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Geographical variations in mortality and morbidity from road traffic accidents in England and Wales

A.P. Jones[a,*], R. Haynes[a], V. Kennedy[a], I.M. Harvey[b], T. Jewell[c], D. Lea[d]

[a]School of Environmental Sciences, University of East Anglia, Norwich, Norfolk NR4 7TJ, UK
[b]School of Medicine, Health Policy and Practice, University of East Anglia, Norwich, Norfolk NR4 7TJ, UK
[c]Chief Medical Officer Wales, Second floor, Cathays Park (1), Cardiff CF10 3NQ, UK
[d]Anglia Support Partnership, Kingfisher House, Kingfisher Way, Hinchingbrooke Business Park, Huntingdon, Cambridgeshire PE29 6FH, UK

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Abstract

Data on road traffic fatalities, serious casualties and slight casualties in each local authority district England and Wales were obtained for 1995–2000. District-level data were assembled for a large number of potential explanatory variables relating to population numbers and characteristics, traffic exposure, road length, curvature and junction density, land use, elevation and hilliness, and climate. Multilevel negative binomial regression models were used to identify combinations of risk factors that predicted variations in mortality and morbidity. Statistically significant explanatory variables were the expected number of casualties derived from the size and age structure of the resident population, road length and traffic counts in the district, the percentage of roads classed as minor, average cars per capita, material deprivation, the percentage of roads through urban areas and the average curvature of roads. This study demonstrates that a geographical approach to road traffic crash analysis can identify contextual associations that conventional studies of individual road sections would miss.

Keywords: Road traffic accidents; Mortality; GIS; Spatial-variation

Introduction

Fatalities from road traffic accidents (RTAs) in Britain have averaged over 3000 per annum since 1998, and in 2006 a further 29,000 people were seriously injured on the nation's roads (Department for Transport, 2007). Although RTAs account for less than 1% of all deaths, a feature of mortality from this cause is that the highest incidence is amongst young adults, particularly those aged between 15 and 29 years. In this group, almost 17% of deaths occur as a result of collisions on the road. Because of this distinctive age distribution, RTAs are the cause of 3.6% of the total years of life lost to trauma and disease in Britain (Office of National Statistics, 2004). Furthermore, the community burden of long and short term disability associated with injuries sustained in RTAs is substantial.

Achieving reductions in levels of mortality and morbidity from RTAs is a national priority, and

*Corresponding author. Tel.: +44 01603 593127; fax: +44 01603 507719.
E-mail address: a.p.jones@uea.ac.uk (A.P. Jones).

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RTAs formed one of the five key areas in the Health of the National White Paper (Department of Health, 1992), and the more recent Saving Lives: Our Healthier Nation (Department of Health, 1999). That document set a target of reducing the number of road users killed or seriously injured in 2010 by 40% from a 1994 to 1998 baseline.

Despite the significant impact of RTAs on the health of the public and the fact that, unlike many diseases, much of the burden of mortality and morbidity from RTAs is preventable (Peden and Hyder, 2002), they receive rather little attention from the research community in comparison with similar health issues (World Health Organisation, 1996). Amongst the studies that have been undertaken, many concentrate on the role of carriageway, vehicle, and occupant associated characteristics in determining the probability and outcome of collision events (Bull and Raffle, 1990; Hughes et al., 1997; Farmer et al., 1997). These approaches can provide a useful insight into the importance of factors such as roadside safety features, vehicle design and driver training in the aetiology of RTAs. However, as our knowledge of the role of vehicle and roadway engineering in road safety improves, interventions which focus solely on such considerations will eventually have diminishing returns. Furthermore, approaches which rely on modifying driver behaviour, both via publicity campaigns or driver training courses, seem to have limited effectiveness (Morrison et al., 2003) and may even increase risk in certain situations (Vernick et al., 1999).

An alternative to the study of micro scale factors in the aetiology of RTAs is the development of models to predict how collision and casualty counts may evolve over time (Broughton, 1991; Broughton et al., 2000). These typically use forecasts of traffic growth and casualty rates to predict the number of collisions and casualties that may be anticipated at different points in the future. Such models are useful for planning broad investment patterns in road safety and predicting future health service costs that may arise from RTAs. However, they are often complex and contain high levels of uncertainty and it is difficult for many organisations to use their output to identify local interventions to reduce risks.

A third type of approach is geographical. Whitelegg (1987) first drew attention to the geographical distribution of road accidents in the UK and Barker et al. (1987) recommended that transport analysts should begin to focus on wider areas rather than just sites with the highest crash frequencies. The study of geographical variations in RTAs allows a system wide approach to be undertaken whereby these events may be examined within the context of the environment within which they occur. Such studies do involve conceptual and practical problems, such as the difficulty of defining the population at risk in an area (Gooder and Charny, 1993). There are also statistical challenges, which have prompted methodological developments in the spatial analysis of road crashes. These include examinations of the effects of spatial aggregation (Thomas, 1996; Lassarre and Thomas, 2005), the application of K-function analysis to identify geographical clustering of possible risk factors (Jones et al., 1996), the development of a method to integrate spatial autocorrelation into logistic regression (Flahaut, 2004), an exploration of the statistical implications of spatial dependence (Hewson, 2005), demonstration of Bayesian modelling techniques (MacNab, 2004) and the application of multilevel models for hierarchical data (Jones and Jørgensen, 2003). At the same time, the development of Geographical Information Systems (GISs) for road safety research (e.g. Kam, 2003) has revolutionised data generation and management.

Studies of the geographical distribution of road casualties in several countries have established that contextual socio-economic characteristics such as population density, economic activity and urban land use have effects on road casualties. These have included, for example, studies in the USA (Baker et al., 1987; Levine et al., 1995; Clark and Cushing, 1999; LaScala et al., 2000; Noland and Oh, 2004), in Norway, where daylight hours and snowfall were also associated (Fridstrom and Ingebrigtsen, 1991), and a comparison of 21 OECD countries (Page, 2001). In the UK, earlier studies revealed that road traffic mortality rates were highest in rural areas (Gardner et al., 1984; Bentham, 1986; Williams et al., 1991; Preston, 1991) while more recent work has focussed on the effects of various physical, economic and demographic characteristics in very small areas, concentrating particularly on employment density (Graham and Glaister, 2003; Noland and Quddus, 2004). However, no study so far has assembled a range of physical, environmental and social data to investigate variations in road traffic mortality at the geographical scale, where local road safety policy operates.