Journal of Transport & Health xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Comparative fatality risk for different travel modes by age, sex, and deprivation

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ARTICLE INFO

Keywords:
Road traffic fatality
Perceived risk
Cycling
Active travel
Walking
Driving
Deprivation

ABSTRACT

Background: Cycling is perceived as an unsafe travel mode in many countries. However, road deaths in England have fallen sharply since 2007. We explored whether differences in fatality rates by age, gender and mode persist, and the associations of deprivation with these.
Methods: Using ONS (cycling, pedestrian) and Stats19 (driving) 2007–2012 data for travel-related deaths, including pedestrian falls, and National Travel Surveys 2007–2012 travel data, we calculated fatality rates for England by distance (f/bnkm) and time travelled (million hours' use, f/mhu) by age, travel mode, and gender or residential Index of Multiple Deprivation.
Results: Fatality rates fell significantly 2007–2009 to 2010–2012: male f/bnkm from 2.8 (95%CI 2.7–2.9) to 2.0 (1.9–2.1) for driving; 32.1 (28.5–36.0) to 20.8 (18.1–23.9) for cycling; and 51.4 (48.5–54.4) to 36.7 (34.3–39.3) for walking. Fatality rates varied by age, gender, and mode. Driving and walking fatality rate ratios were generally higher for males than females. For males 17–20y, fatality rates were 0.76 (0.69–0.83)/mhu for driving and 0.28 (0.18–0.42)/mhu for cycling but were similar by distance. Age-specific rates were J-shape for cycling, U-shape for driving, and increased exponentially with age for walking. Fatality rates aged 80+ were an order of magnitude higher in each mode than the all-age mean. Compared with those aged 17–20, rate ratios were significantly lower for male drivers 21+ and female drivers 21–74, but were higher for male cyclists aged 55+ and pedestrians 45+ (male) and 65+ (female). People living in the most deprived quintile generally had higher fatality rates than those in the least deprived quintile overall (three modes combined) and for walking but not for cycling; Rate ratios were highest for pedestrians 35–64 and drivers 35–54.
Conclusions: Fatality rates for walking, cycling and driving are higher for males than females at almost every age and vary more by age than by travel mode. Deprivation exacerbates walking and driving fatality rates.

1. Introduction

Despite the health benefits of cycling (de Nazelle et al., 2011; Jarrett et al., 2012; Woodcock et al., 2009) and high bicycle ownership in high income countries (Oke et al., 2015), cycling is a little used form of transport in many high income countries (Lindsay et al., 2011; Pucher and Buehler, 2008). Common perceptions of risk may be one of the reasons for this (Koglin and Rye, 2014), and for the marginalisation of walking (Pooley et al., 2014). Cycle deaths are rare – which is a reason for receiving much press

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http://dx.doi.org/10.1016/j.jth.2017.08.007
Received 25 April 2017; Received in revised form 25 July 2017; Accepted 10 August 2017

coverage (Wallop, 2016) that generates or perpetuates perceptions of risk among non-cyclists (Carnall, 2000).

Worldwide, 23–24 million people are injured annually in road crashes each year. Road deaths have increased from 750,000–880,000 in 1999 (Jacobs et al., 2004) to 1.24 million in 2010 (World Health Organization, 2013). 85% of these occur in low and middle income countries (Jacobs et al., 2004) - for example, road travel deaths are the third highest cause of loss of life expectancy in Brazilian males, after homicide and stroke (Auger et al., 2016) - and over one-third are among pedestrians and cyclists (World Health Organization, 2013). The fatality rate among this group is increasing, particularly among countries with low but rising numbers of private motor vehicles and poor infrastructure (Obeng-Atuah et al., 2017).

Although half to one-third lower, and falling, the burden in high income countries remains substantial, at 8.7 fatalities per 100,000 population (World Health Organization, 2013). There are also major social inequalities in road traffic deaths in most countries (Hjern and Bremberg, 2002), particularly for pedestrians and children (Laflamme and Diderichsen, 2000; Roberts, 1997), although these have been falling (Jones et al., 2005).

We have shown previously that road traffic fatality rates in England vary as much by age and sex as they do by travel mode, although hospital admission rates were an order of magnitude higher for walking and cycling than for driving (Mindell et al., 2012). Similar results were found in France, although the difference between cycling and driving was much less (Bouaoun et al., 2015). Since then, road travel fatality rates have fallen substantially in Great Britain. We therefore analysed data for England in 2007–2012, to ascertain whether all road users have benefited equally from the reductions in fatalities. Using six years of data, we have been able to examine narrower age bands, to investigate particularly the fatality rates for younger and older travellers and address some of the drawbacks of earlier work. We have also investigated the associations of deprivation with travel fatality rates by age and travel mode in this six year period.

2. Methods

2.1. Participants and data

In England and Wales, deaths from external causes are always referred to a coroner for the circumstances of the death to be examined. The coroner determines the cause of death, normally after an inquest. The death is then registered and the data recorded then is sent to ONS, (formerly the Office for National Statistics). The ONS database stores details of the deceased, including the causes of death. ONS convert the information recorded on the causes of each death into codes, using the International Classification of Diseases (ICD-10). One code is selected as the underlying cause of death (the disease or injury which initiated the chain or morbid events leading directly to death).

Numerator data for fatalities for England were extracted from ONS mortality data for 2007 to 2012 with external ICD-10 codes indicating a road-related death for cyclists, and pedestrians. To be comparable with single vehicle motor vehicle crashes and single vehicle crashes and falls for cyclists, we included pedestrian falls that occurred on a public highway. Others have shown that for travel-related, non-fatal injuries requiring hospital treatment, falls on the pavement were five times as frequent as collisions with a motor vehicle (Naumann et al., 2011). The codes used are listed in Supplementary Table S1.

The ONS mortality file also contains the postcode of usual residence of the deceased which made it possible to link individual deaths with the Index of Multiple Deprivation (IMD) of residence, based on Census lower super output areas (LSOAs). [Deprivation is measured using seven domains incorporating 38 indicators. Each LSOA contains around 1500 residents.] The record-level mortality data linkage was done at Public Health England before the aggregated data were released for analysis for this study.

Some deaths of car/van occupants in ONS mortality data were coded neither as driver nor passenger but ‘unknown occupant’. Comparison with numbers of car/van driver fatalities in the police Stats 19 dataset for the same years showed that the number of drivers killed, by age and sex was virtually identical between the ONS and Stats 19 datasets for drivers aged 30 + . For drivers aged 17–29, the number of driver fatalities in the Stats 19 dataset equalled the number of drivers plus ‘unknown occupant’ deaths in the ONS data. As the police investigate fatal car crashes, while hospitals and those certifying deaths are more concerned with the medical state of injured patients, we decided the Stats 19 data were more likely to be correct, so used those as the numerator data for driver deaths. We were unable to make a similar comparison for pedestrians, as police data are collected only for collisions and injuries involving a vehicle, thus excluding pedestrian-only incidents.

Denominator data for a nationally-representative sample of the general population in England were provided by the Department for Transport National Travel Survey team, as mean distance travelled and time spent travelling as a pedestrian, cyclist or driver by sex, five-year age group, and quintile of IMD 2010 of home address for each three-year period 2007–09 and 2010–12 inclusive. Stage (not trip) data were used, to obtain the most accurate record of travel. These figures were multiplied by the ONS population estimates for the relevant age-sex group for each year to provide data on the total distance travelled and time spent travelling by travel mode for each age-sex group.

2.2. Analysis

We summed the number of fatalities by age, travel mode and either sex or IMD quintile for each period (three years by sex, six years by IMD). We divided these by the total distance travelled over that period for that age-group, travel mode and sex or IMD quintile to yield fatalities per billion km (f/bnkm) or by time spent travelling (fatality rate per million hours use, f/mhu).

As driving is not legal below the age of 17, denominator data are very unreliable, so analyses of driving by age group and comparison of the all-ages rates for the three modes were restricted to those aged 17 and over. Because of small numbers, analyses by