

# Deaths of cyclists in London 1985-92: the hazards of road traffic

Katie Gilbert, Mark McCarthy

## Abstract

**Objective**—To determine the characteristics of cyclists and vehicles involved in fatal cycling accidents.

**Design**—Analysis of data routinely collected by police for each accident from January 1985 to December 1992 and held in a national master file (Stats 19) by the Department of Transport.

**Setting**—Greater London, which comprises inner London (12 boroughs and the City of London) and outer London (20 boroughs).

**Subjects**—178 cyclists who died (78 in inner London and 100 in outer London; age range 3-88).

**Main outcome measures**—Associations between characteristics of cyclists, type of vehicle involved, and place of accident.

**Results**—Motor vehicles were involved in 173 deaths. Heavy goods vehicles were involved in 75 deaths (30/100 (30%) in outer London and 45/78 (58%) in inner London); cars in 74 (54/100) (54%) in outer London and 20/78 (26%) in inner London); light goods vehicles in 12/178 (7%); and buses in 6/178 (3%). Thirty five of the people who died were children aged  $\leq 16$ . Female cyclists were especially at risk from heavy goods vehicles in inner London (22 deaths), while male cyclists were especially at risk from cars in outer London (50 deaths).

**Discussion**—Cyclists who died in urban areas are more likely to be adults than children. In inner London, in relation to their traffic volume, heavy goods vehicles are estimated to cause 30 times as many cyclists' deaths as cars and five times as many as buses. Until the factors leading to this excess risk are understood, a ban on heavy goods vehicles in urban areas should be considered.

## Introduction

Cycling is environmentally clean and protects against coronary heart disease.<sup>1</sup> Many people, however, are frightened of cycling in towns and cities because of motor vehicle traffic.<sup>2</sup> In Britain in 1991 there were 242 deaths of cyclists, representing about 1 in 20 of all road deaths.

Targets for reductions in road casualties and road accident deaths have been set by the Department of Transport and the Department of Health respectively.<sup>3,4</sup> So that realistic policies to reduce the number of deaths of cyclists can be formulated, information is needed on how these deaths occur.

Because deaths of cyclists are relatively rare, studies based on data from accident and emergency departments have included few or no such deaths.<sup>5-7</sup> The findings on the circumstances of cyclists' deaths cannot be extrapolated readily to cover other accidents involving cyclists because different severities of injury are probably caused by different sorts of accident. Studies of cyclists' deaths in the United States,<sup>8,9</sup> Australia,<sup>10,11</sup> Sweden,<sup>12</sup> and New Zealand<sup>13</sup> have described the characteristics of cyclists and their injuries, but few have considered the type of motor vehicle involved. We used data for London in a preliminary investigation of the circumstances of deaths of urban cyclists in Britain.

## Methods

In Britain road accidents resulting in injury must by law be reported to the police. For each reported case an accident report book is completed routinely by a police officer. Details from completed report books are coded by the police information processing unit for storage on a national master file of the Department of Transport known as Stats 19. Data for London are available to the public from the London Research Centre (81 Black Prince Road, London SE1 7SZ). Data in Stats 19 for accidents involving cyclists comprise the time, weather, age, and sex of the cyclist and a brief account of the circumstances; no details are stored about injuries sustained, use of a bicycle helmet or lamps, or alcohol concentrations of cyclists. Data on other people involved but not killed in the accidents are incomplete.

We assembled data from Stats 19 on fatal accidents involving a cyclist in greater London from January 1985 to December 1992. We divided data into two categories: inner London (comprising 12 boroughs and the City of London), which has a high density of buildings and had a population of 2 265 815 in 1991; and outer London (comprising 20 boroughs), a more suburban area with a population of 4 021 611 in 1991. Vehicles involved in these fatal accidents were classified in a standardised abbreviated form—for example, "heavy goods vehicle" indicated a goods vehicle  $>1.524$  tonnes unladen weight and "light goods vehicle" indicated a goods vehicle  $\leq 1.524$  tonnes unladen weight.

Routine statistical information—for example, national and local statistics on accidents<sup>3</sup>—is based on data held in the Stats 19 file. Random variation among police officers in recording accidents is reduced because the report books are used regularly, are clearly laid out, and only a few items have to be completed. A more important problem of systematic bias is that some road accidents, especially those involving cyclists, are not reported at all.<sup>6</sup> Police reports are probably completed more fully for accidents involving a death than for less serious accidents.

We sought to determine rates of use of different types of road transport in London to provide denominators. In the most recent survey in London, in 1991, 60 000 (2%) households were interviewed about their use of transport.<sup>13a</sup> Results are available from the London Research Centre and the Department of Transport.

Accurate information on the exposure of cyclists to other road traffic is lacking, but some assessment can be made from data in the London Traffic Monitoring Report.<sup>14</sup> This report includes the results of traffic counts across three cordons—central, inner, and boundary cordons. The central cordon, which surrounds an area within a radius of 3 km from Aldwych, is monitored annually; but the inner cordon, which corresponds roughly to the boundary of the former London County Council, and the outer cordon, which corresponds roughly to the boundary of the former Greater London Council, are monitored every three years. The inner cordon separates approximately the inner and outer London boroughs. Traffic counts are taken for six minutes one to four times an hour between 0700 and 1900 at any point at which a road crosses a

Public Health, Camden and Islington Health Authority, London NW1 2LJ

Katie Gilbert, research assistant

Mark McCarthy, director of public health

Correspondence to: Dr McCarthy.

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cordon. Twenty four hour counts are taken on a sample of roads. The volume of traffic and the type of vehicle are recorded.

## Results

### CHARACTERISTICS OF DEATHS

In all, 178 deaths of cyclists were recorded by the police in greater London from 1985 to 1992; 78 occurred in inner London and 100 in outer London. Data on age were not available for two of the male deaths in inner London. Most (134) of the deaths were of males; 28 (36%) of the deaths in inner London were of females compared with 16 (16%) in outer London. The distribution of deaths by age in inner London (range 8-80 years) was unimodal, dominated by adults aged 20-39, but in outer London (range 3-88) it was bimodal, the largest proportion being of children and adolescents and of older people (table I). Thirty five of the cyclists who died were aged  $\leq 16$ , 101 were men aged  $> 16$ , and 42 were women aged  $> 16$ .

### VEHICLES INVOLVED

Almost all (173) of the deaths involved a motor vehicle (table II). Four cyclists, however, died without a vehicle or pedestrian being involved and one died after a collision with a pedestrian. The main motor vehicles involved were heavy goods vehicles and cars. Heavy goods vehicles were involved in 75 of the deaths (30 (30%) of the deaths in outer London and 45 (58%) in inner London). Cars were involved in 74 deaths (54 (54%) of the deaths in outer London but only 20 (26%) in inner London). Few deaths were associated with light goods vehicles (12), public service vehicles (buses and coaches) (six), or other motor vehicles including motorcycles.

Twenty two (28%) of the cyclists who died in inner London were women who were in collision with a heavy goods vehicle, compared with only eight (8%) in outer London. Fifty (50%) of the deaths in outer London were of male cyclists in accidents involving a car, compared with 17 (22%) in inner London.

According to the surveys for 1986-90 reported in the *London Traffic Monitoring Report 1992*,<sup>14</sup> bicycles account for on average 0.7% of all road traffic at the boundary cordon, 1.1% at the inner cordon, and 2.2%

TABLE I—Distribution of 178 deaths of cyclists in inner and outer London in 1985-92 by age and sex

Age (years)	Inner London (n=78)*			Outer London (n=100)		
	Males	Females	Total	Males	Females	Total
$\leq 9$	1		1	4		4
10-	9		9	25	3	28
20-	14	8	22	10	2	12
30-	9	13	22	9	2	11
40-	5	3	8	4	2	6
50-	4	2	6	15	3	18
60-	3	2	5	8	2	10
70-	2		2	7	2	9
80-9	1		1	2		2

\*Data on age not available for two male deaths.

TABLE II—Types of vehicle involved in collisions causing cyclists' deaths in London 1985-92

Vehicle	Inner London			Outer London			Greater London		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
Heavy goods vehicle	23	22	45	22	8	30	45	30	75
Car	17	3	20	50	4	54	67	7	74
Light goods vehicle	3	3	6	5	1	6	8	4	12
Public service vehicle (bus or coach)	3		3	2	1	3	5	1	6
Other motor vehicle	3		3	1	1	2	4	1	5
Motorcycle				1		1	1		1
No other vehicle	1		1	2	1	3	3	1	4
Pedestrian				1		1	1		1
Total	50	28	78	84	16	100	134	44	178

at the central cordon. In greater London medium and heavy goods vehicles together (classified as heavy goods vehicles by us) account for about 7% of traffic, light goods vehicles 10%, buses and coaches 2%, and cars 75%. We found, however, that from 1985 to 1992 these vehicles were involved in 42%, 7%, 3%, and 42%, respectively, of cyclists' deaths. In inner London medium and heavy goods vehicles account for about 6% of traffic, light goods vehicles 11%, buses and coaches 2%, and cars 72%. These vehicles were involved in 58%, 8%, 4%, and 26%, respectively, of cyclists' deaths.

### MANOEUVRES

Stats 19 provides only a limited description of the manoeuvres that contributed to the accidents, but it is possible, tentatively, to group some of the accidents together according to the manoeuvre. In 30 fatal accidents the vehicle turned left across the cyclist's path, and in all but one of these accidents the vehicle was a heavy goods vehicle. In a further four deaths both the vehicle and the cyclist were apparently turning left together.

Sixteen collisions occurred when the cyclist was on the nearside of a vehicle that was going straight ahead, 22 cyclists were hit from behind, and eight were said to have swerved into a vehicle's path. Of the 35 children aged  $\leq 16$  who died, 14 were struck by a vehicle after cycling off the pavement.

Four cyclists died after being hit by vehicle drivers opening their doors, and two were killed while cycling across zebra crossings. Alcohol intoxication in the driver was recorded as the main cause of the accident in only one of the 178 accidents.

### VARIATIONS WITH TIME

The annual number of deaths fell from 25 to 18 between 1985 and 1992. An exception to this trend, however, occurred in 1989, a year which showed a sharp increase in inner London; this increase might be related to more cyclists being on the roads because of the dry summer and strikes on the underground. Each year, and for 1985-92 as a whole, peaks in the number of deaths occurred in the summer and autumn. In outer London, accidents were evenly distributed over the week, but in inner London few fatal accidents occurred at weekends. Daily variation in the numbers of deaths was bimodal, with peaks between 0600 and 1000 (the main peak in inner London) and between 1200 and 1800 (the main peak in outer London).

### ENVIRONMENTAL CONDITIONS

Most fatal accidents occurred in dry conditions (151) and most occurred in daylight (half an hour before sunrise to half an hour after sunset) (137).

### OTHER FATAL ACCIDENTS INVOLVING CYCLISTS

In addition to the 178 accidents in which cyclists died, there were eight fatal accidents involving bicycles in which the cyclist did not die. Five pedestrians who were crossing the road died in collisions with cyclists. Two motorcyclists died after hitting cyclists, and one car driver had a cardiac arrest after being in collision with a cyclist.

## Discussion

Three issues arising from this analysis of deaths of cyclists in London require emphasis. Firstly, most deaths were of adults rather than children. Secondly, cyclists rather than drivers died in collisions between cyclists and vehicles. Thirdly, there was a particular danger, especially in inner London, from heavy goods vehicles.

Most cyclists dying in London are adults. The London area transport survey of 1991 indicated that 45% of the cyclists in London who cycled at least once a week were children aged 5-16<sup>13a</sup>; Stats 19 indicates that children aged  $\leq 15$  accounted for 21% of all reported accidents involving cyclists in greater London<sup>15</sup>; and our study indicates that only 20% of cyclists who died were aged 3-18. The rate of accidents and deaths involving child cyclists may not, therefore, be higher than that involving adult cyclists.

Studies of cycling accidents have tended to focus on child rather than adult cyclists.<sup>7-9 11 16 17</sup> In the United States cycling accidents were more common among children than adults until the 1990s,<sup>8 9 18</sup> but researchers and policymakers may also perceive that children are most obvious users of bicycles whereas adults use motor vehicles. A study of deaths of cyclists in northern Sweden showed that 22% occurred in children but that the median age at death was 60.<sup>12</sup> Although cycling accidents involving children remain important, more attention should be given to the circumstances and prevention of cycling accidents involving adults.

#### STRATEGIES FOR CYCLISTS

New policies are needed to meet the targets for a reduction in road accidents set by the Department of Transport and the Department of Health. Some public bodies—for example, the Royal Society for the Prevention of Accidents,<sup>19</sup> the Child Accident Prevention Trust,<sup>20</sup> and the Parliamentary Advisory Council for Transport Safety<sup>21</sup>—propose policies that restrict cyclists rather than motor vehicles. But a policy of more protection—for example, through the compulsory use of bicycle helmets—does not address the issue of the source of danger in accidents in which the injuries are severe or fatal.<sup>22 23</sup> In contrast, other bodies—for example, the Confederation of British Industry,<sup>24</sup> the British Medical Association,<sup>1</sup> and the Cyclists' Touring Club<sup>25</sup>—suggest that safety would be increased through restricting motor vehicle traffic, with more traffic free environments and safe bicycle tracks.

Motor vehicles, especially cars, constitute a hazard to health because of the possibility of accidents, because of air pollution, and because they inhibit exercise. Priority should be given to the use of bicycles in urban design and regulation.

#### DANGERS FROM HEAVY GOODS VEHICLES

Our study draws attention to the particular danger to cyclists from heavy goods vehicles. In Britain heavy goods vehicles are recorded as being involved in only 3% of all cycling accidents but being involved in 18% of deaths.<sup>3</sup> In London the impact of heavy goods vehicles is greater: during the period under review such vehicles were involved in almost a third of cyclists' deaths in outer London and almost two thirds of those in inner London. From the estimates of vehicle use in London, the risk of heavy goods vehicles being involved in accidents in which cyclists die in inner London can be estimated at five times that of buses, 14 times that of light goods vehicles, and 30 times that of cars.

The limited information available on vehicle manoeuvres showed that left turns by heavy goods vehicles were particularly hazardous. Turns are inevitably more common in inner urban areas, but buses in inner London were involved in far fewer accidents in which cyclists died than heavy goods vehicles. The danger from heavy goods vehicles, especially when compared with the danger from buses, may reflect either aspects of their design or less competence and awareness on the part of the drivers. The drivers of buses and heavy

### Clinical implications

- Cycling is healthy and should be encouraged, but the dangers to cyclists need to be reduced
- Most studies of cycling accidents and their prevention have described the victim rather than the cause of the accident
- Almost all cyclists' deaths in London are due to collision with motor vehicles, especially heavy goods vehicles
- Primary prevention of accidents involving cyclists could be achieved by reducing dangers from high risk vehicles

goods vehicles may also differ in the way they take risks.

The Transport and Road Research Laboratory studied the involvement of heavy goods vehicles in road traffic accidents in 1976.<sup>26</sup> It estimated that the number of deaths due to a cyclist being run over by the rear wheels of the vehicle could be reduced by the installation of guard rails. Although most heavy goods vehicles now have such rails, no published study has evaluated the effectiveness of these rails. Since October 1988 all lorries over 12 000 kg gross vehicle weight have had to have close proximity mirrors on the top of the nearside doors, angled down to reflect an image of the area around the front wheel. The effectiveness of these mirrors has not been evaluated.

The higher proportion of women cyclists who die in accidents involving heavy goods vehicles in inner London cannot be explained satisfactorily. A closer study is needed of the circumstances of collisions between buses and cyclists and between heavy goods vehicles and cyclists, with an examination of the characteristics of drivers as well as those of vehicles. The results should be reviewed and recommendations for prevention implemented. Until then, where orbital roads exist around towns and conurbations there are grounds for banning vehicles of over 1.524 tonnes unladen weight in urban areas.

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## Injury patterns in cyclists attending an accident and emergency department: a comparison of helmet wearers and non-wearers

C Maimaris, C L Summers, C Browning, C R Palmer

### Abstract

**Objectives**—To study circumstances of bicycle accidents and nature of injuries sustained and to determine effect of safety helmets on pattern of injuries.

**Design**—Prospective study of patients with cycle related injuries.

**Setting**—Accident and emergency department of teaching hospital.

**Subjects**—1040 patients with complete data presenting to the department in one year with cycle related injuries, of whom 114 had worn cycle helmets when accident occurred.

**Main outcome measures**—Type of accident and nature and distribution of injuries among patients with and without safety helmets.

**Results**—There were no significant differences between the two groups with respect to type of accident or nature and distribution of injuries other than those to the head. Head injury was sustained by 4/114 (4%) of helmet wearers compared with 100/928 (11%) of non-wearers ( $P=0.023$ ). Significantly more children wore helmets (50/309 (16%)) than did adults (64/731 (9%)) ( $P<0.001$ ). The incidence of head injuries sustained in accidents involving motor vehicles (52/288 (18%)) was significantly higher than in those not involving motor vehicles (52/754 (7%)) ( $\chi^2=28.9$ ,  $P<0.0001$ ). Multiple logistic regression analysis of probability of sustaining a head injury showed that only two variables were significant: helmet use and involvement of a motor vehicle. Mutually adjusted odds ratios showed a risk factor of 2.95 (95% confidence interval 1.95 to 4.47,  $P<0.0001$ ) for accidents involving a motor vehicle and a protective factor of 3.25 (1.17 to 9.06,  $P=0.024$ ) for wearing a helmet.

**Conclusion**—The findings suggest an increased risk of sustaining head injury in a bicycle accident when a motor vehicle is involved and confirm protective effect of helmet wearing for any bicycle accident.

### Introduction

The incidence of bicycle related injury and the resulting morbidity and mortality have serious economic implications in terms of provision of health care and lost working time. Admissions to hospital and deaths from bicycle related trauma are usually due to head injury.<sup>1</sup> Several studies of the use of cycle safety helmets report that they reduce head injuries,<sup>2,9</sup> and in a case control study the risk of head injury was significantly reduced if a helmet was worn.<sup>2</sup> The wearing of approved helmets by cyclists has been made compulsory in several states in Australia and the United States and recently in New Zealand. However, the prevalence of wearing cycle helmets remains low in Britain and in other countries,<sup>3,10</sup> despite various

campaigns aimed at encouraging their use, especially among the vulnerable teenage population.<sup>4</sup> Some authors have argued that cycle helmets are not effective in protection in collisions with motor vehicles,<sup>11-13</sup> while others have maintained that they are effective.<sup>14-16</sup> It has also been suggested that evidence of a lower risk of head injury in cyclists wearing helmets is flawed because such cyclists may be more cautious.<sup>10,11</sup> But, again, others have claimed that such cyclists feel less vulnerable and ride less cautiously, so that they are more likely to have an accident.<sup>13</sup>

The aims of this study were to assess all patients presenting in an accident and emergency department with bicycle related injuries and to compare the types of injuries sustained by those who wore helmets with the injuries of those who did not.

### Patients and methods

From 1 January 1992 to 31 December 1992 we prospectively collected data on all patients who attended the accident and emergency department of Addenbrooke's Hospital as a result of a bicycle accident. The information collected included age and sex, date and place of accident, and the nature of the accident—whether the accident involved a moving motor vehicle (car, lorry, bus, or motorcycle) or cycle, a pedestrian, or a stationary object or whether it was the result of simply falling off the machine. We also recorded details of helmet use at the time of the accident and helmet ownership; details of the injuries sustained, including the presence of a head injury; and details on follow up of patients, including the length of stay for those admitted to hospital.

In this study we recorded head injury if there was evidence of skull fracture, brain injury shown by computed tomography, or if loss of consciousness or post-traumatic amnesia was associated with important postconcussion symptoms (defined as persistent headaches, dizziness, nausea, vomiting, tiredness, or lack of concentration that required time off school or work or did not allow immediate resumption of normal activities). We did not regard simple scalp abrasions, lacerations, or contusions not associated with loss of consciousness or postconcussion symptoms as head injuries.

Patients admitted to hospital were followed up through hospital records, and any patient who had sustained a head injury but was not admitted was followed up by telephone inquiry for evidence of postconcussion symptoms. The assessors (CLS and CM) knew whether patients had worn helmets, but questions were standardised to minimise possible bias.

### STATISTICAL METHODS

Differences in the incidence of injuries between helmet wearers and non-wearers at the time of the

Accident and Emergency Department, Addenbrooke's Hospital, Cambridge CB2 2QQ

C Maimaris, consultant  
C L Summers, senior registrar  
C Browning, senior house officer

Department of Community Medicine, Institute of Public Health, University of Cambridge, Cambridge CB2 1TN  
C R Palmer, medical statistician

Correspondence to: Mr C Maimaris.

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