



Australian Government

Rural Industries Research and
Development Corporation

Health and Safety in Australian Horse Racing

RIRDC Publication No. 10/067





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Development Corporation**

Health and Safety in Australian Horse Racing

by C Foote, A McIntosh, P V'Landys, K Bulloch

March 2011

RIRDC Publication No 10/067
RIRDC Project No PRJ-000765

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ISBN 978 1 74254 040 5
ISSN 1440-6845

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Electronically published by RIRDC in March 2011
Print-on-demand by Union Offset Printing, Canberra at www.rirdc.gov.au
or phone 1300 634 313

Foreword

Jockeys and track riders may face personal hardship and a limited career span due to a range of issues, including major (or a series of minor) injuries sustained whilst competing in races, barrier trials or track work. Impacts from injuries associated with horse racing are numerous. At an individual level there are the direct losses associated with the injury such as medical costs, loss of work time, rehabilitation and required support of friends and family. These costs are borne directly by individuals and also by the racing industry and community at large. At an industry level, injuries lead to increased Workcover and other insurance premiums, departure of persons from the industry and reputation damage.

This report describes risk factors associated with injuries to jockeys involved in Thoroughbred racing and evaluates currently available safety equipment and standards. Firstly, stewards' reports and insurance claim data were analysed to obtain an accurate indication of the incidence and risk factors associated with horse falls in Thoroughbred racing. The second part of the project involved the implementation of a national incident database to allow for analysis of current injury priorities to both horse and rider, and to enable ongoing review of the effectiveness of intervention strategies, such as the introduction of new helmets and alternative body protectors. The benefit of having access to informed data will be to target a reduction in human and horse injuries and associated costs across the Australian Thoroughbred racing industry. Finally, in collaboration with the University of New South Wales, a critical review of the protective capabilities of currently used helmets and current standards and their appropriateness under Australian conditions was conducted. This work resulted in the development of an alternative prototype helmet designed to meet more stringent safety standards which may be better suited to prevent the types of injuries being sustained. By aligning testing methods more closely to actual injuries and events, riders will benefit from the outcomes of the research as improved equipment should provide maximum protection.

This project was funded by RIRDC from industry revenue which is matched by funding provided by the Australian Government.

This report is an addition to RIRDC's diverse range of over 2000 research publications and it forms part of our Horse R&D program, which aims to assist in developing the Australian horse industry and enhancing its export potential.

Most of RIRDC's publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation

Acknowledgments

This project required a major national collective effort in developing a team with a range of skills including those relevant to project management, epidemiology, medical knowledge, information transfer and practical horsemanship. The project was under the supervision of the National Jockey Safety Review Committee (NJSRC). The working group included the following key members:

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We extend our gratitude to the following (*indicates also member NJSRC):

Racing NSW: *Mr Ray Murrhly (Chief Stipendiary Steward), Mr Marc Van Gestel (Deputy Chairman of Stewards, Dr Craig Suann (Senior Veterinary Surgeon), Mr Maurice Logue (General Manager Education and Employment), *Mr Ron Quinton (Jockey Liaison Officer).

Racing Victoria Limited: *Mr Des Gleeson (Chief Stipendiary Steward), *Mr David Charles (Jockey Welfare Officer), Mr Chris Watson (General Manager Training).

Racing and Wagering Western Australia: *Mr John Zucal (Chief Stipendiary Steward), Mr Ron Fleming (Training Manager).

Australian Racing Board: *Mr Geoff Bloom (Board Member), Mr Andrew Harding (Chief Executive), Dr Caron Jander (National Medical Officer)

University of NSW, School of Risk and Safety Sciences: Dr B Fréchède (Research Fellow), Declan Patton (PhD Student), Kim Thai (PhD Student)

Dr Nigel Perkins (AusVet Animal Services); Dr Tom Gibson (Human Impact Engineering); Dr Michael Turner (Chief Medical Officer the Jockey Club UK); Professor John Carlson (Victoria University); *Mr Des O'Keefe (Victorian Jockey's Association); *Mr Paul Innes (Australian and NSW Jockeys Association); Mr Ros Inglis (Australian Jockey's Association); Mr Brendan Markey (Markey's Saddlery); Mr Richard Boyd (Horsewear International); Mr Rob Casson (RC's helmets).

And to the jockeys, in particular:

Glen Boss, Darren Gauci, Mark de Montfort, *Darren Beadman, Greg Childs, *John Grisedale, Hugh Bowman, James Innes, Allan Robinson, Shane Dye, Craig Williams, Darren Gauci, Ray Silburn, Brent Stanley, *Stephen Baster, *Damien Oliver, Matthew Cahill

This review is dedicated to these elite athletes including those killed in tragic circumstances on the tracks over the years.

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Executive Summary

Background

Thoroughbred Racing in Australia is one of the most competitive sports of its type anywhere in the world. Jockeys and track riders may face personal hardship and a limited career span due to a range of events, including injuries sustained whilst competing in races, barrier trials or track work. These injuries are of concern for the racing industry for reasons including moral and legal obligations to provide a safe working environment; economic loss; loss of jockeys from the industry; a national shortage of track work riders; and public perception.

There is a paucity of information on the incidence and type of injuries suffered by professional jockeys in Australia. As a consequence injury rates and risk factors associated with injuries in Australia are poorly documented. There exists a need to compile available information on injuries to both horse and rider in Australia which would allow for regular analysis of current injury priorities and enable ongoing review of the effectiveness of intervention strategies.

The industry perception of the currently available equipment is that the vest is restrictive and provides limited ventilation under the extreme Australian environmental conditions, and that the helmet could be improved to afford better protection. There has been a suggestion that current safety standards can be improved for Australian conditions. It is desirable that standards be reviewed with the aim of developing one which better reflects the types of injuries being sustained to riders, and which is appropriate for the hot conditions experienced in this country.

Aims/objectives

The overall aim of this project was to identify the incidence and risk factors associated with jockey injuries and to investigate current and alternative safety equipment and standards.

The project had the following objectives:

1. To conduct a retrospective analysis of jockey injuries and risk factors associated with injuries;
2. To develop an accurate and extensive national database of injuries and incidents to persons (and horses) participating in the Australian Thoroughbred Racing Industry;
3. To evaluate jockey safety equipment and review new standards for the equipment.

Methods used

A number of studies were conducted to address these objectives. These included:

1. An Australian jockey survey designed to obtain information on jockeys' perception of the helmets, vests and other gear;
2. A retrospective analysis of jockey injuries. Studies were conducted to identify bodily location and nature of injuries; the incidence of injuries; and also the effect of the introduction of the vests in 1998;
3. A modification, adoption and implementation of a national Thoroughbred web based Australian Racing Incident Database (ARID); and
4. Evaluation and development of a high performance helmet under stringent European standards.

Results and recommendations

Australian Jockey Survey

A survey was conducted as part of this research to obtain the opinions of the jockeys on current safety equipment, standards and overall working conditions. Overall, jockeys reported that current vests were restrictive and poorly ventilated and most respondents felt helmets did not provide them with adequate protection. The majority of jockeys also wanted to see the minimum riding weight lifted. As a result of this initial work, changes were made to minimum riding weights for feature races which had been in some instances markedly lower than standard races.

Retrospective analysis of jockey injuries

The first part of this study simply analysed the bodily location and nature of injuries being reported in insurance claims in NSW and Victoria due to falls from a height. The majority of injuries were sustained in the lower and upper extremities and in the shoulder region. Injuries in the back region were also significant, accounting for 14% of all insurance claims. Fractures and sprains and strains were the most common nature of injury. The currently available protective equipment aims to protect bodily areas which account for only 28% of the injuries sustained. Shoulder injuries are significant in racing as are upper and lower limb injuries, in total contributing to approximately 60% of the injuries reported in insurance claims. There is currently no protective gear recommended for the upper and lower limb or the shoulder region. This study identifies the potential need for research and development of such protection.

The second part of this study provides an accurate indication of incidents (accidents/injuries) in Australian racing. The total recorded incident rate for NSW was calculated as 0.29%, which equates to approximately one incident in every 330 starts, or approximately one incident in every four race meetings. Nearly 60% of all incidents involved the rider being dislodged. The total injury rate for NSW was calculated as 0.17%, which equates to approximately one injury in every 500 starts, or approximately one injury in every six race meetings. Barrier injuries accounted for a total of 27% of all injuries. This second study provides a descriptive report of injury incidence and the locations on the track that are associated with injury among professional jockeys in Australia. The potential need for research and development into alternative body protection particularly for the upper limbs, the shoulder region and the lower limbs particularly the leg and foot are identified.

The purpose of the third study was to investigate whether there has been a change in the number of injury claims made due to falls from a height as a result of the introduction of the vests in December 1998. Interpretation of the insurance claim data had severe limitations, however overall the data gave no indication that there has been any significant decrease in the number of back, neck, chest or rib claims due to falls from a height in the five years following the introduction of the vests. The data suggests that although there has been a reduction in the number of insurance claims in the period following the introduction of the vests, the number of incidents of injury remains higher than acceptable. Further investigation into alternative body protectors is warranted.

Australian Racing Industry Database

A comprehensive review of the requirements to modify and adapt the Australian Racing Industry Database (ARID) into an existing racing system was undertaken. The jockey and horse incident forms are now in use in a number of States and data collected are being entered into the national database. As the statistical data grow, a range of reports will be available to allow researchers, doctors and veterinarians to conduct analysis on the pattern of injury, with an aim of improving safety standard for the industry.

Evaluation of jockey safety equipment and safety standards

Jockeys and track work riders currently wear helmets approved to one of three standards. However, in contrast to these there exists a European High Performance Standard (EN14572) that promotes a higher level of impact protection against severe head trauma than other standards. Currently, no helmets certified to this standard are available for purchase in Australia (or, to the best of our knowledge, anywhere in the world). In the first part of this work, five popular models of jockey helmets were tested to this European standard. Alternative helmet liner materials were also tested. None of the helmets tested met the requirements of the high performance standard. As a consequence, alternate helmet liner materials were researched and tested inside existing shells. The best liner materials proved to be dual density combinations of polyurethane and expanded polypropylene with polymer honeycomb also showing promising results. Two prototype helmets were then constructed incorporating a liner made from dual density and materials. The prototypes demonstrated that in comparison to the standard helmets improvements could be made to impact energy attenuation using impacts between 1 and 2.5 metres. The prototype however did not reveal any significant advantages from low drop points (1.0 metre) and at the highest energy impact compared well against the best commercially available helmet. The prototype testing reinforced the direction of the research. These materials were further assessed in a helmet design using the numerical simulation package MADYMO. This method allows for a cost-effective way to explore and evaluate different helmet configurations using a computer. The tests confirmed that it is possible to design a helmet that would meet or would come very close to meeting the requirements set out by the much higher European standard. Further prototype testing was undertaken with a selection of different shells and liners based on the results at that point in time. Significant improvements in helmet performance were achieved with the prototypes, exemplified by peak headform accelerations being recorded at 240 G for 2.75 m drop height tests. The prototypes exceeded greatly the requirements of existing standards and came close to meeting aspects of the High Performance Standard. Changes to the helmets required to meet the high impact performance in mass and usability need to be considered in terms of jockey acceptance. This work provides a strong basis for future helmet development and interaction with a helmet manufacturer.

Relevance and benefits

The main beneficiaries of this research will be the Australian racing industry, and the jockeys themselves. The racing industry is the third largest industry in Australia. 391 race clubs conduct race meetings at 364 tracks around the country. 31,600 horses compete annually in 20,000 races, with total starters nearing the 200,000 mark. \$421,000,000 in prize money is distributed to owners and licensed professionals;- 4700 trainers and over 1000 registered jockeys compete for a share of the spoils. Many more thousand stable hands, stud hands and tradesman also earn part or all of their living through racing.

Racing activity derives income from two main resources; wagering investment, and non wagering activity such as racecourse attendance gate takings, catering and function income and other related promotional activities. If the occurrence of injury to riders can be reduced, and altogether health and safety improved, it means that more riders will compete more often and for longer periods, improving confidence in the industry in general.

It is difficult to quantify the benefits of this research in exact dollar terms. Aside from the personal impact on earnings that a long term injury inflicts on the rider him/herself, there is an overall but largely unmeasurable cost to the industry. For example, a highly skilled and well known leading jockey can add dollar value to a racing carnival by recognition of name, attendance at media launches and promotional functions, and of course ability and skill on the racetrack that may attract specific following amongst punters. Absence from such event, whether city or country race meetings, undoubtedly have a financial impact on the industry. Also, the loss of any rider for a period of time impacts financially on racing in general terms as he/she may be the only track rider/stable jockey for

some trainers, a favoured race rider by particular owners, or generate a following amongst punters who may choose not to bet if their favourite jockey is absent.

Thirdly, the cost of insurance and expenses that are incurred by jockey injury impact on the entire industry, as Workers Compensation and Public Liability insurance costs are reviewed annually and adjusted according to claims. Payment of levies is borne by jockeys (public liability) and trainers/owners (workers compensation). Any increase in fees that can be prevented, or decrease in fees if research strategy outcomes result in less claims would benefit the industry.

In regard to non financial benefit, the personal impact of injury of jockeys can be ‘measured’ physically, emotionally and socially. Any injury, whether short or long term, can have debilitating effects on the rider’s career and personal life. Reduction of incidence of injury is paramount to the objectives of this research.

Introduction

Thoroughbred Racing in Australia is one of the most competitive sports of its type anywhere in the world. Jockeys and track riders may face personal hardship and a limited career span due to a range of events, including major (or a series of minor) injuries sustained whilst competing in races, barrier trials or track work. These injuries are a concern for the racing industry for reasons including moral and legal obligations to provide a safe working environment; economic loss; loss of jockeys from the industry; a national shortage of track work riders; and public perception.

Occupational health and safety is of critical importance to Australian racing. In recent years, a number of serious and sometimes fatal injuries have been incurred by riders and horses whilst participating in races, barrier trials or track work. The focus on the health and safety of jockeys, and this project in particular, complements and extends the occupational health and safety position adopted by the industry.

Epidemiology of injury incidence and causation in Thoroughbred racing

There is a paucity of information on the incidence and type of injuries suffered by professional jockeys. Many of the published studies are case reports of serious injuries rather than injury epidemiology. In the US, Press et al. reported a retrospective questionnaire study of 706 experienced professional jockeys and their injuries and health concerns. Fractures were the most common (64% of total injuries), followed by concussion (8%) and joint dislocation (7%). Of the fractures, 41% were upper limb, 24% were lower limb, 12% were rib fractures, 10% were spinal fractures, 9% were skull fractures, and 3% were hip/pelvis fractures. In a study entitled "Injuries in professional horse racing in Great Britain and the Republic of Ireland during 1992-2000" by Turner et al. (2002), in contrast to the US study, most injuries were soft tissue (80%), and upper limb/clavicle fractures predominated. This may in part be related to the surface on which horse racing occurs, but is more likely to be because jockeys take soft tissue injuries as part and parcel of everyday life and often omit details of them from any questionnaires. More recently, a Tasmanian group reported on a retrospective analysis of data on race-day falls from stewards' reports provided by the Principal Racing Authority of each state and territory of Australia from August 2002 until July 2006 (Hitchens et al., 2009). Falls were reported to occur at a rate of 0.42 per 100 rides in flat races and 5.26 per 100 rides in jumps races. In flat racing, 55% of falls occurred before the start of the race and 11% occurred post-race. The 34% of falls that occurred during flat races resulted in 62% of the injuries sustained. In jumps racing, most falls occurred at a jump and 10% of jockeys who fell were transported to hospital and/or declared unfit to ride. Fall and injury rates were comparable with those found in the United Kingdom, Ireland, France and Japan.

Protective equipment is a mandatory requirement for jockeys and track riders in Australia. In 2004, a RIRDC publication explored the use of the currently available vests and their influence on neck injury frequency in Australia (McLean, 2004). An increase in neck injuries was observed in the four years following the introduction of the vests, however as there was no other information obtained regarding circumstances under which the injuries were sustained, the author stated this increase may have arisen due to factors unrelated to the requirement to wear the protective vest.

In reviewing available data for this project, it became very clear that injury rates and risk factors associated with injuries in Australia are poorly documented. This reflects the reported lack of data collection that can only be achieved through a national database of injuries and incidents. There exists a real and urgent need to compile available information on injuries to both horse and rider in Australia. This would allow for regular analysis of current injury priorities and would enable ongoing review of the effectiveness of intervention strategies, such as the introduction of new helmets and alternative

body protectors. This risk management approach is in line with best practice in many sports and industries.

Effectiveness of current safety equipment and standards

Protective helmets are generally constituted by two main layers. As described by Mills (Mills, 1996), the shell should absorb energy, distribute local forces from impact, protect as much as possible of the head (including face and temples), prevent the foam liner from fracturing, and slide easily on the impact surface. Similarly, the foam liner should provide a stopping distance for the head, protect as much as possible of the head, provide a close fit to the head shape and contribute to the stiffening of the helmet.

Jockeys and track work riders in NSW are currently required¹ to wear helmets approved to either of the following standards:

- AS/NZS 3838:2003 Helmets for horse-riding and horse related activities
- ASTM F1163-01 Standard Specification for Headgear Used in Horse Sports and Horseback Riding
- British Standard (BS) EN 1384/1996 (and onwards) Specification for helmets for equestrian activities

In the Australian Standard, helmet samples are conditioned under ambient (18 to 25°C), cold (-10°C) and hot (50°C) temperatures, water immersion and solvent treatment prior to testing. The helmets are strapped to the appropriate sized ISO headform and dropped in a guided fall onto a steel anvil. In these tests, the peak acceleration measured at the headform centre of mass must not exceed 300G. Additionally, the duration in which the headform acceleration exceeds 200G shall not exceed 3ms, and 150G for 6 ms. AS/NZS 3838 includes two impact test configurations:

- 1.5 metre drop on to the flat anvil
- 1.3 metre drop on to the “V” anvil

The ASTM F1163 and EN 1384 helmets offer similar levels of protection. ASTM has a 300G requirement for a 1.8 metre drop on to the flat anvil, and a 1.3 metre drop on to the hazard anvil. EN 1384 specifies a 250G requirement for a 1.5 metre drop on to the flat anvil only.

In the European High Performance standard (EN 14572), helmet samples are exposed to 50°C, -20°C, UV radiation and water conditioning prior to testing. The Standard includes the following tests for impact energy attenuation and loading:

- 2 metre drops on to the hazard and hemispherical anvils: 250g max. peak headform acceleration, >150g for max. 5 ms.
- 3 metre drop on to the flat anvil: 250g max. peak headform acceleration, >150g for max. 5 ms.
- 1 metre drop on to the flat anvil: 80g max. peak headform acceleration.
- Resistance to penetration: 0.5 metre striker drop onto helmet, striker shall not leave an indentation on the test block.

¹ Racing NSW, “Rules of Racing of Racing NSW – as amended 19 November 2009”.
<http://www.racingnsw.com.au/site/content/document/00000401-source.pdf>

- Lateral crush: 180J lateral impact (7.5kg @ 2.45 metres), headform load shall not exceed 10kN.

EN 14572 promotes a higher level of impact protection than other standards, however there are currently no helmets certified to this standard available for purchase in Australia. Further, it was not known how current jockey helmets performed against EN 14572 requirements.

Objectives

The overall aim was to identify the incidence and risk factors associated with jockey injuries and to investigate current and alternative safety equipment and standards.

Therefore the project had the following objectives:

1. To conduct a retrospective analysis of jockey injuries and risk factors associated with injuries
2. To develop of an accurate and extensive national database of injuries and incidents to persons (and horses) participating in the Australian Thoroughbred Racing Industry
3. To complete evaluation of jockey safety equipment and the development of new standards for the equipment

These aims were addressed within the following studies:

Australian Jockey Survey

A total of 229 jockeys from across Australia were surveyed on a variety of health and safety issues. The jockeys were asked to comment on their vests, helmet and other gear, riding weight, weight reduction strategies, working hours and injuries.

Retrospective analysis of jockey injuries

Review of bodily locations of injury and nature of injuries sustained by jockeys and track work riders due to a fall

Insurance claim data resulting from “falls from a height” were obtained from Racing NSW and Racing Victoria Ltd over a 12 year period (1992 – 2004). The data were used to review the bodily locations of injury to jockeys and track work riders and the nature of injuries sustained due to a fall.

Review of fall/injury incident data obtained from NSW race days over a three year period

All NSW Stewards’ reports were analysed for fall/injury incidents over the period Mar 2003 to Mar 2006. Unlike the insurance data, these data represents a true fall injury/incident rate for race-days.

Analysis of insurance claims prior to and following the introduction of the vests

Insurance claim data resulting from “falls from a height” were obtained from Racing NSW and Racing Victoria for the five year period prior to (August 1993 – July 1998) and following the introduction of the vests (August 1999 – July 2004). The data were then studied to investigate any changes in the number of claims made, the bodily location of claims and the nature of the injuries for the two periods. In order to then determine if the vests have influenced the injury rates and locations, specific bodily locations associated with the vests were examined, that is, the back, chest, neck and ribs.

Development and implementation of a national Thoroughbred web based incident database

The aim of this part of the project was to implement an operational system called ARID (Australian Racing Industry Database) within the racing industry, and to establish linkages with existing industry databases to provide maximum benefit from the data being analysed.

Evaluation and development of a high performance helmet

In collaboration with the University of New South Wales, the final part of the project firstly involved the evaluation of currently available helmets and their ability to withstand the European testing requirements and secondly the development of a prototype helmet designed to aim to meet these more stringent requirements.

1. Australian Jockey Survey

A total of 229 jockeys from across Australia were surveyed on a variety of health and safety issues. The respondents were located in the following areas:

- NSW (metropolitan (25 respondents) provincial tracks (28 respondents) and country (Wagga Wagga (10 respondents), Hunter and North-West (11 respondents), Dubbo (10 respondents), Port Macquarie (17 respondents));
- Victoria (26 respondents);
- Western Australia (24 respondents);
- Queensland (78 respondents).

The jockeys were asked to comment on their vests, helmet and other gear, riding weight, weight reduction strategies, working hours and injuries.

Vests worn by race-day jockeys

The vests most frequently worn by jockeys were the Racesafe (53% of respondents), followed by the Ozvest (31%) and the Tipperary (4%). It should be noted that many jockeys own more than one type of vest and alternate them depending upon what minimum weight is required in each particular race.

Rating of the vests and other equipment

The jockeys were asked to rate the vests according to how flexible they are, how restrictive they are, how hot they get in them and how protective they are from falls and kicks. Due to the small number of jockeys wearing the Tipperary and Ransome vests, results are shown for the Racesafe and Ozvests only.

The majority of Racesafe and Ozvest wearers found their vests to be moderately to slightly flexible (Fig 3.1), and moderately to slightly restrictive (Fig 3.2). The majority of Ozvest and Racesafe wearers found they became extremely to moderately hot wearing the vests (Fig 3.3) and the majority of wearers of both vests found them moderately protective against falls (Fig 3.4) and kicks.

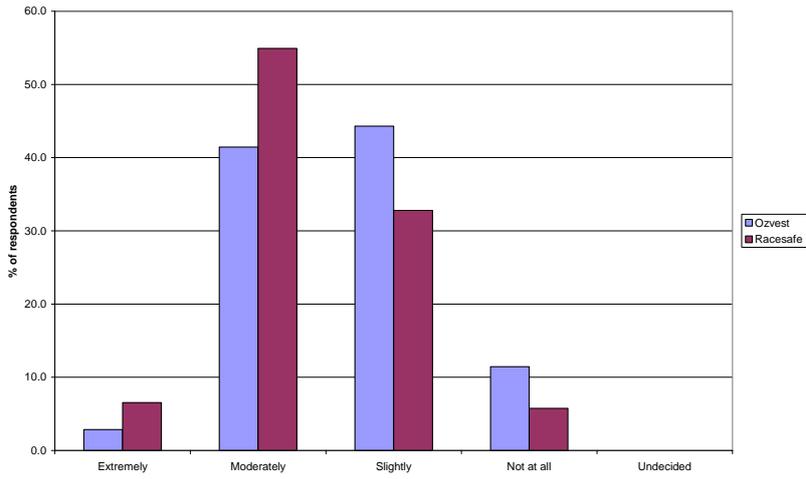


Figure 1.1 Flexibility of Ozvest and Racesafe vests according to surveyed jockeys

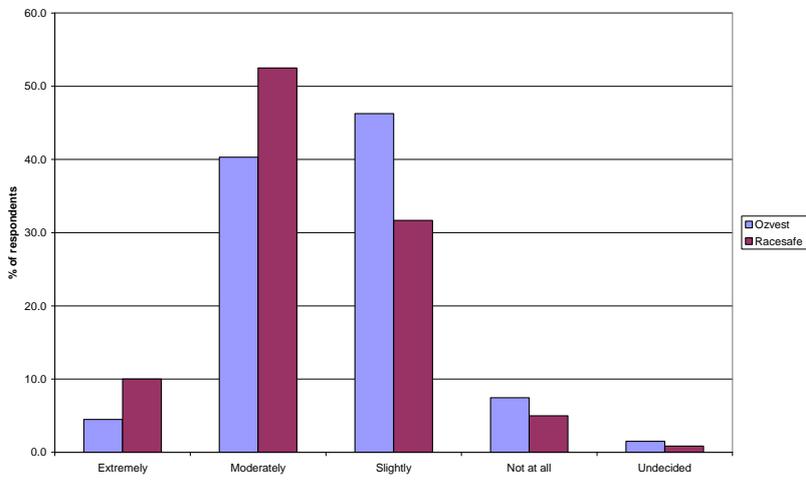


Figure 1.2 Restrictiveness of Ozvest and Racesafe vests according to surveyed jockeys

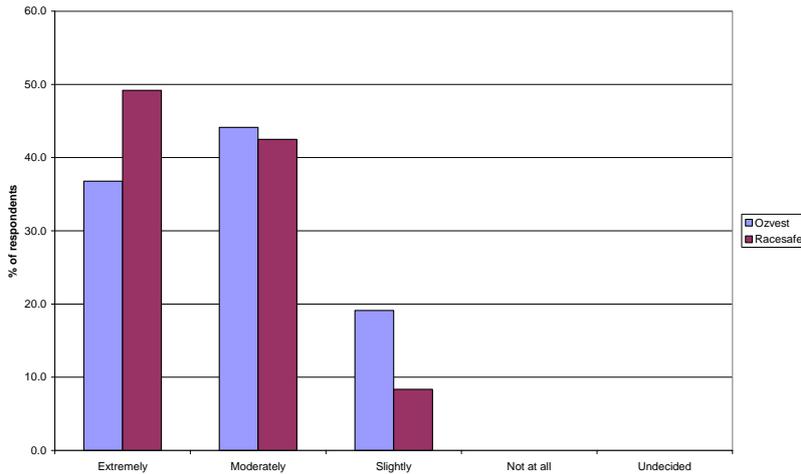


Figure 1.3 Heat retention of Ozvest and Racesafe vests according to surveyed jockeys

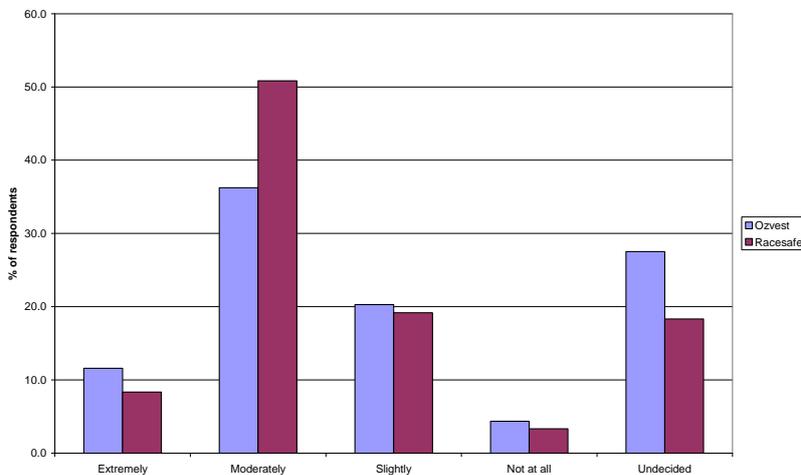


Figure 1.4 Protection of vests during a fall according to jockeys surveyed

A total of 17% of all riders believe the vests have contributed to injuries of the neck, collarbone and ribs (9% of Ozvest wearers and 20% of Racesafe wearers)

64 respondents (28%) believe the current helmets do not provide adequate protection. When asked what additional areas the jockeys would like to see protected; 21% of respondents identified the jaw; 27% identified the face; 11% identified the nose and 3% identified the neck as an additional area.

10% of respondents admitted to not following a routine checking of gear prior to each rider. Of all respondents, 3% do not routinely check stirrup leathers and 8% do not check lead weights are fitted correctly.

Riding weight

Approximately 40% of jockeys ride at a minimum riding weight of 53kg. Figure 3.5 describes the spread of the minimum riding weight of respondents. When asked what a jockey’s “ideal” riding weight would be, the spread of weights changes, with a total of 70% of riders wanting the ideal minimum riding weight to be 53kg or higher as shown in Figure 3.6. 62% of respondents would like to see the minimum weight lifted.

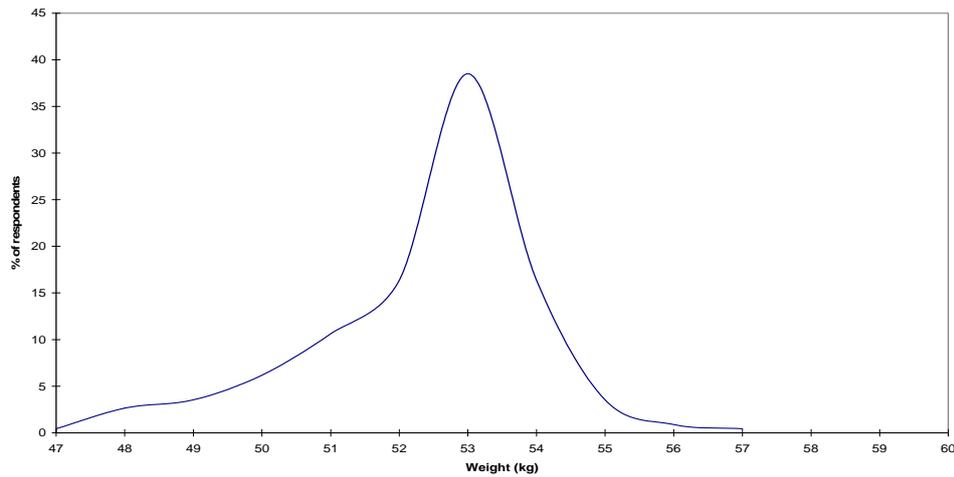


Figure 1.5 Spread of the current minimum riding weight of respondents

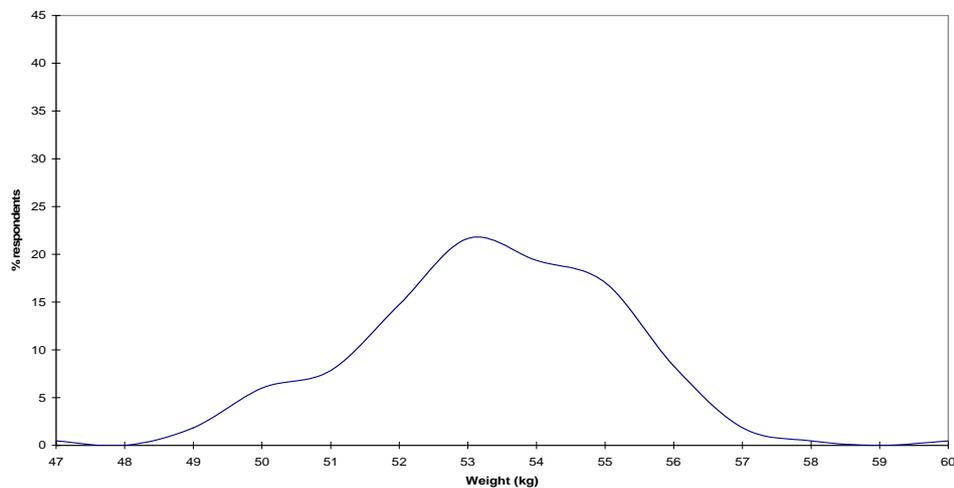


Figure 1.6 Spread of "ideal" minimum riding weight.

Weight reduction strategies

In a typical week of riding, the average variation in weight of respondents was 2.4kg. Methods for losing weight included diet (65% of respondents); exercise (72%); the sauna (46%) and the spa (37%).

Working hours

The average number of hours that a jockey would spend riding track work on a race-day was 3 hours. The average working day including travelling was 10 hours. The average number of days worked in a row was 6 days.

Injuries

Injuries sustained during career

Jockeys were asked what injuries they have sustained in their riding career. The results are shown in Table 1.1.

Table 1.1 Percentage of jockeys who have sustained an injury during their riding career

| Injury type | % of jockeys who have sustained an injury |
|--------------------|--|
| Fracture | 78 |
| Spinal injury | 20 |
| Head injury | 57 |
| Facial injury | 45 |
| Shoulder injury | 52 |
| Sprain/strain | 77 |

Time off due to injury

When asked how much time each jockey had taken off due to injuries in the past 12 months, the average figure was calculated to be 5 weeks. Furthermore, half of the jockeys surveyed claimed to have at least one injury in the last 12 months which resulted in more than 5 days off. This equates to an annual single injury rate of 500 per 1000 (compared to the rate of 15 in 1000 for all employees in NSW (Workcover)).

2. Retrospective analysis of jockey injuries

Review of bodily locations of injury and nature of injuries sustained by jockeys and track work riders due to a fall

Insurance claim data resulting from “falls from a height” were obtained from Racing NSW and Racing Victoria Ltd over a 12 year period (1992 – 2004). The data were used to review the bodily locations of injury to jockeys and track work riders and the nature of injuries sustained due to a fall.

A total of 1565 claims were received in NSW and Victoria over a twelve year period (1992 – 2004) due to falls from a height. These claims were then categorized into bodily locations and nature of injuries. Figure 4.1 describes the bodily location of these claims, while Figure 4.2 depicts the nature of these injuries.

Bodily location of injuries

Limb injuries made up a total of 40% of claims, with 25% of claims due to injuries of the lower limb and 15% of claims due to injuries of the upper limb. A total of 17% of all claims were due to shoulder injuries, followed by back injuries which made up 14% of claims. Head, neck and rib injuries each accounted for 5-7% of claims, while all other injuries, chest, face, abdomen, accounted for less than 5% of claims.

Nature of injuries

Fractures and sprains and strains accounted for nearly three-quarters of all injury types sustained resulting in claims due to falls from a height. Contusions and crushings made up 14% of injury claims with the remaining 15% of claims due to open wounds, soft tissue injuries (STI), intracranial injuries, dislocations and other injuries.

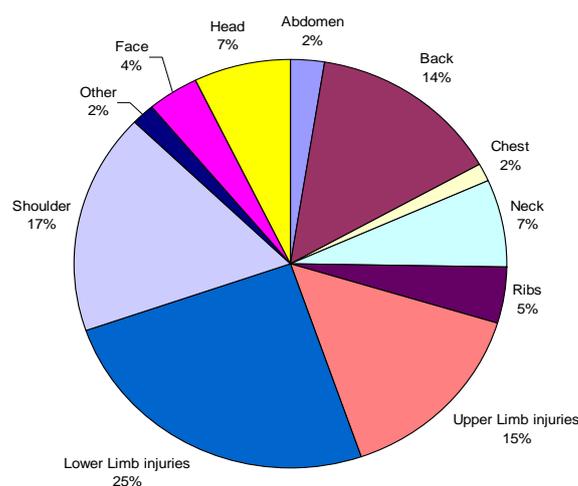


Figure 2.1 Pie chart illustrating the bodily location of injuries recorded in NSW and Victorian claims made due to falls from a height

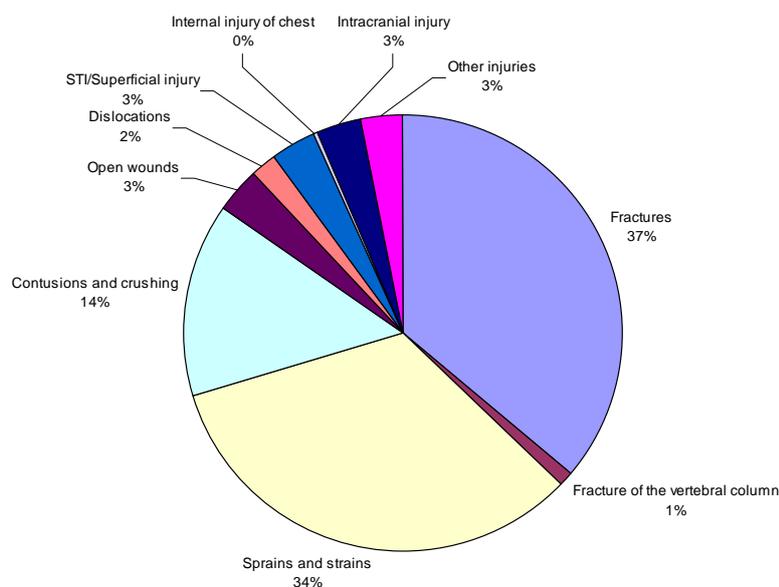


Figure 2.2 Pie chart illustrating the nature of injuries recorded in NSW and Victorian claims made due to falls from a height

Discussion

The first part of this study simply analysed the bodily location and nature of injuries being reported in insurance claims in NSW and Victoria due to falls from a height. The majority of injuries were sustained in the lower and upper extremities and in the shoulder region. Injuries in the back region were also significant, accounting for 14% of all insurance claims. Fractures and sprains and strains were the most common nature of injury. Many of the published studies are case reports of serious injuries rather than injury epidemiology. In the US, Press et al., (1995) reported a retrospective questionnaire study of 706 experienced professional jockeys and their injuries and health concerns. Similar to the results of the current study, fractures were the most common (64% of total injuries), followed by concussion (8%) and joint dislocation (7%). Of the fractures, 41% were upper limb, 24% were lower limb, 12% were rib fractures, 10% were spinal fractures and 9% were skull fractures, and 3% were hip/pelvis fractures. In contrast to the US study, a British study (Turner et al., 2002) found most injuries were soft tissue (80%), and upper limb/clavicle fractures predominated. This may in part be related to the surface on which horse racing occurs, but is more likely to be because jockeys take soft tissue injuries as part and parcel of everyday life and often omit details of them from any questionnaires. It should be noted that the data analysed in the current study were insurance claim data, and like the US study, it is likely that some of the more minor injuries including the soft tissue injuries were not included in the analysis. Also similar to the findings of the current study, Bixby-Hammett and Brooks (1990) reported injury rates to be highest in the upper and lower extremities. The currently available protective equipment aims to protect bodily areas which account for only 28% of the injuries sustained. Shoulder injuries are significant in racing as are upper and lower limb, in total contributing to approximately 60% of the injuries reported in insurance claims. There is currently no protective gear recommended for the upper and lower limb or the shoulder region. This study identifies the potential need for research and development of such protection.

Review of fall/injury incident data obtained from NSW race-days over a three year period

All NSW Stewards' reports were analysed for fall/injury incidents over the period Mar 2003 to Mar 2006. Unlike the insurance data, these data also represent recorded incidents allowing for the calculation of a fall injury/incident rate for race-days. Frequencies were calculated based on an average of 169485 starters over the three years and the data were used to determine the frequency of incidents, injuries and factors associated with injuries. A summary of the collected data is shown in Appendix 1.A.

Incident frequency

A total of 493 fall/injury incidents were recorded over the three year period. The race-day incident rate was calculated to be 0.29% (incident incidence/ride %). Of these incidents there were 283 injuries, 125 non-injuries and 85 unknown outcomes. 18% of all incidents occurred at the barriers. 58% of all incidents involved the rider being dislodged and 10% of all incidents involved the horse falling. There was a race-day rider fall incident rate of 0.17% (fall incident/ride %).

Injury frequency

57% of all incidents resulted in injury. The total injury rate in NSW over the three year period was 0.17% (injury incidence/ride %). 89% of all barrier incidents resulted in injury. 39% of all incidents involving the rider being dislodged resulted in injury. 77% of all incidents involving the horse falling resulted in injury.

Factors influencing injuries

27% of all injuries occurred in the barriers. 40% of injuries involved the jockey being dislodged. 14% of injuries were a result of the horse falling and 26% of all injuries involved apprentices. 12% of injuries were on metropolitan tracks.

Barrier injuries

Over a quarter of all injuries occurred in the barriers. Table 2.1 describes the bodily location of injuries sustained by jockeys due to barrier incidents. The jockey's foot and leg were the most vulnerable areas in the barriers resulting in over half of the injuries sustained.

Table 2.1 Bodily location of injuries due to barrier incidents

| Bodily location | % of barrier injuries |
|-----------------|-----------------------|
| Foot | 31 |
| Leg | 21 |
| Ankle | 13 |
| Knee | 10 |
| Other | 25 |

Injuries due to jockey being dislodged

40% of all injuries involved the jockey being dislodged. Table 2.2 summarises the locations on the racecourse where the jockeys were dislodged over the three years studied. While the majority of

jockeys were dislodged during the race, a large proportion of jockeys were dislodged before the race on the way to the barriers, or behind the barriers. 16% of all dislodgements occurred after the post, while a number of jockeys were dislodged in the enclosure (12%).

Table 2.2 Location of dislodgement of the jockeys

| Location of jockey dislodged | % |
|------------------------------|----|
| Enclosure | 12 |
| Before race | 24 |
| During race | 48 |
| After race | 16 |

Discussion

The second part of this study provides an accurate indication of the incidents in Australian racing. The data were collected from stewards' reports from a three year period and all fall/injury incidents were recorded (not just those which resulted in an insurance claim). The total incident rate for NSW was calculated as 0.29%, which equates to approximately one incident in every 330 starts, or approximately one incident in every four race meetings. Nearly 60% of all incidents involved the rider being dislodged. The total injury rate for NSW was calculated as 0.17%, which equates to approximately one injury in every 500 starts, or approximately one injury in every six race meetings. This injury rate is identical to the injury rate recorded in flat racing in Great Britain and very similar to the injury rate for flat racing in Ireland (0.15%) (Turner et al., 2002). 39% of all incidents involving the rider being dislodged resulted in injury which is also very similar to the findings of Turner et al., 2000 for Great Britain and Ireland (injury incidence/fall % for Great Britain and Ireland was 40.4% and 39.9% respectively).

Barrier injuries accounted for a total of 27% of all injuries. This figure is supported by a US study (Waller et al., 2000) which showed that 35% of injuries occurred when the horse was entering, within or leaving the starting gate. Similar to the findings of this current study, the US paper described a significant number of injuries to the leg and the foot in the barriers. This study by Waller et al., (2000) also identified the home stretch and the finish line as common sites for injury events. In this current study, 35% of injuries due to the rider being dislodged occurred in the home straight or at the finish line (data not shown). The barriers present a great opportunity for the jockey to be crushed against a rigid surface by the horse. Injuries incurred in the barriers may be reduced by padding or altering the shape of the gate.

This second study provides a descriptive report of injury incidence and the locations on the track that are associated with injury among professional jockeys in Australia. All jockey injuries in this study were captured. The potential need for research and development into alternative body protection particularly for the upper limbs, the shoulder region and the lower limbs particularly the leg and foot are identified. Injuries in the barriers need to be addressed and alternative barrier protection such as protective boots for jockeys, and alternative padding on the gates may be justified. It does not however address any "horse" factors which may be contributing to these incidents. Factors such as horse age, state of training, level of fitness. Nor does it address any other factors which contribute to these incident rates such as track and environmental conditions. This research also reiterated the call for national jockey and horse injury surveillance, centrally compiled and annually analysed, which would create an opportunity to better understand the injury profiles of jockeys and horses and develop protocols to reduce injury, hence the development of the ARID database was included in this project.

Analysis of insurance claims prior to and following the introduction of the vests

Insurance claim data resulting from “falls from a height” were obtained from Racing NSW and Racing Victoria for the five year period prior to (August 1993 – July 1998) and following the introduction of the vests (August 1999 – July 2004). The data were statistically analysed relative to the number of starters in each period (Appendix 1.B) however due to the nature of the database, it was impossible to separate race day, track work and barrier trial incidents in NSW. The Victorian dataset was race day injuries only, and as it reflects a more concentrated situation the data is presented here. The data was studied to investigate any changes in the number of claims made, the bodily location of claims and the nature of the injuries for the two periods. In order to then determine if the vests have influenced the injury rates and locations, specific bodily locations associated with the vests were examined, that is, the back, chest, neck and ribs.

Number of claims received in Victoria due to “falls from a height”

There was a significant decrease in the number of claims received due to “falls from a height” in Victoria with 278 claims received in the five years prior to the introduction of the vests and 199 claims received in the five year period following the introduction of the vests ($P < 0.0003$). 74.2% of all claims over study period were due to falls from a height.

Figure 2.3 illustrates this decrease in the number of claims made due to a fall in Victoria over the study period. The line represents the point at which the vests were introduced.

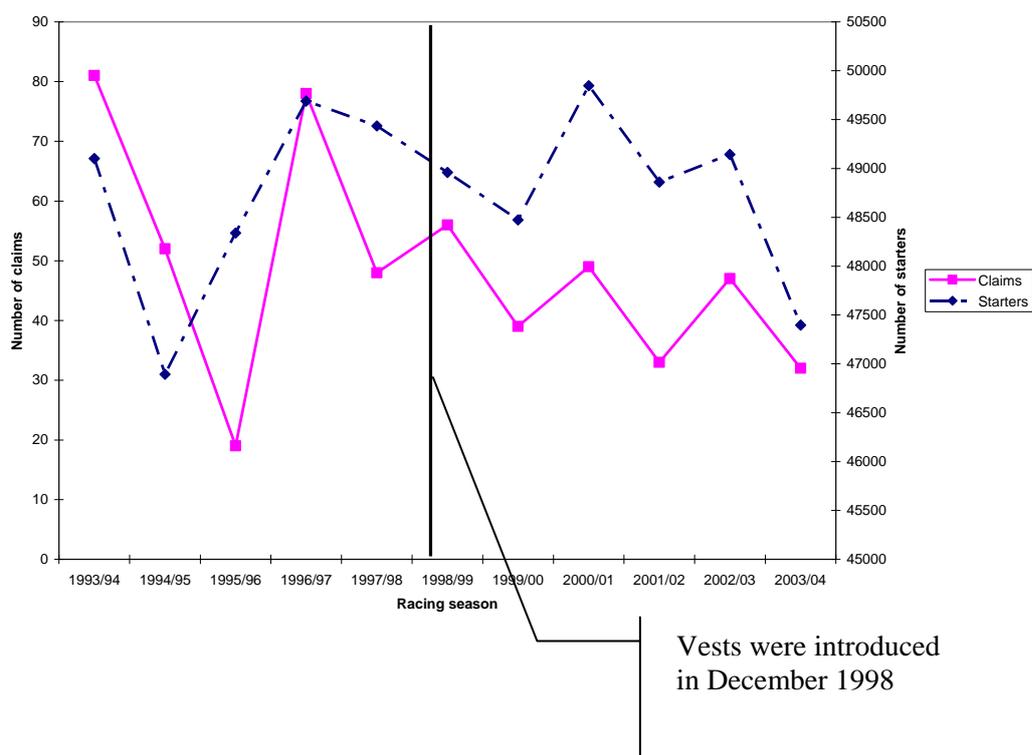
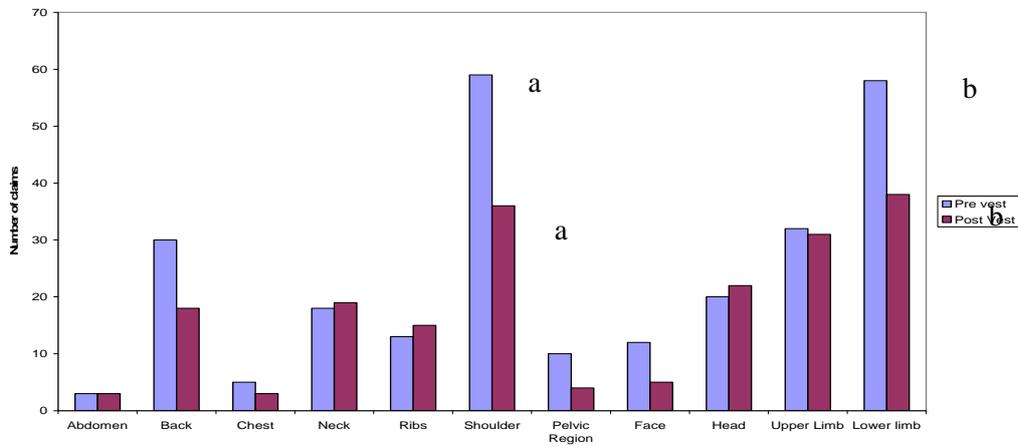


Figure 2.3 Number of insurance claims due to a fall relative to the number of starters in Victoria

Bodily location of all injuries due to “falls from a height”

The bodily location of all claims due to falls from a height in VIC is shown in Figure 2.4.



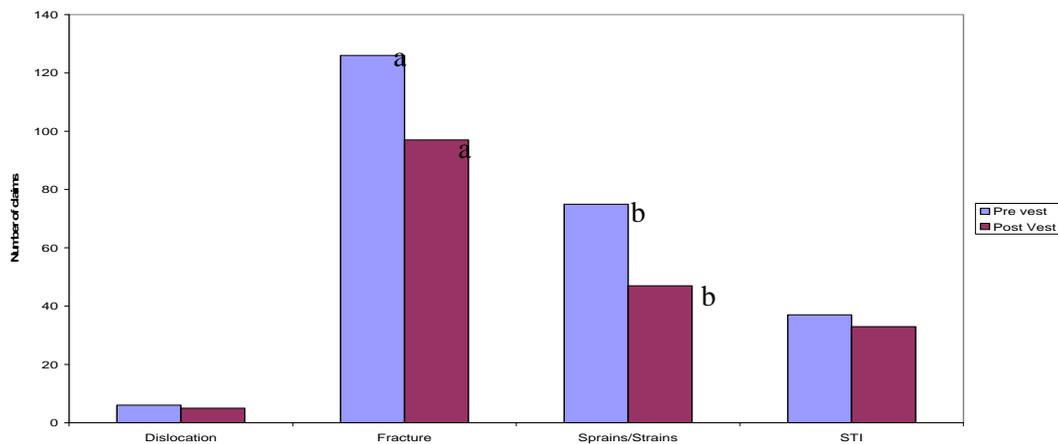
Note: a. $P = 0.023$; b. $P = 0.051$

Figure 2.4 Bodily location of all claims due to falls from a height in VIC

There has been a significant decrease in the number of shoulder injuries (59 (pre-vest) vs 36 (post-vest)) and also a reduction in lower limb injuries (58 (pre-vest) vs 38 (post-vest)) in the years following the introduction of the vests. A decrease in back injuries is also evident however the reduction does not reach statistical significance (30 (pre-vest) vs 18 (post-vest), $P = 0.11$).

Nature of all injuries due to “falls from a height”

The nature of all claims due to falls from a height in VIC are shown in Figure 2.5.



Note: a. $P = 0.059$; b. $P = 0.014$

Figure 2.5 Nature of all claims due to falls from a height in VIC

There has been a significant decrease in the number of sprains and strains in the Victorian dataset (75 (pre-vest) vs 47 (post-vest)) and a decrease also in the number of fractures (126 (pre-vest) vs 97 (post-vest)) in the years following the introduction of the vests.

Nature of injuries occurring in areas associated with wearing the vest: the back, chest, neck and rib area

Back injuries

The nature of all back injuries sustained due to a fall is shown in Figure 2.6.

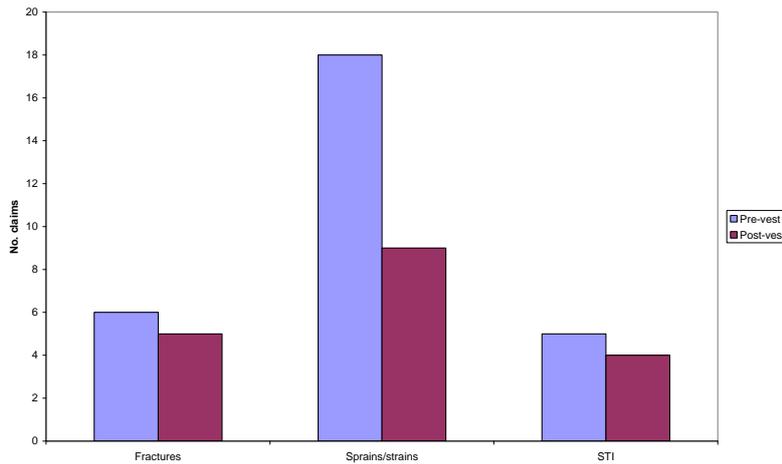


Figure 2.6 Nature of back injuries sustained due to a fall from a height in Vic.

There has been no significant change in the nature of back injuries in the years following the introduction of the vests.

Chest injuries

The nature of all chest injuries sustained due to a fall is shown in Figure 2.7.

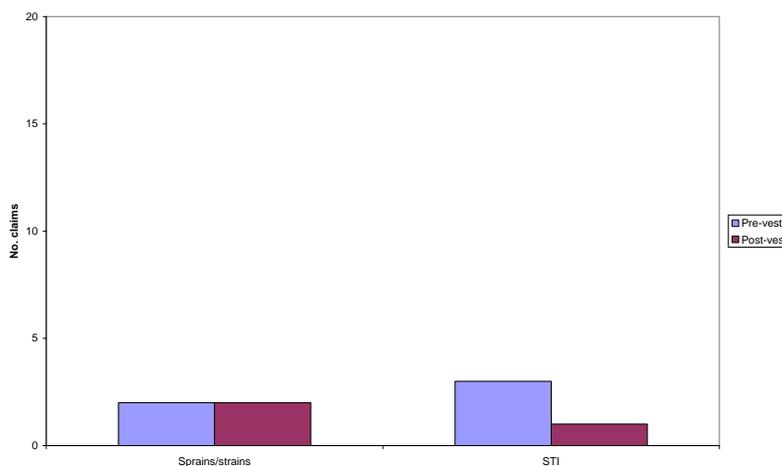
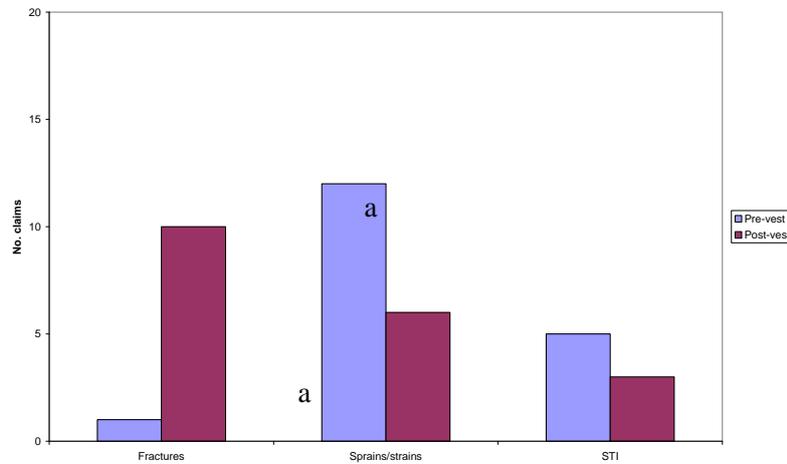


Figure 2.7 Nature of chest injuries sustained due to a fall from a height in Vic.

There has been no change in the nature of chest injuries in the years following the introduction of the vests.

Injuries in the neck region

The nature of all injuries in the neck region sustained due to a fall is shown in Figure 2.8.



Note: a. $P = 0.015$

Figure 2.8 Nature of injuries in the neck region sustained due to falls from a height

While the total number of injuries in the neck region has not changed, there has been a change in the nature injuries in this area, with a decrease in the number of neck sprains and strains and neck soft tissue injuries, against an increase in the number of fractures observed in the years following the introduction of the vests (1 (pre-vest) vs 10 (post-vest)).

Rib injuries

The nature of all rib injuries sustained due to a fall is shown in Figure 2.9.

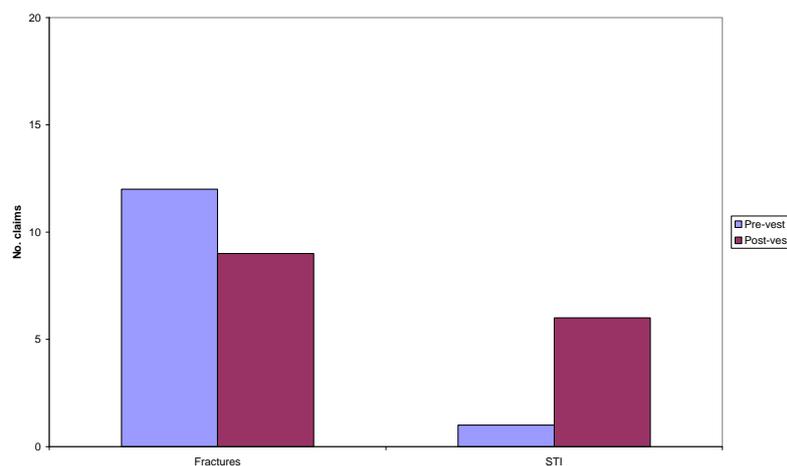


Figure 2.9 Nature of rib injuries sustained due to falls from a height in VIC

There has been no change in the nature of rib injuries in the years following the introduction of the vests.

Discussion

The purpose of this study was to investigate whether there has been a change in the number of injury claims made due to falls from a height as a result of the introduction of the vests in December 1998. The Victorian dataset included race-day data only, allowing for a more focussed analysis compared to the NSW dataset obtained. There was a significant decrease in claims made due to falls from a height, and no significant increase in claims in the neck region. There was however a significant decrease in shoulder, as well as a reduction in lower limb claims, suggesting that other factors may be playing a role in reducing the number of claims due to a fall other than the presence of a vest. Fractures have decreased as have sprains and strains. While the total number of claims in the neck region in Victoria remained unchanged in the years prior to and following the introduction of the vests, there was a reduction in the number of neck sprains and strains and neck soft tissue injuries against an increase in the number of fractures in the neck area. There were also limitations to the Victorian dataset. The data obtained for this study were retained for insurance purposes only and was not easily accessible for the purposes of this project. The system does not allow data to be sorted except in a limited number of standard formats and there may also be variation depending on the person entering the data. For these reasons there does exist the possibility of inaccuracies within the dataset.

This study was instigated due to a suggestion that the currently available vests may be contributing to injuries particularly sustained in the neck area. The Victorian dataset had severe limitations, but while there was no increase in total injuries in the neck region, the pattern of injuries appears to have changed with an increase in fractures in this area. While an increase in neck injuries is suspected, it cannot be concluded that the vest has caused this apparent increase. Other factors may be contributing to increased injuries in this area such as riding style and as there were no other factors examined, it is impossible to conclude that the introduction of the vests has caused an increase in associated injuries. Findings of a Biomechanical Engineer reported no signs that any of the current safety equipment was increasing the likelihood of injury (pers. comm.). Further investigation is however recommended to ensure vests are not increasing risks of certain injuries.

Interpretation of the insurance claim data has severe limitations, however overall, the data gave no indication that there has been any significant decrease in the number of back, neck, chest or rib claims due to falls from a height in the five years following the introduction of the vests. The inconsistencies between the datasets highlight the importance of further investigation of factors associated with injuries on not only race-day but also track work and barrier trial activities. Clearly the changes in the number of claims made due to falls from a height is a multifactorial issue and more thorough investigation of the data might reveal further significant changes in injury types and location. This would however require detailed analysis of stewards' reports combined with claim data and the use of a racing injury reporting system such as the Australian Racing Incident Database (ARID).

This data suggests that although there has been a reduction in the number of insurance claims in the period following the introduction of the vests, the number of incidents of injury remains higher than acceptable. Further investigation into alternative body protectors is warranted.

3. Development and implementation of a national Thoroughbred web based incident database

In recognition of the absence of studies into the causes of injuries to persons and horses the Rural Industries Research and Development Council funded a project to produce an injury recording system for the Australian racing industry. The output of that project was an operational system (Australian Racing Incident Database [ARID]) on a demonstration site and a detailed report for implementation of the system. The aim of this part of the current Health and Safety project was to implement the system within the racing industry, and to establish linkages with existing industry databases to provide maximum benefit from the data being analysed.

Following a review process, existing jockey incident forms used to collect fall and injury data were redrafted to include additional fields and to be more compatible with racing systems. Five forms were created as follows:

- RR (Raceday/Rider) for when a rider incident occurs on raceday/trials;
- RNR (Raceday/Non Rider) for a non rider incident on raceday/trials;
- TR (Training Centre) for a rider incident at a training centre/stables;
- TNR (Training Centre/Non Rider) for a non rider incident at a trainer centre/stables;
- H (Horse incident form) regardless of where the incident occurs.

User-training guides and information posters were designed for the first stage of implementation. An example of the RR form is shown in Fig 3.1.

Implementation of reporting system

The ARID system was integrated into the National Racing Database known as *SIRIUS*. A rollout of the information and standardised reporting forms has been provided to each Australian State's Principal Racing Authority allowing their personnel to record information in the field in a standard format and then load the data relating to Horse and Person injury directly into the one central database.

NSW and Victoria were first to start collecting forms and entering data. In 2009 South Australia, Tasmania and Northern Territory followed, In 2010 Western Australia and Queensland committed to the data collection process and commenced entered into ARID. All of the states log-in directly to the National database and enter information in identical format allowing easy master review and assessment of data.

Preliminary Analysis of data

An initial analysis was conducted on data entered into the database during the period 1st August 2008 to 31st July, 2009.

Results

Number of entries

| | |
|----------------------------|----|
| Raceday/Rider: | 84 |
| Training Centre: | 28 |
| Training Centre/Non rider: | 3 |

Race types

- 14 flat races
- 2 flat trials
- 29 hurdle races
- 16 hurdle trials
- 20 steeple races
- 3 steeple trials
- 31 other (track work, training, etc)

Injuries

- 17 injuries
- 6 taken to hospital

Injury categories are shown in table 3.1.

Table 3.1 Bodily location of injuries from data collected from ARID database.

| Bodily location | Number |
|-----------------------------|---------------|
| Shoulder | 2 |
| Upper extremities | 6 |
| Lower extremities | 3 |
| Chest/back/neck/ribs/coccyx | 5 |
| Lip | 1 |

All incidents involved jockeys except 1 barrier attendant and 1 strapper.

As the statistical data grows, a range of reports will be available to allow researchers, doctors and veterinarians to conduct analysis on the pattern of injury, with an aim of improving safety standard for the industry. This is an important component of an overall risk management approach. Accurate and informative data in a consistent format is required. The training of staff in how to complete injury forms consistently has been implemented through instruction packages forwarded to each state jurisdiction. This is an important component of an overall risk management approach. Participation in the recording of data is agreed by each State racing Principal Authority. Metropolitan racecourse data will be the most consistent.

Raceday and Trial Incident Report (Jockeys)

RR

Mark selections clearly with a cross. X

Section 1: Incident/Examination ID

Track Name: _____ Day: ____/____/____ Year: ____ Race No: ____

Rider Name: _____ Male Female

Was an examination performed? Yes No

Did an incident occur? Yes (Go to section 2) No (Go to section 3)

Section 2: About the Incident

Weather: Fine Overcast Showers Raining

Visibility: Good Poor Foggy

Wind: Calm Light Moderate Strong

Name of Horse: _____ Incident Time: _____ : _____

A. Activity

Mounting Mounted Dismounting Unseating Obstructing Standing on barrier Other (details below)

B. When

Before race Prior to leading During leading When loaded On jumping leads During race Pulling up Returning to mounting yard After race

C. Where

Mounting yard Before race (on track) Barrier During race - straight During race - turn During race - jump During race - unknown After race (on track) Other (details below)

Approx. distance from finish: _____ Jump Number: _____

D. What (multiple)

Rider fell Horse and rider fell Dragged by foot Kicked (back leg) Struck (front leg) Tripped Rolled on Cracked Hit by head Blown Near miss (detail below) Other (detail below)

E. Cause (multiple)

Fall Interference Clipped heels Brought down Stumped Struck/shield Horse unbalanced Rider unbalanced Bucked Reared Collapsed Knocked Equipment failure Saddle slipped Horse slipped Horse fell/jump Horse fell on landing Unknown Other (details below)

G. Impact (multiple)

Barrier Inside railing rail Outside rail fence Upright Ground Other horse Jump Other (detail below) Not applicable

F. PPE and Risk Factors
(complete for fall or impact to PPE)

Helmet Yes No

Male _____
Model _____
Age _____

Vest Yes No

Male _____
Model _____
Age _____

Stirrups Race iron Toe Clipper Buckle Other _____

Foot Position Toes only End of foot Full Foot Not specified

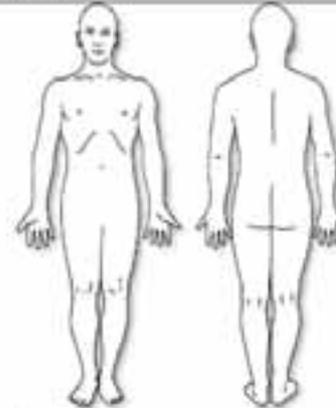
Section 3: Examination results

Significant findings detected? Yes No

Nature and location of signs/symptoms:

Treatment / Other comments:

Diagnosis (if known):



Findings
Please provide as much detail as is suitable

Musculoskeletal

Joint Dislocation Joint injury

Muscle Tendon/ligament Bone (fracture)

Neurological

Head injury Unconscious (Time?)

Spinal injury Flaccid

Eye injury Paralysis Sensory changes

External trauma

Laceration Bruising/contusion Abrasion Puncture

Abdominal

Pain Internal haemorrhage

Respiratory

Coughing Respiratory distress Wheezing Chest pain

Multiple

Heat stressed Exhausted

Temp: _____ °C

WtGt: _____

Comments (Note any hazards and/or solutions to prevent recurrence)

Outcome

No injury, returned to work

Minor injury, no treatment returned to work

First aid, returned to work

First aid, off work

Taken to hospital (specify in comments above)

Other (explain in comments)

Findings reported by

Doctor Ambulance officer First aid officer Steward Other (explain in comments)

Follow-up medical report recommended? Yes No

Medical clearance required before riding? Yes No

Medical Official: Name: _____ Sign: _____

Industry Official: Name: _____ Sign: _____

Is a follow-up hazard report / investigation recommended? Yes No

Illness Name: _____ Telephone: _____

Figure 3.1 Example of an ARID form (for Raceday Rider)

Additional forms may be found at <http://www.racingsw.com.au/default.aspx?s=arid>

4. Evaluation and development of a high performance helmet

In collaboration with the University of New South Wales, the final part of this project firstly involved the evaluation of the impact performance of currently available helmets, their ability to withstand the European testing requirements, and the development of a prototype helmet designed to meet these more stringent requirements.

Testing of current jockey helmets and materials to the European High Performance standard

Test Rig

Initial tests were conducted at the Roads and Traffic Authority Crashlab. The helmet impact test rig (Fig 6.1) consists of a drop carriage running along two vertical rails, which can be electronically or manually raised or lowered as required. The drop arm is detached from the carriage by a pneumatic pin release mechanism, falling in a guided fall via two guide wires. A rigid headform is attached to the drop arm and contains a tri-axial accelerometer at the centre of mass. The sample to be tested is lightly taped to the base of the rig so that the crown of the headform will impact the centre of the sample (Fig 6.2). Just before the impact the drop arm passes through a light gate, which is used to trigger the accelerometer data and high speed video capture (Fig 6.3). A protective Perspex casing surrounds the drop rig and the drop arm cannot be released unless the door of this case is closed. This set-up is typically used for helmet certification tests.

The drop height and the mass of the headform (which replicates the size, shape and mass of a typical human head) determine the impact energy. The data recorded from the headform accelerometers are indicative of the impact force experienced by the head under certain impact conditions. The High Performance European standard includes an impact energy attenuation test from a drop height of 3m. From Figure 1 it can be seen that the Crashlab test rig measures 3m from the base to the top of the rail structure, however the drop carriage and release mechanism prevent the drop arm from being raised to the full height. The maximum drop height that can be achieved on this particular drop rig is 2.8m. Later tests were conducted on a similar rig at UNSW with a maximum drop height of 2.8 m.

Helmet Testing

Three popular current models of jockey helmets were provided by the National Jockey Safety Review Committee for testing. Equine Science Distributions Pty/Ltd also provided samples of a light weight equestrian helmet for comparison. Five helmet models were assessed.

The helmets were strapped to an ISO “E” (4.1kg), “J” (4.7kg) or “M” (5.6kg) size rigid half-headform with a chin attachment, and drop tested in four configurations under ambient laboratory conditions:

- 1.5 metre guided drop onto the flat anvil
- 2.5 metre guided drop onto the flat anvil (the limit at the Crashlab)
- 2.0 metre guided drop onto a hemispherical anvil
- 2.0 metre guided drop onto an equestrian hazard/“V” anvil

The impacts were positioned above the AS/NZS 2512 test lines in the frontal, rear, crown, left temporal and right temporal regions. Up to 4 tests were performed per helmet per drop height each onto an untested location. The mean and standard deviation for the peak accelerations were calculated.

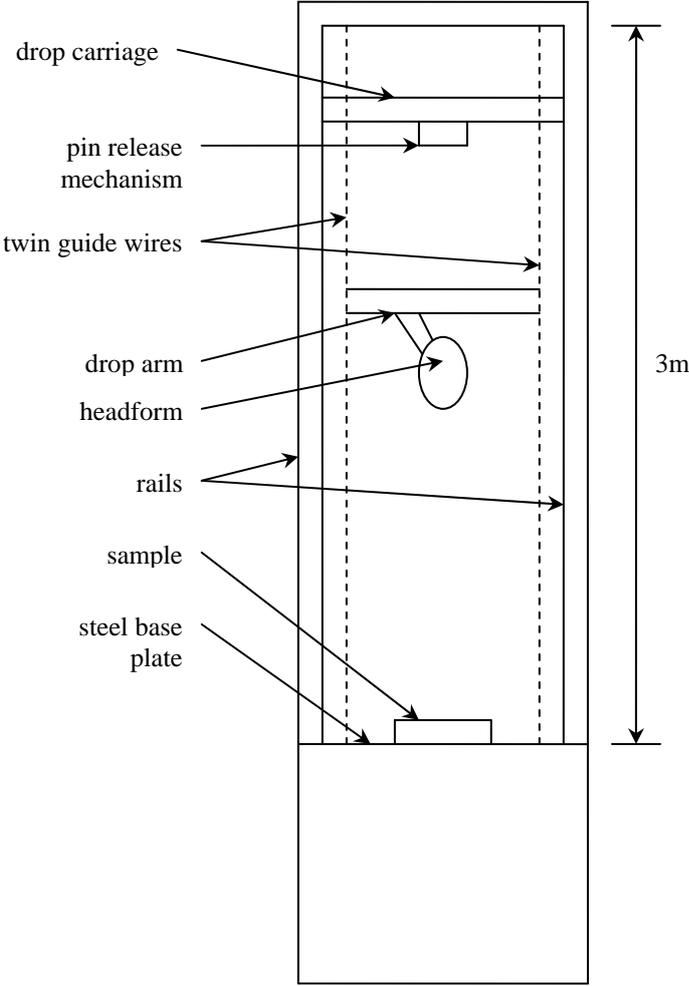


Figure 4.1 Lay-out of the Crashlab helmet impact test rig



Figure 4.2 Impact test set-up

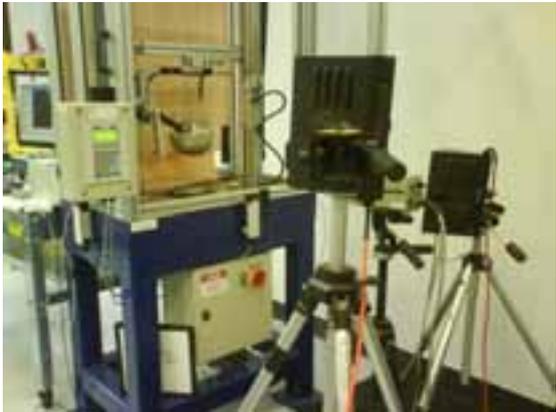


Figure 4.3 High-speed camera set-up



Champion Ventair Deluxe Jockey Helmet

The Champion Ventair Deluxe Jockey Helmet by Champion Manufacturing (Safety Headwear) Ltd. (UK) is designed to meet PAS 015:1998 and BS.EN.1384:1997. It has a glass-reinforced polymer (GRP) shell with a rough textured finish, and an EPS liner. It features a frontal reinforcement strip with air-vents. This helmet retails at around \$250-\$280. The 54-57cm sizes tested here weighed 488-556g. (Image reproduced from <http://www.hylandsportswear.com>).



Las Country HD Jockey Helmet

The LAS Country HD helmet by LAS High-Tech Sportswear & Helmets (Italy) is designed to meet EN 1384:1996. It has a textured ABS shell and EPS liner. This helmet retails at around \$180-\$270. The 53-56cm sizes tested here weighed 457-480g. (Image reproduced from <http://www.hylandsportswear.com>).



GPA Jock-up One Jockey Helmet

The GPA Jock-up One helmet by GPA-Sports (Switzerland) is designed to meet EN 1384:1996. It features a woven fibreglass shell coated in epoxy resin with an EPS liner. The design includes frontal ventilation and reinforcement in Titium (Aluminium/Titanium alloy). This helmet retails at around \$850-\$900. The 53-58cm sizes tested here weighed 477-539g. (Image reproduced from <http://www.gpa-sport.com>).



Aussie 21 Equestrian Helmet

The Aussie 21 equestrian helmet by Aussie Rider Safety Pty Ltd (Australia) is approved to AS/NZS 3838. It features an in-mould thermoplastic shell and EPS liner, with 11 air vents. This helmet retails at around \$130. The Large size tested here weighs around 320g. (Image reproduced from <http://www.aussierider.biz>).



GPA Jock-up Three Jockey Helmet

GPA Jock-up 3 from GPA-Sports is a light weight, EN 1384 approved helmet with a painted polymer resin shell and EPS liner. Two samples were purchased at \$380 each, in the 58 and 59cm sizes

Helmet Liner Material Testing

The liner materials tested included three different polymer foams at various densities, which included expanded polystyrene (EPS), polyurethane (PU), and expanded polypropylene (EPP) foams, and two honeycomb materials made from aluminium and polypropylene. 3mm thick samples of Acrylonitrile Butadiene Styrene (ABS) were tested in combination with the liner combinations to measure the effects of a rigid shell.

The materials were loosely attached to the flat steel base of the Crashlab Helmet Test Rig and impacted by the crown of the 4.7kg ISO J headform assembly at heights of up to 2.5 metres.

Helmet test results

Flat Anvil

Low Severity Impacts: When tested at a drop height of 1 metre onto the crown, all helmet models gave average peak accelerations above 80G. This was above the maximum allowable peak acceleration at 1 metre in EN 14572.

Medium Severity Impacts: At the 1.5 metre drop, all helmet models gave peak accelerations below 300G in accordance with the requirements of AS/NZS 3838. The Aussie 21 helmet was taken to a maximum drop height of 2 metres, at which its peak acceleration approached 250G.

High Severity Impacts: At 2.5 metres, the Champion Ventair and GPA Jockup-One helmets bordered on 250G whilst the LAS gave peak accelerations of approximately 400G.

Hemispherical Anvil

When tested from 2 metres on the 48 mm radius hemispherical anvil, all helmets gave peak accelerations well above 250G which is the maximum allowable peak acceleration at 3m in EN 14572.

Hazard /“V” Anvil

The GPA helmet gave peak accelerations below 250G when impacted at 2.0 metres on the V anvil, while the Champion and LAS helmets exceeded 250G.

Material Test Results

Single liner materials were tested at varying thickness at increasing drop heights until failure. At a thickness of 20mm or below, the only material which came close to meeting the requirements was the higher density EPP. At a thickness of 30mm or below, both the low and higher density PU samples and both the Aluminium and Polypropylene honeycombs gave peak accelerations below 250G when tested at 2.5 metres. The EPP samples were not tested to this thickness. When tested with a 3mm ABS shell covering, the 20mm thick PU and the 30mm thick polypropylene honeycomb gave peak accelerations below 250G at the 2.5 metre drop height.

Composite liner materials were tested at varying thickness at increasing drop heights until failure (ie. headform acceleration > 250 G). At a thickness of around 20mm, the only material combination which came close to meeting the requirements was the 12mm Aluminium honeycomb layered with 10mm thick 48kg/m³ polyurethane foam. This gave peak accelerations below 200G at 2 metres, but above 250G at 2.5 metres. The different materials were layered with the 15mm polypropylene honeycomb to make up 25mm samples. The best performing combination of these was that with the 48kg/m³ PU foam, which gave peak accelerations bordering on 250G at 2.5 metres.

Discussion

The results of the testing revealed that the current jockey helmets, which differ widely in price and design, performed quite similarly in terms of impact attenuation.

Although the results showed that the current helmets do not perform well enough to meet the requirements of the high performance standard, the Champion Ventair Deluxe, GPA Jockup-One and the Aussie 21 helmets performed consistently in most configurations at ambient conditions.

The best performing helmet overall was the GPA Jockup-One, which came close to meeting the requirements of the High Performance standard. It is envisaged that a slightly thicker liner in this helmet combined with modifications to the liner material might meet the more severe requirements of EN14572.

Testing of the various liner material combinations revealed that in general, a liner thickness of at least 25mm of most materials is required to meet (or come close to meeting) the impact requirements of EN 14572.

The best liner materials tested in this series were dual density combinations of polyurethane and expanded polypropylene. Whilst combinations of aluminium honeycomb with these materials also performed well, the manufacturing difficulties and weight issues make this solution less favourable. The polymer honeycomb tested showed promising results, however different thicknesses of this material should be further explored in order to achieve the desired results.

Development of a helmet prototype

Helmet Prototype Testing – Stage 1

Two prototype helmets were constructed based on the material and helmet testing at that time. One liner was 25 mm thick the other 30 mm thick. Both were made from a combination of polymer honeycomb and polyurethane foam. The shell from the New Derby helmet was incorporated in each prototype. The prototypes were tested from 1.5, 2 and 2.5 m drop heights onto a flat anvil and compared with matching unmodified models and the commercially available helmets tested in this project to date.

The prototype helmet testing showed that improvements could be made to impact energy attenuation by increasing the liner thickness and changing the liner material. Whereas the standard helmet resulted in headform accelerations greater than 250 g for a 2 m drop, the prototypes maintained the acceleration below this threshold. The 30 mm liner performed very well at the 1.5 m drop height resulting in a headform acceleration of 131 g. At 2.5 m drop heights the acceleration was 244 g. At 2 m, the headform acceleration for the 30 mm liner helmet was 208 g compared to 300 g for the standard New Derby helmet.

Disappointingly, the prototype helmet tests did not reveal any significant advantages at the higher energy impacts (2.5 m) compared with the best performing commercially available helmets. No helmet would appear to meet the European High Performance standard requirements for a 3 m drop with headform acceleration less than 250 g. In comparison the prototype was also the heaviest helmet, raising issues about comfort and usability.

The prototype testing did demonstrate the benefits of the design direction being taken at that time. It is likely that with further refinement of the materials, the construction and assessment, the prototype helmet would reveal advantages over the standard helmets at 3 m impacts. Due to the soft polyurethane liner component, the prototype helmet would perform well at low severity impacts, eg. 1 m as required by the European High Performance standard. Therefore, there are potential design advantages in utilizing: a thicker than normal liner (eg. 30 mm) and a soft plastic liner material (polyurethane) in combination with a stiffer plastic liner material (the honeycomb).

Numerical Evaluation of Prototype Helmet Design and further work

Numerical simulations provide a cost-effective way to explore configurations in a predictive approach and were chosen to complement and advance the laboratory research. A numerical study using MADYMO, a rigid-body/Finite Element (FE) analysis program, was carried out to explore the possibility of improving the impact attenuation characteristic of a prototype jockey helmet. It allows

combined rigid-body and FE simulations and has a reasonable library of material behaviours, including the specific implementation of foams and honeycomb constitutive laws. As some successful helmet modelling work had already been performed with this package at UNSW, it was chosen for the study.

This highly complex software system involved choosing an adequate FE code for the analysis, obtaining a precise geometry of the prototype helmet, modelling and validating the behaviours of its materials, reconstructing and validating a reference drop-test and designing a parametric simulations matrix that could be carried out in the required time frame.

Based on the conclusions of the previous stages of the High Performance Equestrian Helmet study, a parametric simulation matrix was designed to evaluate:

1. The response of the prototype helmet to low and high severity impacts
2. The strongest parameter of influence for acceleration attenuation
3. An indication of the best possible design combination

Most importantly, the parametric study gave some basis towards the optimisation of a design that would meet the requirements of standard EN14572.

The tests confirmed that the choice of a “soft” PU foam used in combination with a “stiffer” honeycomb material appears to be a valid strategy to meet both the low and high severity impact requirements of standard EN14572.

The honeycomb material used in the prototype helmet was chosen so as to be effective in dissipating the impact energy in the “severe” impact range (i.e. aiming at the 3.0 drop-height). However, the numerical simulations showed that it may be slightly too stiff for the 1.0 – 3.0 drop-height range. Further development work to explore the potential of this material was recommended. In addition to selecting the correct structure, the ability to shape the material in a cost-effective manner requires assessment.

The parametric study confirmed that it was possible to design a helmet that would meet, or would come close to meeting the high energy impact requirements of standard EN14572 at the 3.0 m drop-height. However, meeting the low severity requirement of this standard as well will prove extremely difficult with this design. At the other extreme, a single simulation run of a very high energy impact, equivalent to a four metre drop, showed that the honeycomb and polyurethane combination performed very well in extreme impacts.

It is determined that:

- The addition of a comfort liner might contribute to the helmet getting closer to the requirements of EN14572 at the 1.0 m drop-height low severity impact,
- Increasing the relative and absolute thickness of the Polyurethane liner component, especially if a more compliant honeycomb material could not be sourced, will improve the helmet performance beyond the physical prototype.
- The helmet bias will be towards preventing the more severe spectrum of injuries resulting from severe impacts, while offering fair protection at lower severity impacts.

The helmet dimensions would ultimately be in the range 35-40 mm and 550 grams. The mass and usability aspects need to be considered in terms of jockey acceptance.

Further interaction with a helmet manufacturer and/or material supplier is recommended before additional prototype testing is conducted.

Helmet Prototype Testing – Stage 2

Based on parallel research on motorcycle helmets, the availability of exemplar helmets, and discussions at that time with a manufacturer/importer, a THH 170 ‘shorty’ helmet was used as the basis for the stage 2 physical prototype. The helmet was configured with either a dual material liner or a solid 35 mm polyurethane liner, and both incorporated a comfort liner. Excellent results were observed for tests up to 2.75 m drop heights with the prototype helmets. At 2.75 m drop heights, a severe impact, headform accelerations were less than 250 G. The prototypes performed much better than the standard helmet over the range of impacts. Little difference was observed between the dual material liner and the single density polyurethane liner.

The project showed through a series of prototype designs, incorporating novel liners, that a jockey helmet could be constructed that offered good impact performance and protection to the head across a wide range of impact severities.

Helmet Prototype Testing – Stage 3

Prototype testing with an industry partner have revealed very good helmet performance outcomes based on the research steps in the overall project. A different shell combined with the novel liner is being assessed. In high severity impact tests, the peak headform acceleration was between 170 and 207 G.

Implications and recommendations

A survey was conducted as part of this research to obtain the opinions of the jockeys on current safety equipment, standards and overall working conditions. Overall, jockeys reported that current vests were restrictive and poorly ventilated and most respondents felt helmets did not provide them with adequate protection. The majority of jockeys also wanted to see the minimum riding weight lifted. As a result of this initial work, changes were made to minimum riding weights for feature races which saw the Melbourne and Caulfield Cup weight minimums lifted to 50kg and all other Group 1 Handicaps to 51kg. All other Group and Listed handicap races were increased to 52 or 53kg and the weight-for-age scale raised by 1kg. In addition, the weight for age scale rose by 1kg. Prior to this work, minimums were as low as 47kg.

Insurance claim data were used to analyse the bodily location and nature of injuries in NSW and Victoria due to falls from a height. The currently available protective equipment aims to protect bodily areas which accounted for only 28% of the injuries sustained. Shoulder injuries are significant in racing as are upper and lower limb, in total contributing to approximately 60% of the injuries reported in insurance claims. There is currently no protective gear recommended for the upper and lower limb or the shoulder region. This study identifies the potential need for research and development of such protection.

Stewards' reports were also analysed to provide an accurate indication of the incidents in Australian racing. The potential need for research and development into alternative body protection particularly for the upper limbs, the shoulder region and the lower limbs particularly the leg and foot was identified. Injuries in the barriers need to be addressed and alternative barrier protection such as protective boots for jockeys, and alternative padding on the gates may be justified. This research also reiterates the call for national jockey and horse injury surveillance, centrally compiled and annually analysed, which would create an opportunity to better understand the injury profiles of jockeys and horses and develop protocols to reduce injury.

Victorian insurance claim data were then used to investigate whether there has been a change in the number of injury claims made due to falls from a height as a result of the introduction of the vests in December 1998. Interpretation of the insurance claim data had severe limitations, however overall, the data gave no indication that there has been any significant decrease in the number of back, neck, chest or rib claims due to falls from a height in the five years following the introduction of the vests. This data, combined with information obtained from the jockey survey suggests that the number of incidents of injury remains higher than acceptable. Further investigation into alternative body protectors is warranted.

A comprehensive review of the requirements to modify and adapt the Australian Racing Industry Database (ARID) into an existing racing system was undertaken. The jockey incident forms are now in use in a number of States and data collected is being entered into the national database. As the statistical data grows, a range of reports will be available to allow researchers, doctors and veterinarians to conduct analysis on the pattern of injury, with an aim of improving safety standard for the industry.

Five popular models of jockey helmets were tested to a European High Performance standard. Alternate liner materials were also tested. None of the helmets tested met the requirements of the high performance standard. The best performing helmet was the GPA Jockup-One which came closest to meeting the requirements. The best liner materials tested were dual density combinations of polyurethane and expanded polypropylene with polymer honeycomb also showing promising results. An iterative program of helmet prototyping, testing and numerical modelling, has led to the development of current jockey helmet prototypes that offer excellent protection to the head across a wide range of impacts leading up to and including severe impacts. Further research and development

is now being undertaken in partnership with a manufacturer. The mass and usability aspects need to be considered in terms of jockey acceptance.

According to the reported survey of jockeys, the average jockey loses five weeks per year due to injury. Based on an average jockey income of \$52,000 pa, the estimated cost of injuries in Australian racing (based on lost time, and medical and insurance costs due to a fall only) is in the order of \$10 million per year. In the Australian jockey survey, half of the respondents claim to have had an injury which has resulted in at least five days lost time in the last twelve months. This results in an annual injury rate per 1000 jockeys being approximately 500/1000 compared with 15/1000 achieved by all other employees in NSW (according to Workcover). If we can set a conservative target of reducing injuries by 20%, the saving would be in the order of \$2 million per year.

Appendix 1.A Summary of fall/injury incident data obtained from NSW racedays over a three year period.

| Incident | Number of incidents | % of all incidents | Number resulting in injury | % resulting in injury |
|---|---------------------|--------------------|----------------------------|-----------------------|
| Aggravated an existing injury during a race | 2 | 0.4 | 2 | 100.0 |
| Rider almost dislodged during race | 4 | 0.8 | 4 | 100.0 |
| Barrier incident | 88 | 17.9 | 78 | 88.7 |
| Jockey collapsed on dismounting | 1 | 0.2 | 1 | 100.0 |
| Rider dislodged | 286 | 58.0 | 113 | 39.5 |
| Horse fell | 52 | 10.6 | 40 | 76.9 |
| Horse other incident* | 9 | 1.8 | 5 | 55.6 |
| Miscellaneous injuries during race | 44 | 8.9 | 38 | 86.4 |
| Jockey kicked by a horse | 7 | 1.4 | 2 | 28.6 |

Note: *including flipping in barrier, jumping awkwardly, hitting running rail, clipping heels of another horse

Appendix 1.B Number of starters in NSW and Victoria per racing season

| Racing season | NSW | Victoria |
|-------------------------|---------------|---------------|
| <i>Pre-vest period</i> | | |
| 1993/94 | 73234 | 49102 |
| 1994/95 | 70053 | 46894 |
| 1995/96 | 67977 | 48340 |
| 1996/97 | 63534 | 49689 |
| 1997/98 | 60580 | 49435 |
| Total | 335378 | 243460 |
| <i>Post-vest period</i> | | |
| 1999/00 | 61183 | 48473 |
| 2000/01 | 59327 | 49848 |
| 2001/02 | 59201 | 48861 |
| 2002/03 | 56773 | 49144 |
| 2003/04 | 56796 | 47397 |
| Total | 293280 | 243723 |

Source: Australian Racing Fact Book, Australian Racing Board Limited

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Health and Safety in Australian Horse Racing

by C. Foote, A. McIntosh, P. V'Landys, K. Bulloch

Publication No. 10/067

This report describes risk factors associated with injuries to jockeys involved in Thoroughbred racing and evaluates currently available safety equipment and standards.

Firstly, stewards' reports and insurance claim data were analysed to obtain an accurate indication of the incidence and risk factors associated with horse falls in Thoroughbred racing. The second part of the project involved the implementation of a national incident database to allow for analysis of current injury priorities to both horse and rider, and to enable ongoing review of the effectiveness of intervention strategies, such as the introduction of new helmets and alternative body protectors.

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