



# Families bereaved by road traffic crashes: linkage of mortality records with 1971–2001 censuses

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## ABSTRACT

**Objective:** To estimate the number of people alive in England & Wales who have lost a close family member in a fatal road traffic crash.

**Design:** Linkage of mortality records in a sample of 1.1% of the population during 1971–2005 with records from the 1971, 1981, 1991 and 2001 censuses. For each person killed in a road traffic crash, the number of close family members still alive in 2005 was estimated by applying life table probabilities of survival.

**Setting:** England & Wales, UK.

**Subjects:** Adults and children killed in road traffic crashes 1971–2005.

**Main outcome measure:** Number of close family members alive in 2005.

**Results:** In a sample of approximately 1.1% of the population in 1971–2005, a total of 1801 adults and children died in road traffic crashes. These deaths left 6467 close family members bereaved in 2005, corresponding to a total of 590 518 bereaved in the population (including 131 399 parents who had lost a child and 107 384 offspring who had lost a parent).

**Conclusion:** Over 1% of the population of England & Wales alive in 2005 had lost a close family member in a fatal road traffic crash since 1971. This may imply a greater public health burden of road traffic crashes than previously estimated.

Road traffic crashes (RTCs) kill 1.2 million people each year worldwide, and rank as one of the leading causes of the global burden of disease.<sup>1</sup> In the UK, RTCs account for about 3000 deaths each year, with ten times as many people left seriously injured or disabled.<sup>2</sup> Estimates of the cost per fatality in several high-income countries range from €1.2 million to €3.6 million (2004 price level).<sup>3</sup> Such estimates of the economic and societal costs of RTCs usually include lost productivity due to hospitalisation or death, but exclude other costs incurred by bereavement. This omission may be due to a lack of any reliable estimates of the number of people who are left to cope with the loss of a loved one.

Bereavement can impact on the health and well-being of those affected immediately after a death, as well as in the longer term. It forces individuals to relearn the way they think about, plan for, and cope with the problems of everyday life.<sup>4</sup> The effects of bereavement may decrease over time but are likely to endure.<sup>5</sup> We sought to estimate the prevalence of familial bereavement associated with road traffic deaths in England & Wales, to help inform the full public health and economic impacts of RTCs.<sup>6</sup>

## METHODS

### Data sources

In 1974 the Office for National Statistics (ONS) established the Longitudinal Study (LS) to provide more reliable and detailed information on occupational mortality and fertility patterns in England & Wales.<sup>7</sup> The LS links vital events and census records for all individuals born on one of four specific days of the year (providing information on 1.1% (4/365.25) of the population). The original LS sample was drawn from people recorded as resident in England & Wales in the 1971 census, and has been updated continuously as the population changes. In addition, the LS links census records for individuals resident in the same household as the LS member at the time of each census. The Centre for Longitudinal Study Information and User Support (CeLSIUS) enabled access to the anonymised records of all LS members who died in RTCs, with linked records from the 1971, 1981, 1991 and 2001 censuses.

LS member records included date of death, cause of death, year of birth and sex. All deaths were included where the underlying cause of death was given as “motor vehicle traffic collisions” using the International Classification of Diseases (ICD), Eighth, Ninth and Tenth Revisions (ICD-8: E810–819, E825–827; ICD-9: E810–819, E826–829; ICD-10: V01–V04, V06, V09–V80, V87, V89, V99, Y85.0), or where “road traffic” was cited as a contributory factor on death certificates. At the time of analysis, the most recent year for which complete data on deaths were available from the LS was 2005.

### Close family members

Linked census files provided information about each household member recorded as living with the LS member at the time of the census, including sex, month/year of birth and relationship to LS member. The categories of household members in linked census records were mapped to broad categories for use in this study (table 1). Household members that were considered as the “close family” of LS members were: cohabitantes (eg, spouse or partner), parents (including step-parents), children (including stepchildren), siblings (including half-siblings), grandparents and grandchildren. A separate file provided information about children born to female LS members.

### Identifying unique household members

Where LS members linked to more than one census, we conducted several checks based on the household members’ details at each census, to ensure that household members were neither double-counted

**Table 1** Mapping of household member codes and categories used in linked census records

This study	Census categories with their respective codes*			
	1971	1981	1991	2001
1. Cohabitee	1. Husband 2. Wife	1. Spouse 13. De-facto spouse	1. Spouse 2. Cohabitee 32. Spouse/cohabitee	1. Spouse 2. Partner 12. Partner or spouse
2. Parent	3. Father 4. Mother	4. Parent	7. Parent	6. Parent 7. Step-parent 14. Parent/step-parent
3. Sibling	5. Sibling	6. Sibling	9. Brother/sister	5. Sibling 15. Sibling
4. Child	6. Dependent child 7. Non-dependent child	2. Child	3. Son/daughter 4, 31. Son/daughter of cohabitee	3. Child 4. Stepchild 13. Child/stepchild
5. Grandparent	–	18. Grandparent	18. Grandparent	9. Grandparent
6. Grandchild	–	8. Grandchild	11. Grandchild	8. Grandchild
7. Other relation	–	3. Child-in-law 5. Parent-in-law 7. Sibling-in-law 9. Nephew/niece 10. Other relative 19. Uncle/aunt	5. Son/daughter-in-law 6. Cohabitee of son/daughter 8. Parent-in-law 10, 36. Brother/sister-in-law 12. Niece/nephew 13. Other related 17. First cousin 19. Great grandchild 20. Great grandparent 21. Great nephew/niece 22. Uncle/aunt 23. Great uncle/aunt 39. Parent, uncle/aunt 40. Brother or sister, first cousin 43. Spouse, brother or sister	10. Other related
8. Unrelated	8. Unrelated	11. Resident servant 12. Boarder 14. Joint head, other sex† 15. Joint head 16. Unrelated other sex 17. Unrelated other	14. Boarder/lodger 15. Joint head 16. Other unrelated 24–30, 33–35, 37, 38, 41, 42. Unrelated	11. Unrelated

\*Numbers used in each census to code the relationship of a household member to the Longitudinal Study member.

†Joint head of household of opposite sex to Longitudinal Study member.

nor omitted. We also checked whether household members may have skipped one or two censuses (eg, recorded in the 1971 and 2001 censuses only) to ensure that they were only counted as one individual. Furthermore, if a household member was recorded as close family in an earlier census and was subsequently recorded as “unrelated” (eg, from “stepdaughter” to “unrelated”), we counted them as close family. Similarly, if a household member was recorded as “unrelated” in an earlier census and was subsequently recorded as a close relative (eg, from “unrelated” to “parent”), we counted them as close family. We also examined whether household members might be twins or triplets (different or same sex) appearing in successive censuses. When conducting these checks, we were aware that, should a household member’s birthday fall during the month of census data collection, that individual might appear to age by 9 or 11 years between censuses, rather than the expected 10 years.

### Imputation

As only cohabiting family members were recorded with the LS members, other close relatives needed to be imputed.

### Parents and grandparents

When one or more parents or grandparents were unknown, we estimated their ages at the last census in which the LS member was recorded. We assumed at the time of birth of the LS member a mean maternal age of 27 years,<sup>8</sup> a mean paternal age of 29 years,<sup>9</sup> a mean age of grandmothers of 54 years, and a mean age of grandfathers of 58 years.

### Children

To estimate the number of children born to male LS members since their last recorded census, we applied male age-specific fertility rates to the period between the census and the male LS member’s date of death.<sup>10</sup> Children born to female LS members did not need to be imputed, as their birth records are linked to their LS mother.

### Siblings

To estimate the number of siblings of LS members, we derived a distribution of the number of siblings expected, based on the distribution of number of children born to women of child-

bearing age (using the most recent cohort for which completed family size data were available for England & Wales).<sup>11</sup> We then imputed sufficient siblings to ensure that the distribution of siblings of LS members matched the expected distribution.

### Cohabitees and grandchildren

When cohabitees or grandchildren of LS members were unknown, we applied the average number of cohabitees and grandchildren per LS member identified from census linkages.

### Survival probabilities

The number of close family members still alive in 2005 was estimated by applying life table probabilities of survival ( ${}_n p_x$ ) between their age at the last census in which they had been recorded and their age in 2005. We used inter-census life tables to account for any improvements in survival over each time period. For example, if an LS member died in 1974, we estimated survival in any close family recorded in the 1971 census by applying 1976 life table probabilities of survival between their age in 1971 and their age in 1981. We then used 1986 life tables for survival between 1981 and 1991, and so on. For survival between 2001 and 2005 we used 2001 life tables.

Survival in imputed parents and grandparents was estimated in the same way by applying life table probabilities to their imputed age at the last census in which the LS member was recorded. Survival in imputed children and siblings of LS members was estimated by applying the average survival probability found in all the known children and siblings of LS members (as we do not know the ages of imputed children and siblings). Survival in imputed cohabitees and grandchildren was taken into account in the imputation method used (ie, applying average numbers of cohabitees and grandchildren surviving per LS member).

The number of close family members still alive per LS member who died in the periods 1971–80, 1981–90, 1991–2000 and 2001–05 was estimated. For this, we added imputed family members to known family members, and assumed that the distribution by time period and family member category was

the same as that in known family members. We used the population of England & Wales in 2005 to estimate the prevalence of bereavement due to RTCs.<sup>12</sup> The study was approved by the ONS Longitudinal Study Research Board and London School of Hygiene & Tropical Medicine Research Ethics Committee.

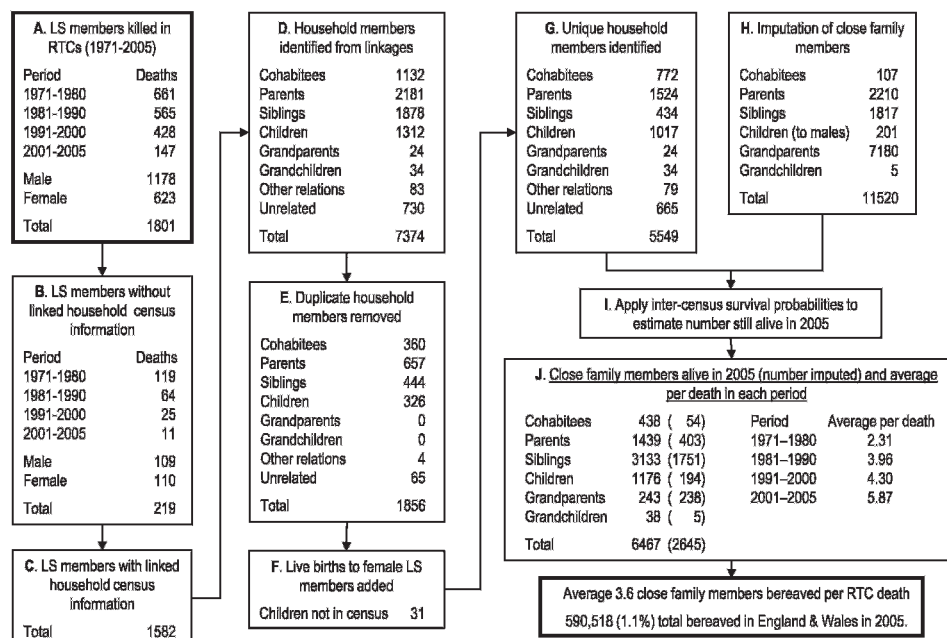
## RESULTS

During 1971–2005 a total of 1801 LS members died in RTCs (fig 1, box A). Of these, 1661 (92.2%) were deaths where RTC was cited as the underlying cause of death, and 140 (7.8%) were deaths where RTC was a contributory cause. The theoretical true LS sampling fraction is 4/365.25, so these deaths are equivalent to 164 454 deaths in England & Wales in this period. There was no information from census records about the close family of 219 LS members (fig 1, box B). Of these, 46 could not be linked to a census record and 173 were recorded as living alone, so all of these required imputation of close family members. We identified 7374 household members (fig 1, box D) from the linked census records of 1582 LS members. Of these, 1856 household members were subsequently identified as duplicates (ie, individuals recorded in more than one census) and so were removed (fig 1, box E). The data file on live births to female LS members provided information on 86 babies, 31 of whom had not been recorded in any census and so were added (fig 1, box F).

There were therefore 5549 unique household members identified from the LS before imputation (fig 1, box G). A further 107 cohabitees, 2210 parents, 1817 siblings, 201 children (born to male LS members), 7180 grandparents and five grandchildren were included after imputation (fig 1, box H).

After applying survival probabilities from inter-census life tables, we estimate that, in the LS sample, 6467 close family members had been bereaved by RTCs and were alive in 2005 (fig 1, box J). These 6467 family members equate to 590 518 family members in the whole of England & Wales, and include 131 399 parents who lost a child and 107 384 offspring who lost a parent. As the population of England & Wales in 2005 was

**Figure 1** Longitudinal Study (LS) members killed in road traffic crashes (RTCs) and estimated number of family members bereaved. Source: Office for National Statistics Longitudinal Study.



53.4 million, we estimate that 1.1% of the population had lost a close family member in a fatal RTC since 1971.

## DISCUSSION

This study estimates that over 1% of the population of England & Wales has lost a close family member in a fatal RTC since 1971. Many will have incurred costs as a result of time off work or time off school, with consequential impacts on income and education. Each will have suffered bereavement to varying degrees and over varying periods of time. Some will possibly have experienced serious mental health problems (eg, post-traumatic stress disorder or depression).

The Department for Transport estimated the value of prevention of all fatal, serious and slight road traffic casualties in England, Wales and Scotland in 2002 to be £17 760 million.<sup>13</sup> This estimate includes the value placed on expected loss of earnings, the loss of employers' national insurance payments, and ambulance and hospital costs. It also includes human costs based on the underlying principle of "willingness to pay". This approach makes some attempt to value the pain, grief and suffering of casualties, relatives and friends. However, as our study is the first to use the LS to quantify the number of people bereaved by RTCs, our estimates may imply a greater public health burden from RTCs than previously indicated. For our results to be used in future estimates of the public health and economic effects of RTCs, we need to consider their accuracy.

## Strengths and weaknesses of the study

### Mortality records

The ONS LS provides a unique opportunity to link the records of individuals killed in RTCs with information about members of their households collected during the censuses. The number of LS members killed in RTCs suggests that there have been 164 454 such deaths in England & Wales during 1971–2005. This estimate is in close agreement with the 159 639 RTC deaths recorded by ONS mortality records.<sup>14 15</sup> The ONS LS only includes records from 1971, so we were unable to estimate the number of close family members of people killed in RTCs before 1971. However, extrapolating from our estimates of the number of close family members still alive per death in each period (fig 1, box J), we might reasonably expect about one close family member to still be alive for each RTC death during the period 1951–1970. As there were about 68 000 deaths from RTCs during the 1960s and 50 000 deaths in the 1950s,<sup>14</sup> we can reasonably increase our estimate of the number of close family members alive in 2005 by a further 118 000 people. This means that an estimated 708 518 people alive in England & Wales have lost a close family member in a fatal RTC since 1951 (1.3% of the population).

### Imputation

The LS can only record the close family members who were cohabiting with LS members at the time of one or more censuses. It will therefore exclude close family of LS members who never lived at the same private address as the LS member (which accounts for possibly the largest group of omissions). It might also exclude close family of LS members who: (i) were living in institutions (eg, armed forces, boarding schools or nursing homes) on the census night; (ii) were born and died between censuses; or (iii) migrated into England & Wales and died between censuses. It would also exclude the children born to male LS members who died between censuses (although not children born to female LS members). We have imputed these

## What is already known on the subject

- ▶ There is good existing epidemiological information about the number of deaths from road traffic crashes in most developed, and many developing, countries.
- ▶ There are no reliable estimates of the number of close family members who have been bereaved as a result of road traffic crashes.

## What this study adds

- ▶ We estimate that over 1% of the population living in England & Wales has lost a close family member in a road traffic crash.
- ▶ This could be an important message in future road safety campaigns.
- ▶ The public health burden of road traffic crashes may be greater than previously estimated.

family members on the basis of assumptions about average fertility rates and average parental ages.

Our estimate of the number of siblings showed the greatest increase when imputed values were applied. This was because 61% of LS members had no census records of siblings living with them, but only 6.7% of the population has no sibling.<sup>11</sup> This discrepancy may be because most LS members were adults at the time of death and unlikely to have been living with siblings. Our estimate of numbers of grandchildren may seem low; however, almost 40% of RTC fatalities were aged less than 30 years and are therefore unlikely to have had grandchildren. To provide a more accurate estimate of the number of grandchildren would require more elaborate modelling of fertility and survival.

Our estimates do not take into account the fact that injury deaths are socially stratified, with a disproportionate number occurring among poorer families.<sup>16 17</sup> It is likely therefore that both family structure and survival of families of LS members who die in RTCs will differ from the general population.<sup>18</sup> The LS members who died in RTCs will on average be from larger families, such that we will have underestimated the total number bereaved. Conversely, we would also expect their family members to have lower than average life expectancy, such that we will have overestimated the number still alive. We have not modelled this further complexity. Whether we have overestimated or underestimated the true prevalence of bereavement therefore remains a matter of judgement.

## IMPLICATIONS FOR PREVENTION

To estimate the true cost of RTCs, governments and insurers must include the effects of RTCs on the bereaved. It has been suggested that, if the bereaved were to be included, the real human cost may increase by 50%,<sup>19</sup> although this is not based on reliable estimates of numbers of family members bereaved. Our estimate of over 1% of the population bereaved is only approximate, but it allows the likely magnitude of suffering caused by RTCs to be seen more clearly. With the population of England & Wales ageing and the proportion of young people being killed in RTCs remaining high, the number of "secondary" casualties may continue to rise.

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**Competing interests:** None.

**Ethics approval:** The study was approved by the ONS Longitudinal Study Research Board and London School of Hygiene & Tropical Medicine Research Ethics Committee.

**Contributors:** PE, AS and RS designed the study. CM extracted the data and commented on the manuscript. RS conducted all analyses. PE, AS and RS interpreted the data. RS, PE drafted the manuscript. AS and CM commented on the manuscript.

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## Lacunae

### GOOD NEWS AND BAD NEWS DEPARTMENT

The good news is that a few months ago Montreal placed 3000 bicycles (Bixi = bike + taxi) in key locations around the city. They are free for the first half hour and available as rentals after that. The idea has been immensely popular, aided no doubt by a rapidly growing network of bike paths. The bad news is that there is no provision for helmets in spite of the inevitable head injuries that followed. Everything from hygiene to theft has been cited as reasons why the helmets cannot be provided. As other cities follow suit (Boston and possibly New York), it will be interesting to see how they deal with the helmet issue. No doubt the usual anti-helmet folks will soon raise their voices to utter dire predictions. (*Contributed by Barry Pless*)

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