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Federation Equestre Internationale (FEI)
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# An Audit into Eventing Incorporating an Analysis of Risk Factors for Cross Country Horse Falls at FEI Eventing Competitions

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**This document has been reviewed and accepted by the Eventing Committee and the publication of full report supported by the FEI Bureau.**

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# 1. Introduction

Charles Barnett was instructed by the President of the FEI to assess the ways in which the risks associated with falls on the Cross Country phase of Eventing could be minimised. All horse-related activities carry with them an element of risk, and while we must do all we can to minimize that risk, we will never eliminate it. It is part of the essence of all equine sport. In 2000, the Hartington Report rightly stated: "*a fundamental conclusion which pervades every detailed recommendation is that everything should be done to **prevent horses from falling**: this single objective should greatly reduce the chances of riders being seriously injured as well as significantly improving the* safety of competing riders."[1]

# 2. Approach

This audit was conducted over the period of January to November 2015. The findings are based upon quantitative and qualitative research. Data supplied by the FEI was analysed by a team of independent researchers from the Universities of Liverpool and Bristol with backgrounds in equestrian epidemiology This analysis was supported by a broad range of interviews conducted by the author of this report, notably lengthily discussions with the Chairman and CEO of the Eventing Committee. The interviews, particularly with riders, were undertaken on a confidential basis. The following is a descriptive list of sources with whom the author spoke:

- Current senior level riders from the UK, Germany, Australia, New Zealand, Brazil, Columbia, Uruguay, Ireland, almost all of whom had represented their countries in international competitions. Many of these riders had significant medal achievement at the highest level including World Equestrian Games and Olympic Games. The majority had competed at 4* level;
- A large number of riders in the UK who rode at lower level both in FEI events and in BE events. These comprised both owner-riders who are genuinely “amateur” and those who are embarking on a career in the sport;
- Numerous officials, mostly Course Builders, Technical Delegates, and Members of Ground Juries. These officials were from many nationalities and included the UK, Germany, Australia, New Zealand, Brazil, Ireland, Sweden, Russia, Poland, Switzerland, United States, Canada;
- Chiefs d’Equipe;
- Event Organisers;
- TV Producers and other media figures;
- Senior vets from Germany, the UK, Ireland;
- Doctors from Germany, the UK, United States, Canada;
- Existing and past National Team Trainers at various levels from the UK, Germany, Brazil, Canada, France, Australia;
- Officials from other sports both Equestrian and non –Equestrian;
- Representatives of National Federations from the UK, Germany, Belarus, Russia, France, Canada, the United States, Brazil; and,
- The Eventing Committee and Department Heads and many others from the FEI Headquarters in Lausanne.

These interviews were conducted at various event and other venues visited by the author in the following countries The UK, Canada, Belarus, Germany, and Sweden.

The two main Appendices present the full results of the comprehensive data analysed (Appendix A and B). These are an integral part of the report, but due to their detail and complexity they have been prefaced by the summary presentation that was made by the author to the Eventing Committee, the Bureau and the General Assembly, Appendix C.

Many of the findings and recommendations may seem obvious to those in the sport. It should be emphasised that the author has looked at the sport as an independent ‘outsider’ with experience in the field of horse racing.

# 3. Executive Summary

This report deals principally with the collection of data, safety, riders and their qualification, officials, and the appeal of the sport and its future.

There are a number of headline recommendations some of which are already under consideration but the key ones are as follows:

- An improvement in certain aspects of the data collection process;
- Annual, detailed analysis of all the data collected and a comparison of this analysis to previous years;
- The dissemination of the findings of this audit in relation to horse falls since 2010 to key stakeholders, in particular, course designers in so far as fence types are concerned;
- The dissemination of the findings of this audit to riders in order to increase their awareness of the issues directed related to them, such as the relevance of the age of their horse to the category of the event, the higher risk of falls in championship events, and the impact of rider speed in Cross Country;
- The further development of officials worldwide and the appointment, and payment, of Course Designers and the Ground Jury at 4* and 3* events by the FEI centrally rather than their appointment by the organisers from an FEI approved list;
- The appointment and payment by the FEI of an assistant to the Course Designer at 4* and 3* events;
- The televising of all 4* and 3* events and the broadcast of this to spectators at the events;
- A way of making it easy for spectators to follow the sport by proper branding on the riders and a means of identifying the relative positions of the riders at each stage of the competition, most importantly the cross country phase; and,
- The establishment of a working party to consider radical and shortened versions of the sport to enhance public engagement and produce results of competition in real time.

# 4. Improvements to Data Collection

Although data has been collected for some 14 years and the quality of its collection has improved significantly, the data collection process needs to be reviewed. It is always going to be difficult to obtain accurate and objective data when it is mainly collected by Fence Judges who provide their services for free. However, it would not be overly difficult to provide significant assistance to this large group of volunteers. My recommendations are as follows:

1. The FEI Eventing Fall Report Form has been in existence for some time and I feel it could be improved and developed into a more comprehensive 'Fence Judge Report Form', to capture all relevant information. This redesign is a complex task and I would recommend the formation of a working party to undertake this work. ('The Working Group'). The Working Group should include a cross section of practitioners, technical advisers and data analysts to ensure that the information gathered is relevant and can enable scientifically robust analysis.

2. The Fence Description Sheet has been in existence for 10 years. Whilst the diagrams and broad classification of fences provide some useful descriptive information, more detailed data is now required. Thus, my recommendation is that fences are redefined and full descriptive data and measurements are recorded. The aforementioned Working Group could undertake this task.

3. With the increased use of frangible devices, it is crucial to record full details of the instances when these devices are broken. It is equally important to record the instances when a fence has been impacted yet the frangible device remains unbroken. Thus, my recommendation is that a specific form is created which is dedicated to fences where there is a frangible device. The Working Group could also carry out this task; and it could be incorporated into the Judges Report Form.

4. Ensure a system of gathering data for random controls is implemented. Effective analysis of risk factors for horse falls requires comparison with a population of non-fallers. Thus the Fence Judge Report Form should be completed not only for horse falls and unseated riders, but also for a random sample of horse-rider combinations that clear each fence on each course. Information relating to refusals would also be useful and allow for more comprehensive and detailed analysis.

5. So often, during this study, I have wanted to see a film of an incident. If we had a film of each fall we could learn a lot from it.

    a. Filming every horse jumping every fence would be immensely helpful and thus I recommend that consideration be given to the provision of head camera for Fence Judges. While it would be advantageous to have this for all FEI events, at this stage it is not practical. As such, I suggest the provision at 4* and 3* level. A stock of such cameras could be owned by the FEI and sent to each event. The memory card in these cameras could be sent back to Lausanne if there had been a fall. It would also be available to the T.D./Ground Jury for immediate review, if required. In addition, if the Ground Jury had film of each fence, they could deal with any objections/enquiries very soon after the event, and in any event on the day, so a result can be properly given.

b. Alongside the provision of head cameras, I recommend that, for 4* and 3* events, the FEI require these to have a specified minimum level of TV coverage.

6. Request Fence Judges and/or Technical Delegates/Course Designers to photograph every fence and attach this image to the Event Report Form which is sent back to Lausanne

7. Data collection is a substantial and labour consuming task. With the use of modern technology, it should be possible to create a Fence Judge Report form that can, in the main, be computer read. If that were possible then much time at Lausanne, currently used in manually transferring data, could be freed up and there would be less chance of inaccuracies and human error when data is transposed.

8. As collection of data is so important, it would be helpful and welcomed by most Fence Judges if a training and explanatory video were prepared for them. This could be disseminated by the T.D., Head Steward or organiser and would help them in their job of recording what had happened at their fence.

9. We need to provide a clearer definition of what we mean by a Horse Fall, in particular, a Rotational Horse Fall, so that all Fence Judges can utilise these definitions when filling in their Fall Report Forms.

10. With avoiding rotational falls being so critical to the sport, more information on ground lines and their position relative to the main body of the fence would be beneficial. Distance of a ground line from the vertical and height of a ground line may help in identifying the fences, which are least likely to cause a rotational fall. Additionally, more information is required about the front contour of fences. These aspects could be incorporated in (1) above.

11. The data which the FEI has collected over many years is invaluable but needs to be properly analysed and my suggestion is that there needs to be an annual detailed analysis carried out of all this data collected at FEI events. This would allow the FEI to track trends and to see if interventions have had any positive effect.

# 5.Safety

This analysis of the FEI Data was conducted in two phases:

- **Phase 1 – attached as Appendix A** looked exclusively at Fence Related Factors and made some significant findings. It was concluded that it should be possible to introduce some fence modifications with the aim of reducing the risk of a horse fall, but it also emphasised the need to explore other factors.

- **Phase 2 - attached as Appendix B** looked at many more factors than those related to the fence. In particular, it looked at those related to the horse and rider.

- A synopsis of Phase 1 and 2 which was presented to the FEI General Assembly in October is attached – **Appendix C.**

Compared to other horse related sports, such as steeple chasing, the proportion of horse falls is relatively small. However as a result of the speed and nature of the fences in Cross Country, horse falls, particularly rotational falls, can result in more serious injuries to rider and horse.

The most important findings in the data analysis are set out below, along with recommendations for what steps might be taken to reduce the likelihood of a fall.

The FEI has a robust system of utilizing the Safety Officers from National Federations ('NF') to give feedback to the Eventing Executive. The annual conference, where safety matters are discussed is well attended and thorough.

The feedback from National Safety Officers at this meeting is also valuable in establishing the state of play at National Events worldwide and how the NFs are managing safety nationally.

I understand that there is a plan to hold a second such conference annually to also include Course Designers and Technical Delegates. I can only applaud this initiative. The more Safety Officers and other officials that share information, the more safety will improve.

The Eventing Team already has an informal relationship with the FIS. I think there is much that can be learned from different sports and how they deal with safety, especially some of the winter sports, which arguably have more serious injuries than Eventing. I was interested in the relationship between the FIS and the Association of Helmet Manufacturers and feel that the Eventing Committee could develop a similar relationship.

I recommend that the existing informal relationship with the FIS be further developed by holding a more formal meeting to discuss safety matters once or twice a year.

The main recommendations from the study which directly relate to Safety are:

1. **Dissemination of current findings**: Disseminate competition and fence-related information to Course Designers and Technical Delegates;

2. **Rider education**: disseminate report findings, especially,

    - Rider-related differences (e.g., gender);

- Implications of inappropriate speed; and,
- Implications of riding younger horses.

3. **Rider qualification**:

- Explore potential revision of Minimum Eligibility Requirement ('MER') requirements;
- Consider further categorisation of riders e.g. a category E;
- Standardise entry qualifications at each level;
- Standardise National Federation requirements; and.
- Review entry qualifications for all event levels.

4. **Horse qualification**: Gather further information relating to MERs. Review qualification for younger horses.

- 6 year olds at 1*
- 7 year olds at 2*

# 6. Riders And Their Qualification

Riders have been categorized since 2013; the initial categorization came from previous rider results in FEI events. It has undoubtedly had a beneficial effect on the sport. Some riders, with whom I spoke, made the argument that it is hard to break into the top/elite level of the sport.

This is no different from many other sports and actually should help with quality at the top level, and the consequential safety. The analysis showed that Category A riders were the least likely to be involved in a horse fall.

A review of rider qualification would be worthwhile. As riders in the lower categories (or uncategorized) were more likely to have had a horse-fall when competing at the higher levels, excluding these riders from the higher graded events should be considered. Indeed, as there are so many riders who fit into the Non-Categorised Group, it may be the moment to create a further level of rider category below D.

It might also be appropriate now to prevent riders who fit into the NC Group, and maybe even Category D riders, from participating 3* and 4* Events.

Categorization, coupled with the MER system, should help prevent riders getting into events that are beyond them, where the risks are greater.

The MER system has undoubtedly had a significant and beneficial effect on preventing unsuitable combinations entering events in which they are not capable of competing. Almost all the riders to whom I have spoken feel the system is good and does ensure, to some extent, that unsuitable partnerships do not get out of their depth. However, the rider categorization system can hinder a rider with one good horse climbing up the ladder. In order to get the necessary qualifications to progress, there is some evidence that combinations may take part in too many events and over face a horse. Having said this, it is better to err on the side of safety and keep a strict qualification system. If a rider is good enough, they should be able to get more horses to ride and thereby improve.

It is in the interest of the sport to encourage younger and talented individuals to progress but only if they can do so safely. Much of the responsibility for this development has to be left to the NF. I cannot see that a detailed plan for rider development worldwide is the responsibility of the FEI. Unless there is a change in the current view, I feel rider development should remain with the NFs.

The framework of the top level of events for younger people seems to work well and is supported by those with whom I spoke. Having the Championships at Pony, Junior and Young Rider ‘owned’ by the FEI ensures control, particularly of safety.

Almost all the senior riders with whom I spoke felt that horse-falls usually occurred as a result of rider error. One very senior rider said to me “*if I have a fall, it is always my fault, not the horse’s’*”. However, the combined Phase 2 analysis showed that fence and competition factors were still implicated in horse falls, regardless of rider experience. The analysis also showed that horses that fell were more likely to have fallen previously. There was also an effect of horse age, with younger horses more likely to be involved in a rotational fall, regardless of rider experience. Thus, horse demographics should still be considered when exploring risk factors and the qualification system should aim to protect younger, more inexperienced horses. It is also noteworthy that there were proportionately more falls at Championship Events than other events. This could mean that the higher the status of an event, the more pressure that is placed upon riders, which increases the likelihood of horse falls. However, further exploration is required into this area before firm conclusions can be drawn. The crucial factor is to ensure that Championship courses rigorously comply with the regulations and that course designers are aware of the greater likelihood of a horse fall at such events.

Many people have raised the issue of safety equipment. I feel it is right for the FEI to provide an outline of the rules on safety equipment – crash helmets and body protectors. It would be helpful if one rule for these two items is universal throughout the world for FEI events. Crash Helmets, in particular, can be damaged following a fall. It would be a good idea to encourage riders to check them and, in any event, a helmet and body protector should be checked at the 'declaration' stage of the event to ensure they comply with the sports requirements.

There is one area of rider safety that should be investigated, namely, the issue of 'concussion'. While NFs seem to manage this matter well, the existing system does not prevent concussed riders from participating again in their jurisdiction until it is medically safe for them to do so. As it currently stands, a rider who is concussed in one jurisdiction can ride in another before it may be safe for them to do so. Increasingly sports are coming into line over a concussion protocol as knowledge about head injuries in sport improves. My recommendation is that all riders at FEI events should have a medical record book, as they do in horse racing. Each rider has to 'declare' their horse when they get to an event so it would not be too hard to produce the Medical Record Book at that occasion. If a rider has been concussed or has had another significant injury, then the doctor at the place where this occurred would include a red entry in the book with some details of the injury. This would allow officials at future events to check whether a rider is fit to participate in that event.

Training: Some aspects of the analysis suggested that individual rider behaviour may be implicated in increasing the risk of a horse-fall, but this was not explored in depth in this study. However, emphasis on excellent training at all levels and particularly at a young age is crucial. I was most struck by how the system for training younger riders in Germany operated and, in particular, the way that a 'style' mark is so crucial at all phases of the event rather than other traditional penalties. This related to the analysis showing that, in Germany, there are less falls in percentage terms at 1* and 2* levels than most other similar nations. This would imply that their system works. The spreading of good practice is something the FEI could focus on.

# 7. Officials

There is a general view that there are not enough officials coming through at senior level and that, at the very top, only a few get the best jobs. The officials are key to most sports and Eventing is no exception. Indeed, it could be said that the Course Designers have the sport in their hands. For this reason, the training regime for these and indeed all key officials is crucial.

## 7.1. Course Designers

As the best Course Designers get older, there are not enough good ones to follow them.

The Course Designers are essential for the development of the sport and they must be extremely well trained and understand the sport completely. It is vital that they have ridden at least to mid-grade level.

Currently, Course Designers are chosen and paid for by the venue. However, at Championship and 4* and 3* level, they must come from an FEI approved list.

However, a number of riders and officials feel that, particularly at the highest level, the appointment of Course Designers could be improved. The system of the Event Organiser choosing and paying for the Course Designer from an FEI list works in principal. However, bringing on younger Course Designers is crucial for the future of the sport and an introduction process is essential. My recommendation is that for 4* and 3* events, the FEI take over the appointment and payment of Course Designers and that at these events they also appoint a Course Designer Assistant, who would in training. The lead Course Designer could report back on how the assistant is developing and it would give a possible career structure for younger designers.

## 7.2. Technical Delegates

The Technical Delegates system has no detractors although some complain that the top events always have the same Technical Delegates. Again, the FEI should look at succession planning in this sphere.

## 7.3. Ground Jury

The Ground Jury are chosen by the venue from an FEI list but are not paid. Reports on the Ground Jury are sent in confidence to the FEI by the Technical Delegates. Very often these reports are anodyne and it is hard to demote a member of the Ground Jury if they are found to be incompetent. This is particularly so as they are unpaid.

Taking note from what happens in Racing, there is an argument to pay the Ground Jury members thereby creating a proper career structure for officialdom in the sport. Racing is moving towards a panel of fully paid Official Stewards (the Ground Jury) from a system of all amateur with a professional secretary. Clearly, there is a cost involved in doing this but I feel it would create a greater degree of consistency and a proper career path for those who have probably been riders. It would also make it easier to control the standard of Ground Jury, if they are not volunteers

My conclusion thus is that for 4* and 3* FEI events, the Ground Jury is appointed by the FEI. There may be an argument that there needs to be an appointments committee for this rather than it being done by the Executive to avoid accusations of favouritism. The rules on rotation at events should continue to apply. They should also be paid centrally by the FEI.

The FEI system for training officials is excellent and very well received worldwide. In addition, the way the Solidarity programme has been implemented has ensured there are trained officials available for all jurisdictions. It is crucial that this programme continues to develop, as it is the bedrock for the further development of the sport. In some jurisdictions they would like more help with training and the FEI should do all it can to agree to these requests.

# Analysis of horse falls related to jumping efforts during the cross country test of FEI Eventing competitions

## First Phase: Fence Related Factors

**A confidential report prepared by**

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# Executive Summary

This report provides an evaluation of fence-related risk factors for horse falls related to jumping efforts during the cross country test of FEI Eventing competitions. This initial phase of the study has focused on fence related factors, whilst the next phase will incorporate horse and rider related factors.

All data available for FEI events during 2008 – 2104 were included in the analysis. A multivariable regression model identified several fence related factors that independently increased or decreased the risk of horse falls.

These were:

- Event level - increased risk at higher levels, especially at 4*
- Fence types
    - increased risk at square spreads, corners (unless with a solid top and open front)
    - upright post and rails, brushes with a ditch in front
    - decreased risk at ascending spreads
- Frangible fences - increased risk
- Landing
    - Increased risk with downhill landing
    - Decreased risk with uphill landing
- Water – increased risk for fences into, out of, or within water

A comparison of rotational and non- rotational falls revealed very few fence related differences. There was a slightly higher proportion of rotational falls at post and rails and palisades. Fence judges reported that riders involved in rotational falls were more likely to have approached the fence at an inappropriate speed (either too fast or too slow).

We highlight some study limitations and make recommendations for future developments. We recommend a review of the current system of collecting and recording data, including modifying the fence and fall report forms. We also suggest more detailed monitoring and evaluation of frangible fences.

We conclude that the fence related factors included in this analysis accounted for approximately 10% of the variability in horse falls. On this basis we suggest some modifications to current fence design that may reduce this risk, but recommend that other factors should also be explored to explain more of the variability.

Phase two of the study aims provide a more comprehensive picture of the risk factors for horse falls by including variables relating to the effect of horse and rider and the qualification system.

## Contents

The summary report consists of



**Acknowledgements**

We would like to thank Professor Dominique Maes for her input and the staff at the FEI headquarters who responded so quickly to queries and requests for information.

## 1. Introduction

This study was commissioned as part of a wider audit of FEI Eventing. Concerns about safety in the sport prompted this analysis of risk factors for horse falls related to jumping efforts during the cross country test.

For this first phase of the study, the focus was on fence-related factors, with the acknowledgement that this may be one aspect of what is likely to be a much bigger picture. Further analysis (planned for the second phase of this work) will explore other contributing factors such as those relating to the horse and rider.

The main aim for this initial analysis was to establish if there were any fence-related factors which increased (or decreased) the risk of horse falls at FEI Eventing competitions during the period 2008-2014.

Our research questions were:

• Did any fence-related factors increase the risk of a horse fall?

• Were there particular factors which increased the risk of a horse fall becoming rotational?

## 2. Methodology

### Data

Data were supplied by the FEI from their database of competition records from 2008 – 2014.

Information was extracted from several different files. To maximise the power of the analysis all fences and falls were included, even if there were missing values for some variables. The number of fences, falls, or other variables in different parts of this report may therefore differ slightly.

### Variables in Analyses

*Table 1: Independent variables*

| **Physical factors**<br>**Available for all fences – obtained from Technical Delegate (TD) reports** | **Environmental factors**<br>**Available only for fences where there were falls – obtained from fence judges' fall report forms** | **Other factors - extracted from registration files** |
|---|---|---|
| Course Designer<br>Event level (1,2,3,4*)<br>Competition type (CIC/CCI)<br>Fence type and category<br>Is fence a combination?<br>Is fence a frangible?<br>Is fence portable?<br>Is fence into or out of water?<br>Is fence associated with water?<br>Approach terrain<br>Landing terrain<br>Does fence have a ground line?<br>Is fence off a bend – left or right? | Was an air jacket worn?<br>Was air jacket inflated?<br>Did frangible break?<br>Did horse tread on athlete?<br>Did horse slip?<br>Wind conditions<br>Visibility<br>Did horse refuse?<br>Did horse hit fence on way up?<br>Did horse hit fence on way down?<br>Did horse hit fence hard?<br>Did portable tip over?<br>Did fence break?<br>Did horse somersault (i.e. was this a rotational fall)?<br>Did rider misjudge situation?<br>Was athlete inexperienced?<br>Was athlete distracted?<br>Was athlete fatigued?<br>Was horse out of control?<br>Was horse too fast?<br>Was horse too slow?<br>Was jump Into shadow?<br>Was jump Into brightness?<br>Was horse Injured?<br>Was horse fatigued?<br>Was horse distracted?<br>Point of impact | Athlete gender<br>National Federation |

***Dependent (outcome) variables***

The outcome variables were

- Horse fall: yes / no
- Rotational fall: yes / no

**Near Misses**

Near misses were included in the initial dataset. These were classified as unseated riders where the horse had hit the fence hard on the way up. However, in the absence of control data this category contributed little to the study and was therefore not included in the main analysis.

An analysis of the concept of ‘near misses’ would require comparable ‘control’ data for occasions where horses hit the fence hard on the way up without a resulting horse or rider fall.

## 3. Comparison of horse falls versus non-fallers

For each cross-country fence jumped during the study period, jumping efforts were divided into those which incurred a horse fall and those which did not (non-fallers).

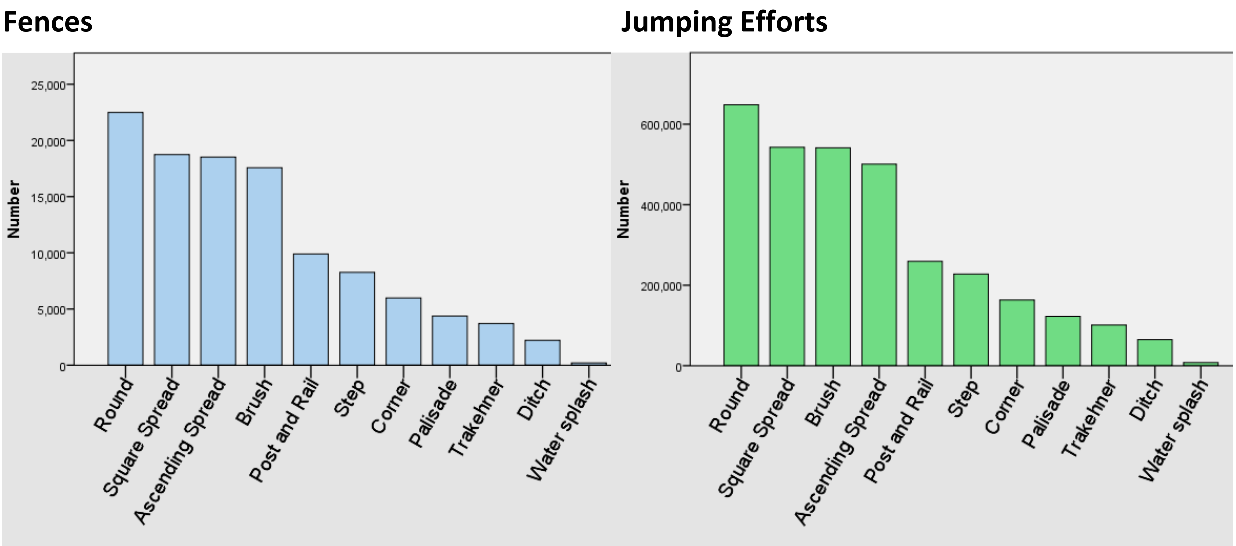
### Descriptive Statistics

The initial analysis included all fences jumped at FEI competitions between the years 2008 – 2014. The total number of jumping efforts over each fence was calculated using information provided about the numbers of cross country starters and finishers as recorded by technical delegates and input onto the database by FEI staff. The number of clear jumping efforts, defined as non-fallers, was calculated as the total number of jumping efforts minus the number of horse falls for each individual fence. We were unable to account for other penalties at individual fences (e.g. refusals). To take account of retirements and eliminations, an algorithm based on a normal distribution model was developed to estimate the proportion of starters that cleared each fence.

*Table 2: Summary of Cross country data*

| | |
|---|---:|
| Number of fences | 113,354 |
| Fences at which there were one or more horse falls | 1572 |
| Number of horse falls in this analysis | 1689 |
| Non-fallers (jumping efforts) | 3,210,347 |
| Total number of jumping efforts | 3,212, 036 |

*Figure 1: Distribution of cross country fences and jumping efforts*




Detailed information was not available for all fences thus numbers used for individual analyses may be slightly lower than those above.

## 3.1 Univariable Analyses (Individual effects)

Firstly, we considered the individual effects of all the listed variables. Individual effects need to be interpreted with care as they may not all be directly causal. For example, a particular fence type might be associated with an increased proportion of horse falls, but if this fence type is often situated downhill we would need to explore whether it is the fence type or the terrain which increases the risk of a horse fall (or both).

We have presented the data as follows:

- Cross tabulations identify variables where a significant association was found between certain conditions and the number of horse falls
- The Chi Square ($\chi^2$) statistic indicates the size of the difference between conditions – the larger the number the greater the difference
- Statistically significant differences have been colour coded:

| | | | |
|---|---|---|---|
| (green) | Significantly lower (reduced risk of a horse fall) | (orange) | Significantly higher (increased risk of a horse fall) |

- Jumping efforts per horse falls represents the average number of times that type of fence would be jumped between horse falls – the smaller the number of jumping efforts / horse fall, the greater the risk of a fall (within the dataset analysed)

**Variables that had a significant effect on horse falls:**

**Event Level**

There was a progressive increase in the proportion of horse falls as the level of the competition increased.

*Table 3: The effect of event level*

| Level | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---|---|---|
| 1★ | 1,465,223 | 532 | 2753 |
| 2★ | 1,069,636 | 593 | 1803 |
| 3★ | 587,096 | 448 | 1309 |
| 4★ | 90,084 | 116 | 776 |

($\chi^2$ = 237.87, df = 3, $p < 0.01$)

**Competition Type**

There was a higher proportion of horse falls at CCI competitions.

*Table 4: The effect of competition type*

| Type | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---|---|---|
| CCI | 1,240,705 | 751 | 1651 |
| CIC | 1,971,334 | 938 | 2101 |

($\chi^2 = 24.29$, df = 1, $p < 0.01$)

**Fence Type and Category (see appendix 1 for fence descriptions)**

Certain fence types and categories were associated with a higher proportion of horse falls. When interpreting the figures it is important to look at both the number and proportion of falls.

**Fence Types**

The results demonstrated:

- Higher proportion of horse falls at fence types A, C, G and J
- Type G had the highest proportion of horse falls (defined as the lowest number of jumping efforts per horse fall)
- Lower proportion of horse fall at fence types D, E, F and L

*Table 5: The effect of fence type*

| Fence Type | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---|---|---|
| **All fences (average)** | 3,179,399 | 1666 | 1908 |
| A : Post and rail | 259,416 | 160 | 1621 |
| B : Palisade | 122,666 | 69 | 1778 |
| C : Square spread | 542,494 | 357 | 1520 |
| D : Ascending spread | 500,708 | 177 | 2829 |
| E : Brush | 541,344 | 209 | 2590 |
| F : Round | 647,604 | 300 | 2159 |
| G : Corner | 163,191 | 156 | 1046 |
| H : Trakehner | 101,333 | 65 | 1559 |
| J : Step | 227,751 | 151 | 1508 |
| K : Water | 8,144 | 6 | 1357 |
| L : Ditch | 64,748 | 16 | 4047 |

($\chi^2 = 154.65$, df = 10, $p < 0.01$)

**Fence categories**

- Some within type differences e.g. categories A1 and E4 are worth noting
- Fence type J shows a difference between steps involving water (J2 and J3 and those not involving water (J4 and J5)
- Within type differences for the higher risk fences (C and G) indicate that the front contour and top of fence may have an effect – e.g. for type C (square spread) there was a higher risk of a horse fall (indicated by fewer jumping efforts per horse fall) at fences with an open (C1) rather than solid top (C2, C3).

*Table 6: The effect of fence category*

| Fence Category | Jumping efforts with no horse fall | Number of Horse Falls | Total jumping Efforts | Jumping Efforts per horse fall |
|---|---|---|---|---|
| A0 | 29,572 | 20 | 29,592 | 1479 |
| A1 | 127,920 | 92 | 128,012 | 1390 |
| A2 | 34,136 | 16 | 34,152 | 2134 |
| A3 | 52,227 | 24 | 52,251 | 2176 |
| A4 | 15,402 | 7 | 15,409 | 2200 |
| B1 | 94,184 | 47 | 94,231 | 2004 |
| B2 | 28,285 | 22 | 28,307 | 1286 |
| C1 | 89,553 | 69 | 89,622 | 1298 |
| C2 | 168,931 | 113 | 169,044 | 1495 |
| C3 | 283,652 | 175 | 283,827 | 1621 |
| D1 | 39,497 | 20 | 39,517 | 1975 |
| D2 | 75,872 | 34 | 75,906 | 2232 |
| D3 | 286,714 | 90 | 286,804 | 3186 |
| D4 | 98,447 | 33 | 98,480 | 2983 |
| E1 | 146,515 | 58 | 146,573 | 2526 |
| E2 | 216,184 | 63 | 216,247 | 3431 |
| E3 | 60,364 | 21 | 60,385 | 2874 |
| E4 | 62,564 | 47 | 62,611 | 1331 |
| E5 | 6,833 | 2 | 6,835 | 3417 |
| E6 | 48,674 | 17 | 48,691 | 2863 |
| F1 | 388,435 | 199 | 388,634 | 1952 |
| F2 | 259,497 | 101 | 259,598 | 2569 |
| G1 | 26,986 | 32 | 27,018 | 843 |
| G2 | 25,839 | 16 | 2,5855 | 1615 |
| G3 | 110,210 | 108 | 110,318 | 1020 |
| H1 | 93,899 | 61 | 93,960 | 1539 |
| H2 | 3390 | 2 | 3392 | 1695 |
| H3 | 3979 | 0 | 3979 | 0 |
| J2 | 30,148 | 51 | 30,199 | 591 |
| J3 | 36,011 | 31 | 36,042 | 1162 |
| J4 | 68,681 | 19 | 68,700 | 3615 |
| J5 | 92,759 | 50 | 92,809 | 1855 |
| K | 7995 | 6 | 8001 | 1333 |
| L | 64,748 | 16 | 64,764 | 4047 |

($\chi^2 = 294.31$, df = 33, $p < 0.01$)

**Combinations**

There were slightly more horse-falls (per jumping effort) at combination fences than at fences that were not part of a combination.

*Table 7: The effect of combinations*

| Fence Type | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---:|---:|---:|
| Combination | 1,496,363 | 772 | 1749 |
| Non-combination | 1,350,506 | 737 | 2030 |

($\chi^2$ = 8.39, df = 1, p < 0.01)

F**rangible fences**

There was a greater likelihood of horse falls at fences that were fitted with frangible devices than at those without. This may not be a direct effect and could reflect the type of fence at which frangible devices are fitted. The independent effect of frangible fences was tested in the multivariable analysis (next section).

*Table 8: The effect of frangible fences*

| Fence Type | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---:|---:|---:|
| Frangible | 131,969 | 126 | 1047 |
| Non-frangible | 3,080,068 | 1563 | 1971 |

($\chi^2$ = 48.18, df = 1, p < 0.01)

According to the data collected from fence judges, in 94% (118/125) of horse falls at frangible fences the frangible device had not activated.

*Table 9: Frangible fence activation*

| | Did Frangible break? | | |
|---|---:|---:|---:|
| **Type of Horse fall** | **Yes** | **No** | **Not recorded** |
| Rotational | 0 | 18 | |
| Non-rotational | 7 | 100 | 1 |
| Total | 7 | 118 | 126 |

We were unable to obtain comparative data relating to the number of frangible devices that were activated in the absence of a horse fall or unseated rider. It was therefore not possible to explore whether the use of frangible fences had prevented any horse falls.

There were also some issues relating to recording of information– for example there were 7 instances (including 4 horse falls) where it was reported that the frangible device had broken, but the fence was not recorded as a frangible fence.

**Portable fences**

There were fewer horse-falls (per jumping effort) at portable fences than at non-portable fences. This may not be a direct effect – use of portables may reflect the type of fence or possibly the type of course / venue where these fences are used.

*Table 10: The effect of portable fences*

| Fence Type | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---:|---:|---:|
| Portable | 1,496,466 | 696 | 2150 |
| Non-portable | 1,715,553 | 993 | 1728 |

($\chi^2$ = 19.67, df = 1, p < 0.01)

There was some incorrect recording – e.g. 8 horse falls where it was recorded that portable fences were tipped over at fences that were recorded as being non-portable .

**Approach**

There was a significantly higher proportion of horse falls when there was a downhill approach. An uphill approach, conversely, had a slight protective effect compared to approaches on the level.

*Table 11: The effect of approach to fence*

| Approach | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---:|---:|---:|
| Level | 2,496,621 | 1300 | 1920 |
| Uphill | 391,994 | 179 | 2190 |
| Downhill | 319,368 | 208 | 1535 |

($\chi^2$ = 13.26, df = 2, p < 0.01)

**Landing**

There was a significantly higher proportion of horse falls when there was a downhill landing and significantly fewer when the landing was uphill. The Chi-squared value is higher for 'landing' than for 'approach' implying the greater effect of the former – this was explored further in the multivariable analysis.

*Table 12: The effect of fence landing*

| Landing | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---|---|---|
| Level | 2,400,905 | 1207 | 1989 |
| Uphill | 216,725 | 90 | 2408 |
| Downhill | 590,305 | 390 | 1514 |

($\chi^2$ = 27.90, df = 2, $p < 0.01$)

**Water**

Fences were re-coded into one of four categories:

- Into water (but not out of water)
- Out of water (but not into water)
- Within water (both into and out of water)
- Associated with water (but not directly into or out of water)

Fences jumped into, out of, or within water were associated with a higher proportion of horse falls compared to those simply associated with water or not involving water at all.

*Table 13: The effect of water*

| Water | Total number of jumping efforts | Number of horse falls | Jumping efforts per horse fall |
|---|---|---|---|
| No water | 2,757,968 | 1299 | 2123 |
| Into Water | 136,057 | 172 | 791 |
| Out of Water | 72,600 | 61 | 1190 |
| Within Water | 55,324 | 62 | 892 |
| Associated with water | 188,383 | 95 | 1983 |

($\chi^2$ =207.52, df = 4, $p < 0.01$)

### Course Designers (CDs)

Initial analysis showed a strong effect of course designer, with some CDs having a much higher proportion of horse falls on their courses. However, this may be due to certain course designers working with particular federations or at particular types of events (e.g. championships). The effect of the course designer will be explored further in the next phase of the study.

### Previous Fence details

There was a slight effect of previous fence type – i.e. the fence jumped prior to the 'fall' fence. Horses were more likely to fall when the previous fence was Type E (brush) and less likely to fall when the previous fence was J5 (step up) although the differences were slight. There was also an indication that a previous downhill landing was associated with increased likelihood of horse falls at the next fence (when compared to an uphill landing), but the difference was not statistically significant. However we did not have information about the distance between the fences or the terrain.

The effect of factors relating to the previous fence / terrain should be explored further.

### Non-significant factors

The following factors did not have a significant effect on horse falls in the current analysis (see appendix 3 for further detail).

- Ground lines
- Bends

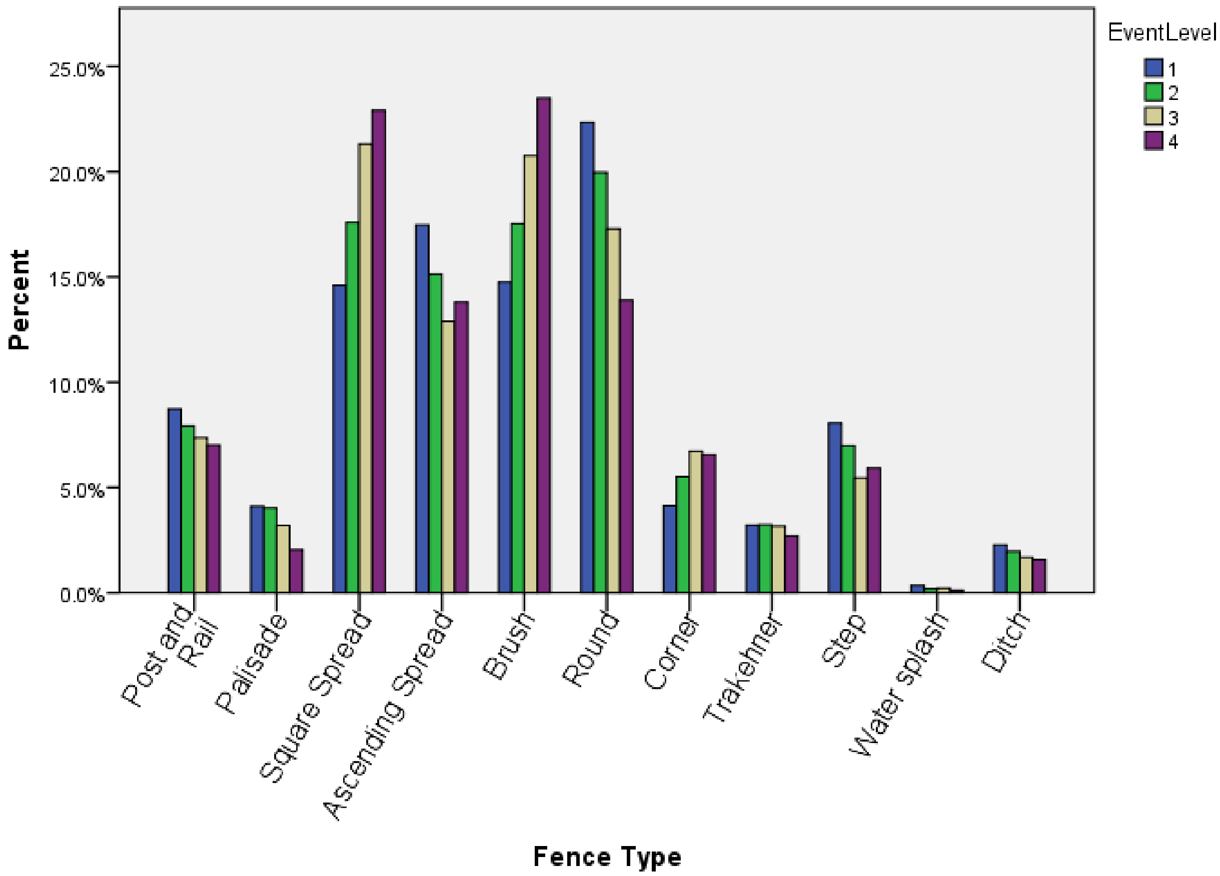
However, more detailed measurements relating to these variables could provide further information.

## 3.2 Multivariable Analysis

### Event Level

An initial exploration of fence type and event level indicated that the difference in risk of a horse fall could be partly attributed to different distribution of fences– with greater use of fences types C (square spread) and G (corner) and less use of Type D (ascending spreads) at the higher levels.

*Figure 2: Distribution of fences from 1* to 4**




In order to study interactions further a smaller dataset was created with an equal ratio of cases (horse falls) and controls (non-fallers).

We did this by extracting all the fences at which there had been horse falls and an equal number of random fences at which there had been no fallers. Fences at which there had been unseated riders were excluded from the control group, in order to have a clearer differentiation between the two groups. Fences at which there had been multiple horses falls were represented more than once to reflect the number of falls.

**Multivariable model**

Multivariable regression analysis resulted in the following model. The variables remaining in the model were those which had an independent effect on the likelihood of a horse fall.

*Table 14: Multivariable model of risk factors for horse falls*

| Factor | Baseline | Category | Odds ratio* | Risk |
|---|---|---|---|---|
| **Event level** | 1★ | 2★ | 1.2 | Increases |
| | | 3★ | 1.7 | |
| | | 4★ | 4.2 | |
| **Fence type** | All other fences | D3 Ascending spread | 0.8 | Decreased risk |
| | | A1 Upright Post and Rail | 1.4 | Increases |
| | | C1 / C3 Square Spread | 1.4 | |
| | | C2 Square Spreads | 1.8 | |
| | | E4 Brush with ditch | 1.8 | |
| | | G1 Corner (open) | 2.0 | |
| | | G3 Corner (solid) | 2.5 | |
| **Frangible fences** | Non-frangibles | Frangible fences | 1.8 | Increased risk |
| **Landing** | Level | Up | 0.7 | Decreased risk |
| | | Down | 1.3 | Increased risk |
| **Water** | No Water | Out of water | 2.1 | Increases |
| | | Within water | 2.2 | |
| | | Into water | 3.1 | |

*The odds ratio refers to the amount of increased risk for the specified category compared to the baseline. For example, at a 4★ event there was over 4 times the risk of a horse fall compared to 1★. This is an independent effect, i.e. after accounting for all other effects within the model such as the different proportion of various fence types at each level.

Odds ratios of less than 1 indicate a decreased risk – e.g. the odds ratio of 0.8 indicates that there were 20% less falls at ascending spreads than at the other fences.

Full statistical details can be found in appendix 2.

## 4. Comparison of Rotational and non-rotational falls

### Descriptive Statistics

All horse falls recorded during the study period were included in the initial analysis.

*Table 15: Summary of horse fall type*

| | |
|---|---:|
| Non-rotational Falls | 1465 |
| Rotational falls | 274 |
| **Total number of horse falls** | **1739** |

The number of horse falls included in this part of the analysis is greater than for the previous analysis. In the analysis of fallers versus non-fallers we could only include falls that were attributed to a particular fence. For some falls the fence ID was missing, therefore, these falls were excluded from the previous analysis, but were retained in the comparison of rotational versus non-rotational falls if there was information available from the fence judges' reports.

## 4.1 Univariable Analyses ( Individual effects)

All fence variables recorded by the TDs were included in this analysis, with the addition of the information recorded by fence judges relating to environmental factors and fall characteristics.

### Fence related variables

Very few fence related factors showed a significant association with a rotational (as opposed to non-rotational) horse fall (table 16), implying that there are factors other than the fence which determine whether a fall becomes rotational.

There was a slightly greater likelihood of a fall being rotational at fence types A (post and rail) and B (palisade), and a slightly reduced likelihood at fence type J (step).

It is important, however, to look at the number of rotational falls as well as the proportions. For example, palisades had a greater proportion of rotational horse falls than some other fence types, but this type of fence had fewer horse falls in total and therefore, the number of rotational falls was still relatively low. In contrast, square spreads had the greatest number of horse falls, but there was no difference in the proportion of rotational and non-rotational falls at this type of fence.

*Table 16: Effect of jump type on rotational falls*

| | | Rotational Fall | | Total |
|---|---|---|---|---|
| | | **No** | **Yes** | |
| Fence Category | A : Post and rail | 118 | 42 | 160 |
| | B : Palisade | 51 | 18 | 69 |
| | C : Square spread | 296 | 60 | 356 |
| | D : Ascending spread | 149 | 28 | 177 |
| | E : Brush | 180 | 29 | 209 |
| | F : Round | 248 | 52 | 300 |
| | G : Corner | 139 | 17 | 156 |
| | H : Trakehner | 57 | 8 | 65 |
| | J : Step | 144 | 7 | 151 |
| | K : Water | 6 | 0 | 6 |
| | L : Ditch | 15 | 1 | 16 |
| **Total** | | **1403** | **262** | **1665** |

**Environmental factors**

Data from the fall report forms indicated that horses that had rotational falls were more likely than those having non-rotational falls to have the following characteristics:

- Hit the fence hard ($\chi^2 = 80.69$, df = 29, $p < 0.01$)
- Hit the fence on the way up ($\chi^2 = 66.73$, df = 1, $p < 0.01$)
- Athlete misjudged situation ($\chi^2 = 7.95$, df = 1, $p < 0.01$)
- Inappropriate speed –
    - too fast ($\chi^2 = 7.24$, df = 1, $p < 0.01$)
    - too slow ($\chi^2 = 14.22$, df = 1, $p < 0.01$)

They were less likely to have:

- Slipped ($\chi^2 = 19.11$, df = 1, $p < 0.01$)

It must be noted that the falls report form contains subjectively reported data and could have been affected by reporter bias.

As a result of a rotational (versus non-rotational) horse fall, there was a higher likelihood of the following:

- Horse treading on the athlete ($\chi^2 = 14.52$, df = 1, $p < 0.01$)
- Horse breaking the fence ($\chi^2 = 5.97$, df = 1, $p < 0.05$)
- Serious athlete injury ($\chi^2 = 57.41$, df = 1, $p < 0.01$)
- Horse injury ($\chi^2 = 12.02$ , df = 1, $p < 0.01$)

***Horse and Rider Injury***

As shown above, and previously documented, rotational (versus non-rotational) horse falls were more likely to result in horse or rider injury. The conditions associated with injury were, as expected, similar to those linked with rotational falls, with the following additional effects:

- Horse and rider injury both more likely if reported as approaching the fence too fast (rather than too slow)
- Less likelihood of serious athlete injury at fences related to water
- More likelihood of serious athlete injury at portable fences

Horse and rider injury will be explored in more depth in the second phase of the study.

## 4.2 Rotational vs non-rotational falls: multivariable analysis

A reduced dataset was created which was comprised of the 274 rotational falls and an equal number of non-rotational falls, randomly selected.

Both fence type (A and J) and rider speed remained influential in the multivariable model. These factors together explained around 8% of the variability in rotational (vs non-rotational) horse falls. As the dataset was quite small, and rider speed objectively assessed, these effect should be interpreted with caution. We would be wary of drawing any firm conclusions at this point.

*Table 17: Multivariable model of risk factors for rotational (compared non-rotational) horse falls*

| Factor | Baseline | Category | Odds ratio* | Risk |
|---|---|---|---|---|
| **Fence type** | All other fences | J Step | 0.2 | Decreased risk |
| | | A Post and Rail | 1.6 | Increased risk |
| **Speed** | Appropriate speed | Too Slow | 1.7 | Increases ⇩ |
| | | Too Fast | 2.2 | |

Full statistical details can be found in appendix 5.

## 5. Study Limitations

As is inevitable with such a complex analysis and large dataset, there were some limitations.

**Study Data**

Data from 2008 – 2014 were included. There have been many developments within the sport during this period including rule changes that may have affected factors such as rider behaviour, and trends in course design. The introduction and popularity of air jackets may have increased the 'risk-taking' behaviour of riders, as has been documented in other sports. In order to have sufficient statistical power we analysed the data set as a whole rather than dividing the dataset into smaller time periods. As more detailed information becomes available in future years it will be possible to look more closely at annual trends and explore smaller differences.

The fence descriptors enabled us to explore the impact of different fence types and categories but more detail would allow identification of the key factors involved. Linear dimensions such as height and width of fence, angle of front face, distance between the ground line and the fence would allow more detailed analysis. Some factors currently integrated into the fence type (e.g. association with water, ditch in front) could be recorded separately to provide greater detail.

There were also some coding / input errors – for example some fences where it was reported that the frangible device had been activated, were not recorded as frangible fences.

**Observer Bias**

Fall report forms were completed by the fence judges following a horse fall or unseated rider. Thus there may be a degree of observer bias evident in that judges may be seeking a 'reason' for the fall.

**Control Data**

The parameters reported on the falls report form were only available for fallers. Therefore it was not possible to explore the effects of some environmental factors (such as visibility, ground conditions) as this information was not available for non-fallers.

## 6. Phase 1 Summary and Recommendations

### Summary

This analysis indicated several fence related factors that had affected the likelihood of a horse fall. The multivariable analysis enabled us to define which of these factors had an independent effect.

In total, the effect of the fence related variables included in this study accounted for 9.7% of the variability in horse falls. This means that it should be possible to reduce the risk of a horse fall by making some modifications to fence design and siting, but that there is still a large amount of variance in horse falls that cannot be explained by the fence related variables included in this study.

There must therefore be other factors or 'reasons' for the majority of horse falls.

These reasons could include:

- Fence related variables not included in the current study e.g.
    - fence dimensions – height / width / angle
    - fence appearance – colour / contrast / contour
    - environmental factors - visibility / ground conditions etc.

- Other competition related factors e.g.
    - course design
    - competition status - such as championship

- Non-competition / fence related variables e.g.
    - horse related factors – fitness, previous performance etc.
    - rider related factors – physical and psychological
    - eligibility and the qualification system

- Factors so far unknown

- Chance

**Recommended modifications:**

Analysis of the data currently available suggests that fence related factors are implicated in the likelihood of horse falls, but that this effect is relatively small. Therefore we are cautious about recommending major changes to fence design as it is unlikely that addressing these issues alone will remove the risk of horse falls. However, consideration of the following modifications may ***reduce*** this risk:

1. Review the use of frangible fences. The current dataset indicated a higher likelihood of a horse fall at fences where frangible devices were fitted. It is possible that riders approach frangible fences differently, assuming a degree of 'safety'. If the frangible devices are not being activated at the correct force this could increase the risk of a horse fall.
2. Consider the terrain when using higher risk fences e.g. avoiding upright fences downhill.
3. Square spreads were higher risk fences in all situations. Consider judicious replacement of some square spreads with ascending spreads. When square spreads are used, a solid top may reduce the risk of a horse fall.
4. Corner fences that were 'open' (front and top – G1), or 'solid' (front and top – G3) also presented a higher risk of a horse fall. There were fewer horse falls at corner fences which had an open front and a solid top. More detailed data would allow us to explore whether this is due to the contour of the front (open / less vertical) or the appearance (visual cues?) of the fence.
5. Jumps into and out of water have a higher incidence of horse falls. Consider the type of fence and avoid high risk fences into and out of water e.g. corners and square spreads.

**Other recommendations:**

1. This study emphasised the need to explore other factors as defined above, which will be included in the second phase of the study ( see appendix 6)
2. Review the current system of data collection and input to reduce inconsistencies
3. Consider adapting the fence description sheet and fall report forms to ensure more effective recording and analysis
4. Frangible fence design and function should be explored, and all instances where frangible devices are activated should be recorded with the same level of detail as for horse falls.
5. Consider collecting data for a sample of 'non- fallers' e.g. from 2 competitors selected at random at each fence
6. Explore the potential to gather some objective data - in particular rider approach speed as the current analysis suggested that this may be implicated in rotational horse falls.

If required we can suggest modifications to the fence description and fall report forms in an additional report.

**Conclusions**

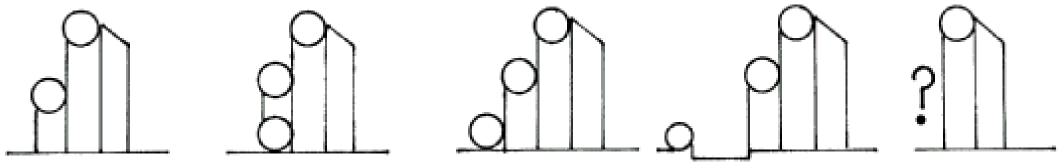
This study identified several fence related factors which were linked with the risk of horse falls on the cross country test of FEI Eventing. By considering these findings it should be possible to introduce modifications with the aim of reducing this risk; however, it is likely that there are other factors which play a larger part in the likelihood of a horse fall. Some of these factors will be explored in the second phase of the study.

# Appendices

## Appendix 1;FENCE TYPES (e.g. A, B, C,). FENCE CATEGORIES (e.g. (1), (2),(3),).

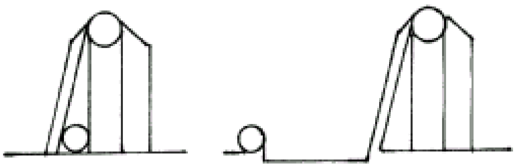
If in **any** Fence Type your fence is **VERY** different from the categories offered, you should categorise it as (0) and describe it in the remarks column of the Fence Description Form.

**A** POST & RAILS



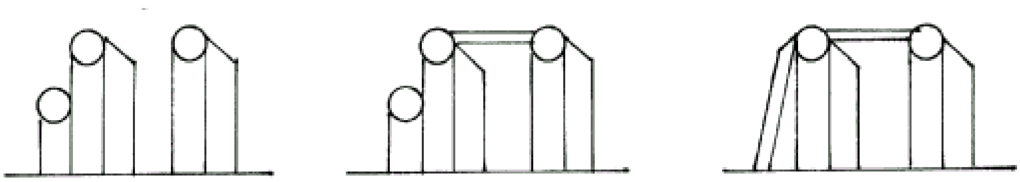

(1) (2) (3) (4) (0)

**B** PALISADE



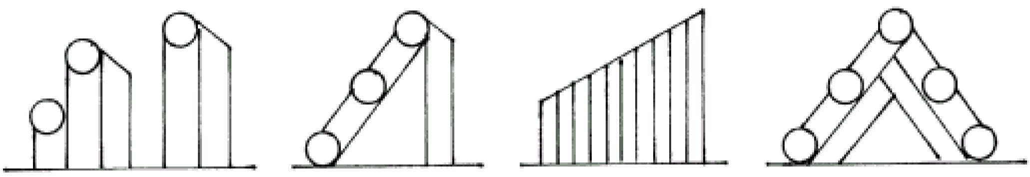
(1) (2)

**C** SQUARE SPREAD



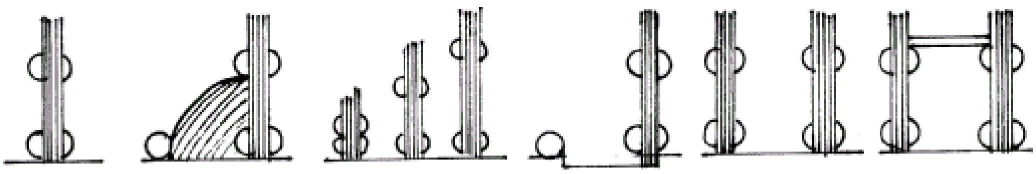
(1) (2) (3)

**D** ASCENDING SPREAD



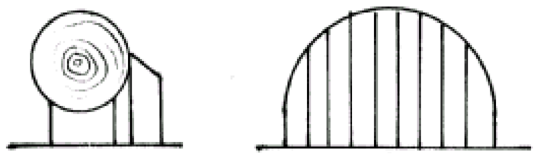
(1) (2) (3) (4)

**E** BRUSH



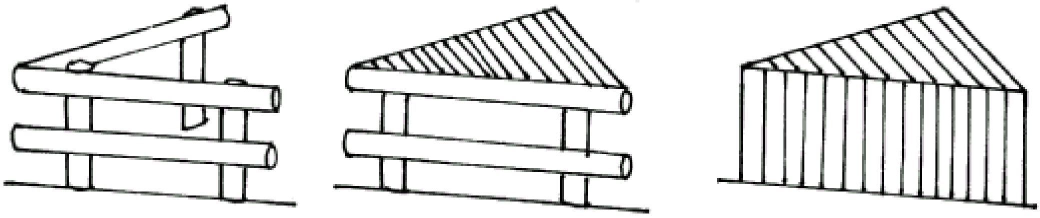
(1) (2) (3) (4) (5) (6)

**F** ROUND



(1) (2)

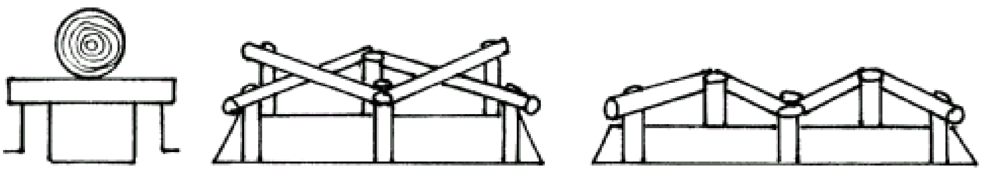
**G** CORNER



(1) (2) (3)

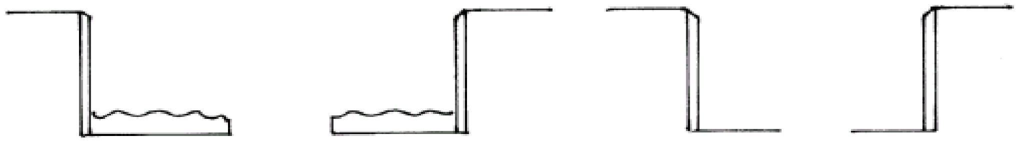
Please state in the remarks column whether **left** (as shown) or **right** corner.

**H** TRAKEHNER



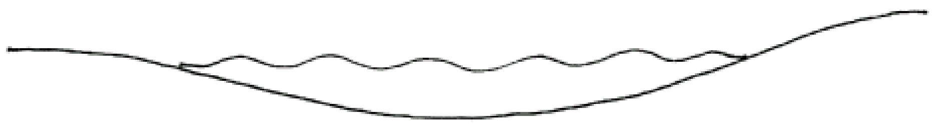
(1) (2) (3)

**J** STEP

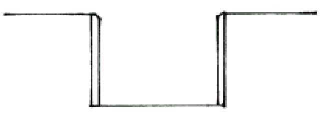


(2) step into water (3) step out of water (4) step down (5) step up

**K** WATER



**L** DITCH



**Appendix 2: Multivariable Regression Model to explore risk factors for horse falls**

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Event Level 1* | | | 60.89 | 3 | .00 | | | |
| Event Level 2* | .22 | .08 | 6.67 | 1 | .01 | 1.24 | 1.05 | 1.46 |
| Event Level 3* | .50 | .10 | 26.64 | 1 | .00 | 1.65 | 1.36 | 1.99 |
| Event Level 4* | 1.42 | .21 | 44.52 | 1 | .00 | 4.15 | 2.73 | 6.29 |
| Other fences | | | 58.09 | 8 | .00 | | | |
| A1 Vertical Post and Rail | .31 | .17 | 3.18 | 1 | .07 | 1.36 | 0.97 | 1.91 |
| C1 square Spread | .30 | .20 | 2.21 | 1 | .14 | 1.36 | 0.91 | 2.03 |
| C2 Square Spread | .58 | .16 | 13.13 | 1 | .00 | 1.79 | 1.31 | 2.45 |
| C3 Square Spread | .36 | .12 | 8.57 | 1 | .00 | 1.44 | 1.13 | 1.83 |
| D3 Ascending spread | -.27 | .14 | 3.49 | 1 | .06 | 0.76 | 0.58 | 1.01 |
| E4 Brush with ditch | .60 | .24 | 6.07 | 1 | .01 | 1.83 | 1.13 | 2.95 |
| G1 Corner (open) | .71 | .33 | 4.63 | 1 | .03 | 2.04 | 1.07 | 3.92 |
| G3 Corner (solid) | .90 | .17 | 26.92 | 1 | .00 | 2.45 | 1.75 | 3.44 |
| Frangible | .61 | .18 | 11.20 | 1 | .00 | 1.84 | 1.29 | 2.62 |
| Landing -level | | | 12.84 | 2 | .00 | | | |
| Landing - up | -.33 | .15 | 4.73 | 1 | .03 | 0.72 | 0.54 | 0.97 |
| Landing - down | .24 | .09 | 6.45 | 1 | .01 | 1.27 | 1.06 | 1.52 |
| Water - none | | | 72.40 | 3 | .00 | | | |
| Water - into | 1.12 | .16 | 52.19 | 1 | .00 | 3.08 | 2.27 | 4.17 |
| Water - out of | .76 | .21 | 13.10 | 1 | .00 | 2.14 | 1.42 | 3.22 |
| Water - within | .78 | .22 | 12.10 | 1 | .00 | 2.19 | 1.41 | 3.40 |
| Constant | -.57 | .07 | 63.05 | 1 | .00 | .564 | | |

**Model Summary**

| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|---|---|---|---|
| 1 | 4364.185[a] | .073 | .097 |

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## Appendix 3: non-significant factors

### Ground Lines

There was no significant difference in the proportion of horse-falls at fences with ground lines compared with those without ($\chi^2 = 0.03$, df = 1, $p = 0.87$)

This could mean that ground lines are not implicated in horse-falls or that they are already being used appropriately. There was no information about the distance between the ground line and the fence, which could provide additional information.

### Bends

There was no difference in the proportion of horse-falls at fences off bends (right or left) compared with those without ($\chi^2 = 0.83$, df = 2, $p = 0.66$).

This could mean that jumping off a bend is not implicated in horse-falls or, more likely, that bends are already being used appropriately.

## Appendix 4: Rider Demographics

### *Gender*

The gender of riders experiencing horse falls was compared with the total number of registered riders. It was not possible to account for the number of rides / jumping efforts per rider so results to be taken as a guideline only.

The results indicated that male riders were more likely to have experienced horse falls. However we need to explore if this is purely a gender effect or due to other factors (e.g. different proportions of each gender at different event level / competition types). This factor will be analysed further in phase 2 of the study (horse and rider variables).

| Gender | Number of riders who had horse falls | Total number of riders registered | Percentage of registered riders who experienced horse falls |
|---|---|---|---|
| Male | 568 | 3363 | 17% |
| Female | 718 | 7588 | 9% |
| Total | 1286 | 10,951 | 12% |

($\chi^2$ = 124.03, df = 1, p < 0.01)

### *National Federation*

This was a preliminary exploration and results need to be interpreted with caution -

The number of riders who had experienced horse falls was expressed as a proportion of number of riders registered with that National Federation.

Numbers were not weighted for

- Number of horses ridden by each rider
- Number of FEI cross  country starts
- Number of horse falls for? each rider
- Number of years rider registered with the FEI within the study period

However, the analysis does suggest that there are differences in the proportion of horse falls between different Federations. This needs further exploration in conjunction with other factors and will be analysed further in Phase 2.

| National Federation | Number of registered riders who had horse falls | Total number of riders registered | Percentage of registered riders who experienced horse falls |
|---|---|---|---|
| ARG | 10 | 69 | 14% |
| AUS | 99 | 854 | 12% |
| AUT | 17 | 99 | 17% |
| BEL | 46 | 214 | 21% |
| BLR | 2 | 52 | 4% |
| BRA | 16 | 107 | 15% |
| CAN | 24 | 270 | 9% |
| CHN | 1 | 53 | 2% |
| CZE | 12 | 93 | 13% |
| DEN | 12 | 80 | 15% |
| ESP | 22 | 87 | 25% |
| FIN | 3 | 59 | 5% |
| FRA | 139 | 978 | 14% |
| GBR | 274 | 2420 | 11% |
| GER | 112 | 1078 | 10% |
| HUN | 6 | 56 | 11% |
| IND | 5 | 96 | 5% |
| IRL | 68 | 496 | 14% |
| ITA | 42 | 294 | 14% |
| NED | 44 | 181 | 24% |
| NZL | 57 | 407 | 14% |
| POL | 30 | 149 | 20% |
| POR | 8 | 56 | 14% |
| RSA | 11 | 102 | 11% |
| RUS | 18 | 229 | 8% |
| SUI | 24 | 122 | 20% |
| SWE | 29 | 174 | 17% |
| URU | 3 | 87 | 3% |
| USA | 109 | 1395 | 8% |
| Other* | 43 | 594 | 7% |
| Total | 1286 | 10,951 | 12% |

($\chi^2$ = 162.03, df = 29, $p < 0.01$)

*National federations with less than 50 registered riders were grouped together

**Appendix 5: Multivariable Regression Model to explore risk factors for rotational horse falls**

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for EXP(B) Lower | 95% C.I.for EXP(B) Upper |
|---|---|---|---|---|---|---|---|---|
| Other fences | | | 14.498 | 2 | .001 | | | |
| Fence type A | .480 | .274 | 3.060 | 1 | .080 | 1.615 | .944 | 2.765 |
| Fence type J | -1.417 | .439 | 10.442 | 1 | .001 | .242 | .103 | .572 |
| Speed | | | 12.759 | 2 | .002 | | | |
| Too fast | .807 | .253 | 10.134 | 1 | .001 | 2.241 | 1.364 | 3.683 |
| Too slow | .558 | .259 | 4.638 | 1 | .031 | 1.747 | 1.051 | 2.903 |
| Constant | -.186 | .115 | 2.630 | 1 | .105 | .830 | | |

**Model Summary**

| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|---|---|---|---|
| 1 | 693.999[a] | .058 | .077 |

**Appendix 6: Phase B**: Review of the qualification system

Subject to the provision of files by the FEI that contains the data needed for the proposed analysis, we will complete an analysis of the previous FEI experience and FEI competition record of both horse and rider as recorded by the FEI to include:

a) Number of cross-country starts at FEI competitions
b) M.E.R. record
c) Horse and rider partnership (e.g. ownership of horse)
d) Previous horse and / or rider falls
e) Average SJ and Dr penalties at previous FEI competitions

Risk factors associated with the same outcomes addressed in Phase A of this research project will be studied:

Outcome 1: Horse falls recorded by fence judges during the cross-country phase of FEI competitions.

Outcome 2: Rotational horse falls recorded by fence judges during the cross-country phase of FEI competitions.

Outcome 3: Fatal or serious injuries to horses as a consequence of horse falls.

Outcome 4: Fatal or serious injuries to riders as a consequence of horse falls.

# Analysis of horse falls related to jumping efforts during the cross country test of FEI Eventing competitions

**Final Report (Phase 2)**

**July 2015**

**A confidential report prepared by**

**Dr Nia Huws**

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**Commissioned by Charles Barnett for the**

**Fédération Equestre Internationale**

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# Executive Summary

This report evaluates risk factors for horse falls and subsequent horse and rider injuries as a result of jumping efforts during the cross-country test of FEI Eventing competitions. This second phase of the study explored factors related to the horse and rider, building on findings from the first phase, which focused on fence-related factors. A separate report is available for phase 1, and the Phase 1 Executive Summary is included for reference in Appendix 1 of the current document.

All data available for FEI events from July 2010 – December 2014 were included in the analysis. A multivariable logistic regression model identified several factors that independently increased or decreased the risk of horse falls.

Risk factors identified during phase 1 and phase 2 that were found to be independently associated with the risk of a horse fall were:

- Event level - increased risk at the higher levels, especially at 4★
- Athlete Category – increased risk for non-categorised or lower category riders especially at 3★ and 4★ events
- Fence types
  - increased risk at square spreads, corners (unless with a solid top and open front)
  - decreased risk at some ascending spreads and brush fences
  - frangible fences - increased risk
  - landing - increased risk with downhill landing
  - water - increased risk for fences into, out of, or within water

A comparison of rotational and non-rotational horse falls revealed very few fence-related differences. Horses involved in rotational falls (compared to non-rotational falls) were more likely to have hit the fence hard on the way up. They were also more likely to be reported by fence judges as having approached the fence at an inappropriate speed (either too fast or too slow). Younger horses (7 years old or under) were more likely to have a horse fall that was rotational.

Injury to horse and/or rider was more likely following a rotational rather than a non-rotational horse fall, and approaching the fence too fast increased the likelihood of injury further.

We highlight some study limitations and make recommendations for modifications and future developments. In particular, we recommend a review of the current system of collecting and recording data, including revising the fence descriptors and developing a new fence judge report sheet to replace the current fall report form.

## Contents

The summary report consists of

## 1. Introduction

This study was commissioned as part of a wider audit of FEI Eventing. Concerns about safety in the sport prompted an analysis of risk factors for horse falls related to jumping efforts during the cross-country (x-c) test.

The first phase of the study identified several risk factors associated with the cross-country fences. This second phase explored factors relating to the horses and riders.

The main aim was to establish whether any factors related to the prior experience and qualifications of the horse or rider increased (or decreased) the risk of horse falls at FEI Eventing competitions.

We also aimed to combine the results of phase 2 analysis with the results from phase 1

Our research questions were:

- Did any horse / rider-related factors increase the risk of a horse fall? If so, which factors and to what extent?
- What were the combined effects of all factors?
- Did any particular factors increase the risk of a horse fall becoming rotational?
- What factors, if any, affected the severity of injury to horse and / or rider?

## 2. Methodology

### Data

Data were supplied by the FEI from their database of competition records from 2008 – 2014. These files contained information provided by technical delegates and fence judges.

This phase of the study used data from July 2009 to December 2014. This was due to a rule change in July 2009 which stated that riders would be eliminated following any fall (including unseated rider). It is possible that the rule change may have affected the competition results and also rider behaviour. Therefore, we analysed horse falls that occurred from July 2010 onwards, to ensure consistency of historical data relating to horse and rider performance over the preceding 12 months.

### Analyses

Descriptive, univariable and multivariable statistics are presented in this report. Explanations of these terms are provided on the next page.

### Factors / Variables

The following variables were examined for their relationship/effect in the analyses:

| Independent variables (factors) | Dependent variables (outcomes): |
|---|---|
| • Competition-related e.g. event level,<br>• Rider-related e.g. gender<br>• Horse-related e.g. age | • Horse fall<br>• Rotational/non-rotational horse fall<br>• Horse injury<br>• Rider injury |

## Descriptive, Univariable and Multivariable Statistics

**Descriptive statistics:** provide the number and percentage of horse falls

**Univariable analysis**: used to explore factors individually.

**Multivariable analysis**: compares the relative effects of multiple factors

So, using 'combination fences' and 'fences related to water' as examples (phase 1 data):

**Descriptive statistics** provided the number and percentage of horse falls at each type of fence.

**Univariable analysis** was then used to explore these factors individually.

We reported in phase 1 that there was an:

- increased likelihood of a horse fall at combination fences , compared to 'single' fences
- increased likelihood of a horse fall at fences related to water, compared to fences that were not associated with water

**Multivariable analysis** compared the relative effects of these factors and we were able to conclude that the 'risk' was due to the association with water rather than with the combination aspect of the fence. (Many 'water' fences were also part of a combination, hence the increased risk at combination fences in the univariable analysis, as the 'water' factor was not being taken into account).

The results of the multivariable analysis therefore indicated that modifications to reduce the risk of a horse fall should focus on fences related to water rather than combination fences as a whole.

## 3. Comparison of horse falls versus non-fallers

### Descriptive Statistics

The initial analysis included all the results for cross-country starters at FEI competitions between July 2010 and December 2014. Our focus in this phase was on competition, horse and rider related factors and so we based our analyses on competition results rather than jumping efforts, but we have included the latter in the descriptive statistics for reference.

*Table 1: Descriptive Statistics for Cross-Country Starters*

| Number of horse falls | Total number of x-c starts | Percentage horse falls / x-c starts | Total number of jumping efforts | Percentage horse falls / jumping efforts |
|---|---|---|---|---|
| 1,180 | 76,638 | 1.54% | 2,184,489 | 0.05% |

## 3.1 Univariable Analyses (Individual effects)

We initially considered the individual effects of each variable. Individual effects need to be interpreted with care as they may not all be directly causal. For example, age of horse might be associated with an increased or decreased proportion of horse falls, but if the ages of horses competing at different levels vary, we would need to explore whether it is the age or the event level which affects the risk of a horse fall (or both).

Due to of the different demands of each event level, we split the data where appropriate to make results more meaningful, and to reflect the requirements of the sport.

*Table 2: Descriptive Statistics for Horse falls / Cross-country starters split by event level*

| | | Number of horse falls | Total x-c starts | Percentage horse falls / x-c starts | Total jumping efforts | Percentage horse fall / jumping efforts |
|---|---|---|---|---|---|---|
| Event Level | 1★ | 360 | 37,836 | 0.95% | 993,161 | 0.04% |
| | 2★ | 394 | 24,781 | 1.59% | 726,813 | 0.05% |
| | 3★ | 339 | 12,454 | 2.72% | 404,875 | 0.08% |
| | 4★ | 87 | 1,567 | 5.55% | 59,640 | 0.15% |
| Total | | 1,180 | 76,638 | 1.54% | 2,184,489 | 0.05% |

## Presentation of Results

The results of the univariable analyses are presented as follows:

- 'Percentage horse falls' represents the percentage of cross-country starters that fell
- Cross tabulations identify variables where a significant association was found between certain conditions and the number of horse falls
- Statistically significant differences have been colour coded:

| | | | |
|---|---|---|---|
| | Significantly lower<br>(reduced risk of a horse fall) | | Significantly higher<br>(increased risk of a horse fall) |

Knowledge of statistics is not required in order to understand the results, but some details related to the statistics that are provided underneath tables are included for interest:

- The Chi-Square ($\chi^2$) value indicates the size of the difference between conditions – the larger the number the greater the difference
- The "p" (probability) value refers to the significance of the result – the smaller the p value the lower the likelihood of the result being due to chance. For example, a p value $< 0.01$ indicates that there is less than 1 chance in a hundred of the result occurring due to chance

### 3.1.1 Competition-related Factors

This analysis aimed to focus mostly on horse and rider variables, but some additional competition-related variables were explored if we considered that they could have an effect on horse and rider performance.

#### Type of Competition - Standard or Championship

Championships included all regional, national and international championships (e.g. Olympics and World Equestrian Games). There was a higher likelihood of a horse fall at a championship compared to a standard competition. However, the relative number of competitors at championships is very small, so although the percentage of horse falls is higher per starter, the majority of horse falls still occur at standard competitions.

*Table 3: Competition type*

| | | Horse Fall | | Total | Percentage Horse Falls |
|---|---|---|---|---|---|
| | | No | Yes | | |
| Competition Type | Standard | 72,958 | 1,096 | 74,054 | 1.48% |
| | Championship | 2,500 | 84 | 2,584 | 3.25% |
| Total | | 75,458 | 1,180 | 76,638 | 1.54% |

($\chi^2 = 51.64$, $p < 0.01$)

#### Venues

Venues were also included to reflect and explore different qualification requirements. The caveat relating to the different event levels applies here also. In comparison to the average risk of a horse fall, there was a higher likelihood of a horse fall at some venues, and a lower likelihood at others ($\chi^2 = 493.9$, $p < 0.01$). The individual venues where the likelihood of a horse fall was higher or lower than average are listed in Appendix 2. These are anonymised in this report and the venue codes are provided in a separate document. It was beyond the scope of this study to explore the venue effect in great detail, and so for the multivariable analysis we grouped venues further as high, low, or average risk.

#### Course Designers

Initial univariable analysis indicated that there was a relationship between the course designer and the likelihood of a horse fall. Again, the impact of country, venue and competition type may inter-relate with the effect of the course designer. Therefore, we have not presented the results for individual course designers here, but included summary statistics relating to this factor in the multivariable model. Information relating to individual course designers could be extracted if required.

### Other factors

Other factors that were influential at univariable level, but did not have an effect when included in the multivariable model, are listed below. There are further details in the appendices.

- Country of Competition (Appendix 3)
- Test order (SJ / X-C) (Appendix 4)

## 3.1.2 Rider-related Factors

### Rider Qualifications

The files provided by the FEI lacked sufficient historical data relating to MERs (Minimum Eligibility Requirements) to allow their use in this analysis. We therefore relied on 'athlete (rider) category' as an indicator of rider experience.

See Appendix 5 for a summary of MER / athlete categorisation.

### Rider Category

We explored rider category by event level, as there were proportionally more non-categorised riders competing at the lower levels. At all levels, non-categorised riders were more likely to have had a horse fall than categorised riders. The difference was most evident at 3★ and 4★ levels.

*Table 4: Rider category (Category A: most experienced, NC: non-categorised - least experienced)*

| Event Level | | | Horse Fall | | Total | Percentage Horse Falls |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| 1★/ 2★ | Rider Category | A | 2,270 | 15 | 2,285 | 0.66% |
| | | B | 3,492 | 28 | 3,520 | 0.80% |
| | | C | 9,126 | 97 | 9,223 | 1.05% |
| | | D | 13,938 | 172 | 14,110 | 1.22% |
| | | NC | 33,037 | 442 | 33,479 | 1.32% |
| | | **Total** | 61,863 | 754 | 62,617 | 1.20% |
| 3★ / 4★ | Rider Category | A | 2,373 | 53 | 2,426 | 2.18% |
| | | B | 3,043 | 79 | 3,122 | 2.53% |
| | | C | 4,915 | 152 | 5,067 | 3.00% |
| | | D | 2,644 | 110 | 2,754 | 3.99% |
| | | NC | 620 | 32 | 652 | 4.91% |
| | | **Total** | 13,595 | 426 | 14,021 | 3.04% |
| **Grand Total** | | | 75,458 | 1,180 | 76,638 | 1.54% |

1★/ 2★: $\chi^2 = 16.32$, $p < 0.01$ 3★ / 4★: $\chi^2 = 25.04$, $p < 0.01$

### Gender

There were more female riders, but male riders had a higher percentage of horse falls from cross-country starts. The overall results were largely due to differences at 1★ level. At the higher levels there was no difference in the ratio of female: male riders or the percentage of horse falls.

*Table 5: Rider gender*

| Event Level | | | Horse Fall | | Total x-c starts | Percentage Horse Falls |
|---|---|---|---|---|---|---|
| | | | No | Yes | | |
| 1★ | Rider Gender | Male | 14,093 | 168 | 14,261 | 1.18% |
| | | Female | 23,383 | 192 | 23,575 | 0.81% |
| 2★ | Rider Gender | Male | 10,487 | 182 | 10,669 | 1.71% |
| | | Female | 13,900 | 212 | 14,112 | 1.50% |
| 3★ | Rider Gender | Male | 5,833 | 169 | 6,002 | 2.82% |
| | | Female | 6,282 | 170 | 6,452 | 2.63% |
| 4★ | Rider Gender | Male | 779 | 44 | 823 | 5.35% |
| | | Female | 701 | 43 | 744 | 5.78% |
| **Total** | **Rider Gender** | **Male** | **31,192** | **563** | **31,755** | 1.77% |
| | | **Female** | **44,266** | **617** | **44,883** | 1.37% |
| | **Total** | | **75,458** | **1,180** | **76,638** | **1.54%** |

($\chi^2 = 19.46$, $p < 0.01$)

### National Federation

Riders representing certain National Federations were more likely than others to have had a horse fall. This effect became non-significant within the multivariable model. The univariable analysis is available in Appendix 6.

### Previous Rider performance

The FEI files recorded data relating to horse and rider performance on a 12 month calendar basis. These did not allow for equal comparison of previous horse and rider experiences for falls that occurred at different times of the year. We therefore developed an algorithm to track each horse and rider's performance over the exact 12 months preceding each horse fall.

**Previous horse falls**

Riders who had a horse fall were more likely to have had one or more other horse falls during the preceding 12 months. However, the numbers and differences are relatively small, so this result should be interpreted with care.

*Table 6: Previous horse falls (rider)*

| | | Result recorded as Horse Fall | | Total | Percentage Horse Falls |
|---|---|---|---|---|---|
| | | No | Yes | | |
| Rider involved in horse fall during previous 12 months | No | 68,181 | 1,045 | 69,226 | 1.51% |
| | Yes | 7,277 | 135 | 7,412 | 1.82% |
| Total | | 75,458 | 1,180 | 76,638 | 1.54% |

($\chi^2 = 4.29$, $p < 0.05$)

**Other rider-related variables**

Other factors which were non-significant or showed significance at only certain event levels are summarised below. These were not explored further at univariable level but were included in the multivariable model building process.

*Table 7: Other rider-related variables*

| Factor | Result |
|---|---|
| Rider age | **Not significant** |
| Number of horses ridden during fall year | **Significant at 2* and 3* levels only:**<br>Riders involved in horse falls had, on average, ridden fewer horses during that calendar year than riders who had not had a horse fall. |
| Number of cross-country starts during previous 12 months | **Significant at 2*only**:<br>Riders involved in horse falls had, on average, fewer cross-country starts during the previous 12 months than riders who had not had a horse fall. |
| Previous 'near miss' (where horse hit the fence hard on the way up, and rider unseated) | **Significant at 2* only:**<br>Riders involved in a horse fall were less likely to have had a near miss during the previous 12 months than riders who had not had a horse fall. |
| Previous 'unseated rider' | **Significant at 4* only:**<br>Riders involved in a horse fall were less likely to have been unseated during the previous 12 months than riders who had not had a horse fall. |

The results above, though tenuous, suggest that rider experience is a factor in horse falls. Riders with more horses and having more cross-country starts were less likely to be involved in a horse fall than riders with fewer cross-country starts/ horses.

### 3.1.3 Horse- related Factors

There were very few horse-related factors consistently associated with an increased or decreased risk of a horse fall.

#### Horse Qualifications and Experience

As for the rider, there was a lack of consistent data for the eight year rolling MERs to be used in this analysis. We therefore explored horse experience on the basis of their previous 12 months' performance, including MERs gained during this period.

#### Previous Horse falls

Horses that fell were more likely to have fallen in the previous 12 months, but this was still a small number of the total horse falls.

*Table 8: Previous horse falls (horses)*

| | | Result recorded as a Horse Fall | | Total | Percentage Horse Fall |
|---|---|---|---|---|---|
| | | No | Yes | | |
| Horse fell during previous 12 months | No | 72,994 | 1,122 | 74,116 | 1.51% |
| | Yes | 2,464 | 58 | 2,522 | 2.30% |
| Total | | 75,458 | 1,180 | 76,638 | 1.54% |

($\chi^2 = 9.94$, $p < 0.01$)

The test statistic shows that the likelihood of a repeated horse fall is greater for horses than for riders. There were insufficient data in the current analysis to explore this relationship further, but it would be useful to continue to monitor fall patterns of horse-rider partnerships.

### Other horse-related variables

Other factors which were non-significant or showed some significance at certain event levels are summarised below. These were not explored further at univariable level but were included in the multivariable model building process.

*Table 9: Other horse-related variables*

| Factor | Result |
|---|---|
| Horse age | Overall, horses that fell were older than those that did not fall, reflecting the increased average age of horses competing at the higher levels. Age was not significant at individual event level. |
| Number of MERs at each level for previous 12 months | Not significant |
| Number of cross-country starts during previous 12 months | Horses that fell had, on average, more cross-country starts during the previous 12 months than those that did not fall. This was not significant at individual event level. |
| Previous dressage penalties | Horses that fell had, on average, higher dressage penalties during the previous 12 months than those that did not fall. This was not significant at individual event level. |
| Previous Show Jumping (SJ) penalties (jump penalties) | **Significant at 2* and 3* levels only:** Horses that fell had, on average, more SJ penalties during the previous 12 months than those that did not fall. |

## 3.2 Multivariable Analysis

For the multivariable analysis a smaller dataset was generated with a control: case ratio of 2:1.

We wished to include factors related to the fences in order to explore the combined effect of competition, fences, horse and rider on the risk of a horse fall. In order to do this we included all fences at which there had been a horse fall, and a random selection of 'control' fences at which there had been no fallers. Prior to random selection, the individual fences were weighted (multiplied by the number of recorded jumping efforts), so that fences that were jumped more frequently had a greater chance of being represented in the sample. Fences at which there had been unseated riders were excluded from the control group, in order to have a clearer differentiation between the two groups.

Each of the 'control' fences was then allocated a 'rider' based on the competition results. As we did not have specific rider information for each fence, random riders were selected from those who had completed the cross-country test. Our rationale was that if they had completed the cross-country course, they would by default have cleared the control fence.

The variables that remained influential in the final multivariable model are shown in Table 10.

### Risk Factors

The Odds Ratios (OR) in Table 10 refer to the amount of increased risk for the specified category compared to the reference category within each variable. For example, at a 4★ event there was 3.5 times the likelihood of a horse fall compared to at a 1★ event. This was an independent effect, i.e. after accounting for all other effects within the model such as the different proportion of various fence types at each level.

Odds ratios of less than 1 indicate a decreased risk – for example the odds ratio of 0.3 for Category A riders indicates that Category A riders were 70% less likely to have a horse fall than non-categorised riders.

Odds ratios compare categories within a certain variable (e.g. male and female) but they do not provide information about the overall risk within the population. For example the odds ratio of 3.5 for 4★ events shows that at 4★ events there was 3.5 times the likelihood of a horse fall, compared to at a 1★ event. We know, however, that there were fewer competitors at 4★ level so the actual number of horse falls may be smaller. In terms of recommending modifications we needed to compare the relative risks for all competitors. We did this by calculating the Population Attributable Risks (PAR) for all the modifiable factors that were shown to increase the likelihood of a horse fall. These are shown in Table 11.

*Table 10: Multivariable model of risk factors for horse falls (full model in Appendix 4)*

| Factor / variable | Reference Category | Category | OR | Risk |
|---|---|---|---|---|
| **Event level** | 1★ | 2★ | 1.6 | Increases |
| | | 3★ | 2.6 | |
| | | 4★ | 3.5 | |
| **Competition type** | Standard | Championship | 1.9 | Increased risk |
| **Venue** | All other venues | Lower risk venues | 0.4 | Decreased risk |
| | | Higher risk venues | 1.8 | Increased risk |
| **Course designer** | All other CDs | Lower risk CDs | 0.3 | Decreased risk |
| | | Higher risk CDs | 1.5 | Increased risk |
| **Fence type*** | All other fences | E2 & E3 Brush | 0.5 | Decreased risk |
| | | D3 & D4 Spread | 0.7 | |
| | | F2 Round | 0.7 | |
| | | C2 & C3 Square Spreads | 1.4 | Increases |
| | | G1 & G3 Corners | 2.4 | |
| **Frangible fences** | Non-frangibles | Frangible fences | 1.7 | Increased risk |
| **Landing** | Level or Up | Down | 1.4 | Increased risk |
| **Water** | No Water | Associated with water | 1.7 | Increases |
| | | Out of water | 1.8 | |
| | | Within water | 2.5 | |
| | | Into water | 3.6 | |
| **Rider category** | Non-categorised | Category D | 0.7 | Decreases |
| | | Category C | 0.5 | |
| | | Category B | 0.4 | |
| | | Category A | 0.3 | |
| **Rider gender** | Female | Male | 1.4 | Increased risk |
| **Prev. near miss (rider)** | No previous NM | Previous near miss | 0.4 | Decreased risk |
| **Mean SJ penalties during prev. 12 months (horse)** | 0 | Each additional penalty | 1.03 | Increased risk |

*Fence details provided in appendix 3.

**Population Attributable Risk**

The Population Attributable Risk **(PAR)** refers to the overall risk of a horse fall due to a particular variable. It takes into account the number of horse falls in each category. The PAR statistic corresponds to the percent reduction in risk if that category was removed. For example, if there had been no 4★ events, the overall risk of a horse fall would have been reduced by 5%. The higher PAR values for 2★ and 3★ events show that although the likelihood of a fall was greater at 4★ level, modifications at 2★ and 3★ levels would have more effect in reducing the overall number of horse falls.

Variable PARs cannot be simply added together because the variables often overlap. For example, if a horse fell at a 4★event that was also a Championship, their data would be included in both categories. A statistical adjustment to allow for any overlap estimates an overall PAR of 58% for all the variables in Table 11. This means that removing all the high risk categories would reduce the overall risk of a horse fall by 58%. In practice, of course, it would not be feasible to completely **remove** all high risk categories as this would alter the structure of the sport. However the PAR statistics indicate which areas to prioritise when considering modifications to **reduce** risk.

*Table 11: Risk factors for horse falls - Population Attributable Risks*

| Factor/ variable | Reference | Category | Category PAR | Variable PAR |
|---|---|---|---|---|
| **Event level** | 1★ | 2★ | 12% | 34% |
| | | 3★ | 17% | |
| | | 4★ | 5% | |
| **Competition type** | Standard | Championship | 3% | 3% |
| **Venue** | All other venues | Higher risk venues | 4% | 4% |
| **Course designer** | All other CDs | Higher risk CDs | 12% | 12% |
| **Fence type** | All other fences | C2 & C3 Square Spreads | 6% | 12% |
| | | G1 & G3 Corners | 6% | |
| **Frangible fences** | Non-frangible | Frangible fences | 4% | 4% |
| **Landing** | Level or Up | Down | 7% | 7% |
| **Water** | No Water | Associated with water | 2% | 14% |
| | | Out of water | 2% | |
| | | Within water | 2% | |
| | | Into water | 8% | |
| **Rider Category** | Categorised Riders | Non-categorised riders | 15% | 15% |

## 5. Comparison of rotational and non-rotational falls

### Descriptive Statistics

All horse falls recorded during the study period were included in the initial analysis. Horse falls were defined as 'rotational' or 'non-rotational' according to fence judges' descriptions of whether the horse 'somersaulted'. It is possible that some falls were misclassified.

*Table 18: Summary of horse fall type*

| | | Percentage of total horse falls |
|---|---|---|
| Non-rotational falls | 1,003 | 84.93% |
| Rotational falls | 179 | 15.16% |
| **Total number of horse falls** | **1,181** | |

### 5.1 Univariable Analyses (Individual effects)

All variables explored in the initial section of this report were included in this analysis, with the addition of the information recorded by fence judges relating to environmental factors and fall characteristics.

### Fence Type and Category

There was only a small association between fence-related factors and the likelihood of a fall becoming rotational. As found previously (in phase 1 analysis), there was a slightly greater likelihood of a fall being rotational at fence types A (post and rail) and B (palisade), and a reduced likelihood at fence type J (step). This was not significant at univariable level ($p = 0.07$). Due to their low statistical significance, these effects were not explored in detail at univariable level but were included in the multivariable model building process.

Other factors which were associated with a higher or lower likelihood of a horse fall being rotational are presented below (Table 12).

*Table 12: Factors related to rotational horse falls*

| | | Fall type | | | | |
|---|---|---|---|---|---|---|
| **Factor** | | Non - rotational | Rotational | % Rotational | $\chi^2$ | P-value |
| **Speed** | Too fast | 132 | 35 | 21.0% | 16.73 | < 0 .01 |
| | Too slow | 92 | 30 | 24.6% | | |
| | Appropriate | 778 | 114 | 12.8% | | |
| **Hit fence hard** | Yes | 480 | 136 | 22.1% | 47.97 | <0 .01 |
| | No | 522 | 43 | 7.6% | | |
| **Hit fence way up** | Yes | 526 | 145 | 21.6% | 50.31 | <0 .01 |
| | No | 476 | 34 | 6.7% | | |
| **Horse age (years)*** | <=7 | 120 | 41 | 25.5% | 15.41 | <0.01 |
| | 8+ | 882 | 138 | 13.5% | | |

* Horse age was explored further by event level:

**At 1★ level:**
Horses aged 6 years or younger were more likely to have a rotational horse fall than horses aged 7 or older ($\chi^2$ = 7. 75, $p < 0.05$).

**At 2★ level:**
Horses aged 7 years or younger were more likely to have a rotational horse fall than those aged 8 or older ($\chi^2$ = 6.69, $p < 0.05$).

### 5.2 Rotational vs non-rotational falls: multivariable analysis

The following factors remained influential in the multivariable model. 'Speed too slow', is included for comparative reasons, despite not being significant.

As the dataset was quite small, and rider speed subjectively assessed, these effects should be interpreted with caution. It is interesting to note, however, that the odds ratios for rider speed are almost identical to those reported in the phase 1 report, where a different sample of control cases was used. This suggests that the results are reliable.

*Table 13: Multivariable model of risk factors for rotational (compared to non-rotational) horse falls (full model Appendix 5)*

| Factor / variable | Reference | Category | OR | Risk |
|---|---|---|---|---|
| **Horse Age** | Aged 8 years or older | Aged 7 years or younger | 2.5 | Increased |
| **Hit fence** | Fence not hit hard | Fence hit hard | 2.4 | Increased |
| **Hit fence on way up** | Fence not hit on way up | Fence hit on way up | 2.7 | Increased |
| **Speed** | Appropriate speed | Too Slow* | 1.5 | Increases |
| | | Too Fast | 2.1 | |

*p =0.07, not significant

#### Population Attributable Risks for Rotational Horse Falls

Table 14 shows the PAR for the likelihood of a horse fall being rotational. It is clear that ascending impact with the fence from a fast approach contributes most of the risk associated with a rotational (as opposed to non-rotational) horse fall.

*Table 14: Risk factors for horse falls becoming rotational - Population Attributable Risks*

| Factor / variable | Reference | Category | PAR |
|---|---|---|---|
| **Horse Age** | Aged 8 years or older | Aged 7 years or younger | 14% |
| **Hit fence** | Fence not hit hard | Fence hit hard | 45% |
| **Hit fence on way up** | Fence not hit on way up | Fence hit on way up | 51% |
| **Speed** | Appropriate speed | Too Fast | 37% |

## 5. Horse Injuries

### Descriptive Statistics

Horse injuries were classified as slight, serious or fatal without formal guidelines for this categorisation. Prior to 2012, injuries were recorded by fence judges and from 2012 by the attending Veterinary Surgeon. There was no reliable follow-up information available.

Due to the small numbers and lack of clear classification guidelines, fatal and serious injuries were grouped together in the univariable analysis.

*Table 15: Horse Injury as a result of a horse fall (2010 – 2014 data)*

| Injury level | Number | Percentage |
|---|---|---|
| None | 1,038 | 87.9 |
| Slight | 115 | 9.7 |
| Serious | 11 | 0.9 |
| Fatal | 17 | 1.4 |
| **Total** | **1,181** | |

## 5.1 Univariable Analyses (Individual effects)

### Type of Horse fall

As previously documented, horses were more likely to be injured following a rotational (compared to non-rotational) fall.

*Table 16: Effect of horse fall type on horse injury*

| | | Horse Injury | | | Total | Percentage serious/Fatal injuries |
|---|---|---|---|---|---|---|
| | | None | Slight | Serious / Fatal | | |
| Horse fall rotational | No | 893 | 86 | 23 | 1,002 | 2.3% |
| | Yes | 145 | 29 | 5 | 179 | 6.3% |
| Total | | 1,038 | 115 | 28 | 1,181 | 2.4% |

($\chi^2 = 10.35$, $p < 0.05$).

Other factors influential at univariable level are presented in table 17 below.

*Table 17: Factors related to horse injury*

| Horse Injury | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | | None | Slight | Serious/Fatal | Percentage Serious/Fatal | $\chi^2$ | p |
| **Event Level** | 4★ | 66 | 17 | 4 | 4.6% | 14.97 | < 0.05 |
| | 3★ | 303 | 28 | 9 | 2.6% | | |
| | 2★ | 345 | 39 | 10 | 2.5% | | |
| | 1★ | 324 | 31 | 5 | 1.4% | | |
| **Hit Fence Hard** | Yes | 513 | 79 | 24 | 3.9% | 28.35 | < 0.01 |
| | No | 525 | 36 | 4 | 0.7% | | |

There was a higher likelihood of a horse being injured at 4* events. This is despite there being no difference in the percentage of rotational falls at this level. This suggests that something other than the type of horse fall (rotational/non-rotational) is related to the increased likelihood of injuries at this level, such as: speed of travel, size of the obstacles.

### 5.2 Horse Injuries: Multivariable Analysis

For the multivariable analysis, all injuries were considered together, and all horses that fell were classified as 'injured' or 'not injured'.

*Table 18: Multivariable model of risk factors for horse injury after a fall (full model Appendix 6)*

| Factor / variable | Reference Category | Category | OR | Risk |
|---|---|---|---|---|
| **Horse fall type** | Non-rotational fall | Rotational fall | 1.6 | Increased risk |
| **Event level** | All other levels | 4★ | 2.3 | Increased risk |
| **Hit fence** | Did not hit fence hard | Hit fence hard | 2.3 | Increased risk |

## 6. Rider Injuries

### Descriptive Statistics

Rider injuries were classified as slight (e.g. sprains, slight cuts and bruises), serious (e.g. fractures, concussion, injuries requiring hospital treatment) or fatal. Prior to 2012, injuries were recorded by fence judges and from 2012 by the Chief Medical Adviser. There was no reliable follow-up information available.

*Table 19: Rider injury as a result of a horse fall (2010 – 2014 data)*

| **Injury level** | **Number** | **Percentage** |
|---|---:|---:|
| None | 986 | 83.5 |
| Slight | 122 | 10.3 |
| Serious | 69 | 5.8 |
| Fatal | 4 | 0.3 |
| **Total** | **1181** | |

### 6.1 Univariable Analyses (Individual effects)

Riders were more likely to be injured following a rotational fall. Three of the four fatal injuries during the period of the study resulted from horse falls classified as rotational.

*Table 20: Effect of horse fall type on rider injury*

| | | Rider Injury | | | Total | % Serious / Fatal injuries |
|---|---|---:|---:|---:|---:|---:|
| | | None | Slight | Serious/ Fatal | | |
| Horse fall rotational | No | 870 | 85 | 47 | 1,002 | 4.26% |
| | Yes | 116 | 37 | 26 | 179 | 14.53% |
| Total | | 986 | 122 | 73 | 1,181 | 6.18% |

($\chi^2$ = 54.42.33, $p < 0.01$).

Other factors that were significant at univariable level are presented together in table 21 below:

*Table 21: Factors related to rider injury*

| Rider Injury | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Injury Level | | | | | |
| **Factor** | | None | Slight | Serious / fatal | % Serious / fatal | $\chi^2$ | p-value |
| **Competition Type** | Championship | 62 | 15 | 7 | 8.3% | 6.65 | < 0 .05 |
| | Standard | 924 | 107 | 66 | 6.0% | | |
| **Gender** | Female | 493 | 73 | 51 | 8.3% | 13.89 | < 0.01 |
| | Male | 493 | 49 | 22 | 3.9% | | |
| **Horse Age (years)** | < = 7 | 123 | 26 | 12 | 7.5% | 7.72 | < 0.05 |
| | 8+ | 863 | 96 | 61 | 6.0% | | |
| **Speed** | Too fast | 125 | 27 | 15 | 9.0% | 10.63 | < 0 .01 |
| | Not too fast | 861 | 95 | 58 | 5.7% | | |
| **Hit fence hard** | Yes | 472 | 92 | 52 | 8.4% | 44.34 | < 0.01 |
| | No | 514 | 30 | 21 | 3.7% | | |
| **Hit fence way up** | Yes | 531 | 87 | 53 | 7.9% | 21.39 | < 0.01 |
| | No | 455 | 35 | 20 | 3.9% | | |
| **Frangible fence** | Yes | 68 | 18 | 6 | 6.5% | 9.35 | < 0.01 |
| | No | 918 | 104 | 67 | 6.2% | | |
| **Into Water** | No | 819 | 116 | 70 | 7.0% | 19.51 | < 0.01 |
| | Yes | 167 | 6 | 3 | 1.7% | | |
| **Out of Water*** | Yes | 63 | 12 | 5 | 6.3% | 2.04 | = 0.36 |
| | No | 923 | 110 | 68 | 6.2% | | |

*not significant but included in multivariable model due to high risk of horse fall

## Other factors

There was an indication that riders who had ridden more horses, and had more cross-country starts in the previous 12 months, were less likely to be injured. These variables were therefore retained at the multivariable model building stage.

### 6.2 Rider Injuries: Multivariable Analysis

For the multivariable analysis, all injuries were considered together, and riders classified as 'injured' or 'not injured'.

*Table 22: Multivariable model of risk factors for rider injury (full model Appendix 7)*

| Factor / variable | Reference Category | Category | OR | Risk |
|---|---|---|---|---|
| **Type of fall** | Non-rotational | Rotational | 2.7 | Increased |
| **Competition type** | Standard | Championship | 1.8 | Increased |
| **Horse Age (years)** | 8 yrs. or older | 7 yrs. or younger | 1.8 | Increased |
| **Speed** | Not too fast | Too fast | 1.5 | Increased |
| **Fence type (frangible)** | Non-frangible | Frangible | 1.9 | Increased |
| **Hit fence hard** | Fence not hit hard | Fence hit hard | 2.4 | Increased |
| **Out of water** | Not out of water | Out of water | 2.8 | Increased |
| **Into water** | Not into water | Into water | 0.2 | Decreased |

## 7. Study Limitations

As in phase 1 there were some study limitations.

### Study Data

For this second phase we used updated data files provided by the FEI, but there were still some coding / input errors found. For example, some riders classified as having had a horse fall were also classed as 'placed' in the results files. The files and data were cleaned prior to analysis to reduce these errors where possible.

### Observer Bias

As noted in phase 1, there may be a degree of observer bias evident in the fall report forms due to the subjective assessment of some variables e.g. rider speed, classification of rotational horse falls.

### Control Data

The parameters reported on the falls report form were only available for fallers. Therefore it was not possible to explore the effects of some environmental factors on the variables that were included in the models.

## 8. Summary and Recommendations

Our analysis identified several factors that had affected the likelihood of a horse fall and horse/rider injury. The key factors are summarised below.

### Competition Factors

#### Event Level

Event level was one of the strongest risk factors for a horse fall, with a progressive increase in the likelihood of a fall at the higher levels, especially for Category D and non-categorised riders. In particular, there was a higher likelihood of a horse fall, and horse injury, at 4★ events. These are also usually the most high profile, public facing competitions. However, there are fewer competitors at 4★ level, and our analysis showed that in order to reduce the total number of horse falls, the demands of 2★ and 3★ levels should also be explored. We therefore recommend that the qualification system be reviewed for **all** levels.

#### Competition Type

There was an increased likelihood of a horse fall **and** of rider injury at championship level competitions (compared to standard competitions). This may be due to entry qualifications and/or an effect of increased pressure on the rider.

#### Venue and Course Design

There was a significant difference in the likelihood of a horse fall at different venues. This was independent of event level. This finding could be connected to factors inherent in the venue such as terrain, course design or individual competition qualification. An in-depth analysis was beyond the scope of this study but we recommend that variation between venues and course designers continue to be monitored.

#### Country / National Federation

Some NFs (i.e. the riders representing those countries) had a higher or lower likelihood of horse falls when considered at univariable level. However NF was not influential in the multivariable model. Nevertheless, we recommend that it might be beneficial to explore the training systems and qualification requirements of the NFs with lower likelihood of horse falls, since they could serve as examples of good practice for other NFs.

## Horse / Rider Factors

### Rider Category / MERs

Rider category was one of the strongest risk factors in our analysis when considered in conjunction with event level. Higher category (more experienced) riders were less likely to have a horse fall than lower category or non-categorised riders. The FEI may wish to consider additional qualifications before permitting non-categorised or Category D riders to enter 3★ and 4★ events. With the large numbers of non-categorised riders, perhaps further stratification of this group by experience level might be beneficial?

Consistent and historical information relating to MERs would have allowed us to explore whether the current system of rider classification is the most appropriate, but a detailed analysis was not possible due to missing data, changes in regulations, and different requirements of individual competitions and National Federations. We recommend that the FEI considers standardising MER and entry requirements to ensure consistency and generate comparable data for future analysis.

### Rider gender

Male riders were more likely to have had a horse fall, though this was due to results at 1★ level only. Conversely, female riders were more likely to be injured. Clearly gender is not modifiable but these findings provide some insight into the effect of individual differences between athletes, either relative to physical body type, psychological factors or reporting bias

### Horse age

There was no age effect on the likelihood of a horse fall. Amongst fallers, horses aged seven years or younger were more likely to have a rotational fall. There was also a higher likelihood of rider injury on younger horses. At 1★ level, horses aged 6 years or younger were more likely to have a rotational fall, whereas at 2★, it was horses aged 7 years or younger. The FEI may wish to review the entry qualifications for these younger horses.

### Previous Horse Falls

Horses and riders involved in a horse fall were slightly more likely to have had another horse fall in the preceding 12 months. The FEI may wish to identify and monitor horse / rider faller partnerships.

## Fence Factors

### Fence Type

Fence-related factors associated with horse falls in were considered in detail in phase 1. Fence type, association with water, frangible fences and landing all remained influential in the multivariable model. The consistent significance of these factors confirms that these particular risk factors have an independent effect, and that regardless of horse and rider experience, certain fences increased (or decreased) the likelihood of a horse fall.

The influence of water remained very strong in all models, with more horse falls at fences associated with water. The highest likelihood of a horse fall connected to water was at fences jumped into water, but these fences were also associated with lower rates of rider injury. Conversely fences jumped out of water were associated with a smaller increase in horse falls, but a much higher likelihood of rider injury. Particular consideration should therefore be given to the type of fence jumped out of water, avoiding use of high risk fences such as corners and square parallels.

### Fence Impact

'Hitting fences hard' was a major risk factor for rotational falls and injury to both horse and rider. In the absence of control data it is not possible to say if hitting the fence is a risk factor for horse falls per se, although it would be reasonable to assume so. This supports our phase 1 recommendation that more information and further study related to ground lines and the front contours of fences would be useful.

As in phase 1, speed was a significant factor, with riders involved in rotational falls more likely to be reported by fence judges as approaching at an inappropriate speed. Approaching the fence too fast, rather than too slowly, increased the risk of a rotational fall and was also associated with a higher likelihood of rider injury.

# Analysis of risk factors for horse falls in the cross-country test of FEI Eventing

This presentation will discuss

- Results of commissioned research to explore:
  - Risk factors for horse falls
  - Rotational vs non-rotational horse falls
  - Rider injury as a result of a horse fall
- Recommendations for future developments

Presented by Charles Barnett

# Analysis of risk factors for horse falls in the cross-country test of FEI Eventing


The Research Team

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Senior Lecturer in Equine Orthopaedics

# Background Information

- Data extracted from FEI database from July 2010 to December 2014
- 'One fall and out' rule introduced in July 2009

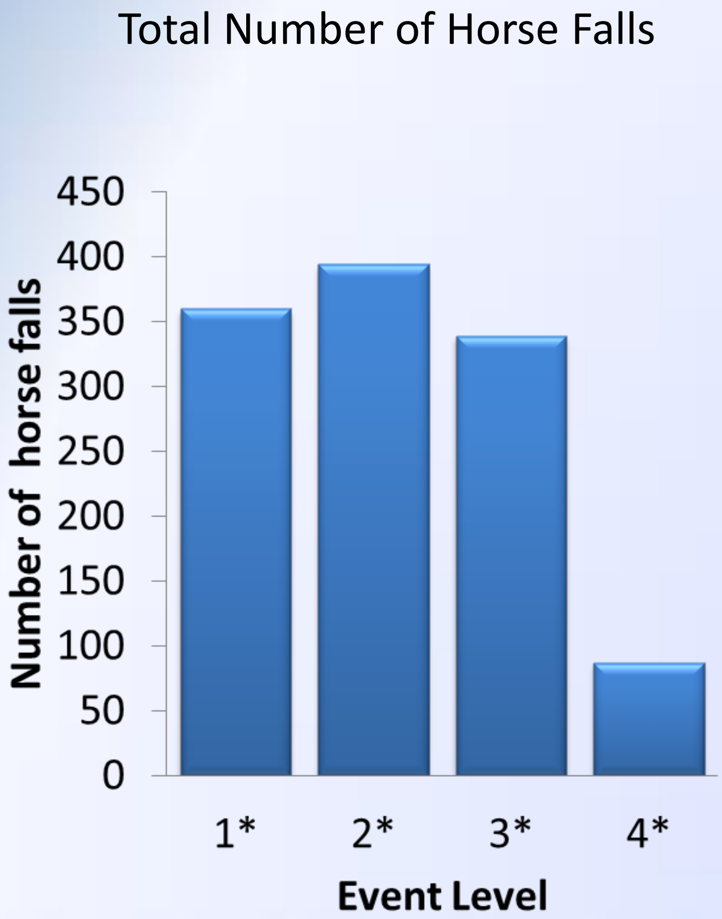
Study Sample

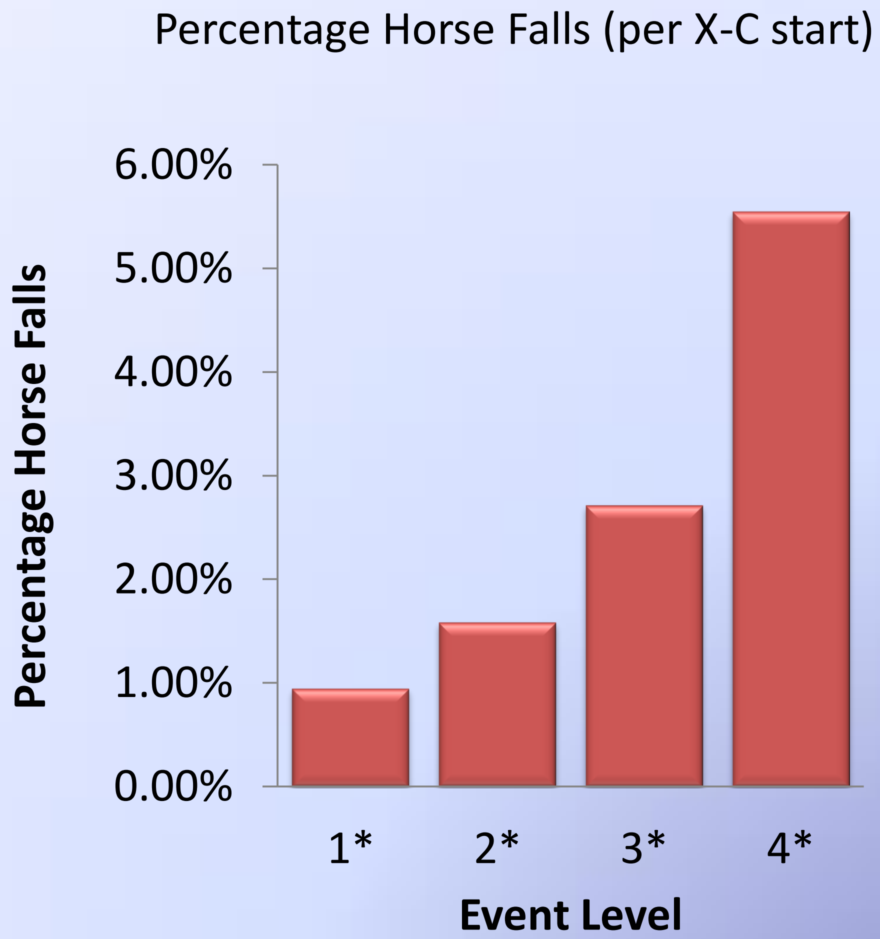
| | | Number of horse falls | Total x-c starts | Total jumping efforts |
|---|---|---|---|---|
| Event Level | 1★ | 360 | 37,836 | 993,161 |
| | 2★ | 394 | 24,781 | 726,813 |
| | 3★ | 339 | 12,454 | 404,875 |
| | 4★ | 87 | 1,567 | 59,640 |
| Total | | 1,180 | 76,638 | 2,184,489 |

**Information Sources**

- Horse registrations
- Rider registrations
- Technical Delegates
- Fence Judges

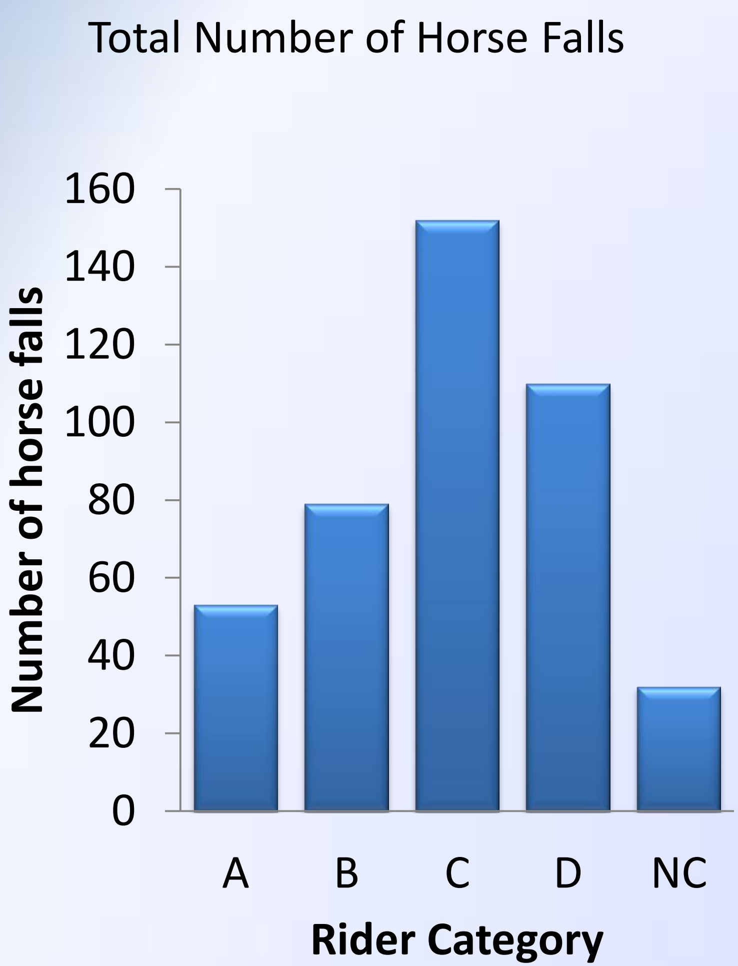
# Horse Falls at each Event Level (2010 – 2014)

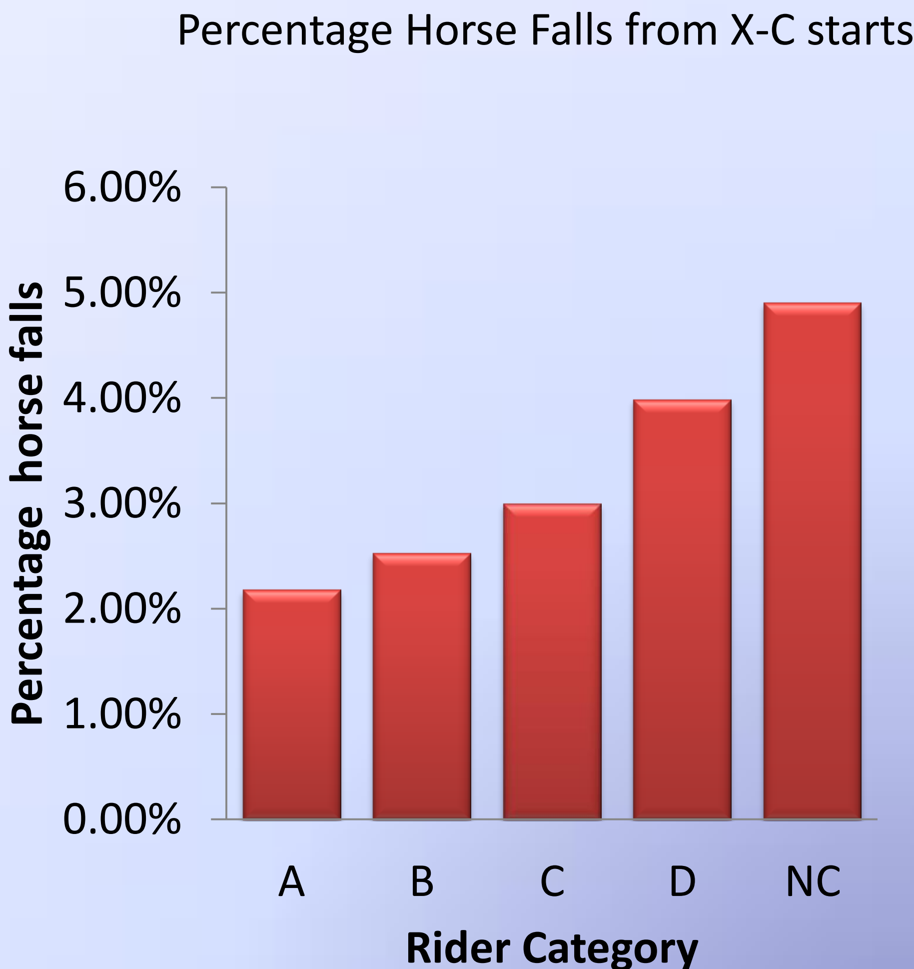



- Higher percentage of horse fall at 4* level, but
- Lower number of actual falls due to fewer competitors

# Horse Falls at 3* / 4* Event Levels (2010 – 2014)




- Higher percentage of horse fall for lower category riders (D and NC) , but
- Higher number of actual falls in category C

# Individual Factors (Univariables)

Factors that were individually found to affect the likelihood of a horse fall:

Competition factors

- Event level (1* - 4*)
- Event type (CCI vs CIC)
- Championship?
- Venue
- Course Designer

Fence Factors

- Type
- Related to Water
- Combination
- Landing
- Frangible

Rider factors

- Rider category
- Gender
- National Federation

Horse factors

- Age

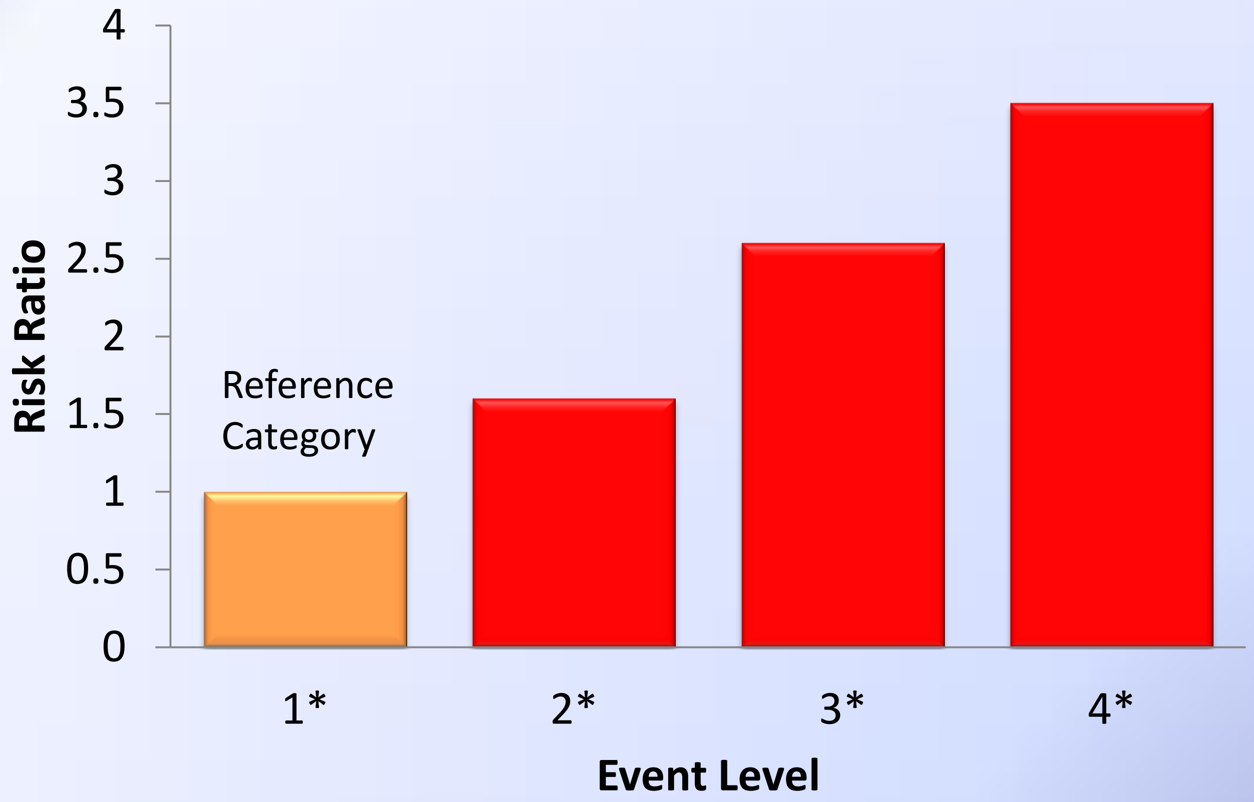
Previous horse / rider performance

- Previous X-C performance – number of runs / starts
- Previous dressage performance
- Previous SJ performance
- Previous horse falls

# Multivariable Analysis

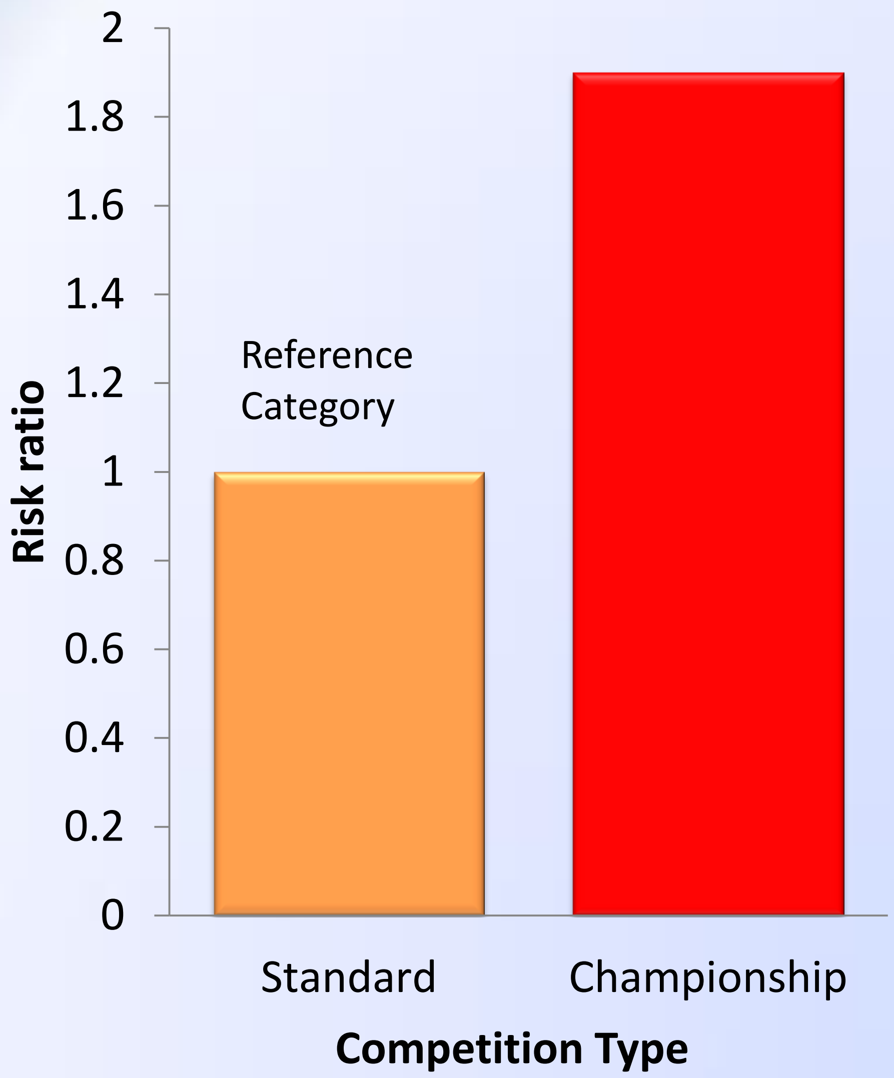
- Identifies the **independent** effects of the individual (univariable) factors
  - e.g. it was found that event type CCI / CIC was not influential – it was the level (1* - 4*) that affected the risk of a horse fall
- The following slides explore some of the more important independent risk factors

# Risk of horse fall at different Event levels



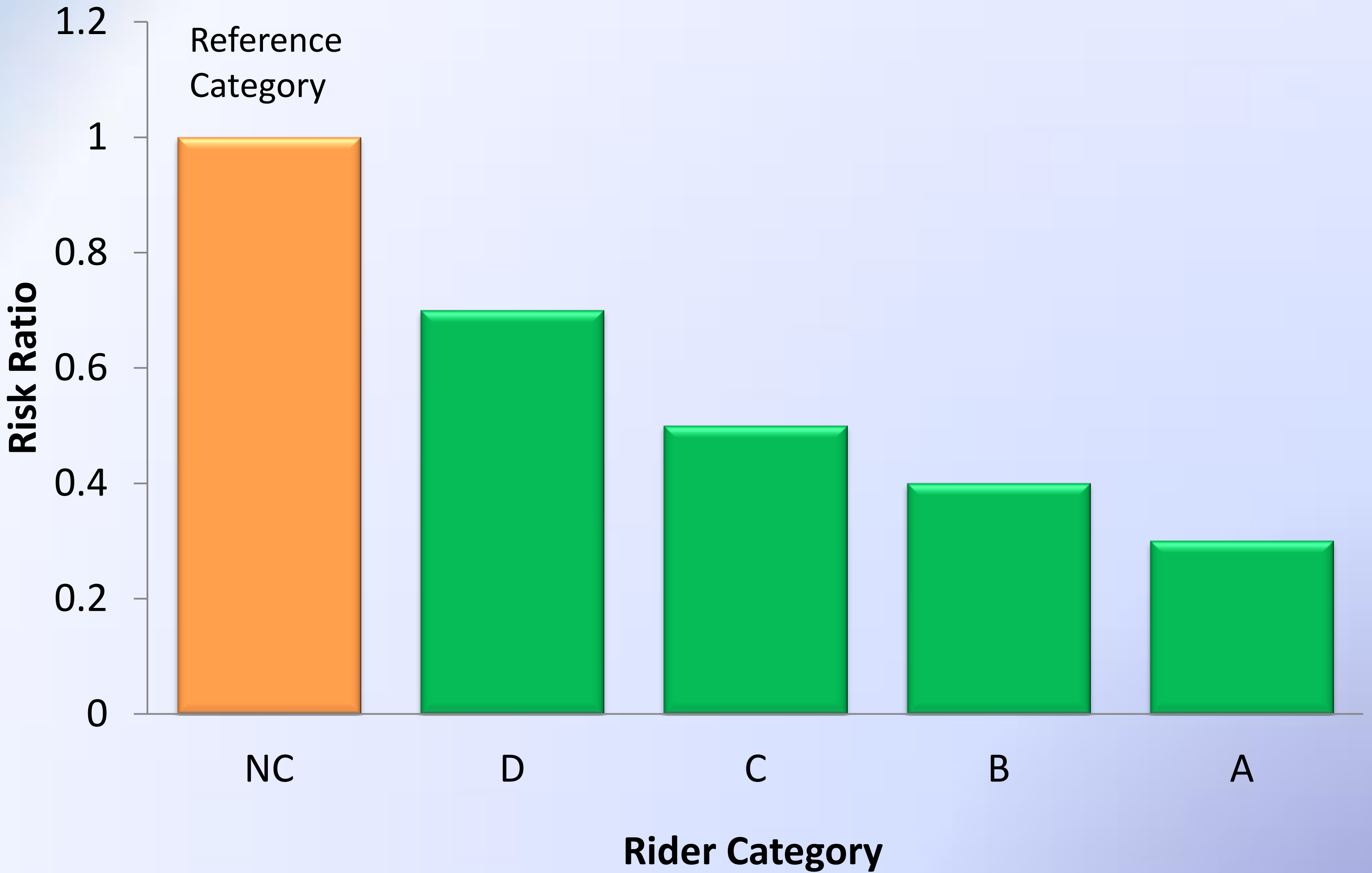

- Risk of horse fall at 4* level is 3.5 x that at 1* level
- This was independent of all other factors e.g. number of fences, venue, whether it is a championship

# Risk of horse fall at Championships



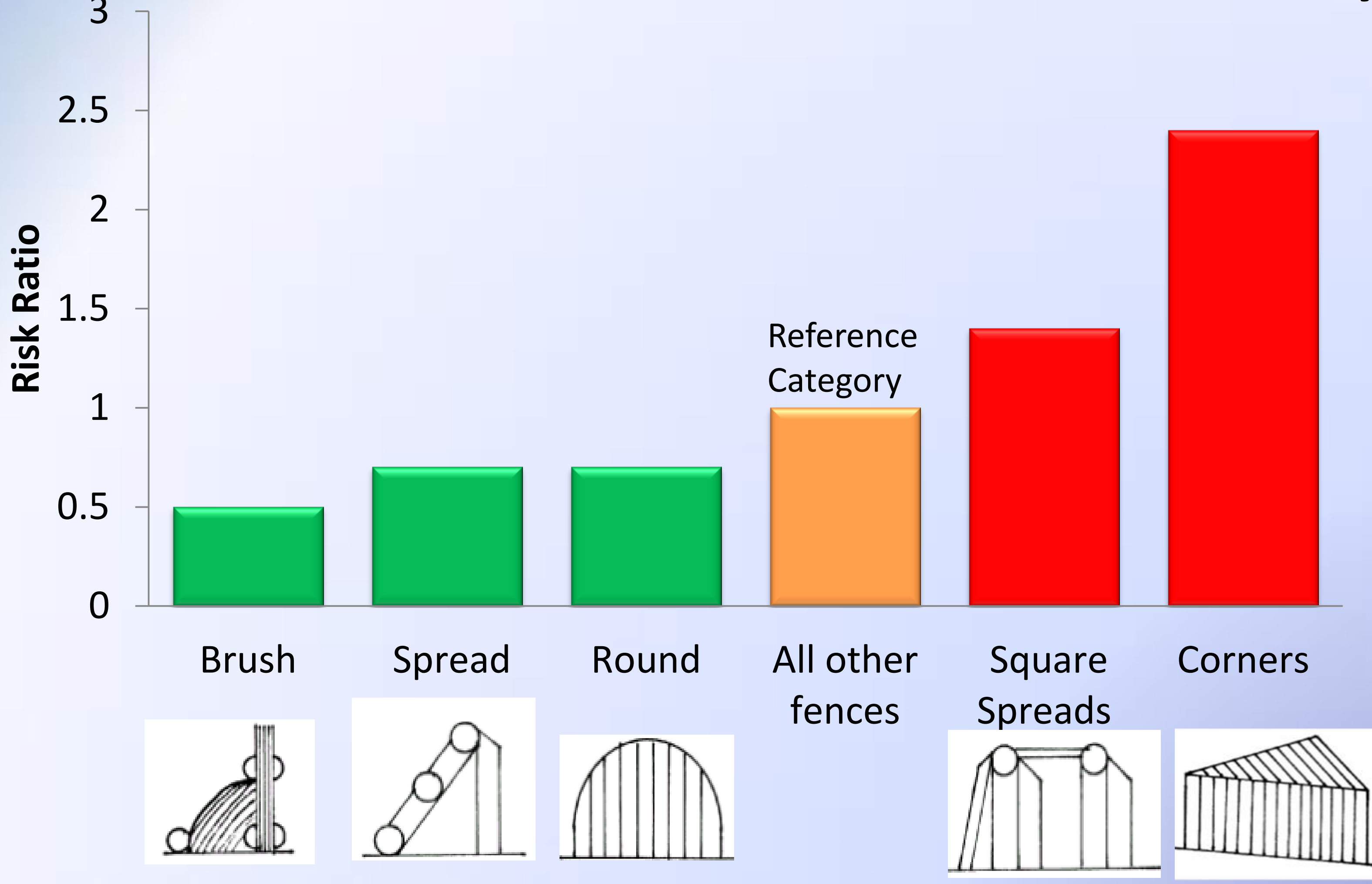

- Risk of horse fall at Championship is almost twice that at a standard competition
- This was independent of all other factors e.g. event level, venue, rider category

# Risk of horse fall for different rider categories



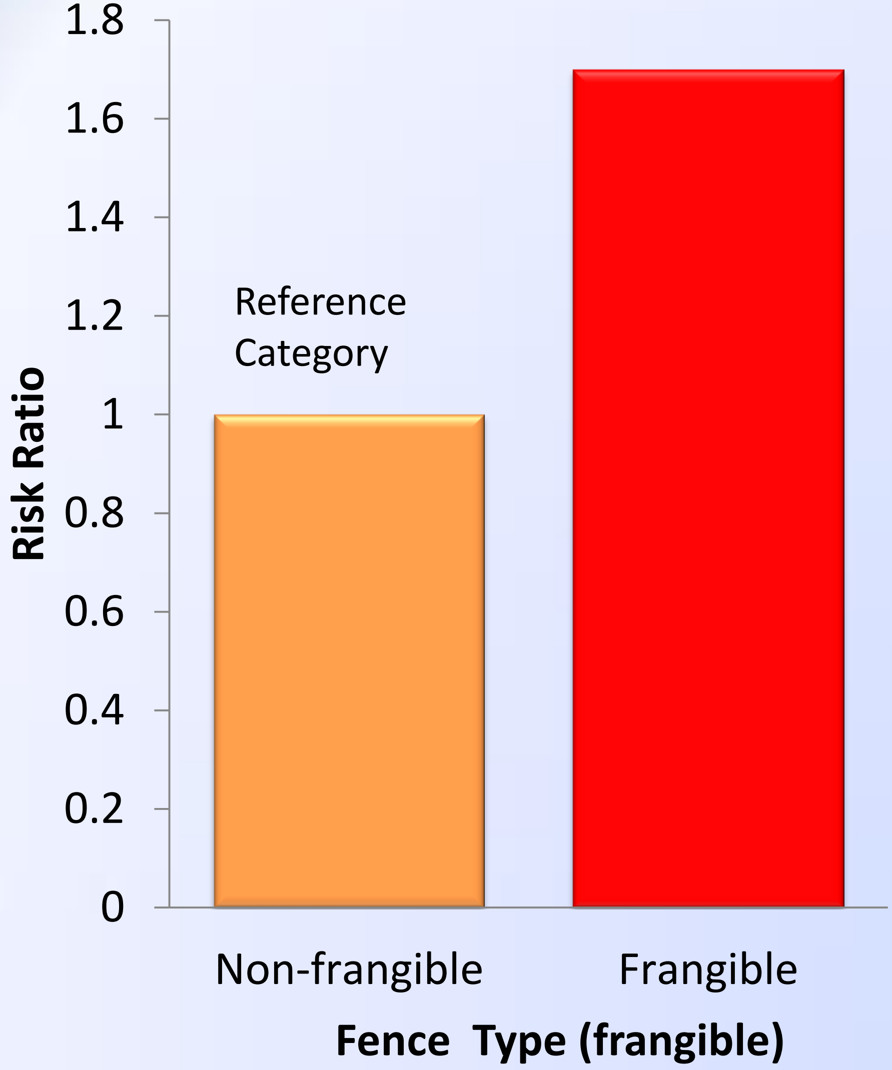

- Decreased risk of horse fall for higher category riders
- This was independent of other factors e.g. event level, competition type

# Risk of horse fall for different fence types



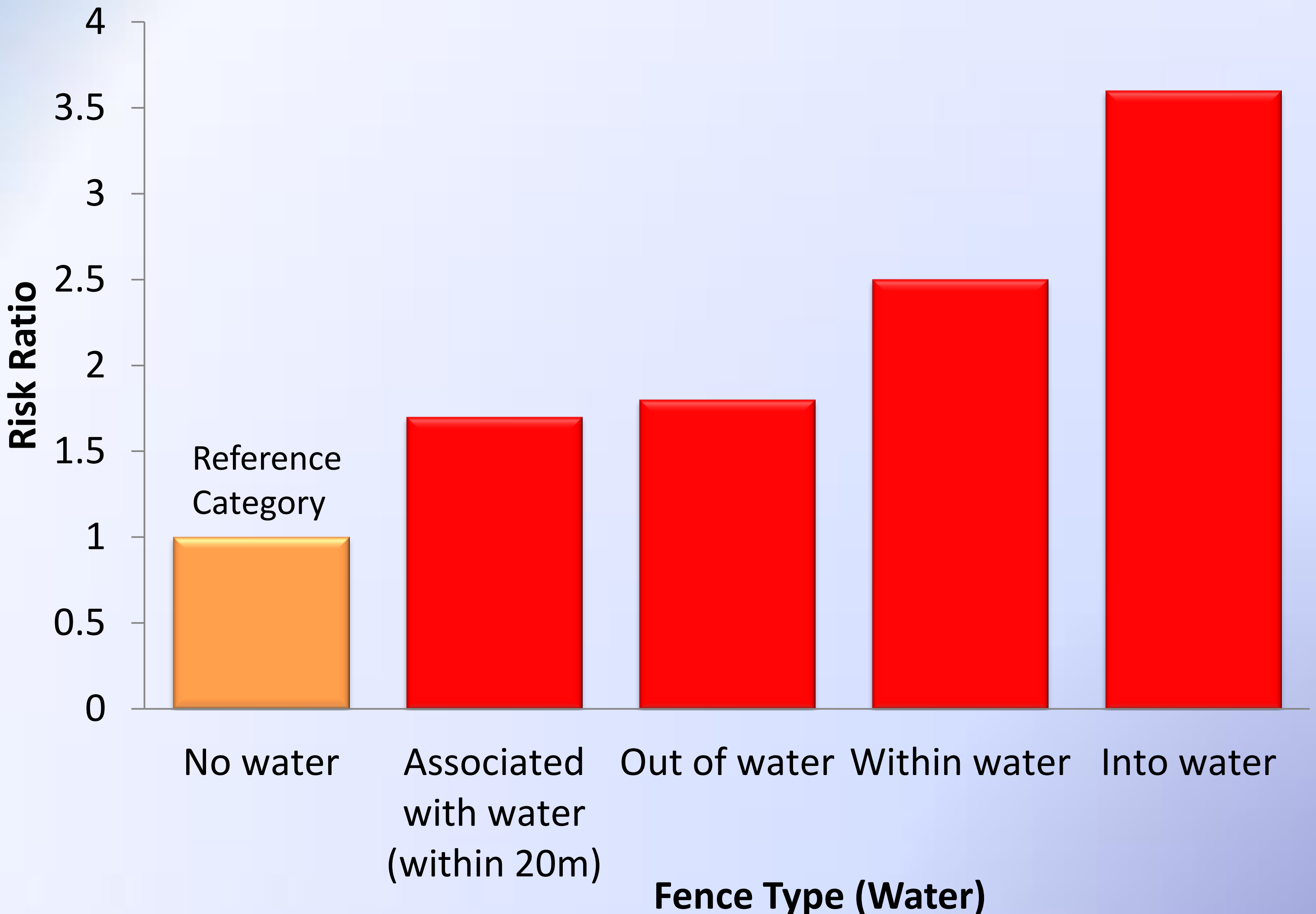

- Increased risk of horse fall at corner fences and square spreads
- Decreased risk of horse fall at brush fences and ascending spreads

# Risk of horse falls at Frangible Fences



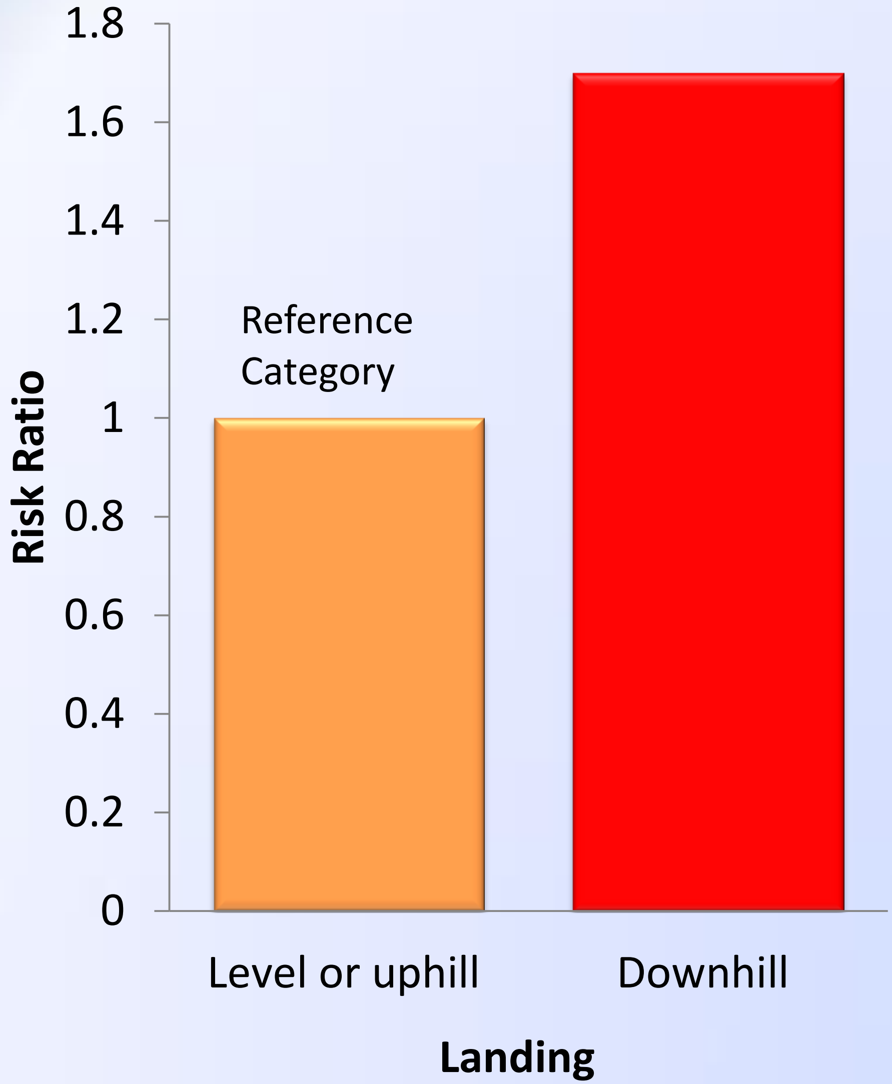

- Increased risk of horse fall at frangible fences
- This is independent of all other factors e.g. fence type, event level
- More control data required before firm conclusions can be drawn

# Risk of horse fall for fences related to water




- Increased risk of horse fall for fences related to water
- This is independent of other factors e.g. type of fence

# Risk of horse falls at downhill fences

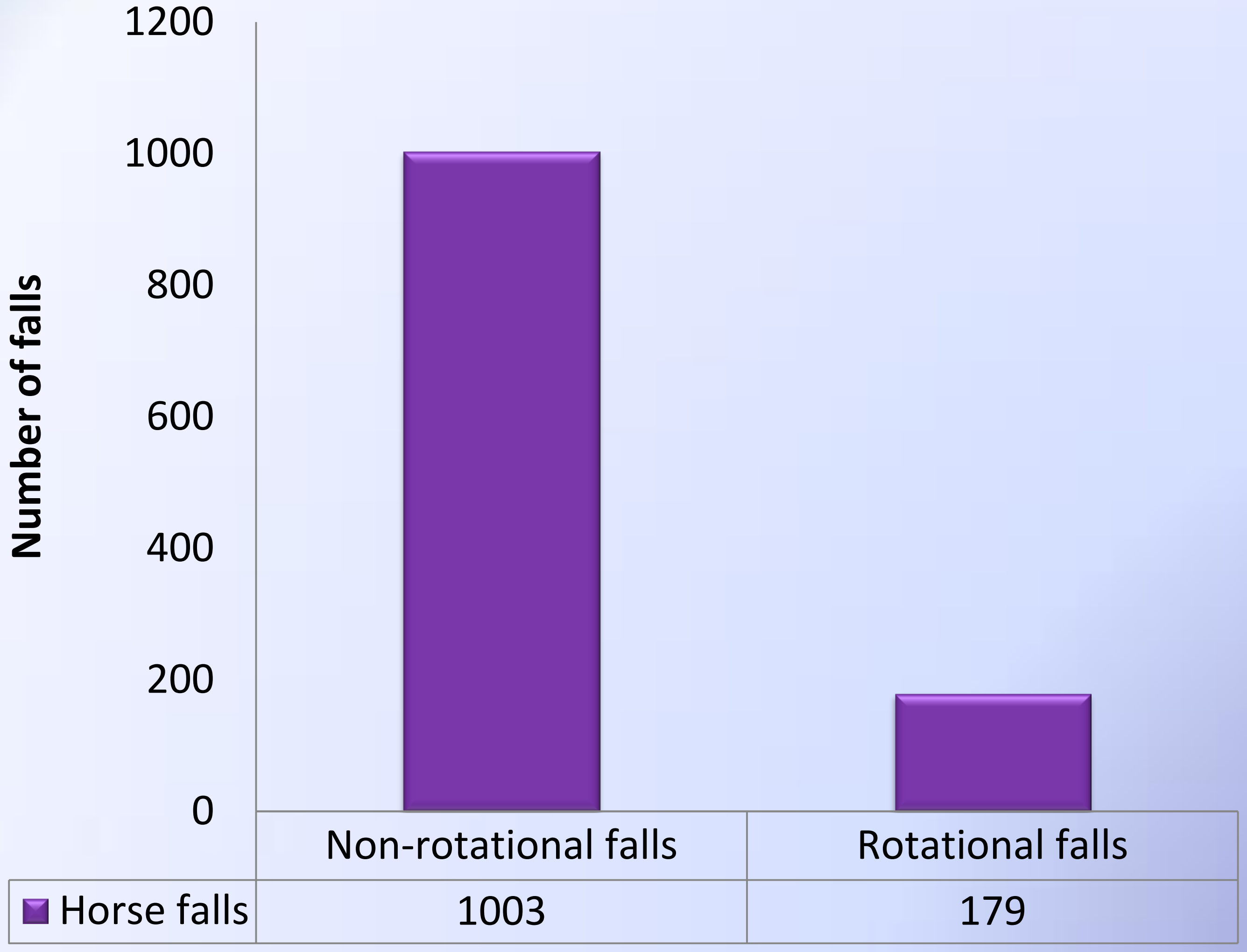



- Increased risk of horse fall at downhill fences
- This is independent of all other factors e.g. fence type, event level

# Venue and Course Designer

- Some venues have higher risk of horse falls than other. This is independent of other factors e.g. event level.
- The same effect is evident for Course Designers
- Individual venues / CDs were not explored in detail in this study but this should be monitored

# Rotational vs Non-rotational horse falls



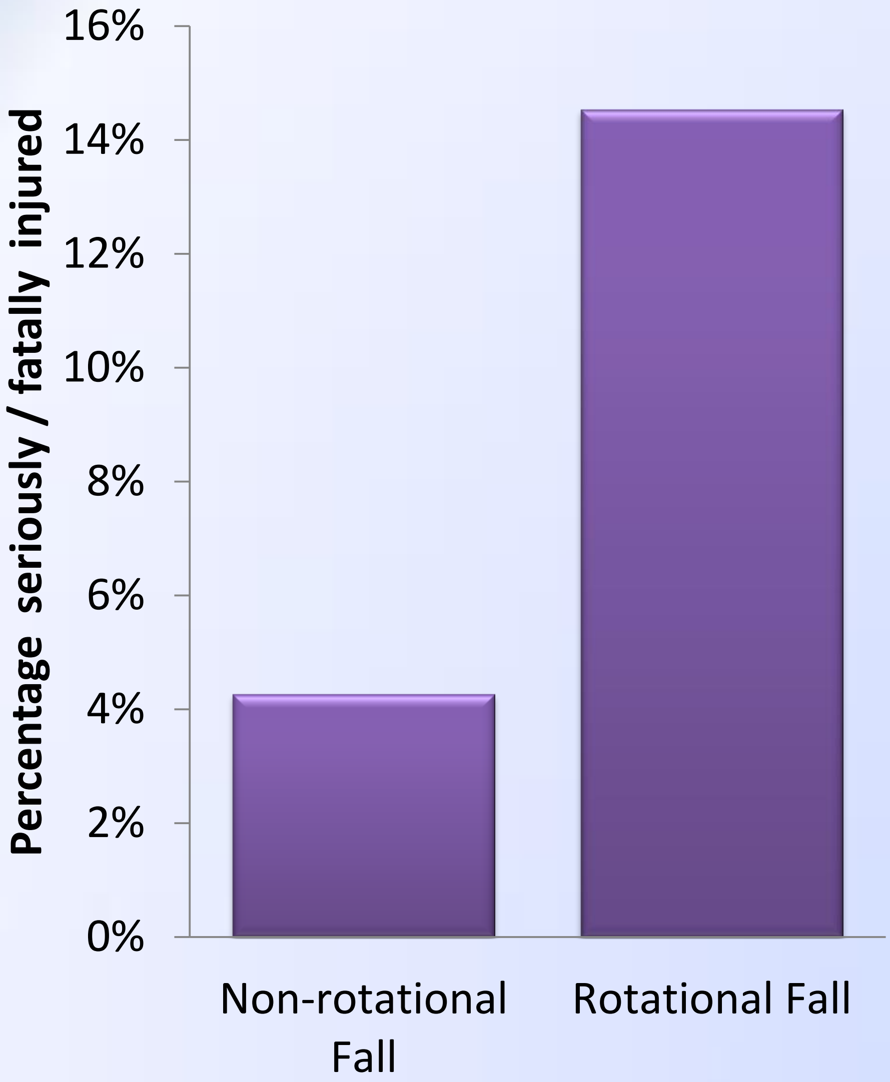
# Rotational vs Non-rotational horse falls

Factors that are linked with rotational (as opposed to non-rotational) horse falls:

| Factor | Risk ratio |
|---|---|
| Horse hit fence hit hard | 2.4 |
| Horse hit fence on way up | 2.7 |
| Horse aged 7 years or younger | 2.5 |
| Horse approach too fast | 2.1 |

Assessment of speed and impact with fence via fence judge observation – some bias possible

# Rider injury as a result of a horse fall




Increased percentage of serious / fatal injuries following a rotational fall

# Rider Injury Following a Horse Fall

## Other factors linked with rider injury

| **Factor** | **Risk ratio** |
|---|---|
| Championship Competition | 1.8 |
| Horse aged 7 years or younger | 2.5 |
| Horse approach too fast | 1.5 |
| Horse hit fence hard | 2.4 |
| Frangible fence | 1.9 |
| Fence jumped out of water | 2.8 |
| Fence jumped into water | 0.2* |

*Although there is a high risk of a horse fall for fences jumped into water, the risk of rider injury is lower

# Key Recommendations

## Competition Factors

- Event Level - review qualification system for all levels.
- Consider standardising competition entry requirements worldwide
- Venue and Course Design **-** continue to monitor

## Horse / Rider Factors

- Rider Category - review qualifications for 3★ and 4★ events (rider licence?)
- Review MERs as more data become available
- Horse age - review the entry qualifications for younger horses.
- Monitor horse / rider faller partnerships
- Gather information about rider speed
- Rider education - disseminate report findings

# Key Recommendations

**Fence Factors**

- Disseminate study findings to CDs and TDs
- Avoid combined use of high risk fences e.g.
  - Square parallels coming out of water
  - Corner fences with downhill landing
- Prioritise further analysis of frangible fences
  - Additional data collection including control data
  - Review information provided by TDs and fence judges
- Develop new fence descriptor form with more objective measurements
  - Height
  - Width at base and top
  - Ground line position
  - Terrain and location
  - Front face angle and contour

# Key Recommendations

## Data collection and input

- Explore methods of collecting objective data e.g. of rider speed
  - Use of head-cams (for fence judges)
  - Photographs of fences
  - Film record of all events
- Collect data from non-fallers
  - Random controls
  - All refusals
  - All activated frangible devices
- Modify and simplify forms and include standardised descriptions of:
  - Rotational fall
  - Horse injury
  - Rider injury
- Fence judge training – develop online guidelines / video examples

# Any Questions ?