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ORIGINAL ARTICLE

Urban-rural variation in mortality and hospital admission rates for unintentional injury in Ireland

M Boland, A Staines, P Fitzpatrick, E Scallan

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Objective: To explore urban-rural differences in the mortality and hospital admission rates for unintentional injuries in the Republic of Ireland.

Design: Standardised mortality ratios (SMRs) in residents of urban and non-city areas (called rural areas) from all causes of unintentional injury were calculated using Central Statistics Office mortality data from 1980–2000. Hospital admission data (Hospital In-Patient Enquiry) from 1993–2000 were used to calculate standardised hospital admission ratios (SARs) in urban and rural residents. Population data were obtained from the 1981, 1986, 1991, and 1996 censuses.

Results: The rate of unintentional injury mortality was significantly higher in rural residents for all-cause unintentional injury mortality (SMR 103.0, 95% confidence interval 101 to 105), and specifically for deaths related to motor vehicle trauma (MVT), drowning, machinery, and firearms. There were significantly higher SMRs in urban residents for falls and poisoning. The rate of unintentional injury hospital admission was significantly higher in rural residents for all-cause unintentional injury (SAR 104.6, 95% confidence interval 104 to 105) and specifically for injuries from falls, MVT, being struck by or against an object, injuries in pedal cyclists, fire/burn injuries, and machinery injuries. SARs were significantly higher in residents of urban areas for poisoning and injuries in pedestrians.

Conclusions: There are urban-rural differences in mortality and admissions for injuries in Ireland. Possible reasons for the higher rural mortality rates are higher case fatality in MVT and rural exposure to hazardous farm machinery, firearms, and open areas of water. This information could assist in targeting prevention programmes under the proposed National Injury Prevention Strategy.

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Injuries are a major cause of death, hospital admissions, health service expenditure, and long term disability in the Republic of Ireland. Unintentional injuries (including poisoning) are the leading cause of death among young people in Ireland, causing 44.3% of deaths in the 5–14 year age group and 70% of deaths in 15–24 year olds.[1] [2] Unintentional injury is responsible for approximately 45 000 hospital admissions per year in Ireland, representing 8.5 % of all admissions.[3]

All-cause unintentional and intentional injury in Ireland varies substantially at the county level. Lowest standardised mortality rates occur in the east of the country, predominantly an urban environment, including Dublin, the capital city.[2] [4]

Cause specific urban-rural analysis of unintentional injury has not been undertaken before in Ireland and will inform the proposed National Injury Prevention Strategy for Ireland,[5] facilitating targeted injury prevention activity.

This study aimed to identify differences in mortality and hospital admission rates from unintentional injury between urban and rural populations, in order to identify those at higher or lower risk of specific injuries and to make recommendations for prevention.

METHODS

Two data sets were used in our analyses: Central Statistics Office mortality data, and Hospital In-Patient Enquiry (HIPE) hospital admissions data. Central Statistics Office and HIPE records were included if any *International Classification of Diseases, 9th revision, clinical modification* (ICD-9-CM) code (primary or other) indicated injury, or if any diagnosis was classified according to the external cause (E codes).[6] E codes, which range from E800–E999 provide an essential supplementary classification of the cause or mechanism of the

injury (for example, fall) and the intent or manner of injury (for example, unintentional).

Deaths and admissions are classified as a motor vehicle trauma (MVT) injury if the person injured received an MVT injury as driver, occupant, or unspecified.[7] Events are classified as occurring in pedal cyclists and pedestrians because of the category of the person injured, and may also be from involvement in MVT.

Mortality data

Central Statistics Office mortality data from 1980–2000 were used, coded by cause of death and place of residence. Deaths from adverse events of medical or surgical treatment were included as unintentional injury deaths. There were no missing data, with all area codes being recorded.

Hospital admissions data

HIPE data from 1993–2000 were used, coded for source or cause of unintentional injury and for place of residence.[8] The HIPE system is the principal source of national data on discharges from acute public hospitals in Ireland. Hospital chart information is entered by trained HIPE coders into a computer. Each HIPE record represents one episode of care. Although HIPE data are not gathered from private hospitals, almost all acute injury admissions in this country occur via the accident and emergency departments of public hospitals. HIPE data are unlinked, but transfers between hospitals are recorded and were excluded from analysis.[9]

The primary (first recorded) E code was used. If the E code was missing, which occurred in 11.3% of admissions (59 181

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Abbreviations: CI, confidence interval; HIPE, Hospital In-Patient Enquiry; MVT, motor vehicle trauma; SAR, standardised admission ratio; SMR, standardised mortality ratio

Table 1 A comparison of urban and rural standardised mortality ratios for the leading causes of unintentional injury for all age groups (1980–2000)

Cause	No of observed cases		SMR-rural	95% CI	p Value
	Urban	Rural			
All-cause	6039	12 146	103.0	101 to 105	<0.001
MVT injury	2453	5174	107.4	105 to 110	<0.001
Fall	1206	2094	94.5	91 to 99	<0.05
Poisoning	437	348	70.2	63 to 78	<0.001
Drowning	350	1032	117.4	110 to 125	<0.001
Fire/burn	403	860	101.7	95 to 109	NS
Machinery	38	279	137.3	122 to 154	<0.001
Struck by	72	151	105.4	89 to 124	NS
Firearm	10	86	142.4	114 to 176	<0.05
Pedal cyclist	27	65	108.2	84 to 138	NS
Pedestrian	28	41	91.2	65 to 124	NS

NS, not significant.

of 520 972), the record was excluded as it could not be classified by cause or intent. There was a similar proportion of missing E codes in rural (10.1%) and urban (12.7%) records. Those normally resident outside Ireland (9352 records, 1.8%) and those with missing area code or no fixed abode (537 records, 0.1%) were excluded.

Urban-rural definitions
A record was defined as urban if place of residence was one of the five defined cities in the Republic of Ireland (Dublin, Cork, Limerick, Galway, and Waterford)[10] or the surrounding administrative counties of the capital city, Dublin (Dun Laoghaire-Rathdown, Fingal, and South Dublin). All other records were defined as rural.

The urban-rural boundary definitions have been relatively stable over the past two decades, but there has been a population shift towards urban areas, and in 1996, 37% (1 337 271) of the population lived in urban areas and 63% (2 288 816) in rural areas.

Data analysis
Standardised mortality ratios (SMR) and standardised admission ratios (SAR) were calculated for specific causes of unintentional injury using standard methods, with the appropriate set of age, sex, or year specific rates for the entire country as the standard. Census data from 1981, 1986, 1991, and 1996 were used for standardisation.

The statistical packages SAS[11] and Stata[12] were used to analyse data. Data are presented as standardised rates followed by 95% confidence intervals for the estimated rate.

RESULTS
Mortality
The total number of deaths from all-cause unintentional injury from 1980–2000 was 18 185, comprising 73.0% of all (unintentional and intentional) injury deaths. Of these unintentional injury deaths 6039 (33.2%) occurred in urban residents and 12 146 (66.8%) in rural residents. There were 12 026 (66.1%) male and 6159 (33.9%) female deaths, with a per annum mortality rate of 40 per 100 000 in males and 20 per 100 000 in females. The leading causes of deaths were MVT injuries, falls, drowning, poisoning, and fire/burn injuries.

The rate of all-cause unintentional injury mortality was significantly higher in rural residents, with a SMR of 104.6 (95% confidence interval (CI) 104 to 105). The number of observed cases and the SMRs for rural populations are shown in table 1 for the 10 leading causes of unintentional injury mortality. Cause specific SMRs were significantly higher in rural residents for MVT injury, drowning, machinery and firearms, and SMRs from falls and poisoning were higher in urban residents. No urban-rural differences were found for deaths from fire/burns, or deaths in pedal cyclists or pedestrians.

Deaths in the under 25 year age group accounted for 29% of records (5272 of 18 185) and the urban-rural comparison is shown in table 2. The relative contribution of drowning to unintentional injury deaths is higher in under 25 year olds compared with the population overall (10.6% v 7.5%). The relative contribution of falls to unintentional injury deaths is much less in this age group (3.7% v 18.1%), with no urban-rural difference in SMR.

Table 2 A comparison of urban and rural standardised mortality ratios for the leading causes of unintentional injury in under 25 year olds (1980–2000)

Cause	No of observed cases		SMR-rural	95% CI	p Value
	Urban	Rural			
All-cause	1573	3699	115.6	112 to 119	<0.001
MVT injury	985	2353	117.4	113 to 122	<0.001
Fall	97	99	83.2	68 to 101	NS
Poisoning	99	81	74.4	59 to 92	<0.001
Drowning	121	437	127.9	116 to 140	<0.001
Fire/burn	102	186	101.3	87 to 117	NS
Machinery	7	93	150.1	121 to 184	<0.001
Struck by	22	71	120.7	94 to 152	NS
Firearm	3	40	155.1	111 to 211	<0.05
Pedal cyclist	12	25	109.9	71 to 162	NS
Pedestrian	11	13	87.0	46 to 149	NS

NS, not significant.
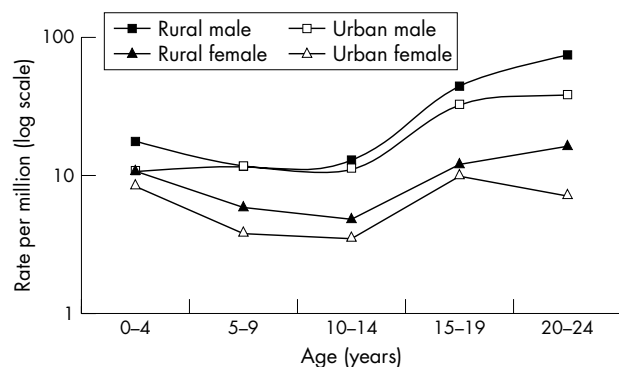
Figure 1 Comparison of SMRs for unintentional injury in males and females by urban and rural area 1980–2000: 0–24 year age group.

Figure 1 shows age specific unintentional injury rates in males and females in the under 25 year age groups. Mortality is consistently higher in males. Mortality is higher in rural males and females compared to their urban counterparts.

Hospital admissions

The total number of admissions for unintentional injury recorded from 1993–2000 was 348 800, comprising 64.0% of all (unintentional and intentional) injury admissions. Sixty percent of admissions were male; 68% (235 809) were rural residents and 32% (112 991) were urban residents. The admission rate for unintentional injuries was 1670 per 100 000 for males and 1050 per 100 000 for females. The all-cause unintentional injury SAR was higher in rural residents (SAR 104.6, 95% C.I 104 to 105). Table 3 shows urban and rural standardised hospital admission ratios for the 10 leading causes of unintentional injury.

For the three main causes of unintentional injury admissions, namely falls, MVT, and being struck by or against an object, there was a higher SAR in those from rural areas. Rural residents had a higher SAR for injuries to pedal cyclists, fire or burn injuries, and machinery injuries. SARs for poisoning and pedestrian injury were significantly higher in urban residents. The SAR for drowning and firearm injury did not differ by population.

In the under 25 year age group (table 4) falls comprise the same proportion of admissions as in the population overall (33.8% v 33.8%) but the urban SAR for falls is higher, whereas the rural SAR for falls in the entire population is higher. For poisoning, the SAR in under 25 year olds shows no urban-rural difference, whereas the rural SAR is lower for the entire population.

Figure 2 shows admission rates in the under 25 year age group. Admission rates are consistently higher in males. For both males and females higher admission rates occur in children from urban areas and adolescents from rural areas.

DISCUSSION

The Republic of Ireland is a small country, with an area of 70 282 km^2 and is predominantly rural, with few major cities. Compared with other European countries, Ireland is sparsely populated, with an average of 52 inhabitants per km^2. While the urban-rural boundaries have remained stable over 20 years, there has been a gradual shift in the population to urban areas, particularly over the past decade. We found that the death rate and the hospital admission rate for all-cause unintentional injury was higher in the rural population in Ireland, similar to the United States.[13] The cause specific analysis showed further urban-rural variation.

Urban-rural cause specific injury differences

MVT is the leading cause of death from unintentional injury in Ireland, with a death rate of 10.1 per 100 000 in 2002.[14] Most MVT injuries occur close to place of residence, but it is acknowledged that major injuries could occur elsewhere. We found the admission rate for MVT and the mortality rate are higher in rural residents. In the Republic of Ireland only 2% of traffic is on motorways[15] and a combination of speed, drink-driving, poor lighting, low seat belt use, narrow country roads, and use of farm vehicles may explain some of the rural excess.[14][16] Differences in case fatality rates may also be a factor, as may be the reduced access for the rural population to emergency care and to public transport.

For falls, the admission rate is higher in rural residents, but the death rate is higher in city residents. While these findings hold for the total population, no such differences were found in those under 25 years; the small number of falls in the younger age group may account for this. The use of accident and emergency observation wards in large city hospitals may reduce admissions for falls for urban residents.

Poisoning admission rates and mortality rates are higher in urban residents, concurring with figures from the United States.[17] Possibly, parasuicide attempts may be miscoded as unintentional poisoning in urban residents.

Drowning deaths were significantly higher in rural residents. Private pools are uncommon in Ireland. Recreational habits, the presence of unfenced bodies of water, and inability to swim are the likely contributory factors. This rural association has been previously described in Canada and Scotland.[18][19]

We found unintentional fire/burns injury admissions to be higher in rural populations. There were greater numbers of

Table 3 A comparison of urban and rural standardised hospital admission ratios for the leading causes of unintentional injury for all age groups (1993–2000)

Cause	No of observed cases		SAR-rural	95% CI	p Value
	Urban	Rural			
All-cause	112 991	348 800	104.6	104 to 105	<0.001
Fall	53 987	102 464	101.3	101 to 102	<0.001
MVT	12 983	36 965	119.8	119 to 121	<0.001
Struck by	10 451	24 347	111.3	110 to 113	<0.001
Poisoning	8419	12 326	95.1	93 to 97	<0.001
Pedal cyclist	2936	6243	104.5	102 to 107	<0.001
Fire/burn	2265	4959	107.6	105 to 111	<0.001
Machinery	1079	4911	130.5	127 to 134	<0.001
Pedestrian	670	1026	93.3	88 to 99	<0.05
Drowning	130	215	99.4	87 to 114	NS
Firearm	135	199	95.6	83 to 110	NS

NS, not significant.

Table 4 A comparison of urban and rural standardised hospital admission ratios for the leading causes of unintentional injury in under 25 year olds (1993–2000)

| Cause	No of observed cases		SAR-rural	95% CI	p Value
	Urban	Rural			
All-cause	29 599	56 874	103.8	103 to 105	<0.001
Fall	10 965	18 324	97.3	96 to 99	<0.001
MVT injury	3293	9024	119.9	117 to 122	<0.001
Struck by	4007	8616	107.6	105 to 110	<0.001
Poisoning	3197	5075	97.9	85 to 101	NS
Pedal cyclist	1470	3066	103.3	100 to 107	NS
Fire/burn	226	371	97.6	88 to 108	NS
Machinery	180	854	133.8	125 to 143	<0.001
Pedestrian	260	395	92.5	84 to 102	NS
Drowning	33	67	108.0	84 to 137	NS
Firearm	26	44	101.8	74 to 137	NS

NS, not significant.

deaths from burns in rural residents, but this difference did not reach statistical significance. Other research found that burns occur more often in rural areas, and that burns experienced in rural areas may be more severe and cause more deaths.[20] Poorer access to emergency services may be implicated here.

Both hospital admissions and deaths were higher in rural residents for machinery injuries. Most farm accidents are machinery related,[21] and exposure to hazardous agricultural machinery is a likely contributor to the higher rural rates found. The Republic of Ireland is predominantly rural, with a high proportion of the labour force engaged in work related to agriculture. In addition adolescent or young adult family members often work on farms, especially at times of peak activity in the farming year.

Ireland has very restrictive gun laws, and numbers of deaths are relatively low. There was a significant excess of firearm deaths in rural residents, which has been found previously.[22] Our finding may reflect the greater number of firearms held on farms and in the countryside for recreational purposes. Many of the serious firearm injuries will result in death before hospital admission.

Other research has found higher mortality in pedestrians in the rural setting,[23] with poorly lit roads and less favourable health care emerging as significant variables. We found no urban-rural difference in the mortality rate for pedestrian or pedal cyclist injury. Rates of walking are higher in urban areas, as absence of footpaths and poor lighting in some rural areas is unsupportive of pedestrians. This may explain the higher admission rate for pedestrian injury in city residents. Cycling rates are higher in urban areas, and we found admission rates to be significantly lower for pedal cyclist injuries in urban residents. This concurs with the finding by Jacobsen that the likelihood that a given person walking or
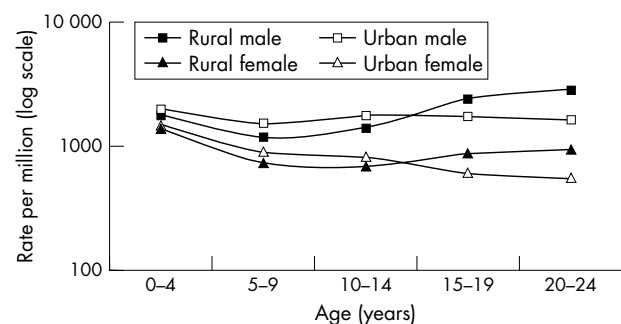
Key points

- Unintentional injury standardised mortality and hospital admission ratios are higher in rural residents in Ireland for all-cause unintentional injury.
- Higher SMRs occur in rural populations for deaths related to motor vehicle trauma, drowning, machinery and firearms.
- Higher SMRs occur in urban populations for falls and poisoning.
- A policy of targeted injury prevention activity needs to be implemented.

bicycling will be struck by a motorist varies inversely with the amount of walking or bicycling.[24]

Data limitations

This study used the most complete datasets available in Ireland for unintentional injury prevention research.[25] Data on social class and poverty, an important injury risk factor, were not available from routine data sources. Emergency department records and general practitioner data are not routinely collated in Ireland; these are a rich but little used source of morbidity information to complement mortality data. Other routine data sources such as the police force (An Garda Siochána) and the National Roads Authority exist but are not mutually compatible and are inadequate in their current format for epidemiological purposes.[26]

We sought to maximise ascertainment of admission data by including records with an E code recorded for any of the six possible diagnoses and including repeat admissions to avoid underestimation of injuries that may recur, such as burns or falls.[9] It is possible, however, that repeat admissions for treatment of the same injury led to overestimation.

CONCLUSIONS

The public health approach to injury control must continue to focus on developing combinations of educational strategies, environmental modifications, legislation, and engineering techniques[27] together with improvement of existing data sources. Narrowly targeted injury prevention programmes focused on a particular group and a particular injury have been found to be more successful than broad diffuse programmes.[16] The benefit of identification of populations with higher rates of cause specific unintentional injury deaths or hospital admissions is that likely causal factors and pathways for prevention may be highlighted, facilitating

Figure 2 Comparison of SARs from unintentional injury in males and females by urban and rural area 1993–2000: 0–24 year age group.

targeted health promotion activity.[13] One existing programme in this country is the accident prevention education programme aimed specifically at the farming community. Further targeting should occur with, for example, a water safety programme in relation to unsupervised rural settings and boating. Accident prevention programmes could be prioritised with reference to the specific risk highest in urban and rural populations. Our findings have implications for health care policy makers responsible for planning injury control strategies and will, it is hoped, influence the proposed National Injury Prevention Strategy for Ireland.

ACKNOWLEDGEMENTS

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LACUNAE ....

Revocation of US safety rules on rat poison formulation

Activist groups have filed suit against the US Environmental Protection Agency (EPA), alleging that the agency's revocation of safety rules on the formulation of rat poison has put children at risk. The plaintiffs are calling for the reinstatement of federal controls that required rat poisons to contain an ingredient that makes the poison taste bitter and a dye to make it obvious when a child has ingested the poison. The controls were abandoned by the EPA in 2001 after consultations with the manufacturers led to a mutual agreement to rescind the requirements. Millions of pounds of rat poisons are applied nationally each year—about 800 pounds of rat poison have been used in one New York City housing project alone this year, and the poisons are also used at schools and parks. More than 50 000 children under age 6 were sickened by eating rodent control toxins this year, more than triple the number reported in the first full year after the safety measures were adopted, according to the American Association of Poison Control Centers. EPA officials said they are reviewing the complaint and will respond accordingly.