Descriptive epidemiology of veterinary events in flat racing Thoroughbreds in Great Britain (2000 to 2013)

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Ethical animal research

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Abstract

Background: To date, no large scale studies have reported race-day events requiring veterinary attention in British Thoroughbreds racing on the flat. Quantifying and describing common injuries and health conditions affecting racehorses will enable targeted risk factor analysis aimed at reducing their occurrence.

Objective: To describe the type and incidence of race-day veterinary events experienced by Thoroughbred racehorses participating in flat racing in the United Kingdom.

Study design: Retrospective cohort study (2000 to 2013).

Methods: Veterinary events recorded by race-day veterinarians were retrieved and linked to race start data. Race-day veterinary events were described by type, location and anatomical structure(s) affected and whether the outcome was fatal or not. Incidence per 1000 starts was calculated, both overall and by year. Stratified incidence rates were calculated for selected event categories by specific course- and horse-level variables.

Results: There were 7,993 events experienced by 6,727 horses, with an incidence of 9.37 events per 1000 starts. Soft tissue injuries other than tendon and ligament injuries were the most commonly occurring veterinary events (24.1%), followed by gait observations (21.2%) and respiratory conditions (21.2%). In total, 13.8% of events were bone injuries. The incidence of fatality (n=628) was 0.76 per 1000 starts. Most (485/628, 77.2%) fatal events were bone injuries, 64 were due to cardiac conditions and 54 due to tendon and ligament injuries. All-weather tracks had a higher incidence of veterinary events and fatalities than turf tracks. Firmer (turf) or faster (all-weather) going were associated with a higher incidence of all veterinary events.

Main limitations: Events were based on presumptive, rather than definitive veterinary diagnosis.

Conclusion: The most common events experienced by racehorses on race-day were relatively minor and not career-ending. Although more severe bone, joint, tendon and ligament injuries were less common, they had a greater impact on whether the outcome of the event was fatal.

Introduction

Injuries to the musculoskeletal system are the most common reason for fatality on race-day worldwide [1-4]. In flat racing in Great Britain, a fatality incidence of 0.8 per 1000 starts [5] has been reported, with 3.07 limb injuries per 1000 starts [4]. Sudden death in apparently healthy Thoroughbred racehorses, and where death was not attributed to catastrophic injury, has been reported at between 0.07 and 0.09 per 1000 flat racing starts [1; 6].

A number of studies have described the incidence of specific injuries or conditions in racehorse populations [7-10] or have focused specifically on fatality [1-4]. While impact of racehorse fatality on horse welfare, jockey safety and the public perception of the racing industry is widely acknowledged, less is known about non-catastrophic injuries. In Thoroughbred racehorses worldwide, injuries are one of the main reasons for retirement from racing [10; 11]. Similarly, respiratory and cardiac conditions can lead to poor racing performance, retirement from racing or death [1; 4; 12]. However, to date, no large scale studies have specifically investigated the injuries and conditions experienced by flat racing horses on race-day. It is essential to describe and quantify the occurrence of events where the horse required veterinary attention in order to elucidate risk factors and evaluate the effectiveness of subsequent interventions. Therefore, the objectives of the current study were to describe the incidence and distribution of different veterinary events occurring on flat race-days in Great Britain over 14 years.

Methods

Study design, period and population

A retrospective cohort study of Thoroughbreds racing in flat races between 1st January 2000 and 31st December 2013 in Great Britain was conducted. The study population consisted of all horses declared to race in at least one flat race during the study period. The declaration to race is confirmed 45 minutes prior to the start of the race and all horses declared to race were in attendance at the racecourse at this time. Flat race meetings were held at 35 turf tracks and five all-weather tracks.

Data collection

As part of normal race-day procedure, official racecourse veterinarians recorded events where horses present at the racecourse required and received veterinary attention, including injuries, medical and other conditions. Veterinary event reports were primarily based on clinical examination without further diagnostic investigations (presumptive diagnosis). Events were recorded on race-day into the British Horseracing Authority's (BHA) injury database. Additional data, including horse demographics, race and course information for all horses declared to start in a flat race during the study period were collated from the Weatherbys racing database (www.weatherbys.co.uk). A custom-designed (SQL) database was created for the study reported here, to combine the race starts and injury files, linking records by horse and race identification numbers.

Veterinary events

A veterinary event was defined as any event involving a horse that required veterinary attendance on race-day and for which a report was generated in the BHA database. One veterinary event could include multiple diagnoses and include more than one medical condition and/or injury type and/or could affect multiple body regions. Veterinary events were categorised as: bone injuries, joint injuries, tendon and ligament injuries, other soft tissue injuries, gait observations, cardiac, respiratory, metabolic and digestive, or miscellaneous conditions. Events were not mutually exclusive,

so multiple diagnoses were classed across different categories, as appropriate. The bone injury category comprised all injuries that affected bone, including fractures and possible fractures. Joint injuries were all injuries to joints including dislocation and effusion but excluding fractures (which were classed in the bone injury category). Other soft tissue injuries included those affecting the skin and muscles; wounds and lacerations, punctures, haematomas and muscle strains. The category 'gait observations' included lame horses or those with poor/abnormal action, but where no further diagnosis was made. Gait observations also included horses with stringhalt and shivers. Metabolic and digestive conditions included colic, choke, myopathy ('tying up'), fatigue, prolonged recovery and distress. Miscellaneous conditions included allergies and skin conditions unrelated to injury (e.g. ring worm and rain scald). Where appropriate, veterinary events included information regarding the anatomical structure or body region affected. Veterinary events with a fatal outcome were defined as events which resulted in the death or euthanasia of the horse on race-day, henceforth called fatality.

Data analysis

The total number of starts per horse and starts per year were summarised as median and interquartile range (IQR). A horse was deemed to have made a start when it was successfully loaded into the starting gate, so one horse could start in multiple races during the study period. Horses that were declared to race but did not race on that day were described as withdrawn.

Veterinary events and the outcome of veterinary events (fatal or not) were described as counts and percentages, by event category and by injury types/conditions within each category. Where appropriate, events were described by the location on the body where they occurred; distal limb, proximal limb, or other body areas. Bone, joint and tendon and ligament injuries were further described by the anatomical structure(s) affected.

Incidence was calculated as the number of events per 1000 starts for the overall study period and by year, both for all veterinary events and for specific event categories. Stratified incidence rates

were calculated for selected event categories by surface (turf vs all-weather), going (for turf; heavy, soft, good to soft, good, good to firm, firm and hard and for all-weather; slow, standard to slow, standard, standard to fast, fast), sex (male vs female) and age group (in years; 2, 3, 4, 5, 6, 7 and 8 plus). Withdrawn horses were not included in either the numerator or denominator for incidence rate calculations.

As the study included the entire population of flat racehorses over the study period, the precision for the incidence rates were not calculated. All analyses were conducted in Stata version 11[1].

Results

Over the 14-year study period there were 67,670 horses making 806,764 starts and 4,303 withdrawals in 77,336 flat races. Horses that started had a median of 7 (IQR 4 to 14) starts per horse; the maximum was 231 starts. The median number of starts per year was 59,010 (IQR 54,309 to 60,087). Races were held over 11,412 race-days. In total, 51,574 races were run on turf surfaces and 25,762 on all-weather tracks.

Table 1 summarises the number and incidence of race-day veterinary events over the study period. There were a total of 7,993 recorded veterinary events and 437 horses with veterinary events were withdrawn prior to racing. Veterinary events involved 6,727 horses over 7,316 individual races and across 5,069 race-days. The overall incidence of veterinary events was 9.37 per 1000 starts.

Bone injuries

The incidence of bone injuries was 1.32 per 1000 starts. In 41 events, horses with bone injuries were withdrawn. Most bone injuries were described as fractures, comminuted fracture, compound

[1] StataCorp. 2009.*Stata Statistical Software: Release 11*. College Station, TX: StataCorp LP.

fracture or possible fractures (n=1,045; 94.2%). Sixty-eight bone injuries did not specify the type of bone injury that had occurred and seven bone injuries included more than one description of fracture type.

Distal and proximal limb injuries accounted for 641 (57.8%) and 336 (30.3%) bone injuries, respectively (Table 2). Five veterinary events described bone injuries in two locations and 10 distal limb events included more than one bone. On the distal limb, the third metacarpal or metatarsal (MC3/MT3) bone were the most commonly affected structures (n=261; 40.7%). Most proximal limb fractures (67.3%; n=226) were of the pelvis.

Joint injuries

The incidence of joint injuries was 0.18 per 1000 starts; 13 horses with joint injuries were withdrawn. Most joint injuries were strains (n=72; 45.3%), followed by enlargements and effusions (n=32; 20.1%), dislocations (n=25; 15.7%), unspecified joint injuries (n=27; 17.0%) and penetration injuries (n=3; 1.9%). The fetlock and carpus were affected in 64.5% (n=102) and 22.0% (n=35) of joint injuries, respectively. Other structures affected included the sacroiliac joint (n=7; 4.4%), hock (n=5; 3.2%), stifle (n=3; 1.9%) and pastern (n=3; 1.9%).

Tendon and ligament injuries

The incidence of tendon injuries was 0.61 per 1000 starts; two horses with tendon and ligament injuries were withdrawn. Most tendon and ligament injuries were to the superficial digital flexor tendon (SDFT; n=365; 74.2%), followed by the suspensory ligament (n=84; 17.1%). Other structures affected include, tthe deep digital flexor tendon (DDFT; n=25; 5.1%), Achilles mechanism (n=10; 2.0%), check ligament (n=9; 1.8%) and sesamoidean ligament (n=8; 1.6%). In 18 tendon and ligament injuries the affected structure was not listed. In 26 (5.3%) events, more than one tendon or ligament was affected; DDFT and SDFT (n=13), DDFT, SDFT and suspensory ligament (n=1), suspensory

and SDFT (n=1). All injuries of the Achilles mechanism (n=10) and one injury of the sesamoidean ligament included injury to the SDFT as well.

Overall, 210 (42.7%) tendon and ligament injuries were reported as moderate strains, 152 (30.9%) as severe strains or ruptures, 62 (12.6%) as slight strains. In 33 (6.7%) cases the tendon or ligament was severed, 15 (3.0%) were reported as lacerations and 20 (4.0%) as other types of injury.

Other soft tissue injuries

A total of 178 horses with other soft tissue injuries were withdrawn and the incidence of other soft tissue injuries was 2.17 per 1000 starts. The majority (n=1,349, 70.0%) of other soft tissue injuries were lacerations and wounds, 291 (15.1%) were inflammation or soreness, 97 (5.0%) were bruises or haematomas, 52 (2.7%) were muscle strains, 45 (2.3%) were punctures and 27 (1.4%) were other types of injuries. In 69 (3.6%) cases the affected structure was not recorded. Most of the other soft tissue injuries occurred in the distal limb (n=1,157; 60.1%) and 17.6% (n=399) in the proximal limb.

Gait observations

'Gait observations' were recorded in 1,698 veterinary events. In 1,532 (90.2%) of these, horses were reported as lame, poor movers, unlevel or stiff. The incidence of gait observations was 1.90 per 1000 starts (Supplementary Table 1).

Cardiac, respiratory, metabolic or digestive and miscellaneous conditions

There were a total of 283 cardiac events, the majority were dysrrhythmias (n=166; 58.6%), followed by vascular catastrophe (n=67; 23.7%). Twenty-one percent (n=1,698) of veterinary events were recorded as respiratory conditions; most were episodes of epistaxis (n=1,026; 60.5%) with an epistaxis incidence of 1.25 per 1000 starts. In 165 (9.7%) events, horses underwent airway endoscopy and blood and/or mucopus was present; in 97 (5.7%) events, horses underwent airway endoscopy but no abnormalities were detected. Metabolic and digestive conditions were reported in 370 (4.6%)

events. There were 388 other veterinary events. Supplementary Table 1 provides a more detailed summary of cardiac, respiratory, metabolic and digestive conditions.

Fatalities

In total, 628 (7.9%) events had a fatal outcome, 18 of which occurred prior to the horse starting in a race. The incidence of fatality was 0.76 per 1000 starts (Table 1). The most common cause of fatality was bone injury (n=485; 77.2%), followed by cardiac conditions (n=64; 10.2%). The distribution of fatal bone injuries is summarised in Table 2. Fatal cardiac conditions were described as vascular catastrophe in 62 cases; the other two did not have further details recorded. All eight respiratory fatalities were attributed to epistaxis. Two fatalities were reported in the 'other' category; one fatality was due to concussion and one due to a neurologic condition. Seventeen events with a fatal outcome had more than one condition and/or injury listed.

Stratified incidence rates

Table 3 summarises the incidence of veterinary events by categories of selected events and outcome, stratified by sex, age, surface and going. All stratified incidence rates were higher on all-weather tracks compared to turf tracks. Hard and firm, standard to fast and fast going had a higher incidence of all types of events for turf and all-weather surfaces, respectively. The incidence of veterinary events overall decreased with increasing age but rates of tendon and ligament injury, epistaxis and fatality tended to increase with older age. The incidence of bone injury was lowest in two-year-olds and highest in three-year-olds. Figure 1 summarises incidence rates by year for all categories of veterinary events over the study period.

Discussion

This large-scale study has, for the first time, described the type and incidence of veterinary events reported during race-days in flat racing Thoroughbreds in Great Britain. Soft tissue injuries other than to tendon or ligament structures, lameness with no further diagnosis and respiratory conditions were most commonly reported race-day events although none of these were associated with substantial fatality rates. Whilst bone injuries comprised a relatively small proportion (14%) of all race-day veterinary events, nearly half of these (44%) had a fatal outcome and the majority of fatalities (77%) were associated with bone injuries. The overall incidence of fatality in this study of 0.76 per 1000 starts was similar to previously reported fatality rates in British flat racing of between 0.8 and 0.9 fatalities per 1000 starts [2; 5], suggesting that fatality rates in flat racing have remained relatively stable in the past decade. However, they remain substantially lower than fatality rates in jump racing, which have been reported as 4.9 and 6.7 fatalities per 1000 starts for hurdle and steeplechase races, respectively [13].

Many veterinary events were classed as 'gait observations', where horses were examined for lameness but where no conclusive diagnosis was achieved. In a study of 1,002 lame racehorses that underwent nuclear scintigraphy at two equine hospitals in North America, 19% had stress fractures [14]. It is arguable that further diagnostic investigation of the horses classed with 'gait observations' in the current study would have revealed underlying pathology that would have allocated the veterinary event to a different category and, as a result, the incidence of bone, joint or tendon injuries reported here may reflect conservative estimates. Lame horses are likely to have undergone further investigations when they returned home after racing, although this information was not available for the study and is not reported here.

The more severe veterinary events were bone, joint, tendon and ligament injuries, and most of these injuries occurred in the distal limb. The structures most commonly affected were the third metacarpal or third metatarsal, proximal phalanx, carpus, tarsus, sesamoid bones, SDFT and the

fetlock joint which is comparable to previous studies in the racing population in Great Britain [2; 15; 16]. The combined incidence of bone, joint and tendon and ligament injury in the current study was lower than a previously reported estimate of 3.07 (95% CI 2.78 to 3.37) per 1000 flat racing starts for all types of limb injury [4], although it is not exactly clear what types of limb injury were included in the previous study and therefore whether estimates are directly comparable. The incidence of tendon and ligament injuries in the current study (0.61 per 1000 starts) appeared to be slightly lower than reported previously in Great British flat racing horses at 0.78 (95% CI 0.63 to 0.93) per 1000 starts [4], although the latter study was smaller and thus the incidence estimate may be less precise. Overall, the incidence of tendon and ligament injuries in flat racehorses is much lower compared with horses starting in National Hunt races, with an incidence of 6.11 and 6.30 per 1000 starts for hurdles [7] and steeplechase racing [8], respectively, due to the increased loading of limbs over jumps [12].

Similarly, the incidence of epistaxis remains much lower in flat racing than in jump racing; 1.25 per 1000 starts in the current study compared to 3.6 and 5.3 per 1000 starts for hurdles and steeplechasing respectively, over a similar time period (2000 to 2009) [9]. Race type has previously been identified as a risk factor for epistaxis, with horses involved in jumps races at a higher risk, due in part to the increased loading on the forelimbs due to jumping [12]. However, regardless of race type, the incidence of epistaxis (1.25 per 1000 starts in the current study) seems to have increased compared to previously reported estimates of 0.33, 1.26 and 2.11 episodes per 1000 flat, hurdles and steeplechase starts, respectively [4; 12]. Newton *et al.* [12] hypothesised that the incidence reported was likely to be an underestimate of the total number of horses experiencing epistaxis on race-day, as horses that win or place and/or horses with poor performance would be under greater veterinary observation than other horses. It is likely however that under-reporting of epistaxis also affected incidence estimates in the current study and so this may only partly explain the higher rates recorded. Future risk factor analysis for epistaxis may identify underlying risk factors that could help to explain the reported increase in this condition.

The observed incidence of injuries and fatalities varied by surface, sex, age and going. For all injuries and fatalities, incidence rates were higher on all-weather tracks compared to turf tracks, and on firmer and faster turf and all-weather going, respectively. This observation is consistent with findings in previous studies assessing risk factors for epistaxis [9; 12], tendon injury [7; 8] and fatality [2]. The general trend for increasing rates of tendon and ligament injury, epistaxis and fatality with increasing age seen in this study is also consistent with findings in previous studies [17]. Although the incidence of bone injury was lowest in two-year-olds and highest in three-year-olds, previous studies using multivariable risk factor analysis have not identified associations between age and fracture [16; 18]. It would therefore be inappropriate to draw conclusions about potential associations between age and bone injury based only on the descriptive incidence rates reported here. Similarly, although the incidence of tendon and ligament injuries, epistaxis and fatality were higher in male horses whereas females had a higher incidence of bone injuries, it would be prudent not to draw conclusions about potential sex effects without conducting further multivariable analyses. Previous studies identifying risk factors for tendon injuries in National Hunt racehorses in racing and training did not identify differences between males and females in multivariable analyses [7; 8; 19] although in a Hong Kong-based study, male horses were more likely to sustain SDFT injury than females [10]. Similarly, although sex was not found to increase the risk of metacarpal or metatarsal joint fractures in some studies [20], in others, male horses were more likely to sustain a fracture [21; 22]. Further multivariable analyses will enable quantification of the associations between the stratification variables reported here and specific outcomes, when adjusted for the effects of potential confounders.

Over the 14-year study period the incidence of some conditions, particularly gait observations and respiratory conditions seemingly increased from 2004 onwards, while the incidence of fatalities, joint and tendon and ligament injuries remained relatively stable. In 2004, the BHA's injury database moved to entirely electronic recording of events, which became rigorously enforced. Increased reporting is a likely explanation for the apparent rise in less severe veterinary events over the study

period, whereas it is likely that more severe veterinary events would have been reported regardless of the method of recording. The incidence of bone injuries, which fluctuated between 2000 and 2006, increased from 2007. This apparent increase requires further investigation, given the severity of type of veterinary event and associated fatality rate.

The categorisation of veterinary events was based on race-day reports and the pro-forma recording systems developed by the BHA and, given the limited diagnostic facilities on British racecourses, it is likely that some reported injuries or conditions were misclassified. Many of the veterinary events described were based on the signs identified during a clinical examination (presumptive diagnosis) rather than on a definitive diagnosis. Further diagnostic techniques were used in some cases, although it was not always clear from the records why these occurred and some resulted in no abnormal findings being reported (e.g. in 97 veterinary events, horses categorised as having a respiratory condition, underwent endoscopic examination but no abnormalities were detected). Also, horses could leave the racecourse before an injury was diagnosed, even when it was sustained during racing. Some events, like tendon and ligament injuries, may have been under-reported, or misclassified based on the presenting signs at the time of the event [10]. Consequently, it is likely that incidence rates reported here, particularly for less severe events, are under-estimates of the true incidence.

Bone injuries reported as fractures may also have been misclassified to some extent. Reardon *et al.* [23] reported that race-day veterinarians correctly identified that a horse had a fracture on greater than 90% of occasions. However the correct recording of at least one of the fractured bones occurred on between 65% and 90% of occasions, based on subsequent post mortem examination. Additionally, between 5% and 6% of injuries reported as fractures were not fractures but, most commonly, suspensory ligament rupture or sesamoidean ligament damage. The authors reported that injuries in these misclassified cases were still severe enough to justify euthanasia. Given that the current study has utilised the same data recording methods, albeit over a longer time period, similar

misclassification errors would be expected. The routine availability of basic diagnostic facilities on British racecourse would reduce the potential for misclassification of veterinary events and increase the accuracy of incidence rate estimates. Furthermore, ability to access on-course diagnostic facilities to aid in the diagnosis of injury could improve the prognosis for non-catastrophic injuries, in particular fractures [24]. However, there are issues associated with this including the practicality, costs and lack of infrastructure on-course.

This study has identified the most commonly occurring race-day veterinary events for flat racing Thoroughbreds in Great Britain. Soft tissue injuries other than tendon or ligament injuries were most commonly reported, followed by gait observations and respiratory conditions. The incidence of bone injuries was lower, but these were associated with the highest incidence of fatality, followed by cardiac conditions. The findings from this study will now inform further multivariable statistical analysis to determine modifiable risk factors for selected outcomes, in particular injuries. The results also provide a baseline against which to measure the effect of potential interventions aimed at reducing injury and fatality occurrence in flat racing in Great Britain.

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Conflict of interest

The authors report no conflict of interest.

Figure 1 – Incidence of veterinary events experienced by flat racing Thoroughbreds in Great Britain as reported by race-day veterinarians (2000 to 2013), by year. (A) Bone, joint and tendon and ligament injuries, (B) Respiratory conditions, gait observations and soft tissue injuries (other than to tendon or ligament structures), (C) Cardiac, metabolic and digestive and other conditions, (D) Fatalities.

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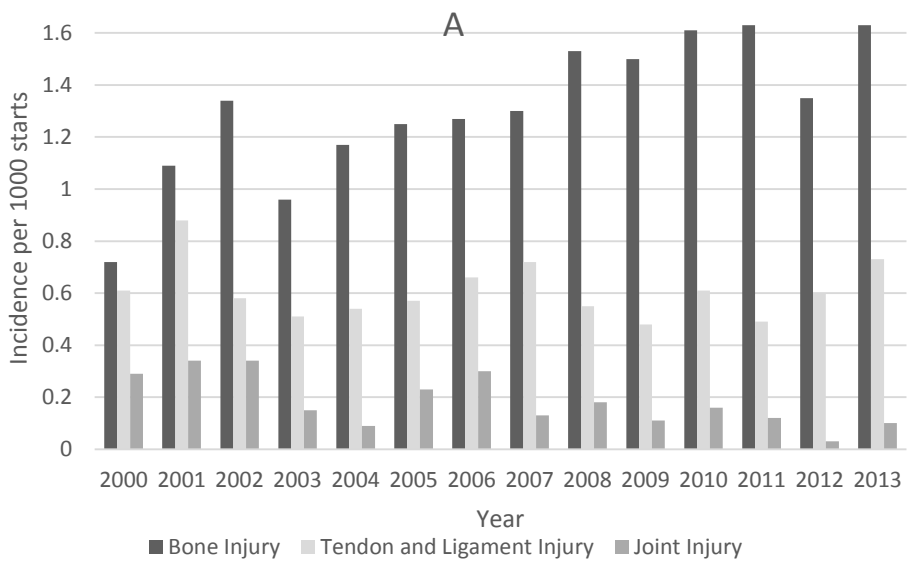
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Incidence per 1000 starts
1.6
1.4
1.2
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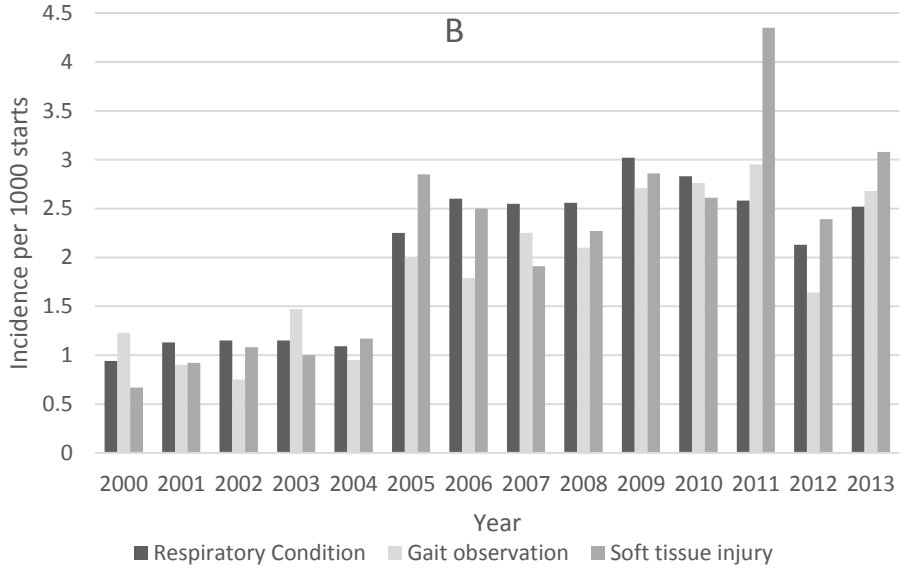
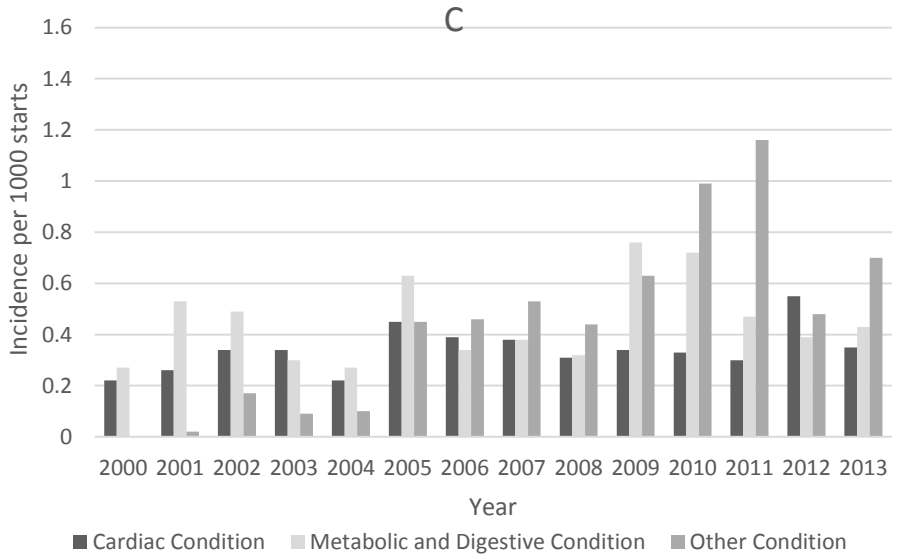
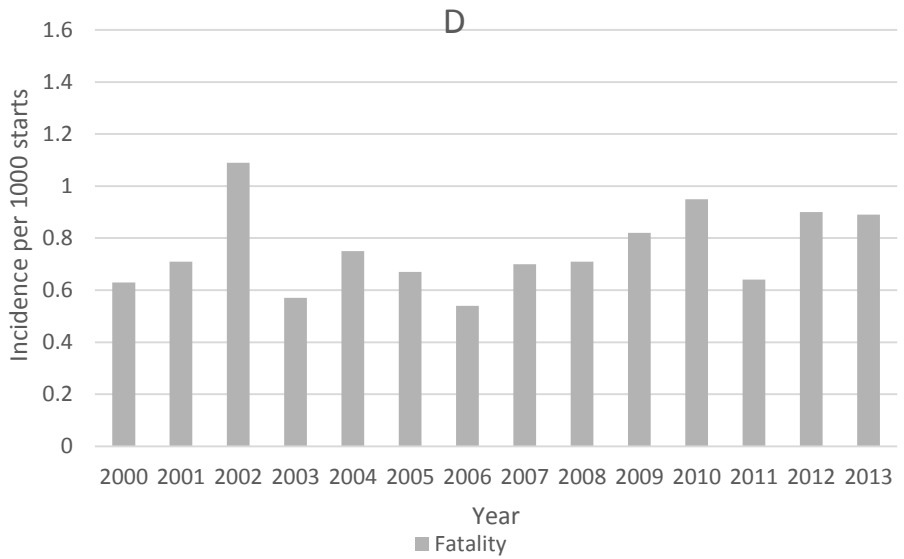
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Bone Injury
Tendon and Ligament Injury
Joint Injury


B
Incidence per 1000 starts
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Respiratory Condition
Gait observation
Soft tissue injury


C
Incidence per 1000 starts
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Cardiac Condition
Metabolic and Digestive Condition
Other Condition


D
Incidence per 1000 starts
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Fatality