

## ORIGINAL RESEARCH

# Comparison of injury-related hospitalised morbidity and mortality in urban and rural areas in Australia

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## ABSTRACT

**Introduction:** Rural residents generally experience a higher rate of injury than residents in urban settings. This article sought to identify and compare the pattern of injury mortality and hospitalised injury morbidity for urban and rural residents in New South Wales (NSW), Australia.

**Method:** Hospitalisation data for 1 July 2000 to 30 June 2005 and Australian Bureau of Statistics mortality data for 1 January 2000 to 31 December 2004 were obtained for NSW residents. The enhanced Accessibility/Remoteness Index of Australia (ARIA+) was used to define urban and rural locations. Standardised hospital admission ratios (SAR) and standardised mortality ratios (SMR) compared urban and rural injury hospitalised morbidity and mortality, respectively.

**Results:** The rate of hospitalised injury (1755 vs 2482 per 100 000) and injury mortality (33.2 vs 48.1 per 100 000) was 1.5 times as high for rural compared with urban residents. Rural males aged 70 years and over and 20–34 years had particularly high injury mortality rates. There was variation in the ratio of injury mortality and hospitalised injury between rural and urban residents by injury mechanism, with rural residents experiencing higher SMRs for machinery (4.84), firearms (4.20), struck by/struck against (3.52), fire and burns (2.08), natural and environmental factors (1.91), motor vehicle crashes (1.88), interpersonal violence (1.58), suffocation (1.51) and self-harm (1.36) injuries and higher SARs for all mechanisms, except drowning-related admissions.

**Conclusions:** Differences exist in the injury hospitalisation and mortality rates between rural and urban residents, with rural injury rates higher than urban injury rates. Mechanisms of injury that have demonstrably higher SMRs and SARs in rural compared with urban locations should be targeted for injury prevention activity in NSW.



**Key words:** injury hospitalisation, injury mortality, rural–urban comparison.

## Introduction

Worldwide, injuries represent a substantial public health issue, accounting for approximately 5 million deaths in 2000, a mortality rate of 83.7 per 100 000 population<sup>1</sup>. In Australia, injury is the leading cause of death for individuals aged 1 to 44 years<sup>2</sup> and is the fifth leading cause of hospitalisation for all age groups<sup>3</sup>. However, the rate of injury differs for urban and rural residents. For example, the rate of hospitalised injury for rural residents is 1.4 times higher than that of urban residents<sup>4</sup>. This urban–rural difference in injury rates is common in other countries<sup>5-7</sup>.

In 2005, Australia's National Injury Prevention Plan was released, in which the prevention of injury in rural and remote Australian populations was declared a national priority<sup>4</sup>. In order to identify where injury prevention strategies for rural populations should be targeted in New South Wales (NSW), Australia's most populous state, information is required about the patterns and causes of injury-related hospitalised morbidity and mortality. This article provides this by identifying and comparing the pattern of hospitalised injury morbidity and injury mortality for urban and rural residents in NSW.

## Method

### *Hospital admission data*

Hospitalisation data were obtained from the NSW Admitted Patients Data Collection (APDC) from 1 July 2000 to 30 June 2005. The APDC includes information on inpatient separations from NSW public and private hospitals, private day procedures and public psychiatric hospitals. Information collected includes patient demographics, diagnoses and clinical procedures. Hospitalised morbidity data were coded

using the ICD, 10th revision, Australian Modified (ICD-10-AM)<sup>8-10</sup>.

Injury-related hospitalised morbidity was identified using the following criteria:

- the hospitalisation was for a resident of NSW
- a principal diagnosis was in the ICD-10-AM range S00-T98
- an external cause code was in the ICD-10-AM range V00-Y98.

The NSW hospitalisation data include information on episodes of care in hospital that end with the discharge, transfer or death of the patient, or when the service category for the admitted patient changes. Also included within the APDC are hospitalisations of NSW residents that occurred in another state or territory of Australia.

Hospitalisations relating to transfers or statistical discharges were excluded from the analysis in order to partly eliminate 'multiple counts', which occur when an individual has more than one episode of care for an injury. These exclusions refer to transfers between hospitals or changes in the service category (eg a change from acute to rehabilitation care) for a patient during one episode of accommodation in a single facility<sup>11</sup>.

### *Mortality data*

Mortality data were obtained from the Australian Bureau of Statistics (ABS) mortality data file from 1 January 2000 to 31 December 2004. Deaths in NSW are registered with the NSW Department of Births, Deaths and Marriages and information collected from death certificates (certified by a medical practitioner or pathologist) includes demographic data and the cause of death. This information is provided to



the ABS and mortality data is coded using the International Classification of Diseases (ICD) v10<sup>12</sup>.

Injury-related mortality was identified using the following criteria:

- the deceased was a resident of NSW and the death occurred in Australia
- an external cause code was in the ICD-10 range V00-Y98.

## *Urban–rural classification*

The enhanced Accessibility/Remoteness Index of Australia, classification, ARIA+<sup>13</sup>, was used to define urban and rural locations. The ARIA+ is a continuous varying index with values ranging from 0 (high accessibility) to 15 (high remoteness). The ARIA+ measures access in terms of remoteness determined on road distance measurements from 11 914 populated localities to the nearest 5 categories of service centre, based on population sizes of more than 250 000 persons; 48 000 to 249 999 persons; 18 000 to 47 999 persons; 5000 to 17 999 persons; and 1000 to 4999 persons. Localities that are more remote have less access to service centres; those that are less remote have greater access to service centres. The 5 ARIA+ scores are classified into 5 groups: major cities, inner regional, outer regional, remote and very remote.

## *Data analysis*

Analysis was performed using SAS v9.1 (SAS Institute, Cary, North Carolina, USA). For hospitalisation and mortality data, age- and sex-specific population estimates as at 31 December and 30 June 2001 were used as the standard population, respectively, obtained from the NSW Health Department. These estimates are based on the ABS population estimates<sup>14</sup>. Direct age standardised rates were calculated using the estimated Australian residential population at 30 June 2001 as the standard population. Standardised mortality ratios (SMR) and standardised admission ratios (SAR) were calculated for specific injury

mechanisms. Indirect age standardised rates were used to calculate the SMR and SARs using the age-specific rate for urban residents as the standard rate. Ninety-five percent confidence intervals (95% CI) were calculated assuming a Poisson distribution<sup>15,16</sup>. *P*-values were generated using the method of exact confidence intervals of the SMRs<sup>17</sup>. For the analysis, the statistical local area (SLA) of residence of the injured person was used to identify the geographic location, the ARIA+ classification groups of ‘major cities’ and ‘inner regional’ were defined as ‘urban’, while the classification groups of ‘outer regional’, ‘remote’ and ‘very remote’ were defined as ‘rural’.

There were 609 970 injury-related hospital admissions identified, 1986 (0.3%) of which did not have a SLA code and for 3633 (0.6%) SLAs an ARIA+ code could not be defined. A total of 12 331 injury-related deaths were identified from the mortality data. There were 131 (1.1%) deaths that did not have an SLA code and for 623 (5.1%) SLAs an ARIA+ code could not be defined. These cases with missing data were excluded from the analyses. In addition, the gender of five hospitalised individuals and the age of 542 hospitalised and nine deceased individuals was unknown and these cases were excluded from the gender-based and age-specific analyses, respectively.

## Results

### *Hospital admissions*

There were 604 351 injury-related hospitalisations during the period 1 July 2000 to 30 June 2005, giving an overall rate of 1805.6 per 100 000 population. Of these hospitalisations, 544 322 (90.1%) were of urban (1754.6 per 100,000 population) and 60 029 (9.9%) were of rural (2481.8 per 100,000 population) residents. Rural males had the highest hospitalisation rate (3023.6 per 100 000 population) and this rate was almost 1.5 times the rate of urban males (2117.4 per 100 000). Rural females had a hospitalisation rate higher than urban females (1871.8 per 100 000 and 1377.1 per 100 000, respectively). Hospitalised injury rates for both



sexes were higher in rural compared with urban residents over time (Fig1).

Males aged 15–29 years had the highest rates of hospitalised injury and for rural males the rate was twice as high as the hospitalisation rate for urban males. The highest hospitalised injury rates for rural females were for those aged 65 years and over (Fig2).

Rural residents had an increase likelihood of being hospitalised for each injury mechanism, except drowning (Table 1). Incidents involving firearms or natural and environmental factors were at least 3 times more likely to involve rural rather than urban residents. Incidents involving interpersonal violence (IPV), fire and burns, machinery, and electric currents were at least twice as likely to involve a rural resident being admitted to hospital than an urban resident.

## **Mortality**

There were 11 577 injury-related deaths during the period 2000 to 2004, giving an overall rate of 34.2 per 100 000 population. Of these, 10 421 (90.0%) were of urban (33.2 per 100 000 population) and 1156 (10.0%) were of rural (48.1 per 100 000 population) residents. Rural males had the highest injury mortality rate (69.9 per 100 000 population) and this was 1.5 times higher than the rate of urban males (48.1 per 100 000). Rural females had an injury mortality rate approximately 1.3 times higher than their urban counterparts (26.0 per 100 000 and 19.3 per 100 000, respectively). Injury mortality rates were higher in rural compared with urban residents over time (Fig3). Males aged 70 years and over and 20–34 years had the highest rates of injury mortality. Rural females aged 15–34 and rural and urban females aged 70 years and over had the highest injury mortality rates for females. Rural children aged less than 5 years had injury mortality rates twice as high as urban children (Fig4).

Rural residents had an increase likelihood of being fatally injured by each injury mechanism, except falls, poisoning,

drowning, non-motor vehicle road transport, natural and environmental factors and electrocution (Table 2). Fatal incidents that involved machinery, firearms, and struck by/struck against objects were between 3 and 4 times more likely to involve rural than urban residents.

## **Discussion**

Injuries represent a substantial public health issue in many countries<sup>18</sup>, with some sections of a population identified as being more at risk of injury than others<sup>19</sup>. This study found that despite only 10% of rural residents in NSW being hospitalised for an injury or being fatally injured, injury-related hospitalisation and mortality rates were almost 1.5 times higher for rural compared with urban residents. Other studies have also identified higher injury<sup>6,20,21</sup> and injury mortality<sup>6</sup> rates in rural versus urban locations. There are numerous factors that could play a part in the higher rates of hospitalised injury and injury mortality in rural locations in NSW, such as different environmental conditions and an increased likelihood of a rural residents' exposure to some injury mechanisms, particularly mechanical agents, such as firearms and machinery<sup>22</sup>.

Rural males had the highest injury hospitalisation and mortality rates in the current study. Likewise, males in both small and large rural areas were found to have the highest injury hospitalisation rates in the USA in 2004, compared with males in small urban areas and females in any location<sup>23</sup>. In a prior US study during 1997 to 2001, rural males were found to have higher injury rates compared with males in suburban, small and large urban locations and females in any location<sup>20</sup>. In NSW, rural males are more likely to be employed in rural high risk industries, such as agriculture, forestry and logging, and mining industries. These industries have all been shown to have higher work-related fatal injury rates in Australia when compared to the all-industry average<sup>23</sup>.

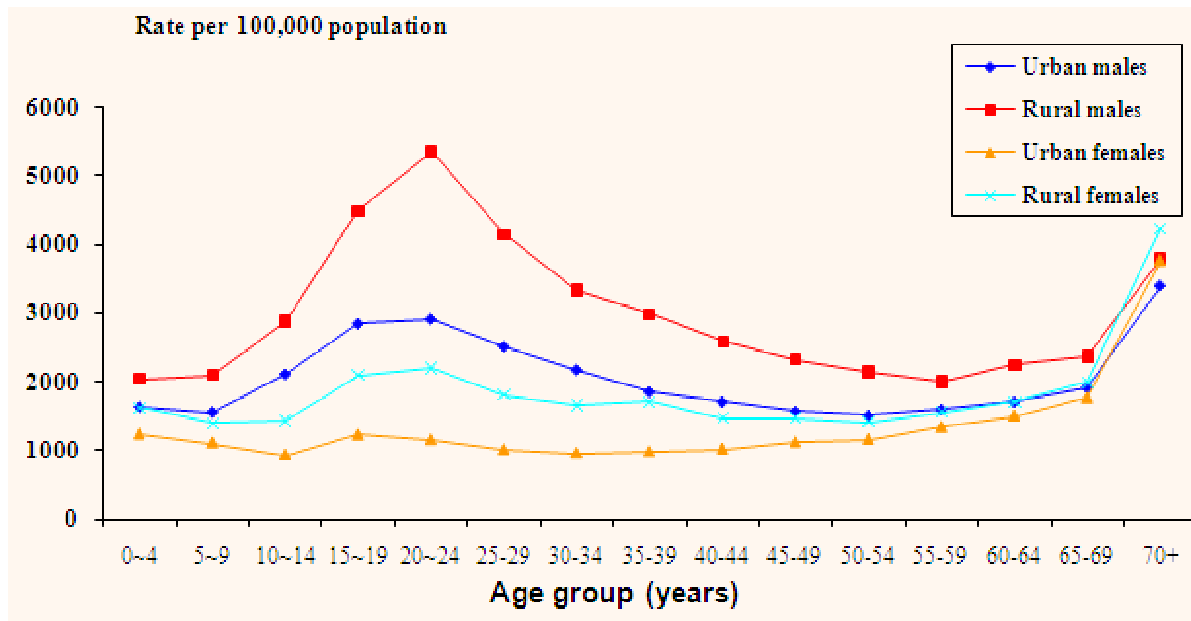


Figure 1: Injury-related hospital admissions (age-standardised hospitalisation rates) in New South Wales for urban and rural residents by gender, 1 July 2000 to 30 June 2005.

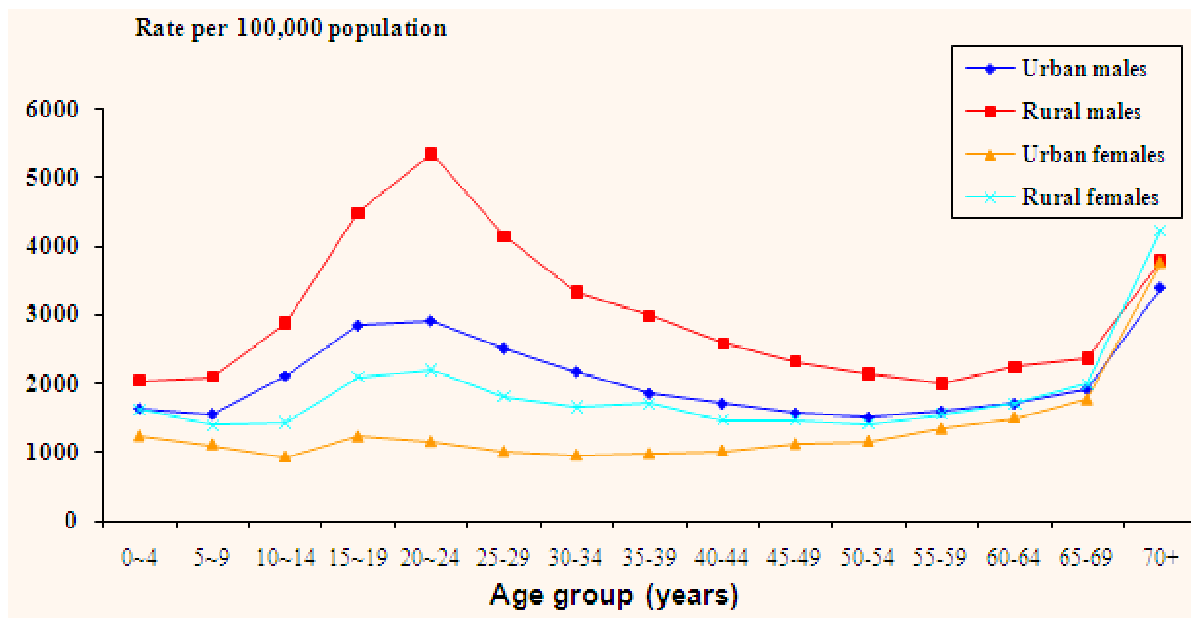


Figure 2: Injury-related hospital admissions (age-standardised hospitalisation rates) in New South Wales for urban and rural residents by gender and age group, 1 July 2000 to 30 June 2005.

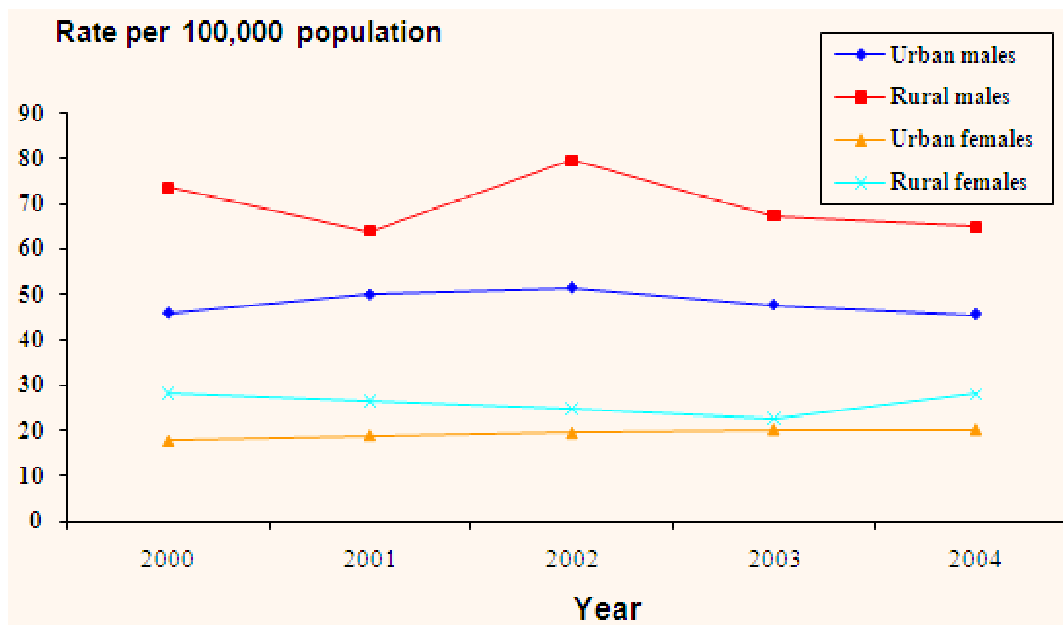


**Table 1: Urban and rural indirect standardised hospital admission ratios for injury-related admissions in New South Wales by injury mechanism, 1 July 2000 to 30 June 2005**

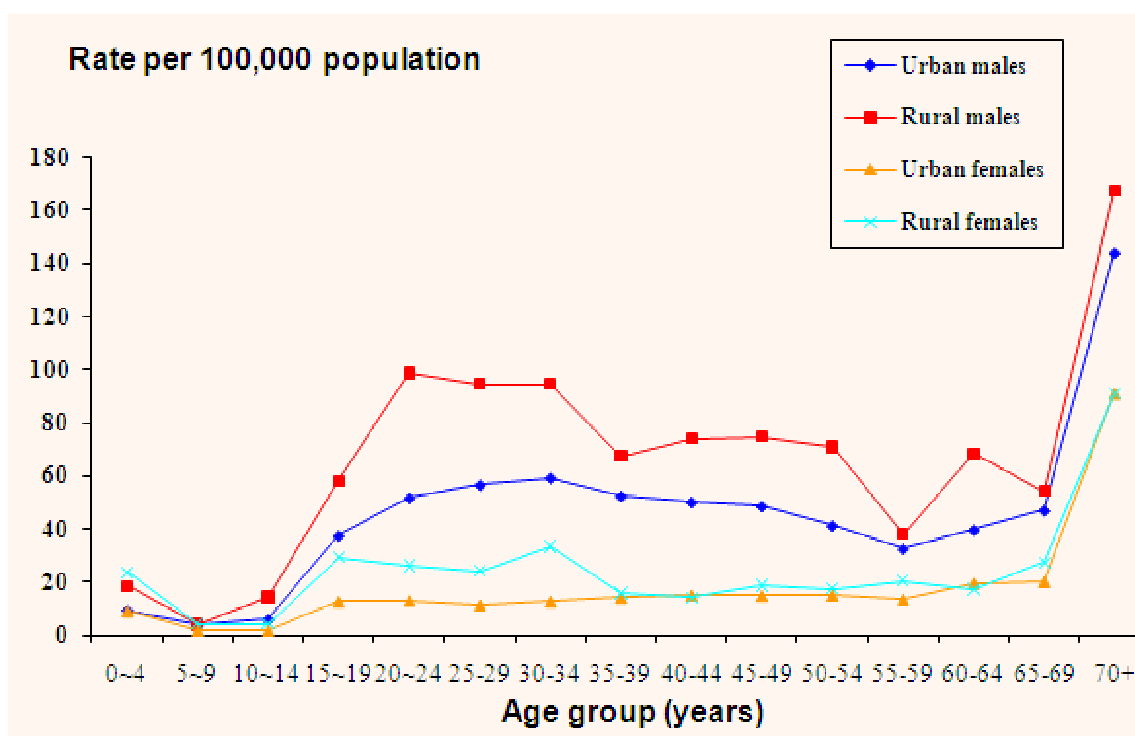
Mechanism	No. observed cases		SAR	95% CI	P-value
	Urban	Rural			
All causes	544 322	60 029	1.39	1.38-1.40	<0.0001
Falls	159 881	16 085	1.20	1.18-1.22	<0.0001
Motor vehicle crash	47 697	6337	1.79	1.75-1.83	<0.0001
Struck by/ against	32 342	3537	1.43	1.39-1.48	<0.0001
Self-harm	30 454	2485	1.15	1.10-1.19	<0.0001
Cut/ pierced	28 008	2455	1.18	1.13-1.23	<0.0001
Interpersonal violence	25 467	3764	2.15	2.08-2.22	<0.0001
Poisoning	14 289	1521	1.42	1.35-1.49	<0.0001
Non-motor vehicle road transport	13 297	1959	1.85	1.76-1.93	<0.0001
Natural and environmental factors	10 929	2922	3.37	3.25-3.49	<0.0001
Foreign bodies	7595	881	1.40	1.31-1.50	<0.0001
Fire and burns	6679	1131	2.14	2.02-2.27	<0.0001
Machinery	6590	1027	2.07	1.95-2.20	<0.0001
Electric currents	939	139	2.04	1.71-2.41	<0.0001
Drowning	839	74	1.10	0.86-1.38	0.27
Suffocation	785	87	1.31	1.05-1.62	0.04
Firearms	221	54	3.49	2.62-4.55	<0.0001
Other <sup>†</sup>	158 310	15 571	1.21	1.19-1.23	<0.0001

CI, Confidence interval; SAR, standardised admission ratio.

<sup>†</sup>Remaining injury mechanisms.



**Figure 3: Injury-related mortality (standardised mortality rates) in New South Wales for urban and rural residents by gender, 2000–2004.**



**Figure 4: Injury-related mortality (age-standardised mortality rates) in New South Wales for urban and rural residents by gender and age group, 2000–2004.**

**Table 2: Urban and rural indirect standardised mortality ratios for injury-related deaths in New South Wales by injury mechanism, 2000–2004**

Mechanism	No. observed cases		SMR	95% CI <sup>†</sup>	P-value
	Urban	Rural			
All causes	10 421	1156	1.41	1.33-1.50	<0.0001
Self-harm	2868	296	1.36	1.21-1.53	0.0003
Motor vehicle crash	2155	307	1.88	1.67-2.10	<0.0001
Falls	1071	72	0.80	0.62-1.00	0.922
Poisoning	858	38	0.60	0.43-0.83	0.995
Drowning	364	42	1.43	1.03-1.94	0.06
Interpersonal violence	363	42	1.58	1.14-2.13	0.03
Suffocation	361	44	1.51	1.10-2.03	0.04
Fire and burns	138	24	2.08	1.33-3.09	0.003
Non-motor vehicle road transport	79	6	1.02	0.37-2.21	0.41
Struck by/against	60	17	3.52	2.05-5.63	0.004
Natural and environmental factors	55	9	1.91	0.88-3.63	0.09
Electrocution	48	5	1.42	0.46-3.31	0.23
Firearms	46	15	4.20	2.35-6.93	<0.01
Machinery	18	7	4.84	1.95-9.97	0.02
Cut/ pierced	9	0	-	-	-
Other <sup>‡</sup>	1928	232	1.43	1.25-1.63	0.0003

CI, Confidence interval; SMR, standardised mortality ratio.

<sup>†</sup> Not calculated due to low cell size.

<sup>‡</sup> Remaining injury mechanisms.



In the current study, the high injury mortality rates of rural children aged less than 5 years compared to urban children is of concern. For children living in rural areas, their home and playground is often also a workplace. Studies in Colorado<sup>24</sup> and the USA<sup>21</sup> also showed higher rates of injury for children residing in rural compared with urban localities, due to the dual nature of locations as worksite and an area for recreation<sup>25</sup>. Recommended strategies for the prevention of injury to young children have focused on limiting their exposure to hazards found on rural properties, such as through the creation of designated safe play areas, the establishment of guidelines for children's work in agriculture, and the restriction of access to farm machinery<sup>26-28</sup>.

Injury mechanisms differed between the rural and urban population, with rural residents experiencing higher SARs for almost all injury mechanisms. Mechanisms, such as firearms and machinery, generally had high SMRs and SARs for rural residents. Machinery, such as tractors and related equipment, are common agents of fatal injury on rural properties, often involving tractor rollovers and run overs<sup>29-33</sup>. Prevention strategies such as fitting roll over protective structures (ROPS) have shown demonstrable reductions in fatalities due to tractor rollover<sup>34</sup>. In order to reduce the incidence of tractor run overs, tractor safety access platforms have been recommended<sup>35</sup>.

Other fatal mechanisms, such as fire and burns, motor vehicle crashes (MVCs), and natural and environmental factors were almost twice as likely to involve rural rather than urban residents. For hospitalised injuries, IPV, fire and burns, machinery, and electric currents, were all twice as likely to involve rural residents. In part, the higher SMRs and SARs for mechanisms, such as MVCs, natural and environmental factors, and machinery are due to increased exposure to these mechanisms compared with urban residents. In particular, for MVCs, factors such as travel distance, vehicle speed, lighting conditions and a lack of road safety features, have all been found to contribute to higher injury mortality and hospitalisation rates in rural

compared with urban residents<sup>5,6</sup>. Other possible reasons for higher injury mortality rates in rural residents have included an increased time to discovery and poorer access to rescue and retrieval and/or medical services<sup>5</sup>. However, these factors alone do not explain the increase in hospitalised injury morbidity among rural residents.

## *Study limitations*

There are several limitations to the current study. These included the absence of information regarding the geographic location of the fatal or non-fatal injury in the mortality and hospitalisation data collections. Instead, an assumption was made that residents were injured in the location in which they resided. It is possible that admission practices may differ between more urban compared to more remote locations. However, incidentally, the home has been found to be a common location of injury<sup>36</sup>, particularly for children<sup>37</sup>. It is recommended that the feasibility of collecting information regarding the geographic location of the injury should be assessed. Approximately 1% of injury-related hospital admissions and 6% of deaths could not be allocated an ARIA+ code due to missing or inadequate SLA information. However, these proportions are relatively small and would not have changed the findings of the current study. The quality of the hospital morbidity and mortality data in NSW is largely unknown and it is possible that poor data validity might have affected the study's results.

## **Conclusion**

This article has quantified the difference in the experience of hospitalised injury and injury mortality between rural and urban residents in NSW, with rural residents experiencing a higher injury burden. Mechanisms of injury that have demonstrably higher SMRs and SARs in rural compared with urban locations should be targeted for injury prevention activity. This has implications for policy-makers who are charged with implementing the National Injury Prevention and Safety Promotion Plan in NSW, particularly because there has been little change in the incidence rates of





mortality and hospitalised injury over time in NSW during the time periods examined.

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