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Analysis of factors that increase motorcycle rider risk compared to car driver risk

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ABSTRACT

As in other parts of the Western world, there is concern in New Zealand about increasing popularity of motorcycles because of potential increases in road trauma. This study sought to identify important factors associated with increased risk for motorcyclists to inform potential policy approaches to reduce motorcyclist injury, such as changes to motorcyclist licensing, training and education. Using data extracted from a register of all New Zealand licensed motor vehicles that were matched to crash data, statistical models were fitted to examine patterns of motorcycle risk in comparison with small cars. These showed generally elevated risks for motorcyclists compared to cars, but particularly elevated risks for motorcycle owners aged in their 20s or who lived in more urbanised settings. In crashes, motorcyclists have little protection from injury, putting the motorcyclist at high risk of injury. When comparing new motorcycles with new cars, the odds of fatal or serious injury to a motorcycle rider involved in an injury crash were almost eight times the odds for a car driver.

1. Background

Motorcycles are relatively cheap to run and, particularly when petrol prices are high, they can offer an attractive alternative means of transport to some drivers who would otherwise use a car. What should be a major disincentive to motorcycle riding is the high risk of fatal and serious injury that motorcyclists experience, estimated to be more than 20 times the risk of passenger vehicle drivers per distance travelled in Australia (Federal Office of Road Safety, 1997). Some 20 years ago, New Zealand motorcycle ownership was much higher than it is currently, with disturbingly high motorcyclist death rates: throughout the 1980s, there were at least 100 motorcyclist deaths annually (Ministry of Transport, 2009). A graduated licensing scheme was introduced in 1987 to restrict the exposure of learner motorcyclists to certain riding situations thought to be of higher risk (night riding; riding at speeds in excess of 70 km/h; riding with a passenger; riding motorcycles with capacity greater than 250 cm^3), which has been shown to be associated with a decline in hospitalised injuries for young riders (Reeder et al., 1999).

Over the 1980s and 1990s, motorcycle ownership was gradually declining, accompanied by falling casualty rates (see Fig. 1). More recently, Fig. 1 shows that motorcycles have been growing in popularity and casualties have now started to increase correspondingly. The disturbing prospect of a return to historical patterns of high motorcycle casualty rates provides motivation to study patterns of motorcycle ownership, usage and risk to develop effective policies and programmes for motorcyclists. In particular, policies and practices need greater emphasis on circumstances of elevated risk to motorcyclists; there is already substantial focus on ways to reduce car occupant risk. This paper therefore focuses on the way that risks *differ* between motorcyclists and drivers of small cars. Small cars are a likely alternative vehicle to motorcycles as they share some of the same benefits of being relatively cheap to purchase and run.

2. Data and methods

New Zealand has very good data for studying risk by vehicle type. Each vehicle driven on public roads is legally required to be licensed and, excepting mopeds (defined below), is also required to be inspected periodically by a mechanic to certify that there are no significant safety-related problems with the vehicle. Vehicles less than six years old are inspected annually and older vehicles are inspected every six months. There are fines for drivers who are caught driving a vehicle that is either unlicensed or does not have its certificate of roadworthiness (the "Warrant of Fitness"). A driver can also be fined by police for driving a vehicle that is has become un-roadworthy (e.g., with worn tyres) since its inspection. At the time of these periodic vehicle inspections, odometer readings are recorded by the inspecting mechanic. These data, along with the results of the vehicle inspection, are entered on-line and stored on the Motor Vehicle Register (MVR). Estimating vehicle distance driven is possible because two consecutive odometer readings for any vehicle inspected at least twice can be extracted

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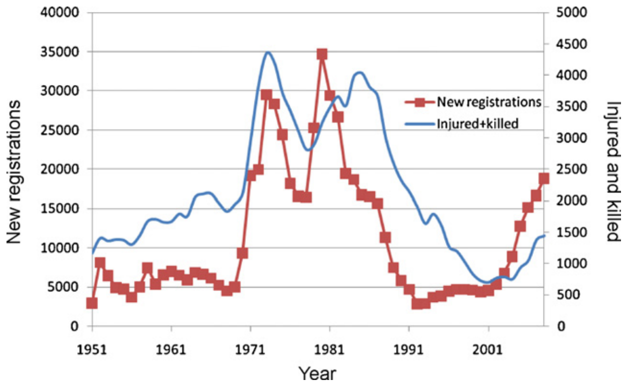

Fig. 1. Number of new motorcycle/moped registrations and number of motorcyclist casualties by year in New Zealand (Ministry of Transport, 2009).

from the database, along with the dates of the inspections. This provides an estimate of distance driven over the period between the inspections. Such estimates can then be converted into estimates of annual distance driven, providing a measure of exposure to risk.

The study was a population study of New Zealand small cars, motorcycles and mopeds licensed in the years 2005 and 2006. The main data source for this study, the MVR, contains data on licensed vehicle type, age, make and model as well as owner information, including age, gender and home address. Land Transport New Zealand provided a file of 101,126 motorcycles and mopeds and 800,346 small cars that were licensed during either or both of March 2005 and February 2006. This can be considered as the complete population of licensed vehicles of this type over this time period. If, for a given vehicle, owner data had changed between March 2005 and February 2006, data from the latter date was used. This meant that the owner data studied was primarily that of early 2006, with relatively few vehicles with owner data from 2005 (that were not licensed in 2006). This was considered appropriate as the mid-point of the period of the crash data used (see below) was early 2006.

Motorcycles and mopeds were identified according to their classification on the MVR, subject to the definition specified on the Land Transport New Zealand website (Land Transport New Zealand, 2006). Technical requirements for licensing are different for mopeds. Mopeds are not required to undergo the periodic vehicle inspection required for motorcycles and cars. For vehicle registration and licensing, a moped is defined as a two-wheeled vehicle that has a power output of 2 KW or under and a maximum design speed of 50 km/h or under. A vehicle with a power output over 2 KW or a maximum design speed over 50 km/h is a motorcycle. It is illegal to register a motorcycle as a moped.

About half of the motorcycles (54%) had missing distance driven estimates. Of the cars analysed, only 11% had missing distance driven. The difference in the availability of these data can be attributed to the way that periodic inspections are conducted in New Zealand and also to the reliability of motorcycle odometers and the way that odometer data are recorded, such that records are evidently more accurately and completely obtained from the car odometers. This differential rate of missing distance data means that estimates of crash risk per distance driven may have systematic biases. For that reason, the main focus of this paper is on per-vehicle risk, although comparisons of crude risks per distance travelled are shown in Table 2.

The NZ Ministry of Transport provided a file of 24,676 crash-involved cars and 1767 motorcycles/mopeds (together with the degree and number of injuries, driver age and gender) for the years 2005 and 2006. The injury crashes analysed involved an injury that required medical attention to at least one of the road users involved in the crash. This study relied on ownership data contained in the MVR to classify vehicles, so we only defined those vehicles as crash-involved if a match was made between the MVR and the crash data by the license plate number of the vehicle. 28% of crashed motorcycles 9% of crashed cars were not able to be matched by plate number to the MVR. This differential rate of matching therefore led to underestimated crash rates for motorcycles relative to cars, as discussed below.

All variables, apart from crash involvement, were derived from the owner details in the MVR. Age groups were defined based on previously established groups that have been previously found to be relatively homogeneous in terms of risk (according to prior NZ research, viz. Keall and Frith, 2004): 15–19, 20–29, 30–59 and 60 plus. The level of urbanisation of the owner's address was defined in four levels according to the Local Authority code. These were: Auckland; Local Authorities of other Main Urban Areas with population over 100,000 ("Large Urban"); Local Authorities of smaller Main Urban Areas ("Other Urban"); all other Local Authorities ("Rural"). As the vicinity of the owner's address can be expected to be the main area of driving exposure, these classifications provide a proxy for types of road, which are known to present different levels of risk. For example, urban speed limit roads present the highest risk of injury crash involvement per distance driven (Keall and Frith, 2004).

Two models were fitted, one to estimate injury crash involvement risk for motorcycles compared to small cars (1), the other to estimate fatal or serious (hospitalised) injury risk for the drivers of motorcycles and cars given crash occurrence (2).

The *crash involvement* risk model was estimated from data that included all MVR records for motorcycles and mopeds as well as small cars, typically cars with less than 1300 kg tare mass. Only statistically significant terms were included using backwards variable elimination in PROC LOGISTIC (SAS Institute, 1998). The factors included were: Intercept, agegrp (owner age group), townclass (urbanisation level of owner's address), motorbike (whether the vehicle was a motorcycle or car), veh_age (years since manufacture, a continuous variable), owner_gender, motorbike*agegrp, veh_age*agegrp, motorbike*townclass. The "*" indicates an interaction term. The interaction terms can be interpreted as representing differences in the way that the vehicle and owner factors affected motorcycle risk compared to the way they affected small car risk. For example, the estimated coefficients for the term agegrp*motorcycle measured how much greater the risk was for motorcycles owned by a given age group (e.g., young people) compared to small cars owned by that age group.

The data used in the model to estimate the *odds of fatal or serious injury* to the drivers or riders of the car or motorcycle were passenger cars and motorcycles involved in crashes in 2005 and 2006 that were able to be matched to the MVR and were less than 60 years old. A variable was defined as 1 if there was a fatal or serious injury to the driver/rider of the vehicle, defined as 0 otherwise. Only statistically significant terms were included using backwards variable elimination in PROC LOGISTIC (SAS Institute, 1998), starting with all first and second order terms: Intercept, agegrp (owner age group), townclass (urbanisation level of owner's address), agegrp*townclass, motorbike (whether motorcycle or car), motorbike*agegrp, motorbike*townclass, veh_age (years since manufacture, a continuous variable), veh_age*agegrp, veh_age*townclass, motorbike*veh_age, owner_gender, owner_gender*agegrp, owner_gender*townclass, motorbike*owner_gender, veh_age*owner_gender. The final model consisted of the terms: Intercept, townclass, motorbike, veh_age, motorbike*veh_age.

Vehicle age was allowed to enter both models as a continuous variable modelled as linear in the logistic space as this was considered to provide a proxy measurement for the crashworthiness of cars. Previous work by Newstead and Watson (2005) has shown