

# Epidemiology of Injury Due to Race-Day Jockey Falls in Professional Flat and Jump Horse Racing in Ireland, 2011–2015

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**Context:** Professional horse racing is considered a high-risk sport, yet the last analysis of fall and injury incidence in this sport in Ireland was completed between 1999 and 2006.

**Objective:** To provide an updated analysis of the fall and injury incidence in professional flat and jump horse racing in Ireland from 2011 through 2015, compare it with the previous analysis, and detail the specific types and locations of injuries.

**Design:** Descriptive epidemiology study.

**Setting:** A medical doctor recorded all injuries that occurred at every official flat and jump race meeting for the 2011 through 2015 seasons using standardized injury-report forms.

**Main Outcome Measure(s):** Injury and fall rates and their 95% confidence intervals (CIs) were reported for flat and jump racing. Incidence rate ratios and 95% CIs were calculated between flat and jump racing, between the 1999–2006 analysis and the current results, and between 2011 and 2015. The distribution of injuries for type and location of injury was reported.

**Results:** Compared with flat racing, jump racing had significantly more falls per 1000 rides (49.5 versus 3.8), injuries per 1000 rides (10.1 versus 1.4), and injuries per 1000 meetings

(776.0 versus 94.1). However, the rate of injuries per 1000 falls was significantly higher in flat racing (352.8 versus 203.8). An increase in injuries per 1000 falls between 2011 and 2015 was found in flat racing ( $P = .005$ ). Since the previous analysis, a significant increase in injuries per 1000 rides and falls was noted in jump racing. Soft tissue injuries were predominant in flat and jump racing (61.54% and 68.80%, respectively), with fractures the second most common injury (15.38% and 18.06%, respectively). Concussions were more prevalent from flat-racing falls (incidence rate ratio = 0.30; 95% CI = 0.15, 0.61). The lower limb was the most frequent location of injury (32.89%) in flat racing; however, in jump racing, upper limb injuries (34.97%) were predominant.

**Conclusions:** An update on professional flat- and jump-racing fall and injury epidemiology is provided. Further research to identify risk factors for injury, design and investigate the feasibility of injury-prevention strategies, and document their effects on fall and injury incidence is required.

**Key Words:** National Hunt, injury incidence, injury rate, high-risk sport, concussions, head injury, fractures, bone

## Key Points

- In jump horse racing, 1 fall occurred in every 20 rides, with 20% of these resulting in injury. In contrast, 1 fall occurred in every 250 rides in flat racing, with 35% of these resulting in injury.
- Since the previous analysis (1999–2006), a significant increase in injuries per 1000 rides and falls was noted in jump racing; however, a nonsignificant decrease was found in flat racing.
- Given the variance in the most frequent injury locations, individual injury-prevention strategies should be implemented for flat and jump racing.
- Injury risk factors, the design and feasibility of injury-prevention intervention strategies, and their effects on the incidence of falls and injury risk in Ireland need to be investigated.

Professional horse racing is a highly competitive and popular sport worldwide.<sup>1</sup> Professional jockeys typically compete in either flat or jump (National Hunt) racing. Flat racing is characterized by its high-speed nature (up to 70 km·h<sup>-1</sup>) from a stall start and covers distances ranging from 1 to 4.4 km with no obstacles. In contrast, jump races in Ireland start from a tape barrier and involve a number of fences or hurdles over which the horse must jump, covering distances of 3.2 to 7.2 km. During a race, the jockey is perched approximately 3 m above the ground in a position of forward propulsion and executes

dynamic movements requiring high levels of muscular strength, endurance, and balance in order to coordinate a partnership with the horse.<sup>2</sup>

Competing in this professional sport is often considered high risk and dangerous, with a high incidence of falls and injuries reported.<sup>2–6</sup> Although recent analyses have addressed fall and injury incidence rates in horse racing in Australia,<sup>7,8</sup> New Zealand,<sup>9</sup> and California,<sup>10</sup> the most recent analysis in Europe (ie, France, the United Kingdom, and Ireland) was conducted from 1999 through 2006.<sup>4</sup> The findings of this study<sup>4</sup> and other research<sup>3,9</sup> revealed that

jump racing had the greater rate of falls and injuries per ride, but flat racing had the highest rate of injury per fall. In the 3 countries, the fall incidence in jump racing was 51 to 85 falls per 1000 rides, with 17% to 20% of these falls resulting in injury. In contrast, flat racing in these countries resulted in 2.7 to 4.4 falls per 1000 rides, with 40% to 59% of these falls resulting in injury. Soft tissue injuries have been reported to be the most common type of injury sustained during flat and jump racing; however, fractures and concussions were also prevalent.<sup>4,6,8</sup>

In recent years, the Irish horse-racing regulatory body, the Turf Club, has implemented many targeted health and safety interventions in an attempt to improve health, well-being, and safety standards in professional horse racing. Such initiatives include raising the minimum competition weight standards, implementing a new concussion-assessment protocol,<sup>11</sup> increasing helmet safety standards, introducing a new individualized minimum-weight structure for apprentice jockeys, and implementing an evidence-based exercise and nutrition education program for apprentice jockeys to advise them on optimal preparation strategies for racing. To determine whether such strategies have influenced the incidence of jockey falls and injuries in Ireland, an updated analysis was required.

There is a dearth of recent literature from Europe on fall and injury incidences and the types of injuries that occur in flat and jump racing, and a lack of standardized data collection and reporting is apparent in published studies.<sup>12</sup> Furthermore, no detailed information, other than on soft tissue conditions, fractures, and concussions, exists for the specific types of injuries sustained in professional horse racing as outlined in the European consensus statement<sup>12</sup> on epidemiologic studies of injuries in the thoroughbred horse-racing industry. In this study, therefore, our aims were to provide an updated analysis of the fall and injury rates in professional flat and jump horse racing in Ireland using standardized data-collection and reporting procedures as directed in the European consensus and to detail the specific types and locations of injuries sustained from 2011 through 2015.

## METHODS

We examined the epidemiology of falls and injury in flat and jump horse-racing jockeys in Ireland over a 5-year period (2011–2015). Ethical approval was granted by the Dublin City University Research Ethics Committee. At every official race meeting, a Turf Club–appointed medical doctor, who must be a registered medical doctor and have completed a Turf Club pretrauma course at least every 3 years, was required to be in attendance. The Turf Club–appointed medical doctor, who was present at a race meeting, was required to complete a standardized injury report form to regulate the injury data gathered at each race meeting. This form was developed by the senior medical officer of the Turf Club in accordance with the European guidelines.<sup>12</sup> A *fall* was defined as “a rider being dislodged from a horse, regardless of the outcome.”<sup>6</sup> An *injury* was defined according to the European consensus on epidemiologic injury studies in the thoroughbred horse racing industry and was

any physical complaint sustained by a person that results from competitive riding, training or other recognised

activity that brings a person into contact, or in the close vicinity and with the potential for contact, with 1 or more thoroughbred racehorses, irrespective of the need for medical attention or time loss from horse racing activities.<sup>12</sup>

The senior medical officer collated and reviewed all injury-report forms after each race meeting. The Turf Club–appointed medical doctor was contacted if any discrepancies were noted in the injury report form. The numbers of rides, official race meetings, and licensed professional jockeys from 2011 through 2015 were gathered from the Horse Racing Ireland fact book.<sup>13</sup>

## Data Analysis

Characteristics (means, standard deviations, and ranges) were measured for the flat- and jump-racing jockeys who held professional racing licenses in Ireland from 2011 through 2015. The injury incidence rate per 1000 rides was calculated using the following formula:

$$\text{incidence rate} = \frac{\text{number of injuries}}{\text{total number of rides}} \times 1000$$

The total numbers of falls and race meetings, respectively, were substituted for the total number of rides in calculating incidence rates per 1000 falls and 1000 race meetings. The 95% confidence intervals (CIs) were calculated using the Poisson distribution.

In addition to injury rates, fall, fracture, and concussion rates per 1000 rides, 1000 falls, and 1000 race meetings were calculated in the same manner. Poisson regression was used to examine differences in fall and injury trends over the course of the current study (2011–2015), with incidence rate ratios (IRRs), 95% CIs, and percentage changes presented. The IRRs and 95% CIs were calculated between flat- and jump-racing fall and injury incidence rates (with jump racing being the referent) and between the previously published epidemiologic results (1999–2006)<sup>4</sup> and the current study (2011–2015). An IRR greater or less than 1 indicates an increase or decrease, respectively, in fall and injury incidence rates compared with the reference variable or time. For flat versus jump racing and for the previous incidence in Ireland versus the current study, all CIs not including 1.00 were considered statistically significant.

Frequency of region, location, nature, and type of injury were also captured from the injury report form and recorded as the overall percentage with the 95% CI. Data were statistically analyzed using Excel (version 2010; Microsoft Corp, Redmond, WA) and Stata software (version 14; Stata Corp, College Station, TX).

## RESULTS

From 2011 through 2015,  $100 \pm 7.4$  (range, 90–111) flat-racing jockeys and  $114 \pm 5.2$  (range, 108–122) jump-racing jockeys held professional racing licenses in Ireland. Their characteristics and fall and injury incidences in flat and jump horse racing are presented in Table 1. Over the 5 years, there were  $43.8 \pm 6.4$  falls in  $11\,472 \pm 186.1$  rides with  $15.6 \pm 5.3$  reported injuries in flat racing per year. Jump racing was associated with a higher number of mean falls ( $849 \pm 114.1$ ), rides ( $17\,110 \pm 1291.8$ ), and injuries

**Table 1. Characteristics and Injury Incidence of Flat and Jump Horse-Racing Jockeys in Ireland, 2011–2015**

Characteristics and Injury Incidence	Flat Racing					Jump Racing						
	2011	2012	2013	2014	2015	Total	2011	2012	2013	2014	2015	Total
No. of licensed jockeys	111	107	90	97	100	505	122	109	117	112	108	568
No. of starters	11 309	11 523	11 709	11 259	11 560	57 360	18 797	17 357	17 690	16 217	15 487	85 548
No. of race meetings	153	171	171	170	169	834	228	231	224	220	214	1 117
No. of falls	51	40	48	45	35	219	1 039	768	871	788	777	4 243
No. of injuries	19	8	22	15	14	78	216	138	179	158	175	866
						Mean						Mean
						(95% Confidence Interval)						(95% Confidence Interval)
Falls per 1000 rides	4.5	3.5	4.1	4.0	3.0	3.8 (3.3, 4.4)	55.3	44.3	49.2	48.6	50.2	49.5 (48.1, 51.1)
Injuries												
Per 1000 rides	1.7	0.7	1.9	1.3	1.2	1.4 (1.1, 1.7)	11.5	8.0	10.1	9.7	11.3	10.1 (9.5, 10.8)
Per 1000 falls	372.5	200.0	458.3	333.3	400.0	352.8 (285.3, 444.7)	207.9	179.7	205.5	200.5	225.2	203.8 (191.0, 218.2)
Per 1000 meetings	124.2	46.8	128.7	88.2	82.8	94.1 (74.9, 116.8)	947.4	597.4	799.1	718.2	817.8	776.0 (725.3, 828.7)
Fractures												
Per 1000 rides	0.4	0.3	0.3	0.2	0.0	0.2 (0.1, 0.4)	1.9	1.1	2.2	1.9	2.2	1.9 (1.6, 2.2)
Per 1000 falls	78.4	75.0	62.5	44.4	0.0	54.8 (31.1, 96.5)	34.7	24.7	44.8	38.1	43.8	37.2 (31.9, 43.5)
Per 1000 meetings	26.1	17.5	17.5	11.8	0.0	14.4 (8.2, 25.3)	157.9	155.8	160.7	163.6	168.2	141.5 (121.0, 165.3)
Concussions												
Per 1000 rides	0.2	0.1	0.3	0.2	0.1	0.2 (0.0, 0.3)	0.7	0.5	0.3	0.7	0.9	0.6 (0.5, 0.8)
Per 1000 falls	39.2	25.0	62.5	44.4	28.6	41.1 (21.4, 79.0)	12.5	11.7	6.9	14.0	18.0	12.4 (9.5, 16.4)
Per 1000 meetings	13.1	5.9	17.5	11.8	5.9	10.8 (5.6, 20.7)	57.0	39.0	26.8	50.0	65.4	47.5 (36.3, 62.1)

(173.2 ± 28.9). Although falls per 1000 rides, injuries per 1000 rides, and injuries per 1000 meetings were significantly higher in jump racing, the rate of injuries per 1000 falls was significantly higher in flat racing (Table 2). Slight reductions in falls per 1000 rides and injuries per 1000 meetings were observed in flat and jump racing between 2011 and 2015; however, these values were not significant ( $P > .05$ ). An increase in injuries per 1000 falls over the course of this study was noted only in flat racing ( $P = .002$ ; Table 2). From the previous update on Irish jockey injury incidence between 1999–2006 and the current study, significant increases in injuries per 1000 rides and falls were present in jump racing. Increases of 17.17% and 20.59% in injuries per 1000 rides and falls, respectively, were demonstrated in jump racing (Table 2). Nonsignificant decreases were found in flat racing, with 14.63% and 19.64% reductions in injuries per 1000 rides and falls, respectively, compared with the rates reported by Rueda et al.<sup>4</sup>

Soft tissue injuries were predominant, accounting for 61.54% of injuries in flat racing and 68.80% in jump racing (Table 3). Half of the injuries that occurred during a fall on race day affected the skin, as reflected by the high percentages of skin hematomas/contusions/bruises reported (flat = 46.15%, jump = 42.51%). Fractures were the second most frequently reported injury in flat (15.38%) and jump (18.06%) racing. Fractures per 1000 rides (IRR = 9.50; 95% CI = 5.28, 17.08) and meetings (IRR = 0.10; 95% CI = 0.06, 0.18) were significantly higher in jump racing (Table 2). In contrast, the fracture rate per 1000 falls was higher in flat racing (IRR = 0.68; 95% CI = 0.38, 1.22) but not significantly so. In addition, fractures per 1000 rides (IRR = 0.68; 95% CI = 0.62, 0.75) and meetings (IRR = 0.65; 95% CI = 0.54, 0.78) decreased significantly only between 2011 and 2015 in flat racing. Similar to fracture rates, concussions per 1000 falls were significantly higher in flat racing (IRR = 0.30; 95% CI = 0.15, 0.61), and concussions per 1000 rides (IRR = 3.00; 95% CI = 1.48, 6.08) and meetings (IRR = 4.40; 95% CI = 2.17, 8.92) were significantly higher in jump racing. Concussions represented a higher percentage of overall injuries in flat (11.54%) than in jump racing (6.06%). Although there was a significant overall reduction in concussions per 1000 rides (IRR = 0.56; 95% CI = 0.41, 0.76) and falls (IRR = 0.59; 95% CI = 0.43, 0.81) between 2011 and 2015 and between 1999 and 2006<sup>4</sup> in jump racing, concussions per 1000 rides, falls, and meetings increased between 2011 and 2015 but not significantly so. Concussions per 1000 rides, falls, and meetings decreased between 2011 and 2015 in flat racing, along with a nonsignificant overall reduction in concussion rates between 1999 and 2006<sup>4</sup> and between 2011 and 2015 (Table 2). No dislocations were reported during this study period in flat racing; however, 3.54% of injuries were due to dislocations, subluxations, or instability in jump racing.

Lower limb injury was predominant (32.89%) in flat racing (Table 4), affecting a wide variety of locations in the lower limb, including the shin and calf (9.21%), thigh/femur (7.89%), knee (7.89%), and ankle (6.58%). Although the head and neck was the second most common region of injury (27.63%), head/face injuries were by far the most frequent specific location of injury reported (23.68%). In relation to the upper limb, injuries to the shoulder/scapula/clavicle (9.21%), wrist (5.26%), and hand/finger/thumb

**Table 2. Incidence Rate Ratios (IRRs), 95% Confidence Intervals (CIs), and Percentage Changes for Flat and Jump Horse-Racing Jockeys in Ireland: Differences Between 2011 and 2015 and Between 1999–2006 and 2011–2015**

Variable	Jump Versus Flat Racing				Racing Differences Between 2011 and 2015 <sup>a</sup>				Racing Differences Between 1996–2006 and 2011–2015					
	Flat		Jump		Flat		Jump		Flat		Jump			
	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI	IRR	95% CI		
Falls per 1000 rides	13.03 <sup>b</sup>	11.37, 14.92	0.94	0.68, 1.29	-6.25	0.99	0.91, 1.02	-1.18	1.02	0.86, 1.22	2.15	0.97	0.93, 1.01	-2.92
Injuries					% Change			% Change			% Change			% Change
Per 1000 rides	7.21 <sup>b</sup>	5.72, 9.10	0.97	0.57, 1.65	-2.90	1.01	0.83, 1.23	1.23	0.85	0.65, 1.13	-14.63	1.17 <sup>b</sup>	1.07, 1.28	17.17
Per 1000 falls	0.58 <sup>b</sup>	0.46, 0.73	1.06 <sup>b</sup>	1.02, 1.09	5.49	1.01	0.96, 1.05	0.63	0.80	0.61, 1.06	-19.64	1.21 <sup>b</sup>	1.11, 1.32	20.59
Per 1000 meetings	8.25 <sup>b</sup>	6.54, 10.40	0.96	0.90, 1.02	-4.31	0.98	0.96, 1.00	-1.77						
Fractures					% Change			% Change			% Change			% Change
Per 1000 rides	9.50 <sup>b</sup>	5.28, 17.08	0.67	0.17, 2.71	-32.99	1.08	0.66, 1.70	7.84						
Per 1000 falls	0.68	0.38, 1.22	0.68 <sup>b</sup>	0.62, 0.75	-31.99	1.09	0.98, 1.21	8.89						
Per 1000 meetings	0.10 <sup>b</sup>	0.06, 0.18	0.65 <sup>b</sup>	0.54, 0.78	-34.80	1.02	0.97, 1.07	1.78						
Concussions					% Change			% Change			% Change			% Change
Per 1000 rides	3.00 <sup>b</sup>	1.48, 6.08	0.95	0.22, 4.09	-5.41	1.10	0.50, 2.43	10.20	0.71	0.33, 1.54	-28.57	0.56 <sup>b</sup>	0.41, 0.76	-44.44
Per 1000 falls	0.30 <sup>b</sup>	0.15, 0.61	0.96	0.90, 1.10	-4.50	1.11	0.93, 1.33	11.17	0.55	0.25, 1.18	-45.20	0.59 <sup>b</sup>	0.43, 0.81	-40.95
Per 1000 meetings	4.40 <sup>b</sup>	2.17, 8.92	0.92	0.77, 1.12	-7.56	1.06	0.97, 1.16	6.02						

<sup>a</sup> Poisson regression used to analyze trends over time in injury between 2011 and 2015.

<sup>b</sup> Significant difference,  $P < .05$ .

(5.26%) occurred most often. The sternum/ribs/chest wall (5.26%) was the most predominant injury location in the trunk. In jump racing, injuries were primarily the upper limb (34.97%), with the shoulder/scapula/clavicle predominantly injured in this region. Lower limb (26.69%) and head and neck (19.93%) injuries were the second and third most common regions of injuries, respectively, with the shin/calf (8.51%) and head/face (15.85%) the most common locations of injury in each. Similar to injuries in flat racing, the sternum/ribs/chest wall (5.59%) was the most frequent injury in the trunk in jump racing.

In addition to injuries, there were cases in which the licensed medical doctors determined that a jockey was ineligible to ride because of an illness (typically viral; flat:  $n = 6$ , jump:  $n = 77$ ).

## DISCUSSION

Professional horse racing is classified as a high-risk and dangerous sport,<sup>3,4</sup> yet limited recent information is available on the fall and injury incidences of and types of injuries to professional jockeys in Europe. We aimed to provide an updated overview and comprehensive analysis of fall and injury incidence rates in flat and jump horse racing in Ireland. We also detailed the specific types and locations of injuries sustained by flat and jump horse-racing jockeys.

Results from this study are broadly in line with the previous analysis from 1999 through 2006,<sup>4</sup> suggesting that although falls and injuries were 13.03 and 7.21 times more likely to occur in jump racing, a fall in flat racing was 1.73 times more likely to result in an injury. The greater speed reached in flat races (flat racing speed =  $>65 \text{ km}\cdot\text{h}^{-1}$  when traveling downhill<sup>2</sup>), due to shorter distances and lack of obstacles, may partially explain the greater injury risk as a result of a fall. Other factors that may contribute include jockey experience, jockey age, race grade and prize money, race distance, track surface, and fitness level.<sup>7,14–16</sup> Future researchers should further examine these risk factors in Irish horse racing. These data from 2011 through 2015 reflect a significant increase in injuries per 1000 rides and falls in jump racing and a nonsignificant reduction in flat racing in Ireland since 1999 through 2006.<sup>4</sup> In addition, the fall rates per 1000 rides in flat (mean = 3.8, 95% CI = 3.3, 4.4) and jump (mean = 49.5, 95% CI = 48.1, 51.1) racing in Ireland remain less than the 4.4 and 68 per 1000 rides previously reported<sup>4</sup> in flat and jump racing, respectively, until 2006 in the United Kingdom. In recent years, targeted health and safety interventions in terms of education and support in Ireland have been predominantly directed at flat-racing jockeys, particularly apprentice jockeys. Although these initiatives do not fully explain the changes in the incidence of injuries over the years, they may indicate the potential for implementing similar interventions with jump-racing jockeys in order to optimally prepare all professional jockeys for racing.

Fractures and concussions are prevalent in horse racing. A ride in jump racing is 9.50 times more likely to result in a fracture than one in flat racing; however, fractures are 1.47 times more likely to occur as a result of a fall in flat racing. Fractures are also 9.83 times more likely to occur in a flat than a jump race meeting. This may be the result of the high-speed impact that could result from a fall in flat racing

**Table 3. Natures and Types of Injuries in Flat and Jump Horse-Racing Jockeys in Ireland, 2011–2015**

Injuries	Flat Racing		Jump Racing	
	No.	% (95% Confidence Interval)	No.	% (95% Confidence Interval)
<b>Nature</b>				
Bone	12	15.19 (15.15, 15.22)	159	18.17 (18.17, 18.17)
Joint (nonbone)	0	0	33	3.77 (3.77, 3.78)
Ligament	8	10.13 (10.09, 10.16)	84	9.60 (9.60, 9.60)
Muscle	4	5.06 (5.03, 5.10)	68	7.77 (7.77, 7.77)
Tendon	0	0	8	0.91 (0.91, 0.92)
Skin	41	51.90 (51.86, 51.94)	442	50.51 (50.51, 50.52)
Central/peripheral nervous system	11	13.92 (13.89, 13.96)	61	6.97 (6.97, 6.97)
Other	3	3.80 (3.76, 3.83)	20	2.29 (2.28, 2.29)
<b>Type</b>				
Fracture	12	15.38 (15.26, 15.50)	158	18.06 (18.05, 18.07)
Other bone injury	0	0	1	0.11 (0.11, 0.12)
Dislocation/subluxation/instability	0	0	31	3.54 (3.54, 3.55)
Synovitis	0	0	1	0.11 (0.11, 0.12)
Meniscus/articular cartilage	0	0	1	0.11 (0.11, 0.12)
Sprain	8	10.26 (10.16, 10.35)	84	9.60 (9.59, 9.61)
Strain/spasm/cramp/hematoma	4	5.13 (5.06, 5.20)	68	7.77 (7.76, 7.78)
Tendon tear/tendinopathy	0	0	8	0.91 (0.91, 0.92)
Skin hematoma/contusion/bruise	36	46.15 (45.95, 46.36)	372	42.51 (42.50, 42.53)
Abrasion/laceration	5	6.41 (6.33, 6.49)	70	8.00 (7.99, 8.01)
Concussion	9	11.54 (11.43, 11.64)	53	6.06 (6.05, 6.06)
Structural brain injury	1	1.28 (1.25, 1.32)	1	0.11 (0.11, 0.12)
Spinal cord injury	0	0	3	0.34 (0.34, 0.34)
Nerve injury	0	0	3	0.34 (0.34, 0.34)
Eye injury	1	1.28 (1.25, 1.32)	1	0.11 (0.11, 0.12)
Disc lesion	0	0	1	0.11 (0.11, 0.12)
Visceral injury	1	1.28 (1.25, 1.32)	10	1.14 (1.14, 1.15)
Dental injury	2	2.56 (2.52, 2.61)	8	0.91 (0.91, 0.92)
Undiagnosed injury	0	0	1	0.11 (0.11, 0.12)

and produce a fracture, particularly given that flat-racing jockeys have been reported to have a greater incidence of compromised bone health than their jump-racing counterparts.<sup>17,18</sup> However, fractures did represent a greater percentage of the overall injuries in jump than in flat racing (18.1% versus 15.4%). The rate of fractures per 1000 falls in flat racing (54.8) was lower than the rate previously reported in Ireland from 1992 through 2000 (98.8); yet the rate of fractures per 1000 falls increased in jump racing (1992–2000 = 34.3, 2011–2015 = 37.2).<sup>6</sup> Although reductions of 31.77% and 34.80% in injuries per 1000 falls and meetings, respectively, occurred in flat racing, there was a small, nonsignificant increase in those injuries during jump racing. Therefore, the implementation of an educational program to teach appropriate fall mechanics as an injury-prevention strategy, particularly in jump racing, should be considered. Such fall-training programs are currently being implemented in the United States, Australia, and the United Kingdom, but no scientific research on the effectiveness of these programs in horse racing has yet been published. A jockey was 4.40 times more likely to sustain a concussion during jump racing than during flat racing. A fall in flat racing resulted in a jockey being 3.33 times more likely to sustain a concussion compared with jump racing. In contrast, a ride was 3 times more likely to result in a concussion for the jockey in jump racing. An increase in concussions per 1000 rides, falls, and meetings was noted in jump racing between 2011 and 2015; however, in contrast, a slight decrease was found in flat racing. There was a decrease in the reported number of concussions per

1000 falls (flat racing = 45.20%, jump racing = 40.95%) and rides (flat racing = 28.57%, jump racing = 44.44%) compared with data previously reported from Irish flat racing by Rueda et al.<sup>4</sup> Such reductions in the proportion of injuries classified as concussions may result from the improved helmet safety standards. However, the introduction of the new standardized concussion-assessment protocols in 2010 may have imposed different reporting methods for concussions in recent years and may also explain the conflicting concussion rates reported over the years. The new protocol consists of baseline neuropsychological testing (computerized and pen-and-paper tests) for all professional jockeys every 2 years (before a license renewal) or at the start of the season after any concussion. A standardized medical assessment involving a screening questionnaire and a more detailed neurologic assessment for those jockeys who are thought to have sustained concussions is performed and recorded by the doctor in attendance at the race meeting. Jockeys identified with concussions are immediately stood down for 6 days and must undergo repeat neuropsychological testing and a full neuropsychological examination before being allowed to return to race riding. These assessment reports are reviewed by the Turf Club senior medical officer to determine if the athlete can safely return to race riding or if a further period of rest is required.

Soft tissue injuries, particularly hematomas/contusions/bruises, were the most frequent injury type, at 61.54% and 68.6% of total injuries reported for flat and jump racing, respectively. These values increased from 57.6% and

**Table 4. Region and Location of Injury in Flat and Jump Horse-Racing Jockeys in Ireland, 2011–2015**

	Flat Racing		Jump Racing	
	No.	% (95% Confidence Interval)	No.	% (95% Confidence Interval)
Head and neck	21	27.63 (27.60, 27.67)	171	19.93 (19.93, 19.93)
Head/face	18	23.68 (23.54, 23.83)	136	15.85 (15.84, 15.86)
Neck/cervical spine	3	3.95 (3.89, 4.01)	35	4.08 (4.07, 4.08)
Upper limb	18	23.68 (23.65, 23.72)	300	34.97 (34.96, 34.97)
Shoulder/scapula/clavicle	7	9.21 (9.12, 9.30)	145	16.90 (16.89, 16.91)
Upper arm	0	0	16	1.86 (1.86, 1.87)
Elbow	2	2.63 (2.58, 2.68)	12	1.40 (1.40, 1.40)
Forearm	1	1.32 (1.28, 1.35)	45	5.24 (5.24, 5.25)
Wrist	4	5.26 (5.19, 5.33)	26	3.03 (3.03, 3.04)
Hand/finger/thumb	4	5.26 (5.19, 5.33)	56	6.53 (6.52, 6.53)
Trunk	7	9.21 (9.18, 9.24)	127	14.80 (14.80, 14.81)
Sternum/ribs/chest wall	4	5.26 (5.19, 5.33)	48	5.59 (5.59, 5.60)
Thoracic viscera	1	1.32 (1.28, 1.35)	7	0.82 (0.81, 0.82)
Upper back/thoracic spine	0	0	27	3.15 (3.14, 3.15)
Abdomen/abdominal viscera	0	0	7	0.82 (0.81, 0.82)
Lower back/lumbar spine	1	1.32 (1.28, 1.35)	16	1.86 (1.86, 1.87)
Pelvis/pelvic organs/sacrum/buttocks	1	1.32 (1.28, 1.35)	22	2.56 (2.56, 2.57)
Lower limb	25	32.89 (32.86, 32.93)	229	26.69 (26.69, 26.69)
Hip/groin	0	0	19	2.21 (2.21, 2.22)
Thigh/femur	6	7.89 (7.81, 7.98)	47	5.48 (5.47, 5.48)
Knee	5	6.58 (6.50, 6.66)	34	3.96 (3.96, 3.97)
Shin/calf	7	9.21 (9.12, 9.30)	73	8.51 (8.50, 8.52)
Ankle	6	7.89 (7.81, 7.98)	39	4.55 (4.54, 4.55)
Foot/toe	1	1.32 (1.28, 1.35)	17	1.98 (1.98, 1.99)
Location unspecified	5	6.58 (6.50, 6.66)	31	3.61 (3.61, 3.62)

55.2%, respectively, in a previous analysis.<sup>6</sup> The introduction of location-specific protective padding may help to reduce this injury risk; however, jockeys may resist because of the consequential weight increase while wearing the padding. Thus, any new injury-prevention strategies must be examined initially for their feasibility in terms of implementation, and the use of new lightweight materials in safety vests should be considered. In flat-racing jockeys, injury to the lower limb was most frequent (32.89%), similar to professional rugby union<sup>19</sup> and professional soccer players.<sup>20</sup> A greater number of jump-racing than flat-racing jockeys were deemed ineligible to ride because of illness. This may have been due to the greater average number of race meetings (57) and rides (5638) in jump racing over the 5-year period. In flat racing, a wide variety of locations were injured in the lower limb; however, the head/face (23.68%) was the most common location of injury. In contrast, in jump racing, injuries to the upper limb were predominant (34.97%), with the shoulder region being most affected (16.90%). The upper limb was also the most frequent injury site in elite motorcycle racing (52.6%).<sup>21</sup> A comparison of injury location with previous research in flat and jump horse racing was not possible because we are the first to report on injuries to this level of detail in Irish horse racing. Earlier researchers have identified injury locations; yet differentiations were either not made between flat-racing and jump-racing jockeys<sup>5</sup> or were solely focused on insurance and compensation claims data.<sup>22</sup> Adopting the standardized reporting framework used in this study, which is in line with the European guidelines for epidemiologic studies of injuries in horse racing,<sup>12</sup> will make future comparisons and trend analysis possible.

A limitation of the current study was that we were unable to determine injuries per 1000 hours, as the number of minutes each jockey spent riding at each race was not captured. Additionally, this study focused on race-day injuries only; future investigators should also examine injury incidence during work and training. For the purposes of this study, we used injury report forms that were standardized according to the European consensus statement<sup>12</sup>; therefore, no fall or injury incidences were available from 2007 to 2010. In addition, reporting procedures were different for the previous analysis, and a standardized injury report form used for data collection in the current study was developed in line with the consensus statement. Therefore, comparisons of fall and injury incidences between 1999 and 2006 and the current study should be performed with caution. We examined the overall effects of the health and safety interventions introduced since the previous analysis; however, we were unable to determine the effectiveness of each individual intervention implemented.

## CONCLUSIONS

This study presented prospective epidemiologic data from falls that occurred during Irish flat and jump horse racing from 2011 through 2015, an analysis that has not been conducted since 2006. In jump-racing jockeys, 1 fall occurred in every 20 rides, with 20% of these resulting in injury. In contrast, 1 fall occurred in every 250 rides in flat racing, and 35% of these resulted in injury. Since the previous analysis, a significant increase in injuries per 1000 rides and falls was noted in jump racing, yet a nonsignificant decrease was found in flat racing. A

significant increase in injuries per 1000 falls was observed in flat-racing jockeys between 2011 and 2015. Soft tissue injuries were predominant in flat and jump racing, with fractures the second most common injury noted. Additionally, a concussion was more likely to result from a fall in flat racing compared with jump racing; however, in both cases, the incidence of concussion was reduced compared with previous years, significantly so in jump racing. In a race meeting, fractures were 9.83 times more likely to occur in flat than in jump racing, and concussions were 4.40 times more likely to occur in jump racing. The lower limb and the head and neck were the most frequent locations of injury in flat racing; in jump racing, upper limb and lower limb injuries were predominant. Therefore, individual injury-prevention strategies may be required for flat- and jump-racing jockeys. Given the high-risk nature of horse racing, implementation of injury-prevention strategies is crucial for the health, safety, well-being, and overall performance of jockeys. A decision tree model (similar to that completed in Australia<sup>23</sup>) quantifying the effects of implementing different injury-prevention and safety interventions on fall and injury incidences in Irish horse-racing jockeys and the costs associated with them should be examined. Further research to establish injury risk factors, address the design and feasibility of injury-prevention intervention strategies, and assess their effects on the incidence of falls and injury risk in Irish jockeys are required.

## ACKNOWLEDGMENTS

This research was supported by the Irish Turf Club. We acknowledge the support of the Turf Club medical officers who gathered the valuable data at the various race meetings.

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