

A Geographic Study into Fatal Crash Rates for Local Government Areas in the state of New South Wales Between 1997 and 2001

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Biography

John Wall originally trained as an agricultural scientist and later as a secondary school teacher. He is currently undertaking a Masters Degree in Public Health at the University of Wollongong. Since 1992 John has been involved in developing and implementing road safety programs initially as a road safety adviser with the Catholic Education Office in North West NSW and later as Road Safety Officer and Road User Safety Manager with Roads & Traffic Authority's Southern NSW Region.

He has given papers at National and International Conferences on topics ranging from developing Community Road Safety Groups to preventing Drink Driving and Speeding. Since January of 1998 he has been employed as Country Programs and Special Projects Manager with the RTA's Road Safety Strategy Branch in Sydney.

Abstract

When investigating the prevalence of health and disease, epidemiologists routinely conduct geographic studies. Geographic studies alone cannot determine causality, but are often the impetus for further research. Epidemiologists find computer based geographic information systems (GIS) also effective in the monitoring and control of various infectious diseases. Road safety professionals are also using GIS techniques to monitor the performance of the road network, and to assist in the identification of areas that could benefit from engineering interventions. Little work has been published comparing the rates of crashes at a local or micro area level.

The major aim of this study is to compare the geographic variation in fatal crash rates per capita for license holders in NSW. For each Local Government Area (LGA) in NSW, the number of fatal crashes was obtained from the Roads and Traffic Authority's (RTA's) Traffic Accident Database. The fatal crash rate per 10,000 license holder years was calculated for each LGA, and mapped using GIS software.

When numbers are small, and rates are seen as imprecise and possibly unreliable measures of risk, the use of a statistical model to generate an alternative indicator of risk seems to be an attractive approach. A Poisson distribution was used to calculate upper and lower confidence limits for the number of fatal crashes in each LGA at a 95% confidence level. Fatal crash rate indicators generated through this process were also mapped.

The three maps were then compared. Geographic clumping of 'high risk' areas was evident around major urban population centres when raw fatal crash numbers (by LGA) were mapped. However, when fatal crash rates per license holder were mapped, the pattern of geographic clumping moved from urban to rural and regional areas of the state. A broadly similar pattern was found when mapping the crash rate indicator data.

Number, rate and indicator all provide insights into data interpretation, and these insights are potentially quite different. All of these measures need to be considered carefully by road safety strategists.

INTRODUCTION

Geographic studies are routinely conducted by epidemiologists when investigating the prevalence of health and disease (Mausner & Kramer 1985). These studies alone cannot determine causality, but they are often the impetus for further research. Jurisdictions in Australia frequently measure their performance against other States and countries in terms of road fatality rates per head of population (ATSB 2002)

Just as epidemiologists are finding computer based geographic information systems (GIS) effective in the monitoring and control of various infectious diseases, road safety professionals are also using GIS techniques to monitor the performance of the road network and to assist in the identification of 'black spots' and 'black lengths' that could benefit from engineering interventions (AGCI 2003, Bayapureddy 1996 and Peled et al 1996). However, little work has been published that compares the rate of crashes at a local or micro area level.

AIM

The major aim of this study is to compare the geographic variation in fatal crash rates per capita for license holders in NSW. A secondary aim of the study is to use GIS to assist in identifying patterns and in particular to identify the ten highest and the ten lowest local government area (LGAs) in terms of fatal crash rate within the state. The selected LGAs will then be used as a source of crashes for a subsequent study examining any differences in contributing factors between fatal and non-fatal crashes.

METHOD

The total number of fatal crashes for each LGA in NSW between 1997 and 2001 was obtained from the Roads and Traffic Authority's (RTA) Traffic Accident Database. The number of license holders each year for the period between 1997 and 2001 was sourced from the RTA's Registration and Licensing Policy Branch Database (RTA 2002).

Although the number of license holders by postcode was available for all years between 1997 and 2001 it was decided to use 1999 license holder numbers to calculate a fatal crash rate per 10,000 license holder years for each LGA in NSW. Before the fatal crash rate could be calculated it was necessary to determine the number of license holders per local government area. This necessitated combining some local government areas for the purpose of this study in cases where one postcode covered several local government areas. There were 173 LGAs in NSW and one unincorporated area at the end of 2001. However, for the purpose of this study these 173 LGAs were incorporated into 163 areas. No license holder data was available for the unincorporated area of the state for 1999, so it was excluded from the study.

The fatal crash rate per 10,000 license holder years was calculated using the following formula:

$$\frac{\text{Total No. of fatal crashes in LGA 1997 – 2001}}{\text{No. of license holders in LGA in 1999} \times 5} \times 10,000$$

The fatal crash data used to calculate fatal crash rates can be thought of as a sample of the data over a wider time span, or as the only realised one of many hypothetical samples. (If we could repeat 2002, there would most likely be different outcomes for most things, including road fatalities.) In statistics, it is common therefore to associate confidence intervals with point estimates. Confidence limits may sometimes prove better guides than highly variable point estimates to rating the best and worst regions in terms of fatality rate. This is especially so when low rates are concerned, when they are also based on small numbers of fatal accidents (and from smaller regions with fewer licence holders). The procedure for calculating confidence limits and using them in this way is as follows:

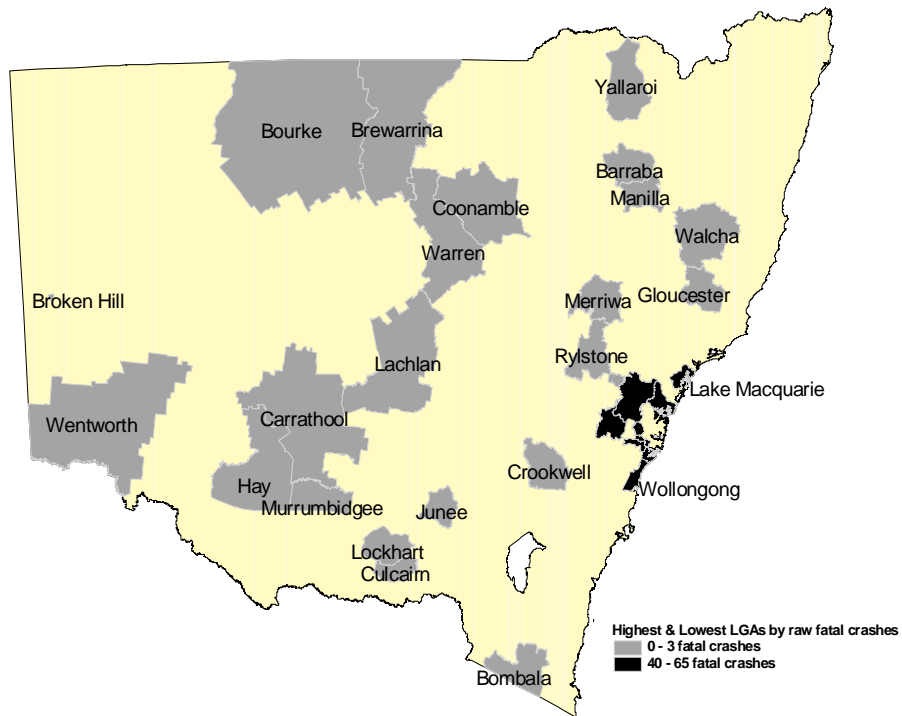
The Poisson distribution is a reasonable model to describe the total number of fatal crashes in each LGA. (Analysis of yearly data in various regions supports this as a reasonable model (RTA 2002b). Exact upper and lower confidence limits are readily found for the Poisson parameter using software packages or statistical tables, or via the Internet (McDonald 2003). Upper (UCL) and Lower (LCL) confidence limits at the 95% level for the underlying mean number of fatal crashes in each local government area was calculated.

From these, it is a simple matter to calculate LCLs and UCLs for fatal crash rates, through extension of the above formula. For the purpose of ranking the LGAs with high crash rates, the crash rate was replaced by the corresponding LCL. For LGAs with low crash rates, the UCL was used as the ranking indicator. These confidence limits are referred to here as fatal crash rate indicators. The numbers of fatal crashes, fatal crash rates, and fatal crash rate indicators for best and worst performing LGAs were then plotted on a map of NSW using the Arcview geographic information system software. The maps produced from this process were then compared for geographic clustering.

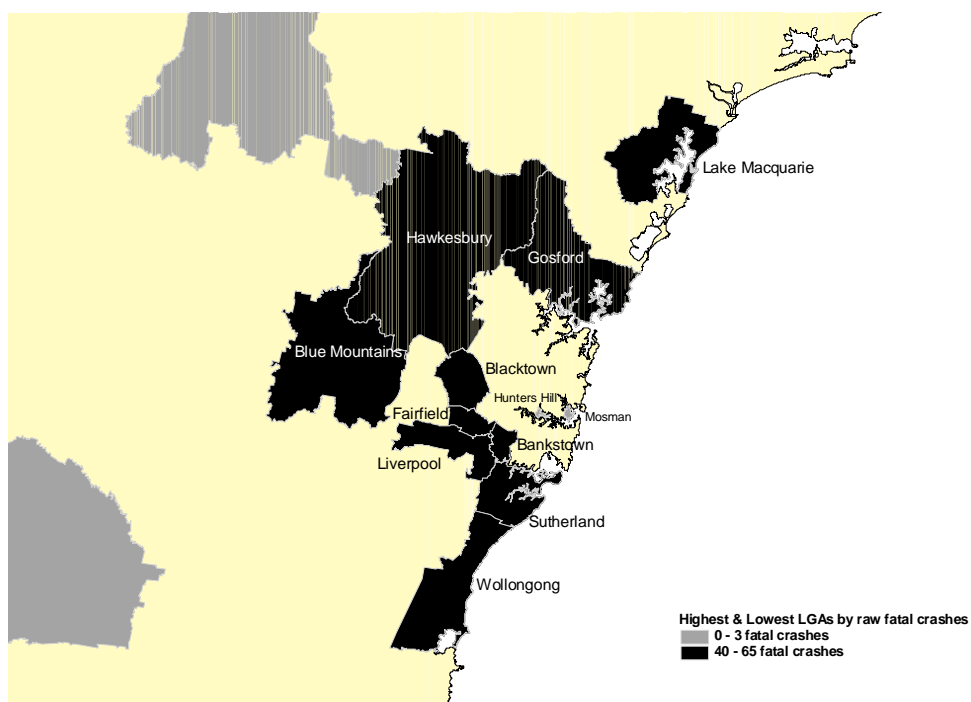
RESULTS

Between 1997 and 2001 there were 2,552 fatal crashes in the state. The maps below show the number of fatal crashes in the best and worst performing LGAs.

Map 1(a) Number of Fatal Crashes (1997 – 2001) by Local Government Area highest and lowest areas only.



Map 1(b) Blow up of map 1 showing Sydney Newcastle & Wollongong Conurbation area only



The maps above show that the highest fatal crash areas are confined to the Sydney, Newcastle and Wollongong Conurbation (SNW Conurb) areas of NSW. Whilst the lowest fatal crash areas, with the exception of Hunters Hill and Mosman, are located within regional and rural areas of the state.

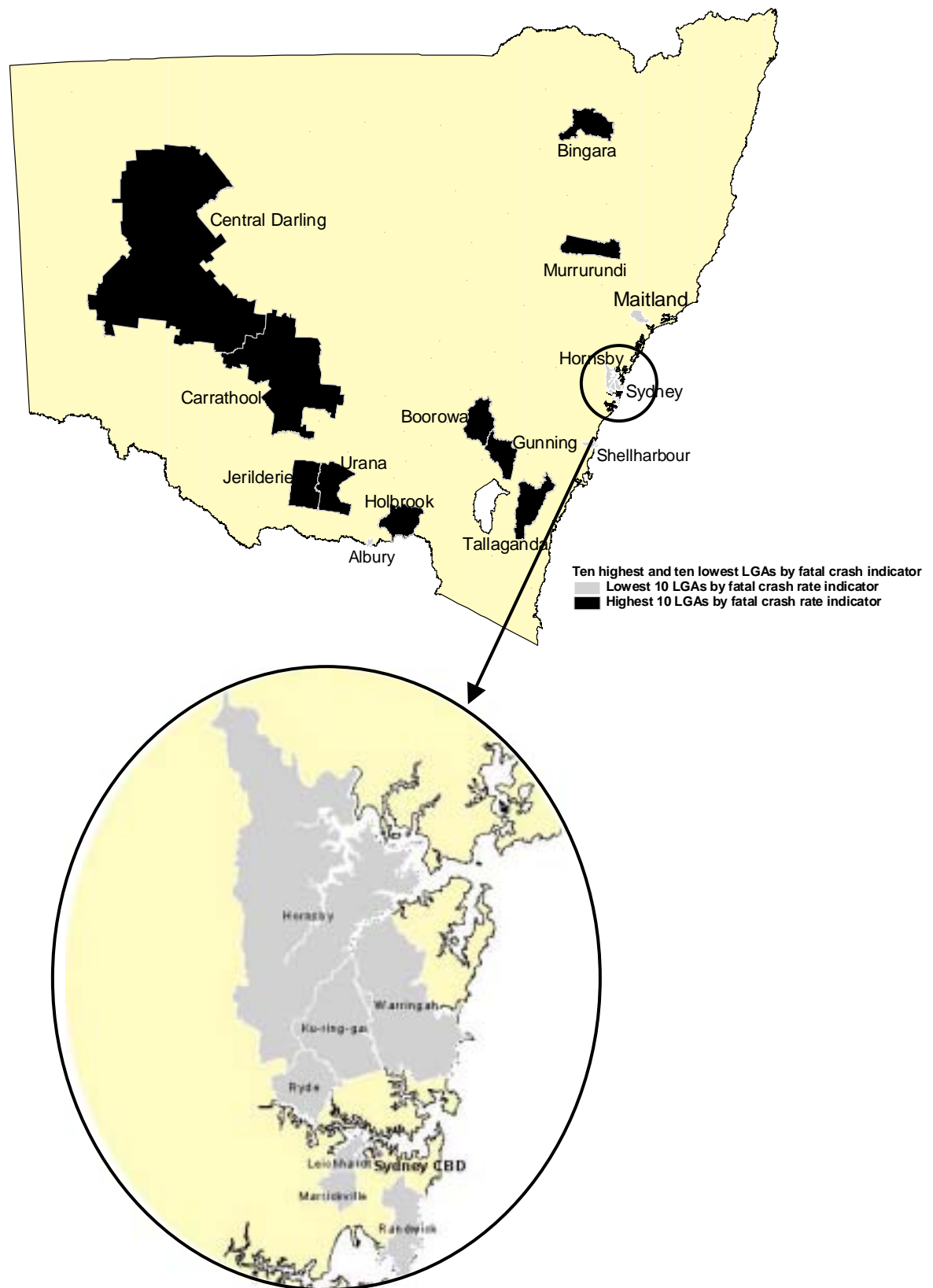
The fatal crash rates per 10,000 license holder years for each Local Government Area were then calculated. A clustering of high fatal crash rates was evident in regional areas of the state with 100% of the ten highest areas being located outside the SNW Conurb area.

Geographic clustering within the lowest fatal crash areas was largely centred around the SNW Conurb with 80% of the lowest areas being located within this part of the state.

After application of a Poisson distribution to the number of fatal crashes in each study area a fatal crash indicator was calculated for each of the study areas. Fatal crash indicators were then plotted using GIS software. Geographic clustering of the fatal crash indicators were again evident with high indicator areas being confined to Regional NSW LGAs and low indicator areas being confined to the SNW Conurbation.

The maps on the next page show the fatal crash indicator rate per 10,000 license holder years in the ten best and ten worst performing study areas in NSW.

Map 2. Fatal Crash Rate Indicator per 10,000 license holder years NSW Local Government Areas between 1997 and 2001. (10 highest and lowest areas only).



DISCUSSION

High raw fatal crash numbers reflect the population distribution of license holders within NSW Local Government Areas. In other words, where there are high numbers of license holders you tend to have high numbers of fatal crashes. All of the worst ten performing Local Government Areas for fatal crashes were situated within the Sydney, Newcastle, and Wollongong Conurbation.

With GIS mapping it is possible to combine different data sets graphically. When we overlaid the number of licence holders with the number of fatal crashes for the top & bottom ten performing LGA areas for fatal crashes we found that the top ten areas for license holders contain 90% of the top ten areas for fatal crashes. This leads to the logical conclusion that high numbers of fatal crashes in an area can be directly associated with a high number of license holders in the same locality.

However, this relationship is not evident in areas with low numbers of license holders. Very few of the bottom LGAs for fatal crashes match LGAs for the bottom ten of license holders. In fact only 13% of the areas within the ten lowest LGAs for fatal crashes are also in the bottom ten LGAs based on number of license holders.

Epidemiologists rarely use raw counts of cases when investigating the incidence of diseases or injuries within a population. Instead they tend to use a rate-based measure. This readily allows a comparison of the risk of contracting a disease or receiving an injury between different communities, states or even countries (Coggan et al 2003 and Songer 2003).

When a rate based measure of road safety was applied to Local Government Areas in NSW a dramatic shift in geographic clustering was observed from the major metropolitan areas of the state where high numbers of fatal crashes occur, to rural and regional NSW.

Even when the number of fatal crashes and subsequent rates were adjusted to take into account areas with small numbers of fatal crashes the geographic clustering pattern did not change.

The highest fatal crash indicator in the state was a regional LGA with 1687 fatal crashes per 10,000 license holder years. This was 28 times higher than the worst performing SNW Conurb area at 60.23 fatal crashes per 10,000 license holders.

A number of rate-based measures could have been used to compare the risk to road users of being involved in a fatal crash or dying in a road crash. The Parliament of Victoria's Inquiry into Rural Road Safety & Infrastructure notes that:

'Crash occurrence varies with exposure to travel. Motorists are more likely to be involved in crashes with increased distance travelled. Crash rates are usually expressed in terms of crashes per 100 million vehicle kilometres of travel'. Parliament of Victoria (2002)

In NSW reliable travel data is only available for areas in the SNW Conurb area and so it was not possible to use this valuable rate based measure for this study. Another rate-based measure that could have been used for this study would have been fatal crash rate per 10,000 vehicle controller's involved in a crash between 1997 and 2001. However, because this study is a prelude to an in depth study of fatal crashes it was decided to use a rate based measure encompassing license holders and fatal crashes.

A disadvantage of using the fatal crash rate based on the number of license holders in an LGA is that it fails to consider traffic volumes throughout rural LGAs. In areas such as the Gunning Shire in Southern NSW two major highways (The Hume and Federal Highways) traverse this sparsely populated shire.

This could lead to an artificially inflated fatal crash rate per resident license holder. However, closer examination of the ten LGAs with the highest fatal crash rate indicates that over 6 out of 10 of these areas do not have a major highway within their boundaries.

Further research is now planned to examine why such a disparity exists in fatal crash risks between Regional and the Sydney, Newcastle and Wollongong Conurbation Area license holders.

Number, rate and indicator all provide insights into data interpretation, and these insights are potentially quite different. All of these measures need to be considered carefully by road safety strategists in the development of road safety countermeasures and the distribution of funding to resource road safety interventions.

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Keywords

Fatal road crashes, statistics, GIS, rural road safety