

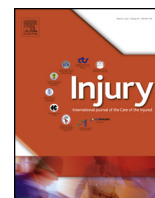


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## The changing epidemiology of open fractures in vehicle occupants, pedestrians, motorcyclists and cyclists

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### ARTICLE INFO

#### Keywords:

Road traffic accidents  
Open fractures  
Epidemiology  
Gustilo classification

### ABSTRACT

**Aims:** To investigate the changing epidemiology of open fractures in vehicle occupants, pedestrians, motorcyclists and cyclists.

**Materials and methods:** Data on all non-spinal open fractures admitted to the Royal Infirmary of Edinburgh after a road traffic accident between 1988 and 2010 were collected and analysed to provide information about the changing epidemiology in different patient groups. Demographic information was collected on all patients with the severity of injury being analysed with the Injury Severity Score (ISS), Musculoskeletal Index (MSI) and the number of open fractures. The severity of the open fractures was analysed using the Gustilo classification. The 23-year study period was divided into four shorter periods and the results were compared.

**Results:** There were 696 patients treated in 23 years. Analysis showed that the incidence of RTA open fractures initially fell in both males and females and continued to fall in females during the 23 years. In males it levelled off about 2000. The age of the female patients also fell during the study period but it did not change in males. The only patient group to show an increased incidence of open fractures were cyclists. In vehicle occupants the incidence fell throughout the study period but it levelled off in pedestrians and motorcyclists. There was no difference in the severity of injury in any group during the study period. The most severe open fractures were those of the distal femur and femoral diaphysis although open tibial diaphyseal fractures were the most common fracture in all patient groups.

**Conclusions:** Improved car design and road safety legislation has resulted in a reduction in the incidence of open fractures in vehicle occupants, pedestrians and motorcyclists. The most obvious group to have benefitted from this are older female pedestrians. The only group to show an increase in age during the study period were male motorcyclists.

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### Introduction

The epidemiology and effects of road traffic accidents are changing rapidly. The World Health Organisation has reported that every year 1.25 million people die in road traffic accidents and that 75% of them are male [1]. However, a recent study of global progression in road injury mortality since 2010 has shown that the global age-adjusted mortality decreased significantly between 2010 and 2013 with the rate changes varying from –1.43% to –0.99%. The decrease was greater in developed countries than in developing countries and there were substantial disparities

between countries [2]. A good example is Germany where it is reported that mortality decreased from nearly 20,000 in 1970 to 3368 in 2014 [3]. This decrease has been mirrored in Scotland where a 35% decrease in road traffic accidents between 2004 and 2008 and 2016 has been recorded [4].

Road traffic accidents also cause significant morbidity in addition to mortality. A review of the Edinburgh fracture databases showed that in 2000 the incidence of non-spinal adult fractures in road traffic accidents was 69/10<sup>5</sup>/year but it had dropped to 61.4/10<sup>5</sup>/year in 2010/2011. In an earlier study we showed that the incidence of adult open fractures following road traffic accidents diminished between 1988 and 2009, but the prevalence of Gustilo type III fractures remained unchanged [5]. However, there is virtually no information about the changing epidemiology of open fractures in the different people who are involved in road traffic accidents, namely vehicle occupants, pedestrians, motorcyclists

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and cyclists. We hypothesised that the incidence of open fractures had probably fallen in vehicle occupants and pedestrians, but had probably increased in cyclists.

**Patients and methods**

The data relating to all open fractures in adults caused by road traffic accidents in the City of Edinburgh, East Lothian and Midlothian were collected. Before 2005 the data was collected prospectively and after this time it was collected retrospectively from the hospital’s computerised database. The Royal Infirmary of Edinburgh is the only hospital treating adult fractures in its catchment area. In this study, we also included local residents who were injured outside our catchment area, but treated in the Royal Infirmary of Edinburgh. We excluded patients who were injured in the catchment area, but were resident outside this area. The study only included adults (≥15 years) as all younger patients are treated in a separate children hospital. We did not analyse spinal fractures because severe spinal fractures are treated in the National Spinal Hospital.

Demographic information was collected on all patients. This included the name, address, date of birth, gender, date of injury, mode of injury, type of fracture, degree of soft tissue injury and the presence of other injuries. The severity of the soft tissue injury was assessed using the Gustilo classification [6,7] and the overall severity of injury was assessed using the Injury Severity Score (ISS) [8], this being derived from the Abbreviated Injury Scale (AIS) [9] of each fracture. There is some debate about the relevant AIS for open fractures, as opposed to closed fractures, but in this analysis we have used an AIS of 3 for all long bone fractures, 2 for all carpal, hindfoot, midfoot and metatarsal fractures and 1 for all finger and toe phalangeal fractures. An AIS score of 1 was given for all Gustilo type I and II open fractures and a score of 2 was given for all Gustilo type III fractures. An isolated Gustilo type I open finger fracture was given a total AIS of 2, whereas a Gustilo IIIB open tibial fracture was given an AIS of 13. The ISS was calculated by adding the squares of the three highest AIS scores in each patient.

Each severe musculoskeletal injury was analysed to provide a Musculoskeletal Index (MSI). All fractures and severe soft tissue injuries, such as ligamentous disruptions, dislocations, nerve damage and tendon injuries were given a score of 1 and the total was used to provide an assessment of the degree of musculoskeletal injuries. Minor joint sprains and soft tissue injuries were excluded from analysis. In addition, the number of open fractures in each patient was recorded.

The patients who had open fractures following road traffic accidents were divided into vehicle occupants, pedestrians, motorcyclists and cyclists. The change in the epidemiology of RTA open fractures in these groups with time was analysed by dividing the study years into four periods, these being 1988–1993, 1994–1999, 2000–2005 and 2006–2010. Fracture incidence was calculated by averaging the appropriate yearly population counts for Edinburgh, Midlothian and East Lothian.

The study was considered to be audit and therefore permission from the Hospital ethical committee was not required.

**Results**

Between 1988 and 2010 there were 696 open fractures associated with a road traffic accident. Analysis showed that 70.2% occurred in males with an average age of 37.2 years and 29.7% occurred in females with an average age of 51 years. The gender and age distributions for the five periods that were analysed are shown in Table 1. It shows that there has been a steady decline in the number of RTA open fractures between 1988 and

**Table 1**

The numbers of patients with RTA open fractures in the different time periods.

	1988–2010		1988–1993		1994–1999		2000–2005		2006–2010	
	n	%	n	%	n	%	n	%	n	%
All patients	696		277		167		140		112	
Males	489	70.2	196	70.7	109	65.3	94	67.1	90	80.3
Females	207	29.7	81	29.2	58	34.7	46	32.9	22	19.6
Age (yrs)										
All patients	41.4		43.1		42.7		38.9		38.4	
Males	37.2		38.4		36.3		35.9		37.8	
Females	51.2		54.6		55.0		45.1		40.9	

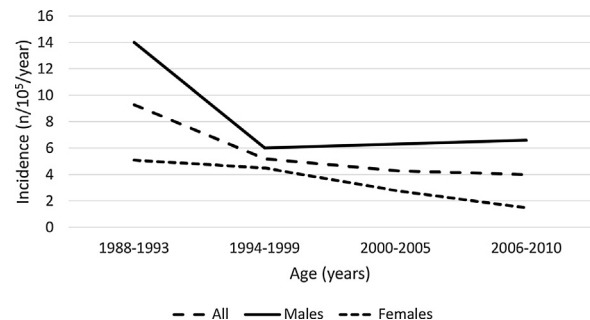
1993 and 2006–2010 and while the average age of males has not changed, there has been a decline in the age of females since 2000.

The overall incidence of RTA open fractures between 1988 and 2010 was 5.8/10<sup>5</sup>/year, with the incidences in males and females being 8.4/10<sup>5</sup>/year and 3.2/10<sup>5</sup>/year respectively. Fig. 1 shows that the incidence of RTA open fractures declined in males and females between 1988 and 1999, after which the decline in incidence continued in females, but levelled off in males. The male incidence declined from 14/10<sup>5</sup>/year in 1988–1993 to 6.6/10<sup>5</sup>/year in 2006–2010 with the equivalent incidences in females being 5.1/10<sup>5</sup>/year and 1.5/10<sup>5</sup>/year respectively.

The prevalence of RTA open fractures in the different patient groups is shown in Table 2. It shows that the commonest patient groups who present with open fractures are pedestrians and motorcyclists. Open fractures in motorcyclists are most commonly seen in males, whereas pedestrian open fractures most commonly occur in females. Open fractures associated with cycling are relatively uncommon, particularly in females. The greatest age difference between males and females can be observed in pedestrians and further analysis shows that 50.4% of female pedestrians were ≥65 years. Analysis of the changing age of the different patient groups with time showed no significant differences except in female pedestrians, where the average age declined from 62.1 years in 1988–1993 to 39.5 years in 2006–2010 and in male motorcyclists where the average age rose from 28.7 years in 1988–1993 to 35.6 years in 2006–2010.

The overall incidence of RTA open fractures in the different groups between 1988 and 2010 was 1.3/10<sup>5</sup>/year in vehicle occupants, 2.0/10<sup>5</sup>/year in pedestrians, 1.7/10<sup>5</sup>/year in motorcyclists and 0.4/10<sup>5</sup>/year in cyclists. Fig. 2 shows the changing incidence of RTA open fractures in the different patient groups between 1988 and 2010. The incidence in pedestrians and vehicle occupants has steadily declined, although in pedestrians it levelled off about 2005. In motorcyclists the incidence declined until 2000 and then levelled off, whereas in cyclists there has been a steady increase in the incidence of open fractures since 1988.

Figs. 3 and 4 show the changing incidence of open fractures with increasing age in the different patient groups. In male vehicle occupants (Fig. 3) the highest incidence of open fractures was seen



**Fig. 1.** The changing incidence of open fractures during the four time periods.

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