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Motorcycle ownership and injury in China

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Abstract

Background. China has made tremendous progress in its economic development in the past two decades. Accompanying this economic development has been an evident shift in the modes of transport, from walking and cycling to the use of motorcycles and, increasingly, four-wheel vehicles. Such changes are likely to have also produced changes in the patterns and numbers of road traffic injuries, including increases in motorcycle injuries. However, such changes have not been well documented. The work described in this paper sought, therefore, to document the changes in motorcycle ownership, motorcyclist mortality and injury rates in China since 1987.

Methods. National traffic ownership and injury data from 1987 to 2001 were obtained from the National Bureau for Traffic Administration. Additionally, traffic ownership and injury records from 1997 to 2001 were collected from local police offices from 20 counties in Guangxi Region. Population data were obtained from the national and county statistics bureaus. Motorcycle ownership, fatality and injury trends over time were calculated.

Results. Nationally, motorcycles accounted for 23.4% of all registered motor vehicles in 1987, increasing to 63.2% in 2001. Motorcyclist fatalities and injuries increased 5.5-fold and 9.3-fold, respectively, between 1987 and 2001. In 1987, 7.5% of all traffic fatalities and 8.8% of all traffic injuries were sustained by motorcyclists, with the corresponding proportions increasing to 18.9% and 22.8%, respectively, in 2001. The changing proportions of both traffic fatalities and injuries sustained by motorcyclists were positively correlated with the change in the proportion of motorcycles among all motor vehicles. In the 20 counties in Guangxi, motorcyclist fatality and injury rates also increased between 1997 and 2001. Moreover, these rates were considerably higher than the national rates.

Conclusions. Motorcyclist injury in China is a serious public health problem. Motorcyclist fatalities and injuries are likely to continue to increase unless appropriate intervention programmes are implemented.

Keywords: Motorcycles; fatalities and injuries.

Introduction

With the implementation of economic reform policies, China has made tremendous progress in its economic development in the past two decades. Accompanying this economic growth has been an evident increase in the sale of motorcycles and, as a consequence, motorcycles have become one of the more common modes of transportation. In 1989, motorcycle production in China was about 1 million units annually, increasing to 12.9 million units in 2002, with a sale-production ratio of 100%.1 Exports of motorcycles constituted only a small proportion of the total number produced, less than 2.5% before 1999, increasing to 16.8% in 2000 (Personal communication: Motorcycle production and market analysis, Tianjin Motorcycle Technical Center). Consequently, a majority of motorcycles produced in China have been supplied to the domestic market.

In high-income countries, riding a motorcycle has proved to be more dangerous than driving a car. The fatality rate, per registered vehicle, for motorcyclists was 3.6 times that for passenger car occupants in the USA, in 1999. Motorcyclists,
per vehicle mile, were also about 18 times as likely as passenger car occupants to die in a traffic crash and three times as likely to be injured. With the apparent increase in motorcycle ownership in China, the number of motorcyclist fatalities and injuries would also be expected to increase. The aims of this paper were, therefore, to describe the trends in motorcycle ownership, mortality and injury rates, and their relationship to each other, at provincial and national levels in China, since 1987.

Material and methods

National data on motorcycle and motor vehicle ownership, traffic fatality and injury during the period 1 January 1987 to 31 December 2001 were obtained from the National Bureau for Traffic Administration, the Ministry of Public Security, China. These data had been derived from traffic police offices, at the county level, in 31 provinces (or regions). A person who died within 7 days, as a result of injuries in a road traffic crash, was recorded as a road traffic fatality. Individuals who were injured but did not die within 7 days were recorded as a traffic injury. Population data were obtained from the National Statistics Bureau.

Data on motorcycle and motor vehicle ownership, and traffic injury, during the period 1 January 1997 to 31 December 2001, were also obtained from 20 of 100 counties (including cities) in Guangxi Region. Guangxi is an autonomous region in south-western China and was chosen as a study locality, in part, because motorcycles are the second most popular mode of transportation in the region and, in part, because of the commitment from local authorities to support this project. The 20 counties selected for inclusion were also chosen because local traffic administration authorities in these counties were enthusiastic about contributing to the study.

Traffic fatality and injury data were collected from police records using a standardized, close-ended data collection form. Data on the numbers of motorcycles and motor vehicle ownership were obtained from motor vehicle registration offices. Population data were obtained from the statistic bureaus in the 20 selected counties.

For both the national and county level data, motorcycles as a proportion of all registered motor vehicles, motorcyclist fatalities as a proportion of all traffic fatalities and motorcyclist injuries as a proportion of all traffic injuries were then calculated. Motorcyclist mortality and injury rates were also calculated, using the numbers of registered motorcycles and the numbers in the population as the denominators. Tests of linear trend were used to determine whether there were any systematic changes over time. Correlations between the proportion of motorcycles among all motor vehicles and the proportions of road traffic fatalities and injuries were assessed at the national level using linear regression analysis. All analyses were performed using SPSS V11.5.0.1

Results

Motorcycle ownership, fatalities and injuries at a national level

The number of registered motorcycles has increased significantly (test of trend $p < 0.001$) in the past 15 years, from about 2.5 million units (23.4% of all registered motor vehicles) in 1987 to nearly 43.3 million units (63.2% of all registered motor vehicles) in 2001 (Table 1 and Figure 1).

The numbers of fatalities and injuries due to motorcycle crashes were 3078 and 12,129, respectively, in 1987, increasing significantly (test of trend $p < 0.001$) in 2001 to 20,068 (a 5.5-fold increase) and 124,847 (a 9.3-fold increase), respectively (Table 1). In 1987, 7.5% of all traffic fatalities and 8.8% of all traffic injuries were sustained by motorcyclists, with the corresponding proportions increasing significantly (test of trend $p < 0.001$) to 18.9% and 22.8% in 2001 (Figure 1). The proportions of both road traffic fatalities and injuries sustained by motorcyclists were significantly correlated with the proportion of motorcycles among all motor vehicles during the same period (adjusted R-square = 0.93, $p < 0.001$ for injury; adjusted R-square = 0.95, $p < 0.001$ for fatality) (Figure 1).

Motorcyclist fatality and injury rates at a national level

The motorcyclist fatality rate decreased from 12.4 per 10,000 motorcycles in 1987 to 4.6 per 10,000 motorcycles in 2001. The injury rate also decreased, from 49.0 per 10,000 motorcycles in 1987 to 11.7 per 10,000 motorcycles in 1993, but increased to 28.8 per 10,000 motorcycles in 2001 (Figure 2). However, both fatality and injury rates per 100,000 population were increasing over this period. The motorcyclist fatality rate increased from 0.3 per 100,000 population in 1987 to 1.6 per 100,000 population in 2001, while the injury rate increased from 1.1 per 100,000 population in 1987 to 9.8 per 100,000 population in 2001 (Figure 3).

Motorcycle ownership, fatalities and injuries in 20 counties of Guangxi

The number of registered motorcycles increased over the 5 years of study, with motorcycles as a proportion of all motor vehicles also increasing from 76.0% in 1997 to 78.6% in 2001 (Table 2 and Figure 1). Traffic fatalities and injuries increased significantly (test of trend $p < 0.001$) during the study period, with motorcycle fatalities as a proportion of all motor vehicle fatalities increasing from 22.9% to 37.5% and motorcycle injuries as a proportion of all vehicle injuries increasing from 31.7% to 56.3% (Table 2 and Figure 1).

Motorcyclist fatality and injury rates in 20 counties of Guangxi

The motorcyclist fatality rate was 5.4 per 10,000 motorcycles in 1997, increasing to 7.8 per 10,000 motorcycles in 2001 (Figure
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Table 1. Registered motorcycles and motor vehicles, population estimates, motorcycle and total motor vehicle injuries and fatalities in China (1987–2001).

<table>
<thead>
<tr>
<th>Year</th>
<th>MC</th>
<th>MV</th>
<th>Pop. ('000)</th>
<th>Motorcycle</th>
<th>Total MV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inj.</td>
<td>Fatalities</td>
</tr>
<tr>
<td>1987</td>
<td>2,477,639</td>
<td>10,610,294</td>
<td>1,093,000</td>
<td>12,129</td>
<td>3,078</td>
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<td>1988</td>
<td>3,023,941</td>
<td>11,902,031</td>
<td>1,110,260</td>
<td>10,236</td>
<td>2,909</td>
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<tr>
<td>1989</td>
<td>3,593,348</td>
<td>13,185,335</td>
<td>1,127,040</td>
<td>9,392</td>
<td>2,522</td>
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<tr>
<td>1990</td>
<td>4,212,779</td>
<td>14,762,633</td>
<td>1,143,330</td>
<td>9,987</td>
<td>2,842</td>
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<tr>
<td>1991</td>
<td>5,051,480</td>
<td>16,576,596</td>
<td>1,158,230</td>
<td>10,657</td>
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<td>1992</td>
<td>6,474,915</td>
<td>19,450,252</td>
<td>1,171,710</td>
<td>8,812</td>
<td>3,632</td>
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<td>1993</td>
<td>8,587,874</td>
<td>23,316,423</td>
<td>1,185,170</td>
<td>10,018</td>
<td>4,476</td>
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<tr>
<td>1994</td>
<td>10,938,161</td>
<td>27,355,980</td>
<td>1,198,500</td>
<td>16,959</td>
<td>6,126</td>
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<td>1995</td>
<td>13,719,272</td>
<td>31,797,795</td>
<td>1,211,210</td>
<td>21,877</td>
<td>7,710</td>
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<td>1996</td>
<td>16,100,508</td>
<td>36,096,463</td>
<td>1,223,890</td>
<td>26,475</td>
<td>9,050</td>
</tr>
<tr>
<td>1997</td>
<td>20,222,195</td>
<td>42,093,152</td>
<td>1,236,260</td>
<td>33,300</td>
<td>10,370</td>
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<tr>
<td>1998</td>
<td>25,137,106</td>
<td>45,077,049</td>
<td>1,248,100</td>
<td>42,696</td>
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<td>1999</td>
<td>31,666,660</td>
<td>54,047,278</td>
<td>1,259,090</td>
<td>60,717</td>
<td>13,923</td>
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<tr>
<td>2000</td>
<td>37,717,900</td>
<td>65,978,900</td>
<td>1,267,430</td>
<td>82,475</td>
<td>16,261</td>
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<tr>
<td>2001</td>
<td>43,307,700</td>
<td>68,518,778</td>
<td>1,276,270</td>
<td>124,847</td>
<td>20,068</td>
</tr>
</tbody>
</table>

MC, motorcycles; MV, motor vehicles; Pop., population; Inj., injuries.

Figure 1. Motorcycles as a proportion of all motor vehicles; motorcyclist fatalities and injuries as a proportion of all traffic fatalities and injuries. MC, percentage of motorcycles; MF, percentage of motorcyclist fatalities; MJ, Percentage of motorcyclist injuries. MC1, MF1 and MJ1 are the percentages at national level. MC2, MF2 and MJ2 are percentages at county level.

2) The injury rate was 57.7 per 10,000 motorcycles in 1997, increasing to 88.9 per 10,000 motorcycles in 2001. However, the injury rate in 1999 was 104.7 per 10,000 motorcycles, which was much higher than those in other years (Figure 2). The motorcycle fatality rate was 1.5 per 100,000 population in 1997, increasing to 3.3 per 100,000 population in 2001, while the injury rate increased from 16.1 per 100,000 population in 1997 to 37.5 per 100,000 population in 2001 (Figure 3).
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Table 2. Registered motorcycles and motor vehicles, population estimates, motorcyclist and total motor vehicle injuries and fatalities in 20 counties of Guangxi (1997–2001).

<table>
<thead>
<tr>
<th>Year</th>
<th>MC</th>
<th>MV</th>
<th>Pop. ('000)</th>
<th>Motorcycle</th>
<th>Total MV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inj.</td>
<td>Fatalities</td>
</tr>
<tr>
<td>1997</td>
<td>416,206</td>
<td>547,639</td>
<td>14,893</td>
<td>2,400</td>
<td>226</td>
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<tr>
<td>1998</td>
<td>416,955</td>
<td>550,073</td>
<td>15,057</td>
<td>2,686</td>
<td>241</td>
</tr>
<tr>
<td>1999</td>
<td>510,769</td>
<td>661,618</td>
<td>15,223</td>
<td>5,350</td>
<td>332</td>
</tr>
<tr>
<td>2000</td>
<td>593,175</td>
<td>764,401</td>
<td>15,393</td>
<td>5,139</td>
<td>418</td>
</tr>
<tr>
<td>2001</td>
<td>656,410</td>
<td>835,127</td>
<td>15,550</td>
<td>5,834</td>
<td>512</td>
</tr>
</tbody>
</table>

MC, motorcycles; MV, motor vehicles; Pop., population; Inj., injuries.

Discussion

The numbers of registered motorcycles as a proportion of all registered vehicles have increased dramatically in China over the past 15 years, such that they now account for almost two-thirds of all registered motor vehicles. Not surprisingly, the numbers of motorcyclist fatalities and injuries and their proportionate contribution to all motor vehicle fatalities and injuries have also increased dramatically. However, motorcyclist fatalities and injuries still account for less than a quarter of all traffic fatalities and injuries. Nevertheless, the results of linear regression analysis show that there is a strong positive correlation between the growth in motorcycles and the growth in motorcyclist fatalities and injuries. While the motorcyclist mortality and injury rates per 10,000 motorcycles in 2001 were lower than in 1987, the injury rate has started to rise since 1993. By comparison, the mortality and injury rates per 100,000 population are clearly increasing. In the 20 counties of Guangxi, consistent with the national trends, dramatic increases can be observed in both motorcycle ownership and in motorcyclist fatalities and injuries, especially in relation to the growth of other vehicles and other vehicle-related injury. However, the proportionate growth in motorcycle ownership and motorcyclist fatalities and injuries is much higher in these counties than nationally, as are the fatality and injury rates.

To our knowledge, this is the first study that has sought to examine the relationship between motorcycle ownership and motorcyclist fatalities and injuries in China and to compare motorcycle ownership and motorcyclist mortality and injury rates at the national and county levels. There are, however, some weaknesses in our data that need to be considered in interpreting the findings. Motorcyclist fatalities and injuries might be underestimated, as they are based on police records. Previous studies have shown the injury rates are likely to be underestimated using police data alone. For example, a study conducted in Indonesia showed that the total number of motorcycle injuries exceeded police records by up to 9-fold. Even in the Netherlands, the completeness of police data declined with severity of injuries: inpatient about 70% complete; outpatient about 26%; and extramural about 11%. It is also possible that the reported national traffic fatalities and injuries are underestimated, given the potential variable quality of data in different parts of China, as a consequence especially of limited resources in the poorer regions of the country. However, police records on traffic fatality and injury are currently the only available data source for estimating the magnitude of motorcyclist injuries in China.

Our results clearly suggest that the burden of motorcyclist fatality and injury is increasing in China and that this is largely due to the increasing ownership of motorcycles. While in some small part the increase in injuries may reflect improvements in the injury surveillance systems over time, it seems highly unlikely that real increases in injuries are not...
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occurring. These increases, however, contrast with many developed countries where motorcyclist fatalities are decreasing, e.g., by 6% from 1991 to 2001 in Australia and by 29% in the Organization for Economic Cooperation and Development (OECD) nations, despite increases in motorcycle ownership between 1987 and 1997.

Motorcyclist fatalities as a proportion of the total road toll are high and increasing in China. The current estimates, suggesting that almost 20% of traffic fatalities nationally and 35% of the fatalities in Guangxi are sustained by motorcyclists, contrast markedly with the data from Australia (about 12.4%) and the USA (about 7.6%). Clearly these differences reflect in large part the significance of motorcycles in the vehicle fleet. For example, motorcycles made up less than 2% of all registered vehicles in the USA, but more than 60% in China as a whole, and almost 80% in the 20 counties in Guangxi. By comparison, the proportions of motorcyclists in the vehicle fleet are not dissimilar to the proportions in countries such as Malaysia (about 50%) and Taiwan (about 74%), but in Malaysia motorcycles account for about 68% of all road injuries and 60% of all road fatalities, whereas in Taiwan, motorcycle deaths account for about 45% of all motor vehicle deaths. These differences suggest either that the risks for motorcyclists in China are less than in these countries or that there are real problems with underreporting in China.

The consistently higher motorcyclist fatality and injury rates in the 20 counties of Guangxi compared with the rates at the national level may be explained by surveillance systems issues discussed previously (underestimating the national level rates), by the much higher proportions of motorcycles in the vehicle fleet in the counties or may indeed reflect poorer driving practices and greater exposures to risk in the counties. However, the motorcyclist fatality rate per 100,000 population among the 20 counties was similar to that in Guangzhou, the largest city in southern China.

Despite some of the limitations with the data described above, it is clear that the burden of motorcyclist injury is increasing in China, especially in those areas where motorcycles are a popular means of transport. In large part this increase is due to the dramatic increases in motorcycle ownership that are occurring in China. By 2005, it is anticipated that motorcycle production in China will be about 12 million units annually, and that exports will account for 15–20% of total sales. The total number of motorcycles registered in China is expected to reach 95–100 million, while the demand will be for 12–13 million motorcycles annually. Consequently, it seems extremely likely that the number of motorcyclist fatalities and injuries will continue to increase dramatically unless interventions for motorcycle injury prevention are implemented. Further research is clearly warranted on the reliability of the current motorcyclist injury reporting systems, and the cultural, demographic, environmental and other factors that may be contributing to these trends and their implications for motorcycle road safety.

Acknowledgements

We are grateful to colleagues at the National Bureau of Traffic Administration, the Ministry of Public Security, who provided road traffic injury data. Thanks are also due to Dr. Chen Naying, Dr. Meng Jun and Dr. Xian Mingpu from Guangxi Regional Center for Disease Control and Prevention, who assisted in the collection of road traffic injury data from the 20 counties.

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