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Risk factors associated with musculoskeletal injuries in Australian Thoroughbred racehorses

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Abstract

Risk factors for musculoskeletal injury in racing Thoroughbreds were investigated in a case-control study conducted at racetracks administered by the Australian Jockey Club. Univariable analysis of 137 cases from the official Veterinary Surgeon's reports and an equal number of randomly selected controls from the Australian Race Results identified field size, barrier position and class of race as being significantly associated with breakdown ($P < 0.05$). Multiple logistic regression was then used to investigate the effect of each putative risk factor whilst controlling for all others. Horses at greater risk were older, started from a wider barrier position, ran at the same distance as their previous race and raced in the highest class of race. There was no significant difference between tracks or significant association with track condition. The incidence of fatalities in the study population was less than that reported in the UK and USA. © 1997 Elsevier Science B.V.

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1. Introduction

Breakdowns or musculoskeletal injuries sustained on racetracks have been investigated by a number of workers in different countries throughout the world (Hill et al.,

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1986; Haynes and Robinson, 1989; Mohammed et al., 1991; Ueda et al., 1993; Peloso et al., 1994; Bourke, 1995; Estberg et al., 1995, 1996; McKee, 1995; Wilson et al., 1996). Putative risk factors have included exercise level, distance, cumulative racing-speed exercise distance, age, sex, racing weight, track, track condition, position on track and pre-existing pathology. However, conclusions with regard to some of these variables, such as track condition and surface, have been equivocal (Hill et al., 1986; Haynes and Robinson, 1989; Mohammed et al., 1991; Wilson et al., 1996), and most of the studies dealt with the factors in isolation. An exception was the study by Mohammed et al. (1991), which used multivariable techniques to investigate the factors associated with injuries on New York Racing Association tracks. Mohammed and his colleagues identified the following factors as being significantly associated with a higher risk of breakdown: dirt track surfaces (compared with turf); certain racecourses; summer (compared with winter or spring); racing in an earlier race; fewer seasons in racing; fewer starts per year; a lower number of total starts; older racehorses.

Estberg et al. (1996) also used logistic regression in the investigation of fatal musculoskeletal injuries in California, focusing on the effects of age, sex and race-meet. Males were reported to be at higher risk than females, as were 4-year-olds when compared with 3-year-olds. The type of race-meet (major vs. fair) was not found to be a significant risk factor.

With regard to the Australian racing industry, Bourke (1995) studied fatalities at race meetings in Victoria and although his study population included horses destroyed for serious musculoskeletal injury, the factors associated specifically with this group were not investigated. The industry in Australia is a major contributor to Gross Domestic Product, races exclusively on grass throughout the year, and has an emphasis on the racing of 2-year-olds. Breakdowns directly associated with racing represent a loss to the industry, and the identification of risk factors is an important step towards minimising such wastage.

From a preliminary survey of the opinions of trainers in the Sydney area, musculoskeletal injury was considered to be a major reason for days lost from training (Bailey et al., 1997). Furthermore, the trainers believed that race and training track design were the most important issues for future research, reflecting the perception that breakdown rates at different tracks varied. The objectives of the present study were to identify factors associated with musculoskeletal injuries at two of the largest Sydney racetracks administered by the Australian Jockey Club (AJC), and to use multivariable techniques to investigate the inter-relationship of the risk factors.

2. Materials and methods

2.1. Population: Selection of cases and controls

The investigation was in the form of a retrospective study conducted in 1995. The population of animals at risk were all horses racing at either Randwick or Warwick Farm racetracks during the period 1 August 1985 to 28 February 1995. Cases were

identified from the reports of the veterinary surgeon at each racecourse, which were maintained by one of the authors (CJS) over the period of study. The definition of a case was any horse that was recorded in the Veterinary Surgeon's reports by the attending veterinarian as having a musculoskeletal injury and that then failed to race or trial for 6 months from the date of the injury. The 6-month period was used in order to include only serious musculoskeletal injuries ('breakdowns'), and so that our study would be

Table 1

Categorical variables investigated for their association with musculoskeletal breakdown in horses racing at Randwick or Warwick Farm between August 1985 and February 1995

Variable	Category and codings	Number of horses	
		Controls	Cases
Age	≤ 4 years, 0	99	89
	> 4 years, 1	38	48
Gender	Female, 0	44	48
	Male, 1	93	89
Track	Warwick Farm, 0	48	38
	Randwick, 1	89	99
Track condition	Fast	16	24
	Good	74	76
	Dead	22	22
	Slow	18	10
	Heavy	7	5
Class of race	Non-Stakes race, 0	122	108
	Stakes race, 1	15	29
Field size	≤ 10 horses, 0	34	21
	> 10 horses, 1	103	116
Barrier position	1–6, 0	82	62
	7–12, 1	43	57
	13–18, 2	12	18
Change in distance from previous race	Same, 0	32	40
	Decrease, 1	37	25
	Increase, 2	68	72
Season	Summer, 0	52	47
	Autumn, 1	25	33
	Winter, 2	32	22
	Spring, 3	28	35
Age at first start	2 years, 0	93	83
	> 2 years, 1	44	54
Racing year	Aug. 85–Jul. 86	13	16
	Aug. 86–Jul. 87	17	14
	Aug. 87–Jul. 88	10	15
	Aug. 88–Jul. 89	14	18
	Aug. 89–Jul. 90	12	9
	Aug. 90–Jul. 91	7	17
	Aug. 91–Jul. 92	12	11
	Aug. 92–Jul. 93	21	17
	Aug. 93–Jul. 94	20	13
	Aug. 94–Feb. 95	11	7

comparable with that of Mohammed et al. (1991). Inspection procedures did not differ between the two tracks. An equal number of control animals was randomly selected from horses listed in the Australian Race Results. The randomization mechanism involved random number generation from a uniform distribution. Only those animals that had raced at either of the two racetracks were considered eligible for inclusion. For both cases and controls, any animal with missing data was excluded from the analysis. In the instance of an animal being selected twice, the details associated with the first appearance in the records were used in the investigation.

2.2. Data

The variables or factors recorded for each horse are presented in Tables 1 and 2. Track conditions are categorized according to the amount of rain which had affected the track, and ranged from 'fast' (hardest and driest), followed by 'good', 'dead' and 'slow', to 'heavy' (the most rain-affected). Stakes races are the highest level of competition and include Group and Listed races. In addition to these factors, an average resting period between races was included to represent a strain variable, calculated by dividing the number of days since the first race start by the total number of starts.

2.3. Statistical analysis

An initial screening was performed to identify those variables that had little or no association with disease. Student's *t*-test was used for continuous variables, and χ^2 -tests and odds ratios were calculated for categorical variables. All variables significant at $P \leq 0.25$ were considered eligible for inclusion in the multiple logistic regression analysis (Hosmer and Lemeshow, 1989). Dummy variables were generated for any categorical variable with more than two levels. Backward elimination was used to determine which factors could be dropped from the multivariable model. The level of significance for a variable or factor to remain in the final model was set at 10%. Biologically meaningful interaction terms among the explanatory variables were examined after identification of the reduced set main effects. Each interaction was added to

Table 2

Continuous variables investigated for their association with musculoskeletal breakdown in horses racing at Randwick or Warwick Farm between August 1985 and February 1995

Variable	Median	
	Controls	Cases
Total number of starts	12	13
Days since first start	442	500
Race number	5	4
Distance of race (m)	1400	1400
Weight carried (kg)	53	53
Distance of previous race (m)	1400	1300
Days since previous race	14	14
Average days rest	30	31

the model and the significance assessed in the same way as for the explanatory variables. The goodness-of-fit of the model was assessed by the Hosmer–Lemeshow statistic (Lemeshow and Hosmer, 1982), and outliers were assessed by inspection of the square of the standardised residuals, the leverage and the predicted probability. All statistical analyses were performed using Statistix version 4.1 (Analytical Software, Tallahassee, FL).

3. Results

3.1. General

During the period under investigation, there were 57 831 race starts in 4 682 races. One hundred and thirty-seven cases of musculoskeletal injury were identified in the records of the Veterinary Surgeon at the two racecourses. The incidence rate of musculoskeletal breakdown (according to the case definition) per start was approximately 0.24% (2.4/1000 starts), whilst the incidence rate of fatalities (died or euthanased on course) for any reason among all starts was 0.04% (0.4/1000 starts), and the rate due to musculoskeletal injury alone was 0.03% (0.3/1000 starts).

3.2. Univariable

The results of the univariable screening are summarised in Table 3. Three factors were significant at $P < 0.05$. The odds ratio (95% confidence interval) for class of race was 2.2 (1.1, 4.5). This means that horses racing in a Stakes race were more than twice as likely to suffer a musculoskeletal injury as those in a non-Stakes race, ignoring all other factors and variables. The odds ratio for running in a field of more than ten animals relative to running in a field of less than or equal to ten horses was 1.8 (1.0, 3.5). Horses starting from the outer and middle one-thirds of the track had odds ratios of 1.8 (1.0, 3.0) and 2.0 (0.8, 4.8), respectively, relative to those starting closest to the rail.

Table 3
Significance levels resulting from the univariable screening of factors associated with breakdown

Not significant ($P > 0.25$)	Significant at $P \leq 0.25$ ^a	Significant at $P < 0.05$ ^a
Previous race distance	Age	Field size
Gender	Days since first start	Barrier position
Race number	Days since last start	Class
Total number of starts	Distance difference	
Distance	Track	
Weight	Age at first start	
Track condition		
Season		
Racing year		
Average days rest		

^a Eligible for inclusion in initial multivariable model.

Table 4

Coefficients, standard errors, odds ratios and 95% confidence intervals from the multiple logistic regression model for factors associated with the risk of injury in horses at two Sydney Metropolitan racetracks

Variable	Coefficient	Standard error	Odds ratios (95% CI)
Constant	-0.33	0.29	-
Age			
≤ 4 years	0		1
> 4 years	0.56	0.28	1.8 (1.0, 3.0)
Barrier position			
1–6	0		1
7–12	0.64	0.27	1.9 (1.1, 3.2)
13–18	0.71	0.43	2.0 (0.9, 4.8)
Distance change			
No change	0		1
Decrease	-0.79	0.37	0.5 (0.2, 0.9)
Increase	-0.19	0.30	0.8 (0.5, 1.5)
Class of race			
Non-Stakes	0		1
Stakes race	0.83	0.36	2.3 (1.1, 4.6)

3.3. Multivariable

All variables significant at $P \leq 0.25$ (Table 3) were included in the initial model. Age, barrier position, distance change from previous race and class of race were significant in the final model (Table 4). The Hosmer–Lemeshow statistic was 4.73 with seven degrees of freedom ($P = 0.7$) and so the model was judged to fit the observed data well.

4. Discussion

Variability in the definitions of racing injuries make direct comparisons of incidence figures difficult. However, the low incidence of fatalities in the present study is of particular note. For those arising for any reason, the incidence rate of 0.04% per racing start was lower than that reported by McKee (1995) in a study involving horses in the UK (0.08%), whilst the 0.03% resulting from a musculoskeletal catastrophe was considerably lower than the 0.14% reported by Peloso et al. (1994) in the USA. Our findings on fatalities are similar to data from another Australian state (Bourke, 1995), where the incidence rate of all fatalities was reported to be 0.03%. The reasons for this difference between Australian tracks and those elsewhere are not immediately apparent. It is unlikely that horses in the Australian racing industry are inherently more resilient, and it would seem that features of training and track design, together with differences in weather and track surface features, may be important.

In our investigation we have addressed putative risk factors for musculoskeletal injury (including fatalities) occurring during racing and being sufficiently severe to warrant a veterinary report and preclude racing for 6 months. Independent assessment of each of the variables and factors suggested that the class of race, the field size and the barrier position were significantly associated with injury. Racing in a Stakes race, in a large field size, and starting from a wider barrier position all increased risk. However, the latter two variables illustrated the need for a multivariable approach: animals starting from a wide barrier position were unlikely to be competing in small field sizes. The two factors were demonstrably inter-related or collinear with each other. The racing year in which the horse started was not a risk factor for musculoskeletal breakdown. This lack of temporal association is not surprising, since no major changes were made to the two racetracks or the system of racing during the study period.

In our multivariable model, the only significant factors were age, barrier position, class of race and the difference in distance from the previous race. All these variables were treated as categorical. Of the intrinsic factors listed by Mohammed et al. (1991), only age was of significance, with horses over 4 years of age being 1.8 times more likely to suffer an injury than those 4 years old or less. This is not surprising given that older horses are more likely to have been exposed to greater lifetime repetitive microtrauma from racing and training (Pool and Meagher, 1990). Our findings support those of Haynes and Robinson (1989) and Mohammed et al. (1991).

With regard to barrier position, those animals closest to the rail were nearly half as likely to suffer a musculoskeletal injury as those starting in the outer two-thirds of the track. This may be due to the extra effort and competition encountered by those animals attempting to move to the rail from a greater distance. In addition, the banking of the track on the outer circumference may also play a role in the increased risk of breakdown (Dalin et al., 1973; Rooney, 1983). The lack of a clear 'dose-response' relationship may be due to some horses settling to the rear of the field when starting from very wide barrier positions, and the fact that there are fewer races with large field sizes. Barrier position was considered collinear with field size, which was not significant in the final model. Interaction between the two variables was not significant.

The risk associated with the change in distance from the previous race is more difficult to assess. From our study, those animals running at increased or decreased distance were at less than half the risk of injury than those racing at the same distance as the previous race. However, a proportion of the animals that were included as racing at an increased distance were running in their first race. If these animals are removed from the analysis, the significance associated with increased distance is further reduced, leaving the sparing effect of running at reduced distance predominant and the rest of the model unaltered.

The risk of breakdown associated with running in a Stakes race was 2.3 times higher than that in a non-Stakes race. The former events may be more competitive by nature owing to the potential rewards and the type of animal they attract. Training leading up to these events may also be more exacting, and as breakdown has been related to pre-existing and sometimes subclinical pathological changes (Stover et al., 1992), this increase in risk might be expected. All horses were subject to the same degree of scrutiny, regardless of the class of race, discounting the possibility of detection bias.

A number of factors found to be significant in the study of Mohammed et al. (1991) were not associated with risk in our investigation. To some extent, this may be accounted for by obvious differences between the industries in the two countries and by the increased variation within variables common to the two. For example, track surfaces are more varied in the United States than in Australia owing to the use of both grass and dirt, and climatic changes associated with season are less dramatic in the Sydney area than in New York State. In consideration of a strain variable, Mohammed et al. (1991) used number of starts per season and found it to be significant, whilst we used number of days rest between races, which did not qualify for the final model. Essentially, these measures are the inverse of one another. Estberg et al. (1995) noted that prolonged periods of absence from racing often dilute career estimates of exercise intensity, providing a possible explanation for the lack of association between musculoskeletal injury and the strain variable in our study.

5. Conclusion

Multiple logistic regression identified age, barrier position, change in distance from previous race and class of race as being significant risk factors for musculoskeletal injuries sustained at two Sydney racetracks. The lack of a significant difference between the two racetracks refutes any suggestion that one track had a higher incidence of breakdown than the other, assuming that there was no detection bias in the study. The same Veterinary Surgeon attended both tracks, and inspection procedures did not differ.

Finally, although the odds of becoming injured may be quite high for some factors, the absolute incidence of serious injury is very low at both tracks, and horses racing at them appear to be as safe or safer than horses racing at tracks in the UK and USA.

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