horses that raced was among those that were sold (84.6%), followed by those that were not sold (78.4%) and finally by those that were withdrawn from the sale (69.7%), as seen in Figure 4.5 below. This difference was evident in both mares (χ^2 = 38.542, df = 2, P < 0.001) and geldings (χ^2 = 25.880, df = 2, P < 0.001). Again, those that were sold were most likely to race, followed by those not sold and withdrawn.

For the rest of the variables, only horses that raced were included in the analysis, however, 161 of these horses raced in only British Point-to-Point races and due to lack of data were excluded from further analysis. There was a significant difference in the proportions of horses that raced by age four years between those sold, not sold and withdrawn (χ^2 = 32.953, df = 2, P < 0.001). The highest proportion of horses that raced by four was among those that were sold, followed by those that were not sold and finally by those that were withdrawn from the sale. Within mares there was also a significant difference (χ^2 = 13.823, df = 2, P = 0.001). Mares that were sold were most likely to race, followed by those not sold and withdrawn. Amongst the geldings, there was also a significant difference between groups (χ^2 = 19.757, df = 2, P < 0.001). Again, geldings which were sold were most likely to race at age four years, followed by those not sold and withdrawn.

There was also a significant difference in the proportions of horses that raced by age five years between those sold, not sold and withdrawn (χ^2 = 33.389, df = 2, P = 0.001). The highest proportion of horses that raced by age five years, was among those that were sold, followed by those that were not sold and finally by those that were withdrawn from the sale. Within mares there was also a significant difference (χ^2 = 18.383, df = 2, P < 0.001). Mares which were sold were most likely to race, followed by those not sold and withdrawn. There was also a significant difference in racing status amongst geldings of various sales status (χ^2 = 18.696, df = 2, P < 0.001). Again, geldings which were sold were most likely to race by age five years, followed by horses that were not sold and horses that were withdrawn from the sale.



	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
Sold	84.6%	25.3%	79.5%	73.0%	23.3%	81.0%	88.9%	26.0%	79.0%
Not Sold	78.4%	17.4%	72.7%	66.6%	13.1%	69.1%	84.9%	19.4%	74.4%
Withdrawn	69.7%	14.9%	67.3%	45.8%	11.8%	66.7%	79.5%	15.6%	67.4%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.5: Proportion of Sold, Not Sold and Withdrawn Horses that Raced

4.3.3.2 Effect of Selling Status on Winning Status

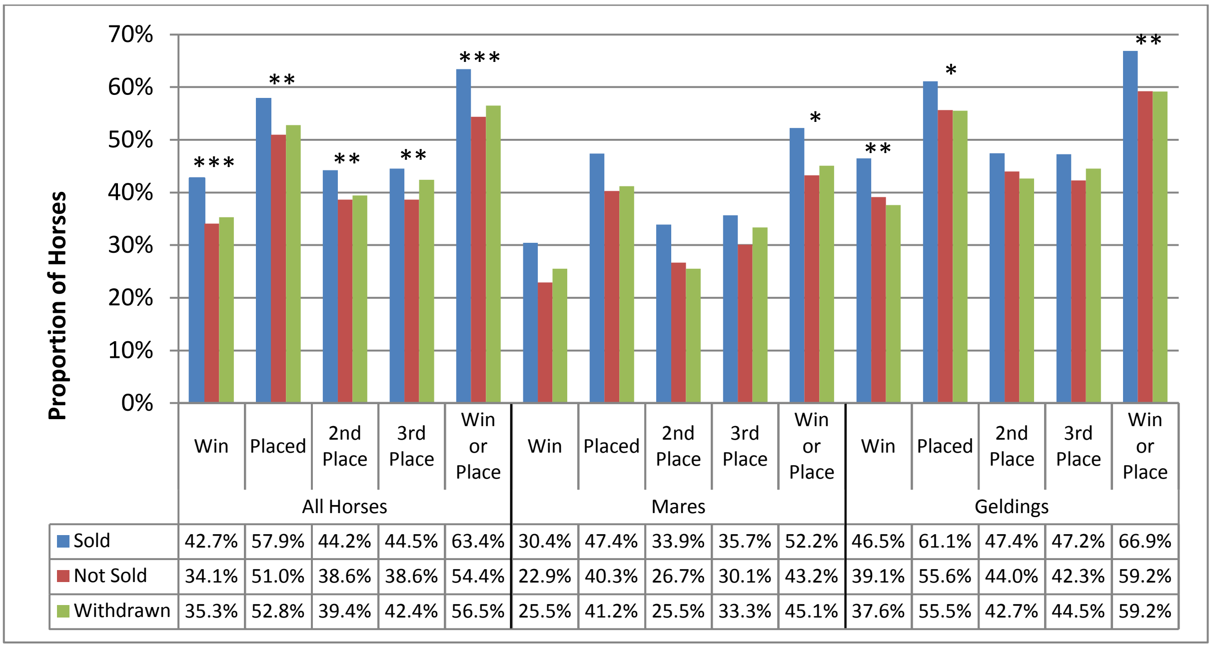
Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was a significant difference in the proportions of horses that won a race between those sold, not sold and withdrawn from the sale (χ^2 = 22.466, df = 2, P < 0.001). The highest proportion of horses that won was among those that were sold (42.7%), followed by those that were withdrawn (35.3%) and finally by those that were not sold at the sale (34.1%). Within mares, however, there was no significant difference (χ^2 = 5.228, df = 2, P = 0.073). There was a significant difference in the racing success of geldings of different selling status (χ^2 = 14.313, df = 2, P = 0.001). Geldings which were sold were most likely to win, followed by those not sold and finally by those that were withdrawn from the sale.

There was a significant difference in the proportion of horses that were placed in a race between those sold, not sold and withdrawn (χ^2 = 13.357, df = 2, P = 0.001). The highest proportion of horses that were placed was among those that were sold, followed by those that were withdrawn and finally by those that were not sold. Within mares there was no significant difference (χ^2 = 4.057, df = 2, P = 0.132). However, within geldings, selling status did affect racing performance (χ^2 = 7.281, df = 2, P = 0.026). Sold horses were most likely to place followed by those that were not sold and those that were withdrawn.

There was a significant difference in the proportions of horses that were placed second between those sold, not sold and withdrawn (χ^2 = 9.356, df = 2, P = 0.009). The highest proportion of horses that were placed second was among those that were sold, followed by those that were withdrawn and finally by those that were not sold. Within mares there was no significant difference in second place success between animals of different selling status (χ^2 = 5.302, df = 2, P = 0.071). There was also no significant difference within geldings between groups (χ^2 = 3.451, df = 2, P = 0.178).

There was a significant difference in the proportions of horses that were placed third between those sold, not sold or withdrawn (χ^2 = 8.840, df = 2, P = 0.012). The highest proportion of horses that were placed third was among those that were sold, followed by those that were withdrawn and finally by those that were not sold. Within mares there was no significant difference (χ^2 = 2.498, df = 2, P = 0.287). There was also no significant difference within geldings between groups (χ^2 = 4.580, df = 2, P = 0.101).

There was a significant difference in the proportions of horses that won or were placed in a race between those sold, not sold and withdrawn from the sale (χ^2 = 24.093, df = 2, P < 0.001). The highest proportion of horses that won or were placed was among those that were sold, followed by those that were withdrawn and finally by those that were not sold. Within mares there was a significant difference (χ^2 = 6.279, df = 2, P = 0.043). Mares that were sold had the highest proportion of horses that won or were placed in a race, followed by mares that were withdrawn from the sale while mares that were not sold had the lowest proportion. There was also a significant difference between the geldings based on sale status (χ^2 = 14.858, df = 2, P = 0.001). Geldings which were sold were most likely to win, followed by those not sold and those that were withdrawn from the sale, both of which had 59.2% of horses subsequently winning or placing in a race.

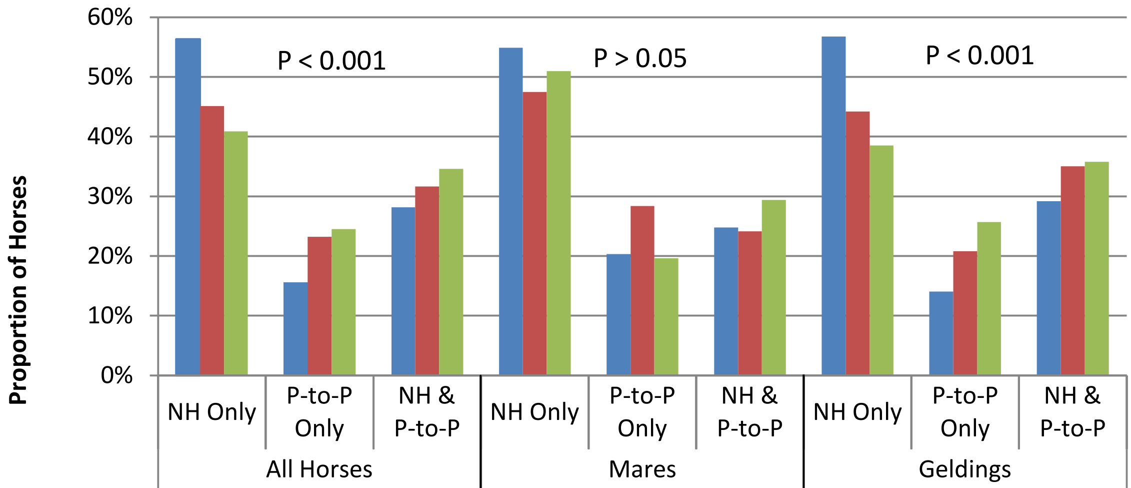


*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.6: Proportion of Sold, Not Sold and Withdrawn Horses that Won or Placed in a Race

4.3.3.3 Effect of Selling Status on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career amongst horses of different selling status (χ^2 = 57.073, df = 4, P < 0.001). Overall, 53.07% (2,220) of the population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. A higher proportion of horses that were sold (56.3%) raced in only NH races compared to horses that were unsold or withdrawn from the sale (45.1% and 40.9%, respectively), while higher proportions of horses that were unsold or withdrawn from the sale raced in only Irish Point-to-Point Races than horses that were sold, as shown in Figure 4.7 below. Similar results were observed within geldings (χ^2 = 55.717, df = 4, P < 0.001) however, no significant difference was observed within mares (χ^2 = 7.742, df = 4, P = 0.102).



	All Horses NH Only	All Horses P-to-P Only	All Horses NH & P-to-P	Mares NH Only	Mares P-to-P Only	Mares NH & P-to-P	Geldings NH Only	Geldings P-to-P Only	Geldings NH & P-to-P
Sold	56.3%	15.5%	28.1%	54.9%	20.4%	24.8%	56.8%	14.0%	29.2%
Not Sold	45.1%	23.2%	31.6%	47.5%	28.4%	24.2%	44.2%	20.8%	35.0%
Withdrawn	40.9%	24.5%	34.6%	51.0%	19.6%	29.4%	38.5%	25.7%	35.8%

Figure 4.7: Proportion of Sold, Not Sold and Withdrawn Horses that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

4.3.3.4 Effect of Selling Status on the Age in Years at First Race

Only horses that raced were examined to determine the age at first race. Overall, the mean age of the sample population at first race was 5.04$\pm$0.818 years. Age at first race was significantly influenced by selling status. Horses that were sold raced significantly earlier (5.00$\pm$0.01 years) than horses that were not sold (5.16$\pm$0.03 years) or those horses that were withdrawn (5.25$\pm$0.05 years) from the sales ($P < 0.001$). However, there was no significant difference between the age at first race for horses that were not sold and those withdrawn from sale. Mares and geldings showed similar results, as seen in Table 4.15 below.

Table 4.15: Age in Years at First Race for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean ± S.E.*		*Sig.*
Age at First Race	All Horses	Sold	3,145	5.00±0.014	a	<0.001
		Not Sold	769	5.16±0.030	b	
		Withdrawn	269	5.25±0.051	b	
	Mares	Sold	743	4.99±0.028	a	<0.001
		Not Sold	236	5.26±0.056	b	
		Withdrawn	51	5.29±0.110	b	
	Geldings	Sold	2,398	5.00±0.017	a	<0.001
		Not Sold	532	5.12±0.035	b	
		Withdrawn	218	5.24±0.057	b	

4.3.3.5 Effect of Selling Status on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference between the mean number of overall starts per year raced for horses that were sold, not sold or withdrawn from sale (data not shown, see Appendix 6, Table A.7); however, there were significant differences within the mean number of NH starts, hurdle starts, steeplechase starts and Irish Point-to-Point starts per year raced ($P < 0.001$) as seen in Table 4.16 below.

Horses that were sold had a significantly ($P < 0.001$) higher mean number of NH starts per year raced than those that were not sold or withdrawn, 2.63±0.04 compared to 2.22±0.07 and 2.16±0.13, respectively. There was no significant difference between the means for those sold and those withdrawn from sale. While the mean numbers of steeplechase starts and Ire Irish Point-to-Point starts per year raced showed significant differences overall between horses sold, not sold and withdrawn within the whole sample, there was no difference for these variables within mares and no difference for mean number of steeplechase starts per year raced within geldings.

Table 4.16: Mean Number of Starts per Year Raced for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean ± S.E.*		*Sig.*
Mean Number of NH Starts per Year Raced	All Horses	Sold	3,145	2.63±0.036	a	<0.001
		Not Sold	769	2.22±0.075	b	
		Withdrawn	269	2.16±0.127	b	
	Mares	Sold	743	2.40±0.076	a	0.010
		Not Sold	236	1.96±0.134	b	
		Withdrawn	51	1.99±0.244	ab	
	Geldings	Sold	2,398	2.70±0.041	a	<0.001
		Not Sold	532	2.33±0.090	b	
		Withdrawn	218	2.20±0.146	b	
Mean Number of Hurdle Starts per Year Raced	All Horses	Sold	3,145	1.87±0.028	a	<0.001
		Not Sold	769	1.58±0.058	b	
		Withdrawn	269	1.50±0.088	b	
	Mares	Sold	743	2.12±0.067	a	0.006
		Not Sold	236	1.69±0.119	b	
		Withdrawn	51	1.91±0.238	ab	
	Geldings	Sold	2,398	1.79±0.030	a	<0.001
		Not Sold	532	1.54±0.064	b	
		Withdrawn	218	1.40±0.092	b	
Mean Number of Steeplechase Starts per Year Raced	All Horses	Sold	3,145	0.77±0.023	a	0.017
		Not Sold	769	0.64±0.042	b	
		Withdrawn	269	0.66±0.078	ab	
	Mares	Sold	743	0.30±0.030	a	0.189
		Not Sold	236	0.27±0.054	a	
		Withdrawn	51	0.08±0.033	a	
	Geldings	Sold	2,398	0.91±0.027	a	0.110
		Not Sold	532	0.80±0.055	a	
		Withdrawn	218	0.80±0.093	a	
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	Sold	3,145	0.83±0.023	a	<0.001
		Not Sold	769	1.11±0.053	b	
		Withdrawn	269	1.27±0.102	b	
	Mares	Sold	743	1.02±0.056	a	0.233
		Not Sold	236	1.21±0.111	a	
		Withdrawn	51	1.20±0.260	a	
	Geldings	Sold	2,398	0.77±0.025	a	<0.001
		Not Sold	532	1.06±0.058	b	
		Withdrawn	218	1.29±0.110	c	

4.3.3.6 Effect of Selling Status on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. There was a significant difference in the mean numbers of starts at ages four and five years, and up to age eight years ($P < 0.05$) between horses of different selling status. However, there was no significant difference for ages six, seven or eight (data not shown, see Appendix 6, Table A.7). When looking at all the horses, those that were sold were found to have significantly more starts at ages four and five years and up to age eight years, than those that were not sold or withdrawn from sale ($P < 0.05$), as seen in Table 4.17 below. There was no significant difference between the number of starts for horses that were not sold and horses that were withdrawn from sale. Within mares, those that were sold had significantly more starts at age four years than those that were not sold. However, there was no significant difference between the mares that were withdrawn and those that were sold or not sold. There was no significant difference in the number of starts at age five years for mares ($P > 0.05$) or in the number of starts up to age eight years in geldings ($P > 0.05$)

Table 4.17: Number of Starts at Various Ages for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean ± S.E.*		*Sig.*
Starts at Age 4 Years	All Horses	Sold	3,145	0.63±0.025	a	<0.001
		Not Sold	769	0.41±0.042	b	
		Withdrawn	269	0.35±0.062	b	
	Mares	Sold	743	0.61±0.053	a	0.006
		Not Sold	236	0.32±0.075	b	
		Withdrawn	51	0.27±0.116	ab	
	Geldings	Sold	2,398	0.64±0.028	a	0.001
		Not Sold	532	0.45±0.051	b	
		Withdrawn	218	0.36±0.071	b	
Starts at Age 5 Years	All Horses	Sold	3,145	2.54±0.044	a	0.001
		Not Sold	769	2.27±0.089	b	
		Withdrawn	269	2.09±0.145	b	
	Mares	Sold	743	2.61±0.090	a	0.065
		Not Sold	236	2.33±0.182	a	
		Withdrawn	51	1.88±0.305	a	
	Geldings	Sold	2,398	2.51±0.050	a	0.012
		Not Sold	532	2.25±0.100	b	
		Withdrawn	218	2.14±0.164	b	
Starts up to Age 8 Years	All Horses	Sold	3,145	10.04±0.143	a	0.003
		Not Sold	769	9.14±0.290	b	
		Withdrawn	269	8.88±0.452	b	
	Mares	Sold	743	8.54±0.270	a	0.003
		Not Sold	236	6.92±0.427	b	
		Withdrawn	51	6.49±0.817	b	
	Geldings	Sold	2,398	10.50±0.167	a	0.146
		Not Sold	532	10.13±0.366	a	
		Withdrawn	218	9.44±0.518	a	

4.3.3.7 Effect of Selling Status on Career Length

There were no significant differences in the career lengths of horses that were sold, not sold or withdrawn from the sale (data not shown, see Appendix 6, Table A.6).

4.3.3.8 Effect of Selling Status on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was a significant difference in the proportions of non-finished races per start between horses that were sold, not sold or withdrawn from sale ($P < 0.05$). Horses that were sold had a significantly lower proportion of non-finished races (24.60%±0.484) than those that were not sold (30.96%±1.137) or horses that were withdrawn (32.14%±1.930). However, there was no significant difference in the mean proportion of non-finished races between horses that were not sold or withdrawn, as shown in Table 4.18 below. Mares that were unsold had significantly more non-finished races per start than those that were sold or withdrawn from the sale ($P < 0.05$), with no significant difference between those that were sold or those that were withdrawn. Geldings that were sold had the lowest proportion of non-finishes per start (24.05%±0.530), followed by those that were not sold (30.10%±1.281) and finally by geldings that were withdrawn from sale, which had the highest proportion of non-finished races, (34.96%±2.155).

Table 4.18: Mean Proportion of Non-Finished Races per Start for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean±S.E.(%)*		*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	Sold	3,145	24.60±0.484	a	<0.001
		Not Sold	769	30.96±1.137	b	
		Withdrawn	269	32.14±1.930	b	
	Mares	Sold	743	26.37±1.127	a	0.005
		Not Sold	236	32.95±2.320	b	
		Withdrawn	51	20.10±3.945	a	
	Geldings	Sold	2,398	24.05±0.530	a	<0.001
		Not Sold	532	30.10±1.281	b	
		Withdrawn	218	34.96±2.155	c	

4.3.3.9 Effect of Selling Status on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%$\pm$11.689, 13.37%$\pm$16.319 and 20.11%$\pm$21.999, respectively. Horses that were sold had significantly higher win strike rates than horses that were not sold or horses that were withdrawn from the sale ($P < 0.05$). There was no significant difference between the win strike rates for horses that were not sold or those withdrawn from sale. Similar results were observed within geldings while there was no significant difference within mares.

There was also a significant difference in the place strike rates and the third place strike rates amongst horses of different selling status ($P < 0.05$). Horses that were sold had significantly higher place strike rates than horses that were not sold, as shown in Table 4.19 below. There was no significant difference between the second place strike rates for horses that were withdrawn from sale and horses that were sold or not sold. There was no significant difference within mares or within geldings. Similar results were found for third place strike rates.

Table 4.19: Win and Place Strike Rates for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean±S.E. (%)*		*Sig.*
Win Strike Rate	All Horses	Sold	3,145	7.22±0.214	a	<0.001
		Not Sold	769	5.23±0.361	b	
		Withdrawn	269	5.49±0.722	b	
	Mares	Sold	743	4.39±0.341	a	0.440
		Not Sold	236	3.49±0.658	a	
		Withdrawn	51	3.95±1.342	a	
	Geldings	Sold	2,398	8.09±0.258	a	<0.001
		Not Sold	532	6.01±0.428	b	
		Withdrawn	218	5.84±0.833	b	
Place Strike Rate	All Horses	Sold	3,145	13.78±0.291	a	0.017
		Not Sold	769	12.12±0.578	b	
		Withdrawn	269	12.08±1.047	ab	
	Mares	Sold	743	10.83±0.543	a	0.511
		Not Sold	236	9.69±1.040	a	
		Withdrawn	51	9.30±2.396	a	
	Geldings	Sold	2,398	14.69±0.340	a	0.054
		Not Sold	532	13.16±0.690	a	
		Withdrawn	218	12.74±1.162	a	
Third Place Strike Rate	All Horses	Sold	3,145	6.18±0.170	a	0.016
		Not Sold	769	5.12±0.335	b	
		Withdrawn	269	5.52±0.613	ab	
	Mares	Sold	743	5.41±0.338	a	0.276
		Not Sold	236	4.38±0.625	a	
		Withdrawn	51	4.32±1.247	a	
	Geldings	Sold	2,398	6.41±0.196	a	0.084
		Not Sold	532	5.43±0.397	a	
		Withdrawn	218	5.81±0.697	a	
Overall Win and Place Strike Rate	All Horses	Sold	3,145	21.00±0.396	a	<0.001
		Not Sold	769	17.35±0.745	b	
		Withdrawn	269	17.57±1.363	b	
	Mares	Sold	743	15.23±0.705	a	0.323
		Not Sold	236	13.18±1.298	a	
		Withdrawn	51	13.25±2.850	a	
	Geldings	Sold	2,398	22.79±0.465	a	<0.001
		Not Sold	532	19.17±0.899	b	
		Withdrawn	218	18.58±1.539	b	

Horses that were sold had significantly higher overall win and place strike rates than horses that were not sold or horses that were withdrawn from the sale ($P < 0.05$). There was no significant difference between the overall win and place strike rates for horses that were not sold or withdrawn from sale. Similar results were observed within geldings while there was no significant difference within mares.

4.3.3.10 Effect of Selling Status on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Horses that were sold had significantly higher NH win and place strike rates than those that were not sold ($P < 0.05$). However, there was no significant difference between the horses that were withdrawn and those that were not sold. Geldings showed similar results however, there was no significant difference within mares (Table 4.20). Horses that were sold also had significantly higher Irish Point-to-Point win strike rates than those that were not sold, while there was no significant difference between horses that were withdrawn and those that were sold or not sold. There was no significant difference in the Irish Point-to-Point place strike rates between horses that were sold, not sold or withdrawn from the sale (data not shown, see Appendix 6, Table A.7).

Table 4.20: NH and Irish Point-to-Point Win and Place Strike Rates for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean±S.E.(%)*		*Sig.*
NH Win Strike Rate	All Horses	Sold	2,649	6.21±0.206	a	<0.001
		Not Sold	588	3.98±0.351	b	
		Withdrawn	203	4.46±0.691	b	
	Mares	Sold	590	3.37±0.330	a	0.833
		Not Sold	168	3.06±0.780	a	
		Withdrawn	41	2.70±1.513	a	
	Geldings	Sold	2,056	7.02±0.245	a	<0.001
		Not Sold	420	4.34±0.379	b	
		Withdrawn	162	4.90±0.775	b	
NH Place Strike Rate	All Horses	Sold	2,649	12.68±0.308	a	0.011
		Not Sold	588	10.62±0.614	b	
		Withdrawn	203	11.37±1.117	ab	
	Mares	Sold	590	9.28±0.584	a	0.397
		Not Sold	168	8.81±1.240	a	
		Withdrawn	41	6.14±1.746	a	
	Geldings	Sold	2,056	13.65±0.356	a	0.023
		Not Sold	420	11.34±0.699	b	
		Withdrawn	162	12.69±1.310	ab	
Irish Point-to-Point Win Strike Rate	All Horses	Sold	1,376	12.61±0.634	a	0.015
		Not Sold	420	9.56±1.011	b	
		Withdrawn	159	8.90±1.610	ab	
	Mares	Sold	335	9.46±1.049	a	0.084
		Not Sold	123	5.62±1.280	a	
		Withdrawn	25	12.59±5.684	a	
	Geldings	Sold	1,039	13.61±0.765	a	0.025
		Not Sold	296	11.24±1.321	ab	
		Withdrawn	134	8.21±1.595	b	

4.3.3.11 Effect of Selling Status on the Mean Earnings per Start

Overall, the mean earnings per start in the sample population were £443.0±1,350.34. Significant differences in the mean earnings per start were found among horses that were sold, not sold or withdrawn ($P < 0.001$). Horses that were sold earned significantly more money per race (£481.75±21.71) than those that were not sold (£260.9±26.88), however, there was no significant difference in the mean earnings for horses that were withdrawn from sale (£510.7±186.49) and horses that were sold or horses that were not sold, as shown in Table 4.21. Similar results were observed in geldings, however, no significant difference was observed in mares.

Table 4.21: Mean Earnings per Start for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean ± S.E. (£)*		*Sig.*
Mean Earnings per Start	All Horses	Sold	3,145	481.7±21.71	a	<0.001
		Not Sold	769	260.9±26.88	b	
		Withdrawn	269	510.7±186.49	a	
	Mares	Sold	743	237.7±23.59	a	0.187
		Not Sold	236	152.6±30.57	a	
		Withdrawn	51	248.8±144.45	a	
	Geldings	Sold	2,398	557.4±27.33	a	0.002
		Not Sold	532	309.4±36.23	b	
		Withdrawn	218	572.0±227.57	a	

4.3.3.12 Effect of Selling Status on the Win and Place Strike Rates at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. Horses that were sold had a significantly higher win strike rate at age five years ($P < 0.05$) than horses that were not sold. There was no significant difference between horses that were withdrawn from the sales and those that were sold or unsold. Geldings showed similar results, however within mares unsold horses had a significantly lower win strike rate than those that were sold or withdrawn from the sale.

There was no significant difference in the place strike rates at age five years for horses that were sold, not sold or withdrawn from the sale. Nor was there a significant difference within mares. Within geldings however, those that were sold had a significantly higher place strike rate at age five years than those that were withdrawn from the sale. There was no significant difference between those that were not sold and those that were sold or those that were withdrawn.

Horses that were sold had a significantly higher place strike rate at age six years than those that were unsold ($P < 0.05$); however, horses that were withdrawn were not significantly different from those that were sold or those that were unsold. There were no significant differences within mares or within geldings. Significant differences were also observed in the win and place strike rates at age seven years, as shown in Table 4.22 below. There was no significant difference between horses that were sold, not sold and withdrawn at ages four or eight (data not shown, see Appendix 6, Table A.7).

Table 4.22: Win and Place Strike Rates at Various Ages for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Selling Status*	*n*	*Mean±S.E.(%)*		*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	Sold	2,343	8.56±0.417	a	0.003
		Not Sold	532	5.42±0.656	b	
		Withdrawn	175	8.19±1.518	ab	
	Mares	Sold	558	4.98±0.604	a	0.033
		Not Sold	154	2.38±0.640	b	
		Withdrawn	32	8.26±3.811	a	
	Geldings	Sold	1,782	9.69±0.511	a	0.031
		Not Sold	378	6.65±0.878	b	
		Withdrawn	143	8.18±1.657	ab	
Places at Age 5 Years Strike Rate	All Horses	Sold	2,343	14.38±0.497	a	0.096
		Not Sold	532	12.49±1.002	a	
		Withdrawn	175	11.45±1.537	a	
	Mares	Sold	558	9.37±0.745	a	0.625
		Not Sold	154	9.66±1.548	a	
		Withdrawn	32	12.56±3.909	a	
	Geldings	Sold	1,782	15.96±0.606	a	0.036
		Not Sold	378	13.65±1.258	ab	
		Withdrawn	143	11.20±1.671	b	
Places at Age 6 Years Strike Rate	All Horses	Sold	2,220	15.76±0.476	a	0.036
		Not Sold	537	13.09±0.953	b	
		Withdrawn	184	14.02±1.729	ab	
	Mares	Sold	470	13.38±0.961	a	0.063
		Not Sold	149	11.11±1.754	a	
		Withdrawn	28	4.63±2.639	a	
	Geldings	Sold	1,746	16.36±0.545	a	0.134
		Not Sold	387	13.80±1.134	a	
		Withdrawn	156	15.71±1.956	a	
Wins at 7 Years Strike Rate	All Horses	Sold	1,637	9.06±0.460	a	0.008
		Not Sold	386	6.58±0.801	b	
		Withdrawn	146	5.70±1.173	b	
	Mares	Sold	292	5.20±0.849	a	0.222
		Not Sold	83	2.69±1.106	a	
		Withdrawn	20	1.98±1.505	a	
	Geldings	Sold	1,343	9.86±0.526	a	0.032
		Not Sold	303	7.65±0.966	ab	
		Withdrawn	126	6.30±1.332	b	
Places at 7 Years Strike Rate	All Horses	Sold	1,637	16.41±0.590	a	0.014
		Not Sold	386	12.76±0.967	b	
		Withdrawn	146	14.22±1.702	ab	
	Mares	Sold	292	15.40±1.350	a	0.212
		Not Sold	83	11.07±2.159	a	
		Withdrawn	20	10.19±4.765	a	
	Geldings	Sold	1,343	16.59±0.655	a	0.061
		Not Sold	303	13.22±1.081	a	
		Withdrawn	126	14.86±1.823	a	

Wins up to Age 8 Years Strike Rate	All Horses	Sold	3,145	6.39±0.192	a	<0.001
		Not Sold	769	4.67±0.331	b	
		Withdrawn	269	4.77±0.644	b	
	Mares	Sold	743	4.24±0.334	a	0.331
		Not Sold	236	3.23±0.602	a	
		Withdrawn	51	3.77±1.333	a	
	Geldings	Sold	2,398	7.05±0.228	a	<0.001
		Not Sold	532	5.32±0.393	b	
		Withdrawn	218	5.00±0.731	b	
Places up to Age 8 Years Strike Rate	All Horses	Sold	3,145	12.61±0.280	a	0.007
		Not Sold	769	10.85±0.531	b	
		Withdrawn	269	10.85±0.993	ab	
	Mares	Sold	743	10.46±0.533	a	0.419
		Not Sold	236	9.11±1.001	a	
		Withdrawn	51	9.01±2.389	a	
	Geldings	Sold	2,398	13.29±0.327	a	0.024
		Not Sold	532	11.58±0.622	b	
		Withdrawn	218	11.28±1.091	ab	

Horses that were sold had a significantly higher win strike rate up to age eight years than those that were not sold or withdrawn from the sale ($P < 0.001$), with no significant difference between those unsold and those withdrawn from the sale. Similar results were observed within geldings however, no significant difference was observed within mares.

There was also a significantly higher place strike rate up to age eight years for horses that were sold compared to those that were not sold (Table 4.22). There was no significant difference between those that were withdrawn from the sale and those that were sold or unsold. Similar results were observed within geldings however, no significant difference was observed within mares.

4.3.3.13 Effect of Selling Status on the Number of Wins and Places up to Age Eight Years

Only horses that raced by age eight years were included in the analysis for the number of wins and places at age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. Horses that were sold had significantly more wins and places up to age eight years ($P < 0.05$) than horses that were not sold or were withdrawn from the sale. There was no significant difference between horses that were not sold and horses that were withdrawn from the sales. Similar results were observed within mares and geldings however, there was no significant difference within mares between those that were withdrawn from the sale and those that were sold or unsold (Table 4.23).

Table 4.23: Number of Wins and Places up to Age Eight Years for Horses Sold, Not Sold and Withdrawn from Sale

Means with the same letter are not significantly different from each other

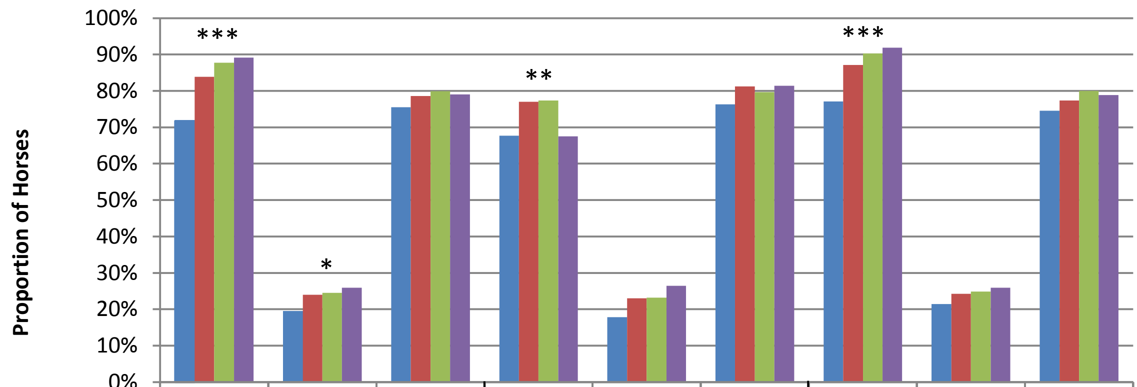
Variable	*Group*	*Selling Status*	*n*	*Mean ± S.E.*		*Sig.*
Wins up to Age 8 Years	All Horses	Sold	3,145	0.96±0.029	a	<0.001
		Not Sold	769	0.71±0.052	b	
		Withdrawn	269	0.71±0.089	b	
	Mares	Sold	743	0.55±0.042	a	0.016
		Not Sold	236	0.33±0.047	b	
		Withdrawn	51	0.39±0.122	ab	
	Geldings	Sold	2,398	1.09±0.035	a	0.003
		Not Sold	532	0.88±0.071	b	
		Withdrawn	218	0.78±0.106	b	
Places up to Age 8 Years	All Horses	Sold	3,145	1.81±0.044	a	0.001
		Not Sold	769	1.51±0.083	b	
		Withdrawn	269	1.41±0.125	b	
	Mares	Sold	743	1.29±0.075	a	0.015
		Not Sold	236	0.95±0.109	b	
		Withdrawn	51	0.75±0.168	ab	
	Geldings	Sold	2,398	1.97±0.053	a	0.030
		Not Sold	532	1.77±0.109	b	
		Withdrawn	218	1.56±0.147	b	

4.3.4 Effect of Price Realised at Sale on Racing Performance

Only horses that went through the sales ring were included in the analysis of the effect of price realised at sale on racing performance. Horses that were withdrawn from sale were not included in this section as no selling price was realised. For horses that were not sold, the highest bid value was used as this indicated the perceived value of the horse by the industry. This resulted in a sample of 4,610 horses. The sample was then split into four groups according to price; less than €5,000, between €5,001 and €10,000, between €10,001 and €20,000 and greater than €20,001. One thousand and thirty-two horses were less than €5,000 and composed 22.4% of the sample, 1,046 horses were between €5,001 and €10,000 (22.7%), 1,203 horses were between €10,001 and €20,000 (26.1%) and 1,329 horses were more than €20,001 (28.8%). The data from all 4,610 horses were examined to determine the proportion of horses that raced or did not race. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced or that raced in only British Point-to-Point races were excluded from the analysis.

4.3.4.1 Effect of Price Realised at Sale on Racing Status

Overall, of the horses that realised a price at sale, 83.69% (3,858) raced at some stage in their life and of those that raced, 23.84% (886) had raced by age four years and 78.50% (2,917) had raced by the age of five. There were significant differences in the proportions of horses that raced at some stage in their careers ($\chi^2 = 152.522$, df = 3, P < 0.001) or raced by age four years ($\chi^2 = 10.626$, df = 3, P = 0.014) between the horses in the various sale price groups. The highest proportions of horses that raced and raced by four were among those that realised a price of over €20,001, followed by those that realised a price between €10,001 and €20,001, then those that realised a price between €5,001 and €10,000 and finally by those that realised a price of less than €5,000. There was no significant difference in the proportion of horses that raced by five according to price realised at sale ($\chi^2 = 5.121$, df = 3, P = 0.163).



	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
1-5,000	71.7%	19.4%	75.5%	67.7%	17.8%	76.3%	77.1%	21.4%	74.5%
5,001-10,000	83.8%	23.9%	78.6%	77.0%	23.0%	81.3%	87.1%	24.2%	77.4%
10,001-20,000	87.8%	24.5%	79.9%	77.4%	23.2%	79.7%	90.3%	24.8%	80.0%
>20,001	89.2%	25.9%	79.0%	67.5%	26.5%	81.4%	91.9%	25.9%	78.8%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.8: Proportion of Horses that Raced According to Price Realised at Sale

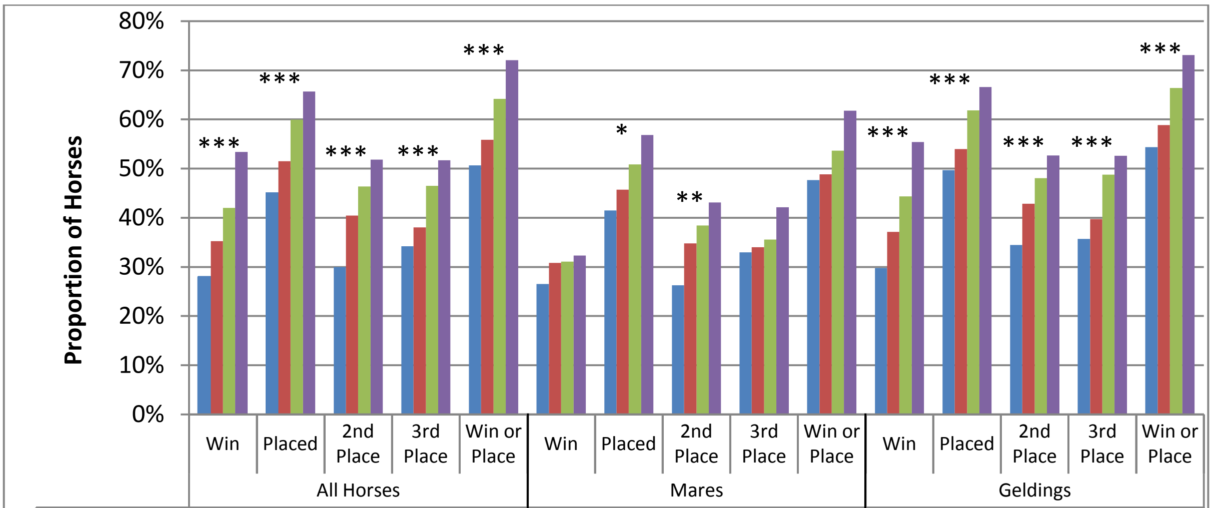
There was a significant difference in the proportion of geldings that raced ($\chi^2 = 73.262$, df = 3, P < 0.001) according to price realised at sale. The highest proportion of geldings that raced was among those that realised a price of over €20,001, followed by those that realised a price between €10,001 and €20,001, then those that realised a price between €5,001 and €10,000 and finally by those that realised a price of less than €5,000. There was no significant difference in the proportion of geldings that raced by four (χ^2 = 2.715, df = 3, P = 0.438) or raced by five (χ^2 = 4.559, df = 3, P = 0.207) according to price realised at sale.

There was a significant difference in the proportion of mares that raced (χ^2 = 14.399, df = 3, P = 0.002) according to price realised at sale. Unlike geldings, mares that realised a price of over €20,001 had the lowest proportion that raced. Instead, the highest proportion of horses that raced was among those that realised a price between €10,001 and €20,001, followed by those that realised a price between €5,001 and €10,000, then by those that realised a price of less than €5,000 and finally by mares that realised a price of over €20,001. There was no significant difference in the proportion of mares that raced by four (χ^2 = 5.331, df = 3, P = 0.149) and raced by five (χ^2 = 2.872, df = 3, P = 0.412) according to price realised at sale.

4.3.4.2 Effect of Price Realised at Sale on Winning Status

Overall, 41.39% (1,538) of the horses that realised a price at sale won a race, while 57.02% (2,119) were placed in a race, 43.62% (1,621) placed second and 43.86% (1,630) placed third. Altogether, 62.19% of the horses that achieved a price at sale (2,311) won or placed in a race. There were significant differences in the proportions of horses that won a race (χ^2 = 134.800, df = 3, P < 0.001), placed in a race (χ^2 = 90.420, df = 3, P < 0.001), placed second (χ^2 = 92.568, df = 3, P < 0.001), placed third (χ^2 = 70.252, df = 3, P < 0.001) and that won or placed in a race (χ^2 = 104.514, df = 3, P < 0.001), according to price realised at sale. The highest proportions of horses that won and placed were among those that realised a price of over €20,001, followed by those that realised a price between €10,001 and €20,001, then those that realised a price between €5,001 and €10,000 and finally by those that realised a price of less than €5,000.

There were significant differences in the proportions of mares that were placed in a race (χ^2 = 9.686, df = 3, P = 0.021) and that were placed second in a race (χ^2 = 15.385, df = 3, P = 0.002), according to price realised at sale. The highest proportion of mares that were placed was among those that realised a price of over €20,001, followed by those that realised a price between €10,001 and €20,001, then those that realised a price between €5,001 and €10,000 and finally by those that realised a price of less than €5,000. There were no significant differences in the proportions of mares that won a race (χ^2 = 2.450, df = 3, P = 0.484), placed third (χ^2 = 3.118, df = 3, P = 0.374) and won or placed in a race (χ^2 = 7.396, df = 3, P = 0.060), between the animals in the various price categories.



	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
1-5,000	28.0%	45.1%	30.0%	34.2%	50.6%	26.5%	41.5%	26.3%	33.0%	47.7%	29.8%	49.7%	34.5%	35.7%	54.3%
5,001-10,000	35.3%	51.5%	40.4%	38.0%	55.8%	30.9%	45.7%	34.8%	34.0%	48.8%	37.1%	54.0%	42.9%	39.7%	58.9%
10,001-20,000	42.0%	59.9%	46.4%	46.5%	64.2%	31.1%	50.8%	38.4%	35.6%	53.7%	44.4%	61.9%	48.1%	48.8%	66.4%
>20,001	53.4%	65.7%	51.8%	51.7%	72.1%	32.4%	56.9%	43.1%	42.2%	61.8%	55.4%	66.6%	52.7%	52.6%	73.1%

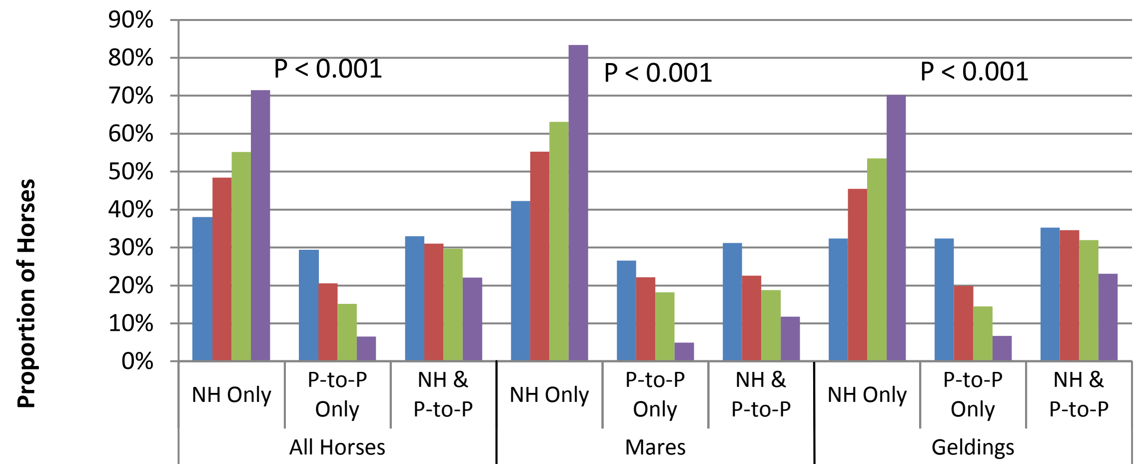
*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 4.9: Proportion of Horses that Won or Placed in a Race According to Price Realised at Sale

There were significant differences in the proportions of geldings that won a race (χ^2 = 90.817, df = 3, P < 0.001), placed in a race (χ^2 = 42.898, df = 3, P < 0.001), placed second (χ^2 = 38.350, df = 3, P < 0.001), placed third (χ^2 = 43.069, df = 3, P < 0.001) and won or placed in a race (χ^2 = 56.215, df = 3, P < 0.001), according to price realised at sale. The highest proportions of geldings that won and placed were among those that realised a price of over €20,001, followed by those that realised a price of between €10,001 and €20,001, then those that realised a price between €5,001 and €10,000 and finally by those that realised a price of less than €5,000.

4.3.4.3 Effect of Price Realised at Sale on Type of Racing Career

Overall, 55.30% (2,051) of the horses that realised a price at sale raced in only NH races while 16.47% (611) raced in only Irish Point-to-Point races and 23.23% (1,047) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses in the different sale price categories (χ^2 = 276.544, df = 6, P < 0.001). Higher proportions of horses in the higher price categories raced in only NH races than horses in the lower categories, while higher proportions of horses in the lower price categories raced in only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point races than horses in the higher price categories (Figure 4.10). Similar results were observed within both mares (χ^2 = 64.149, df = 6, P < 0.001) and geldings (χ^2 = 232.823, df = 6, P < 0.001).



	All Horses			Mares			Geldings		
	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P
1-5,000	37.7%	29.3%	33.0%	42.3%	26.5%	31.2%	32.4%	32.4%	35.2%
5,001-10,000	48.4%	20.6%	31.0%	55.3%	22.2%	22.6%	45.5%	19.9%	34.6%
10,001-20,000	55.2%	15.1%	29.7%	63.1%	18.2%	18.8%	53.5%	14.5%	32.0%
>20,001	71.4%	6.5%	22.0%	83.3%	4.9%	11.8%	70.2%	6.7%	23.1%

Figure 4.10: Proportion of Horses that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races According to Price Realised at Sale

4.3.4.4 Effect of Price Realised at Sale on the Age in Years at First Race

Only horses that raced were examined to determine the age at first race. Overall, the mean age at first race of the horses that realised a price at sale was 5.03$\pm$0.814 years. There was a significant difference in the age at first race according to price realised at sale (P < 0.05). Horses that realised a price less than €5,000 were significantly older at their first race than horses in any other price category, as shown in Table 4.24. There was however no significant difference in the age at first race between horses in the other price categories. There was no significant difference within mares or within geldings according to price realised at sale.

Table 4.24: Age in Years at First Race According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean ± S.E.*		*Sig.*
Age at First Race	All Horses	1-5,000	711	5.12±0.031	a	0.011
		5,001-10,000	831	5.03±0.028	b	
		10,001-20,000	1,011	5.01±0.026	b	
		>20,001	1,163	4.99±0.023	b	
	Mares	1-5,000	388	5.12±0.039	a	0.114
		5,001-10,000	256	5.00±0.049	a	
		10,001-20,000	177	5.02±0.061	a	
		>20,001	102	4.96±0.075	a	
	Geldings	1-5,000	322	5.11±0.049	a	0.115
		5,001-10,000	574	5.05±0.035	a	
		10,001-20,000	834	5.01±0.029	a	
		>20,001	1,059	5.00±0.025	a	

4.3.4.5 Effect of Price Realised at Sale on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for horses that realised a price at sale was 3.49±1.812, with horses participating in significantly more hurdle races than any other type of race (1.84±1.563), followed by Irish Point-to-Points (0.86±1.340) and then steeplechase races (0.75±1.255). There were significant differences in the mean number of starts per year raced, the mean number of NH starts per year raced and the mean number of Irish Point to point starts per year raced ($P < 0.05$) according to price realised at sale. Horses in the under €5,000 category had significantly fewer starts per year raced (3.32±0.07) than horses in the €10,001 - €20,000 category (3.58±0.06) and the over €20,001 category (3.56±0.05). There was no significant difference between the mean number of starts per year raced for horses in the €10,001 - €20,000 category and the over €20,001 category and there was no significant difference between the mean number of starts per year raced for horses in the €5,001 - €10,000 (3.42±0.06) category and any other category. There was no significant difference within mares or within geldings.

There was a highly significant difference in the mean number of NH starts per year raced according to price realised at sale, with each price category being significantly different from each other ($P < 0.001$). Horses in the over €20,001 category had significantly more NH starts than any other group while horses in the under €5,000 category had significantly fewer NH starts than any other group. Similar results were found within geldings, as seen in Table 4.25. Mares in the over €20,001 category had significantly more NH starts than any other group while mares in the under €5,000 category had significantly fewer than any other group. There was no significant difference between mares in the €5,001 - €10,000 category and mares in the €10,001 - €20,000 category.

Horses in the over €20,001 category had significantly more hurdle starts than any other group while horses in the under €5,000 category had significantly fewer hurdle starts than any other group, (2.09 ± 0.04 and 1.51 ± 0.06 respectively). There was no significant difference between the number of starts between horses in the €5,001 - €10,000 category and the €10,001 - €20,000 category. Similar results were observed within mares and within geldings ($P < 0.05$).

There was a highly significant difference in the mean number of steeplechase starts per year raced according to price realised at sale, with each price category being significantly different from each other ($P < 0.001$). Horses in the over €20,001 category had significantly more steeplechase starts than any other group while horses in the under €5,000 category had significantly fewer than any other group. There was no significant difference within mares; however, geldings in the over €20,001 category had significantly more steeplechase starts than any other group while geldings in the under €5,000 category and the €5,001 - €10,000 category had significantly fewer than either of the other groups. There was no significant difference between geldings in the €5,000 category and the €5,001 - €10,000 category.

There was a highly significant difference in the mean number of Irish Point-to-Point starts per year raced according to price realised at sale, with each price category being significantly difference from each other ($P < 0.001$). Horses in the over €20,001 category had significantly fewer Irish Point-to-Point starts than any other group (0.43 ± 0.03) while horses in the under €5,000 category had significantly more than any other group (1.40 ± 0.06). Similar results were found within geldings, as seen in Table 4.25. Mares in the over €20,001 category had significantly fewer Irish Point-to-Point starts than any other group, while mares in the under €5,000 category had significantly more than any other group. There was no significant difference between mares in the €5,001 - €10,000 category and the €10,001 - €20,000 category.

Table 4.25: Mean Number of Starts per Year Raced According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean ± S.E.*		*Sig.*
Mean Number of Starts per Year Raced	All Horses	1-5,000	711	3.32±0.069	a	0.008
		5,001-10,000	831	3.42±0.064	ab	
		10,001-20,000	1,011	3.58±0.058	b	
		>20,001	1,163	3.56±0.051	b	
	Mares	1-5,000	388	3.27±0.093	a	0.128
		5,001-10,000	256	3.45±0.121	a	
		10,001-20,000	177	3.56±0.144	a	
		>20,001	102	3.70±0.199	a	
	Geldings	1-5,000	322	3.38±0.103	a	0.133
		5,001-10,000	574	3.41±0.076	a	
		10,001-20,000	834	3.59±0.064	a	
		>20,001	1,059	3.55±0.052	a	
Mean Number of NH Starts per Year Raced	All Horses	1-5,000	711	1.87±0.074	a	<0.001
		5,001-10,000	831	2.37±0.070	b	
		10,001-20,000	1,011	2.69±0.066	c	
		>20,001	1,163	3.09±0.054	d	
	Mares	1-5,000	388	1.90±0.095	a	<0.001
		5,001-10,000	256	2.41±0.133	b	
		10,001-20,000	177	2.62±0.157	b	
		>20,001	102	3.36±0.209	c	
	Geldings	1-5,000	322	1.84±0.116	a	<0.001
		5,001-10,000	574	2.34±0.082	b	
		10,001-20,000	834	2.70±0.072	c	
		>20,001	1,059	3.07±0.056	d	
Mean Number of Hurdle Starts per Year Raced	All Horses	1-5,000	711	1.51±0.061	a	<0.001
		5,001-10,000	831	1.75±0.058	b	
		10,001-20,000	1,011	1.84±0.049	b	
		>20,001	1,163	2.09±0.041	c	
	Mares	1-5,000	388	1.71±0.085	a	<0.001
		5,001-10,000	256	2.07±0.115	b	
		10,001-20,000	177	2.24±0.134	b	
		>20,001	102	3.06±0.182	c	
	Geldings	1-5,000	322	1.28±0.084	a	<0.001
		5,001-10,000	574	1.62±0.066	b	
		10,001-20,000	834	1.76±0.052	b	
		>20,001	1,059	2.00±0.041	c	
Mean Number of Steeplechase Starts per Year Raced	All Horses	1-5,000	711	0.37±0.037	a	<0.001
		5,001-10,000	831	0.62±0.039	b	
		10,001-20,000	1,011	0.84±0.042	c	
		>20,001	1,163	1.00±0.039	d	
	Mares	1-5,000	388	0.22±0.036	a	0.143
		5,001-10,000	256	0.34±0.060	a	
		10,001-20,000	177	0.38±0.066	a	
		>20,001	102	0.30±0.079	a	
	Geldings	1-5,000	322	0.56±0.068	a	<0.001
		5,001-10,000	574	0.74±0.049	a	
		10,001-20,000	834	0.94±0.048	b	
		>20,001	1,059	1.07±0.042	c	

Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	1-5,000	711	1.40±0.060	a	<0.001
		5,001-10,000	831	1.00±0.049	b	
		10,001-20,000	1,011	0.86±0.042	c	
		>20,001	1,163	0.43±0.027	d	
	Mares	1-5,000	388	1.32±0.083	a	<0.001
		5,001-10,000	256	0.99±0.094	b	
		10,001-20,000	177	0.92±0.124	b	
		>20,001	102	0.31±0.089	c	
	Geldings	1-5,000	322	1.49±0.087	a	<0.001
		5,001-10,000	574	1.00±0.056	b	
		10,001-20,000	834	0.85±0.044	c	
		>20,001	1,059	0.44±0.028	d	

4.3.4.6 Effect of Price Realised at Sale on the Number of Starts at Various Ages

Horses that realised a price at sale had a mean number of 0.59±1.371 starts at age four years, 2.49±2.454 starts at age five years, 2.96±2.999 starts at age six years, 2.22±2.978 starts at age seven years, 1.62±2.830 starts at age eight years and 9.90±8.026 starts up to age eight years. There was no significant difference in the number of starts at ages four and five according to price realised at sale (data not shown, see Appendix 7, Table A.8) however, there was a significant difference at ages six, seven, eight and up to age eight years ($P < 0.001$). Horses in the over €20,001 category had significantly more starts at age six years than horses in the under €5,000 category and horses in the €5,001 - €10,000 category while horses in the under €5,000 category had significantly fewer starts at age six years than horses in any other category, as shown in Table 4.26. There was no significant difference in the number of starts between horses in the €5,001 - €10,000 category and horses in the €10,001 - €20,000 category or between horses in the €10,001 - €20,000 category and horses in the over €20,001 category. There was no significant difference in the number of starts at age six years within mares, however, geldings in the over €20,001 category had significantly more starts at age six years than geldings in the under €5,000 category and geldings in the €5,001 - €10,000 category. There was no significant difference between geldings in the under €5,000 category, the €5,001 - €10,000 category and the €10,001 - €20,000 category.

Table 4.26: Number of Starts at Various Ages According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean + S.E.*		*Sig.*
Starts at Age 6 Years	All Horses	1-5,000	711	2.56+0.110	a	<0.001
		5,001-10,000	831	2.92+0.107	b	
		10,001-20,000	1,011	2.98+0.096	bc	
		>20,001	1,163	3.22+0.085	c	
	Mares	1-5,000	388	2.36+0.139	a	0.067
		5,001-10,000	256	2.96+0.209	a	
		10,001-20,000	177	2.84+0.229	a	
		>20,001	102	2.82+0.297	a	
	Geldings	1-5,000	322	2.80+0.175	a	0.030
		5,001-10,000	574	2.91+0.123	a	
		10,001-20,000	834	3.01+0.106	ab	
		>20,001	1,059	3.26+0.089	b	
Starts at Age 7 Years	All Horses	1-5,000	711	1.83+0.111	a	<0.001
		5,001-10,000	831	1.97+0.099	a	
		10,001-20,000	1,011	2.37+0.097	b	
		>20,001	1,163	2.51+0.086	b	
	Mares	1-5,000	388	1.57+0.138	a	0.945
		5,001-10,000	256	1.66+0.175	a	
		10,001-20,000	177	1.64+0.206	a	
		>20,001	102	1.49+0.255	a	
	Geldings	1-5,000	322	2.15+0.180	ab	0.002
		5,001-10,000	574	2.10+0.120	a	
		10,001-20,000	834	2.53+0.109	bc	
		>20,001	1,059	2.61+0.090	c	
Starts at Age 8 Years	All Horses	1-5,000	711	1.00+0.090	a	<0.001
		5,001-10,000	831	1.38+0.089	b	
		10,001-20,000	1,011	1.84+0.095	c	
		>20,001	1,163	1.99+0.088	c	
	Mares	1-5,000	388	0.79+0.101	a	0.382
		5,001-10,000	256	1.01+0.147	a	
		10,001-20,000	177	1.10+0.179	a	
		>20,001	102	0.86+0.248	a	
	Geldings	1-5,000	322	1.27+0.156	a	<0.001
		5,001-10,000	574	1.53+0.111	a	
		10,001-20,000	834	2.00+0.108	b	
		>20,001	1,059	2.09+0.093	b	
Starts up to Age 8 Years	All Horses	1-5,000	711	8.19+0.276	a	<0.001
		5,001-10,000	831	9.38+0.274	b	
		10,001-20,000	1,011	10.43+0.265	c	
		>20,001	1,163	10.86+0.234	c	
	Mares	1-5,000	388	7.62+0.333	a	0.105
		5,001-10,000	256	8.88+0.518	a	
		10,001-20,000	177	8.86+0.547	a	
		>20,001	102	8.61+0.738	a	
	Geldings	1-5,000	322	8.87+0.456	a	<0.001
		5,001-10,000	574	9.58+0.322	a	
		10,001-20,000	834	10.77+0.298	b	
		>20,001	1,059	11.08+0.245	b	

Horses in the under €5,000 category and the €5,001 - €10,000 category had significantly fewer starts at age seven years than horses in the €10,001 - €20,000 category and in the over €20,001 category ($P < 0.001$). There was no difference in the number of starts at age seven years for horses in the under €5,000 category and for those in the €5,001 - €10,000 category or for horses in the €10,001 - €20,000 category and in the over €20,001 category. There was no significant difference within mares, while within geldings, those in the over €20,001 category had significantly more starts at age seven years than those in any other category, as seen in Table 4.26.

Horses in the €10,001 - €20,000 category and in the over €20,001 category had significantly more starts at age eight years and significantly more starts up to age eight years than either of the other categories while horses in the under €5,000 category had significantly fewer starts at age eight years and up to age eight years than any other category. There was no significant difference between horses in the over €20,001 category and the €10,001 - €20,000 category. There was no significant difference in the number of starts at age eight years or the number of starts up to age eight years within mares, however, geldings in the under €5,000 category and in the €5,001 - €10,000 category had significantly fewer starts at age eight years and significantly fewer starts up to age eight years than geldings in the €10,001 - €20,000 category and in the over €20,001 category, as shown in Table 4.26.

4.3.4.7 Effect of Price Realised at Sale on Career Length

There was a significant difference in the career lengths of horses according to price realised at sale ($P < 0.05$). The highest proportions of horses that raced at ages seven and eight were in the >€20,001 price category while the lowest proportions were in the <€5,000 price category (Table 4.27). Similar results were seen within geldings while there was no significant difference within mares.

Table 4.27: Effect of Price Realised at Sale on the Proportion of Horses Racing at Various Ages

Variable	*Group*	*Price at Sale (€)*	*n*	*%*	*Chi-Square*	*Sig.*
Raced at 7 Years	All Horses	1-5,000	307	43.2	53.571	<0.001
		5,001-10,000	390	46.9		
		10,001-20,000	540	53.4		
		>20,001	685	58.9		
	Mare	1-5,000	158	40.7	1.478	0.687
		5,001-10,000	98	38.3		
		10,001-20,000	65	36.7		
		>20,001	36	35.3		
	Gelding	1-5,000	149	46.3	30.804	<0.001
		5,001-10,000	291	50.7		
		10,001-20,000	475	57.0		
		>20,001	648	61.2		
Raced at 8 Years	All Horses	1-5,000	169	23.8	87.018	<0.001
		5,001-10,000	275	33.1		
		10,001-20,000	400	39.6		
		>20,001	513	44.1		
	Mare	1-5,000	79	20.4	5.081	0.166
		5,001-10,000	61	23.8		
		10,001-20,000	44	24.9		
		>20,001	15	14.7		
	Gelding	1-5,000	90	28.0	42.273	<0.001
		5,001-10,000	213	37.1		
		10,001-20,000	356	42.7		
		>20,001	497	46.9		

4.3.4.8 Effect of Price Realised at Sale on the Proportion of Non-Finished Races per Start

The mean proportion of non-finished races per start for horses that realised a price at sale was 25.27%±27.670. Horses in the over €20,001 category had a significantly smaller proportion of non-finished races per start than any other group (16.88%±0.574) while horses in the under €5,000 category had significantly more than those in any other category (19.25%±0.626 and 34.65%±1.238, respectively) ($P < 0.001$). Mares in the over €20,001 category had a significantly lower proportion of non-finished races per start than any other group, while mares in the under €5,000 category had a significantly higher proportion than those in any other category (Table 4.28). There was no significant difference between horses in the €5,001 - €10,000 category and the €10,001 - €20,000 category. Geldings in the over €20,001 category had a significantly lower proportion of non-finished races per start than any other group while horses in the under €5,000 category had a significantly higher proportion than those in any other category (19.79%±0.656 and 37.10%±1.825, respectively) (P < 0.001).

Table 4.28: Mean Proportion of Non-Finished Races per Start According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean±S.E.(%)*		*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	1-5,000	711	34.65±1.238	a	<0.001
		5,001-10,000	831	27.58±1.038	b	
		10,001-20,000	1,011	23.69±0.820	c	
		>20,001	1,163	19.25±0.626	d	
	Mares	1-5,000	388	32.52±1.682	a	<0.001
		5,001-10,000	256	26.48±1.959	b	
		10,001-20,000	177	23.20±2.243	b	
		>20,001	102	13.85±2.028	c	
	Geldings	1-5,000	322	37.10±1.825	a	<0.001
		5,001-10,000	574	28.10±1.222	b	
		10,001-20,000	834	23.80±0.874	c	
		>20,001	1,059	19.79±0.656	d	

4.3.4.9 Effect of Price Realised at Sale on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. Horses that realised a price at sale had mean win, place and overall win and place strike rates of 6.94%±11.810, 13.62%±16.319 and 20.55%±22.078, respectively. Horses that were in the higher price categories had significantly higher win strike rates, place strike rates, second place strike rates, third place strike rates and overall win and place strike rates than horses in the lower price categories, as shown in Table 4.29 below. Similar results were observed within mares and within geldings for each variable.

Table 4.29: Win and Place Strike Rates According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean±S.E. (%)*		*Sig.*
Win Strike Rate	All Horses	1-5,000	711	4.05±0.339	a	<0.001
		5,001-10,000	831	5.39±0.346	b	
		10,001-20,000	1,011	7.13±0.400	c	
		>20,001	1,163	9.63±0.383	d	
	Mares	1-5,000	388	3.36±0.388	a	0.009
		5,001-10,000	256	4.21±0.594	ab	
		10,001-20,000	177	5.08±0.858	bc	
		>20,001	102	6.78±1.268	c	
	Geldings	1-5,000	322	4.89±0.582	a	<0.001
		5,001-10,000	574	5.88±0.421	a	
		10,001-20,000	834	7.57±0.448	b	
		>20,001	1,059	9.90±0.401	c	
Place Strike Rate	All Horses	1-5,000	711	10.02±0.565	a	<0.001
		5,001-10,000	831	12.64±0.570	b	
		10,001-20,000	1,011	14.33±0.517	c	
		>20,001	1,163	15.90±0.482	d	
	Mares	1-5,000	388	9.18±0.741	a	0.020
		5,001-10,000	256	11.09±0.944	ab	
		10,001-20,000	177	11.38±1.064	ab	
		>20,001	102	14.17±1.802	b	
	Geldings	1-5,000	322	11.07±0.869	a	<0.001
		5,001-10,000	574	13.32±0.709	ab	
		10,001-20,000	834	14.96±0.583	bc	
		>20,001	1,059	16.06±0.500	c	
Second Place Strike Rate	All Horses	1-5,000	711	4.47±0.371	a	<0.001
		5,001-10,000	831	5.91±0.340	b	
		10,001-20,000	1,011	6.90±0.329	c	
		>20,001	1,163	7.60±0.304	c	
	Mares	1-5,000	388	4.11±0.527	a	0.040
		5,001-10,000	256	5.66±0.622	ab	
		10,001-20,000	177	6.03±0.731	b	
		>20,001	102	6.85±1.287	b	
	Geldings	1-5,000	322	4.91±0.519	a	<0.001
		5,001-10,000	574	6.02±0.406	ab	
		10,001-20,000	834	7.09±0.367	bc	
		>20,001	1,059	7.67±0.310	c	
Third Place Strike Rate	All Horses	1-5,000	711	4.75±0.341	a	<0.001
		5,001-10,000	831	5.50±0.342	ab	
		10,001-20,000	1,011	6.06±0.267	b	
		>20,001	1,163	7.16±0.293	c	
	Mares	1-5,000	388	4.63±0.462	a	0.033
		5,001-10,000	256	5.10±0.564	a	
		10,001-20,000	177	5.19±0.626	a	
		>20,001	102	7.70±1.216	b	
	Geldings	1-5,000	322	4.91±0.509	a	0.001
		5,001-10,000	574	5.67±0.426	ab	
		10,001-20,000	834	6.24±0.295	b	
		>20,001	1,059	7.10±0.299	c	

Overall Win and Place Strike Rate	All Horses	1-5,000	711	14.07±0.711	a	<0.001
		5,001-10,000	831	18.03±0.729	b	
		10,001-20,000	1,011	21.46±0.711	c	
		>20,001	1,163	25.53±0.671	d	
	Mares	1-5,000	388	12.54±0.898	a	0.001
		5,001-10,000	256	15.30±1.219	ab	
		10,001-20,000	177	16.45±1.514	bc	
		>20,001	102	20.95±2.327	c	
	Geldings	1-5,000	322	15.96±1.130	a	<0.001
		5,001-10,000	574	19.20±0.900	b	
		10,001-20,000	834	22.53±0.796	c	
		>20,001	1,059	25.96±0.699	d	

4.3.4.10 Effect of Price Realised at Sale on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. There was a significant difference in the NH win strike rates according to price realised at sale with all of the price categories being significantly different (P < 0.001). Horses in the under €5,000 category had the lowest NH win strike rates and horses in the over €20,000 category had the highest NH win strike rates, as shown in Table 4.30. Mares in the under €5,000 category had significantly lower NH win strike rates than mares in the two highest price categories and mares in the over €20,001 category had significantly higher NH win strike rates than mares in the two lowest price categories. Geldings in the under €5,000 category and in the €5,001 - €10,000 category had significantly lower NH win strike rates than geldings in the €10,001 - €20,000 category or in the over €20,000 category while geldings in the over €20,000 category had significantly higher NH win strike rates than geldings in any other price category.

There was a significant difference in the NH place strike rates according to price realised at sale with all of the price categories being significantly different from each other (P < 0.001). Horses in the under €5,000 category had the lowest NH place strike rates and horses in the over €20,000 category had the highest NH place strike rates. Mares in the under €5,000 category had significantly lower NH place strike rates than mares in the two highest price categories and mares in the over €20,001 category had significantly higher NH place strike rates than mares in the two lowest price categories. Geldings in the under €5,000 category and in the €5,001 - €10,000 category had significantly lower NH place strike rates than geldings in the over €20,001 category. There was no significant difference in the NH place strike rates between geldings in the under €5,000 category and in the €5,001 - €10,000 category.

There was a significant difference in the Irish Point-to-Point win strike rates for horses according to price realised at sale ($P < 0.05$). Horses in the over €20,001 category had significantly higher Irish Point-to-Point win strike rates than horses in any other category and horses in the under €5,000 category had significantly lower Irish Point-to-Point win strike rates than horses in any other price category. There was no significant difference between horses in the €5,001 - €10,000 category and horses in the €10,001 - €20,000 category. There was no significant difference within mares however, geldings in the over €20,001 category had significantly higher Irish Point-to-Point win strike rates than those in the other price categories.

Horses in the under €5,000 category had significantly lower Irish Point-to-Point place strike rates than horses in any other price categories ($P = 0.001$). There was no significant difference between the other price categories. Similar results were observed within geldings however, there was no significant difference within mares.

Table 4.30: NH and Irish Point-to-Point Win and Place Strike Rates According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean±S.E.(%)*		*Sig.*
NH Win Strike Rate	All Horses	1-5,000	500	2.81±0.328	a	<0.001
		5,001-10,000	695	4.17±0.314	b	
		10,001-20,000	855	5.94±0.370	c	
		>20,001	1,084	8.42±0.360	d	
	Mares	1-5,000	284	1.97±0.338	a	0.001
		5,001-10,000	199	3.46±0.480	ab	
		10,001-20,000	144	4.60±0.984	bc	
		>20,001	97	5.60±1.247	c	
	Geldings	1-5,000	216	3.92±0.609	a	<0.001
		5,001-10,000	459	4.45±0.398	a	
		10,001-20,000	711	6.21±0.397	b	
		>20,001	985	8.70±0.375	c	
NH Place Strike Rate	All Horses	1-5,000	500	8.36±0.646	a	<0.001
		5,001-10,000	695	11.20±0.673	b	
		10,001-20,000	855	12.70±0.503	b	
		>20,001	1,084	14.93±0.482	c	
	Mares	1-5,000	284	6.91±0.806	a	0.001
		5,001-10,000	199	9.36±1.001	ab	
		10,001-20,000	144	10.85±1.218	bc	
		>20,001	97	13.31±1.814	c	
	Geldings	1-5,000	216	10.27±1.043	a	<0.001
		5,001-10,000	459	11.98±0.861	ab	
		10,001-20,000	711	13.07±0.551	b	
		>20,001	985	15.08±0.498	c	
Irish Point-to-Point Win Strike Rate	All Horses	1-5,000	442	8.28±0.869	a	<0.001
		5,001-10,000	429	11.50±1.066	b	
		10,001-20,000	456	11.78±1.064	b	
		>20,001	331	18.44±1.579	c	
	Mares	1-5,000	223	7.87±1.148	a	0.445
		5,001-10,000	114	8.34±1.665	a	
		10,001-20,000	66	11.01±2.831	a	
		>20,001	17	13.49±4.711	a	
	Geldings	1-5,000	218	8.74±1.314	a	<0.001
		5,001-10,000	314	12.52±1.316	a	
		10,001-20,000	390	11.91±1.150	a	
		>20,001	314	18.71±1.645	b	
Irish Point-to-Point Place Strike Rate	All Horses	1-5,000	442	12.66±0.968	a	0.001
		5,001-10,000	429	16.30±1.109	b	
		10,001-20,000	456	17.79±1.167	b	
		>20,001	331	18.70±1.488	b	
	Mares	1-5,000	223	12.53±1.324	a	0.906
		5,001-10,000	114	14.02±1.826	a	
		10,001-20,000	66	13.97±2.584	a	
		>20,001	17	13.60±4.426	a	
	Geldings	1-5,000	218	12.85±1.423	a	0.027
		5,001-10,000	314	17.18±1.360	b	
		10,001-20,000	390	18.44±1.290	b	
		>20,001	314	18.97±1.550	b	

4.3.4.11 Effect of Price Realised at Sale on Earnings

Overall, the mean earnings per start for horses that realised a price at sale were £448.6±1,154.34. Horses in the under €5,000 category (£161.3±19.76) and in the €5,001 - €10,000 category (£245.3±18.70) had significantly lower mean earnings per start than horses in the €10,001 - €20,000 category (£461.9±41.55) or in the over €20,000 category (£757.9±43.40) while horses in the over €20,000 category had significantly higher mean earnings per start than horses in any other price category. Mares in the under €5,000 category and the €5,001 - €10,000 category also had significantly lower mean earnings per start than mares in the €10,001 - €20,000 category and in the over €20,001 category (Table 4.31). Geldings in the under €5,000 category and in the €5,001 - €10,000 category had significantly lower mean earnings per start than geldings in the €10,001 - €20,000 category or in the over €20,000 category while geldings in the over €20,000 category had significantly higher mean earnings per start than geldings in any other price category.

Table 4.31: Mean Earnings per Start According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean ± S.E. (£)*		*Sig.*
Mean Earnings per Start	All Horses	1-5,000	711	161.3±19.76	a	<0.001
		5,001-10,000	831	245.3±18.70	a	
		10,001-20,000	1,011	461.9±41.55	b	
		>20,001	1,163	757.9±43.40	c	
	Mares	1-5,000	388	130.1±21.95	a	<0.001
		5,001-10,000	256	199.7±28.00	a	
		10,001-20,000	177	328.3±64.96	b	
		>20,001	102	422.2±79.74	b	
	Geldings	1-5,000	322	199.5±34.61	a	<0.001
		5,001-10,000	574	264.4±23.96	a	
		10,001-20,000	834	490.3±48.40	b	
		>20,001	1,059	790.8±46.92	c	

There was a significant difference in the mean earnings up to age eight years according to price realised at sale ($P < 0.001$). Horses in the under €5,000 category and in the €5,001 - €10,000 category earned significantly less by age eight years than horses in the two higher price categories and horses in the over €20,001 category earned more by age eight years than horses in any other price category. Similar results were observed in geldings while mares in the under €5,000 category earned significantly less than those in any other price category.

Table 4.32: Mean Earnings up to Age Eight Years According to Price Realised at Sale

Group	*Price at Sale (€)*	*n*	*Mean±S.E.(£)*		*Sig.*
All Horses	1-5,000	711	2,776.6±416.54	a	<0.001
	5,001-10,000	831	4,244.4±393.62	a	
	10,001-20,000	1,011	8,094.6±843.21	b	
	>20,001	1,163	12,429.9±826.89	c	
Mares	1-5,000	388	1,886.7±348.85	a	0.003
	5,001-10,000	256	3,806.9±724.04	b	
	10,001-20,000	177	5,255.9±1,266.52	b	
	>20,001	102	4,432.6±790.95	b	
Geldings	1-5,000	322	3,857.5±814.80	a	<0.001
	5,001-10,000	574	4,415.2±469.11	a	
	10,001-20,000	834	8,697.1±985.20	b	
	>20,001	1,059	13,205.2±901.32	c	

In order to determine the proportion of horses that earned more than the price they realised at sale, earnings were converted into Euro using the mean of the European Central Bank exchange rates for the first available date in January from 1999 to 2009. There was a highly significant difference in the proportions of horses earning different amounts according to price realised at sale ($P < 0.001$). A high proportion of horses in the under €5,000 category had zero earnings by the age of eight (68.5%) while the lowest proportion of horses to have zero earnings was in the over €20,001 category (32.8%). Conversely, 13.5% of horses in the over €20,001 category earned more than €20,001 while only 3.1% of horses in the under €5,000 category earned more than €20,001 (Table 4.33). Similar results were observed within mares and within geldings. Only 10.78% (401 horses) had earned more by age eight years than the price they realised at sale.

Table 4.33: Proportion of Horses Earning Different Amounts According to Price Realised at Sale

Price at Sale (€)	*n*	*% (€) Zero*	*% (€) 1-5,000*	*% (€) 5,000-10,000*	*% (€) 10,001 – 20,000*	*% (€) >20,000*	*Chi-Square*	*Sig.*
All Horses								
1-5,000	711	68.5	21.2	4.1	3.1	3.1	294.571	<0.001
5,001-10,000	831	57.2	25.2	7.0	6.1	4.6		
10,001-20,000	1,011	46.9	28.2	8.9	7.8	8.2		
>20,001	1,163	32.8	32.1	10.1	11.3	13.8		
Mares								
1-5,000	388	72.9	18.3	3.6	3.4	1.8	49.493	<0.001
5,001-10,000	256	63.7	21.5	7.4	3.9	3.5		
10,001-20,000	177	57.1	27.7	4.5	5.6	5.1		
>20,001	102	44.1	29.4	15.7	7.8	2.9		
Geldings								
1-5,000	322	63.0	24.8	4.7	2.8	4.7	169.411	<0.001
5,001-10,000	574	54.4	26.8	6.8	7.0	5.1		
10,001-20,000	834	44.7	28.3	9.8	8.3	8.9		
>20,001	1,059	31.7	32.4	9.5	11.5	14.8		

4.3.4.12 Effect of Price Realised at Sale on the Win and Place Strike Rates at Various Ages

Only horses that raced at the relevant age were included in the analysis for win and place strike rates at that age. There was no significant difference in the win or place strike rates at age four years or eight according to price realised at sale (data not shown, see Appendix 7, Table A.8) however, there was a significant difference in the win strike rates at ages five, six, seven and up to age eight years and in the place strike rates at ages five, six, seven and up to age eight years, as shown in Table 4.34 below.

Horses in the over €20,001 category had a significantly higher win strike rate at age five years than any other category while horses in the under €5,000 category had a significantly lower win strike rate than the two highest price categories, 12.61%±0.833 and 3.82%±0.507 respectively. There was no significant difference between horses in the €5,001 - €10,000 category and horses in either the under €5,000 category or the €10,001 - €20,000 category. Mares in the over €20,001 category had a significantly higher win strike rate at age five years than mares in any other price category. There was no significant difference between mares in the under €5,000 category, the €5,001 - €10,000 category or the €10,001 - €20,000 category. Geldings in the under €5,000 category had a significantly lower win strike rate at age five years than geldings in the €10,001 - €20,000 category and the over €20,001 category while geldings in the over €20,001 category had a significantly higher win strike rate at age five years than geldings in any of the other categories. There was no significant difference between the geldings in the €5,001 - €10,000 category and the geldings in the under €5,000 category or the geldings in the €10,001 - €20,000 category.

Horses in the over €20,001 category had a significantly higher place strike rate at age five years than horses in the under €5,000 category and horses in the €5,001 - €10,000 category, while horses in the under €5,000 category had a significantly lower place strike rate at age five years than horses in any other category, as shown in Table 4.34. There was no significant difference in the number of places at age five years between horses in the €5,001 - €10,000 category and horses in the €10,001 - €20,000 category or between horses in the €10,001 - €20,000 category and horses in the over €20,001 category. Geldings in the under €5,000 category had a significantly lower place strike rate at age five years than geldings in any other category and there was no significant difference among mares.

Horses in the over €20,001 category had a significantly higher win strike rate at age six years than any other category while horses in the under €5,000 category had a significantly lower strike rate than any other category. There was no significant difference between horses in the €5,001 - €10,000 category and the €10,001 - €20,000 category. Similar results were observed within geldings and there was no significant difference within mares.

There was a significant difference in the place strike rate at age six years for horses according to price realised at sale ($P < 0.05$). Horses in the under €5,000 category had a significantly lower place strike rate at age six years than any other price category while there was no significant difference amongst the other price categories. There was no significant difference within mares; however, there was a significant difference within geldings ($P < 0.05$). Geldings in the under €5,000 category had a significantly lower place strike rate at age six years than geldings in the €10,001 - €20,000 category and the over €20,001 category. There was no significant difference in the place strike rates at age six years for geldings in the €10,001 - €20,000 category and the over €20,001 category and there was no significant difference between the place strike rates at age six years for geldings in the €5,001 - €10,000 category and any other category.

Table 4.34: Win and Place Strike Rates at Various Ages According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean±S.E.(%)*		*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	1-5,000	505	3.82±0.507	a	<0.001
		5,001-10,000	605	5.87±0.662	ab	
		10,001-20,000	762	7.59±0.692	b	
		>20,001	863	12.61±0.833	c	
	Mares	1-5,000	280	3.14±0.525	a	0.004
		5,001-10,000	189	5.33±1.219	a	
		10,001-20,000	136	3.83±0.877	a	
		>20,001	73	9.34±2.467	b	
	Geldings	1-5,000	224	4.69±0.935	a	<0.001
		5,001-10,000	415	6.06±0.790	ab	
		10,001-20,000	626	8.41±0.817	b	
		>20,001	789	12.93±0.882	c	
Places at Age 5 Years Strike Rate	All Horses	1-5,000	505	8.73±0.796	a	<0.001
		5,001-10,000	605	13.28±0.991	b	
		10,001-20,000	762	15.04±0.884	bc	
		>20,001	863	17.13±0.873	c	
	Mares	1-5,000	280	8.12±0.979	a	0.065
		5,001-10,000	189	9.02±1.320	a	
		10,001-20,000	136	13.10±1.833	a	
		>20,001	73	9.55±1.901	a	
	Geldings	1-5,000	224	9.52±1.311	a	<0.001
		5,001-10,000	415	15.26±1.302	b	
		10,001-20,000	626	15.47±0.999	b	
		>20,001	789	17.82±0.935	b	
Wins at Age 6 Years Strike Rate	All Horses	1-5,000	453	4.20±0.625	a	<0.001
		5,001-10,000	583	7.50±0.660	b	
		10,001-20,000	702	8.58±0.675	b	
		>20,001	890	11.73±0.701	c	
	Mares	1-5,000	237	4.98±0.994	a	0.094
		5,001-10,000	169	5.11±0.893	a	
		10,001-20,000	117	8.92±1.813	a	
		>20,001	66	7.28±1.739	a	
	Geldings	1-5,000	215	3.35±0.729	a	<0.001
		5,001-10,000	413	8.49±0.853	b	
		10,001-20,000	585	8.51±0.726	b	
		>20,001	822	12.11±0.745	c	
Places at Age 6 Years Strike Rate	All Horses	1-5,000	453	11.54±0.963	a	<0.001
		5,001-10,000	583	14.92±0.950	b	
		10,001-20,000	702	16.68±0.876	b	
		>20,001	890	16.87±0.760	b	
	Mares	1-5,000	237	11.46±1.366	a	0.532
		5,001-10,000	169	14.05±1.632	a	
		10,001-20,000	117	13.60±1.865	a	
		>20,001	66	14.72±2.854	a	
	Geldings	1-5,000	215	11.69±1.362	a	0.008
		5,001-10,000	413	15.07±1.145	ab	
		10,001-20,000	585	17.30±0.982	b	
		>20,001	822	17.05±0.790	b	

Wins at Age 7 Years Strike Rate	All Horses	1-5,000	307	4.89±0.727	a	<0.001
		5,001-10,000	390	6.45±0.753	ab	
		10,001-20,000	540	8.44±0.756	b	
		>20,001	685	11.69±0.821	c	
	Mares	1-5,000	158	4.14±1.014	a	0.520
		5,001-10,000	98	4.64±1.393	a	
		10,001-20,000	65	5.16±1.587	a	
		>20,001	36	7.99±3.429	a	
	Geldings	1-5,000	149	5.69±1.041	a	<0.001
		5,001-10,000	291	6.96±0.888	a	
		10,001-20,000	475	8.88±0.830	a	
		>20,001	648	11.86±0.846	b	
Places at Age 7 Years Strike Rate	All Horses	1-5,000	307	12.05±1.163	a	0.011
		5,001-10,000	390	16.28±1.209	b	
		10,001-20,000	540	16.72±0.968	b	
		>20,001	685	17.18±0.947	b	
	Mares	1-5,000	158	11.07±1.602	a	0.020
		5,001-10,000	98	18.19±2.389	b	
		10,001-20,000	65	19.90±3.336	b	
		>20,001	36	13.92±3.274	ab	
	Geldings	1-5,000	149	13.09±1.691	a	0.244
		5,001-10,000	291	15.63±1.407	a	
		10,001-20,000	475	16.29±1.001	a	
		>20,001	648	17.29±0.981	a	
Wins up to Age 8 Years Strike Rate	All Horses	1-5,000	711	3.65±0.303	a	<0.001
		5,001-10,000	831	4.76±0.307	b	
		10,001-20,000	1,011	6.39±0.370	c	
		>20,001	1,163	8.41±0.338	d	
	Mares	1-5,000	388	3.10±0.342	a	0.004
		5,001-10,000	256	4.08±0.588	ab	
		10,001-20,000	177	4.98±0.845	b	
		>20,001	102	6.63±1.261	c	
	Geldings	1-5,000	322	4.33±0.525	a	<0.001
		5,001-10,000	574	5.04±0.358	a	
		10,001-20,000	834	6.69±0.411	b	
		>20,001	1,059	8.59±0.351	c	
Places up to Age 8 Years Strike Rate	All Horses	1-5,000	711	9.22±0.537	a	<0.001
		5,001-10,000	831	11.75±0.581	b	
		10,001-20,000	1,011	13.02±0.477	bc	
		>20,001	1,163	14.29±0.454	c	
	Mares	1-5,000	388	8.69±0.723	a	0.013
		5,001-10,000	256	10.71±0.916	ab	
		10,001-20,000	177	11.23±1.062	ab	
		>20,001	102	13.66±1.766	b	
	Geldings	1-5,000	322	9.88±0.803	a	<0.001
		5,001-10,000	574	12.22±0.735	b	
		10,001-20,000	834	13.40±0.532	bc	
		>20,001	1,059	14.35±0.269	c	

There was a significant difference in the win strike rates at age seven years for horses according to price realised at sale ($P < 0.05$). Horses in the under €5,000 category had a significantly lower win strike rate at age seven years than any other price category while horses in the over €20,001 category had a significantly higher win strike rate than the other price categories. There was no significant difference within mares; however, there was a significant difference within geldings ($P < 0.05$). Geldings in the over €20,001 category had a significantly higher win strike rate at age seven years than geldings in any other category and there was no significant difference amongst the other categories.

There was a significant difference in the place strike rates at age seven years for horses according to price realised at sale ($P < 0.05$). Horses in the under €5,000 category had a significantly lower place strike rate at age seven years than any other price category while there was no significant difference amongst the other price categories, as seen in Table 4.34. Mares in the under €5,000 category had a significantly lower place strike rate at age seven years than mares in the €5,001 - €10,000 category or in the €10,001 - €20,000 category. There was no significant difference in the place strike rate at age seven years for mares in the over €20,001 category and mares in any other price category. There was no significant difference within geldings.

There was a highly significant difference in the win strike rate up to age eight years according to price realised at sale, with each price category being significantly different from each other ($P < 0.001$). Horses in the over €20,001 category had a significantly higher win strike rate up to age eight years than any other group while horses in the under €5,000 category had a significantly lower win strike rate than any other group. There was a significant difference in the win strike rates up to age eight years for mares according to price realised at sale ($P < 0.05$). Mares in the under €5,000 category had a significantly lower win strike rate up to age eight years than mares in the €10,001 - €20,000 category or in the over €20,001 category while mares in the over €20,001 category had a significantly higher win strike rate than mares in any other category, as seen in Table 4.34. Geldings in the over €20,001 category had a significantly higher win strike rate up to age eight years than any other group while geldings in the under €5,000 category and the €5,001 - €10,000 category had a significantly lower strike rate than either of the other groups. There was no significant difference between geldings in the under €5,000 category and the €5,001 - €10,000 category.

Horses in the under €5,000 category had a significantly lower place strike rate up to age eight years than any other price category while horses in the €10,001 - €20,000 category and in the over €20,001 category had significantly higher place strike rates up to age eight years than either of the other two categories. There was no significant difference in the place strike rates up to age eight years for horses in the €10,001 - €20,000 category and those in the over €20,001 category. Mares in the under €5,000 category had a significantly lower place strike rate up to age eight years than mares in the over €20,001 category. There was no significant difference in the place strike rates up to age eight years for mares in the €5,001 - €10,000 category and the €10,001 - €20,000 either with each other, or with the other categories. Geldings in the under €5,000 category had a significantly lower place strike rate up to age eight years than geldings in the other categories and geldings in the over €20,001 category had a significantly higher place strike rate than geldings in the under €5,000 category and the €5,001 - €10,000 category ($P < 0.001$). There was no difference in the place strike rates up to age eight years for geldings in the €10,001 - €20,000 category and those in either the €5,001 - €10,000 category or the over €20,001 category, as shown in Table 4.34.

4.3.4.13 Effect of Price Realised at Sale on the Number of Wins and Places up to Age Eight Years

Only horses that raced by age eight years were included in the analysis for the number of wins and places at age eight years. Horses that realised a price at sale had a mean number of 0.92 ± 1.567 wins and 1.78 ± 2.472 places up to the age of eight. There was a highly significant difference in the number of wins up to age eight years according to price realised at sale, with each price category being significantly different from each other ($P < 0.001$). Horses in the over €20,001 category had significantly more wins up to age eight years than any other group while horses in the under €5,000 category had significantly fewer than any other group. There was a significant difference in the number of number of wins up to age eight years for mares according to price realised at sale ($P < 0.05$). Mares in the under €5,000 category had significantly fewer wins up to age eight years than any other price category while there was no significant difference amongst the other price categories, as seen in Table 4.35. Geldings in the over €20,001 category had significantly more wins up to age eight years than any other group while geldings in the under €5,000 category and the €5,001 - €10,000 category had significantly fewer than either of the other groups. There was no significant difference between geldings in the €5,000 category and the €5,001 - €10,000 category.

Horses in the under €5,000 category had significantly fewer places up to age eight years than any other price category while horses in the €10,001 - €20,000 category and in the over €20,001 category had significantly more places up to age eight years than either of the other two categories. There was no significant difference in the number of places up to age eight years for horses in the €10,001 - €20,000 category and those in the over €20,001 category. Mares in the under €5,000 category had significantly fewer places up to age eight years than mares in the €5,001 - €10,000 category or in the €10,001 - €20,000 category. There was no significant difference in the number of places up to age eight years for mares in the over €20,001 category and mares in any other price category. Geldings in the under €5,000 category and the €5,001 - €10,000 category had significantly fewer places up to age eight years than geldings in the €10,001 - €20,000 category and in the over €20,001 category ($P < 0.001$). There was no difference in the number of places up to age eight years for geldings in the under €5,000 category and the €5,001 - €10,000 category or for geldings in the €10,001 - €20,000 category and in the over €20,001 category, as shown in Table 4.35.

Table 4.35: Number of Wins and Places up to Age Eight Years According to Price Realised at Sale

Means with the same letter are not significantly different from each other

Variable	*Group*	*Price at Sale (€)*	*n*	*Mean ± S.E.*		*Sig.*
Wins up to Age 8 Years	All Horses	1-5,000	711	0.47±0.037	a	<0.001
		5,001-10,000	831	0.73±0.048	b	
		10,001-20,000	1,011	0.95±0.051	c	
		>20,001	1,163	1.31±0.053	d	
	Mares	1-5,000	388	0.38±0.040	a	0.014
		5,001-10,000	256	0.60±0.081	b	
		10,001-20,000	177	0.60±0.094	b	
		>20,001	102	0.65±0.112	b	
	Geldings	1-5,000	322	0.58±0.065	a	<0.001
		5,001-10,000	574	0.79±0.059	a	
		10,001-20,000	834	1.02±0.058	b	
		>20,001	1,059	1.37±0.057	c	
Places up to Age 8 Years	All Horses	1-5,000	711	1.14±0.075	a	<0.001
		5,001-10,000	831	1.59±0.083	b	
		10,001-20,000	1,011	1.94±0.080	c	
		>20,001	1,163	2.15±0.077	c	
	Mares	1-5,000	388	0.97±0.082	a	0.006
		5,001-10,000	256	1.46±0.153	b	
		10,001-20,000	177	1.44±0.156	b	
		>20,001	102	1.40±0.180	ab	
	Geldings	1-5,000	322	1.34±0.132	a	<0.001
		5,001-10,000	574	1.65±0.098	a	
		10,001-20,000	834	2.05±0.091	b	
		>20,001	1,059	2.22±0.083	b	

4.4 Discussion

4.4.1 Effect of Sex on Racing Performance

This study identified a number of significant differences between mares and geldings, with regards to racing performance. Overall, geldings were significantly more likely to race, win and place than mares ($P < 0.001$). Geldings also had significantly more starts at ages six, seven, eight and up to age eight years than mares ($P < 0.001$). It is possible that this may be because mares racing careers are ended earlier for breeding purposes. While similar proportions of mares and geldings raced at age five years (70.3% and 70.2%, respectively) the proportions were seen to drop more rapidly for mares than geldings by age eight years (19.9% and 39.4% racing, respectively), indicating that mares are indeed retired earlier. However, another possibility is that mares are overall less suited to NH racing than geldings. A study by Mukai et al. (2003) indicated that female horses have higher heart rates at submaximal exercise than male horses, suggesting they may have a lower aerobic capacity than males. This would negatively affect the racing performance of mares. This was further supported by findings by Ohmura et al. (2002) that training significantly increased the V_{200} of male horses while having no significant difference on the V_{200} of female horses. Geldings are often larger than mares and have a longer stride length (Seder and Vickery, 2003). However, this is generally not taken into consideration and the majority of NH races are not gender specific providing geldings with an advantage. This may be a reason for the larger win, place and overall win and place strike rates for geldings when compared to mares. It is also possible that breeders may have been anxious to realise some profit from mares by retiring them to breeding.

Table 4.36: Summary of Effect of Sex on Racing Performance (Compared to Geldings)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Mare	↓***	↓*	–	↓***	↓***	↓***	↓***	–

Geldings were found to have significantly more NH starts overall and more steeplechase starts while mares had significantly more hurdle and Irish Point-to-Point starts ($P < 0.001$). Steeplechase starts are more physically demanding, and therefore geldings may be preferred for these types of races. This agrees with findings by Whitaker et al. (2008) who found that as the level of competition increased, the proportion of mares competing decreased. Geldings had significantly more wins, overall places, seconds, thirds and overall wins and places than mares ($P < 0.001$). They also had significantly higher NH win and place strike rates than mares ($P < 0.001$) while mares had significantly higher Irish Point-to-Point win and place strike rates than geldings. These data provide further support for the contention that geldings are more suited to NH races resulting in more starts, wins and places. Harkins et al. (1992) discovered that female horses are less competitive than male horses. Females were found to run significantly slower competitively compared to their performance in a solo run with the same jockey and over the same course, while there was no significant difference for geldings. As breeders wish to record some racing wins prior to breeding it is possible that they direct the mares to the Irish Point-to-Point races where they feel the mares have a greater chance of winning. Geldings also had significantly higher win strike rates at ages four to seven and up to age eight years ($P < 0.01$), significantly higher place strike rates at ages four, five, six and up to age eight years ($P < 0.001$) and earned significantly more than mares ($P < 0.001$). This again indicates that geldings may be inherently more suited to NH racing than mares.

4.4.2 Effect of Selling Status on Racing Performance

Selling status significantly influenced racing performance. There was a highly significant difference ($P < 0.001$) in the proportions of horses that raced, raced by age four years and were raced by age five years between those that were sold, not sold and withdrawn. The highest performance index in each case was observed in horses that were sold, followed by those that were not sold and finally those that were withdrawn. Prejudicial defects were found in 81.5% of the horses that were withdrawn compared to 7.0% and 4.1%, for horses that were not sold and horses that were sold, respectively. This extremely high level of prejudicial defects is probably a strong contributing factor to the lower proportion of withdrawn horses that raced, raced by four and raced by five compared to horses that were sold or not sold. Horses that were sold also had a significantly higher mean number of NH starts, Irish Point-to-Point starts and starts at ages four and five than those that were not sold and those that were withdrawn. This may be due to purchasers having more incentive to invest in training and to run the horse in order to get a return on their investment, than breeders whose horses did not sell or had to be withdrawn from the sale. It may also be assumed that buyers who purchased at the sale did so with the intent of racing the horse while the vendors that were selling horses were less interested in owning race horses than in breeding them. Unsold and withdrawn horses would also incur some delays in their training due to the requirement in most cases of being represented for sale at a later date. However, the higher win, place and overall win and place strike rates for sold horses compared to unsold horses indicates that the horses that were sold were in fact superior horses.

Table 4.37: Summary of Effect of Selling Status on Performance (Compared to Horses That were Sold)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Not Sold	↓***	↓***	↓**	↓**	↓***	↓**	↓***	↑***
Withdrawn	↓***	↓***	↓**	↓*	↓**	↓**	–	↑***

There was also a significant difference in the proportions of horses that won or were placed in a race ($P < 0.05$) depending on the selling status. Here, however, it was found that the highest proportions of horses that won and that were placed were the horses that were sold, followed by those that were withdrawn and finally by those that were not sold. Those horses that were sold also had significantly more career wins, career places and a significantly higher win strike rate than those that were not sold or withdrawn (there was however, no significant difference between not sold and withdrawn). They also had significantly higher place strike rates and overall win and place strike rates than those that were not sold. This indicates that buyers do indeed know what is desirable and undesirable in future racers and place their bids accordingly. As there was no significant difference in the number of places between the horses that were withdrawn and the horses from the other two groups it indicated that possibly the horses that were withdrawn, were withdrawn due to conditions that prevented them racing at an early age, but which had no long-term effect on them in later life. This is further reinforced by the results which show a significant difference in the number of starts at age four years and five and in the number of wins at age five years and the number of places at age six years but not at later ages (data not shown).

Earlier in the study (chapter two), it was found that the proportions of horses without defects, with prejudicial defects, respiratory noise, RLN and tarsal plantar desmitis differed significantly ($P < 0.05$) with respect to selling status, with horses that were sold being more likely to have no defects and horses that were not sold more likely to have prejudicial defects, respiratory noise, RLN and tarsal plantar desmitis. As RLN has frequently been associated with poor racing performance (Morris and Seeherman, 1991; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005), this may have contributed to the observed difference between groups.

Horses that were sold, raced in significantly more steeplechase and hurdle races than those that were not sold, while horses that were not sold or withdrawn raced in significantly more Irish Point-to-Point races than those that were sold. This indicated that not sold and withdrawn horses were directed towards the Point-to-Point circuit while the horses that were sold were more likely to be entered into higher stakes races. This may be due to defects, such as those mentioned above, having a negative impact on their racing performance, however, it is also possible that purchasers wanted more of a return on their investment, thus entering the horses into steeplechase or hurdle races with larger prize funds than Irish Point-to-Points, while horses that were not sold were entered into lower value races possibly to gain experience before returning to sale.

4.4.3 Effect of Price Realised at Sale on Racing Performance

Price realised at sale had a highly significant effect on the likelihood of racing, winning and placing ($P < 0.001$). Horses whose sale prices were in the higher price categories were more likely to race, win and place than horses in the lower price categories. It was also found that horses in the higher price categories had significantly more starts, wins, places and earnings per start than horses in the lower price categories. This is in agreement with the results of several studies which found that as price increased so too did the probability of winning a stakes race (Heckerman, 1996; Robbins and Kennedy, 2001), the number of starts (Jackson et al., 2011) and the prize money earned (Heckerman, 1996; Jackson et al., 2011). Jackson et al. (2011) studied a relatively large sample of 2,773 yearlings to investigate the association between purchase price and performance. They determined that as purchase price increased so too did the likelihood of horses racing, the number of starts and the number of places ($P < 0.001$). These results were very similar to the results in the current study. The above findings indicate that buyers do know what kind of horse is more likely to prove successful on the racetrack and therefore the price increases accordingly. This was further supported by the higher win, place and overall win and place strike rates for horses in the higher price brackets compared to horses in the lower price brackets. Although it was found that as the price at sale increased so too did the prize money earned, it must be noted that only 10.8% (401 horses) earned more than the price they realised at sale, a figure slightly lower than that of 14.5% found in the study by Jackson et al. (2011). Furthermore, nearly 70% of horses that realised a price of less than €5,000 at sale and more than 30% of the horses that realised more than €20,001 at sale had zero earnings, indicating that owning a NH race horse is not a profitable venture.

Horses in the higher price brackets also raced in significantly more NH races and in significantly fewer Irish Point-to-Point races than those in the lower price brackets ($P < 0.001$), indicating that the less expensive horses were directed towards the Point-to-Point circuit while the more expensive horses were more likely to be entered into higher stakes races. More expensive horses also had significantly higher NH and Irish Point-to-Point win and place strike rates than those in the lower price brackets ($P < 0.001$) indicating that the higher priced horses were in fact superior racehorses. Another possibility is that as the price of the horses increased, the purchaser sought a greater return on investment, therefore investing more in training and care of the horse, and requiring that it be run more often. This is further reinforced by the significantly different proportions that raced at ages four, six, seven and eight. Higher proportions of horses in the higher price categories raced at each of these ages than horses in the lower price categories, indicating that the owners of more expensive horses were keener to race them after purchase and were more likely to keep the horses racing in subsequent years resulting in longer careers.

There was no significant difference in the number of starts for horses of different purchase price at ages four or five; however, as they got older, horses in the higher price categories had significantly more starts than horses in the lower price categories. This could be attributed to owners of higher priced horses having more incentive to continue investing in training to produce a result, as the loss of investment would be far greater for an expensive horse than for a less expensive horse. Horses in the higher price brackets had significantly higher win and place strike rates at ages five, six and seven than those in the lower price brackets. This again implies that price does indicate the quality and potential of the horse; however, it is possible that more expensive horses were put into training with better trainers resulting in better results. It is also possible that more expensive horses better withstand the rigours of training due to better initial conformation and the absence of physiological defects while poorer horses have a lower strike rate and do not merit the costs of continued training.

It is worth noting that horses in the higher price categories had significantly fewer prejudicial defects, such as RLN, than horses in the lower price categories (see chapter 2). Such defects have previously been shown to negatively affect performance (Morris and Seeherman, 1991; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005) and therefore are likely to also have been a contributing factor to the differences observed.

4.5 Conclusion

Sex, selling status and price realised at sale had an influence on future racing performance. Mares had significantly fewer career starts, wins and places than geldings. Horses that were sold had significantly more career starts, wins and places than horses that were unsold or that were withdrawn from the sale and horses that were in the higher price brackets at the sales had significantly more career starts, wins and places than horses in the lower price brackets.

Fillies, unsold horses and horses in the lower price categories had significantly fewer steeplechase starts and significantly more Irish Point-to-Point starts per year raced than geldings, sold horses and horses in the higher price categories respectively, indicating that the poorer quality horses were directed towards the Irish Point-to-Point circuit while the more expensive or higher quality horses were directed towards the higher stakes races.

Geldings, sold horses and horses in the higher price categories had significantly higher win and place strike rates throughout their careers and had significantly higher earnings per start than their counterparts. The results indicate that price generally does indicate the quality and potential of the horse, and that buyers know what to look for in a potential racehorse.

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Chapter 5

Effect of Recorded Defects on the Racing Performance of Thoroughbred National Hunt Horses

Abstract

This study sought to investigate the effect of a variety of defects on the racing performance of a large sample of horses. The study population consisted of information concerning 5,282 Thoroughbred National Hunt horses that were presented for sale at ages three and four. The information regarding the defects was gathered using the pre-purchase veterinary examination certificates from three years of Tattersalls Ireland's Derby and August Sales, Goffs Ireland June Sale and Doncaster Bloodstock Sales Ltd. (DBS) Spring Sale, from 2002-2004.

Horses with defects were significantly less likely to race than those without defects (81.3% compared to 85.1%). Horses with prejudicial defects were significantly less likely to race (70.4% compared to 83.7%) or to win a race (33.8% compared to 41.3%) and had significantly fewer career starts (8.68$\pm$0.379 compared to 9.91$\pm$0.131), wins (0.69$\pm$0.071 compared to 0.92$\pm$0.026) and places (1.39$\pm$0.115 compared to 1.76$\pm$0.040) than horses without prejudicial defects ($P < 0.01$). Horses with recurrent laryngeal neuropathy (RLN) were significantly less likely to race (69.4% compared to 83.6%) than those without RLN and had significantly fewer career wins (0.68$\pm$0.092 compared to 0.92$\pm$0.026) and career places (1.35$\pm$0.155 compared to 1.76$\pm$0.040) than those without RLN. They also had a significantly higher proportion of non-finished races than those without RLN (34.01%$\pm$2.147 compared to 25.29%$\pm$0.456).

Horses with tarsal plantar desmitis also had a significantly higher proportion of non-finished races than those without tarsal plantar desmitis (29.96%$\pm$1.754 compared to 25.71%$\pm$0.489). Papillomas significantly adversely affected the number of career starts (8.45$\pm$0.470 compared to 9.87$\pm$0.128), career wins (0.59$\pm$0.079 compared to 0.91$\pm$0.025), career places (1.30$\pm$0.126 compared to 1.75$\pm$0.039) and mean earnings per start (£241.5$\pm$41.85 compared to £454.6$\pm$21.93). Horses with papillomas had significantly more non-finished races than those without papillomas (33.34%$\pm$2.124 compared to 25.85%$\pm$0.448) while interestingly, horses with sarcoids had significantly fewer non-finished races than those without sarcoids (19.44%$\pm$1.805 compared to 26.58%$\pm$0.452). Further adverse significant differences were observed in racing performance for all of the defects analysed. The results indicate that defects noted in pre-purchase veterinary examinations have significant adverse effects on racing performance and indicate that management or selective breeding to reduce the incidence of these defects in the National Hunt population may improve overall racing performance.

5.1 Introduction

Thoroughbred breeding and racing are significant industries in Ireland and the UK, with approximately twelve thousand foals born each year. Not all of the foals bred will make it to the racetrack, approximately one quarter will never race (Minkema, 1975; Pearson, 2006) and of those that do almost half never win a race (More, 1999). Conformational and other defects can affect the soundness (the ability of the horse to perform the function for which it has been purchased) of a horse and can impede its performance to varying degrees. It is therefore important that horses are bred to have as few performance limiting conditions as possible. Pre-purchase examinations are conducted on all three and four year old National Hunt (NH) horses that are sold at public auction in Ireland and the UK. These serve to identify some of the defects present in the horse for the prospective purchaser. However, it is not clear whether some of the defects that may be identified on the certificate are likely to affect the performance of the horse. A number of studies have been performed investigating the connection between various physical and conformational defects and performance. However there is still a dearth of information, regarding the effect, if any, of these defects on future athletic performance. Many of the studies regarding performance affecting defects are general studies investigating the causes of poor performance rather than whether or not specific anatomical or physiological defects cause poor performance (Jeffcott et al., 1982; Bailey et al., 1999; Knight and Evans, 2000; Hernandez and Hawkins, 2001). Others studies have investigated the effect of specific conditions such as recurrent laryngeal neuropathy (RLN) or heart murmurs on performance (Reef, 1995; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Marr, 2005; Kikuta et al., 2006). However, these often study a relatively small sample size and usually report on a variety of infectious and traumatic conditions that may have arisen as a result of the training environment rather than from any inherent defects.

Defects such as lameness (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002; Ross, 2003) and RLN (Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006) have previously been shown to affect the performance of the horse. Rossdale et al. (1985) investigated wastage among Thoroughbreds and found that out of 114,919 available training days, 5.8% were lost as a result of lameness while Kikuta et al. (2006) found racing performance to be significantly affected by RLN in a study comparing affected Thoroughbred racehorses with unaffected racehorses. Horses with RLN were less likely to return to racing after diagnosis, ran fewer races and were more likely to finish 4/5 seconds or more behind the winning horse ($P < 0.05$) than horses without RLN. There is less definitive information on other conditions. It is believed that defects such as tarsal plantar desmitis (Brokken, 1978; Ross et al., 2002; Major and Zubrod, 2006), metacarpal/metatarsal exostoses (Rossdale et al., 1985) and OATJ (Brokken, 1978; Moyer et al., 1983) can be performance limiting, however, no direct evidence of this is offered by the authors. The aim of the present study was to determine if a variety of physical defects affect the racing performance of horses and to attempt to quantify the magnitude of any such effect on performance.

5.2 Materials and Methods

The pre-purchase examination certificates of 5,282 three and four year old NH horses that were presented for sale at Tattersalls Ireland, Goffs Ireland and Doncaster Bloodstock Sales Ltd. (DBS) from 2002 to 2004 were analysed during this study. The number of horses from each sale is shown in Table 4.1 below. These years were chosen as this allowed at least four years of possible racing per horse. The cut-off date for the races included in the analysis was the 31st of December 2009. Any race ran after this date was excluded from the study. The effect of physical defects on racing performance were then analysed to determine if these had an effect on the performance of the horse.

Table 5.1: Number of Horses Analysed from Each Sale for Each Year

	Tattersalls Ire.		*Goffs Ire.*	*Doncaster Bloodstock*	*Total*
	Derby	August	June	Spring	
2004	452	643	459	267	1,821
2003	382	636	416	314	1,748
2002	380	609	402	322	1,713
Total	1,214	1,888	1,277	903	5,282

Information used to identify the horses, such as dam, sire and year of birth was taken from the sales catalogues. Names of the horses were then acquired from the Weatherbys' database using this information and the performance results were taken from the racing post website and the Irish Point-to-Point website. All results were from individual horses. If horses were entered into multiple sales only the most recent sales results were analysed. Earnings were analysed in Pounds Sterling as this was the currency used by the racing post. Although the female horses in the sample were sold as fillies (female horses four years and younger) the majority of their racing careers took place after the age of five, therefore they will be referred to as mares throughout this chapter.

5.2.1 Veterinary Examination Procedure for Sales

When a young untrained NH horse is entered into a sale, it is sold subject to a pre-purchase examination certificate. It is compulsory for the owner or vendor to have a pre-purchase examination carried out on the horse by a privately appointed veterinarian within a defined period prior to the sale (14 days for Tattersalls and Goffs, 28 days for DBS) which is stipulated in the Conditions of Sale of the company. The certificate from this examination is then brought, with the animal, to the sales complex whereupon the animal is examined again, this time by a member of the veterinary panel appointed by the sales company. The allocation of the veterinarians from the panel is arbitrary, with the first free veterinarian taking the next horse in line. Once this examination has been completed the panel veterinarian either agrees or disagrees with the original certificate as to whether or not the defects present are likely to prejudice the horse's use for racing. The panel veterinarian may then make changes to the certificate such as the inclusion of additional defects or the removal of defects that were not found to be present. The defects analysed were only those agreed by the veterinary panel. The defects described by both veterinarians are disclosed during the sale and the certificates are available for inspection by purchasers. Behavioural defects are not identified on the veterinary certificate but are disclosed separately in a vendor's declaration. As these vendor declarations were not available, behavioural defects were not included in this study.

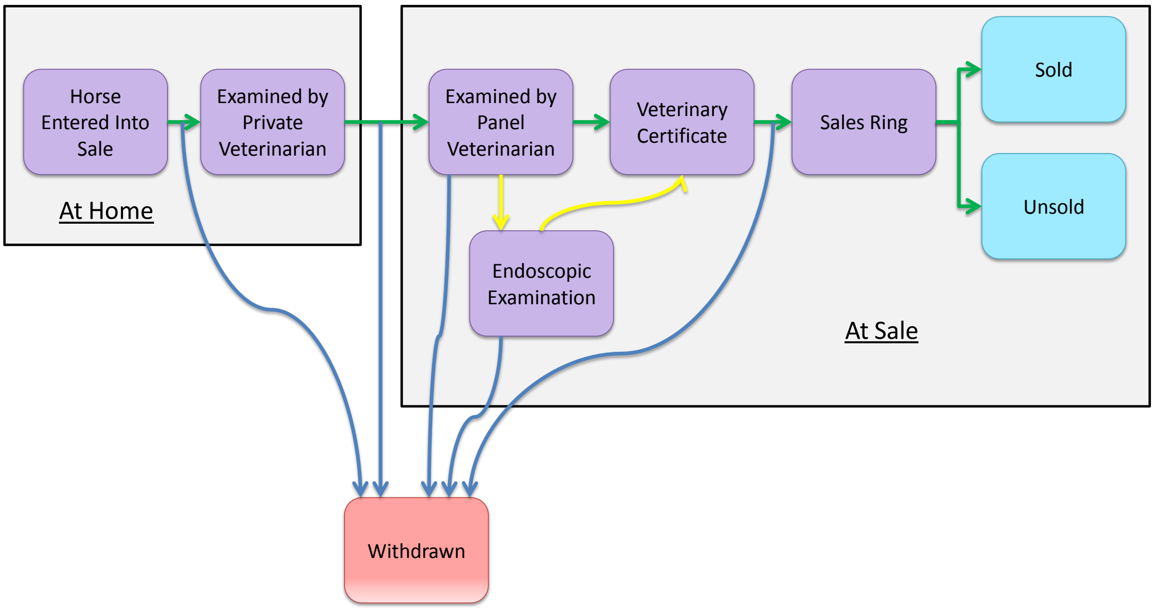


Figure 5.1: Flowchart Showing Progress Through the Pre-Purchase Examinations

Horses could be withdrawn at any stage from the sale (Figure 5.1), either before or after the pre-purchase examinations have taken place. Certificates were only available for the horses that were presented at the sales venue, that is, those which underwent the panel pre-purchase examination. The sales used in this study are considered "select" sales. Horses entered into select sales have to undergo additional pre-screening in order to determine if they are of a high enough quality, with respect to pedigree and conformation, to be offered for sale at these sales. This automatically rules out many horses that may have conformational or other defects. As it is only the higher quality horses that are permitted to enter the sales it is quite possible that the prevalence of the defects noted in this study are consequently conservative values and that the true prevalence may in fact be much higher.

5.2.2 Respiratory Examination

Only the horses identified as producing abnormal respiratory noises were subjected to endoscopic examination. The lunging stage of the examination was carried out in enclosed lunging arenas which allowed the examining veterinarians to hear any abnormal noises. Once the examining panel veterinarian identified an abnormal respiratory noise, another member of the veterinary panel was asked to verify this finding. The examining veterinarian then made the determination that the horse had a defect likely to prejudice its use for racing and the horse was sent for an endoscopic examination to identify any laryngeal or pharyngeal defects that might be present. This was carried out by a group of three panel veterinarians who had been assigned to this task, in a quiet room away from the other horses. The horse was examined using a video endoscope and all three veterinarians observed the larynx together. If paralysis was observed, the horse was recorded as having recurrent laryngeal neuropathy (RLN). If there was no paralysis (or any other laryngeal or pharyngeal defect) present, the horse was still considered to have a defect likely to prejudice its use for racing on the basis of the abnormal respiratory noise.

5.2.3 Statistical Analysis

SPSS version 19.0 for Windows was used to analyse the data. ANOVAs were used to determine the variance of the mean for respiratory defects, metacarpal/metatarsal exostoses and tarsal plantar desmitis, while t-tests were used to analyse the remainder of the defects. Chi-squared tests were used to analyse several of the racing parameters (signified with * below) for each defect. For all other defects the incidence was too low for meaningful comparisons.

The variables that were analysed were:

- Presence of Defects
- Prejudicial Defects
- Respiratory Defects
- Lameness at the Time of the Sale
- Metacarpal/Metatarsal Exostoses
- Tarsal Plantar Desmitis
- Calcaneal Bursitis
- Synovial Distension of the Digital Tendon Sheath (SDDTS)
- Hoof Cracks
- Cardiac Defects
- Sarcoids
- Papillomas
- Hind limb Incoordination
- Oral or dental defects and features
- Parrot Mouth
- Undershot Jaw
- Wolf Teeth
- Ocular Defects
- Muscle Wastage
- Unspecified Synovial Distension

The racing parameters that were analysed were:

1. Raced vs. Unraced *
2. Raced by Age 4 Years vs. Unraced by Age 4 Years*
3. Raced by Age 5 Years vs. Unraced by Age 5 Years*
4. Win vs. No Wins *
5. Placed vs. No Places *
6. Second Placed vs. No Second Places *
7. Third Placed vs. No Third Places *
8. Win or Place vs. No Win or Place *
9. Type of Racing Career*
10. Age at 1st Race
11. Starts per Year Raced
12. National Hunt Starts per Year Raced
13. Hurdle Starts per Year Raced
14. Steeplechase Starts per Year Raced
15. Irish Point-to-Point Starts per Year Raced
16. Starts at Age 4 Years
17. Starts at Age 5 Years
18. Starts at Age 6 Years
19. Starts at Age 7 Years
20. Starts at Age 8 Years
21. Starts up to Age 8 Years
22. Raced at Age 7 Years vs. Unraced at Age 7 Years
23. Raced at Age 8 Years vs. Unraced at Age 8 Years
24. Non-Finished Races per Start
25. Win Strike Rate
26. Place Strike Rate
27. Second Place Strike Rate
28. Third Place Strike Rate
29. Overall Win and Place Strike Rate
30. National Hunt Win Strike Rate
31. National Hunt Place Strike Rate
32. Irish Point-to-Point Win Strike Rate
33. Irish Point-to-Point Place Strike Rate
34. Earnings per Start
35. Wins at Age 4 Years Strike Rate
36. Places at Age 4 Years Strike Rate
37. Wins at Age 5 Years Strike Rate
38. Places at Age 5 Years Strike Rate
39. Wins at Age 6 Years Strike Rate
40. Places at Age 6 Years Strike Rate
41. Wins at Age 7 Years Strike Rate
42. Places at Age 7 Years Strike Rate
43. Wins at Age 8 Years Strike Rate
44. Places at Age 8 Years Strike Rate
45. Wins up to Age 8 Years Strike Rate
46. Places up to Age 8 Years Strike Rate
47. Wins up to Age 8 Years
48. Places up to Age 8 Years

The data selected for analysis varied depending on the racing parameter. All horses were included for analysis of parameter 1. For the rest of the variables, only horses that raced were included in the analysis, however, 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

Only horses that raced were included for analysis of parameters 2-29, 32 and 45-48 inclusive. Only horses that raced by age four years were included for parameters 35 and 36, horses that raced at age five years for 37 and 38, at age six years for 39 and 40, at age seven years for 41 and 42 and at age eight years for 43 and 44. Only horses that raced in NH races were included for parameters 30 and 31 and only horses that raced in Irish Point-to-Point were included for parameters 32 and 33. Parameters 11-15 were calculated by determining the total number of starts that the animal had before the 31^{st} of December, 2009 and dividing by the number of years raced. Parameters 24 and 34 were calculated by determining the total number of non-finished races and the total earnings that the animal had before the 31^{st} of December, 2009 and dividing by the number of starts for that animal. Parameters 16-20 and 35-44 include every start, win or place which the animal had from the 1^{st} of January to the 31^{st} of December of the appropriate year for that particular animal. Every start, win and place the animal had up to and including the age of eight years was included for parameters 21 and 45-48. Parameter 25-29 were calculated by determining the total number of wins, places and total wins and places each animal had up to and including the age of eight years and expressing it as a percentage of the number of starts that animal had up to and including age eight years. Parameters 30-33 were calculated by determining the total number of NH (30-31) wins and places and Irish Point-to-Point (32-33) wins and places each animal had before the 31^{st} of December, 2009 and expressing it as a percentage of the total number of NH or Irish Point-to-Point starts for that animal. Parameters 35-46 were calculated by determining the total number of wins and places each animal had in the relevant year(s) and expressing it as a percentage of the number of starts that animal had in the relevant year(s). Parameter 24 included races where the horse was pulled up, fell, retired, refused, ran out, slipped up and refused to run. It did not include races where the rider was unseated or where the horse was brought down because it was considered that these occurrences did not reflect on the athletic ability of the horse.

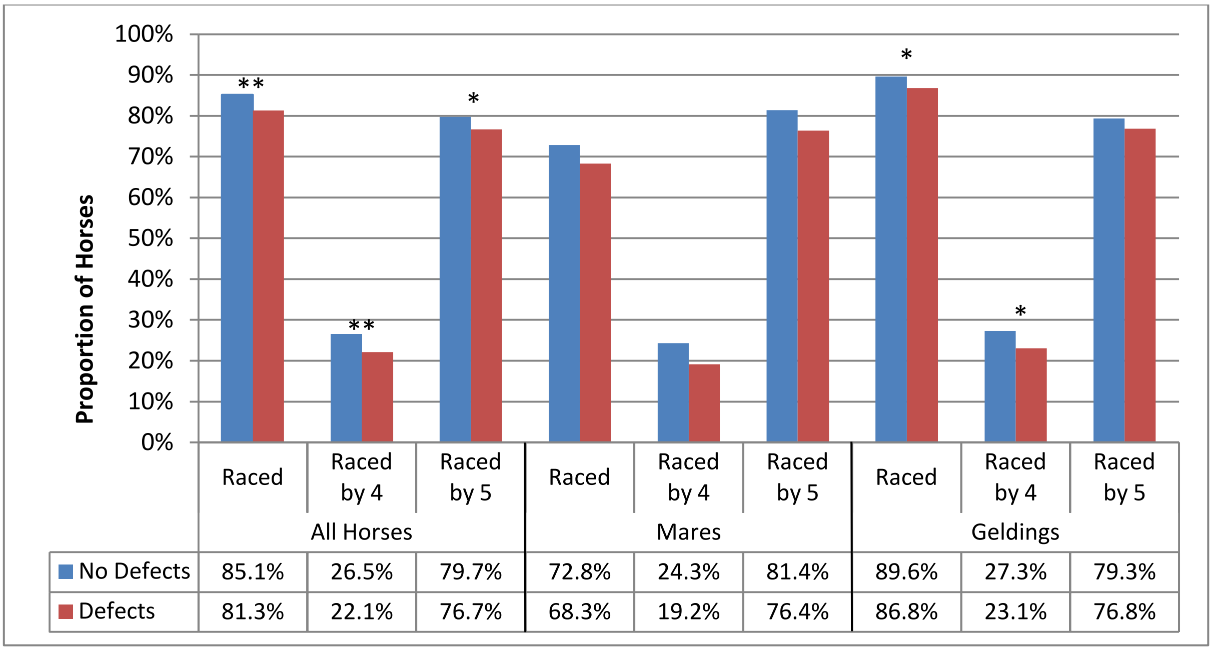
5.3 Results

5.3.1 Effect of Defects on Racing Performance

Within the 5,282 horses in the sample, 1,277 horses or 24.2% of the sample had no defects of any kind recorded on their certificate, while the other 75.8% (4,005 horses) had at least one defect recorded. This included all defects such as scars, scrapes, metacarpal/metatarsal exostoses and RLN. The records of all of these horses were examined to determine the proportion of horses without and with defects that were raced or unraced. However, for the rest of the variables, horses that were not raced were excluded from the analysis (938 horses). An additional 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.1.1 Effect of Defects on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was a significant difference in the proportions of horses without or with defects that subsequently raced (χ^2 = 9.563, df = 1, P = 0.002), raced by age four years (χ^2 = 8.642, df = 1, P = 0.003) or raced by age five years (χ^2 = 4.200, df = 1, P = 0.040). Horses without defects were significantly more likely to race than those with defects (85.1% vs. 81.3%). There was no significant difference between the proportions of mares without and with defects that raced (χ^2 = 2.533, df = 1, P = 0.112), raced by age four years (χ^2 = 3.050, df = 1, P = 0.081) or raced by age five years (χ^2 = 2.702, df = 1, P = 0.100). Within geldings, there was a significant difference between the proportions of geldings without and with defects that raced (χ^2 = 5.142, df = 1, P = 0.023) or raced by age four years (χ^2 = 5.765, df = 1, P = 0.016) where geldings without defects were significantly more likely to race than those with defects. There was however, no significant difference between the proportions of geldings without and with defects which raced by age five years (χ^2 = 2.150, df = 1, P = 0.143).



*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

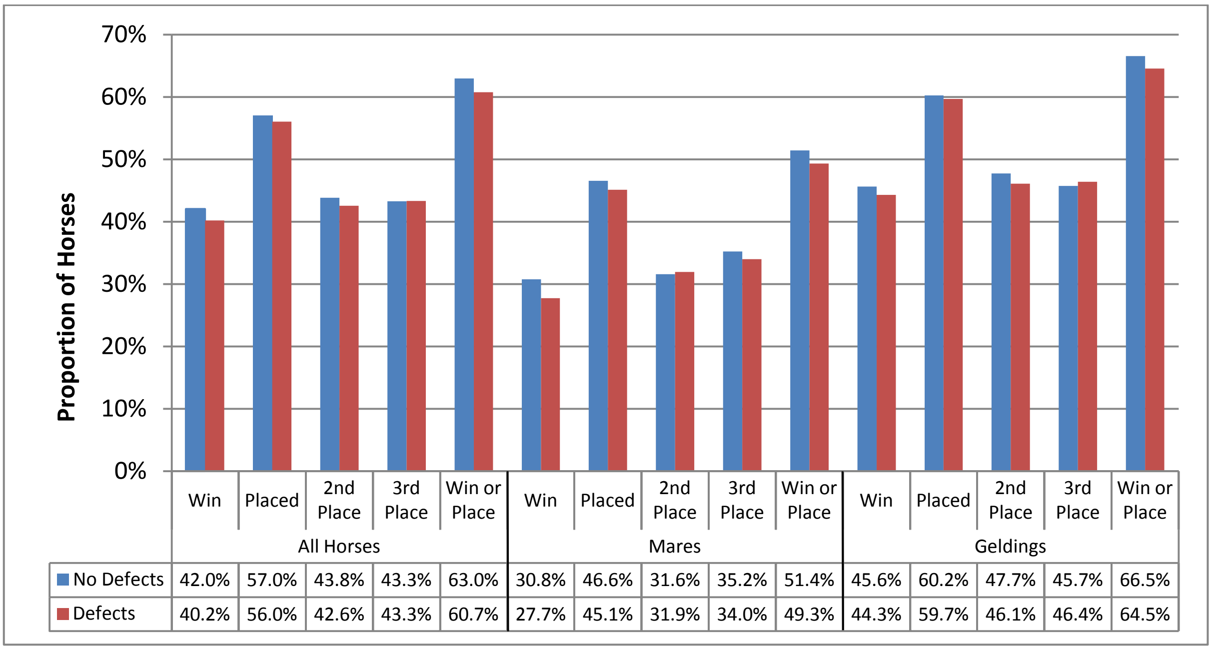
Figure 5.2: Proportion of Horses without and with Defects that Raced

5.3.1.2 Effect of Defects on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses without and with defects that won a race (χ^2 = 1.156, df = 1, P = 0.282), were placed in a race (χ^2 = 0.308, df = 1, P = 0.579), placed second in a race (χ^2 = 0.528, df = 1, P = 0.467) or placed third in a race (χ^2 = 0.000, df = 1, P = 0.989). Similarly, there was no significant difference between the proportions of horses with or without defects that won or placed in a race (χ^2 = 1.676, df = 1, P = 0.195).

There was no significant difference between the proportions of mares without and with defects that won a race (χ^2 = 0.861, df = 1, P = 0.353), were placed in a race (χ^2 = 0.165, df = 1, P = 0.685), placed second in a race (χ^2 = 0.011, df = 1, P = 0.918) or placed third in a race (χ^2 = 0.130, df = 1, P = 0.718). There was also no significant difference between the proportions of mares with or without defects that won or placed in a race (χ^2 = 0.337, df = 1, P = 0.561).

Similarly, there was no difference in the proportions of geldings with or without defects that won a race (χ^2 = 0.413, df = 1, P = 0.521), placed in a race (χ^2 = 0.075, df = 1, P = 0.784), placed second in a race (χ^2 = 0.630, df = 1, P = 0.427), placed third in a race (χ^2 = 0.107, df = 1, P = 0.744) or won or placed in a race (χ^2 = 1.054, df = 1, P = 0.305).



	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No Defects	42.0%	57.0%	43.8%	43.3%	63.0%	30.8%	46.6%	31.6%	35.2%	51.4%	45.6%	60.2%	47.7%	45.7%	66.5%
Defects	40.2%	56.0%	42.6%	43.3%	60.7%	27.7%	45.1%	31.9%	34.0%	49.3%	44.3%	59.7%	46.1%	46.4%	64.5%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.3: Proportion of Horses without and with Defects that Won or Placed in a Race

5.3.1.3 Effect of Defects on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses without and with defects (χ^2 = 7.949, df = 2, P = 0.019). A higher proportion of horses without defects raced in only NH races (55.4% vs. 52.5%) than horses with defects, while a higher proportion of horses with defects raced in only Irish Point-to-Point races (18.5% vs. 14.7%) than horses without defects (Figure 5.4). Similar results were observed within geldings (χ^2 = 8.212, df = 2, P = 0.016) however, no significant difference was observed within mares (χ^2 = 0.806, df = 2, P = 0.668).

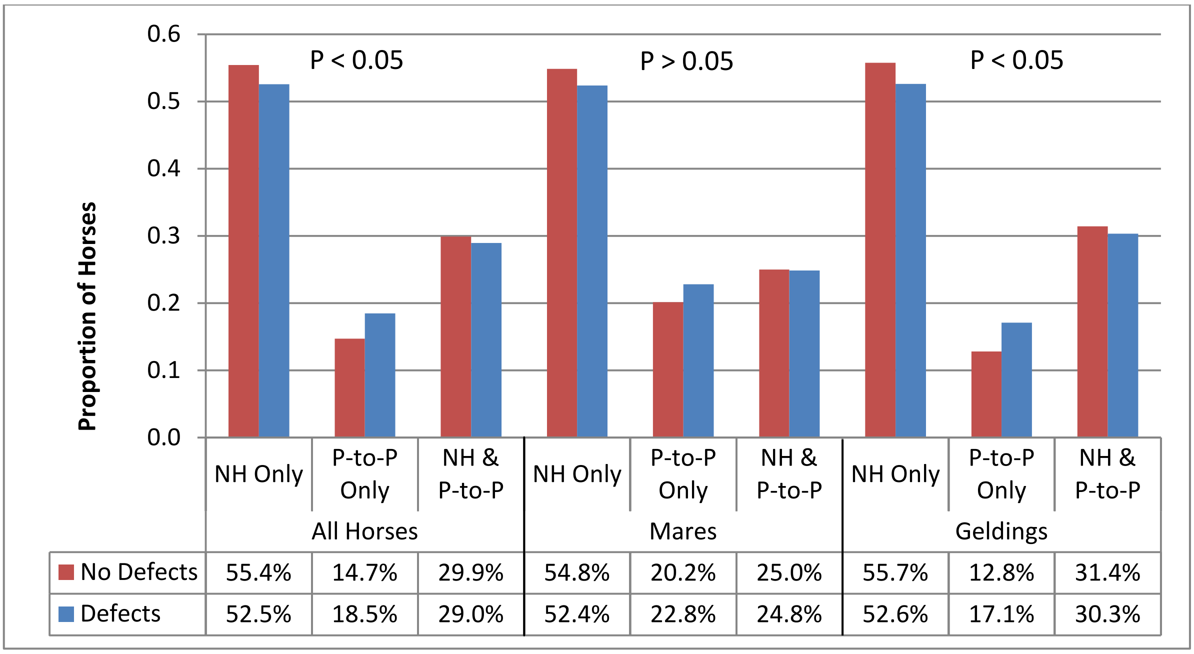


Figure 5.4: Proportion of Horses without and with Defects that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.1.4 Effect of Defects on the Age in Years at First Race

Only horses that raced were examined to determine the age at first race. Overall, the mean age of the sample population at first race was 5.04±0.818 years. There was a significant difference in the age at first race between those without and those with defects ($P < 0.05$). Those without defects were significantly younger at their first race than those with defects, 4.99±0.02 compared to 5.06±0.01. Similar results were seen for geldings. There was however, no significant difference between the age at first race in those mares with or without defects.

Table 5.2: Age in Years at First Race for Horses without and with Defects

Variable	*Group*	*Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Age at 1st Race	All Horses	No	1,056	4.99±0.025	-2.634	0.008
		Yes	3,127	5.06±0.015		
	Mares	No	247	4.99±0.049	-1.757	0.079
		Yes	783	5.09±0.028		
	Geldings	No	807	4.99±0.029	-2.063	0.039
		Yes	2,341	5.05±0.017		

5.3.1.5 Effect of Defects on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference in the mean number of starts per year raced or NH starts per year raced (data not shown, see Appendix 8, Table A.10); however there was a significant difference in the mean number of hurdle starts and Ire Irish Point-to-Point starts per year raced, between horses without and with defects. Horses without defects had significantly more hurdle starts per year raced while, perhaps significantly, horses with defects raced in significantly more Ire Irish Point-to-Point races per year. Mares showed no significant difference in either of these variables (Table 5.3 below). Amongst geldings, however, there was a significant difference between those with defects and without defects in both the number of hurdle starts and the number of Ire Irish Point-to-Point starts per year raced. Geldings without defects had a greater number of hurdle starts (1.83±0.05 vs. 1.68±0.03) than those with defects, while those with defects had more Ire Irish Point-to-Point starts (0.89±0.03) than those without (0.77±0.04).

Table 5.3: Mean Number of Starts per Year Raced for Horses without and with Defects

Variable	*Group*	*Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Hurdle Starts per Year Raced	All Horses	No	1,056	1.90±0.048	2.586	0.010
		Yes	3,127	1.76±0.028		
	Mares	No	247	2.13±0.115	1.206	0.228
		Yes	783	1.97±0.065		
	Geldings	No	807	1.83±0.052	2.499	0.013
		Yes	2,341	1.68±0.030		
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	1,056	0.82±0.040	-2.501	0.012
		Yes	3,127	0.94±0.025		
	Mares	No	247	0.97±0.092	-1.120	0.263
		Yes	783	1.10±0.058		
	Geldings	No	807	0.77±0.043	-2.289	0.022
		Yes	2,341	0.89±0.027		

5.3.1.6 Effect of Defects on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Overall, horses without defects raced in significantly more races at age four years than those with defects ($P < 0.05$), this was also true for mares. However, there was no significant difference between the mean number of starts for geldings with and those without defects.

Table 5.4: Number of Starts at Age Four Years for Horses without and with Defects

Variable	*Group*	*Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	1,056	0.67±0.044	2.669	0.008
		Yes	3,127	0.54±0.023		
	Mares	No	247	0.72±0.105	2.240	0.026
		Yes	783	0.47±0.045		
	Geldings	No	807	0.66±0.058	1.746	0.081
		Yes	2,341	0.56±0.027		

5.3.1.7 Effect of Defects on Career Length

There were no significant differences in the career lengths of horses without and with defects (data not shown, see Appendix 8, Table A.9).

5.3.1.8 Effect of Defects on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was a significant difference in the mean proportion of non-finished races per start between horses without and with defects ($P < 0.05$). Horses with defects had a significantly higher proportion of non-finished races than horses without defects, 26.86%±0.515 compared to 24.45%±0.843. While there was no significant difference within mares, geldings showed similar results (Table 5.5).

Table 5.5: Mean Proportion of Non-Finished Races per Start for Horses without and with Defects

Variable	*Group*	*Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	1,056	24.45±0.843	-2.442	0.015
		Yes	3,127	26.86±0.515		
	Mares	No	247	25.54±1.918	-1.146	0.252
		Yes	783	28.21±1.160		
	Geldings	No	807	24.06±0.932	-2.140	0.032
		Yes	2,341	26.44±0.567		

5.3.1.9 Effect of Defects on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without and with defects (data not shown, see Appendix 8, Table A.10).

5.3.1.10 Effect of Defects on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

There was no significant difference in the NH win or place strike rates or Irish Point-to-Point win or place strike rates for horses without and with defects (data not shown, see Appendix 8, Table A.10).

5.3.1.11 Effect of Defects on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with defects (data not shown, see Appendix 8, Table A.10).

5.3.1.12 Effect of Defects on the Win and Place Strike Rate at Various Ages

There was no significant difference in the win strike rate at any age or in the place strike rate at any age for horses without and with defects (data not shown, see Appendix 8, Table A.10). There was however a significant difference in the place strike rates at age five years within mares ($P < 0.05$). Mares without defects placed in a significantly higher proportion of races at age five years than mares with defects.

Table 5.6: Win and Place Strike Rate at Various Ages for Horses without and with Prejudicial Defects

Variable	*Group*	*Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Places at Age 5 Years Strike Rate	All Horses	No	2,278	14.04±0.505	-0.646	0.518
		Yes	772	13.40±0.813		
	Mares	No	561	10.27±0.792	-2.021	0.044
		Yes	183	7.40±1.183		
	Geldings	No	1,715	15.28±0.616	0.016	0.988
		Yes	588	15.30±0.989		

5.3.1.13 Effect of Defects on the Number of Wins and Places up to Age Eight Years

There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with defects (data not shown, see Appendix 8, Table A.10).

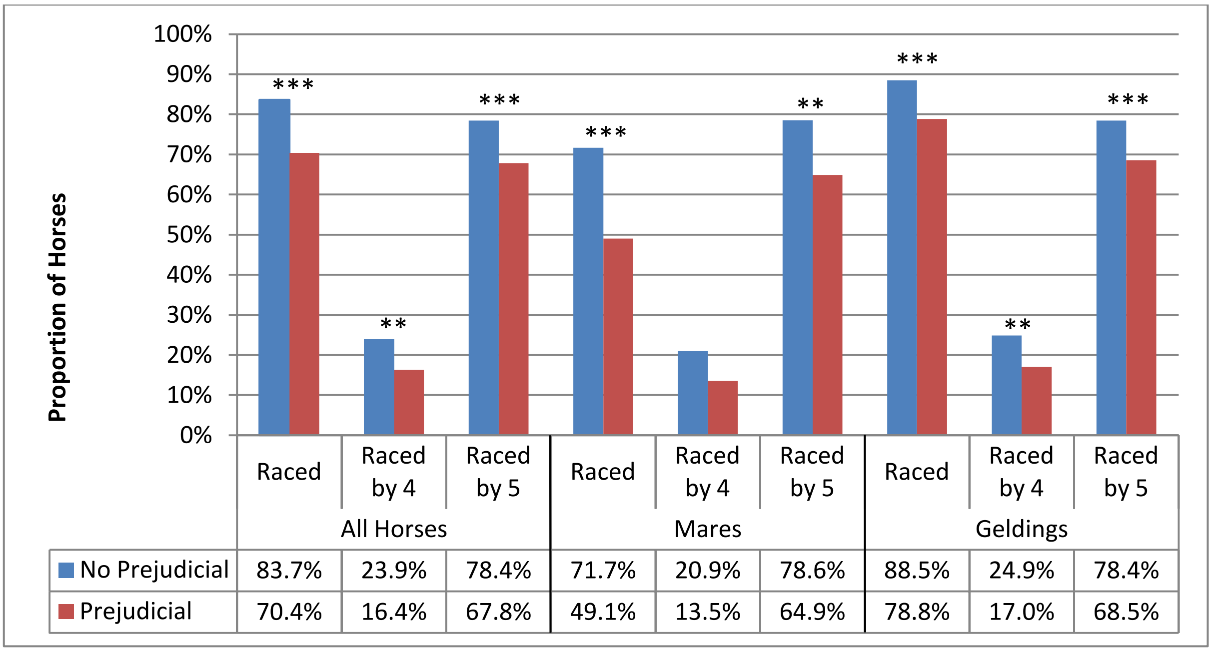
5.3.2 Effect of Prejudicial Defects on Racing Performance

Within the 5,282 horses in the sample, prejudicial defects, considered likely to affect performance, were recorded in 10.6% (560 horses). These have been described in more detail in chapter two. All 5,282 horses were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.2.1 Effect of Prejudicial Defects on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. A significantly higher proportion of horses without prejudicial defects raced at some stage in their careers (83.7% vs. 70.4%, $\chi^2 = 60.579$, df = 1, P < 0.001), raced by age four years (23.9% vs. 16.4%, $\chi^2 = 10.984$, df = 1, P = 0.001) and raced by age five years (78.4% vs. 67.8%, $\chi^2 = 22.209$, df = 1, P < 0.001) than those with prejudicial defects. There was a significant difference between the proportions of mares without and with prejudicial defects that raced ($\chi^2 = 34.237$, df = 1, P < 0.001) and that raced by age five years ($\chi^2 = 7.401$, df = 1, P = 0.007). Mares without prejudicial defects were significantly more likely to race than those with prejudicial defects. There was, however, no significant difference in the proportions of mares without and with prejudicial defects that raced by age four years ($\chi^2 = 2.322$, df = 1, P = 0.128). While the difference was not significant, the trend was similar with a higher proportion of mares without prejudicial defects racing than those with this type of defect. A significantly higher proportion of geldings without prejudicial defects raced ($\chi^2 = 30.803$, df = 1, P < 0.001), raced by four ($\chi^2 =$

9.278, df = 1, P = 0.002) and raced by five (χ^2 = 15.389, df = 1, P < 0.001) than those with prejudicial defects as seen in Figure 5.5 below.



	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
No Prejudicial	83.7%	23.9%	78.4%	71.7%	20.9%	78.6%	88.5%	24.9%	78.4%
Prejudicial	70.4%	16.4%	67.8%	49.1%	13.5%	64.9%	78.8%	17.0%	68.5%

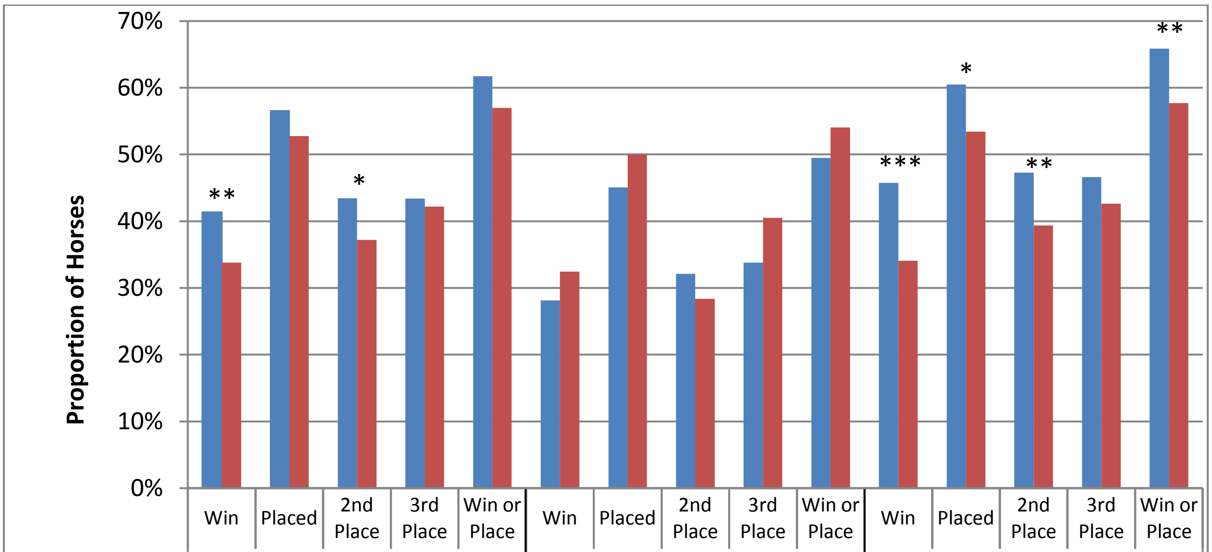
*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.5: Proportion of Horses without and with Prejudicial Defects that Raced

5.3.2.2 Effect of Prejudicial Defects on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was a significant difference between the proportions of horses with prejudicial defects and those without prejudicial defects that won a race (41.3% vs. 33.8%, χ^2 = 8.148, df = 1, P = 0.004). Horses without prejudicial defects were significantly more likely to win a race than those with prejudicial defects. There was no significant difference between the proportions of mares with prejudicial defects and those without prejudicial defects that won a race, as seen in Figure 5.6 (χ^2 = 0.622, df = 1, P = 0.430). A significantly higher proportion of geldings without prejudicial defects won a race (χ^2 = 15.162, df = 1, P < 0.001) than those with prejudicial defects. Geldings without prejudicial defects were significantly more likely to win a race than those with prejudicial defects.

There was no significant difference between the proportion of horses with prejudicial defects and without prejudicial defects that were placed in a race (χ^2 = 2.081, df = 1, P = 0.149). There was also no significant difference between the proportions of mares with prejudicial defects and without prejudicial defects that were placed in a race (χ^2 = 0.670, df = 1, P = 0.413). There was however, a significant difference between the proportions of geldings with prejudicial defects and without prejudicial defects that were placed in a race (χ^2 = 5.707, df = 1, P = 0.017). Geldings without prejudicial defects were significantly more likely to be placed in a race than those with prejudicial defects.



	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No Prejudicial	41.3%	56.6%	43.5%	43.4%	61.7%	28.1%	45.1%	32.1%	33.8%	49.5%	45.8%	60.5%	47.3%	46.6%	65.8%
Prejudicial	33.8%	52.8%	37.2%	42.2%	57.0%	32.4%	50.0%	28.4%	40.5%	54.1%	34.1%	53.4%	39.3%	42.6%	57.7%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.6: Proportion of Horses without and with Prejudicial Defects that Won or Placed in a Race

A significantly higher proportion of horses without prejudicial defects placed second in a race (χ^2 = 5.498, df = 1, P = 0.019) than those with prejudicial defects. There was no significant difference between the proportions of mares with prejudicial defects and without prejudicial defects that were placed second in a race (χ^2 = 0.441, df = 1, P = 0.506). There was however a significant difference between the proportions of geldings with prejudicial defects and without prejudicial defects that were placed second in a race (χ^2 = 6.962, df = 1, P = 0.008). Geldings without prejudicial defects were significantly more likely to be placed second in a race than those with prejudicial defects.

There was no significant difference between the proportions of horses without and with prejudicial defects that were placed third in a race ($\chi^2 = 0.197$, df = 1, P = 0.657). There was also no significant difference for mares ($\chi^2 = 1.391$, df = 1, P = 0.238) or for geldings ($\chi^2 = 1.758$, df = 1, P = 0.185).

There was no significant difference between the proportions of horses without and with prejudicial defects that won or placed in a race ($\chi^2 = 3.254$, df = 1, P = 0.071). Similar results were found for mares ($\chi^2 = 0.576$, df = 1, P = 0.448). Although the difference was not significant, it is interesting to note that a higher proportion of mares with prejudicial defects won or placed in a race than mares without prejudicial defects, 54.1% (40 mares) compared to 49.5% (473 mares). A significantly higher proportion of geldings without prejudicial defects won or placed in a race ($\chi^2 = 8.031$, df = 1, P = 0.005) than those with prejudicial defects. Geldings without prejudicial defects were significantly more likely to win or place in a race than geldings with these types of defects.

5.3.2.3 Effect of Prejudicial Defects on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses without and with prejudicial defects ($\chi^2 = 49.708$, df = 2, P < 0.001). A higher proportion of horses without prejudicial defects raced in only NH races (54.9% vs. 37.0%) than horses with prejudicial defects, while a higher proportion of horses with prejudicial defects raced in only Irish Point-to-Point races (27.5% vs. 16.5%) or in a combination of NH and Irish Point-to-Point races (35.4% vs. 28.6%) than horses without prejudicial defects (Figure 5.7). Similar results were observed within geldings ($\chi^2 = 8.212$, df = 2, P = 0.016) however, no significant difference was observed within mares ($\chi^2 = 0.579$, df = 2, P = 0.742).

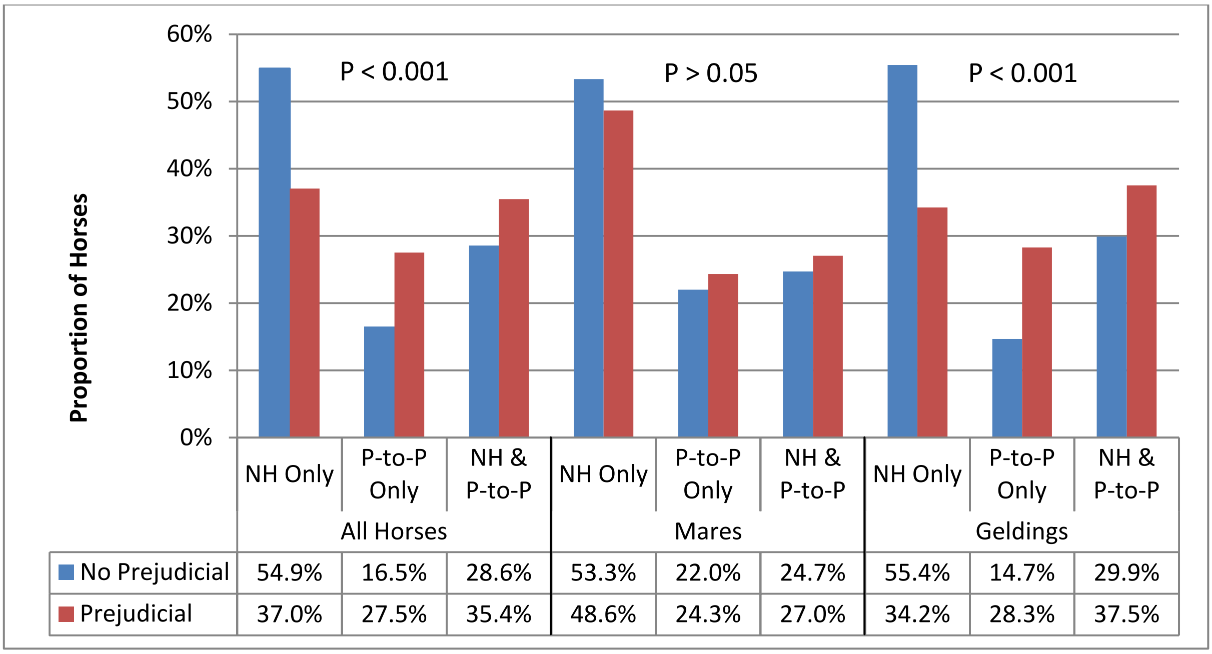


Figure 5.7: Proportion of Horses without and with Prejudicial Defects that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.2.4 Effect of Prejudicial Defects on the Age in Years at First Race

Overall, the mean age of the sample population at first race was 5.04$\pm$0.818 years. Only horses that raced were examined to determine the effect of prejudicial defects on age at first race. Horses with prejudicial defects were significantly older at their first race (5.23$\pm$0.04) than those without prejudicial defects (5.03$\pm$0.01) ($P < 0.001$). This was the case for both mares and geldings.

Table 5.7: Age in Years at First Race for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean $\pm$ S.E.*	*t-value*	*Sig.*
Age at First Race	All Horses	No	3,804	5.03$\pm$0.013	4.497	<0.001
		Yes	379	5.23$\pm$0.043		
	Mares	No	956	5.05$\pm$0.025	2.533	0.013
		Yes	74	5.30$\pm$0.094		
	Geldings	No	2,843	5.02$\pm$0.015	3.827	<0.001
		Yes	305	5.21$\pm$0.049		

5.3.2.5 Effect of Prejudicial Defects on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48$\pm$1.821, with horses participating in significantly more hurdle races than any other type of race (1.79$\pm$1.565), followed by Irish Point-to-Points (0.91$\pm$1.376) and then steeplechase races (0.74$\pm$1.249). There were significant differences between horses without and with prejudicial defects ($P < 0.05$) for mean number of NH starts, hurdle starts, steeplechase starts and Irish Point-to-Point starts. Those without prejudicial defects had significantly more NH starts, hurdle starts and steeplechase starts than those with prejudicial defects. It is interesting to note that those with prejudicial defects had a greater number of Irish Point-to-Point starts than those without. Geldings without and with prejudicial defects also showed significant differences for each variable and followed the same pattern as for all horses. A significant difference was only present within mares for mean number of steeplechase starts ($P < 0.05$) where mares without prejudicial defects had more starts than those with this type of defect.

Table 5.8: Mean Number of Starts per Year Raced for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of NH Starts per Year Raced	All Horses	No	3,804	2.57±0.033	-4.943	<0.001
		Yes	379	2.03±0.103		
	Mares	No	956	2.29±0.067	-0.602	0.547
		Yes	74	2.14±0.221		
	Geldings	No	2,843	2.67±0.038	-5.462	<0.001
		Yes	305	2.01±0.117		
Mean Number of Hurdle Starts per Year Raced	All Horses	No	3,804	1.83±0.025	-4.599	<0.001
		Yes	379	1.44±0.076		
	Mares	No	956	2.01±0.059	0.144	0.886
		Yes	74	2.04±0.209		
	Geldings	No	2,843	1.77±0.028	-5.378	<0.001
		Yes	305	1.29±0.078		
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	3,804	0.75±0.020	-2.452	0.015
		Yes	379	0.59±0.061		
	Mares	No	956	0.29±0.027	-3.436	0.001
		Yes	74	0.10±0.048		
	Geldings	No	2,843	0.90±0.025	-2.481	0.014
		Yes	305	0.71±0.073		
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	3,804	0.87±0.022	5.443	<0.001
		Yes	379	1.33±0.081		
	Mares	No	956	1.05±0.050	1.359	0.175
		Yes	74	1.31±0.213		
	Geldings	No	2,843	0.81±0.024	5.825	<0.001
		Yes	305	1.33±0.087		

5.3.2.6 Effect of Prejudicial Defects on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and a total of 9.80±8.003 starts up to age eight years. There were significant differences between horses without and with prejudicial defects ($P < 0.05$) for the number of starts at age four years, five, eight and up to age eight years. Those without prejudicial defects had significantly more starts at each of these ages than those with prejudicial defects. There was no significant difference at age six years or seven (data not shown, see Appendix 9, Table A.12). Geldings also showed significant differences for each variable. Geldings without prejudicial defects had more starts at age four years, five, eight and up to age eight years than those without prejudicial defects. A significant difference was only present within mares at age four years ($P < 0.05$) where mares without prejudicial defects had more starts than those with this type of defect. While there was no significant difference within mares at ages five and eight and up to age eight years a similar trend was observed where mares without prejudicial defects had more starts than those with this type of defect, as shown in Table 5.9 below.

Table 5.9: Number of Starts at Various Ages for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	3,804	0.59±0.022	-3.799	<0.001
		Yes	379	0.38±0.052		
	Mares	No	956	0.55±0.045	-2.296	0.024
		Yes	74	0.30±0.099		
	Geldings	No	2,843	0.61±0.026	-3.221	0.001
		Yes	305	0.40±0.060		
Starts at Age 5 Years	All Horses	No	3,804	2.49±0.040	-3.323	0.001
		Yes	379	2.09±0.114		
	Mares	No	956	2.54±0.083	-1.223	0.221
		Yes	74	2.16±0.272		
	Geldings	No	2,843	2.48±0.046	-3.023	0.003
		Yes	305	2.08±0.126		
Starts at Age 8 Years	All Horses	No	3,804	1.63±0.050	-3.051	0.002
		Yes	379	1.22±0.125		
	Mares	No	956	0.89±0.072	-1.539	0.127
		Yes	74	0.58±0.190		
	Geldings	No	2,843	1.87±0.056	-3.151	0.002
		Yes	305	1.38±0.148		
Starts up to Age 8 Years	All Horses	No	3,804	9.91±0.131	-3.068	0.002
		Yes	379	8.68±0.379		
	Mares	No	956	8.15±0.234	-1.449	0.148
		Yes	74	6.91±0.703		
	Geldings	No	2,843	10.50±0.154	-2.819	0.005
		Yes	305	9.11±0.436		

5.3.2.7 Effect of Prejudicial Defects on Career Length

There were no significant differences in the career lengths of horses without and with prejudicial defects (data not shown, see Appendix 9, Table A.11). However, geldings without prejudicial defects were significantly more likely to race at age eight years than horses with prejudicial defects (41.7% compared to 35.4%, $\chi^2 = 4.476$, df = 1, P = 0.034).

5.3.2.8 Effect of Prejudicial Defects on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was a significant difference in the mean proportion of non-finished races per start between horses without and with prejudicial defects ($P < 0.05$). Horses with prejudicial defects had a significantly higher proportion of non-finished races than horses without prejudicial defects, 33.33%±1.659 compared to 25.55%±0.453. While there was no significant difference within mares, geldings showed similar results.

Table 5.10: Mean Proportion of Non-Finished Races per Start for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	3,804	25.55±0.453	4.525	<0.001
		Yes	379	33.33±1.659		
	Mares	No	956	27.88±1.035	-1.128	0.260
		Yes	74	23.54±3.585		
	Geldings	No	2,843	24.77±0.495	5.722	<0.001
		Yes	305	35.70±1.846		

5.3.2.9 Effect of Prejudicial Defects on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%±11.689, 13.37%±16.319 and 20.11%±21.999, respectively. Horses without prejudicial defects had higher win strike rates than horses with prejudicial defects. Although this difference was not a significant difference, it did approach significance ($P = 0.053$). There was however, a significant difference within geldings. Geldings without prejudicial defects had significantly higher win strike rates than geldings with prejudicial defects. Geldings without prejudicial defects also had significantly higher place strike rates and overall win and place strike rates than geldings with prejudicial defects, as did overall horses. There was no significant difference within mares.

Table 5.11: Win and Place Strike Rates for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean ± S.E. (%)*	*t-value*	*Sig.*
Win Strike Rate	All Horses	No	3,804	6.86±0.189	-1.938	0.053
		Yes	379	5.64±0.601		
	Mares	No	956	4.13±0.308	0.417	0.677
		Yes	74	4.61±1.071		
	Geldings	No	2,843	7.77±0.229	-2.561	0.010
		Yes	305	5.89±0.700		
Place Strike Rate	All Horses	No	3,804	13.53±0.265	-2.057	0.040
		Yes	379	11.72±0.830		
	Mares	No	956	10.42±0.488	0.585	0.559
		Yes	74	11.49±1.944		
	Geldings	No	2,843	14.57±0.311	-2.875	0.004
		Yes	305	11.78±0.919		
Second Place Strike Rate	All Horses	No	3,804	6.40±0.165	-1.951	0.051
		Yes	379	5.32±0.541		
	Mares	No	956	5.06±0.335	0.277	0.782
		Yes	74	5.42±1.595		
	Geldings	No	2,843	6.85±0.190	-2.658	0.008
		Yes	305	5.30±0.551		
Overall Win and Place Strike Rate	All Horses	No	3,804	20.39±0.357	-2.556	0.011
		Yes	379	17.36±1.104		
	Mares	No	956	14.55±0.625	0.661	0.509
		Yes	74	16.10±2.432		
	Geldings	No	2,843	22.34±0.423	-3.455	0.001
		Yes	305	17.67±1.240		

5.3.2.10 Effect of Prejudicial Defects on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Horses without prejudicial defects had significantly higher Irish Point-to-Point win strike rates than horses with prejudicial defects ($P < 0.05$). Similar results were observed within geldings (Table 5.12) however, there was no significant difference within mares. Geldings without prejudicial defects also had significantly higher NH win strike rates than geldings with prejudicial defects ($P < 0.05$), however there was no significant difference within mares or when all horses were analysed together. There was no significant difference in the NH place strike rates or Irish Point-to-Point place strike rates for horses with or without prejudicial defects (data not shown, see Appendix 9, Table A.12).

Table 5.12: NH and Irish Point-to-Point Win Strike Rates for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Win Strike Rate	All Horses	No	3,166	5.81±0.183	-1.599	0.110
		Yes	274	7.78±0.604		
	Mares	No	743	3.23±0.311	0.538	0.591
		Yes	56	3.87±1.315		
	Geldings	No	2,420	6.60±0.216	-2.116	0.034
		Yes	218	5.01±0.680		
Irish Point-to-Point Win Strike Rate	All Horses	No	1,716	12.05±0.557	-2.297	0.022
		Yes	239	8.83±1.285		
	Mares	No	445	8.53±0.884	0.438	0.662
		Yes	38	9.92±3.184		
	Geldings	No	1,268	13.27±0.683	-2.970	0.003
		Yes	201	8.63±1.407		

5.3.2.11 Effect of Prejudicial Defects on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with prejudicial defects (data not shown, see Appendix 9, Table A.12).

5.3.2.12 Effect of Prejudicial Defects on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. There was no significant difference in the win strike rates at ages four, six or eight or in the place strike rates at ages four, seven or eight for horses without or with prejudicial defects (data not shown, see Appendix 9, Table A.12), however, significant differences were observed at ages five, six, seven and up to age eight years, as shown in Table 5.13 below. Horses without prejudicial defects had significantly higher win strike rates at age seven years and up to age eight years and significantly higher place strike rates at age five years and up to age eight years than horses with prejudicial defects ($P < 0.05$). Similar results were observed within geldings; however, there was no significant difference within mares. Geldings without prejudicial defects also had significantly higher win strike rates at age five years and significantly higher place strike rates at age six years than geldings with prejudicial defects ($P < 0.05$). There was no significant difference within mares or when all of the horses were analysed together.

Table 5.13: Win and Place Strike Rate at Various Ages for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No	2,802	8.12±0.370	-1.353	0.177
		Yes	248	6.57±1.081		
	Mares	No	698	4.41±0.504	1.058	0.295
		Yes	46	7.29±2.673		
	Geldings	No	2,101	9.35±0.462	-2.317	0.021
		Yes	202	6.41±1.183		
Places at Age 5 Years Strike Rate	All Horses	No	2,802	14.25±0.455	-3.466	0.001
		Yes	248	9.77±1.210		
	Mares	No	698	9.58±0.693	-0.062	0.951
		Yes	46	9.40±2.289		
	Geldings	No	2,101	15.81±0.557	-3.970	<0.001
		Yes	202	9.85±1.394		
Places at Age 6 Years Strike Rate	All Horses	No	2,679	15.39±0.437	-1.885	0.060
		Yes	262	12.85±1.274		
	Mares	No	607	12.51±0.848	-0.167	0.868
		Yes	40	11.95±3.032		
	Geldings	No	2,067	16.19±0.506	-2.133	0.034
		Yes	222	13.01±1.403		
Wins at Age 7 Years Strike Rate	All Horses	No	1,981	8.59±0.408	-2.001	0.047
		Yes	188	6.32±1.060		
	Mares	No	367	4.60±0.713	-0.465	0.642
		Yes	28	3.37±1.887		
	Geldings	No	1,612	9.47±0.471	-2.046	0.042
		Yes	160	6.83±1.198		
Wins up to Age 8 Years Strike Rate	All Horses	No	3,804	6.07±0.170	-1.918	0.055
		Yes	379	4.98±0.542		
	Mares	No	956	3.96±0.296	0.417	0.677
		Yes	74	4.42±1.064		
	Geldings	No	2,843	6.78±0.203	-2.540	0.011
		Yes	305	5.12±0.622		
Places up to Age 8 Years Strike Rate	All Horses	No	3,804	12.34±0.253	-2.163	0.031
		Yes	379	10.53±0.781		
	Mares	No	956	10.01±0.476	0.523	0.601
		Yes	74	10.95±1.919		
	Geldings	No	2,843	13.12±0.297	-2.986	0.003
		Yes	305	10.42±0.854		

5.3.2.13 Effect of Prejudicial Defects on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. The number of wins up to age eight years for horses without prejudicial defects was 0.92±0.03, which was significantly higher than the number of wins for horses with prejudicial defects, 0.69±0.07 wins. The number of places up to age eight years for horses without prejudicial defects was also significantly higher than for horses with prejudicial defects, 1.76±0.04 places compared to 1.39±0.11 places. Geldings showed similar results, however, mares showed no significant difference in the mean number of wins and places at any age (P > 0.05).

Table 5.14: Number of Wins and Places up to Age Eight Years for Horses without and with Prejudicial (Prej.) Defects

Variable	*Group*	*Prej. Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Wins up to Age 8 Years	All Horses	No	3,804	0.92±0.026	-3.025	0.003
		Yes	379	0.69±0.071		
	Mares	No	956	0.49±0.034	-0.123	0.902
		Yes	74	0.47±0.102		
	Geldings	No	2,843	1.06±0.032	-3.525	<0.001
		Yes	305	0.74±0.085		
Places up to Age 8 Years	All Horses	No	3,804	1.76±0.040	-3.113	0.002
		Yes	379	1.39±0.115		
	Mares	No	956	1.20±0.063	-0.672	0.502
		Yes	74	1.04±0.193		
	Geldings	No	2,843	1.95±0.048	-3.387	0.001
		Yes	305	1.47±0.134		

5.3.3 Effect of Respiratory Defects on Racing Performance

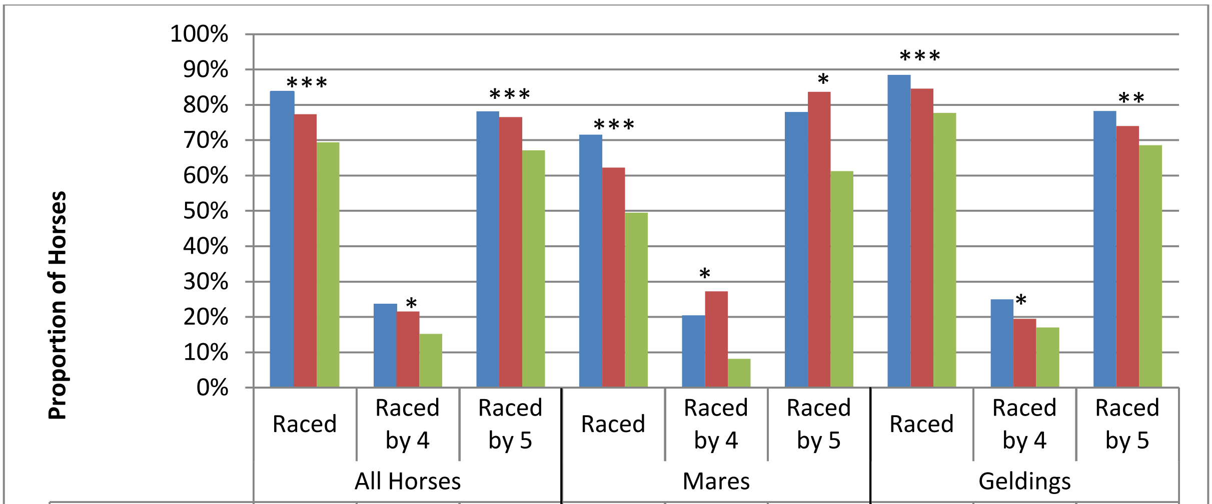
Respiratory defects were present in 12.0% (628 horses) of the sample of 5,282 horses. This was comprised of 350 horses endoscopically diagnosed with RLN and 278 horses with an abnormal respiratory noise but no endoscopically diagnosed RLN. All 5,282 horses were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.3.1 Effect of Respiratory Defects on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and

77.46% (3,240) had raced by the age of five. There was a significant difference in the number of horses that raced between those without respiratory defects, those with a respiratory noise without RLN and those with RLN ($\chi^2 = 50.363$, df = 2, $P < 0.001$). There was also a significant difference between the proportions that raced by four ($\chi^2 = 9.740$, df = 2, $P = 0.008$) and that raced by five ($\chi^2 = 15.863$, df = 2, $P < 0.001$). The highest proportion of horses that raced was among those that had no respiratory defect (83.6%), followed by those that had a respiratory noise without RLN (77.3%) and finally by those that had RLN (69.4%).

Within mares there was also a significant difference in the proportions that raced ($\chi^2 = 24.194$, df = 2, $P < 0.001$). Mares without respiratory defect had the highest proportion that raced, followed by those with a respiratory noise without RLN and then those with RLN. Mares also showed a significant difference between groups for raced by four ($\chi^2 = 6.140$, df = 2, $P = 0.046$) and raced by five ($\chi^2 = 8.778$, df = 2, $P = 0.012$). For these variables the highest proportion that raced were those with a respiratory noise without RLN, followed by those without respiratory defects and finally by those with RLN. Geldings also showed a significant difference between the proportions of horses that raced ($\chi^2 = 26.167$, df = 2, $P < 0.001$), raced by four ($\chi^2 = 8.086$, df = 2, $P = 0.018$) and raced by five ($\chi^2 = 10.566$, df = 2, $P = 0.005$). Again, geldings without respiratory defects had the highest proportion that raced, followed by those with a respiratory noise without RLN and then those with RLN.



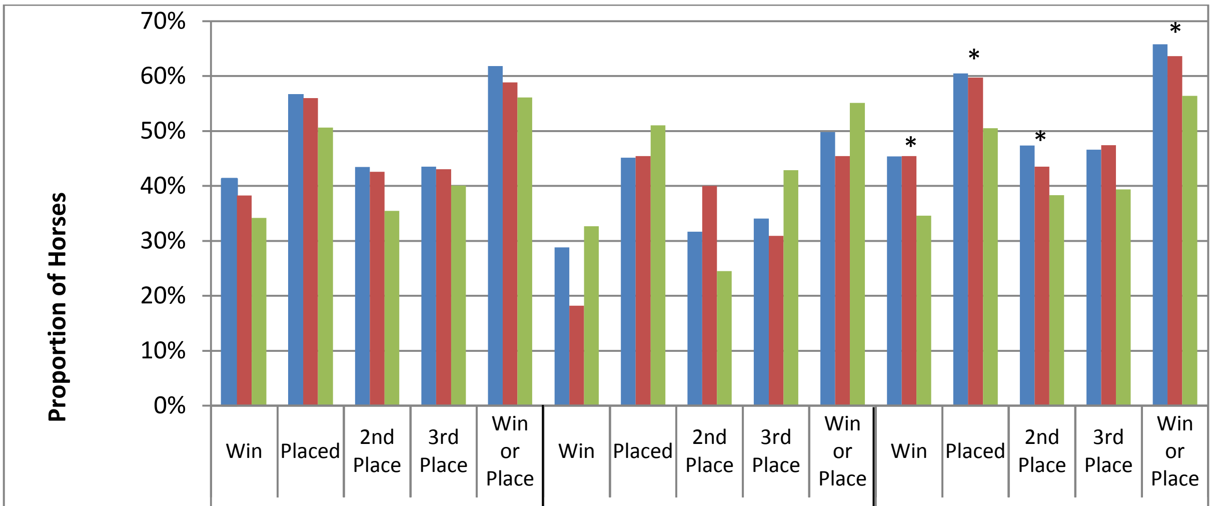
	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
No Resp Defect	83.6%	23.9%	78.2%	71.5%	20.5%	78.0%	88.5%	25.0%	78.3%
Noise, No RLN	77.3%	21.5%	76.6%	62.2%	27.3%	83.6%	84.6%	19.5%	74.0%
RLN	69.4%	15.2%	67.1%	49.5%	8.2%	61.2%	77.7%	17.0%	68.6%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.8: Proportion of Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN that Raced

5.3.3.2 Effect of Respiratory Defects on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses without respiratory defects, those with a respiratory noise without RLN and those with RLN that won a race ($\chi^2 = 5.194$, df = 2, P = 0.074), were placed in a race ($\chi^2 = 3.305$, df = 2, P = 0.192), placed second in a race ($\chi^2 = 5.866$, df = 2, P = 0.053), were placed third in a race ($\chi^2 = 1.077$, df = 2, P = 0.584) or won or were placed in a race ($\chi^2 = 3.651$, df = 2, P = 0.161). Each group was just as likely as each other to win a race or to place in a race. Within mares there was no significant difference between groups in the proportions that won a race ($\chi^2 = 3.341$, df = 2, P = 0.188), placed ($\chi^2 = 0.645$, df = 2, P = 0.724), placed second ($\chi^2 = 2.921$, df = 2, P = 0.232), placed third ($\chi^2 = 1.896$, df = 2, P = 0.387) and won or were placed in a race ($\chi^2 = 0.966$, df = 2, P = 0.617). While geldings showed no significant difference in the proportions of horses in each group that placed third in a race ($\chi^2 = 3.830$, df = 2, P = 0.147), there was, however, a significant difference in the proportions that won a race ($\chi^2 = 8.381$, df = 2, P = 0.015), placed in a race ($\chi^2 = 7.245$, df = 2, P = 0.027), placed second in a race ($\chi^2 = 6.484$, df = 2, P = 0.0.039) and won or were placed in a race (χ^2 = 7.055, df = 2, P = 0.029). For each of these variables, higher proportions of geldings without respiratory defects and geldings with a respiratory noise without RLN won or were placed in races than those with RLN.



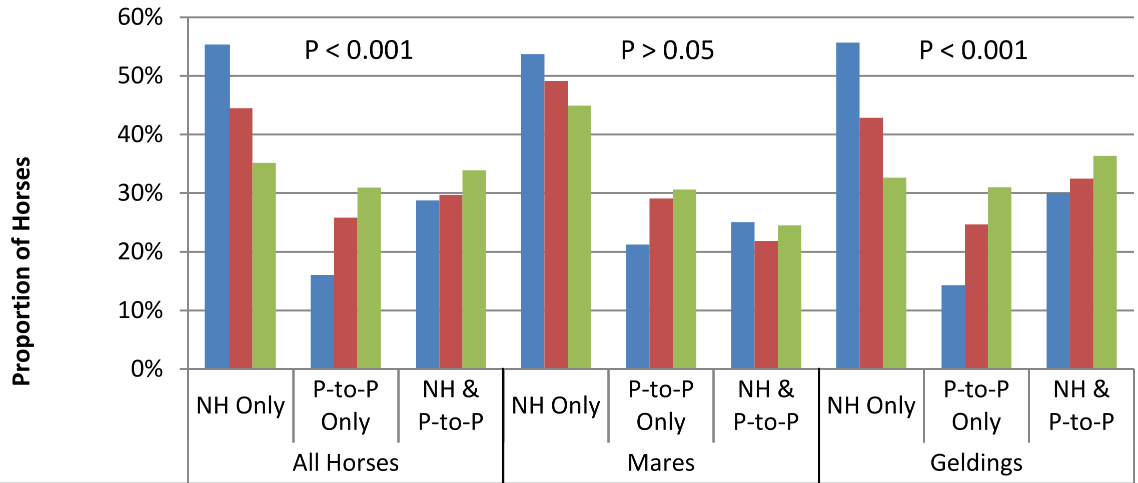
	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No Resp Defect	41.3%	56.7%	43.5%	43.5%	61.8%	28.8%	45.2%	31.7%	34.1%	49.8%	45.4%	60.5%	47.4%	46.6%	65.8%
Noise, No RLN	38.3%	56.0%	42.6%	43.1%	58.9%	18.2%	45.5%	40.0%	30.9%	45.5%	45.5%	59.7%	43.5%	47.4%	63.6%
RLN	34.2%	50.6%	35.4%	40.1%	56.1%	32.7%	51.0%	24.5%	42.9%	55.1%	34.6%	50.5%	38.3%	39.4%	56.4%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.9: Proportion of Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN that Won or were Placed in a Race

5.3.3.3 Effect of Respiratory Defects on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses without respiratory defects, those with a respiratory noise without RLN and those with RLN (χ^2 = 52.219, df = 4, P < 0.001). A higher proportion of horses without respiratory defects raced in only NH races than horses with a respiratory noise or with a respiratory noise and RLN, while a higher proportion of horses with a respiratory noise and RLN raced in only Irish Point-to-Point races or in a combination of NH and Irish Point-to-Point races than horses without respiratory defects (Figure 5.10). Similar results were observed within geldings (χ^2 = 62.431, df = 4, P < 0.001) however, no significant difference was observed within mares (χ^2 = 4.199, df = 4, P = 0.380).



	All Horses NH Only	All Horses P-to-P Only	All Horses NH & P-to-P	Mares NH Only	Mares P-to-P Only	Mares NH & P-to-P	Geldings NH Only	Geldings P-to-P Only	Geldings NH & P-to-P
No Resp Defect	55.2%	16.1%	28.8%	53.7%	21.2%	25.1%	55.7%	14.3%	30.0%
Noise, No RLN	44.5%	25.8%	29.7%	49.1%	29.1%	21.8%	42.9%	24.7%	32.5%
RLN	35.2%	30.9%	33.9%	44.9%	30.6%	24.5%	32.6%	31.0%	36.4%

Figure 5.10: Proportion of Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.3.4 Effect of Respiratory Defects on the Age in Years at First Race

Overall, the mean age at first race of the sample population was 5.04$\pm$0.818 years. Only horses that raced were examined to determine the effect of respiratory defects on age at first race. Horses that had RLN were significantly older at their first race (5.28$\pm$0.06) than horses that had either no respiratory defect (5.03$\pm$0.01) or horses with an abnormal respiratory noise but no RLN (5.09$\pm$0.06) ($P < 0.05$). There was no significant difference between those without respiratory defect and those with an abnormal respiratory noise but no RLN. Mares showed a similar result (Table 5.15 below). Within geldings, those without respiratory defect began their racing career significantly younger than either those with an abnormal respiratory noise and no RLN or those with RLN ($P < 0.05$). There was no significant difference in the age at first race between geldings with an abnormal respiratory noise and no RLN and those with RLN.

Table 5.15: Age in Years at First Race for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean ± S.E.*		*Sig.*
Age at First Race	All Horses	No Respiratory Defect	3,697	5.03±0.013	a	<0.001
		Noise, No RLN	209	5.09±0.058	a	
		RLN	237	5.28±0.056	b	
	Mares	No Respiratory Defect	919	5.06±0.026	a	0.003
		Noise, No RLN	55	4.89±0.099	a	
		RLN	49	5.41±0.113	b	
	Geldings	No Respiratory Defect	2,773	5.02±0.016	a	<0.001
		Noise, No RLN	154	5.16±0.070	b	
		RLN	188	5.24±0.064	b	

5.3.3.5 Effect of Respiratory Defects on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). No significant differences were found in the mean number of starts per year raced and in the mean number of steeplechase starts per year raced between horses that had no respiratory defect, a respiratory noise and no RLN and horses that had RLN (data not shown, see Appendix 10, Table A.14), however, significant differences were observed in the mean number of NH starts per year raced, the mean number of hurdle starts per year raced and the mean number of Irish Point-to-Point starts per year raced ($P < 0.05$). Horses without respiratory defects raced significantly more times than those with respiratory defects in both NH starts and hurdle starts. The opposite was found for the mean number of Irish Point-to-Point starts, as shown in Table 5.16 below. Horses with respiratory noises without RLN and horses with RLN raced in significantly more Irish Point-to-Point races than those without respiratory defects. Similar results were observed within geldings, with no significant differences evident between those with respiratory noises and no RLN and those with RLN. Mares showed no significant differences for the mean number of NH starts per year raced and the mean number of hurdle starts per year raced. However, mares with RLN raced in significantly more Irish Point-to-Point races than those without a respiratory defect

(P < 0.05). There was no significant difference between those with an abnormal respiratory noise and no RLN and those without respiratory defect and those with RLN.

Table 5.16: Mean Number of Starts per Year Raced for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean ± S.E.*		*Sig.*
Mean Number of NH Starts per Year Raced	All Horses	No Respiratory Defect	3,697	2.59±0.033	a	<0.001
		Noise, No RLN	209	2.27±0.149	b	
		RLN	237	1.96±0.132	b	
	Mares	No Respiratory Defect	919	2.30±0.068	a	0.692
		Noise, No RLN	55	2.16±0.283	a	
		RLN	49	2.09±0.281	a	
	Geldings	No Respiratory Defect	2,773	2.68±0.038	a	<0.001
		Noise, No RLN	154	2.31±0.175	b	
		RLN	188	1.93±0.150	b	
Mean Number of Hurdle Starts per Year Raced	All Horses	No Respiratory Defect	3,697	1.84±0.026	a	<0.001
		Noise, No RLN	209	1.58±0.107	b	
		RLN	237	1.40±0.098	b	
	Mares	No Respiratory Defect	919	2.03±0.060	a	0.732
		Noise, No RLN	55	1.82±0.223	a	
		RLN	49	2.01±0.272	a	
	Geldings	No Respiratory Defect	2,773	1.78±0.028	a	<0.001
		Noise, No RLN	154	1.50±0.122	b	
		RLN	188	1.24±0.099	b	
Mean Number of Irish Point -to-Point Starts per Year Raced	All Horses	No Respiratory Defect	3,697	0.86±0.022	a	<0.001
		Noise, No RLN	209	1.20±0.106	b	
		RLN	237	1.40±0.106	b	
	Mares	No Respiratory Defect	919	1.04±0.051	a	0.041
		Noise, No RLN	55	1.13±0.206	ab	
		RLN	49	1.62±0.290	b	
	Geldings	No Respiratory Defect	2,773	0.80±0.024	a	<0.001
		Noise, No RLN	154	1.23±0.124	b	
		RLN	188	1.34±0.110	b	

5.3.3.6 Effect of Respiratory Defects on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Significant differences in the number of starts for horses without respiratory defects, with abnormal respiratory noises without RLN, and those with RLN, were found at ages four and five; however, no significant difference existed at any other age (data not shown, see Appendix 10, Table A.14). Horses without respiratory defects had significantly more starts at ages four and five than horses with RLN ($P < 0.05$). Mares showed no significant difference for either of these variables and geldings showed no significant difference for starts at age four years. However, geldings without respiratory defects had significantly more starts at age five years than those with RLN ($P < 0.05$). There was no significant difference between the geldings with abnormal respiratory noises without RLN and those without respiratory defects or those with RLN.

Table 5.17: Number of Starts at Various Ages for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean ± S.E.*		*Sig.*
Starts at Age 4 Years	All Horses	No Respiratory Defect	3,697	0.59±0.022	a	0.034
		Noise, No RLN	209	0.59±0.100	ab	
		RLN	237	0.35±0.063	b	
	Mares	No Respiratory Defect	919	0.54±0.045	a	0.171
		Noise, No RLN	55	0.64±0.205	a	
		RLN	49	0.18±0.100	a	
	Geldings	No Respiratory Defect	2,773	0.60±0.026	a	0.123
		Noise, No RLN	154	0.57±0.114	a	
		RLN	188	0.40±0.075	a	
Starts at Age 5 Years	All Horses	No Respiratory Defect	3,697	2.49±0.041	a	0.011
		Noise, No RLN	209	2.55±0.175	a	
		RLN	237	2.00±0.139	b	
	Mares	No Respiratory Defect	919	2.50±0.084	a	0.180
		Noise, No RLN	55	3.04±0.368	a	
		RLN	49	2.14±0.325	a	
	Geldings	No Respiratory Defect	2,773	2.49±0.046	a	0.016
		Noise, No RLN	154	2.38±0.200	ab	
		RLN	188	1.96±0.154	b	

5.3.3.7 Effect of Respiratory Defects on Career Length

There were no significant differences in the career lengths of horses without respiratory defects, with a respiratory noise and no RLN and horses with RLN (data not shown, see Appendix 10, Table A.13).

5.3.3.8 Effect of Respiratory Defects on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was a significant difference in the proportion of non-finished races per start amongst horses without respiratory defects, with abnormal respiratory noises without RLN, and those with RLN ($P < 0.05$). Horses without respiratory defects had a significantly lower proportion of non-finished races per year raced (25.29%±0.456) than those with abnormal respiratory noises without RLN (31.84%±2.211) or those with RLN (34.01%±2.147). However, there was no significant difference in the proportion of non-finished races for horses with abnormal respiratory noises without RLN and those with RLN, as shown in Table 5.18 below. Geldings showed a similar result, however there was no significant difference within mares.

Table 5.18: Mean Proportion of Non-Finished Races per Start for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean±S.E.(%)*		*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No Respiratory Defect	3,697	25.29±0.456	a	<0.001
		Noise, No RLN	209	31.84±2.211	b	
		RLN	237	34.01±2.147	b	
	Mares	No Respiratory Defect	919	27.28±1.045	a	0.630
		Noise, No RLN	55	31.52±4.817	a	
		RLN	49	28.07±4.787	a	
	Geldings	No Respiratory Defect	2,773	24.64±0.499	a	<0.001
		Noise, No RLN	154	31.96±2.469	b	
		RLN	188	35.56±2.395	b	

5.3.3.9 Effect of Respiratory Defects on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%±11.689, 13.37%±16.319 and 20.11%±21.999, respectively. There was no significant difference in the win strike rates for horses without respiratory defects, those with a respiratory noise without RLN and those with RLN. There was however a significant difference in the place strike rates and the overall win and place strike rates. Horses with no respiratory defects had significantly higher place strike rates and overall win and place strike rates than horses with RLN. There was no significant difference between the strike rates for horses with abnormal respiratory noises without RLN and horses with no respiratory defects or horses with RLN. Similar results were observed within geldings however, there was no significant difference within mares.

Table 5.19: Place Strike Rates for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean ± S.E. (%)*		*Sig.*
Place Strike Rate	All Horses	No Respiratory Defect	3,697	13.55±0.270	a	0.044
		Noise, No RLN	209	12.97±1.037	ab	
		RLN	237	10.85±1.059	b	
	Mares	No Respiratory Defect	919	10.47±0.499	a	0.984
		Noise, No RLN	55	10.37±1.952	a	
		RLN	49	10.84±2.433	a	
	Geldings	No Respiratory Defect	2,773	14.57±0.316	a	0.011
		Noise, No RLN	154	13.90±1.218	ab	
		RLN	188	10.85±1.178	b	
Second Place Strike Rate	All Horses	No Respiratory Defect	3,697	6.40±0.168	a	0.096
		Noise, No RLN	209	6.14±0.614	a	
		RLN	237	4.93±0.734	a	
	Mares	No Respiratory Defect	919	5.03±0.344	a	0.924
		Noise, No RLN	55	5.60±1.116	a	
		RLN	49	4.93±2.166	a	
	Geldings	No Respiratory Defect	2,773	6.86±0.192	a	0.035
		Noise, No RLN	154	6.33±0.733	ab	
		RLN	188	4.93±0.736	b	
Overall Win and Place Strike Rate	All Horses	No Respiratory Defect	3,697	20.44±0.364	a	0.019
		Noise, No RLN	209	19.02±1.461	ab	
		RLN	237	16.44±1.369	b	
	Mares	No Respiratory Defect	919	14.78±0.644	a	0.679
		Noise, No RLN	55	12.41±2.357	a	
		RLN	49	14.55±2.779	a	
	Geldings	No Respiratory Defect	2,773	22.31±0.429	a	0.006
		Noise, No RLN	154	21.39±1.761	ab	
		RLN	188	16.93±1.568	b	

5.3.3.10 Effect of Respiratory Defects on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

There was no significant difference in the NH win or place strike rates or Irish Point-to-Point win or place strike rates for horses without respiratory defects, with an abnormal respiratory noise without RLN and horses with RLN (data not shown, see Appendix 10, Table A.14).

5.3.3.11 Effect of Respiratory Defects on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without respiratory defects, with an abnormal respiratory noise without RLN and horses with RLN (data not shown, see Appendix 10, Table A.14).

5.3.3.12 Effect of Respiratory Defects on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. There was no significant difference in the win strike rates at any age or in the place strike rates at any age other than up to age eight years for horses without respiratory defects, horses with an abnormal respiratory noise and no RLN and horses with RLN (data not shown, see Appendix 10, Table A.14). However, horses without respiratory defects had significantly higher place strike rates up to age eight years than those with RLN ($P < 0.05$). There was no significant difference between those with an abnormal respiratory noise and no RLN and those without respiratory defects or those with RLN. Geldings showed a similar result (Table 5.20 below), however, there was no significant difference within mares. There was also a significant difference within geldings for the place strike rates at age seven years ($P < 0.05$). Geldings with no respiratory defect had significantly higher place strike rates at age seven years than geldings with an abnormal respiratory noise and no RLN. Interestingly, there was no significant difference between geldings with RLN and those with no respiratory defect or those with a respiratory noise and no RLN. There was no significant difference within mares or when all of the horses were analysed together.

Table 5.20: Win and Place Strike Rate at Various Ages for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

Variable	*Group*	*Respiratory Defect*	*n*	*Mean±S.E.(%)*		*Sig.*
Places at Age 7 Years Strike Rate	All Horses	No Respiratory Defect	1,930	15.83±0.529	a	0.159
		Noise, No RLN	106	12.66±1.758	a	
		RLN	116	12.79±1.882	a	
	Mares	No Respiratory Defect	352	13.81±1.160	a	0.485
		Noise, No RLN	23	18.98±5.150	a	
		RLN	19	16.99±6.867	a	
	Geldings	No Respiratory Defect	1,576	16.25±0.592	a	0.029
		Noise, No RLN	83	10.91±1.705	b	
		RLN	97	11.97±1.816	ab	
Places up to Age 8 Years Strike Rate	All Horses	No Respiratory Defect	3,697	12.37±0.258	a	0.037
		Noise, No RLN	209	11.56±0.942	ab	
		RLN	237	9.75±1.008	b	
	Mares	No Respiratory Defect	919	10.10±0.490	a	0.956
		Noise, No RLN	55	9.48±1.794	a	
		RLN	49	10.01±2.380	a	
	Geldings	No Respiratory Defect	2,773	13.12±0.302	a	0.014
		Noise, No RLN	154	12.30±1.104	ab	
		RLN	188	9.69±1.112	b	

5.3.3.13 Effect of Respiratory Defects on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. Horses without respiratory defects had significantly more wins and places up to age eight years than those with RLN ($P < 0.05$). There was no significant difference between those with a respiratory noise without RLN and those without a respiratory defect or those with RLN. Geldings showed a similar result (Table 5.21 below), however, mares showed no significant difference in the number of wins or places up to age eight years between those without respiratory defects, those with an abnormal respiratory noise without RLN, and those with RLN ($P > 0.05$).

Table 5.21: Number of Wins and Places up to Age Eight Years for Horses without Respiratory Defects, with an Abnormal Respiratory Noise and No RLN, and with RLN

Means with the same letter are not significantly different from each other

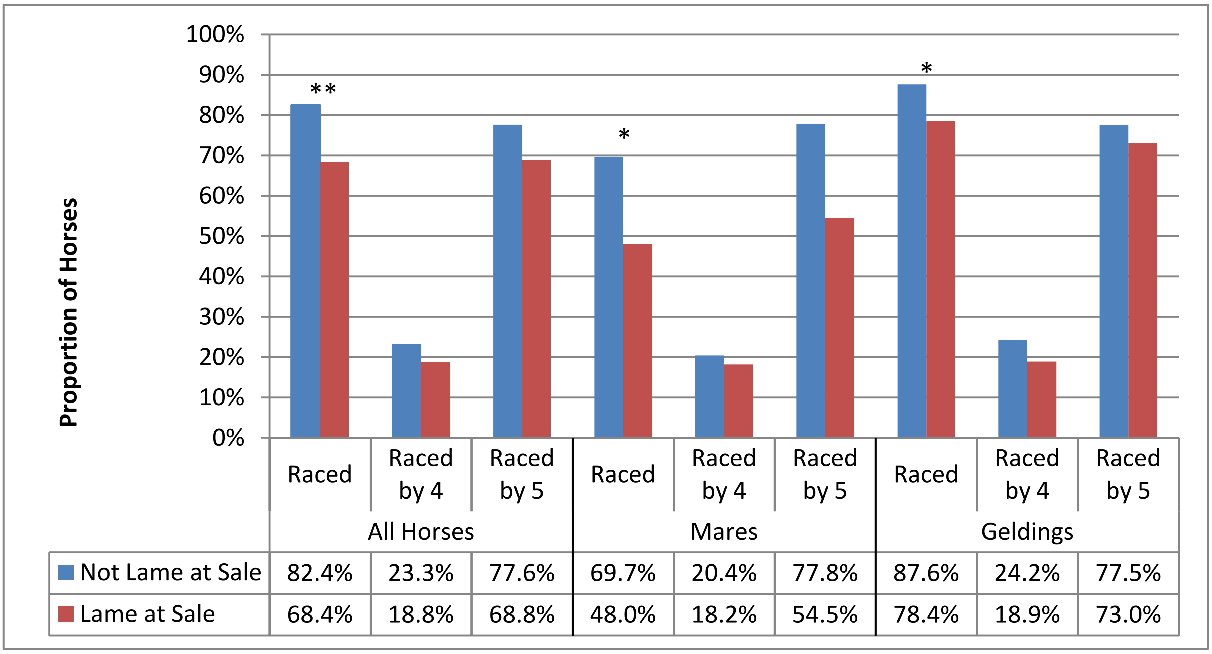
Variable	*Group*	*Respiratory Defect*	*n*	*Mean ± S.E.*		*Sig.*
Wins up to Age 8 Years	All Horses	No Respiratory Defect	3,697	0.92±0.026	a	0.035
		Noise, No RLN	209	0.78±0.093	ab	
		RLN	237	0.68±0.092	b	
	Mares	No Respiratory Defect	919	0.50±0.035	a	0.559
		Noise, No RLN	55	0.36±0.152	a	
		RLN	49	0.41±0.109	a	
	Geldings	No Respiratory Defect	2,773	1.06±0.032	a	0.034
		Noise, No RLN	154	0.94±0.112	ab	
		RLN	188	0.74±0.112	b	
Places up to Age 8 Years	All Horses	No Respiratory Defect	3,697	1.76±0.040	a	0.037
		Noise, No RLN	209	1.64±0.158	ab	
		RLN	237	1.35±0.155	b	
	Mares	No Respiratory Defect	919	1.19±0.065	a	0.815
		Noise, No RLN	55	1.24±0.261	a	
		RLN	49	1.02±0.232	a	
	Geldings	No Respiratory Defect	2,773	1.95±0.049	a	0.025
		Noise, No RLN	154	1.78±0.192	ab	
		RLN	188	1.44±0.186	b	

5.3.4 Effect of Lameness at the Time of Sale on Racing Performance

Only a small number of horses (76) were lame at the time of sale. This represented only 1.4% of the total sample. Unfortunately, the cause of this lameness was not recorded. All 5,282 horses were examined to determine the proportions of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.4.1 Effect of Lameness at the Time of Sale on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was a significant difference between the proportions of horses that were or were not lame at the time of the Sale that subsequently raced (χ^2 = 10.085, df = 1, P = 0.001). Horses without lameness at the time of the Sale were significantly more likely to race than those that were lame (82.4% compared to 68.4%). However, there was no significant difference between the proportions of horses that were and were not lame at the time of sale that raced by age four years (χ^2 = 0.543, df = 1, P = 0.461) and that raced by five (χ^2 = 2.108, df = 1, P = 0.147). There was a significant difference between the proportions of mares that were and were not lame at the time of the sale that raced (χ^2 = 5.427, df = 1, P = 0.020). Mares without lameness at the time of the Sale were significantly more likely to race than those that were lame. There was however, no significant difference for raced by age four years (χ^2 = 0.033, df = 1, P = 0.855) and raced by five (χ^2 = 3.389, df = 1, P = 0.066). There was also a significant difference between the proportions of geldings that were and were not lame at the time of the Sale that raced (χ^2 = 3.858, df = 1, P = 0.050). Geldings without lameness at the time of the Sale were significantly more likely to race than those that were lame. However, there was no significant difference between the proportions of geldings that were and were not lame at the time of sale that raced by four (χ^2 = 0.558, df = 1, P = 0.455) and that raced by five (χ^2 = 0.429, df = 1, P = 0.513).

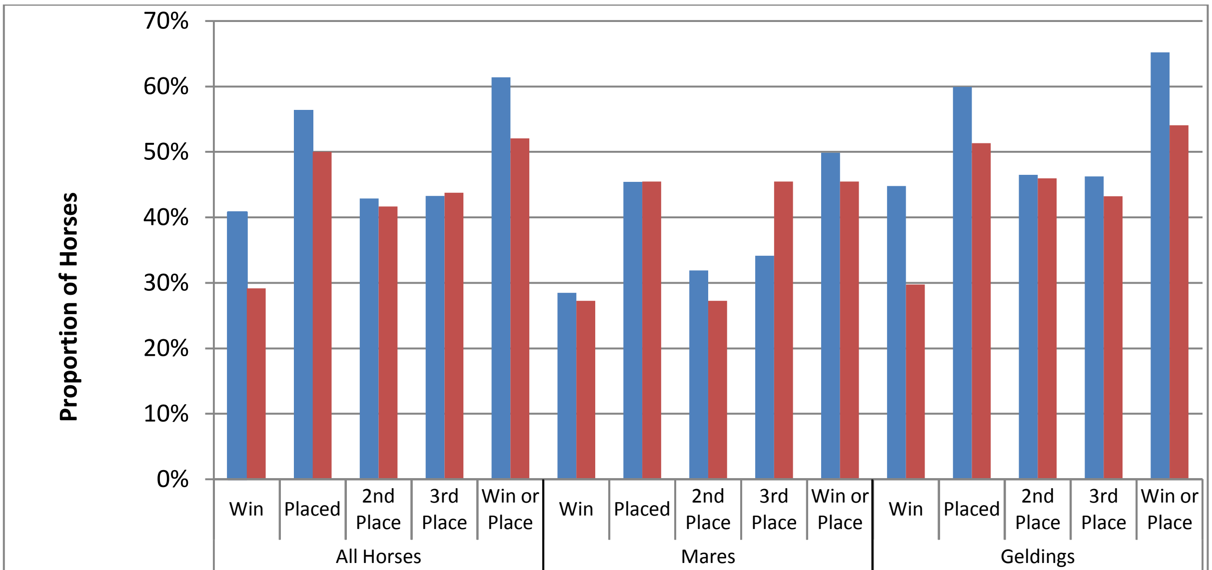


*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.11: Proportion of Horses that were and were not Lame at the Time of Sale that Raced

5.3.4.2 Effect of Lameness at the Time of Sale on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses that were and were not lame at the time of the sale that subsequently won a race (χ^2 = 2.650, df = 1, P = 0.104), were placed in a race (χ^2 = 0.777, df = 1, P = 0.378), placed second (χ^2 = 0.030, df = 1, P = 0.863), placed third (χ^2 = 0.004, df = 1, P = 0.949) or won or placed in a race (χ^2 = 1.737, df = 1, P = 0.188). Similarly, there was no significant difference between the proportions of mares that were and were not lame at the time of the sale that won a race (χ^2 = 0.008, df = 1, P = 0.931), were placed in a race (χ^2 = 0.000, df = 1, P = 0.999), placed second (χ^2 = 0.107, df = 1, P = 0.743), placed third (χ^2 = 0.617, df = 1, P = 0.432) or won or placed in a race (χ^2 = 0.084, df = 1, P = 0.772). Finally, there was no significant difference in the proportions of geldings without and with lameness at the time of sale that won a race (χ^2 = 3.364, df = 1, P = 0.067), placed (χ^2 = 1.116, df = 1, P = 0.291), placed second (χ^2 = 0.005, df = 1, P = 0.945), placed third (χ^2 = 0.133, df = 1, P = 0.715) or won or placed in a race (χ^2 = 1.994, df = 1, P = 0.158).



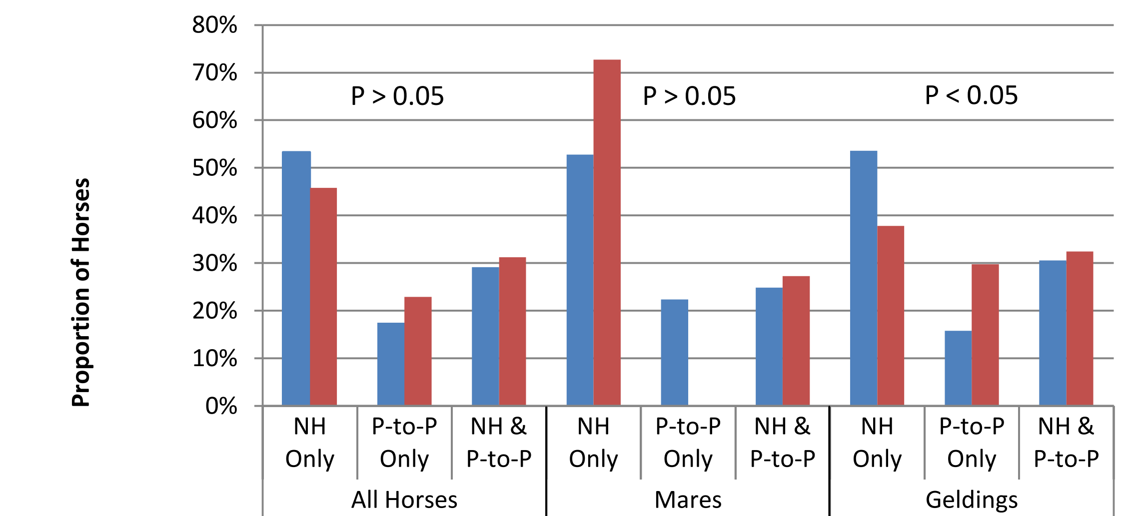
	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
Not Lame at Sale	40.8%	56.3%	42.9%	43.3%	61.4%	28.5%	45.4%	31.9%	34.2%	49.9%	44.8%	59.9%	46.5%	46.3%	65.2%
Lame at Sale	29.2%	50.0%	41.7%	43.8%	52.1%	27.3%	45.5%	27.3%	45.5%	45.5%	29.7%	51.4%	45.9%	43.2%	54.1%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.12: Proportion of Horses that were and were not Lame at the Time of Sale that Won or Placed in a Race

5.3.4.3 Effect of Lameness at the Time of Sale on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was no significant difference in the type of racing career for horses without and with lameness at the time of sale ($\chi^2 = 1.376$, df = 2, P = 0.502) or within mares without and with lameness at the time of sale ($\chi^2 = 3.309$, df = 2, P = 0.191). There was however a significant difference within geldings ($\chi^2 = 6.155$, df = 2, P = 0.046). A higher proportion of geldings that were not lame at the time of sale raced in only NH races than geldings that were lame at the time of sale, while a higher proportion of geldings that were lame at the time of sale raced in only Irish Point-to-Point races or in a combination of NH and Irish Point-to-Point races than geldings that were not lame at the time of sale (Figure 5.13).



	All Horses			Mares			Geldings		
	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P
Not Lame at Sale	53.4%	17.5%	29.2%	52.8%	22.4%	24.9%	53.6%	15.8%	30.6%
Lame at Sale	45.8%	22.9%	31.3%	72.7%	0.0%	27.3%	37.8%	29.7%	32.4%

Figure 5.13: Proportion of Horses that were and were not Lame at the Time of Sale that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.4.4 Effect of Lameness at the Time of Sale on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.4.5 Effect of Lameness at the Time of Sale on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). While there was no significant difference in the mean number of starts per year raced or the mean number of NH starts per year raced (data not shown, see Appendix 11, Table A.16) for horses that were and were not lame at the time of sale, there was however a significant difference in the mean number of Irish Point-to-Point starts per year raced. Geldings that were lame at the time of sale raced in significantly more Irish Point-to-Point races than those that were not lame ($P < 0.05$, 1.30±0.26 starts compared to 0.85±0.02). Although there was no significant difference for mares and geldings combined, they did follow a similar trend, as shown in Table 5.22 below.

Table 5.22: Mean Number of Irish Point-to-Point Starts per Year Raced for Horses that were and were not Lame at the Time of Sale

Variable	*Group*	*Lame at Sale*	*N*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Irish Point-to -Point Starts per Year Raced	All Horses	No	4,135	0.91±0.021	1.008	0.314
		Yes	48	1.11±0.218		
	Mares	No	1,019	1.08±0.050	-1.243	0.214
		Yes	11	0.48±0.321		
	Geldings	No	3,111	0.85±0.023	2.069	0.039
		Yes	37	1.30±0.261		

5.3.4.6 Effect of Lameness at the Time of Sale on the Number of Starts at Various Ages

There was no significant difference in the number of starts at ages four, five, six, seven, eight and up to age eight years for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.4.7 Effect of Lameness at the Time of Sale on Career Length

There were no significant differences in the career lengths of horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.15).

5.3.4.8 Effect of Lameness at the Time of Sale on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%$\pm$28.454. There was no significant difference in the proportions of non-finished races per start for horses that were and were not lame at the time of sale. There was however a significant difference within mares and within geldings ($P < 0.05$). Curiously, mares that were not lame at the time of sale had a significantly higher proportion of non-finished races per start than those that were lame, while geldings that were lame at the time of sale had a significantly higher proportion of non-finished races than geldings that were not lame.

Table 5.23: Mean Proportion of Non-Finished Races per Start for Horses that were and were not Lame at the Time of Sale

Variable	*Group*	*Lame at Sale*	*N*	*Mean$\pm$S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	4,135	26.21$\pm$0.442	0.922	0.357
		Yes	48	30.02$\pm$4.820		
	Mares	No	1,019	27.83$\pm$1.002	-9.726	<0.001
		Yes	11	3.36$\pm$2.308		
	Geldings	No	3,111	25.68$\pm$0.486	2.183	0.036
		Yes	37	37.94$\pm$5.594		

5.3.4.9 Effect of Lameness at the Time of Sale on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.4.10 Effect of Lameness at the Time of Sale on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Horses that were not lame at the time of sale had significantly higher Irish Point-to-Point win strike rates than those that were lame ($P < 0.05$). Geldings showed the same result while mares showed no significant difference (Table 5.24). There was no significant difference in the NH win or place strike rates or in the Irish Point-to-Point place strike rates for horses without or with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

Table 5.24: Irish Point-to-Point Win Strike Rates for Horses that were and were not Lame at the Time of Sale

Variable	*Group*	*Lame at Sale*	*N*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Irish Point-to-Point Win Strike Rate	All Horses	No	1,929	11.75±0.520	-2.791	0.009
		Yes	26	5.06±2.340		
	Mares	No	480	8.54±0.852	1.521	0.129
		Yes	3	25.00±14.434		
	Geldings	No	1,446	12.80±0.630	-6.832	<0.001
		Yes	23	2.46±1.377		

5.3.4.11 Effect of Lameness at the Time of Sale on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.4.12 Effect of Lameness at the Time of Sale on the Win and Place Strike Rate at Various Ages

There was no significant difference in the number of wins and the number of places at ages four, five, six, seven, eight and up to age eight years for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.4.13 Effect of Lameness at the Time of Sale on the Number of Wins and Places up to Age Eight Years

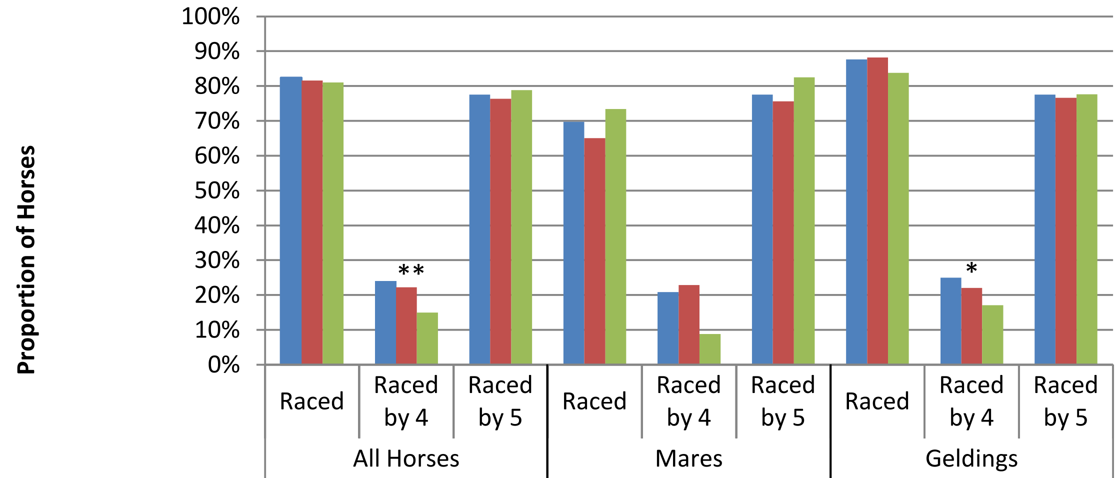
There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with lameness at the time of sale (data not shown, see Appendix 11, Table A.16).

5.3.5 Effect of Metacarpal/Metatarsal Exostoses on Racing Performance

Metacarpal/metatarsal exostoses were present on 19.0% of the horses within the sample. Of these 1,002 horses with metacarpal/metatarsal exostoses 707 had only one metacarpal/metatarsal exostosis while 295 had multiple metacarpal/metatarsal exostoses. These have been discussed in more detail in chapter two. All 5,282 horses were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.5.1 Effect of Metacarpal/Metatarsal Exostoses on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was no significant difference between the proportions of horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses that raced (χ^2 = 0.580, df = 2, P = 0.748) and raced by five (χ^2 = 0.655, df = 2, P = 0.721). All three groups were equally likely to race. There was however a significant difference between the groups in the proportion that raced by four (χ^2 = 9.923, df = 2, P = 0.007). A higher proportion of horses without metacarpal/metatarsal exostoses raced by age four years, followed by those with unilateral metacarpal/metatarsal exostoses and finally those with multiple metacarpal/metatarsal exostoses. There was no significant difference between the proportions of mares without metacarpal/metatarsal exostoses, unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses that raced (χ^2 = 2.483, df = 2, P = 0.289), raced by four (χ^2 = 5.297, df = 2, P = 0.071) and raced by five (χ^2 = 1.069, df = 2, P = 0.586). There was also no significant difference between the proportions of geldings without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses that raced (χ^2 = 2.930, df = 2, P = 0.231) and raced by five (χ^2 = 0.241, df = 2, P = 0.899). However, there was a significant difference between the proportions of geldings without and with metacarpal/metatarsal exostoses that raced by age four years (χ^2 = 6.668, df = 2, P = 0.036) as seen in Figure 5.14.



	All Horses Raced	All Horses Raced by 4	All Horses Raced by 5	Mares Raced	Mares Raced by 4	Mares Raced by 5	Geldings Raced	Geldings Raced by 4	Geldings Raced by 5
No Mc/Mt Exos	82.4%	23.9%	77.5%	69.7%	20.8%	77.5%	87.6%	25.0%	77.6%
Unilateral Mc/Mt Exos	81.6%	22.2%	76.4%	65.0%	22.8%	75.6%	88.2%	22.0%	76.6%
Multiple Mc/Mt Exos	81.0%	15.0%	78.9%	73.4%	8.8%	82.5%	83.8%	17.1%	77.6%

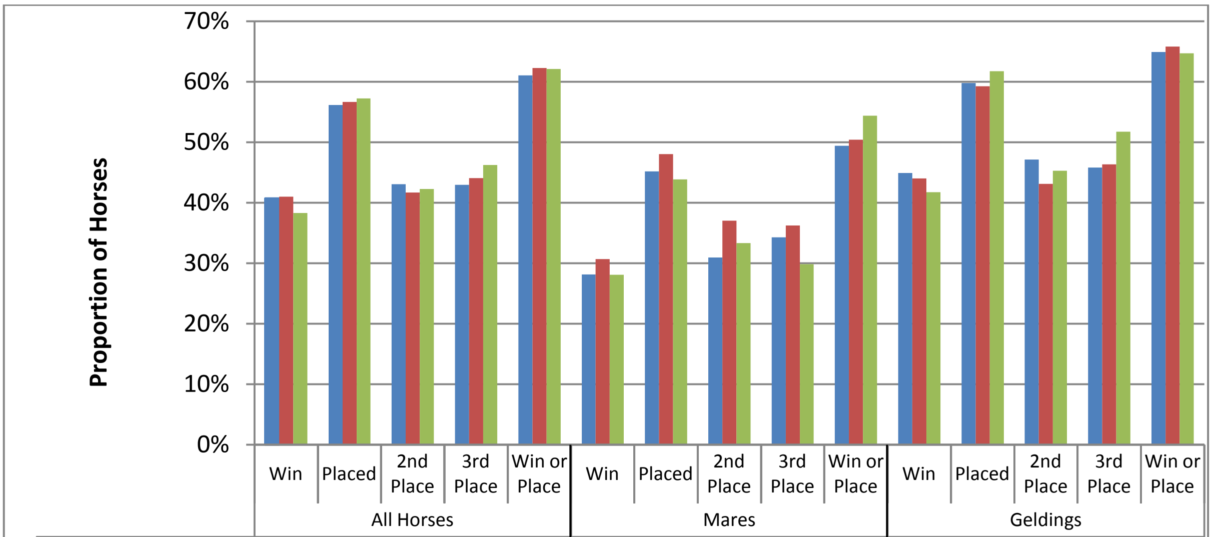
*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.14: Proportion of Horses without Metacarpal/Metatarsal Exostoses (Mc/Mt Exos), with Unilateral Metacarpal/Metatarsal Exostoses or Multiple Metacarpal/Metatarsal Exostoses that Raced

5.3.5.2 Effect of Metacarpal/Metatarsal Exostoses on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses that won a race (χ^2 = 0.541, df = 2, P = 0.763), were placed in a race (χ^2 = 0.160, df

= 2, P = 0.923), placed second (χ^2 = 0.406, df = 2, P = 0.816), placed third (χ^2 = 1.086, df = 2, P = 0.581) or won or placed in a race (χ^2 = 0.363, df = 2, P = 0.834). All three groups were equally likely to win or be placed. There was no significant difference between the proportions of mares without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses that won a race (χ^2 = 0.364, df = 2, P = 0.833), were placed in a race (χ^2 = 0.429, df = 2, P = 0.807), placed second (χ^2 = 1.917, df = 2, P = 0.383), placed third (χ^2 = 0.715, df = 2, P = 0.700) or won or placed in a race (χ^2 = 0.549, df = 2, P = 0.760). There was also no significant difference between the proportions of geldings without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses that won a race (χ^2 = 0.711, df = 2, P = 0.701), were placed in a race (χ^2 = 0.329, df = 2, P = 0.849), placed second (χ^2 = 2.479, df = 2, P = 0.290), placed third (χ^2 = 2.272, df = 2, P = 0.321) or won or placed in a race (χ^2 = 0.130, df = 2, P = 0.937).



	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No Mc/Mt Exos	40.7%	56.1%	43.1%	43.0%	61.1%	28.1%	45.2%	31.0%	34.3%	49.4%	44.9%	59.8%	47.1%	45.8%	64.9%
Unilateral Mc/Mt Exos	41.0%	56.7%	41.7%	44.0%	62.3%	30.7%	48.0%	37.0%	36.2%	50.4%	44.0%	59.3%	43.1%	46.4%	65.8%
Multiple Mc/Mt Exos	38.3%	57.3%	42.3%	46.3%	62.1%	28.1%	43.9%	33.3%	29.8%	54.4%	41.8%	61.8%	45.3%	51.8%	64.7%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.15: Proportion of Horses without Metacarpal/Metatarsal Exostoses (Mc/Mt Exos), with Unilateral Metacarpal/Metatarsal Exostoses or Multiple Metacarpal/Metatarsal Exostoses that Won or Placed in a Race

5.3.5.3 Effect of Metacarpal/Metatarsal Exostoses on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.17).

5.3.5.4 Effect of Metacarpal/Metatarsal Exostoses on the Age in Years at First Race

There was no significant difference in the age at first race for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.5.5 Effect of Metacarpal/Metatarsal Exostoses on the Mean Number of Starts per Year Raced

There was no significant difference in the mean number of starts per year raced for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.5.6 Effect of Metacarpal/Metatarsal Exostoses on the Number of Starts at Various Ages

There was no significant difference in the number of starts at ages four, five, six, seven, eight and up to age eight years for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.5.7 Effect of Metacarpal/Metatarsal Exostoses on Career Length

There were no significant differences in the career lengths of horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.18).

5.3.5.8 Effect of Metacarpal/Metatarsal Exostoses on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.5.9 Effect of Metacarpal/Metatarsal Exostoses on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.5.10 Effect of Metacarpal/Metatarsal Exostoses on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. There was no significant difference in the NH win or place (Table 5.25) strike rates or Irish Point-to-Point win or place strike rates for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or multiple metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19). Within mares however, those with unilateral metacarpal/metatarsal exostoses had significantly higher NH place strike rates than those without metacarpal/metatarsal exostoses or those with multiple metacarpal/metatarsal exostoses ($P < 0.05$).

Table 5.25: NH Place Strike Rates for Horses without Metacarpal/Metatarsal Exostoses, with Unilateral Metacarpal/Metatarsal Exostoses or with Multiple Metacarpal/Metatarsal Exostoses

Means with the same letter are not significantly different from each other

Variable	*Group*	*Metacarpal/Metatarsal Exostosis*	*n*	*Mean±S.E.(%)*		*Sig.*
NH Place Strike Rate	All Horses	No Metacarpal/ Metatarsal Exostoses	2,792	12.13±0.298	a	0.294
		Unilateral Metacarpal/ Metatarsal Exostoses	456	13.27±0.738	a	
		Multiple Metacarpal/ Metatarsal Exostoses	189	11.56±1.086	a	
	Mares	No Metacarpal/ Metatarsal Exostoses	651	8.65±0.558	a	0.009
		Unilateral Metacarpal/ Metatarsal Exostoses	102	12.78±1.608	b	
		Multiple Metacarpal/ Metatarsal Exostoses	46	5.91±1.808	a	
	Geldings	No Metacarpal/ Metatarsal Exostoses	2,138	13.18±0.346	a	0.963
		Unilateral Metacarpal/ Metatarsal Exostoses	354	13.41±0.831	a	
		Multiple Metacarpal/ Metatarsal Exostoses	143	13.37±1.278	a	

5.3.5.11 Effect of Metacarpal/Metatarsal Exostoses on the Mean Earnings per Start

Overall, the mean earnings per start in the sample population were £443.0±1,350.34. There was no significant difference in the mean earnings per start for horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses (Table 5.26), nor was there a significant difference within geldings. Within mares however, those with unilateral metacarpal/metatarsal exostoses earned significantly more per race than those without metacarpal/metatarsal exostoses, £354.1±83.41 compared to £199.6±19.62 ($P < 0.05$). There was no significant difference in the earnings per start for mares with multiple metacarpal/metatarsal exostoses and mares without metacarpal/metatarsal exostoses or mares with unilateral metacarpal/metatarsal exostoses.

Table 5.26: Mean Earnings per Start for Horses without Metacarpal/Metatarsal Exostoses, with Unilateral Metacarpal/Metatarsal Exostoses or Multiple Metacarpal/Metatarsal Exostoses

Means with the same letter are not significantly different from each other

Variable	*Group*	*Metacarpal/Metatarsal Exostosis*	*n*	*Mean ± S.E. (£)*		*Sig.*
Mean Earnings per Start	All Horses	No Metacarpal/ Metatarsal Exostoses	3,398	438.9±23.97	a	0.259
		Unilateral Metacarpal/ Metatarsal Exostoses	554	511.2±53.0	a	
		Multiple Metacarpal/ Metatarsal Exostoses	227	342.4±54.61	a	
	Mares	No Metacarpal/ Metatarsal Exostoses	846	199.6±19.62	a	0.037
		Unilateral Metacarpal/ Metatarsal Exostoses	127	354.1±83.41	b	
		Multiple Metacarpal/ Metatarsal Exostoses	57	202.6±86.95	ab	
	Geldings	No Metacarpal/ Metatarsal Exostoses	2,547	518.5±31.15	a	0.464
		Unilateral Metacarpal/ Metatarsal Exostoses	427	557.9±62.89	a	
		Multiple Metacarpal/ Metatarsal Exostoses	170	389.3±66.58	a	

5.3.5.12 Effect of Metacarpal/Metatarsal Exostoses on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. Significant differences were found in the win and place strike rates at age five years ($P < 0.05$) between horses without metacarpal/metatarsal exostoses, with unilateral metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses, however, no significant difference was found at any other age (data not shown, see Appendix 12, Table A.19). Interestingly, horses with a unilateral metacarpal/metatarsal exostosis won a significantly higher proportion of races at age five years (10.32%±1.131) than horses without metacarpal/metatarsal exostoses (7.73%±0.382) or those with multiple metacarpal/metatarsal exostoses (6.45±1.283) ($P < 0.05$) while there was no significant difference between horses without metacarpal/metatarsal exostoses and those with multiple metacarpal/metatarsal exostoses. Geldings showed similar results, as shown in Table 5.27 below. There was no significant difference within mares for the win strike rates at age five years, however, mares with unilateral metacarpal/metatarsal exostoses placed in a significantly higher proportion of races at age five years (13.65%±2.346) than mares without metacarpal/metatarsal exostoses (8.73%±0.698). There was no significant difference when all horses were analysed together or when geldings were analysed separately.

Table 5.27: Win and Place Strike Rate at Various Ages for Horses without Metacarpal/Metatarsal Exostoses, with Unilateral Metacarpal/Metatarsal Exostoses or Multiple Metacarpal/Metatarsal Exostoses

Means with the same letter are not significantly different from each other

Variable	*Group*	*Metacarpal/Metatarsal Exostosis*	*n*	*Mean±S.E.(%)*		*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No Metacarpal/ Metatarsal Exostoses	2,472	7.73±0.382	a	0.026
		Unilateral Metacarpal/ Metatarsal Exostoses	401	10.32±1.131	b	
		Multiple Metacarpal/ Metatarsal Exostoses	174	6.45±1.283	a	
	Mares	No Metacarpal/ Metatarsal Exostoses	609	4.65±0.570	a	0.831
		Unilateral Metacarpal/ Metatarsal Exostoses	89	4.77±1.362	a	
		Multiple Metacarpal/ Metatarsal Exostoses	46	3.41±1.344	a	
	Geldings	No Metacarpal/ Metatarsal Exostoses	1,860	8.74±0.470	a	0.031
		Unilateral Metacarpal/ Metatarsal Exostoses	312	11.91±1.389	b	
		Multiple Metacarpal/ Metatarsal Exostoses	128	7.55±1.668	a	
Places at Age 5 Years Strike Rate	All Horses	No Metacarpal/ Metatarsal Exostoses	2,472	13.78±0.472	a	0.818
		Unilateral Metacarpal/ Metatarsal Exostoses	401	13.70±1.859	a	
		Multiple Metacarpal/ Metatarsal Exostoses	174	14.58±1.249	a	
	Mares	No Metacarpal/ Metatarsal Exostoses	609	8.73±0.698	a	0.027
		Unilateral Metacarpal/ Metatarsal Exostoses	89	13.65±2.346	b	
		Multiple Metacarpal/ Metatarsal Exostoses	46	12.70±3.012	ab	
	Geldings	No Metacarpal/ Metatarsal Exostoses	1,860	15.45±0.579	a	0.787
		Unilateral Metacarpal/ Metatarsal Exostoses	312	14.84±1.461	a	
		Multiple Metacarpal/ Metatarsal Exostoses	128	14.05±2.290	a	

5.3.5.13 Effect of Metacarpal/Metatarsal Exostoses on the Number of Wins and Places up to Age Eight Years

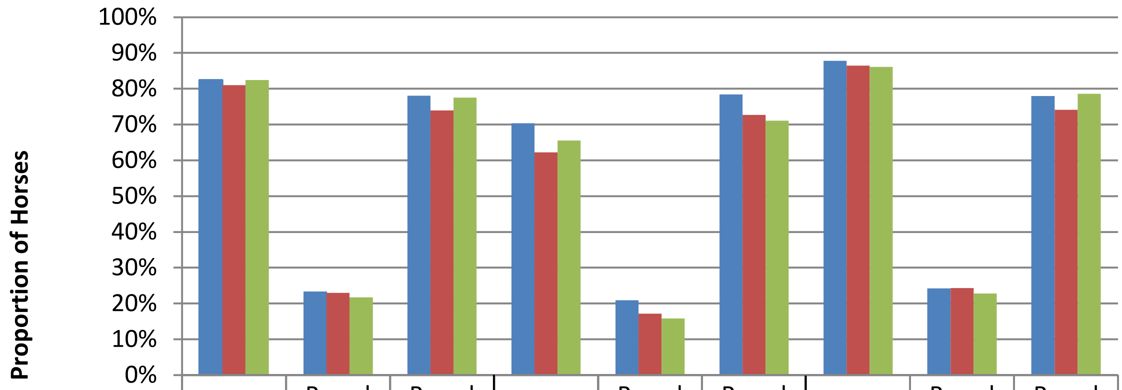
There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with metacarpal/metatarsal exostoses (data not shown, see Appendix 12, Table A.19).

5.3.6 Effect of Tarsal Plantar Desmitis on Racing Performance

Tarsal plantar desmitis affected 19.6% (1,034 horses) of the sample, with 13.2% (699 horses) affected by unilateral tarsal plantar desmitis and 6.3% (335 horses) affected by bilateral tarsal plantar desmitis. All 5,282 horses in the sample were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.6.1 Effect of Tarsal Plantar Desmitis on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was no significant difference between the proportions of horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis that raced (χ^2 = 0.888, df = 2, P = 0.641), raced by four (χ^2 = 0.369, df = 2, P = 0.831) or raced by five (χ^2 = 4.597, df = 2, P = 0.100). There was no significant difference between the proportions of mares without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis that raced (χ^2 = 4.768, df = 2, P = 0.092), raced by four (χ^2 = 1.294, df = 2, P = 0.524) or raced by five (χ^2 = 2.605, df = 2, P = 0.272). There was no significant difference between the proportions of geldings without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis that raced (χ^2 = 1.219, df = 2, P = 0.543), raced by four (χ^2 = 0.251, df = 2, P = 0.882) or raced by five (χ^2 = 3.379, df = 2, P = 0.185).



	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
No TPD	82.4%	23.4%	78.0%	70.3%	20.9%	78.4%	87.8%	24.2%	77.9%
Unilateral TPD	81.0%	23.0%	73.9%	62.3%	17.2%	72.7%	86.5%	24.3%	74.1%
Bilateral TPD	82.4%	21.8%	77.5%	65.6%	15.8%	71.1%	86.1%	22.8%	78.6%

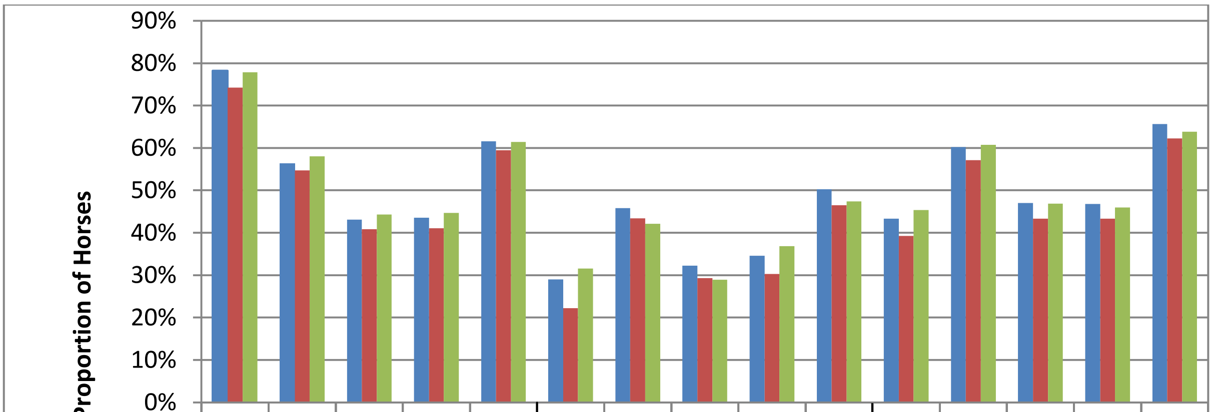
*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.16: Proportion of Horses without Tarsal Plantar Desmitis (TPD), with Unilateral Tarsal Plantar Desmitis or with Bilateral Tarsal Plantar Desmitis that Raced

5.3.6.2 Effect of Tarsal Plantar Desmitis on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis that won a race (χ^2 = 1.093, df = 2, P = 0.579), were placed in a race (χ^2 = 0.862, df = 2, P = 0.650), placed second (χ^2 = 1.178, df = 2, P = 0.555), placed third (χ^2 = 1.405, df = 2, P = 0.495) or won or placed in a race (χ^2 = 0.869, df = 2, P = 0.647). There was no significant difference between the proportions of mares without tarsal plantar desmitis, unilateral tarsal plantar desmitis and bilateral tarsal plantar desmitis that won a race (χ^2 = 2.204, df = 2, P = 0.332), were placed in a race (χ^2 = 0.378, df = 2, P = 0.828), placed second (χ^2 = 0.512, df = 2, P = 0.774), placed third (χ^2 = 0.847, df = 2, P = 0.655) or won or placed in a race (χ^2 = 0.613, df = 2, P = 0.736). There was no significant difference between the proportions of geldings without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis that won a race (χ^2 = 3.435, df = 2, P = 0.180), were placed in a race (χ^2 = 1.574, df = 2, P =

0.455), placed second (χ^2 = 2.155, df = 2, P = 0.340), placed third (χ^2 = 1.838, df = 2, P = 0.399) or won or placed in a race (χ^2 = 2.079, df = 2, P = 0.354).



	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No TPD	78.2%	56.4%	43.1%	43.6%	61.6%	29.0%	45.8%	32.3%	34.6%	50.3%	43.3%	60.2%	47.1%	46.8%	65.7%
Unilateral TPD	74.3%	54.7%	40.9%	41.1%	59.5%	22.2%	43.4%	29.3%	30.3%	46.5%	39.3%	57.1%	43.3%	43.3%	62.3%
Bilateral TPD	77.9%	58.0%	44.3%	44.7%	61.5%	31.6%	42.1%	28.9%	36.8%	47.4%	45.4%	60.7%	46.9%	46.0%	63.8%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.17: Proportion of Horses without Tarsal Plantar Desmitis (TPD), with Unilateral Tarsal Plantar Desmitis or with Bilateral Tarsal Plantar Desmitis that Won or Placed in a Race

5.3.6.3 Effect of Tarsal Plantar Desmitis on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with tarsal plantar desmitis (data not shown, see Appendix 13, Table A.20).

5.3.6.4 Effect of Tarsal Plantar Desmitis on the Age in Years at First Race

There was no significant difference in the age at first race for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.6.5 Effect of Tarsal Plantar Desmitis on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference in the mean number of overall starts per year raced for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22). Horses without tarsal plantar desmitis had a significantly higher mean number of NH starts and hurdle starts per year raced than horses with bilateral tarsal plantar desmitis ($P < 0.05$), see Table 5.28 below. There was however, no significant difference between the mean number of starts for horses with unilateral tarsal plantar desmitis and the horses without tarsal plantar desmitis or bilateral tarsal plantar desmitis. Geldings showed a similar result for the mean number of NH starts per year raced but showed no significant difference for the mean number of hurdle starts per year raced ($P > 0.05$). Conversely, horses without tarsal plantar desmitis had a significantly lower mean number of Irish Point-to-Point starts than those with unilateral or bilateral tarsal plantar desmitis. There was no significant difference in the mean number of NH starts, hurdle starts or Irish Point-to-Point starts per year raced within mares ($P > 0.05$).

Table 5.28: Mean Number of Starts per Year Raced for Horses without Tarsal Plantar Desmitis, with Unilateral Tarsal Plantar Desmitis or with Bilateral Tarsal Plantar Desmitis

Means with the same letter are not significantly different from each other

Variable	*Group*	*Tarsal Plantar Desmitis*	*n*	*Mean ± S.E.*		*Sig.*
Mean Number of NH Starts per Year Raced	All Horses	No Tarsal Plantar Desmitis	3,373	2.57±0.035	a	0.015
		Unilateral Tarsal Plantar Desmitis	548	2.40±0.087	ab	
		Bilateral Tarsal Plantar Desmitis	262	2.25±0.117	b	
	Mares	No Tarsal Plantar Desmitis	893	2.33±0.070	a	0.066
		Unilateral Tarsal Plantar Desmitis	99	1.83±0.166	a	
		Bilateral Tarsal Plantar Desmitis	38	2.41±0.336	a	
	Geldings	No Tarsal Plantar Desmitis	2,476	2.66±0.041	a	0.006
		Unilateral Tarsal Plantar Desmitis	448	2.51±0.099	ab	
		Bilateral Tarsal Plantar Desmitis	224	2.23±0.125	b	
Mean Number of Hurdle Starts per Year Raced	All Horses	No Tarsal Plantar Desmitis	3,373	1.82±0.027	a	0.024
		Unilateral Tarsal Plantar Desmitis	548	1.69±0.066	ab	
		Bilateral Tarsal Plantar Desmitis	262	1.61±0.090	b	
	Mares	No Tarsal Plantar Desmitis	893	2.04±0.062	a	0.163
		Unilateral Tarsal Plantar Desmitis	99	1.68±0.162	a	
		Bilateral Tarsal Plantar Desmitis	38	2.14±0.299	a	
	Geldings	No Tarsal Plantar Desmitis	2,476	1.75±0.029	a	0.068
		Unilateral Tarsal Plantar Desmitis	448	1.69±0.073	a	
		Bilateral Tarsal Plantar Desmitis	224	1.52±0.091	a	
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No Tarsal Plantar Desmitis	3,373	0.88±0.023	a	0.001
		Unilateral Tarsal Plantar Desmitis	548	1.01±0.064	b	
		Bilateral Tarsal Plantar Desmitis	262	1.17±0.096	b	
	Mares	No Tarsal Plantar Desmitis	893	1.05±0.052	a	0.377
		Unilateral Tarsal Plantar Desmitis	99	1.28±0.177	a	
		Bilateral Tarsal Plantar Desmitis	38	1.05±0.238	a	
	Geldings	No Tarsal Plantar Desmitis	2,476	0.81±0.025	a	<0.001
		Unilateral Tarsal Plantar Desmitis	448	0.96±0.067	b	
		Bilateral Tarsal Plantar Desmitis	224	1.19±0.105	c	

5.3.6.6 Effect of Tarsal Plantar Desmitis on the Number of Starts at Various Ages

There was no significant difference in the number of starts at ages four, five, six, seven, eight and up to age eight years for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.6.7 Effect of Tarsal Plantar Desmitis on Career Length

There were no significant differences in the career lengths of horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.21).

5.3.6.8 Effect of Tarsal Plantar Desmitis on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%$\pm$28.454. Horses without tarsal plantar desmitis had a significantly lower proportion of non-finished races per start (25.71%$\pm$0.489) than horses with bilateral tarsal plantar desmitis (29.96%$\pm$1.754) ($P < 0.05$). There was, however, no significant difference between horses with unilateral tarsal plantar desmitis (27.82%$\pm$1.233) and horses without tarsal plantar desmitis or horses with bilateral tarsal plantar desmitis. Similar results were observed in geldings (Table 5.29) however, no significant difference was observed in mares.

Table 5.29: Mean Proportion of Non-Finished Races per Start for Horses without Tarsal Plantar Desmitis, with Unilateral Tarsal Plantar Desmitis or with Bilateral Tarsal Plantar Desmitis

Means with the same letter are not significantly different from each other

Variable	*Group*	*Tarsal Plantar Desmitis*	*n*	*Mean±S.E.(%)*		*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No Tarsal Plantar Desmitis	3,373	25.71±0.489	a	0.026
		Unilateral Tarsal Plantar Desmitis	548	27.82±1.233	ab	
		Bilateral Tarsal Plantar Desmitis	262	29.96±1.754	b	
	Mares	No Tarsal Plantar Desmitis	893	27.03±1.067	a	0.380
		Unilateral Tarsal Plantar Desmitis	99	31.14±3.306	a	
		Bilateral Tarsal Plantar Desmitis	38	31.03±4.962	a	
	Geldings	No Tarsal Plantar Desmitis	2,476	25.24±0.542	a	0.032
		Unilateral Tarsal Plantar Desmitis	448	27.12±1.318	ab	
		Bilateral Tarsal Plantar Desmitis	224	29.78±1.875	b	

5.3.6.9 Effect of Tarsal Plantar Desmitis on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.6.10 Effect of Tarsal Plantar Desmitis on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

There was no significant difference in the NH win or place strike rates or Irish Point-to-Point win or place strike rates for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.6.11 Effect of Tarsal Plantar Desmitis on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without tarsal plantar desmitis, with unilateral tarsal plantar desmitis or with bilateral tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.6.12 Effect of Tarsal Plantar Desmitis on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. There was no significant difference in the win strike rates at ages four, six, seven or up to age eight years or in the place strike rates at ages five, six, seven, eight or up to age eight years (data not shown, see Appendix 13, Table A.22). There was however, a significant difference in the win strike rates at ages five and eight amongst mares ($P < 0.05$). Mares with unilateral tarsal plantar desmitis had a significantly lower proportion of wins at age five years (see Table 5.30) and a significantly higher proportion of wins at age eight years than those without tarsal plantar desmitis or bilateral tarsal plantar desmitis, while there was no significant difference between mares without tarsal plantar desmitis and those with bilateral tarsal plantar desmitis. There was no significant difference amongst geldings or amongst mares and geldings combined. Geldings with bilateral tarsal plantar desmitis had significantly higher place strike rates at age four years than those without tarsal plantar desmitis or those with unilateral tarsal plantar desmitis ($P < 0.05$). There was no significant difference within mares or when all horses were analysed together.

Table 5.30: Win and Place Strike Rate at Various Ages for Horses without Tarsal Plantar Desmitis, with Unilateral Tarsal Plantar Desmitis or with Bilateral Tarsal Plantar Desmitis

Means with the same letter are not significantly different from each other

Variable	*Group*	*Tarsal Plantar Desmitis*	*n*	*Mean±S.E.(%)*		*Sig.*
Places at Age 4 Years Strike Rate	All Horses	No Tarsal Plantar Desmitis	788	13.91±0.945	a	0.088
		Unilateral Tarsal Plantar Desmitis	126	11.71±2.214	a	
		Bilateral Tarsal Plantar Desmitis	56	21.13±4.672	a	
	Mares	No Tarsal Plantar Desmitis	186	9.99±1.556	a	0.091
		Unilateral Tarsal Plantar Desmitis	18	20.24±8.039	a	
		Bilateral Tarsal Plantar Desmitis	6	0.00±0.000	a	
	Geldings	No Tarsal Plantar Desmitis	601	15.14±1.138	a	0.019
		Unilateral Tarsal Plantar Desmitis	108	10.29±2.199	a	
		Bilateral Tarsal Plantar Desmitis	50	23.67±5.120	b	
Wins at Age 5 Years Strike Rate	All Horses	No Tarsal Plantar Desmitis	2,473	7.91±0.385	a	0.651
		Unilateral Tarsal Plantar Desmitis	383	7.93±0.997	a	
		Bilateral Tarsal Plantar Desmitis	194	9.24±1.604	a	
	Mares	No Tarsal Plantar Desmitis	651	4.85±0.557	a	0.021
		Unilateral Tarsal Plantar Desmitis	67	0.63±0.372	b	
		Bilateral Tarsal Plantar Desmitis	26	8.20±2.893	a	
	Geldings	No Tarsal Plantar Desmitis	1,820	9.00±0.481	a	0.905
		Unilateral Tarsal Plantar Desmitis	315	9.50±1.191	a	
		Bilateral Tarsal Plantar Desmitis	168	9.40±1.799	a	
Wins at Age 8 Years Strike Rate	All Horses	No Tarsal Plantar Desmitis	1,218	8.27±0.499	a	0.298
		Unilateral Tarsal Plantar Desmitis	192	9.58±1.782	a	
		Bilateral Tarsal Plantar Desmitis	95	6.00±1.520	a	
	Mares	No Tarsal Plantar Desmitis	188	6.18±1.000	a	0.032
		Unilateral Tarsal Plantar Desmitis	14	20.66±17.752	b	
		Bilateral Tarsal Plantar Desmitis	8	0.00±0.000	a	
	Geldings	No Tarsal Plantar Desmitis	1,029	8.63±0.561	a	0.579
		Unilateral Tarsal Plantar Desmitis	177	8.53±1.344	a	
		Bilateral Tarsal Plantar Desmitis	87	6.55±1.647	a	

5.3.6.13 Effect of Tarsal Plantar Desmitis on the Number of Wins and Places up to Age Eight Years

There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with tarsal plantar desmitis (data not shown, see Appendix 13, Table A.22).

5.3.7 Effect of Calcaneal Bursitis on Racing Performance

Within the 5,282 horses in the sample, 221 horses or 4.2% had calcaneal bursitis. All 5,282 horses were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.7.1 Effect of Calcaneal Bursitis on Racing Status

There was no significant difference between the proportions of horses without and with calcaneal bursitis that raced, raced by four or raced by five (data not shown, see Appendix 14, Table A.23).

5.3.7.2 Effect of Calcaneal Bursitis on Winning Status

There was no significant difference between the proportions of horses without and with calcaneal bursitis that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see Appendix 14, Table A.23).

5.3.7.3 Effect of Calcaneal Bursitis on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.24).

5.3.7.4 Effect of Calcaneal Bursitis on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26).

5.3.7.5 Effect of Calcaneal Bursitis on the Mean Number of Starts per Year Raced

There was no significant difference in the mean number of starts, NH starts, hurdle starts, steeplechase starts or Irish Point-to-Point starts per year raced for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26).

5.3.7.6 Effect of Calcaneal Bursitis on the Number of Starts at Various Ages

There was no significant difference in the number of starts at ages four, five, six, seven, eight and up to age eight years for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26).

5.3.7.7 Effect of Calcaneal Bursitis on Career Length

There were no significant differences in the career lengths of horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.25).

5.3.7.8 Effect of Calcaneal Bursitis on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26).

5.3.7.9 Effect of Calcaneal Bursitis on the Win and Place Strike Rates

In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. There was no significant difference in the win strike rates or the place strike rates for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26). There was however a significant difference in the third place strike rates within mares. Mares without calcaneal bursitis had a higher third place strike rate percent than mares with calcaneal bursitis, 5.26%±0.306 and 3.07%±0.623 respectively (Table 5.31). There was no significant difference for all horses or within geldings.

Table 5.31: Win and Place Strike Rates for Horses without and with Calcaneal Bursitis

Variable	*Group*	*Calcaneal Bursitis*	*n*	*Mean ± S.E. (%)*	*t-value*	*Sig.*
Third Place Strike Rate	All Horses	No	4,012	5.97±0.150	-0.973	0.331
		Yes	171	5.25±0.776		
	Mares	No	962	5.26±0.306	-3.165	0.002
		Yes	68	3.07±0.623		
	Geldings	No	3,045	6.19±0.172	0.518	0.605
		Yes	103	6.69±1.202		

5.3.7.10 Effect of Calcaneal Bursitis on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. There was no significant difference in the NH win (Table 5.32) or place strike rates or Irish Point-to-Point win or place strike rates for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26). Within mares however, those without calcaneal bursitis had significantly higher NH win strike rates than those with calcaneal bursitis ($P < 0.05$).

Table 5.32: NH Win Strike Rates for Horses without and with Calcaneal Bursitis

Variable	*Group*	*Calcaneal Bursitis*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Win Strike Rate	All Horses	No	3,304	12.33±0.275	-1.676	0.096
		Yes	136	10.44±1.093		
	Mares	No	746	9.21±0.540	-2.161	0.034
		Yes	53	6.27±1.252		
	Geldings	No	2,555	13.23±0.316	-0.072	0.943
		Yes	83	13.10±1.538		

5.3.7.11 Effect of Calcaneal Bursitis on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26).

5.3.7.12 Effect of Calcaneal Bursitis on the Win and Place Strike Rate at Various Ages

There was no significant difference in the number of starts for horses without and with calcaneal bursitis (data not shown, see Appendix 14, Table A.26) however, there was a significant difference in the win and place strike rates at various ages ($P < 0.05$). Only horses that raced at the relevant age were included in the analysis for wins and places at that age. Horses without calcaneal bursitis had significantly higher place strike rates at age six years than those with calcaneal bursitis ($P < 0.05$), with 15.33%$\pm$0.426 places compared to 11.06%$\pm$1.570 places. There was no significant difference within geldings however, similar results were found within mares. Mares without calcaneal bursitis also had significantly higher place strike rates at ages four and eight than those with calcaneal bursitis ($P < 0.001$), however, there was no significant difference within geldings or when all horses were analysed together (Table 5.33).

Table 5.33: Win and Place Strike Rate at Various Ages for Horses without and with Calcaneal Bursitis

Variable	*Group*	*Calcaneal Bursitis*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Places at Age 4 Years Strike Rate	All Horses	No	936	14.16±0.884	-0.750	0.454
		Yes	34	10.64±4.068		
	Mares	No	198	11.14±1.634	-4.548	<0.001
		Yes	12	1.39±1.389		
	Geldings	No	737	14.99±1.031	0.114	0.909
		Yes	22	15.68±6.017		
Places at Age 6 Years Strike Rate	All Horses	No	2,822	15.33±0.426	-2.624	0.010
		Yes	119	11.06±1.570		
	Mares	No	602	12.88±0.866	-2.914	0.005
		Yes	45	7.13±1.771		
	Geldings	No	2,215	15.96±0.487	-0.931	0.352
		Yes	74	13.46±2.247		
Places at Age 8 Years Strike Rate	All Horses	No	1,453	15.44±0.564	0.704	0.482
		Yes	52	17.58±3.128		
	Mares	No	198	14.29±1.453	-5.376	<0.001
		Yes	12	2.45±1.659		
	Geldings	No	1,253	15.60±0.613	1.869	0.062
		Yes	40	22.13±3.755		

5.3.7.13 Effect of Calcaneal Bursitis on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. There was no significant difference in the number of wins up to age eight years between horses without or with calcaneal bursitis (data not shown, see Appendix 14, Table A.26). There was also no significant difference in the number of places up to age eight years between horses without or with calcaneal bursitis. However, mares without calcaneal bursitis had significantly more places up to age eight years ($P < 0.05$) than those with calcaneal bursitis, see Table 5.34 below. There was no significant difference within geldings.

Table 5.34: Number of Wins and Places up to Age Eight Years for Horses without and with Calcaneal Bursitis

Variable	*Group*	*Calcaneal Bursitis*	*n*	*Mean $\pm$ S.E.*	*t-value*	*Sig.*
Places up to Age 8 Years	All Horses	No	4,012	1.74$\pm$0.039	-1.110	0.267
		Yes	171	1.53$\pm$0.153		
	Mares	No	962	1.21$\pm$0.064	-2.247	0.027
		Yes	68	0.85$\pm$0.146		
	Geldings	No	3,045	1.90$\pm$0.046	0.268	0.789
		Yes	103	1.97$\pm$0.224		

5.3.8 Effect of SDDTS on Racing Performance

SDDTS were present in 213 horses or 4.0% of the sample while the remaining 5,069 horses were free from SDDTS. All 5,282 horses were examined to determine the proportion of horses that were raced or not raced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.8.1 Effect of SDDTS on Racing Status

There was no significant difference between the proportions of horses without and with SDDTS that raced, raced by four or raced by five (data not shown, see Appendix 15, Table A.27).

5.3.8.2 Effect of SDDTS on Winning Status

There was no significant difference between the proportions of horses without and with SDDTS that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see Appendix 15, Table A.27).

5.3.8.3 Effect of SDDTS on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with SDDTS (data not shown, see Appendix 15, Table A.28).

5.3.8.4 Effect of SDDTS on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with SDDTS (data not shown, see Appendix 15, Table A.30).

5.3.8.5 Effect of SDDTS on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference in the mean number of overall starts, NH starts, steeplechase starts or Irish Point-to-Point starts per year raced for horses without and with SDDTS (data not shown, see Appendix 15, Table A.30). There was however, a significant difference in the mean number of hurdle starts per year raced for geldings ($P < 0.05$). Geldings without SDDTS had 1.73±0.03 hurdle starts per year raced which was significantly more than the mean number for geldings with SDDTS, 1.37±0.12.

Table 5.35: Mean Number of Hurdle Starts per Year Raced for Horses without and with SDDTS

Variable	*Group*	*SDDTS*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Hurdle Starts per Year Raced	All Horses	No	4,022	1.80±0.025	-1.896	0.058
		Yes	161	1.56±0.113		
	Mares	No	977	2.01±0.058	-0.253	0.800
		Yes	53	1.95±0.241		
	Geldings	No	3,040	1.73±0.027	-3.027	0.003
		Yes	108	1.37±0.116		

5.3.8.6 Effect of SDDTS on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Horses without SDDTS had significantly more starts at age five years than those with SDDTS, 2.47±0.04 compared to 2.07±0.16 ($P < 0.05$). Geldings showed a similar result while mares showed no significant difference (Table 5.36).

Table 5.36: Number of Starts at Age five years for Horses without and with SDDTS

Variable	*Group*	*SDDTS*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 5 Years	All Horses	No	4,022	2.47±0.039	-2.381	0.018
		Yes	161	2.07±0.163		
	Mares	No	977	2.51±0.082	-0.223	0.824
		Yes	53	2.43±0.305		
	Geldings	No	3,040	2.46±0.044	-2.881	0.005
		Yes	108	1.90±0.190		

5.3.8.7 Effect of SDDTS on Career Length

There were no significant differences in the career lengths of horses without and with SDDTS (data not shown, see Appendix 15, Table A.29).

5.3.8.8 Effect of SDDTS on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start for horses without and with SDDTS (data not shown, see Appendix 15, Table A.30).

5.3.8.9 Effect of SDDTS on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. There was no significant difference in the win strike rates or place strike rates for horses without and with SDDTS. There was however a significant difference within mares. Surprisingly, mares with SDDTS had significantly higher place strike rates, third place strike rates and overall win and place strike rates than mares without SDDTS ($P < 0.05$).

Table 5.37: Place Strike Rates for Horses without and with SDDTS

Variable	*Group*	*SDDTS*	*n*	*Mean ± S.E. (%)*	*t-value*	*Sig.*
Place Strike Rate	All Horses	No	4,022	13.29±0.256	1.404	0.162
		Yes	161	15.30±1.408		
	Mares	No	977	10.14±0.472	2.402	0.020
		Yes	53	17.15±2.884		
	Geldings	No	3,040	14.30±0.301	0.057	0.954
		Yes	108	14.39±1.554		
Third Place Strike Rate	All Horses	No	4,022	5.92±0.150	0.867	0.386
		Yes	161	6.58±0.801		
	Mares	No	977	4.93±0.289	2.038	0.046
		Yes	53	8.52±1.736		
	Geldings	No	3,040	6.23±0.174	-0.641	0.521
		Yes	108	5.62±0.827		
Overall Win and Place Strike Rate	All Horses	No	4,022	20.07±0.347	0.695	0.487
		Yes	161	21.29±1.774		
	Mares	No	977	14.30±0.613	2.154	0.036
		Yes	53	21.32±3.203		
	Geldings	No	3,040	21.91±0.408	-0.284	0.776
		Yes	108	21.28±2.138		

5.3.8.10 Effect of SDDTS on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. There was no significant difference in the mean number of NH win or place strike rates or Irish Point-to-Point place strike rates for horses without and with SDDTS (data not shown, see Appendix 15, Table A.30). Horses without SDDTS did however have significantly higher Irish Point-to-Point win strike rates than horses with SDDTS, 11.83%±0.528 compared to 7.43%±2.048 (Table 5.38). Similar results were observed within mares however, there was no significant difference within geldings.

Table 5.38: Irish Point-to-Point Win Strike Rates for Horses without and with SDDTS

Variable	*Group*	*SDDTS*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Irish Point-to-Point Win Strike Rate	All Horses	No	1,878	11.83±0.528	-2.080	0.040
		Yes	77	7.43±2.048		
	Mares	No	458	8.99±0.893	-4.327	<0.001
		Yes	25	2.33±1.252		
	Geldings	No	1,417	12.74±0.635	-0.849	0.396
		Yes	52	9.88±2.922		

5.3.8.11 Effect of SDDTS on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with SDDTS (data not shown, see Appendix 15, Table A.30).

5.3.8.12 Effect of SDDTS on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. There was no significant difference in the win strike rates at any age for horses with or without SDDTS (data not shown, see Appendix 15, Table A.30). There was also no significant difference in the place strike rates at any age for horses without or with SDDTS, however, mares with SDDTS had significantly higher place strike rates at ages six and up to age eight years ($P < 0.05$) than those without SDDTS (Table 5.39). There was no significant difference overall or within geldings.

Table 5.39: Win and Place Strike Rate at Various Ages for Horses without and with SDDTS

Variable	*Group*	*SDDTS*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Places at Age 6 Years Strike Rate	All Horses	No	2,828	15.01±0.421	1.845	0.065
		Yes	113	18.98±2.315		
	Mares	No	613	11.94±0.817	2.133	0.040
		Yes	34	22.19±4.734		
	Geldings	No	2,210	15.82±0.485	0.682	0.495
		Yes	79	17.60±2.615		
Places up to Age 8 Years Strike Rate	All Horses	No	4,022	12.11±0.245	1.259	0.210
		Yes	161	13.81±1.329		
	Mares	No	977	9.73±0.462	2.383	0.021
		Yes	53	16.48±2.800		
	Geldings	No	3,040	12.87±0.286	-0.243	0.808
		Yes	108	12.50±1.422		

5.3.8.13 Effect of SDDTS on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. There was no significant difference in the number of places up to age eight years for horses with or without SDDTS (data not shown, see Appendix 15, Table A.30). However, horses without SDDTS had significantly more wins up to age eight years (P < 0.05) than horses without SDDTS (Table 5.40). When analysed separately there was no significant difference within mares or within geldings.

Table 5.40: Number of Wins up to Age Eight Years for Horses without and with SDDTS

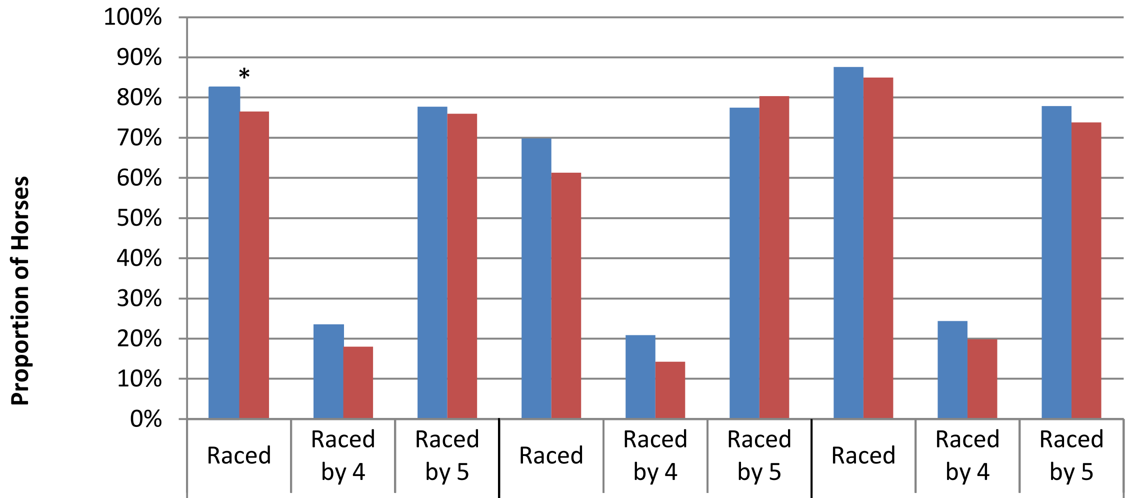
Variable	*Group*	*SDDTS*	*n*	*Mean $\pm$ S.E.*	*t-value*	*Sig.*
Wins up to Age 8 Years	All Horses	No	4,022	0.91$\pm$0.025	-2.451	0.015
		Yes	161	0.66$\pm$0.095		
	Mares	No	977	0.49$\pm$0.034	-0.650	0.516
		Yes	53	0.40$\pm$0.109		
	Geldings	No	3,040	1.04$\pm$0.031	-1.803	0.074
		Yes	108	0.80$\pm$0.130		

5.3.9 Effect of Hoof Cracks on Racing Performance

Within the 5,282 horses in the sample, 260 horses or 4.9% had hoof cracks. All 5,282 horses were examined to determine the proportion of horses raced or unraced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to lack of data, were excluded from further analysis.

5.3.9.1 Effect of Hoof Cracks on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was a significant difference between the proportions of horses without and with hoof cracks that raced ($\chi^2 = 2.043$, df = 1, P = 0.153); horses without hoof cracks were significantly more likely to race than those with hoof cracks. There was no significant difference between the proportions of horses without hoof cracks and with hoof cracks that raced by four ($\chi^2 = 0.027$, df = 1, P = 0.871) or raced by five ($\chi^2 = 0.064$, df = 1, P = 0.800). There was no significant difference between mares without hoof cracks and with hoof cracks that raced ($\chi^2 = 4.638$, df = 1, P = 0.031), raced by four ($\chi^2 = 1.087$, df = 1, P = 0.297) or raced by five ($\chi^2 = 0.046$, df = 1, P = 0.830). There was no significant difference between the proportions of geldings without hoof cracks or with hoof cracks that raced ($\chi^2 = 0.340$, df = 1, P = 0.560), raced by four ($\chi^2 = 0.371$, df = 1, P = 0.543) or raced by five ($\chi^2 = 0.091$, df = 1, P = 0.763).



	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
	All Horses			Mares			Geldings		
No Hoof Crack	82.5%	23.5%	77.8%	69.8%	20.8%	77.5%	87.6%	24.4%	77.9%
Hoof Crack	76.5%	18.0%	76.0%	61.3%	14.3%	80.4%	84.9%	19.8%	73.8%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.18: Proportion of Horses without and with Hoof Cracks that Raced

5.3.9.2 Effect of Hoof Cracks on Winning Status

There was no significant difference between the proportions of horses without and with hoof cracks that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see Appendix 16, Table A.31).

5.3.9.3 Effect of Hoof Cracks on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.32).

5.3.9.4 Effect of Hoof Cracks on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.9.5 Effect of Hoof Cracks on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference in the mean number of overall starts, NH starts, hurdle starts or Irish Point-to-Point starts per year raced for horses without or with hoof cracks. Within mares, those with hoof cracks had significantly fewer steeplechase starts per year raced (0.15±0.06) than those without hoof cracks (0.29±0.03) ($P < 0.05$). There was no significant difference in overall horses or within geldings.

Table 5.41: Mean Number of Steeplechase Starts per Year Raced for Horses without and with Hoof Cracks

Variable	*Group*	*Hoof Crack*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	4,000	0.74±0.020	-0.243	0.808
		Yes	183	0.71±0.088		
	Mares	No	974	0.29±0.027	-2.237	0.028
		Yes	56	0.15±0.055		
	Geldings	No	3,022	0.88±0.024	0.514	0.608
		Yes	126	0.95±0.117		

5.3.9.6 Effect of Hoof Cracks on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Horses with hoof cracks had significantly fewer starts at age four years than those without hoof cracks ($P < 0.05$). Similar results were observed within geldings however, there was no significant difference within mares. There was no significant difference in the number of starts at ages five, six, seven, eight or up to age eight years for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

Table 5.42: Number of Starts at Various Ages for Horses without and with Hoof Cracks

Variable	*Group*	*Hoof Crack*	*n*	*Mean $\pm$ S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	4,000	0.58$\pm$0.021	-2.172	0.031
		Yes	183	0.40$\pm$0.079		
	Mares	No	974	0.53$\pm$0.044	-0.170	0.865
		Yes	56	0.50$\pm$0.192		
	Geldings	No	3,022	0.60$\pm$0.025	-2.883	0.005
		Yes	126	0.37$\pm$0.077		

5.3.9.7 Effect of Hoof Cracks on Career Length

There were no significant differences in the career lengths of horses without and with hoof cracks (data not shown, see Appendix 16, Table A.33).

5.3.9.8 Effect of Hoof Cracks on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.9.9 Effect of Hoof Cracks on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.9.10 Effect of Hoof Cracks on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

There was no significant difference in the NH win or place strike rates or Irish Point-to-Point win or place strike rates for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.9.11 Effect of Hoof Cracks on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.9.12 Effect of Hoof Cracks on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. There was no significant difference in the win strike rates at ages four, five, six, eight or up to age eight years or in the place strike rates at any age for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34). There was however, a significant difference in the win strike rates at age seven years within mares. Mares without hoof cracks had significantly higher win strike rates at age seven years than mares with hoof cracks ($P < 0.001$). There was no significant difference within geldings or when all horses were analysed together.

Table 5.43: Win and Place Strike Rate at Various Ages for Horses without and with Hoof Cracks

Variable	*Group*	*Hoof Crack*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 7 Years Strike Rate	All Horses	No	2,073	8.50±0.395	-1.251	0.211
		Yes	96	6.16±1.617		
	Mares	No	371	4.78±0.716	-5.264	<0.001
		Yes	24	0.42±0.417		
	Geldings	No	1,701	9.29±0.452	-0.697	0.486
		Yes	71	7.72±2.107		

5.3.9.13 Effect of Hoof Cracks on the Number of Wins and Places up to Age Eight Years

There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with hoof cracks (data not shown, see Appendix 16, Table A.34).

5.3.10 Effect of Cardiac Defects on Racing Performance

Cardiac defects were present in 76 horses or 1.4% of the sample while the remaining 5,206 horses were free from cardiac defects. All 5,282 horses were examined to determine the proportion of horses that were raced or not raced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only

British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.10.1 Effect of Cardiac Defects on Racing Status

There was no significant difference between the proportions of horses without and with cardiac defects that raced, raced by four or raced by five (data not shown, see Appendix 17, Table A.35).

5.3.10.2 Effect of Cardiac Defects on Winning Status

There was no significant difference between the proportions of horses without and with cardiac defects that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see Appendix 17, Table A.35).

5.3.10.3 Effect of Cardiac Defects on Type of Racing Career

There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with cardiac defects (data not shown, see Appendix 17, Table A.36).

5.3.10.4 Effect of Cardiac Defects on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with cardiac defects (data not shown, see Appendix 17, Table A.38).

5.3.10.5 Effect of Cardiac Defects on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48 ± 1.821, with horses participating in significantly more hurdle races than any other type of race (1.79 ± 1.565), followed by Irish Point-to-Points (0.91 ± 1.376) and then steeplechase races (0.74 ± 1.249). There was no significant difference in the mean number of overall starts or Irish Point-to-Point starts (data not shown, see Appendix 17, Table A.38) however, within mares there was a significant difference in the mean number of NH starts for mares without and with cardiac defects. Surprisingly, mares with cardiac defects had significantly more NH starts per year raced than those without cardiac defects ($P < 0.05$). There was no significant difference amongst all horses or amongst geldings (Table 5.44 below).

Table 5.44: Mean Number of NH Starts per Year Raced for Horses without and with Cardiac Defects

Variable	*Group*	*Cardiac Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of NH Starts per Year Raced	All Horses	No	4,127	2.52±0.032	1.828	0.068
		Yes	56	3.02±0.321		
	Mares	No	1,021	2.27±0.064	2.144	0.032
		Yes	9	3.74±0.825		
	Geldings	No	3,101	2.60±0.036	0.940	0.348
		Yes	47	2.88±0.349		

5.3.10.6 Effect of Cardiac Defects on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Mares without cardiac defects were found to have significantly more starts at age four years (0.53±0.04) than mares with cardiac defects (0.00±0.00) ($P < 0.001$). However, there were only a small number of affected horses (9). There was no significant difference observed in all horses or within geldings. There was no significant difference in the number of starts at any other age up to age eight years for horses without or with cardiac defects (data not shown, see Appendix 17, Table A.38).

Table 5.45: Number of Starts at Age four years for Horses without and with Cardiac Defects

Variable	*Group*	*Cardiac Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	4,127	0.58±0.021	-1.996	0.051
		Yes	56	0.34±0.118		
	Mares	No	1,021	0.53±0.043	-12.481	<0.001
		Yes	9	0.00±0.000		
	Geldings	No	3,101	0.59±0.024	-0.952	0.341
		Yes	47	0.40±0.138		

5.3.10.7 Effect of Cardiac Defects on Career Length

There were no significant differences in the career lengths of horses without and with cardiac defects (data not shown, see Appendix 17, Table A.37).

5.3.10.8 Effect of Cardiac Defects on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was no significant difference in the proportions of non-finished races per start for horses without and with cardiac defects. There was no significant difference within geldings; however, there was a significant difference within mares ($P < 0.05$). Curiously, mares without cardiac defects had a significantly higher proportion of non-finished races per start than those with cardiac defects (Table 5.46).

Table 5.46: Mean Proportion of Non-Finished Races per Start for Horses without and with Cardiac Defects

Variable	*Group*	*Cardiac Defect*	*N*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	4,127	26.27±0.443	-0.396	0.692
		Yes	56	24.76±3.523		
	Mares	No	1,021	27.69±1.003	-4.062	0.002
		Yes	9	14.36±3.123		
	Geldings	No	3,101	25.81±0.489	0.233	0.816
		Yes	47	26.75±4.102		

5.3.10.9 Effect of Cardiac Defects on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. Horses without cardiac defects had significantly higher place strike rates, third place strike rates and overall win and place strike rates than horses without cardiac defects (Table 5.47). Similar results were observed within geldings; however, there was no difference within mares.

Table 5.47: Place Strike Rates for Horses without and with Cardiac Defects

Variable	*Group*	*Cardiac Defect*	*n*	*Mean ± S.E. (%)*	*t-value*	*Sig.*
Place Strike Rate	All Horses	No	4,127	13.42±0.255	-2.431	0.018
		Yes	56	9.60±1.549		
	Mares	No	1,021	10.48±0.477	0.337	0.737
		Yes	9	12.19±3.861		
	Geldings	No	3,101	14.38±0.298	-3.055	0.004
		Yes	47	9.11±1.700		
Third Place Strike Rate	All Horses	No	4,127	5.97±0.149	-3.366	0.001
		Yes	56	3.54±0.707		
	Mares	No	1,021	5.11±0.291	0.490	0.624
		Yes	9	6.63±2.913		
	Geldings	No	3,101	6.26±0.173	-5.151	<0.001
		Yes	47	2.95±0.618		
Overall Strike Rate	All Horses	No	4,127	20.18±0.343	-2.185	0.033
		Yes	56	14.77±2.454		
	Mares	No	1,021	14.65±0.610	0.251	0.802
		Yes	9	16.28±5.205		
	Geldings	No	3,101	22.00±0.404	-2.276	0.023
		Yes	47	14.48±2.769		

5.3.10.10 Effect of Cardiac Defects on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

There was no significant difference in the NH win or place strike rates or Irish Point-to-Point win or place strike rates for horses without and with cardiac defects (data not shown, see Appendix 17, Table A.38).

5.3.10.11 Effect of Cardiac Defects on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with cardiac defects (data not shown, see Appendix 17, Table A.38).

5.3.10.12 Effect of Cardiac Defects on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. Horses without cardiac defects had significantly higher win strike rates at ages five and six and significantly higher place strike rates at ages five, seven and up to age eight years than those with cardiac defects ($P < 0.05$). Geldings showed similar results however, there was no significant difference amongst mares as shown in Table 5.48 below. There was no significant difference in the win or place strike rates at ages four or eight (data not shown, see Appendix 17, Table A.38).

Table 5.48: Win and Place Strike Rate at Various Ages for Horses without and with Cardiac Defects

Variable	*Group*	*Cardiac Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No	3,005	8.05±0.356	-2.187	0.034
		Yes	45	4.32±1.669		
	Mares	No	737	4.59±0.505	-0.197	0.844
		Yes	7	3.57±3.571		
	Geldings	No	2,265	9.17±0.440	-2.442	0.019
		Yes	38	4.45±1.881		
Places at Age 5 Years Strike Rate	All Horses	No	3,005	13.96±0.434	-2.159	0.036
		Yes	45	8.76±2.367		
	Mares	No	737	9.54±0.669	0.378	0.706
		Yes	7	12.14±6.158		
	Geldings	No	2,265	15.40±0.530	-2.752	0.009
		Yes	38	8.14±2.586		
Wins at Age 6 Years Strike Rate	All Horses	No	2,900	8.61±0.337	-3.786	<0.001
		Yes	41	3.32±1.356		
	Mares	No	639	5.79±0.587	-0.209	0.834
		Yes	8	4.69±3.288		
	Geldings	No	2,256	9.43±0.399	-4.136	<0.001
		Yes	33	2.99±1.505		
Places at Age 7 Years Strike Rate	All Horses	No	2,138	15.70±0.497	-2.269	0.030
		Yes	31	9.67±2.611		
	Mares	No	391	14.23±1.133	-0.059	0.953
		Yes	4	13.57±9.431		
	Geldings	No	1,745	16.00±0.553	-2.486	0.019
		Yes	27	9.09±2.722		
Places up to Age 8 Years Strike Rate	All Horses	No	4,127	12.22±0.243	-2.549	0.013
		Yes	56	8.60±1.399		
	Mares	No	1,021	10.06±0.466	0.429	0.668
		Yes	9	12.19±3.861		
	Geldings	No	3,101	12.93±0.284	-3.303	0.002
		Yes	47	7.92±1.492		

5.3.10.13 Effect of Cardiac Defects on the Number of Wins and Places up to Age Eight Years

There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with cardiac defects (data not shown, see Appendix 17, Table A.38).

5.3.11 Effect of Sarcoids on Racing Performance

Sarcoids were present in 4.6% of the sample or 243 horses while the remaining 5,039 horses were free from sarcoids. All 5,282 horses were examined to determine the proportion of horses that were raced or not raced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.11.1 Effect of Sarcoids on Racing Status

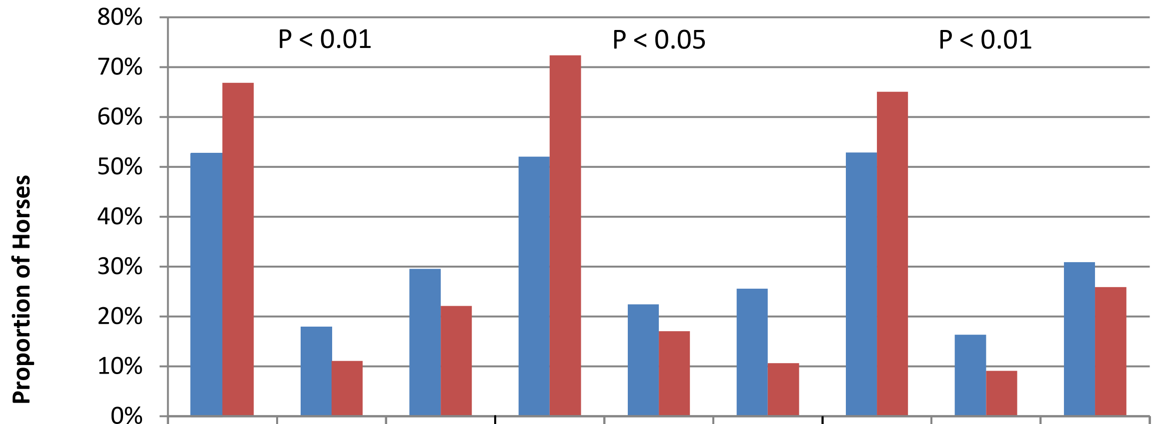
There was no significant difference between the proportions of horses without and with sarcoids that raced, raced by four or raced by five (data not shown, see Appendix 18, Table A.39).

5.3.11.2 Effect of Sarcoids on Winning Status

There was no significant difference between the proportions of horses without and with sarcoids that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see Appendix 18, Table A.39).

5.3.11.3 Effect of Sarcoids on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses without and with sarcoids ($\chi^2 = 15.081$, df = 2, P = 0.001). A higher proportion of horses with sarcoids raced in only NH races than horses without sarcoids, while a higher proportion of horses without sarcoids raced in only Irish Point-to-Point races or in a combination of NH and Irish Point-to-Point races than horses with sarcoids (Figure 5.19). Similar results were observed within both mares ($\chi^2 = 8.092$, df = 2, P = 0.017) and geldings ($\chi^2 = 9.367$, df = 2, P = 0.009).



	All Horses			Mares			Geldings		
	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P
No Sarcoid	52.6%	17.8%	29.5%	52.0%	22.4%	25.6%	52.8%	16.3%	30.8%
Sarcoid	66.8%	11.1%	22.1%	72.3%	17.0%	10.6%	65.0%	9.1%	25.9%

Figure 5.19: Proportion of Horses without and with Sarcoids that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.11.4 Effect of Sarcoids on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with sarcoids (data not shown, see Appendix 18, Table A.41).

5.3.11.5 Effect of Sarcoids on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48$\pm$1.821, with horses participating in significantly more hurdle races than any other type of race (1.79$\pm$1.565), followed by Irish Point-to-Points (0.91$\pm$1.376) and then steeplechase races (0.74$\pm$1.249). Horses without sarcoids had a higher mean number of Irish Point-to-Point starts per year raced (0.93$\pm$0.02) than horses with sarcoids (0.54$\pm$0.08) ($P < 0.05$). Similar results were observed within mares and geldings. There was no significant difference in the mean number of overall starts per year raced or the mean number of NH starts per year raced for horses without or with sarcoids (data not shown, see Appendix 18, Table A.41).

Table 5.49: Mean Number of Irish Point-to-Point Starts per Year Raced for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	3,993	0.93±0.022	-4.802	<0.001
		Yes	190	0.54±0.078		
	Mares	No	982	1.10±0.051	-3.231	0.002
		Yes	48	0.54±0.163		
	Geldings	No	3,006	0.87±0.024	-3.638	<0.001
		Yes	142	0.54±0.089		

5.3.11.6 Effect of Sarcoids on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Horses without sarcoids had significantly more starts at age four years (0.58±0.02) than horses with sarcoids (0.39±0.08) ($P < 0.05$) however; there was no significant difference within mares or within geldings. There was no significant difference in the number of starts at any other age for horses with or without sarcoids (data not shown, see Appendix 18, Table A.41).

Table 5.50: Number of Starts at Age Four Years for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	3,993	0.58±0.021	-2.275	0.024
		Yes	190	0.39±0.080		
	Mares	No	982	0.54±0.044	-0.915	0.360
		Yes	48	0.35±0.144		
	Geldings	No	3,006	0.60±0.025	-1.915	0.057
		Yes	142	0.41±0.095		

5.3.11.7 Effect of Sarcoids on Career Length

There were no significant differences in the career lengths of horses without and with sarcoids (data not shown, see Appendix 18, Table A.40).

5.3.11.8 Effect of Sarcoids on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. There was a significant difference in the proportions of non-finished races per start for horses without and with sarcoids ($P < 0.001$). Interestingly, horses without sarcoids had a significantly higher proportion of non-finished races per start than horses with sarcoids, 26.58%±0.452 compared to 19.44%±1.805. Similar results were observed for mares and for geldings.

Table 5.51: Mean Proportion of Non-Finished Races per Start for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	3,993	26.58±0.452	-3.835	<0.001
		Yes	190	19.44±1.805		
	Mares	No	982	27.85±1.021	-1.260	0.208
		Yes	48	21.90±4.370		
	Geldings	No	3,006	26.17±0.499	-3.817	<0.001
		Yes	142	18.61±1.916		

5.3.11.9 Effect of Sarcoids on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. Surprisingly, horses with sarcoids had significantly higher win strike rates and overall win and place strike rates than horses without sarcoids, as shown in Table 5.52 below. Similar results were found within geldings however, there was no significant difference within mares.

Table 5.52: Win and Place Strike Rates for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean $\pm$ S.E. (%)*	*t-value*	*Sig.*
Win Strike Rate	All Horses	No	3,993	6.62$\pm$0.181	2.399	0.017
		Yes	190	9.44$\pm$1.165		
	Mares	No	982	4.05$\pm$0.285	0.919	0.363
		Yes	48	6.40$\pm$2.539		
	Geldings	No	3,006	7.45$\pm$0.219	2.302	0.023
		Yes	142	10.47$\pm$1.295		
Overall Win and Place Strike Rate	All Horses	No	3,993	19.94$\pm$0.345	2.026	0.044
		Yes	190	23.74$\pm$1.841		
	Mares	No	982	14.53$\pm$0.610	0.737	0.465
		Yes	48	17.27$\pm$3.664		
	Geldings	No	3,006	21.69$\pm$0.407	1.971	0.051
		Yes	142	25.92$\pm$2.106		

5.3.11.10 Effect of Sarcoids on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Horses with sarcoids had significantly higher NH win strike rates than horses without sarcoids ($P < 0.05$). Similar results were observed for geldings however, although similar trends were observed for mares there was no significant difference (Table 5.53). There was no significant difference in the NH place strike rates or in the Irish Point-to-Point win or place strike rates for horses without and with sarcoids (data not shown, see Appendix 18, Table A.41).

Table 5.53: NH Win Strike Rates for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean$\pm$S.E.(%)*	*t-value*	*Sig.*
NH Win Strike Rate	All Horses	No	3,272	5.57$\pm$0.173	2.579	0.011
		Yes	168	8.70$\pm$1.201		
	Mares	No	760	3.07$\pm$0.276	1.357	0.183
		Yes	39	7.29$\pm$3.097		
	Geldings	No	2,509	6.33$\pm$0.207	2.199	0.030
		Yes	129	9.13$\pm$1.258		

5.3.11.11 Effect of Sarcoids on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with sarcoids (data not shown, see Appendix 18, Table A.41).

5.3.11.12 Effect of Sarcoids on the Win and Place Strike Rate at Various Ages

There was no significant difference in the win strike rates at ages four, five, seven and eight or in the place strike rates at any age for horses without and with sarcoids (data not shown, see Appendix 18, Table A.41). Interestingly, horses with sarcoids had significantly higher win strike rates at ages six and up to age eight years ($P < 0.05$) than horses without sarcoids (Table 5.54). Similar results were observed in geldings while there was no significant difference within mares.

Table 5.54: Win and Place Strike Rate at Various Ages for Horses without and with Sarcoids

Variable	*Group*	*Sarcoid*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 6 Years Strike Rate	All Horses	No	2,808	8.37±0.337	2.014	0.046
		Yes	133	12.16±1.852		
	Mares	No	620	5.66±0.578	0.998	0.319
		Yes	27	8.55±4.275		
	Geldings	No	2,183	9.16±0.400	1.873	0.064
		Yes	106	13.08±2.054		
Wins up to Age 8 Years Strike Rate	All Horses	No	3,993	5.85±0.162	2.409	0.017
		Yes	190	8.47±1.076		
	Mares	No	982	3.89±0.274	0.892	0.377
		Yes	48	6.12±2.489		
	Geldings	No	3,006	6.49±0.194	2.347	0.020
		Yes	142	9.27±1.166		

5.3.11.13 Effect of Sarcoids on the Number of Wins and Places up to Age Eight Years

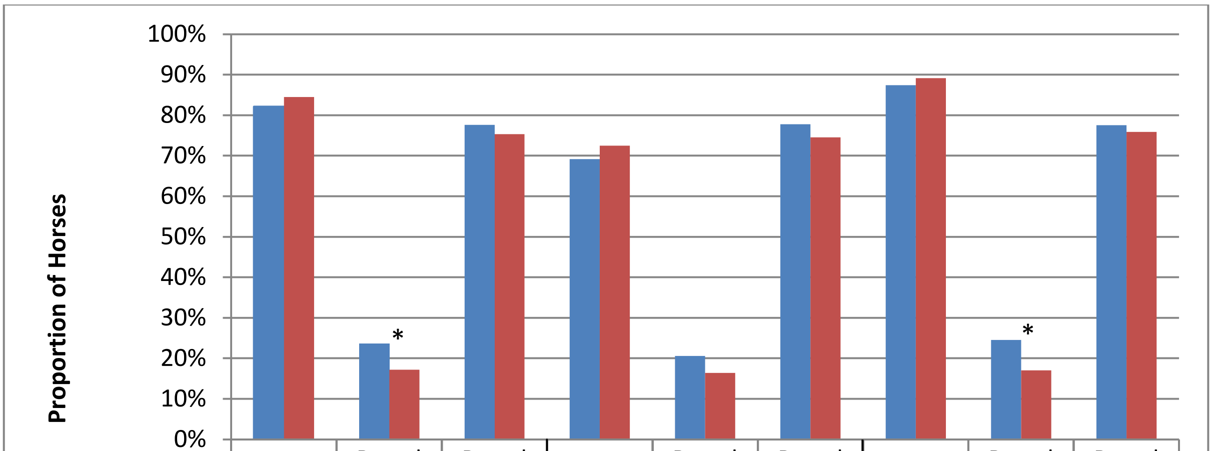
There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with sarcoids (data not shown, see Appendix 18, Table A.41).

5.3.12 Effect of Papillomas on Racing Performance

Papillomas were present in 5.4% of the sample or 284 horses while the remaining 4,998 horses were free from papillomas. All 5,282 horses were examined to determine the proportion of horses that were raced or not raced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis.

5.3.12.1 Effect of Papillomas on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was no significant difference between the proportions of horses without and with papillomas that raced ($\chi^2 = 1.055$, df = 1, P = 0.304) or raced by five ($\chi^2 = 0.621$, df = 1, P = 0.431). There was however, a significant difference in the proportions of horses without and with papillomas that raced by four ($\chi^2 = 4.900$, df = 1, P = 0.027). Horses with papillomas were less likely to race than those without papillomas. There was no significant difference between the proportions of mares without and with papillomas that raced ($\chi^2 = 0.404$, df = 1, P = 0.525), raced by four ($\chi^2 = 0.580$, df = 1, P = 0.446) or raced by five ($\chi^2 = 0.306$, df = 1, P = 0.580). There was also no significant difference between the proportions of geldings without and with papillomas that raced ($\chi^2 = 0.521$, df = 1, P = 0.470) or raced by five ($\chi^2 = 0.252$, df = 1, P = 0.616). There was however, a significant difference in the proportions of geldings without and with papillomas that raced by four ($\chi^2 = 4.924$, df = 1, P = 0.026). Geldings without papillomas were more likely to race than those with papillomas.



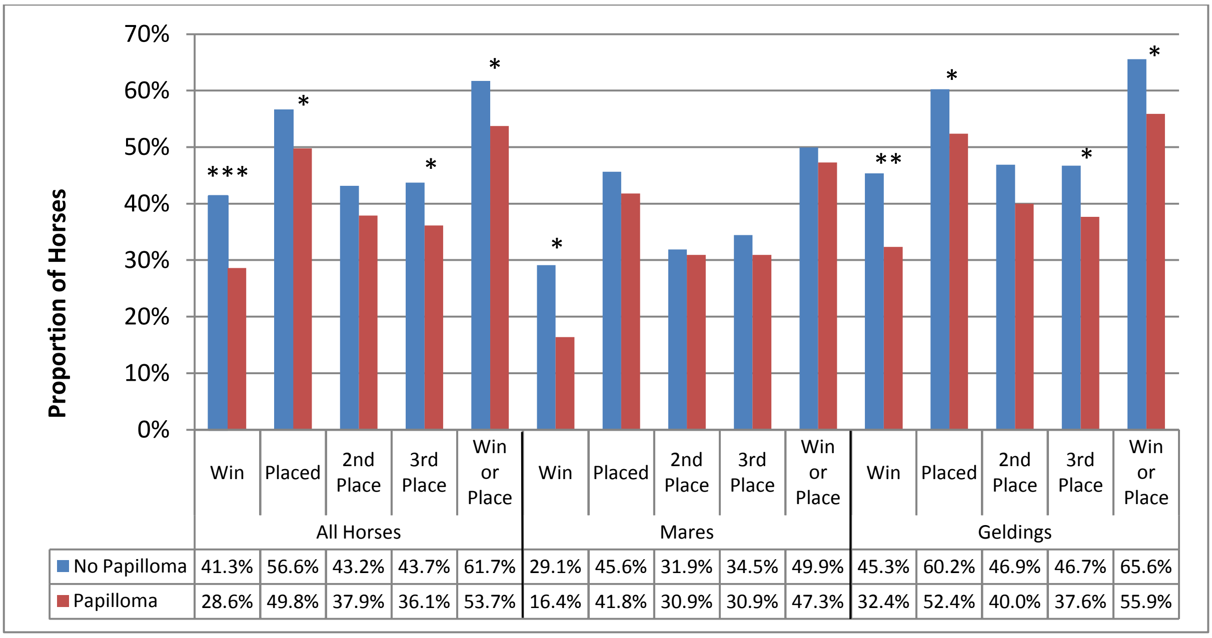
	All Horses			Mares			Geldings		
	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5	Raced	Raced by 4	Raced by 5
No Papilloma	82.1%	23.6%	77.6%	69.1%	20.6%	77.7%	87.4%	24.5%	77.5%
Papilloma	84.5%	17.2%	75.3%	72.5%	16.4%	74.5%	89.1%	17.1%	75.9%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.20: Proportion of Horses without and with Papillomas that Raced

5.3.12.2 Effect of Papillomas on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was a significant difference between the proportions of horses without and with papillomas that won a race (χ^2 = 14.343, df = 1, P < 0.001), placed in a race (χ^2 = 4.116, df = 1, P = 0.042), placed third (χ^2 = 5.027, df = 1, P = 0.025) or won or placed in a race (χ^2 = 5.769, df = 1, P = 0.016). Horses without papillomas performed significantly better for each of these variables. There was no significant difference in the proportions of horses without and with papillomas that were placed second (χ^2 = 2.452, df = 1, P = 0.117). A higher proportion of mares without papillomas won a race (χ^2 = 4.168, df = 1, P = 0.041) than those with papillomas, however, there was no significant difference between the proportions of horses that placed in a race (χ^2 = 0.307, df = 1, P = 0.580), placed second (χ^2 = 0.023, df = 1, P = 0.878), placed third (χ^2 = 0.292, df = 1, P = 0.589) or won or placed in a race (χ^2 = 0.149, df = 1, P = 0.699). Higher proportions of geldings without papillomas won a race (χ^2 = 10.964, df = 1, P = 0.001), were placed in a race (χ^2 = 4.164, df = 1, P = 0.041), placed third (χ^2 = 5.313, df = 1, P = 0.021) and won or placed in a race (χ^2 = 6.654, df = 1, P = 0.010) than geldings with papillomas. There was no significant difference in the proportions of geldings without and with papillomas that were placed second ($\chi^2 = 3.057$, df = 1, P = 0.080).



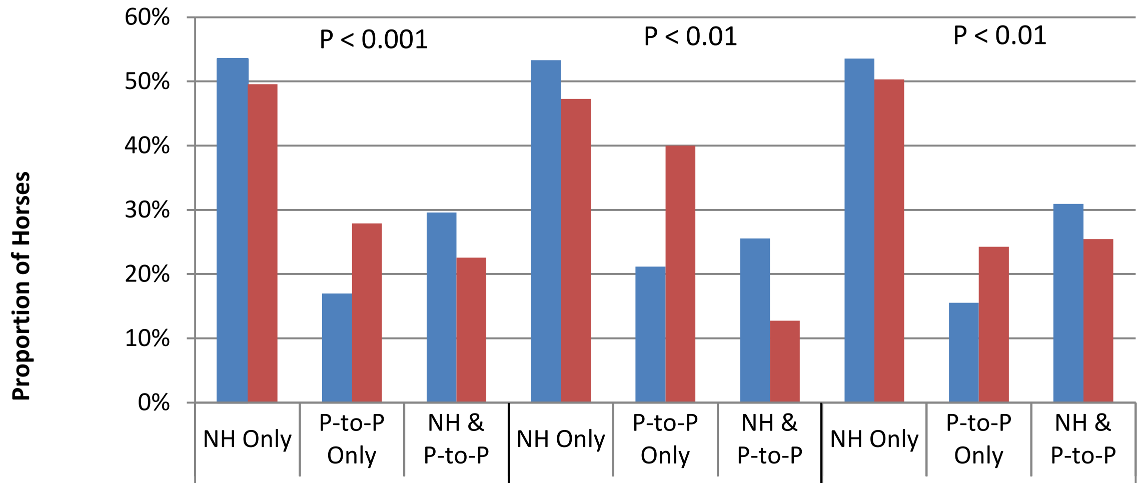
	All Horses					Mares					Geldings				
	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place	Win	Placed	2nd Place	3rd Place	Win or Place
No Papilloma	41.3%	56.6%	43.2%	43.7%	61.7%	29.1%	45.6%	31.9%	34.5%	49.9%	45.3%	60.2%	46.9%	46.7%	65.6%
Papilloma	28.6%	49.8%	37.9%	36.1%	53.7%	16.4%	41.8%	30.9%	30.9%	47.3%	32.4%	52.4%	40.0%	37.6%	55.9%

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Figure 5.21: Proportion of Horses without and with Papillomas that Won or Placed in a Race

5.3.12.3 Effect of Papillomas on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was a significant difference in the type of racing career for horses without and with papillomas ($\chi^2 = 18.790$, df = 2, P < 0.001). A higher proportion of horses without papillomas raced in only NH races or in a combination of NH and Irish Point-to-Point races than horses with papillomas, while a higher proportion of horses with papillomas raced in only Irish Point-to-Point races than horses without papillomas (Figure 5.22). Similar results were observed within both mares ($\chi^2 = 12.153$, df = 2, P = 0.002) and geldings ($\chi^2 = 9.367$, df = 2, P = 0.009).



	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P	NH Only	P-to-P Only	NH & P-to-P
	All Horses			Mares			Geldings		
No Papilloma	53.5%	16.9%	29.6%	53.3%	21.1%	25.6%	53.6%	15.5%	30.9%
Papilloma	49.6%	27.9%	22.6%	47.3%	40.0%	12.7%	50.3%	24.3%	25.4%

Figure 5.22: Proportion of Horses without and with Papillomas that Raced in Only NH Races, Only Irish Point-to-Point (P-to-P) Races or a Combination of NH and Irish Point-to-Point Races

5.3.12.4 Effect of Papillomas on the Age in Years at First Race

There was no significant difference in the age at first race for horses without and with papillomas (data not shown, see Appendix 19, Table A.43).

5.3.12.5 Effect of Papillomas on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48$\pm$1.821, with horses participating in significantly more hurdle races than any other type of race (1.79$\pm$1.565), followed by Irish Point-to-Points (0.91$\pm$1.376) and then steeplechase races (0.74$\pm$1.249). Horses without papillomas had a significantly higher mean number of starts, NH starts, hurdle starts and steeplechase starts per year raced than those with papillomas ($P < 0.05$). Similar results were observed in geldings with the exception of the mean number of hurdle starts per year raced where there was no significant difference. There was no significant difference observed within mares (Table 5.55). There was no significant difference in the mean number of Irish Point-to-Point starts per year raced for horses without and with papillomas (data not shown, see Appendix 19, Table A.43).

Table 5.55: Mean Number of Starts per Year Raced for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Starts per Year Raced	All Horses	No	3,956	3.50±0.029	-2.498	0.013
		Yes	227	3.19±0.110		
	Mares	No	975	3.41±0.061	-0.885	0.376
		Yes	55	3.18±0.246		
	Geldings	No	2,978	3.53±0.033	-2.319	0.020
		Yes	170	3.20±0.123		
Mean Number of NH Starts per Year Raced	All Horses	No	3,956	2.55±0.032	-3.219	0.001
		Yes	227	2.10±0.131		
	Mares	No	975	2.31±0.065	-1.545	0.123
		Yes	55	1.87±0.304		
	Geldings	No	2,978	2.63±0.037	-2.852	0.004
		Yes	170	2.18±0.145		
Mean Number of Hurdle Starts per Year Raced	All Horses	No	3,956	1.80±0.025	-2.018	0.044
		Yes	227	1.59±0.110		
	Mares	No	975	2.03±0.058	-1.728	0.084
		Yes	55	1.60±0.273		
	Geldings	No	2,978	1.73±0.027	-1.219	0.224
		Yes	170	1.59±0.118		
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	3,956	0.75±0.020	-3.327	0.001
		Yes	227	0.51±0.068		
	Mares	No	975	0.28±0.026	-0.112	0.911
		Yes	55	0.27±0.101		
	Geldings	No	2,978	0.90±0.025	-3.660	<0.001
		Yes	170	0.59±0.083		

5.3.12.6 Effect of Papillomas on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Horses without papillomas had significantly more starts at ages four, seven, eight and up to age eight years (9.87±0.13 compared to 8.45±0.47) than those with papillomas ($P < 0.05$). Similar results were found for geldings. However, there was no significant difference within mares. No significant difference was observed in the number of starts at ages five and six for mares without and with papillomas (data not shown, see Appendix 19, Table A.43).

Table 5.56: Number of Starts at Various Ages for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	3,956	0.59±0.022	-3.350	0.001
		Yes	227	0.36±0.065		
	Mares	No	975	0.54±0.044	-0.727	0.467
		Yes	55	0.40±0.160		
	Geldings	No	2,978	0.60±0.025	-3.892	<0.001
		Yes	170	0.32±0.068		
Starts at Age 7 Years	All Horses	No	3,956	2.24±0.048	-1.578	0.115
		Yes	227	1.92±0.185		
	Mares	No	975	1.54±0.085	0.303	0.762
		Yes	55	1.65±0.387		
	Geldings	No	2,978	2.47±0.056	-1.989	0.047
		Yes	170	1.99±0.211		
Starts at Age 8 Years	All Horses	No	3,956	1.61±0.045	-2.020	0.044
		Yes	227	1.29±0.151		
	Mares	No	975	0.87±0.070	-0.187	0.852
		Yes	55	0.82±0.305		
	Geldings	No	2,978	1.85±0.054	-2.262	0.025
		Yes	170	1.44±0.174		
Starts up to Age 8 Years	All Horses	No	3,956	9.87±0.128	-2.924	0.004
		Yes	227	8.45±0.470		
	Mares	No	975	8.08±0.228	-0.205	0.838
		Yes	55	7.87±1.070		
	Geldings	No	2,978	10.46±0.151	-3.410	0.001
		Yes	170	8.62±0.519		

5.3.12.7 Effect of Papillomas on Career Length

Horses without papillomas were significantly more likely to race at age seven years than horses with papillomas (52.3% compared to 44.5%, χ^2 = 5.207, df = 1, P = 0.022). Similar results were observed within geldings (56.8% compared to 47.6%, χ^2 = 5.456, df = 1, P = 0.020) and, although there was no significant difference within mares, a similar trend was observed (38.6% compared to 34.5%, χ^2 = 0.356, df = 1, P = 0.551). There were no significant differences at age eight years (data not shown, see Appendix 19, Table A.42).

5.3.12.8 Effect of Papillomas on the Proportion of Non-Finished Races per Start

Overall, the mean proportion of non-finished races per start in the sample population was 26.25%±28.454. Horses with papillomas had a significantly higher proportion of non-finished races per start (33.34%±2.124) than horses without papillomas (25.85%±0.448) (P < 0.05). Similar results were observed within mares and within geldings (Table 5.57).

Table 5.57: Mean Proportion of Non-Finished Races per Start for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Mean Proportion of Non-Finished Races per Start	All Horses	No	3,956	25.85±0.448	3.454	0.001
		Yes	227	33.34±2.124		
	Mares	No	975	26.58±1.002	3.561	0.001
		Yes	55	45.08±5.099		
	Geldings	No	2,978	25.60±0.496	2.001	0.045
		Yes	170	29.89±2.229		

5.3.12.9 Effect of Papillomas on the Win and Place Strike Rates

Only horses that raced were included for the analysis of win and place strike rates. In the overall sample population, horses had mean win, place and overall win and place strike rates of 6.75%+11.689, 13.37%+16.319 and 20.11%+21.999, respectively. Horses without papillomas had significantly higher win strike rates and overall win and place strike rates than horses with papillomas. Similar results were found within mares for win strike rates and within geldings for both variables. There was no significant difference in the place strike rates (data not shown, see Appendix 19, Table A.43).

Table 5.58: Win and Place Strike Rates for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean ± S.E. (%)*	*t-value*	*Sig.*
Win Strike Rate	All Horses	No	3,956	6.86±0.187	-3.105	0.002
		Yes	227	4.75±0.655		
	Mares	No	975	4.30±0.310	-3.779	<0.001
		Yes	55	1.69±0.618		
	Geldings	No	2,978	7.70±0.225	-2.142	0.032
		Yes	170	5.64±0.828		
Overall Win and Place Strike Rate	All Horses	No	3,956	20.31±0.351	-2.419	0.016
		Yes	227	16.68±1.370		
	Mares	No	975	14.79±0.627	-0.913	0.361
		Yes	55	12.33±2.319		
	Geldings	No	2,978	22.10±0.413	-2.297	0.022
		Yes	170	18.03±1.648		

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Significant differences were observed in the NH place strike rates and in the Irish Point-to-Point win strike rates ($P < 0.05$) for horses without and with papillomas. Horses without papillomas had significantly higher NH place strike rates and significantly higher Irish Point-to-Point win strike rates than horses with papillomas. Similar results were observed within geldings however, there was no significant difference within mares (Table 5.59). There were no significant differences in the NH win strike rates or in the Irish Point-to-Point place strike rates for horses without and with papillomas (data not shown, see Appendix 19, Table A.43).

Table 5.59: NH and Irish Point-to-Point Win and Place Strike Rates for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Place Strike Rate	All Horses	No	3,277	12.38±0.277	-2.702	0.008
		Yes	163	9.71±0.946		
	Mares	No	766	8.96±0.525	0.562	0.574
		Yes	33	10.40±2.290		
	Geldings	No	2,510	13.41±0.321	-3.554	0.001
		Yes	128	9.52±1.048		
Irish Point-to-Point Win Strike Rate	All Horses	No	1,841	11.96±0.535	-2.980	0.003
		Yes	114	6.79±1.649		
	Mares	No	454	8.85±0.877	-0.976	0.330
		Yes	29	5.35±3.587		
	Geldings	No	1,385	12.99±0.649	-3.247	0.002
		Yes	84	6.77±1.802		

5.3.12.10 Effect of Papillomas on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. Significant differences were observed in the NH place strike rates and in the Irish Point-to-Point win strike rates ($P < 0.05$) for horses without and with papillomas. Horses without papillomas had significantly higher NH place strike rates and significantly higher Irish Point-to-Point win strike rates than horses with papillomas. Similar results were observed within geldings however, there was no significant difference within mares (Table 5.60). There were no significant differences in the NH win strike rates or in the Irish Point-to-Point place strike rates for horses without and with papillomas (data not shown, see Appendix 19, Table A.43).

Table 5.60: NH and Irish Point-to-Point Win and Place Strike Rates for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Place Strike Rate	All Horses	No	3,277	12.38±0.277	-2.702	0.008
		Yes	163	9.71±0.946		
	Mares	No	766	8.96±0.525	0.562	0.574
		Yes	33	10.40±2.290		
	Geldings	No	2,510	13.41±0.321	-3.554	0.001
		Yes	128	9.52±1.048		
Irish Point-to-Point Win Strike Rate	All Horses	No	1,841	11.96±0.535	-2.980	0.003
		Yes	114	6.79±1.649		
	Mares	No	454	8.85±0.877	-0.976	0.330
		Yes	29	5.35±3.587		
	Geldings	No	1,385	12.99±0.649	-3.247	0.002
		Yes	84	6.77±1.802		

5.3.12.11 Effect of Papillomas on the Mean Earnings per Start

Overall, the mean earnings per start in the sample population were £443.0±1,350.34. There was a highly significant difference in the mean earnings per start for horses with papillomas and without papillomas ($P < 0.05$). Horses without papillomas earned significantly more per race than horses with papillomas, £454.6±21.93 compared to £241.5±41.85. Similar results were observed in mares and in geldings (Table 5.61).

Table 5.61: Mean Earnings per Start for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean ± S.E. (£)*	*t-value*	*Sig.*
Mean Earnings per Start	All Horses	No	3,956	454.6±21.93	-4.509	<0.001
		Yes	227	241.5±41.85		
	Mares	No	975	225.6±20.79	-3.899	<0.001
		Yes	55	98.1±25.24		
	Geldings	No	2,978	529.7±28.19	-3.974	<0.001
		Yes	170	285.1±54.69		

5.3.12.12 Effect of Papillomas on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. No significant differences were found in the win or place strike rates at ages four or seven (data not shown, see Appendix 19, Table A.43), however horses without papillomas had significantly higher win strike rates at age eight years and up to age eight years and significantly higher place strike rates at age six years than horses with papillomas (P < 0.05). There was no significant difference in the win strike rates at age five years for horses (or within geldings) without or with papillomas, however mares without papillomas had significantly higher win strike rates at age five years than mares with papillomas (P < 0.05).

Table 5.62: Win and Place Strike Rate at Various Ages for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No	2,887	8.10±0.361	-1.287	0.198
		Yes	163	6.09±1.512		
	Mares	No	706	4.74±0.525	-2.996	0.004
		Yes	38	1.69±0.871		
	Geldings	No	2,179	9.20±0.445	-0.995	0.320
		Yes	124	7.28±1.951		
Places at Age 6 Years Strike Rate	All Horses	No	2,778	15.40±0.427	-2.558	0.011
		Yes	163	11.02±1.659		
	Mares	No	610	12.69±0.849	-1.044	0.297
		Yes	37	9.02±2.843		
	Geldings	No	2,165	16.16±0.492	-2.665	0.009
		Yes	124	10.99±1.877		
Wins at Age 8 Years Strike Rate	All Horses	No	1,431	8.49±0.493	-3.175	0.002
		Yes	74	4.41±1.187		
	Mares	No	200	7.26±1.546	-1.047	0.296
		Yes	10	0.00±0.000		
	Geldings	No	1,230	8.67±0.516	-2.710	0.008
		Yes	63	4.78±1.337		
Wins up to Age 8 Years Strike Rate	All Horses	No	3,956	6.06±0.168	-2.460	0.015
		Yes	227	4.43±0.642		
	Mares	No	975	4.12±0.299	-3.640	<0.001
		Yes	55	1.65±0.610		
	Geldings	No	2,978	6.69±0.199	-1.680	0.093
		Yes	170	5.26±0.818		

5.3.12.13 Effect of Papillomas on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90±1.566 wins and 1.73±2.431 places up to the age of eight. Horses without papillomas had significantly more wins up to age eight years and significantly more places up to age eight years than horses with papillomas (P < 0.05). Geldings showed similar results for both the number of wins and the number of places, see Table 5.63 below, while mares showed similar results for the number of wins up to age eight years but no significant difference for the number of places.

Table 5.63: Number of Wins and Places up to Age Eight Years for Horses without and with Papillomas

Variable	*Group*	*Papilloma*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Wins up to Age 8 Years	All Horses	No	3,956	0.91±0.025	-3.915	<0.001
		Yes	227	0.59±0.079		
	Mares	No	975	0.50±0.034	-3.569	0.001
		Yes	55	0.22±0.072		
	Geldings	No	2,978	1.05±0.031	-3.511	0.001
		Yes	170	0.69±0.098		
Places up to Age 8 Years	All Horses	No	3,956	1.75±0.039	-3.432	0.001
		Yes	227	1.30±0.126		
	Mares	No	975	1.19±0.062	-0.090	0.929
		Yes	55	1.16±0.246		
	Geldings	No	2,978	1.94±0.047	-3.827	<0.001
		Yes	170	1.34±0.148		

5.3.13 Effect of Some Other Defects on Racing Performance

All 5,282 horses were examined to determine the proportion of horses that were raced or not raced. However, for the rest of the variables, including raced by age four years and raced by age five years, horses that were not raced were excluded from the analysis (938 horses). A further 161 of these horses raced in only British Point-to-Point races and due to unavailability of data were excluded from further analysis. The prevalences of the remaining defects that were analysed to investigate their effect on racing performance are listed in Table 5.64 below.

Table 5.64: Prevalence of Miscellaneous Other Defects

Defect	*Number*	*Prevalence*
Oral or dental defects and features	106	2.01%
Parrot Mouth	24	0.45%
Undershot Jaw	8	0.15%
Wolf Teeth	38	0.72%
Ocular Defects	91	1.72%
Muscle Wastage	47	0.89%
Unspecified Synovial Distension	38	0.72%

5.3.13.1 Effect of Other Defects on Racing Status

Overall, of the 5,282 horses in the sample, 82.24% or 4,344 horses raced at some stage in their life and of the remaining 4,183 that raced, 23.22% (971) had raced by age four years and 77.46% (3,240) had raced by the age of five. There was no significant difference between the proportions of horses without and with oral or dental defects and features that raced, raced by four or raced by five (data not shown, see Appendix 20, Table A.44) however, mares without oral or dental defects and features were significantly more likely to race by age five years than mares with oral or dental defects and features ($\chi^2 = 4.693$, df = 1, P = 0.030). There was no significant difference within geldings.

There was no significant difference between the proportions of horses without and with parrot mouth that raced or raced by four (data not shown, see Appendix 21, Table A.48) however, horses without parrot mouth were significantly more likely to race by age five years than horses with parrot mouth ($\chi^2 = 4.183$, df = 1, P = 0.041). Similar results were observed within geldings ($\chi^2 = 5.876$, df = 1, P = 0.015) however, there was no significant difference within mares.

There was no significant difference between the proportions of horses without and with ocular defects that raced or raced by four (data not shown, see Appendix 24, Table A.60) however, horses without ocular defects were significantly more likely to race by age five years than horses with ocular defects ($\chi^2 = 6.840$, df = 1, P = 0.009). Similar results were observed within geldings ($\chi^2 = 12.630$, df = 1, P < 0.001) however, there was no significant difference within mares.

There was no significant difference between the proportions of horses without and with muscle wastage that raced or raced by four (data not shown, see Appendix 25, Table A.64) however, horses without muscle wastage were significantly more likely to race by age five years than horses with muscle wastage ($\chi^2 = 4.020$, df = 1, P = 0.045). There was no significant difference within mares or within geldings.

There was no significant difference between the proportions of horses without and with an undershot jaw, wolf teeth or unspecified synovial distension that raced, raced by four or raced by five (data not shown, see appendices 22, 23 & 26).

5.3.13.2 Effect of Other Defects on Winning Status

Overall, 40.64% (1,700) of the sample population won a race, while 56.28% (2,354) were placed in a race, 42.89% (1,794) placed second and 43.29% (1,811) placed third. Altogether, 61.30% of the sample population (2,564 horses) won or were placed in a race. There was no significant difference between the proportions of horses without and with oral or dental defects and features, parrot mouth, an undershot jaw, wolf teeth, ocular defects, muscle wastage or unspecified synovial distension that won a race, were placed in a race, placed second, placed third or won or placed in a race (data not shown, see appendices 20-26). Similar results were observed within geldings. However, within mares, those with muscle wastage were significantly more likely to win a race ($\chi^2 = 4.181$, df = 1, P = 0.041) than those without muscle wastage.

5.3.13.3 Effect of Other Defects on Type of Racing Career

Overall, 53.07% (2,220) of the sample population raced in only NH races while 17.57% (735) raced in only Irish Point-to-Point races and 29.17% (1,220) raced in a combination of NH and Irish Point-to-Point races. There was no significant difference in the proportions of horses that raced in only NH races, only Irish Point-to-Point races or a combination of NH and Irish Point-to-Point for horses without and with oral or dental defects and features, parrot mouth, an undershot jaw, wolf teeth, muscle wastage or unspecified synovial distension (data not shown, see appendices 20-23, 25 & 26).

There was however, a significant difference in the type of racing career for horses without and with ocular defects ($\chi^2 = 6.688$, df = 2, P = 0.035). A higher proportion of horses with ocular defects raced in only NH races than horses without ocular defects, while a higher proportion of horses without ocular defects raced in only Irish Point-to-Point races or in a combination of NH and Irish Point-to-Point races than horses with ocular defects. Similar results were observed within geldings ($\chi^2 = 10.313$, df = 2, P = 0.006) however, no significant difference was observed within mares ($\chi^2 = 0.292$, df = 2, P = 0.864).

5.3.13.4 Effect of Other Defects on the Age in Years at First Race

Only horses that raced were examined to determine the age at first race. There was no significant difference in the age at first race for horses without and with an undershot jaw, wolf teeth, muscle wastage or unspecified synovial distension (data not shown, see appendices 22, 23, 25 & 26).

There was no significant difference in the age at first race for horses without and with oral or dental defects and features. However, geldings with oral or dental defects and features were significantly older at their first race than geldings without oral or dental defects and features, as seen in Table 5.65 ($P < 0.05$). There was no significant difference within mares.

Horses with parrot mouth were significantly older at their first race than horses without parrot mouth ($P < 0.05$), 5.42$\pm$0.16 years compared to 5.04$\pm$0.01. Similar results were observed in geldings however, there was no significant difference in the age at first race for mares without and with parrot mouth.

Horses with ocular defects were significantly older at their first race (5.23$\pm$0.09) than those without ocular defects (5.04$\pm$0.02) ($P < 0.05$). This was the same for geldings; however, there was no significant difference in the age at first race for mares without or with ocular defects.

Table 5.65: Age at First Race for Horses without and with Oral or Dental Defects and Features, Parrot Mouth or Ocular Defects

Variable	*Group*	*Oral/Dental Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Age at First Race	All Horses	No	4,101	5.04±0.013	1.817	0.069
		Yes	82	5.21±0.093		
	Mares	No	1,017	5.07±0.025	-1.022	0.307
		Yes	13	4.85±0.191		
	Geldings	No	3,079	5.03±0.015	2.427	0.015
		Yes	69	5.28±0.103		
Variable	*Group*	*Parrot Mouth*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Age at First Race	All Horses	No	4,164	5.04±0.013	2.010	0.044
		Yes	19	5.42±0.159		
	Mares	No	1,028	5.07±0.025	-0.123	0.902
		Yes	2	5.00±0.000		
	Geldings	No	3,131	5.03±0.015	2.172	0.030
		Yes	17	5.47±0.174		
Variable	*Group*	*Ocular Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Age at First Race	All Horses	No	4,109	5.04±0.013	1.962	0.050
		Yes	74	5.23±0.091		
	Mares	No	1,010	5.07±0.025	-0.393	0.694
		Yes	20	5.00±0.126		
	Geldings	No	3,094	5.03±0.015	2.496	0.013
		Yes	54	5.31±0.115		

5.3.13.5 Effect of Other Defects on the Mean Number of Starts per Year Raced

The number of starts per year raced was calculated by dividing the total number of races run by each horse, by the number of years that that horse raced. Only horses that raced were included in the analysis. Overall, the mean number of starts per year raced for the sample population was 3.48±1.821, with horses participating in significantly more hurdle races than any other type of race (1.79±1.565), followed by Irish Point-to-Points (0.91±1.376) and then steeplechase races (0.74±1.249). There was no significant difference in the mean number of starts, NH starts, hurdle starts, steeplechase starts or Irish Point-to-Point starts per year raced for horses without and with an undershot jaw or with unspecified synovial distension (data not shown, see appendices 22 & 26). There was also no significant difference in the mean number of starts or the mean number of NH starts per year raced for horses without and with oral or dental defects and features (data not shown, see Appendix 20, Table A.47). There was however a significant difference in the mean number of steeplechase start and the mean number of Irish Point-to-Point starts per year raced ($P < 0.05$). Horses with oral or dental defects and features had significantly more steeplechase starts per year raced and significantly fewer Irish Point-to-Point starts per year raced than those without oral or dental defects and features. Similar results were observed for geldings. Mares without oral or dental defects and features had significantly more steeplechase starts per year raced than those with oral or dental defects and features while no significant difference was observed for the mean number of Irish Point-to-Point starts per year raced as shown in Table 5.66 below.

There was no significant difference in the mean number of starts or the mean number of NH starts per year raced for horses without and with parrot mouth (data not shown, see Appendix 21, Table A.51). There was however, a significant difference in the mean number of Irish Point-to-Point starts per year raced. Horses without parrot mouth had significantly more Irish Point-to-Point starts per year raced than horses with parrot mouth. Similar results were seen for geldings (Table 5.66) however, no significant difference was observed in mares.

Table 5.66: Mean Number of Starts per Year Raced for Horses without and with Oral or Dental Defects and Features, Parrot Mouth, Wolf Teeth, Ocular Defects or Muscle Wastage

Variable	*Group*	*Oral/Dental Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	4,101	0.73±0.019	2.233	0.028
		Yes	82	1.18±0.202		
	Mares	No	1,017	0.28±0.026	-7.117	<0.001
		Yes	13	0.03±0.024		
	Geldings	No	3,079	0.87±0.024	2.249	0.028
		Yes	69	1.40±0.231		
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	4,101	0.92±0.022	-2.694	0.008
		Yes	82	0.58±0.123		
	Mares	No	1,017	1.07±0.049	-0.471	0.638
		Yes	13	0.87±0.516		
	Geldings	No	3,079	0.87±0.024	-2.978	0.004
		Yes	69	0.53±0.111		
Variable	*Group*	*Parrot Mouth*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	4,164	0.91±0.021	-3.778	0.001
		Yes	19	0.35±0.149		
	Mares	No	1,028	1.07±0.049	-0.960	0.338
		Yes	2	0.00±0.000		
	Geldings	No	3,131	0.86±0.023	-2.867	0.011
		Yes	17	0.39±0.164		
Variable	*Group*	*Wolf Teeth*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	4,152	0.73±0.019	2.104	0.044
		Yes	31	1.32±0.276		
	Mares	No	1,023	0.28±0.025	-0.797	0.426
		Yes	7	0.04±0.036		
	Geldings	No	3,124	0.88±0.024	2.529	0.019
		Yes	24	1.69±0.319		
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	4,152	0.91±0.021	-2.799	0.009
		Yes	31	0.46±0.162		
	Mares	No	1,023	1.07±0.049	-0.658	0.510
		Yes	7	0.68±0.531		
	Geldings	No	3,124	0.86±0.023	-3.131	0.005
		Yes	24	0.39±0.148		
Variable	*Group*	*Ocular Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Starts per Year Raced	All Horses	No	4,109	3.49±0.028	-1.853	0.064
		Yes	74	3.09±0.209		
	Mares	No	1,010	3.40±0.060	0.128	0.898
		Yes	20	3.45±0.528		
	Geldings	No	3,094	3.52±0.032	-2.270	0.023
		Yes	54	2.96±0.210		
Mean Number of Irish Point-to-Point Starts per Year Raced	All Horses	No	4,109	0.92±0.021	-1.729	0.084
		Yes	74	0.64±0.154		
	Mares	No	1,010	1.07±0.049	0.443	0.658
		Yes	20	1.23±0.428		
	Geldings	No	3,094	0.87±0.023	-3.363	0.001
		Yes	54	0.42±0.131		

Variable	*Group*	*Muscle Wastage*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Mean Number of Steeplechase Starts per Year Raced	All Horses	No	4,144	0.74±0.019	-2.987	0.005
		Yes	39	0.36±0.125		
	Mares	No	1,012	0.28±0.026	0.286	0.775
		Yes	18	0.33±0.157		
	Geldings	No	3,127	0.89±0.024	-2.581	0.018
		Yes	21	0.38±0.194		

There was no significant difference in the mean number of starts per year raced or the mean number of NH starts per year raced for horses without and with wolf teeth (data not shown, see Appendix 23, Table A.59), however, horses with wolf teeth had significantly more steeplechase starts per year raced and significantly fewer Irish Point-to-Point starts per year raced than horses without wolf teeth ($P < 0.05$). Similar results were observed within geldings, however, there was no significant difference between mares without and with wolf teeth, as shown in Table 5.66.

Geldings without ocular defects had a significantly higher mean number of starts and Irish Point-to-Point starts per year raced than geldings with ocular defects ($P < 0.05$). There was no significant difference within mares or in mares and geldings combined, as shown in Table 5.66. There was no significant difference in the mean number of NH starts for horses without and with ocular defects (data not shown, see Appendix 24, Table A.63).

There was no significant difference in the mean number of starts, NH starts or Irish Point-to-Point starts per year raced for horses without and with muscle wastage (data not shown, see Appendix 25, Table A.67). There was however a significant difference in the mean number of steeplechase starts per year raced for horses with or without muscle wastage ($P < 0.05$). Horses without muscle wastage had significantly more steeplechase starts per year raced (0.74±0.02) than those with muscle wastage (0.36±0.13). Geldings showed similar results while there was no significant difference within mares.

5.3.13.6 Effect of Other Defects on the Number of Starts at Various Ages

In the overall sample population, horses had a mean number of 0.57±1.344 starts at age four years, 2.46±2.448 starts at age five years, 2.94±3.007 starts at age six years, 2.22±2.986 starts at age seven years, 1.59±2.805 starts at age eight years and 9.80±8.003 starts up to age eight years. Horses without oral or dental defects and features had significantly more starts at age five years than horses with oral or dental defects and features ($P < 0.05$). Similar results were observed in geldings and although there was no significant difference within mares a similar trend was observed. Horses with oral or dental defects and features had significantly more starts at age seven years than horses without oral or dental defects and features. There was no significant difference within mares or geldings. There was no significant difference in the number of starts at any other age (data not shown, see Appendix 20, Table A.47).

Horses without parrot mouth had significantly more starts at age four years than those with parrot mouth ($P < 0.001$). Similar results were observed in geldings; however, there was no significant difference in the number of starts for mares at age four years as shown in Table 5.67 below. There was no significant difference in the number of starts at any other age (data not shown, see Appendix 21, Table A.51).

Horses without an undershot jaw had significantly more starts at age five years and up to age eight years than horses with an undershot jaw ($P < 0.05$). Geldings showed similar results (Table 5.67). There was no significant difference in the number of starts at any other age (data not shown, see Appendix 22, Table A.55).

There was no significant difference in the number of starts at ages four, five, six, seven, eight or up to age eight years for horses without and with wolf teeth (data not shown, see Appendix 23, Table A.59).

There was a significant difference in the number of starts at ages four and eight ($P < 0.05$) for horses without and with ocular defects, as shown in Table 5.67 below, however, there was no significant difference between the number of starts at any other age or up to age eight years (data not shown, see Appendix 24, Table A.63). Horses without ocular defects had significantly more starts at ages four and eight than those with ocular defects. Geldings showed similar results for both of these variables, as did mares, for the number of starts at age four years. Although there was no significant difference in the number of starts at age eight years for mares without or with ocular defects, similar trends were observed.

Table 5.67: Number of Starts at Various Ages for Horses without and with Oral or Dental Defects and Features, Parrot Mouth, an Undershot Jaw, Ocular Defect, Muscle Wastage or Unspecified Synovial Distension (Unspec. Synovial Dist.)

Variable	*Group*	*Oral/Dental Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 5 Years	All Horses	No	4,101	2.47±0.038	-2.628	0.010
		Yes	82	1.87±0.227		
	Mares	No	1,017	2.51±0.080	-0.069	0.945
		Yes	13	2.46±0.475		
	Geldings	No	3,079	2.46±0.044	-2.389	0.017
		Yes	69	1.75±0.253		
Starts at Age 7 Years	All Horses	No	4,101	2.20±0.046	2.399	0.019
		Yes	82	3.18±0.407		
	Mares	No	1,017	1.53±0.083	1.208	0.250
		Yes	13	2.77±1.020		
	Geldings	No	3,079	2.42±0.055	1.866	0.066
		Yes	69	3.26±0.446		
Variable	*Group*	*Parrot Mouth*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	4,164	0.58±0.021	-9.259	<0.001
		Yes	19	0.05±0.053		
	Mares	No	1,028	0.53±0.043	-0.550	0.582
		Yes	2	0.00±0.000		
	Geldings	No	3,131	0.59±0.024	-8.387	<0.001
		Yes	17	0.06±0.059		
Variable	*Group*	*Undershot Jaw*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 5 Years	All Horses	No	4,176	2.46±0.038	-6.061	0.001
		Yes	7	0.71±0.286		
	Mares	No	1,030	2.51±0.079		
		Yes	0			
	Geldings	No	3,141	2.45±0.043	-5.990	0.001
		Yes	7	0.71±0.286		
Starts up to Age 8 Years	All Horses	No	4,176	9.80±0.124	-3.677	0.010
		Yes	7	5.14±1.262		
	Mares	No	1,030	8.07±0.223		
		Yes	0			
	Geldings	No	3,141	10.37±0.146	-4.118	0.006
		Yes	7	5.14±1.262		
Variable	*Group*	*Ocular Defect*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	4,109	0.58±0.021	-5.366	<0.001
		Yes	74	0.22±0.065		
	Mares	No	1,010	0.54±0.043	-2.699	0.012
		Yes	20	0.20±0.117		
	Geldings	No	3,094	0.60±0.024	-4.574	<0.001
		Yes	54	0.22±0.048		
Starts at Age 8 Years	All Horses	No	4,109	1.60±0.044	-2.679	0.009
		Yes	74	1.01±0.216		
	Mares	No	1,010	0.88±0.069	-0.872	0.383
		Yes	20	0.45±0.223		
	Geldings	No	3,094	1.84±0.053	-2.161	0.035
		Yes	54	1.22±0.279		

Variable	*Group*	*Muscle Wastage*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 4 Years	All Horses	No	4,144	0.58±0.021	-2.127	0.040
		Yes	39	0.28±0.137		
	Mares	No	1,012	0.53±0.043	-0.792	0.429
		Yes	18	0.28±0.226		
	Geldings	No	3,127	0.59±0.024	-1.041	0.298
		Yes	21	0.29±0.171		
Starts at Age 8 Years	All Horses	No	4,144	1.60±0.044	-2.337	0.025
		Yes	39	0.85±0.319		
	Mares	No	1,012	0.88±0.069	-0.402	0.688
		Yes	18	0.67±0.485		
	Geldings	No	3,127	1.83±0.053	-1.916	0.069
		Yes	21	1.00±0.431		
Starts up to Age 8 Years	All Horses	No	4,144	9.81±0.125	-1.823	0.076
		Yes	39	8.18±0.887		
	Mares	No	1,012	8.05±0.225	0.593	0.554
		Yes	18	9.06±1.522		
	Geldings	No	3,127	10.38±0.147	-2.885	0.009
		Yes	21	7.43±1.013		
Variable	*Group*	*Unspec. Synovial Dist.*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Starts at Age 5 Years	All Horses	No	4,155	2.46±0.038	-2.359	0.026
		Yes	28	1.64±0.346		
	Mares	No	1.022	2.51±0.079	-0.011	0.991
		Yes	8	2.50±0.886		
	Geldings	No	3,128	2.45±0.043	-3.589	0.002
		Yes	20	1.30±0.317		
Starts at Age 7 Years	All Horses	No	4,155	2.23±0.046	-2.243	0.033
		Yes	28	1.39±0.369		
	Mares	No	1.022	1.56±0.084	-0.984	0.325
		Yes	8	0.63±0.500		
	Geldings	No	3,128	2.45±0.055	-1.089	0.276
		Yes	20	1.70±0.465		
Starts at Age 8 Years	All Horses	No	4,155	1.60±0.044	-1.935	0.063
		Yes	28	0.89±0.361		
	Mares	No	1.022	0.87±0.068	-0.158	0.874
		Yes	8	0.75±0.750		
	Geldings	No	3,128	1.83±0.053	-2.085	0.050
		Yes	20	0.95±0.420		

Horses without muscle wastage had significantly more starts at ages four and eight and up to age eight years than horses with muscle wastage ($P < 0.05$), as seen in Table 5.67 below. Similar results were observed in geldings up to age eight years while there was no significant difference at any age for mares with or without muscle wastage.

Horses without unspecified synovial distension had significantly more starts at ages five and seven than those with unspecified synovial distension ($P < 0.05$), as shown in Table 5.67

below. Similar results were observed in geldings at age five years and age eight years while no significant difference was found in the number of starts at any age for mares with or without unspecified synovial distension. There was no significant difference in the number of starts at any other age or up to age eight years (data not shown, see Appendix 26, Table A.71) for horses without or with unspecified synovial distension.

5.3.13.7 Effect of Other Defects on Career Length

There were no significant differences in the career lengths of horses without and with parrot mouth, an undershot jaw, wolf teeth, ocular defects, muscle wastage or unspecified synovial distension (data not shown, see appendices 21-26). Horses with oral or dental defects and features were significantly more likely to race at age seven years than horses without oral or dental defects and features (63.4% compared to 51.6%, $\chi^2 = 4.478$, df = 1, P = 0.034) however there was no significant difference at age eight years (data not shown, see Appendix 20, Table A.46).

5.3.13.8 Effect of Other Defects on the Proportion of Non-Finished Races per Start

There was no significant difference in the proportions of non-finished races per start for horses without and with oral or dental defects and features, parrot mouth, an undershot jaw, wolf teeth, ocular defects, muscle wastage or unspecified synovial distension (data not shown, see appendices 20-26).

5.3.13.9 Effect of Other Defects on the Win and Place Strike Rates

There was no significant difference in the win strike rates or the place strike rates for horses without and with oral or dental defects and features, parrot mouth, an undershot jaw, wolf teeth, ocular defects, muscle wastage or unspecified synovial distension (data not shown, see appendices 20-26).

5.3.13.10 Effect of Other Defects on the National Hunt Win and Place Strike Rates and Irish Point-to-Point Win and Place Strike Rates

Only horses that raced in NH races were included for analysis of NH wins and places and only horses that raced in Irish Point-to-Point races were included for analysis of Irish Point-to-Point wins and places. There was no significant difference in the NH win or place strike rates or in the Irish Point-to-Point win or place strike rates for horses without and with oral or dental defects and features, parrot mouth, an undershot jaw or wolf teeth (data not shown, see appendices 20-23).

Table 5.68: NH and Irish Point-to-Point Win and Place Strike Rates for Horses without and with Ocular Defects, Muscle Wastage or Unspecified Synovial Distension (Unspec. Synovial Dist.)

Variable	*Group*	*Ocular Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Place Strike Rate	All Horses	No	3,377	12.17±0.269	1.910	0.061
		Yes	63	16.83±2.425		
	Mares	No	783	9.03±0.519	-0.111	0.911
		Yes	16	8.62±3.036		
	Geldings	No	2,591	13.11±0.310	2.168	0.035
		Yes	47	19.62±2.989		
Irish Point-to-Point Place Strike Rate	All Horses	No	1,931	15.89±0.540	-1.302	0.193
		Yes	24	9.55±4.662		
	Mares	No	473	12.76±0.895	0.157	0.875
		Yes	10	13.75±9.939		
	Geldings	No	1,455	16.92±0.652	-2.607	0.021
		Yes	14	6.55±3.924		
Variable	*Group*	*Muscle Wastage*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Win Strike Rate	All Horses	No	3,408	5.75±0.176	-2.334	0.026
		Yes	32	3.04±1.147		
	Mares	No	785	3.25±0.307	0.549	0.583
		Yes	14	4.52±2.108		
	Geldings	No	2,620	6.50±0.208	-3.769	0.001
		Yes	18	1.89±1.203		
Variable	*Group*	*Unspec. Synovial Dist.*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
NH Place Strike Rate	All Horses	No	3,419	12.23±0.268	1.024	0.318
		Yes	21	16.66±4.320		
	Mares	No	795	8.89±0.508	3.498	<0.001
		Yes	4	34.09±11.809		
	Geldings	No	2,621	13.23±0.311	-0.174	0.862
		Yes	17	12.55±4.141		

There was no significant difference in the NH or the Irish Point-to-Point win strike rates for horses without and with ocular defects (data not shown, see Appendix 24, Table A.63).

However, geldings with ocular defects had significantly higher NH place strike rates and significantly lower Irish Point-to-Point place strike rates than horses without ocular defects (Table 5.68). There was no significant difference within mares or when all horses were analysed together.

There was no significant difference in the NH place strike rates or the Irish Point-to-Point win or place strike rates for horses without and with muscle wastage (data not shown, see Appendix 25, Table A.67). There was however, a significant difference in the NH win strike rates for horses without and with muscle wastage ($P < 0.05$), as shown in Table 5.68. Horses without muscle wastage had significantly higher NH win strike rates (5.75%$\pm$0.176) than those with muscle wastage (3.04%$\pm$1.147). Similar results were observed within geldings however, there was no significant difference within mares.

There was no significant difference in the NH win or place strike rates or in the Irish Point-to-Point win or place strike rates for horses without and with unspecified synovial distension (data not shown, see Appendix 26, Table A.71). There was however, a significant difference in the NH place strike rates within mares ($P < 0.001$). Mares with unspecified synovial distension had significantly higher NH place strike rates than mares without unspecified synovial distension (Table 5.68). There was no significant difference within geldings or when all horses were analysed together.

5.3.13.11 Effect of Other Defects on the Mean Earnings per Start

There was no significant difference in the mean earnings per start for horses without and with oral or dental defects and features, parrot mouth, an undershot jaw, wolf teeth, ocular defects, muscle wastage or unspecified synovial distension (data not shown, see appendices 20-26).

5.3.13.12 Effect of Other Defects on the Win and Place Strike Rate at Various Ages

Only horses that raced at the relevant age were included in the analysis for wins and places at that age. Significant differences were found in the win and place strike rates at age five years for horses without or with oral or dental defects and features (Table 5.69) however, no significant differences were found at any other age (data not shown, see Appendix 20, Table

A.47). Mares without oral or dental defects and features had significantly higher win and place strike rates at age five years than mares with oral or dental defects and features ($P < 0.05$); however, no significant difference was observed in all of the horses or in geldings.

Horses without parrot mouth had significantly higher win strike rates at ages five and six than horses with parrot mouth ($P < 0.05$) as shown in Table 5.69 below. Similar results were observed within geldings however, there was no significant difference within mares. Parrot mouth had no significant effect on the win strike rates at any other age or on the place strike rates at any age (data not shown, see Appendix 21, Table A.51).

Horses without an undershot jaw had significantly higher win strike rates at age six years and significantly higher place strike rates at ages five and six than horses with an undershot jaw ($P < 0.001$). Similar results were observed in geldings as shown in Table 5.69 below.

Horses without wolf teeth had significantly higher win strike rates at age four years ($P < 0.001$), 7.48%$\pm$0.675 compared to 0.00%$\pm$0.000, and significantly lower place strike rates at age six years, 15.09%$\pm$0.415 compared to 26.59%$\pm$5.389, than horses with wolf teeth. There was no significant difference within mares, however, geldings showed similar results. Geldings without wolf teeth also had significantly higher place strike rates at age four years than those with wolf teeth (Table 5.69).

Horses without ocular defects had significantly higher win strike rates up to age eight years and significantly lower place strike rates up to age eight years than those with ocular defects ($P < 0.05$). Similar results were observed in geldings however, no significant difference was observed in mares. Ocular defects were found to have no effect on the win strike rates or the place strike rates at ages four, five, six, seven or eight (data not shown, see Appendix 24, Table A.63).

Table 5.69: Win and Place Strike Rate at Various Ages for Horses without and with Oral or Dental Defects and Features, Parrot Mouth, an Undershot Jaw, Wolf Teeth, Ocular Defects or Muscle Wastage

Variable	*Group*	*Oral/Dental Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No	2,994	7.90±0.351	1.241	0.220
		Yes	56	12.76±3.892		
	Mares	No	733	4.65±0.508	-9.160	<0.001
		Yes	11	0.00±0.000		
	Geldings	No	2,258	8.96±0.432	1.454	0.153
		Yes	45	15.87±4.737		
Places at Age 5 Years Strike Rate	All Horses	No	2,994	13.89±0.432	-0.206	0.837
		Yes	56	13.23±3.912		
	Mares	No	733	9.67±0.674	-3.122	0.009
		Yes	11	2.27±2.273		
	Geldings	No	2,258	15.27±0.525	0.170	0.865
		Yes	45	15.91±4.764		
Variable	*Group*	*Parrot Mouth*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 5 Years Strike Rate	All Horses	No	3,039	8.02±0.353	-22.746	<0.001
		Yes	11	0.00±0.000		
	Mares	No	742	4.60±0.502	-0.475	0.635
		Yes	2	0.00±0.000		
	Geldings	No	2,294	9.13±0.436	-20.962	<0.001
		Yes	9	0.00±0.000		
Wins at Age 6 Years Strike Rate	All Horses	No	2,927	8.57±0.335	-2.574	0.023
		Yes	14	2.38±2.381		
	Mares	No	646	5.79±0.582	-0.391	0.696
		Yes	1	0.00		
	Geldings	No	2,276	9.38±0.396	-2.627	0.021
		Yes	13	2.56±2.564		
Variable	*Group*	*Undershot Jaw*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Places at Age 5 Years Strike Rate	All Horses	No	3,046	13.90±0.430	-32.325	<0.001
		Yes	4	0.00±0.000		
	Mares	No	744	9.56±0.665		
		Yes	0			
	Geldings	No	2,299	15.31±0.524	-29.210	<0.001
		Yes	4	0.00±0.000		
Wins at Age 6 Years Strike Rate	All Horses	No	2,936	8.56±0.334	-25.640	<0.001
		Yes	5	0.00±0.000		
	Mares	No	647	5.78±0.581		
		Yes	0			
	Geldings	No	2,284	9.36±0.394	-23.730	<0.001
		Yes	5	0.00±0.000		
Places at Age 6 Years Strike Rate	All Horses	No	2,936	15.19±0.415	-36.619	<0.001
		Yes	5	0.00±0.000		
	Mares	No	647	12.48±0.817		
		Yes	0			
	Geldings	No	2,284	15.92±0.478	-33.335	<0.001
		Yes	5	0.00±0.000		

Variable	*Group*	*Wolf Teeth*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 4 Years Strike Rate	All Horses	No	961	7.48±0.675	-11.088	<0.001
		Yes	9	0.00±0.000		
	Mares	No	207	3.36±0.949	-0.426	0.671
		Yes	3	0.00±0.000		
	Geldings	No	753	8.59±0.816	-10.529	<0.001
		Yes	6	0.00±0.000		
Places at Age 4 Years Strike Rate	All Horses	No	961	14.03±0.867	0.087	0.931
		Yes	9	14.82±11.264		
	Mares	No	207	10.09±1.507	1.167	0.363
		Yes	3	44.44±29.397		
	Geldings	No	753	15.13±1.022	-14.799	<0.001
		Yes	6	0.00±0.000		
Places at Age 6 Years Strike Rate	All Horses	No	2,923	15.09±0.415	2.166	0.030
		Yes	18	26.59±5.389		
	Mares	No	645	12.46±0.820	0.399	0.690
		Yes	2	18.33±1.667		
	Geldings	No	2,273	15.80±0.478	2.067	0.039
		Yes	16	27.62±6.031		
Variable	*Group*	*Ocular Defect*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Wins at Age 8 Years Strike Rate	All Horses	No	1,478	8.40±0.481	-4.095	<0.001
		Yes	27	2.42±1.380		
	Mares	No	206	7.05±1.503	-0.652	0.515
		Yes	4	0.00±0.000		
	Geldings	No	1,270	8.58±0.503	-3.409	0.002
		Yes	23	2.84±1.608		
Places up to Age 8 Years Strike Rate	All Horses	No	4,109	12.11±0.241	2.059	0.040
		Yes	74	15.87±2.401		
	Mares	No	1,010	10.03±0.461	0.718	0.473
		Yes	20	12.44±5.205		
	Geldings	No	3,094	12.78±0.282	2.015	0.044
		Yes	54	17.14±2.678		
Variable	*Group*	*Muscle Wastage*	*n*	*Mean±S.E.(%)*	*t-value*	*Sig.*
Places at Age 5 Years Strike Rate	All Horses	No	3,027	13.90±0.432	-0.501	0.616
		Yes	23	11.41±4.258		
	Mares	No	733	9.42±0.664	1.253	0.238
		Yes	11	19.32±7.871		
	Geldings	No	2,291	15.34±0.526	-3.910	0.002
		Yes	12	4.17±2.809		
Wins at Age 6 Years Strike Rate	All Horses	No	2,911	8.61±0.336	-4.947	<0.001
		Yes	30	2.08±1.275		
	Mares	No	632	5.87±0.594	-1.016	0.310
		Yes	15	1.94±1.340		
	Geldings	No	2,274	9.39±0.396	-3.175	0.006
		Yes	15	2.22±2.222		
Places at Age 7 Years Strike Rate	All Horses	No	2,150	15.68±0.495	-1.477	0.140
		Yes	19	7.89±3.552		
	Mares	No	387	14.44±1.144	-3.728	0.004
		Yes	8	3.75±2.631		
	Geldings	No	1,761	15.93±0.548	-0.721	0.471
		Yes	11	10.91±5.793		

Horses without muscle wastage had significantly higher win strike rates at age six years than those without muscle wastage ($P < 0.001$), as shown in Table 5.69. Geldings showed similar results in the win strike rates at age six years and the place strike rates at age five years, where geldings without muscle wastage had significantly higher proportions of wins and places than geldings with muscle wastage. Mares without muscle wastage had significantly higher place strike rates at age six years than those with muscle wastage ($P < 0.05$); however, there was no significant difference in overall horses or within geldings.

There was no significant difference in the win strike rates or the place strike rates at any age for horses with or without unspecified synovial distension (data not shown, see Appendix 26, Table A.71).

5.3.13.13 Effect of Other Defects on the Number of Wins and Places up to Age Eight Years

Only horses that raced were included in the analysis for wins and places up to age eight years. In the overall sample population, horses had a mean number of 0.90 ± 1.566 wins and 1.73 ± 2.431 places up to the age of eight. There was no significant difference in the number of wins (data not shown, see Appendix 22, Table A.55) or the number of places up to age eight years for horses without or with an undershot jaw. There was however a significant difference in the number of places up to age eight years within geldings. Geldings without an undershot jaw had significantly more places up to age eight years than geldings with an undershot jaw ($P < 0.001$).

There was no significant difference in the number of wins (data not shown, see Appendix 25, Table A.67) or the number of places up to age eight years for horses without or with muscle wastage. There was however a significant difference in the number of places up to age eight years within geldings. Geldings without muscle wastage had significantly more places up to age eight years than geldings with muscle wastage ($P < 0.001$). There was no significant difference within mares.

There was no significant difference in the number of wins or the number of places up to age eight years for horses without and with oral or dental defects and features, parrot mouth, wolf teeth, ocular defects or unspecified synovial distension (data not shown, see appendices 20, 21, 23, 24 & 26).

Table 5.70: Number of Wins and Places up to Age Eight Years for Horses without and with an Undershot Jaw or Muscle Wastage

Variable	*Group*	*Undershot Jaw*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Places up to Age 8 Years	All Horses	No	4,176	1.73±0.038	-1.260	0.208
		Yes	7	0.57±0.297		
	Mares	No	1,030	1.19±0.060		
		Yes	0			
	Geldings	No	3,141	1.91±0.045	-4.442	0.004
		Yes	7	0.57±0.300		
Variable	*Group*	*Muscle Wastage*	*n*	*Mean ± S.E.*	*t-value*	*Sig.*
Places up to Age 8 Years	All Horses	No	4,144	1.73±0.038	-1.717	0.094
		Yes	39	1.28±0.260		
	Mares	No	1,012	1.18±0.061	0.570	0.569
		Yes	18	1.44±0.459		
	Geldings	No	3,127	1.91±0.046	-2.640	0.015
		Yes	21	1.14±0.287		

5.3.14 Summary of Defects

5.3.14.1 Summary of Defects for All Horses

Horses with defects, prejudicial defects, abnormal respiratory noises without RLN, RLN, lameness at sale or hoof cracks were significantly less likely to race than those without these defects. Horses with defects, prejudicial defects, abnormal respiratory noises without RLN, RLN, unilateral metacarpal/metatarsal exostoses, multiple metacarpal/metatarsal exostoses or papillomas were significantly less likely to race by age four years than those without these defects. Horses with defects, prejudicial defects, abnormal respiratory noises without RLN, RLN, parrot mouth, ocular defects or muscle wastage were significantly less likely to race by age five years than those without these defects, as shown in Table 5.71.

Horses with prejudicial defects, papillomas or an undershot jaw had significantly fewer career starts (to age eight years) than horses without these defects. Horses with prejudicial defects, RLN, SDDTS or papillomas had significantly fewer career wins (to age eight years) than horses without these defects. Horses with prejudicial defects, RLN or papillomas had significantly fewer career places (to age eight years) than horses without these defects.

Horses with papillomas had significantly lower mean earnings per start than horses without papillomas. Horses with defects, prejudicial defects, respiratory noise without RLN, RLN, bilateral tarsal plantar desmitis or papillomas had a significantly higher proportion of non-finished races per start than horses without these defects while horses with sarcoids had a significantly lower proportion of non-finished races than horses without sarcoids.

Table 5.71: Summary of Defects and Features for Horses (Compared to Horses without those Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Defects	*Raced*	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Earnings per Start*	*Non-Finishes per Start*
Defect	↓**	↓**	↓*	–	–	–	–	↑*
Prejudicial Defect	↓***	↓**	↓***	↓**	↓**	↓**	–	↑***
Respiratory Noise, No RLN	↓***	↓*	↓***	–	–	–	–	↑**
RLN	↓***	↓*	↓***	–	↓*	↓*	–	↑***
Lameness at Sale	↓**	–	–	–	–	–	–	–
Unilateral Metacarpal/ Metatarsal Exostoses	–	↓**	–	–	–	–	–	–
Multiple Metacarpal/ Metatarsal Exostoses	–	↓**	–	–	–	–	–	–
Unilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	–
Bilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	↑*
Calcaneal Bursitis	–	–	–	–	–	–	–	–
SDDTS	–	–	–	–	↓*	–	–	–
Hoof Cracks	↓*	–	–	–	–	–	–	–
Cardiac Defects	–	–	–	–	–	–	–	–
Sarcoids	–	–	–	–	–	–	–	↓***
Papillomas	–	↓*	–	↓**	↓***	↓**	↓***	↑**
Oral/Dental Defects and Features	–	–	–	–	–	–	–	–
Parrot Mouth	–	–	↓*	–	–	–	–	–
Undershot Jaw	–	–	–	↓**	–	–	–	–
Wolf Teeth	–	–	–	–	–	–	–	–
Ocular Defects	–	–	↓**	–	–	–	–	–
Muscle Wastage	–	–	↓*	–	–	–	–	–
Unspecified Synovial Distension	–	–	–	–	–	–	–	–

5.3.14.2 Summary of Defects for Mares

Mares with prejudicial defects, abnormal respiratory noise without RLN, RLN or lameness at time of sale were significantly less likely to race than mares without these defects. Mares with abnormal respiratory noise without RLN and mares with RLN were significantly less likely to race by age four years than mares without these defects. Mares with prejudicial defects, abnormal respiratory noise without RLN or those with RLN were significantly less likely to race by age five years than mares without these defects.

There was no significant difference in the number of career starts (to age eight years) for mares with or without any of the defects analysed. Mares with papillomas had significantly fewer career wins (to age eight years) than mares without papillomas and mares with calcaneal bursitis or wolf teeth had significantly fewer career places (to age eight years) than mares without these defects (Table 5.72).

Mares with papillomas or with unilateral metacarpal/metatarsal exostoses had significantly lower mean earnings per start than mares without these defects. Mares with lameness at the time of sale or cardiac defects had a significantly lower proportion of non-finished races per year raced than mares without these defects while mares with papillomas had a significantly higher proportion of non-finished races than mares without papillomas.

Table 5.72: Summary of Defects and Features for Mares (Compared to Mares without those Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Defects	*Raced*	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Earnings per Start*	*Non-Finishes per Start*
Defect	–	–	–	–	–	–	–	–
Prejudicial Defect	↓***	–	↓**	–	–	–	–	–
Respiratory Noise, No RLN	↓***	↓*	↓*	–	–	–	–	–
RLN	↓***	↓*	↓*	–	–	–	–	–
Lameness at Sale	↓*	–	–	–	–	–	–	↓***
Unilateral Metacarpal/ Metatarsal Exostoses	–	–	–	–	–	–	↓**	–
Multiple Metacarpal/ Metatarsal Exostoses	–	–	–	–	–	–	–	–
Unilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	–
Bilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	–
Calcaneal Bursitis	–	–	–	–	–	↓***	–	–
SDDTS	–	–	–	–	–	–	–	–
Hoof Cracks	–		–	–	–	–	–	–
Cardiac Defects	–	–	–	–	–	–	–	↓**
Sarcoids	–	–	–	–	–	–	–	–
Papillomas	–	–	–	–	↓**	–	↓***	↑**
Oral/Dental Defects and Features	–	–	–	–	–	–	–	–
Parrot Mouth	–	–	–	–	–	–	–	–
Undershot Jaw	–	–	–	–	–	–	–	–
Wolf Teeth	–	–	–	–	–	↓***	–	–
Ocular Defects	–	–	–	–	–	–	–	–
Muscle Wastage	–	–	–	–	–	–	–	–
Unspecified Synovial Distension	–	–	–	–	–	–	–	–

5.3.14.3 Summary of Defects for Geldings

Geldings with defects, prejudicial defects, abnormal respiratory noises without RLN, RLN or lameness at sale were significantly less likely to race than those without these defects. Geldings with defects, prejudicial defects, abnormal respiratory noises without RLN, RLN, unilateral metacarpal/metatarsal exostoses, multiple metacarpal/metatarsal exostoses, or papillomas were significantly less likely to race by age four years than those without these defects. Geldings with prejudicial defects, abnormal respiratory noises without RLN, RLN, oral or dental defects and features, parrot mouth or ocular defects were significantly less likely to race by age five years than those without these defects, as shown in Table 5.73.

Geldings with prejudicial defects, papillomas, undershot jaws or muscle wastage had significantly fewer career starts (to age eight years) than horses without these defects. Geldings with prejudicial defects, RLN or papillomas had significantly fewer career wins (to age eight years) than horses without these defects. Horses with prejudicial defects, RLN, sand cracks, papillomas, an undershot jaw or muscle wastage had significantly fewer career places (to age eight years) than horses without these defects.

Geldings with papillomas had significantly lower mean earnings per start than geldings without papillomas. Geldings with defects, prejudicial defects, respiratory noise without RLN, RLN, lameness at sale, bilateral tarsal plantar desmitis or papillomas had a significantly higher proportion of non-finished races per start than geldings without these defects while geldings with sarcoids had a significantly lower proportion of non-finished races than geldings without sarcoids.

Table 5.73: Summary of Defects and Features for Geldings (Compared to Geldings without those Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

Defects	*Raced*	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Earnings per Start*	*Non-Finishes per Start*
Defect	↓*	↓*	–	–	–	–	–	↑*
Prejudicial Defect	↓***	↓**	↓***	↓**	↓***	↓**	–	↑***
Respiratory Noise, No RLN	↓***	↓*	↓**	–	–	–	–	↑**
RLN	↓***	↓*	↓**	–	↓*	↓**	–	↑***
Lameness at Sale	↓**	–	–	–	–	–	–	↑*
Unilateral Metacarpal/ Metatarsal Exostoses	–	↓*	–	–	–	–	–	–
Multiple Metacarpal/ Metatarsal Exostoses	–	↓*	–	–	–	–	–	–
Unilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	–
Bilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	↑*
Calcaneal Bursitis	–	–	–	–	–	–	–	–
SDDTS	–	–	–	–	–	–	–	–
Hoof Cracks	–	–	–	–	–	–	–	–
Cardiac Defects	–	–	–	–	–	–	–	–
Sarcoids	–	–	–	–	–	–	–	↓***
Papillomas	–	↓*	–	↓**	↓**	↓***	↓***	↑*
Oral/Dental Defects and Features	–	–	↓*	–	–	–	–	–
Parrot Mouth	–	–	↓*	–	–	–	–	–
Undershot Jaw	–	–	–	↓**	–	↓**	–	–
Wolf Teeth	–	–	–	–	–	–	–	–
Ocular Defects	–	–	↓***	–	–	–	–	–
Muscle Wastage	–	–	–	↓**	–	↓*	–	–
Unspecified Synovial Distension	–	–	–	–	–	–	–	–

5.4 Discussion

This study utilises one of the largest sample sizes that have been examined to date in order to establish the effect of a variety of anatomical defects on a large range of performance variables, examining the racing performance of 5,282 NH horses. Most previous studies conducted in this area have focused on specific defects such as lameness (Vigre et al., 2002) or respiratory defects (Stick et al., 2001), whilst those investigating a wider range of defects examined the cause of lost training days (Bailey et al., 1999) or the cause of poor performance (Morris and Seeherman, 1991) rather than looking at the effect of specific individual defects. Sample sizes in previous studies are also smaller than the current study; for example, the studies which looked at the risk factors of lameness in Standardbreds (Vigre et al., 2002) and the impact of injuries and disease on young Thoroughbred horses in training (Bailey et al., 1999), had smaller sample sizes of 265 and 160 horses, respectively. The large sample size in the present study was beneficial as it contributed to a more statistically accurate result. Another useful attribute of this study is that it analysed a wide range of defects, unlike the majority of studies which dealt with only one particular type of defect, such as RLN or heart murmurs.

There are, however, several limitations to the study. Only the defects present on the horse, when it was presented at the sale, are included in the study. It is possible that not all of the defects present on each horse were noted in the examination and that further defects may have developed on the horses after this time. It must also be taken into consideration that only horses that were diagnosed with an abnormal respiratory noise were sent for an endoscopic examination to determine the presence of RLN and the horses were only examined at rest. A study by Dixon et al. (2001) found that approximately 90% of the horses affected with RLN produced an abnormal respiratory noise while Marti and Ohnesorge (2002) found that only 54.8% of the horses found to have RLN in their sample were found to produce an respiratory noise. Tan et al. (2005) found that 49% of the horses in their sample which had normal airways when examined at rest had defects identified when examined during exercise. This indicates that some cases of RLN in the sample may have been overlooked. Additionally, adequate information was not available regarding the British Point-to-Point results; therefore, horses racing only in these races had to be excluded from some of the analysis. Only the effect of individual defects on performance, not the cumulative effect of defects, was considered. However, other data in this thesis (chapter 3) does not suggest a strong phenotypic correlation between defects.

It was interesting to note that when investigating the effect of selling status, price realised at sale, and the range of defects on performance, many of the variables that were significantly affected when analysing all horses or only geldings, showed no effect when mares alone were analysed. It is possible that the defects had no effect on the performance of mares as their value is more closely related to their breeding function rather than their racing performance. Alternatively, as mares were retired earlier than geldings (see chapter four), potentially for breeding purposes, therefore any defects present may have had less opportunity to affect performance. It may however, be that the smaller sample size of mares may have influenced the outcome of the statistical analysis.

5.4.1 Effect of Defects and Prejudicial Defects on Racing Performance

The overall proportion of horses with some comment or defect recorded on their veterinary pre-purchase examination certificate was 75.8%. These included any defects that were noted on the pre-purchase veterinary examination certificate, ranging from scars and cuts to RLN and heart murmurs. Horses with defects were significantly less likely to race, to race by age four years, or by age five years than horses without defects. They were also significantly older at their first race than horses without defects and had fewer starts at age four years. It is possible that horses with defects were not raced until they were older in order to allow the defects to be treated or to heal. Various defects theoretically should not cause any problems after a certain amount of time. For example, papillomas will regress spontaneously within six to nine months (Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Postey et al., 2007; Radostits et al., 2007) while it is commonly accepted that metacarpal/metatarsal exostoses no longer cause pain once they have calcified or 'settled' (Baxter, 2011).

It was further found that horses with defects had significantly fewer hurdle starts and significantly more Irish Point-to-Point starts and non-finished races. There was, however, no significant difference in the number of wins or places, in the earnings per start or in the proportions that raced after age four years, indicating that the majority of the defects were not of too serious a nature. As there were many horses whose only defects were scars or scrapes, which should not have an effect on future performance, this may have diluted the effect of the more prejudicial defects, such as RLN, by raising the number of wins. It was therefore important to look at the defects judged by the veterinary panel as being prejudicial to future use as a racehorse independently from those deemed to be non-prejudicial.

Table 5.74: Summary of Effect of Defects and Prejudicial Defects on Racing Performance (Compared to Horses without Defects or Prejudicial Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Defect	↓**	↓**	↓*	–	–	–	–	↑*
Prejudicial Defect	↓***	↓**	↓***	↓**	↓**	↓**	–	↑***

5.4.1.1 Prejudicial Defects

Prejudicial defects are those defects that were classified by the examining veterinarians as likely to prejudice the horses use for racing. They were found to have a significantly negative effect on racing performance. Horses with prejudicial defects were significantly less likely to race, to race by age four years and to race by age five years than horses without prejudicial defects. They were also less likely to win or to place second in a race, were significantly older at their first race and had a significantly higher proportion of non-finished races than horses without prejudicial defects. Furthermore, horses with prejudicial defects had significantly lower overall win and place strike rates and place strike rates than horses without prejudicial defects and geldings with prejudicial defects had significantly lower win strike rates than geldings without prejudicial defects. This is as expected; prejudicial defects included defects such as RLN, lameness and sarcoids in locations likely to interfere with tack. These have been classed as likely to prejudice use as they are accepted by veterinarians and people within the industry as performance limiting defects. Previous research has also indicated that these defects are likely to negatively affect performance (Jeffcott et al., 1982; Rossdale et al., 1985; Morris and Seeherman, 1991; Kaneene et al., 1997; Bailey et al., 1999; Strand et al., 2000; Hernandez and Hawkins, 2001; Stick et al., 2001; Vigre et al., 2002; Ross, 2003; Brown et al., 2005; Bogaert et al., 2008).

Horses with prejudicial defects had fewer career starts, wins and places (up to age eight years) than horses without prejudicial defects and interestingly, while horses with prejudicial defects had significantly fewer NH starts they had significantly more Irish Point-to-Point starts than horses without prejudicial defects. This indicates that horses with prejudicial defects were directed towards the Point-to-Point circuit while those without were more likely to be entered into higher stakes races. This may indicate that trainers feel that horses with prejudicial defects have more chance of success amongst a field of unproven horses. Although horses with prejudicial defects were directed towards the less competitive Irish Point-to-Point circuit they still did not perform as well as their counterparts as they had significantly fewer wins even with significantly more starts than those without prejudicial defects.

Horses with prejudicial defects were less likely to race at ages four, five and eight, and of those that raced, horses with prejudicial defects had significantly fewer starts at these ages than horses without prejudicial defects. Horses with prejudicial defects also had lower win strike rates at ages five, seven and up to age eight years and lower place strike rates at ages five and six and up to age eight years than those without prejudicial defects. This indicates that serious prejudicial defects affect horses throughout their lives and are not resolved as they get older.

These findings agree with previous research which found that prejudicial defects such as RLN had a negative effect on racing performance, resulting in lost training days (Rossdale et al., 1985) and in horses with RLN running in fewer races than horses without RLN (Kikuta et al., 2006). They also confirm that the examining veterinarians are correct in describing these defects as prejudicial to the horses use as a racehorse.

5.4.2 Effect of RLN on Racing Performance

As stated previously, RLN is generally held to be a performance limiting condition (Lane et al., 1987; Strand et al., 2000; Stick et al., 2001; Brown et al., 2005; Kikuta et al., 2006) resulting in lost training days (Rossdale et al., 1985) and in horses with RLN running in fewer races than horses without RLN (Kikuta et al., 2006). These findings are confirmed by the results from the current study where it was found that horses without RLN were highly significantly more likely to race than those with RLN (P < 0.001). Unaffected horses also had a significantly higher mean number of NH starts per year raced than those with RLN. Interestingly, it was also found that horses with RLN raced in significantly more Ire Irish Point-to-Point races than those without RLN (P < 0.001). This may indicate that trainers feel that horses with RLN have more chance of success amongst a field of lower grade horses.

Table 5.75: Summary of Effect of Respiratory Defects on Racing Performance (Compared to Horses without Respiratory Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Respiratory Noise, No RLN	↓***	↓*	↓***	–	–	–	–	↑**
RLN	↓***	↓*	↓***	–	↓*	↓*	–	↑***

While the current study found that there was no difference in the overall likelihood of horses without and with RLN winning a race, there was, however, a difference within geldings. Geldings with RLN were significantly less likely to win, place, place second and win or place than geldings without RLN. There was however a significant difference in the overall number of races won and placed in by the age of eight for all horses (P < 0.05). Horses with RLN had significantly fewer career wins and career places (up to age eight years) than horses without RLN. Similar results were observed by Kikuta et al. (2006) who found that horses with RLN were more likely to finish 4/5 seconds or more behind the winning horse (P < 0.05). It is possible that the reduced number of racing starts for horses with RLN contributed to the decreased number of wins and places by reducing the number of possibilities of winning. However, horses with RLN were found to have significantly lower overall win and place strike rates than horses with no respiratory defects, indicating that this is not the case.

Horses with RLN were found to be significantly older at their first race and lower proportions of horses with RLN raced at ages four and five. Of those that raced, horses with RLN had significantly fewer races at ages four and five than horses without RLN; however, there was no significant difference in the number of races over the age of five. Nor was there a significant difference in the proportions that raced at ages six, seven or eight suggesting that horses with and without RLN enjoy similar career lengths. This indicates that over the age of five, RLN was no longer a problem for the horse, probably due to correction by laryngeal surgery. Previous studies have shown that laryngoplasty improved the racing speed between the race immediately before surgery and the races after surgery ($P < 0.001$) (Strand et al., 2000) and also that horses that had laryngoplasty ran significantly more races and had significantly higher race results ($P < 0.05$) than those, with RLN, that did not have surgery (Kikuta et al., 2006). This may also explain why horses with RLN showed no significant difference in the likelihood of winning from horses without RLN, as it is possible that surgery eliminated the negative effects caused by this defect. Unfortunately it was impossible to determine whether laryngeal surgery was performed on the horses suffering from RLN examined in this study.

5.4.3 Effect of Cardiac Defects on Racing Performance

The current study found that there was no significant difference in the likelihood of racing, winning or placing between those with cardiac defects and those without cardiac defects ($P > 0.05$).

Table 5.76: Summary of Effect of Cardiac Defects on Racing Performance (Compared to Horses without Cardiac Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Cardiac Defects	–	–	–	–	–	–	–	–

This was in agreement with previous studies, which found that there was no significant difference in starts per season and mean number of wins (Kriz et al., 2000), and that there was no effect on racing performance, including percentage of wins (Buhl et al., 2005). Interestingly, mares with cardiac defects were found to race in a significantly higher mean number of NH races per year raced, however, there was no significant difference observed in horses overall or amongst geldings. This may be due to the low number of mares with cardiac defects ($n = 9$), however, this result is in agreement with the findings of Young et al. (2008a), who found that there was a positive correlation between aortic regurgitation and performance in hurdle races and in steeplechases. This indicates that horses with more severe aortic regurgitation were more likely to perform well than those with lower grades of regurgitation (Young et al., 2008b). Unfortunately, in the present study, the grade and location of murmur were unknown, therefore making it impossible to investigate further.

When the racing parameters were further broken down, it was found that those without cardiac defects raced in significantly more races at age four years ($P < 0.05$), however, there was no difference at any other age. Horses without cardiac defects did however have significantly higher win strike rates at ages five and six and significantly higher place strike rates at ages five, six, seven and up to age eight years than those with cardiac defects ($P < 0.05$) indicating that cardiac defects result in poor racing performance throughout their career.

There was also a significant difference in the place strike rates for horses without and with cardiac defects. Horses with cardiac defects had significantly lower place strike rates and overall win and place strike rates than horses without cardiac defects. They also had significantly fewer places at age eight years. Horses without cardiac defects placed in a mean number of 0.82+0.03 races at age eight years compared to 0.35+0.13 for those with cardiac defects. These results signify that Buhl et al. (2005) were correct when they refused to rule out the possibility of heart murmurs decreasing the performance of older horses and indicate that further examination into this area may be beneficial.

It must be noted that these results may not be representative of all horses with cardiac defects as only 1.4% of the sample were diagnosed with cardiac defects compared to 68% in a study by Patteson and Cripps (1993). This lower incidence may possibly be attributed to the fact that the cardiac defects in the present study were diagnosed solely by use of stethoscope, and without the use of more sensitive diagnostic methods such as echocardiography.

5.4.4 Effect of Lameness and other Musculoskeletal defects on Racing Performance

5.4.4.1 Lameness at the Time of Sale

Lameness is widely reported to be the most common cause of poor performance (Ross, 2003) and loss of training days (Jeffcott et al., 1982; Rossdale et al., 1985; Kaneene et al., 1997; Bailey et al., 1999; Hernandez and Hawkins, 2001; Vigre et al., 2002). However, unlike these previous studies the current study investigated whether or not lameness at the time of sale, rather than lameness during training, affected subsequent performance.

Horses that were lame at the time of sale were significantly less likely to race than horses that were not lame at the time of sale. Similarly, Jeffcott et al. (1982) showed that 10.8% of horses did not return to racing after experiencing lameness. While the parameters analysed were different in both studies, it could be inferred that some of the causes of lameness in both studies were so severe as to prevent the horse from reaching the race track after they were affected.

There was no significant difference in the win strike rates or the place strike rates at any age for horses with or without lameness at the time of sale. There was also no significant difference in the number of lifetime starts or earnings per start indicating that past lameness may not imply recurring future lameness. Geldings that were lame at the time of sale raced in significantly more Irish Point-to-Point races and had significantly lower Irish Point-to-Point win strike rates than horses that were not lame. As there was no significant difference within NH races with regards to starts, wins or places this indicates that horses with more long term lameness problems were directed towards the Irish Point-to-Point circuit however, they still did not perform as well as their counterparts as they had significantly fewer wins even with significantly more starts.

These results indicate that lameness at the time of sale does have an effect on future performance; however, it is probable that it is the factors causing the lameness that have more of an effect on future performance rather than the lameness itself. Some of the lameness was attributed to recent injury such as getting cast at the sales venue and therefore would not be expected to have an effect on future performance.

The majority of studies investigating the association between defects and poor performance used loss of training days as the form of measurement or examine poorly performing racehorses to determine what defects or injuries they may have rather than investigating any levels of success or failure on the racetrack. Unfortunately, it is therefore difficult to compare these studies with the results of the current study.

Table 5.77: Summary of Effect of Lameness at the Time of Sale and other Musculoskeletal Defects on Racing Performance (Compared to Horses without those Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Lameness at Sale	↓**	–	–	–	–	–	–	–
Unilateral Metacarpal/ Metatarsal Exostoses	–	↓**	–	–	–	–	–	–
Multiple Metacarpal/ Metatarsal Exostoses	–	↓**	–	–	–	–	–	–
Unilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	–
Bilateral Tarsal Plantar Desmitis	–	–	–	–	–	–	–	↑*
Calcaneal Bursitis	–	–	–	–	–	–	–	–
SDDTS	–	–	–	–	↓*	–	–	–
Hoof Cracks	↓*	–	–	–	–	–	–	–

5.4.4.2 Metacarpal/Metatarsal Exostoses

Horses without metacarpal/metatarsal exostoses were significantly more likely to have raced by age four years than horses with metacarpal/metatarsal exostoses. This could be attributed to the pain that is associated with metacarpal/metatarsal exostoses as they are forming (Baxter, 2011), which is supported by earlier findings of Rossdale et al. (1985) who found that metacarpal/metatarsal exostoses caused lameness in 4% of the horse in their study. However, once ossified, metacarpal/metatarsal exostoses usually no longer cause pain or lameness and therefore should not affect performance (Baxter, 2011). This is evident in that there was no significant difference in the number of starts, wins or places once the horses were older. There was however an interesting result found in the win and place strike rates at age five years. Strangely horses with unilateral metacarpal/metatarsal exostoses had higher win strike rates at age five years than horses without metacarpal/metatarsal exostoses or with multiple metacarpal/metatarsal exostoses and mares with unilateral metacarpal/metatarsal exostoses had significantly higher place strike rates at age five years than mares without metacarpal/metatarsal exostoses. This indicates that owners should not be concerned if their horse has a metacarpal/metatarsal exostosis as they do not appear to have a long-term negative effect on racing performance.

5.4.4.3 Tarsal Plantar Desmitis

There was no significant difference in the likelihood of racing, the number of career starts, wins or places or the earnings per start for horses without or with tarsal plantar desmitis. This was at variance with the findings of Dolvik and Klemetsdal (1999), who reported that horses with "curby hocks" (conformation predisposed to tarsal plantar desmitis) were less likely to have raced by age five years and had significantly lower earnings. Tarsal plantar desmitis were however, found to have a negative effect on some other aspects of racing performance. Overall, comparable proportions of horses without and with tarsal plantar desmitis raced in NH races (82.9% vs 80.7%) and in Irish Point-to-Point races (46.2% vs 48.9%), however, horses with bilateral tarsal plantar desmitis had significantly fewer NH starts and horses with unilateral or bilateral tarsal plantar desmitis had significantly more Irish Point-to-Point starts than horses without tarsal plantar desmitis. This indicates that the horses with tarsal plantar desmitis were directed towards the Point-to-Point circuit while the horses without tarsal plantar desmitis were more likely to be entered into NH races. Horses with bilateral tarsal plantar desmitis had a significantly higher proportion of non-finished races than horses without tarsal plantar desmitis. Tarsal plantar desmitis results from a strain of the plantar tarsal ligament caused due to poor conformation or as a result of a trauma (Major and Zubrod, 2006; Baxter, 2011; Ross and Dyson, 2011). This strain may weaken the hock resulting in the horse being less able to cope with the demands of higher level races and causing them to pull up or fall more frequently than horses without tarsal plantar desmitis. It is possible that bilateral tarsal plantar desmitis indicate that the tarsal plantar desmitis are due to poor conformation which can result in continuing problems with lameness (Baxter, 2011). These findings are in agreement with Major and Zubrod (2006) and Ross et al. (2002) who state that tarsal plantar desmitis can be performance limiting and cause lameness (Rooney, 1981).

5.4.4.4 Calcaneal Bursitis

Calcaneal bursitis were not found to have a serious impact on racing performance. Horses without calcaneal bursitis had significantly higher place strike rates at age six years than those with calcaneal bursitis ($P < 0.05$) and mares without calcaneal bursitis had significantly higher place strike rates at ages four and eight and significantly higher NH win strike rates ($P < 0.001$); however, there was no significant difference for any of the other performance variables. This is consistent with Stashak's (2011) observation that calcaneal bursitis do not cause lameness although affected horses may display considerable swelling in the area. There were however, more significant differences observed within affected mares. Mares without calcaneal bursitis had significantly more wins at ages four and eight and significantly more places at ages four, six and eight and up to age eight years ($P < 0.05$) than those with calcaneal bursitis. Almost double the proportion of mares had calcaneal bursitis in contrast with geldings, 6.5% compared to 3.3%. Calcaneal bursitis are caused by trauma to the area such as from kicking a wall. This may be due to the more nervous temperament of mares compared to geldings (Valberg, 2006) which in turn may negatively affect their racing performance.

5.4.4.5 Synovial Distension of the Digital Tendon Sheath

Horses with SDDTS had significantly fewer starts at age five years, significantly fewer lifetime wins (up to age eight years) and significantly lower Irish Point-to-Point win strike rates than horses without SDDTS ($P < 0.05$). This indicates that while SDDTS did not prevent horses from racing, they did have a negative effect on the number of wins. This disagrees with reports from Marks (1999) who states that they are insignificant with regards to performance. Poor knee and hoof conformation is a contributing factor to SDDTS (Anderson et al., 2004) and it is possible that it is in fact this poor conformation that may be causing the poor performance rather than the presence of SDDTS. It was further found that geldings with SDDTS had significantly fewer hurdle starts per year raced and strangely, that mares with SDDTS had significantly higher place strike rates at age six years and up to age eight years than mares without SDDTS ($P < 0.05$). There were only 53 mares with SDDTS so this small sample may have resulted in some irregularities.

5.4.4.6 Hoof Cracks

Horses with hoof cracks were significantly less likely to race and had significantly fewer starts at age four years than horses without hoof cracks. Hoof cracks have previously been reported to cause pain and lameness and therefore negatively affect performance (Wilson and

Pardoe, 1998; Pardoe and Wilson, 1999; O'Grady, 2001) however, no effect was observed on starts at any other age or overall starts. This indicates that this effect may be eliminated by regular hoof maintenance during training, thus correcting the problem in later years. Corrective treatment to stabilise the hoof wall can prevent further weakening and cracking (Pardoe and Wilson, 1999) and allow the horse to resume training and racing (O'Grady, 2001) therefore it is probable that horses with hoof cracks were treated to allow them to continue with their racing careers. There was however, a significant difference in the win strike rate at age seven years within mares ($P < 0.001$). Those with hoof cracks had significantly lower win strike rates compared to those without hoof cracks. This may indicate that the weaker hoofs prevent the horses running as fast as their competitors.

5.4.5 Effect of Sarcoids and Papillomas on Racing Performance

5.4.5.1 Sarcoids

Horses with sarcoids had significantly fewer Irish Point-to-Point starts per year raced and significantly fewer starts at age four years than horses without sarcoids ($P < 0.05$). It is possible that this was due to the horse being treated for the sarcoids and therefore not being entered into as many races as those without sarcoids until they were five. However, they had significantly higher NH win strike rates, a significantly lower proportion of non-finished races and significantly higher win strike rates and overall win and place strike rates than horses without sarcoids. This is interesting as physiologically, there is no apparent reason why sarcoids should improve performance, in fact, the common perception within in the industry would be to advise against purchasing a horse with sarcoids. However, this is more likely due to possible future spread of these lesions rather than impaired performance, unless the sarcoids were located in areas that would interfere with the bridle or the saddle/girth (Bogaert et al., 2008). It has however, been observed in some horses that successful removal of sarcoids may result in improved performance (Knottenbelt, 2005).

Table 5.78: Summary of Effect or Sarcoids and Papillomas on Racing Performance (Compared to Horses without Sarcoids or Papillomas)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Sarcoids	–	–	–	–	–	–	–	↓***
Papillomas	–	↓*	–	↓**	↓***	↓**	↓***	↑**

5.4.5.2 Papillomas

Papillomas had a significant effect on racing performance. Horses with papillomas were less likely to race by age four years, less likely to win, less likely to place and less likely to place third than horses without papillomas ($P < 0.05$). They also had significantly fewer career starts, wins and places than horses without papillomas and significantly fewer starts per year raced, fewer NH starts and significantly lower NH place strike rates than horses without papillomas. There was no significant difference in the number of Irish Point-to-Point starts for horses with or without papillomas; however, horses with papillomas had significantly lower Irish Point-to-Point win strike rates than horses with papillomas. Horses with papillomas were less likely to race at ages four and seven and had fewer starts at ages four, five (geldings only) and eight than horses without papillomas. They also had lower win strike rates at ages five (mares only) and eight and up to age eight years and lower place strike rates at age six years. Finally, horses with papillomas had a significantly higher proportion of non-finished races, significantly fewer earnings per start and significantly lower win strike rates and overall win and place strike rates than horses without papillomas. As papillomas are caused by a virus, their presence may indicate an impaired immune system (Radostits et al., 2007; Smith et al., 2009). This might prevent horses with papillomas being at their peak fitness or level of performance. However, it is commonly noted that papillomas usually should not affect the horse beyond aesthetics and that they usually spontaneously regress within six months (Ghim et al., 2004; Pilsworth and Knottenbelt, 2007; Postey et al., 2007; Radostits et al., 2007). They are also most commonly found in young horses (Pilsworth and Knottenbelt, 2007; Radostits et al., 2007). It is therefore surprising that so many variables were negatively affected and such a wide range of ages. It is possible that the majority of the papillomas were located in areas where they would affect the tack as it has been stated that papillomas can also cause problems depending on their location (Postey et al., 2007). However, this is unlikely as they are usually located on the face and the genitals (Radostits et al., 2007).

5.4.6 Effect of Other Defects on Racing Performance

5.4.6.1 Oral or Dental Defects and Features

Oral or dental defects and features can affect performance in two ways. They can cause oral discomfort or pain, resulting in head shaking or bit evasion, which takes the horses concentration away from performance (Lane, 1994; Scoggins, 2001; Bryant, 2004) and they can also result in mastication problems which may result in inadequate nutrition and loss of condition (Ford, 1960; Lane, 1994; Linkous, 2005). It was therefore surprising to find that horses with oral or dental defects and features had significantly more starts at ages five and seven and significantly more steeplechase starts per year raced than horses without oral or dental defects and features. This could possibly be attributed to horses with confirmed oral or dental defects and features being provided with better and more frequent dental care and treatment than horses with no oral or dental defects and features at time of purchase. If more care was taken with their teeth this may have improved their performance during training, resulting in an increased number of starts. They did however have fewer Irish Point-to-Point starts than horses without oral or dental defects and features. Again, better subsequent dental care may have resulted in them being directed away from the Irish Point-to-Point circuit towards the more demanding steeplechase races. Oral or dental defects and features did however have a negative effect when looking at mares and geldings independently. Affected geldings were less likely to race by age five years and were significantly older at their first race ($P < 0.05$). It is possible that they were not entered into races as early as geldings without oral or dental defects and features in order to allow for corrective treatment. Mares had significantly lower win and place strike rates at age five years than those without oral or dental defects and features, there was however, no significant difference at any other age. Again, this may indicate that oral or dental defects and features affect performance, but once treated no longer pose a risk.

Table 5.79: Summary of Effect of Oral or Dental Defects and Features on Racing Performance (Compared to Horses without Oral or Dental Defects and Features)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Dental Defects and Features	–	–	–	–	–	–	–	–
Parrot Mouth	–	–	↓*	–	–	–	–	–
Undershot Jaw	–	–	–	↓**	–	–	–	–
Wolf Teeth	–	–	–	–	–	–	–	–

Horses with parrot mouth were less likely to race by age five years and were older at their first race than horses without parrot mouth. They also had fewer Irish Point-to-Point starts, starts at age four years and lower win strike rates at age five years and age six years. Horses with parrot mouth can have difficulties chewing food depending on how severely they are affected. This may result in inadequate nutrition (Radostits et al., 2007) and loss of condition which would impair performance.

Like parrot mouth, horses with an undershot jaw can have difficulties with mastication which can result in inadequate nutrition (Radostits et al., 2007) and loss of condition. This would prevent the horse being at their peak level of fitness and impair performance. This appears to be the case for the horses in the sample as those with an undershot jaw had significantly fewer career starts and starts at age five years than those without an undershot jaw. They also had significantly lower win strike rates at age six years and lower place strike rates at five and six while geldings with an undershot jaw had significantly fewer career places than those without an undershot jaw. Horses with an undershot jaw did however have significantly more places at age four years than horses without an undershot jaw.

Wolf teeth are seen as undesirable in a horse as they can interfere with the action of the bit causing pain to the horse (Linkous, 2005). It would therefore be expected that wolf teeth would have a negative effect on performance; however, this was not always the case. Horses with wolf teeth had significantly more steeplechase starts and overall NH starts (geldings only) per year raced and significantly higher place strike rates at age six years. Mares with wolf teeth had significantly more career places than those without wolf teeth. Lower win (all horses and geldings) and place strike rates (geldings only) were observed at age four years for animals with wolf teeth compared to those without wolf teeth. It is possible that the presence of wolf teeth interfered with the bit resulting in fewer wins and places. However, as no negative effect was observed at any later ages, this indicates that the wolf teeth were removed, therefore eliminating their negative effect.

5.4.6.2 Ocular Defects

Vision is very important in a NH racehorse allowing them to see the fences, railings and other horses. If the vision is impaired this could be detrimental to their success. Rossdale et al. (1985) found that ocular injuries caused lost training days, which may in turn have affected the likelihood of the horses racing. This was similar to the findings of the current study. Geldings with ocular defects had significantly fewer overall starts per year raced, significantly fewer Irish Point-to-Point starts per year raced, significantly lower Irish Point-to-Point place strike rates and significantly higher NH place strike rates than those without ocular defects. Horses with ocular defects were less likely to race by age five years and were older at their first race than horses without ocular defects. They also had lower win strike rates at age eight years and higher place strike rates up to age eight years than horses without ocular defects. It is likely that some of the ocular defects were acute, affecting them at the time but then healing while others got progressively worse and began to affect the horses when they were older.

Table 5.80: Summary of Effect of Other Defects on Racing Performance (Compared to Horses without those Defects)

*Sig. * = p<0.05, ** = p<0.01, *** = p<0.001*

	Raced	*Raced by 4*	*Raced by 5*	*Career Starts*	*Career Wins*	*Career Places*	*Mean Earnings*	*Mean Non-Finishes*
Ocular Defects	–	–	↓**	–	–	–	–	–
Muscle Wastage	–	–	↓*	–	–	–	–	–
Unspecified Synovial Distension	–	–	–	–	–	–	–	–

5.4.6.3 Muscle Wastage

Horses with muscle wastage had significantly fewer starts at ages four and eight, lower win strike rates at age six years and lower NH win strike rates than horses without muscle wastage. Mares with muscle wastage had significantly lower place strike rates at age seven years than mares without muscle wastage while geldings with muscle wastage had significantly fewer career starts, career wins, second places per year raced and lower place strike rates at age five years than geldings without muscle wastage. Muscle wastage on the hind quarters has been associated with hind limb lameness (Henson, 2009); therefore, it is possible that horses with muscle wastage are more likely to go lame from training, resulting in fewer starts.

5.4.6.4 Unspecified Synovial Distension

Horses with unspecified synovial distension had significantly fewer starts at ages five, seven and eight (geldings only), significantly lower win strike rates at age eight years (mares only) and significantly higher NH place strike rates (mares only). This is similar to the results for SDDTS, which is unsurprising as SDDTS are a form of unspecified synovial distension (Baxter, 2011). They did however, have less of an effect on the number of wins than SDDTS. These results indicate that unspecified synovial distensions do not have a great impact on the performance of the horse and have a similar effect to that of SDDTS.

5.5 Conclusion

Each of the defects (except sarcoids) analysed adversely affected some aspect of future racing performance. Defects classified by the examining veterinarians as likely to prejudice the horses use for racing were found to negatively affect a wide range of performance variables while those that were classified as not likely to prejudice the horses use for racing were found to have an effect on fewer variables.

Certain defects such as papillomas and tarsal plantar desmitis which were classified as non-prejudicial significantly and adversely affected a wide range of performance variables.

The results indicate that defects identified in the pre-purchase examination play a significant role in racing performance and indicate that husbandry, management or selective breeding to reduce the incidence of these defects in the NH population might improve overall racing performance.

Overall, the results show the usefulness and importance of veterinary pre-purchase examination certificates. The benefits include the capability to indicate potential difficulties in future racing ability. Without this examination purchasers would be unaware that more than 10% of the horses offered were potentially unsuitable for their intended career. As the results confirm that prejudicial defects are indeed prejudicial to the horse's career and result in financial loss, the pre-purchase examination system implemented by the sales companies is very useful to the purchasers and can play an important role in their selection of horses for purchase.

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