Road traffic mortality in China: analysis of national surveillance data from 2006 to 2016

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Summary

Background Sustainable Development Goal (SDG) 3.6 is to halve the number of global deaths and injuries from road traffic accidents by 2020. We aimed to investigate progress in reducing mortality rates from road traffic injury in China from 2006 to 2016.

Methods We obtained data from national disease surveillance points. Crude and age-standardised mortality were calculated, with SEs. Joinpoint regression analysis was used to examine and quantify trends in overall and subgroup road traffic mortality from 2006 to 2016. Subgroup analyses were done by place (urban and rural), sex, age group, geographical location (province), and road user, and by type of vehicle for motor vehicle occupant deaths.

Findings In 2016 in China, crude road traffic mortality was 11·0 (SE 0·11) deaths per 100 000 population. Overall age-adjusted road traffic mortality increased from 12·6 (SE 0·03) deaths per 100 000 population in 2006 to 15·5 (0·03) deaths per 100 000 population in 2011 then decreased to 10·4 (0·03) deaths per 100 000 population in 2016. Subgroup mortality rates generally followed similar trends. Males, older adults, and rural areas consistently had higher road traffic mortality rates than did females, younger people, and urban areas. Mortality changes varied across urban and rural areas and by sex, age group, and province between 2006 and 2016, revealing large urban–rural and provincial disparities and highlighting pedestrians as the most vulnerable road users. Deaths among occupants of cars and three-wheeled motor vehicles constituted 48% and 20%, respectively, of total occupant mortality from road traffic accidents between 2006 and 2016.

Interpretation Despite a substantial decrease in road traffic mortality since 2011, the SDG target to halve deaths and injuries from road traffic accidents by 2020 is unlikely to be reached in China. Systematic and sustainable efforts are needed to accelerate progress in road traffic safety in China.

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Introduction

In 2010, the UN General Assembly approved the target to halve the number of global deaths and injuries from road traffic accidents by 2020, as part of the Decade of Action for Road Safety 2011–20.[1] This target was reaffirmed in 2015 as one of the UN's Sustainable Development Goals (SDGs).

Global health initiatives and international organisations regularly release progress reports on the SDGs, offering data to influence and support evidence-informed decision making at global and national levels. Reports include those from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD),[2] the UN,[3] WHO,[4] the Sustainable Development Solutions Network,[5] and the World Bank.[6] Epidemiological characteristics of road traffic mortality have also been reported for specific countries such as Iran,[7] Mexico,[8] Brazil,[9] and Slovakia.[10]

As the most populous country in the world, China recorded nearly 262 000 road traffic deaths in 2017, accounting for about 21% of global road traffic deaths according to GBD data. China's progress, therefore, could have a substantial effect on achievement of global road traffic safety goals. A fine-grained analysis of patterns and trends in Chinese road traffic mortality would be valuable for policy making and implementation of road traffic safety interventions. Over the past two decades, some effort has been made to improve road traffic in China, including substantial government investment in transportation infrastructure,[11] encouraging use of trains, aeroplanes, and ships,[12] legislative and public education programmes to raise motor vehicle safety awareness and practice,[13,14] and improvement of prehospital trauma aid and hospital treatment.[15]

A few previous studies offer some data for Chinese road traffic safety trends. Hu and colleagues[16] and Zhang and colleagues[17] used police-reported data from 1985 to 2005 and from 1951 to 2008, respectively, to report trends and disparities in road traffic mortality based on sociodemographic factors, geographical regions, and types of road user. However, these studies are based on police-reported data in China, data which can be biased by under-reporting.[18] Similarly, GBD used quantitative modelling to estimate attainment of road traffic mortality goals and 40 other health-related SDG indicators in 195 countries.

For more on the **SDGs** see https://sustainabledevelopment.un.org/post2015/transformingourworld

For **GBD data** see https://vizhub.healthdata.org/gbd-compare

Research in context

Evidence before this study

We searched PubMed and official websites of the Chinese Government and other institutions for studies or reports that reported road traffic mortality in China, published up to July 18, 2018, with language restricted to English and Chinese. The UN, WHO, the Sustainable Development Solutions Network, the World Bank, and the Global Burden of Diseases, Injuries, and Risk Factors Study regularly release reports on overall progress for some Sustainable Development Goals (SDGs), but none includes fine-grained data for progress of road traffic mortality, with details such as the differences in mortality change across place (urban and rural), geographical location (province), sex, age group, road user type, and type of motor vehicle occupant in specific countries such as China. Two published studies reported changes in road traffic mortality in one Chinese city (Macheng) and a specific age group (0–14 years). A few published studies used police-reported data to investigate recent changes in road traffic mortality in China, but they were limited by under-reporting of these data and a paucity of epidemiological detail.

Added value of this study

Based on national disease surveillance points data, we have reported reliable national and provincial road traffic mortality estimates and investigated road traffic mortality change from 2006 to 2016 in China, by sex, age group, place (urban and rural), province, road user, and type of motor vehicle (for occupant mortality). We provide data for mortality disparities, information on urban–rural gaps in Chinese road traffic safety, and disparities across provinces and road users.

Implications of all the available evidence

Evidence from this study and previous research indicates that China is unlikely to achieve the SDG target of halving global road traffic mortality by 2020. These findings underline the importance of urgent efforts to reduce urban–rural and provincial disparities in road traffic mortality in China and to protect vulnerable road users such as pedestrians.

The GBD 2017 SDG Collaborators concluded that, similar to all other countries studied, China would not reach the SDG target for road injury mortality by 2020 without pronounced acceleration of progress to improve outcomes, reduce risk exposure, and expand essential health services.[3] However, subnational details of road traffic mortality in China were not reported. In this Article, we use data from the national disease surveillance points system, a sample-based system that gathers nationally representative data in China for births, cause of death, and incidence of infectious diseases.[19] The disease surveillance points system provides a routinely updated national dataset for mortality rates in China that is ideal to address research gaps. We aimed to investigate China's progress from 2006 to 2016 in road traffic injury mortality and mortality differences by sex, age group, place (urban and rural), geographical location (province), and road user, and by type of vehicle for motor vehicle occupant deaths.

Methods

Study design and data collection

We designed a population-based longitudinal analysis. Mortality data were derived from the disease surveillance points system, which was initiated in 1978 by the central Chinese Government and has been used to estimate national fatal health outcomes by policy makers and researchers for decades.[19,20] In 2004, the number of disease surveillance points was expanded from 145 to 161, creating a demographically representative sample of the whole country.[20] In 2013, the central Chinese Government combined the surveillance points of the vital registration system with the disease surveillance points system to generate both nationally and provincially representative death estimates. At that time, the number of surveillance points was further expanded to 605, representing 323·8 million Chinese citizens (24·3% of the national population).[20] To avoid bias from the 2013 expansion of the disease surveillance points system, in national-level analyses we analysed data only from the 161 surveillance points that were consistent from 2006 to 2016. Province-based analyses were based on data from all 605 surveillance points from 2014 to 2016, because provincially representative data were unavailable before 2014.

The disease surveillance points system implements a strict internal procedural check to assess completeness, coding, and internal logic across related items reported on death certificates.[20] Any unqualified reports are corrected through reviewing detailed medical records or redoing verbal autopsies.[19] Moreover, a regular nationally representative sample survey is done at all disease surveillance point locations every 3 years to obtain information that corrects under-reporting.[21]

This analysis was approved by the ethics committee of Xiangya School of Public Health, Central South University, Changsha, China (NO.XYGW-2017-01). Data were de-identified for analyses.

Procedures

We defined road traffic mortality as the death rate from motor vehicle traffic crashes. Using the external cause of injury mortality matrix for the 10th revision of the International Classification of Diseases (ICD-10),[22] motor vehicle traffic injury was divided into five types of road users: occupant (V30–V79 [.4–.9], V83–V86 [.0–.3]), motorcyclist (V20–V28 [.3–.9] and V29 [.4–.9]), pedal cyclist (V12–V14 [.3–.9] and V19 [.4–.6]), pedestrian (V02–V04 [.1, .9] and V09.2), and other or unspecified road user (V80 [.3–.5], V81.1, V82.1, V87 [.0–.8], and V89.2).

Occupant-related injury is further classified into six subgroups based on type of motor vehicle: occupant of three-wheeled motor vehicle (V30–V39 [.4–.9]), car occupant (V40–V49 [.4–.9]), occupant of pick-up truck or van (V50–V59 [.4–.9]), occupant of heavy transport vehicle (V60–V69 [.4–.9]), bus occupant (V70–V79 [.4–.9]), or occupant of other land transport vehicle (V83–V86 [.0–.3]).

We considered five relevant sociodemographic factors in our analysis: place (urban and rural), sex (male and female), age group, geographical location (province), and year. Age was divided into seven groups: 0–4 years, 5–14 years, 15–29 years, 30–44 years, 45–59 years, 60–69 years, and ≥70 years. Data analyses excluded Taiwan, Hong Kong, and Macau because these places are not covered by the disease surveillance points system.

Statistical analysis

We calculated age-adjusted mortality rates and SEs using the census population in 2010 as a reference. We did joinpoint regression analysis to examine overall and subgroup mortality trends from 2006 to 2016 and to identify substantial changes in distinct periods with different slopes. We used annual percentage changes and 95% CIs for the whole period and every distinct period to quantify changes and test significance. Negative binomial regression models were used to investigate mortality differences across sex, age group, and place (urban and rural) over time. Maps were drawn to show geographical variations in road traffic mortality and mortality change from 2014 to 2016 across the 31 Chinese provinces only, because provincially representative data were unavailable before 2014. We used the percentage change in road traffic mortality between 2014 and 2016 to quantify the change for each province, which was calculated as (mortality in 2016–mortality in 2014)/mortality in 2014×100%. We used χ^2 tests to assess the significance of change in mortality between 2014 and 2016 for each province. Multistrata subgroup analysis yielded unstable subgroup mortality rates because of small numerators (deaths <20),[23] so we calculated subgroup analyses for occupant-related mortality by place and sex only.

We did joinpoint regression analyses through Joinpoint Regression program version 4.5.0.1. Statistical maps were developed using MapInfo 12.0. Other statistical analyses were done using SAS version 9.2. Differences were judged significant based on two-sided tests if p values were less than 0·05.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all data in the study and had final responsibility for the decision to submit for publication.

Results

115 255 road traffic deaths were reported by the disease surveillance points system between 2006 and 2016. Crude and age-adjusted mortality rates showed highly similar change patterns across the study period, except age-adjusted rates were lower than crude rates after 2008, possibly attributable to the aging population (figure 1A). Crude road traffic mortality was 11·0 (SE 0·11) deaths per 100 000 population in 2016 (appendix p 1). Age-adjusted road traffic mortality increased from 12·6 (SE 0·03) deaths per 100 000 population in 2006 to 15·5 (0·03) deaths per 100 000 population in 2011 (annual percentage change 3% [95% CI 0 to 6]), then decreased to 10·4 (0·03) deaths per 100 000 population in 2016 (–8% [–12 to –5]; appendix pp 2, 3).

See Online for appendix

Across the study period, age-adjusted mortality rates in rural areas were about 2–3 times higher than those in urban areas (z=14·8; p<0·0001; figure 1B). Rural mortality increased from 2006 to 2012 (annual percentage change 5% [95% CI 2 to 7]) then decreased substantially from 2012 to 2016 (–10% [–15 to –6]). By contrast, urban mortality showed a decline from 2006 to 2016 (–4% [–7 to –1]; appendix p 4).

Males were at 2·9–3·4 times higher risk of age-adjusted road traffic mortality compared with females between 2006 and 2016 (z=–24·4; p<0·0001; figure 1C). Mortality rates showed similar trends between 2006 and 2016 for both sexes, increasing to reach a peak in 2012 (annual percentage change 3% [95% CI 0 to 6] for males and 2% [–1 to 6] for females) then dropping substantially from 2012 to 2016 (–11% [–16 to –6] for males and –9% [–15 to –2] for females; appendix p 4).

Road traffic mortality rose strikingly with increasing age across the full study period (z=18·0; p<0·0001; figure 1D). Subgroup analyses by age group showed patterns similar to those for overall age-adjusted mortality, although the observed reduction since the peak years (2011–12) varied somewhat across age groups, with the largest decreases among young adults aged 15–29 years (annual percentage change –18% [95% CI –28 to –6]), followed by an annual percentage change of –15% (95% CI –22 to –8) in the 30–44 years age group and –9% (–16 to –2) in the 0–4 years age group (appendix p 5).

Provincial data were only available from 2014 to 2016. Age-adjusted road traffic mortality varied greatly across the 31 provinces in mainland China, ranging from 3·0 deaths per 100 000 population in Tibet to 18·6 deaths per 100 000 population in Ningxia (figure 2). Between 2014 and 2016, 23 of 31 provinces had substantial mortality reductions, with the largest decreases in Beijing (percentage change –34%), Chongqing (–33%), and Gansu (–30%). By contrast, eight provinces had increases in mortality, with the largest rises occurring in Shaanxi (percentage change 29%), Tianjin (18%), and Jiangsu (16%).

Between 2006 and 2016, pedestrians, motorcyclists, and vehicle occupants were the most common road users

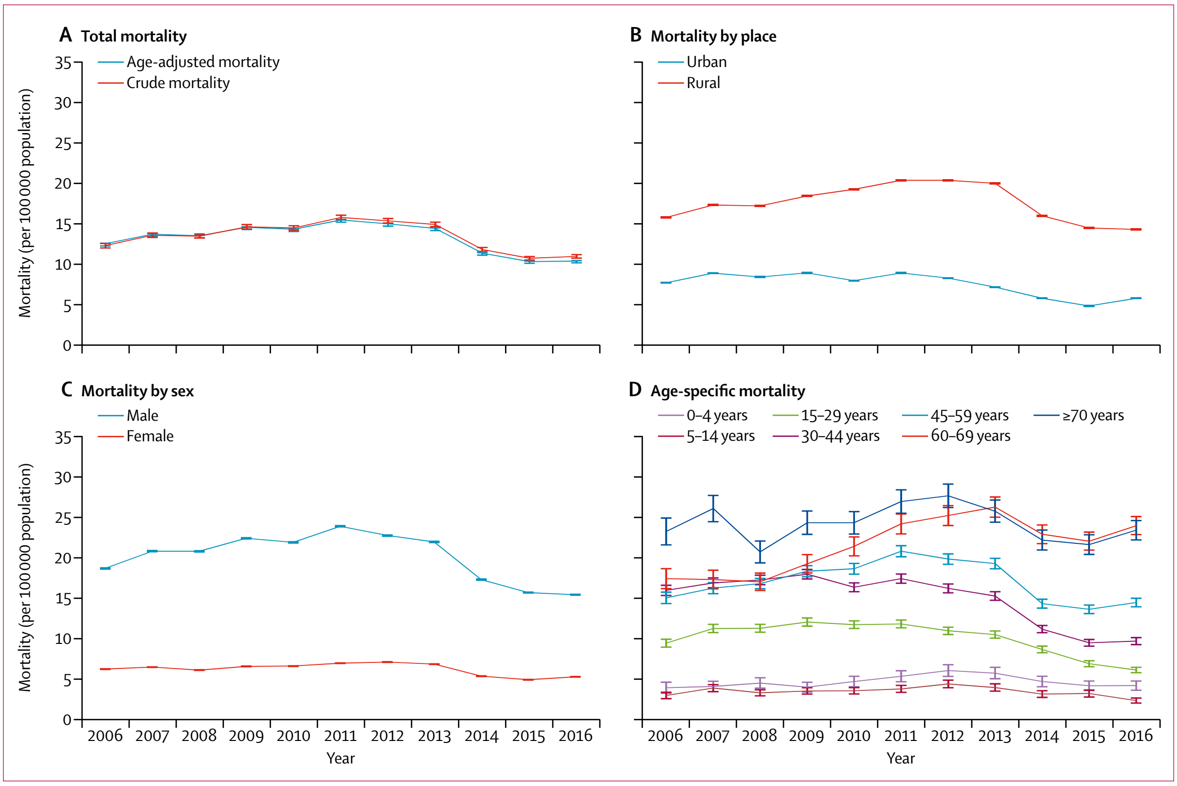

Figure 1: **Road traffic mortality in China, 2006–16**
Total mortality (A), mortality by place (B), and mortality by sex (C) were age-adjusted using population data from the 2010 national census. Age-specific mortality is shown for age groups 0–4 years, 5–14 years, 15–29 years, 30–44 years, 45–59 years, 60–69 years, and ≥70 years (D).

dying in road traffic accidents in China; the respective percentage of mortality from these road user groups was 42%, 25%, and 17% of overall road traffic mortality (figure 3). In general, mortality rates for pedestrians, motorcyclists, pedal cyclists, and other or unspecified road users followed a change pattern that was similar to the overall mortality rate (appendix p 6). Notably, mortality of vehicle occupants remained relatively stable in the observed 10-year period.

Of all road users, pedestrians most frequently died in road traffic accidents across all age groups, with the exception of motorcyclists aged 15–29 years and 30–44 years, who had higher mortality rates in some years compared with pedestrians (figure 3). From 2006 to 2016, road traffic mortality showed similar patterns of change over time for almost all road users in all age groups, generally increasing from 2010 to 2012 and then falling continuously from 2012 to 2016. The magnitude of mortality change varied across road users and age groups (appendix pp 11–14).

Urban and rural areas roughly followed similar patterns of road user mortality from 2006 to 2016, with the exception of a comparatively high proportion of motorcyclist deaths in rural areas (28% in rural areas *vs* 15% in urban areas) and a relatively low proportion of pedestrian mortality in rural areas (40% *vs* 51%; figure 4). Urban areas and rural areas also showed similar trends in mortality rates by specific road users across the study period, except for reaching peak mortality at different years for motorcyclist mortality (2009 for urban areas *vs* 2012 for rural areas). Pedal cyclist mortality (annual percentage change –5% [95% CI –9 to –0]) and occupant mortality (–6% [–9 to –3]) in urban areas decreased significantly, but occupant mortality remained stable in rural areas (1% [–0 to 3]; appendix pp 7–10).

Males had much higher age-adjusted mortality in all road user categories than did females across the study period, particularly motorcyclists (4·8–6·5 times higher) and vehicle occupants (3·4–4·5 times higher; figure 4). The percentage of deaths by road user also differed between males and females, particularly motorcyclists (27% of male deaths *vs* 15% of female deaths) and pedestrians (39% *vs* 52%). Males and females showed similar trends in road user-specific age-adjusted mortality over time, except that mortality remained nearly stable among occupants for both sexes (annual percentage change –1% [95% CI –3 to 1] for males and 0% [–2 to 3] for females) and among motorcyclists for females (annual percentage change 1% [–2 to 3]). Female pedestrian mortality decreased across the study period (annual percentage change –3% [95% CI –6 to –0]; appendix pp 7–10).

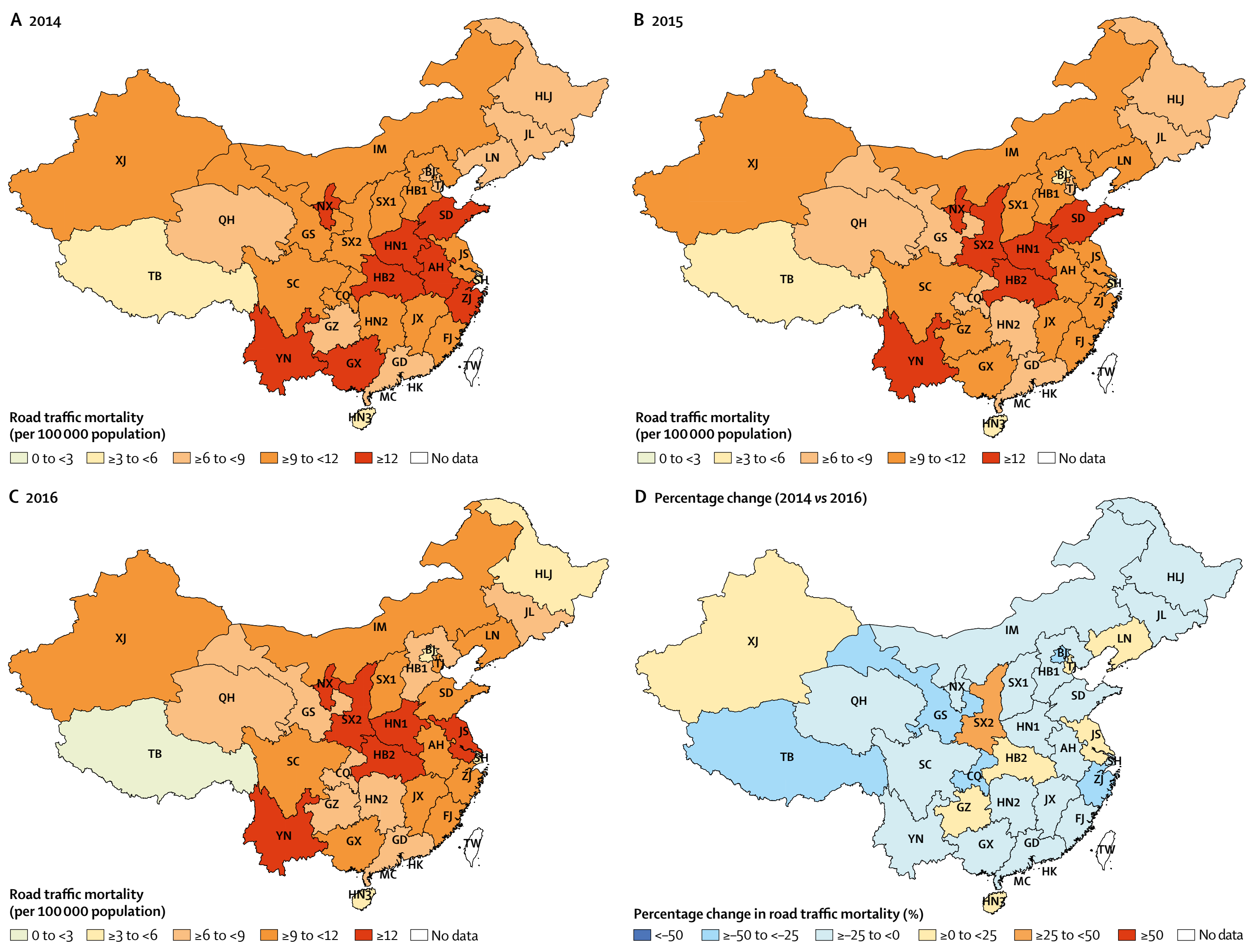

Figure 2: **Age-adjusted road traffic mortality and percentage change in mortality, by province in China, 2014–16**

Mortality rates were age-adjusted using population data from the 2010 national census. Percentage change in mortality between 2014 and 2016 was calculated as (mortality in 2016–mortality in 2014)/mortality in 2014 × 100%. AH=Anhui. BJ=Beijing. CQ=Chongqing. FJ=Fujian. GD=Guangdong. GS=Gansu. GX=Guangxi. GZ=Guizhou. HB1=Hebei. HB2=Hubei. HK=Hong Kong. HLJ=Heilongjiang. HN1=Henan. HN2=Hunan. HN3=Hainan. IM=Inner Mongolia. JL=Jilin. JS=Jiangsu. JX=Jiangxi. LN=Liaoning. MC=Macau. NX=Ningxia. QH=Qinghai. SC=Sichuan. SD=Shandong. SH=Shanghai. SX1=Shanxi. SX2=Shaanxi. TB=Tibet. TJ=Tianjin. TW=Taiwan. XJ=Xinjiang. YN=Yunnan. ZJ=Zhejiang.

Looking at road traffic deaths among vehicle occupants, an analysis of mortality by type of motor vehicle showed that occupants of cars and three-wheeled motor vehicles were most frequent, accounting for 48% and 20%, respectively, of total occupant deaths from road traffic crashes in China between 2006 and 2016 (figure 5). Age-adjusted mortality for car occupants rose during the study period (annual percentage change 4% [95% CI 2 to 7]), while mortality for occupants of three-wheeled motor vehicles remained relatively stable from 2006 to 2016 (annual percentage change 1% [95% CI –2 to 3]). Male occupants and occupants from rural areas were at greater risk of death in a road traffic accident compared with female occupants and people from urban areas (figure 5; appendix p 15).

Notable geographical variations were recorded for all specific road users across the 31 Chinese provinces between 2014 and 2016 (appendix pp 16–19). Significant decreases in age-adjusted road traffic mortality were reported for vehicle occupants in 13 provinces, motorcyclists in 19 provinces, pedal cyclists in 18 provinces, and pedestrians in 25 provinces between 2014 and 2016. By contrast, significant increases in mortality were reported for occupants in 17 provinces, motorcyclists in 12 provinces, pedal cyclists in ten provinces, and pedestrians in five provinces.

Discussion

Our analysis using data from the disease surveillance points system to report road traffic mortality characteristics

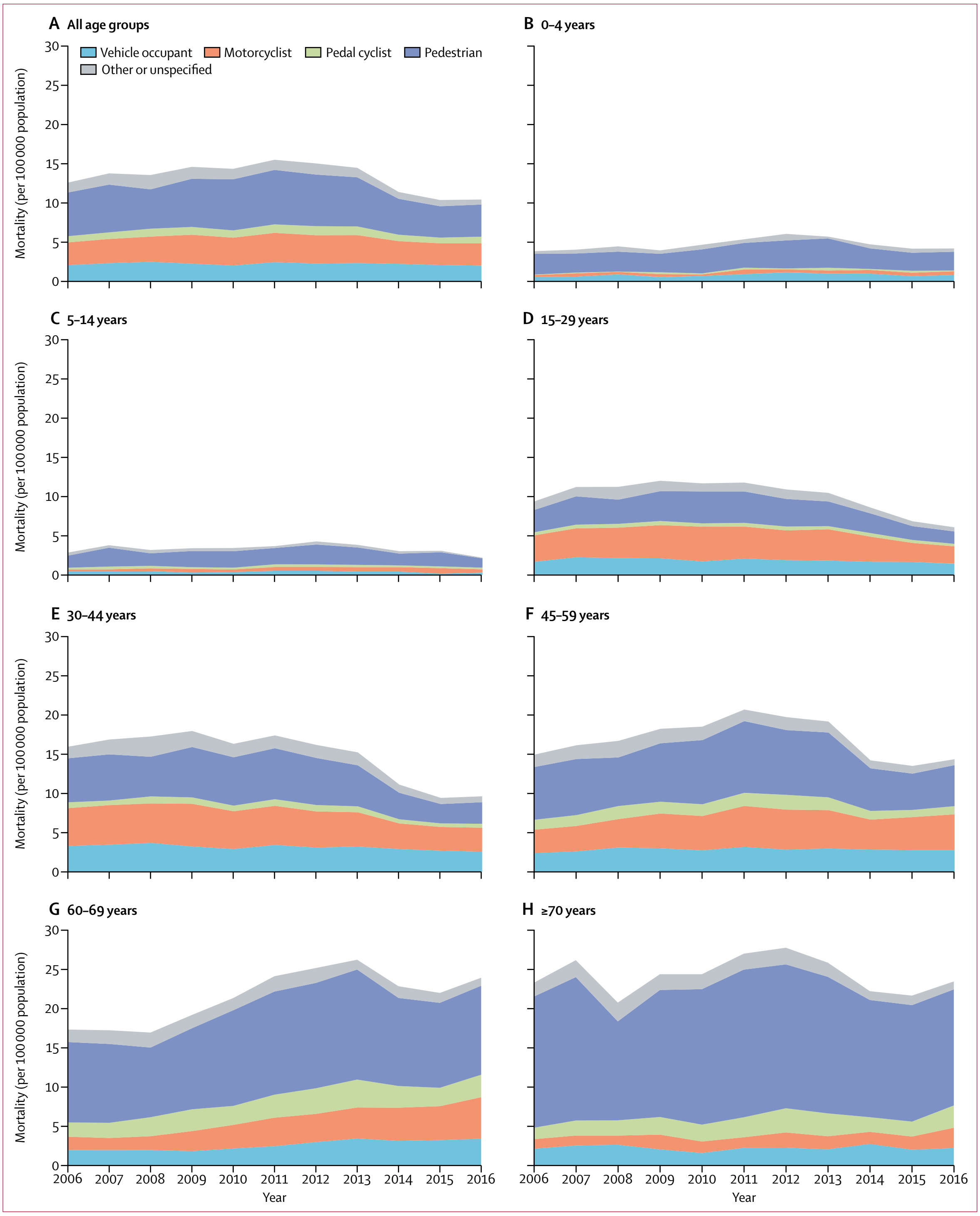

Figure 3: **Age-specific road traffic mortality by road user in China, 2006–16**
Mortality in all age groups (A) was age-adjusted using population data from the 2010 national census. Age-specific mortality is shown for age groups 0–4 years (B), 5–14 years (C), 15–29 years (D), 30–44 years (E), 45–59 years (F), 60–69 years (G), and ≥70 years (H).

from 2006 to 2016 in China yielded three key findings. First, overall age-standardised road traffic mortality increased from 2006 to 2011 then decreased to 2016. Second, we observed important disparities in mortality across place (urban and rural) and by sex, age group, and province. Finally, vulnerable road users—ie, pedestrians,

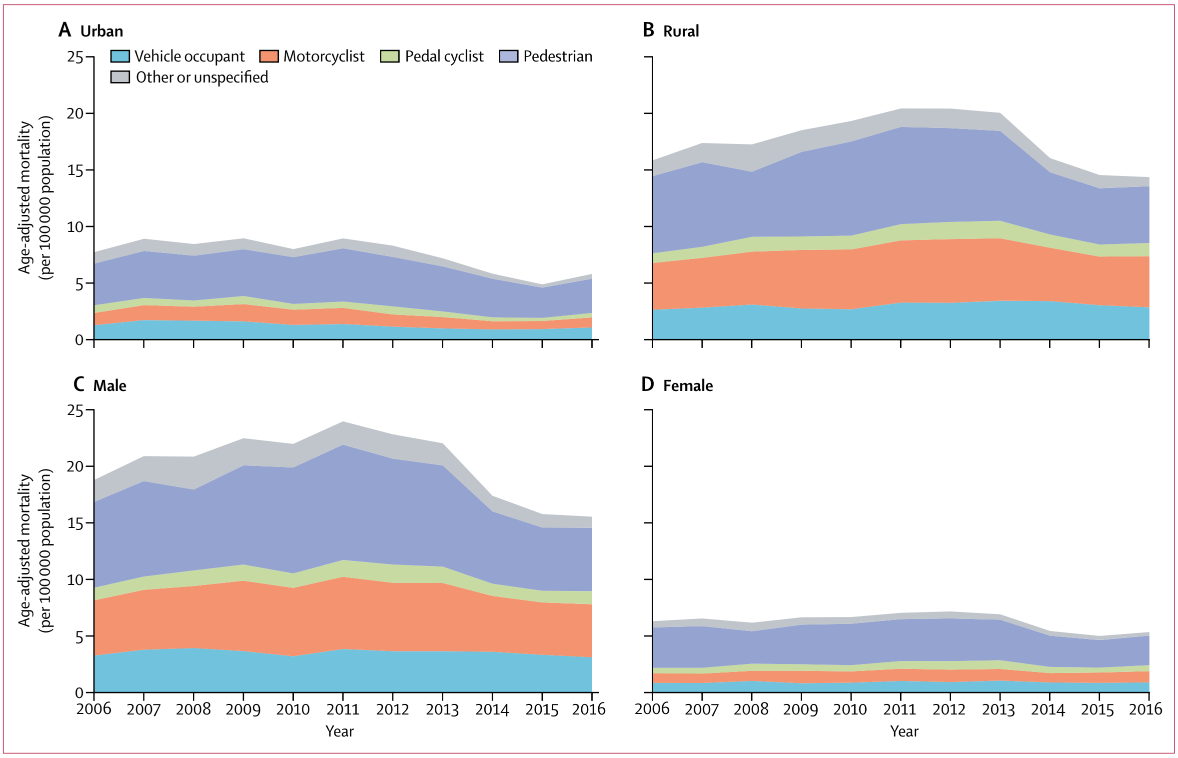

Figure 4: **Trends in road traffic mortality by place, sex, and road user in China, 2006–16**
Mortality rates were age-adjusted using population data from the 2010 national census for urban (A), rural (B), male (C), and female (D) data.

pedal cyclists, and motorcyclists—together constituted about three-quarters of deaths from road traffic accidents from 2006 to 2016 in China. The occupants most frequently dying in road traffic accidents were those riding in cars and three-wheeled motor vehicles.

Previous reports of road traffic mortality[16,17,19,24] have used police-reported data, the validity of which has been questioned because of possible under-reporting of data and scant epidemiological details for urban–rural differences, geographical disparities, and types of motor vehicle. By contrast, in our study we used the latest data from the disease surveillance points system to undertake nationally representative fine-grained analyses. Our results suggest road traffic mortality in China increased from 2006 to 2011, then began to decrease. Police-reported data show a different trend, with rates continuously decreasing from 6·8 deaths per 100 000 population in 2006 to 4·6 deaths per 100 000 population in 2016.[25] Further, our estimates suggest road traffic mortality rates could be more than two times the rate noted in police reports in 2016 (crude mortality 11·0 deaths per 100 000 population in our study *vs* 4·6 deaths per 100 000 population with police data). These disparities in data sources have been reported previously.[18]

Our crude road traffic mortality estimates in 2016 are significantly lower than those reported in GBD (11·0 deaths per 100 000 population *vs* 20·1 deaths per 100 000 population; appendix p 20). Because our study and GBD use different operational definitions and population structures,[22,26] we cannot directly compare the mortality rates across studies. However, mortality rates for transport injury in 2016 are very close between this study and GBD when we compare data from the same population structure and adopt similar ICD-10 codes (eg, 16·2 deaths per 100 000 population for disease surveillance points estimate *vs* 17·9 per 100 000 population for GBD estimate; appendix p 20). Similar disparities have been reported for injury deaths between US Government data and GBD estimates[26] and for country rankings on progress in road traffic mortality and mortality changes from WHO reports and GBD estimates.[27] The differences generally arise out of differing definitions for road traffic death across studies[22,26,28] and from GBD modelling strategies, which are designed to integrate other data sources as inputs of their estimates[29] and to redistribute so-called garbage codes.[28] The disease surveillance points dataset does not redistribute garbage codes, but such redistribution would not be likely to substantially affect our results because unqualified death reports are corrected according to the internal procedural check system used for disease surveillance points data. For example, a typical garbage code—eg, codes for deaths with unspecified causes—accounted for only 1·25% of all codes in 2015.[30]

Our estimates for 2015 suggest China has comparatively high road traffic mortality rates (10·8 deaths per

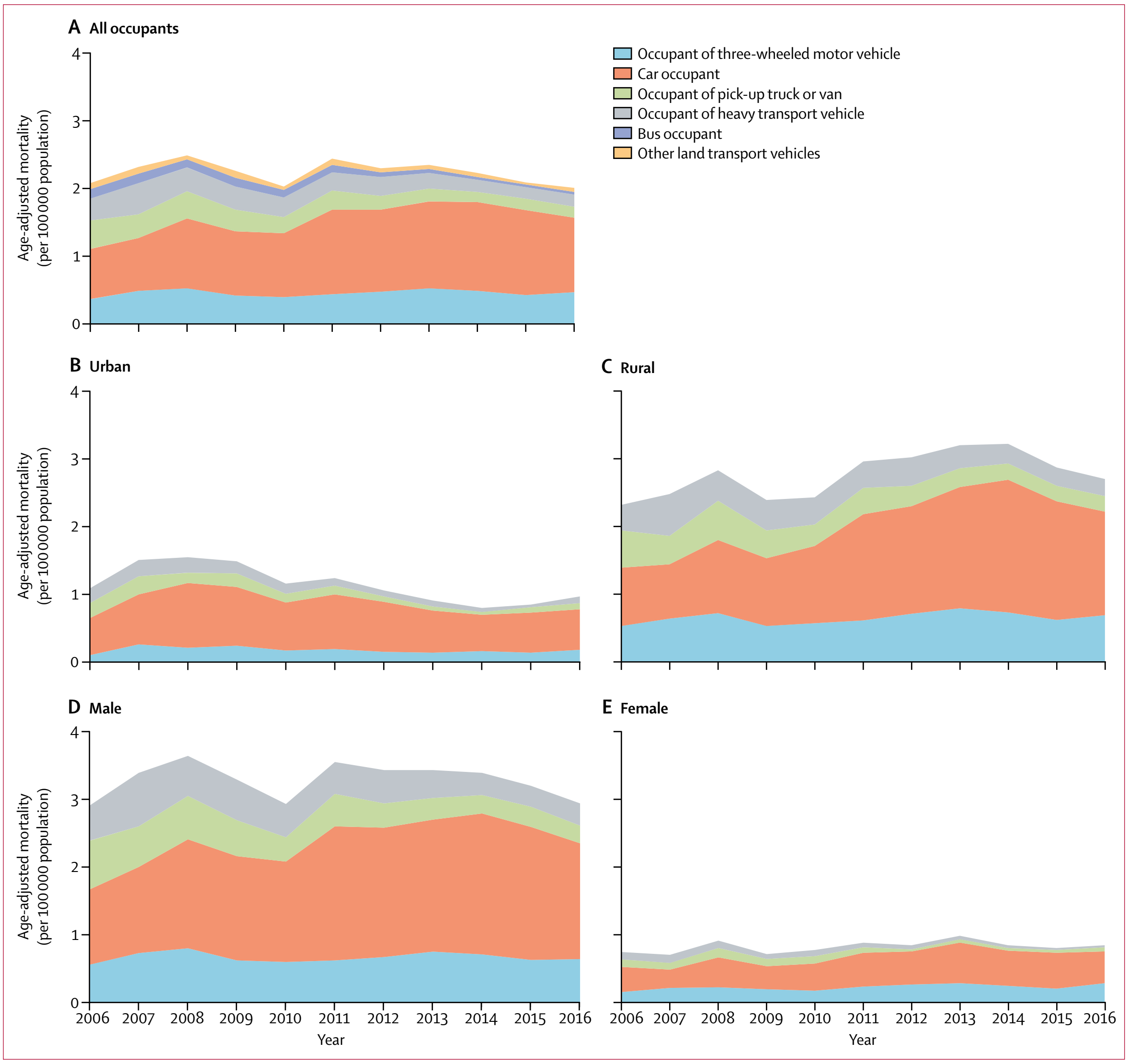

Figure 5: **Road traffic mortality among occupants by place, sex, and type of motor vehicle in China, 2006–16**
Mortality rates were age-adjusted using population data from the 2010 national census (A–E). Fewer than 20 deaths were recorded for bus occupants and other land transport vehicles and data for these motor vehicle types are excluded from place-specific (B, C) and sex-specific (D, E) mortality rates.

100 000 population; appendix p 1) compared with many high-income countries—eg, the UK (2·7 deaths per 100 000 population), Japan (4·2 deaths per 100 000 population), and Australia (5·4 deaths per 100 000 population).[31] These disparities might reflect Chinese uniqueness in culture and infrastructure—eg, different patterns of population mobility that include more pedestrians and bicycle and motorcycle travel; poorer road infrastructure, more lax traffic control, and inferior emergency and long-term trauma care in some regions; and different patterns of population ageing.[28]

The recorded decline in road traffic mortality in China since 2011 is encouraging, particularly considering a 31% increase in registered vehicles was reported over the same period.[25] The mortality decrease probably reflects substantial improvements in transportation infrastructure investment,[11] transition of transport mode,[12] and progress in the health-care system.[15] Between 2011 and 2015, ¥12·5 trillion (Chinese Yuan) were invested to improve transportation infrastructure across the country.[11] The number of passengers using trains rose from 5·3% in 2011 to 14·8% in 2016, corresponding to a decrease in the number of passengers using buses (from 93·2% to 81·2% over the same period).[12]

The Chinese Government has also been active in policy and public education programmes to improve road traffic safety. A national motorcycle helmet law was passed in 2004 to require both drivers and passengers to wear helmets, and national road traffic safety laws were revised in 2011 to increase safety in several domains, including increased penalties for drunk driving.[13,32] Continued education efforts have been made by the Chinese Government to raise road safety awareness among the public (eg, the Civilization Traffic Action Plan from 2010).[14] Moreover, a standardised trauma rescue and treatment network has substantially reduced emergency response times, prehospital transport times, emergency rescue times, and consultation call times resulting in lower patient mortality rates.[15]

In addition to confirming findings that males, rural residents, and older adults are at higher risk of road traffic mortality compared with females, urban residents, and younger people,[33,34] our study identified urban–rural and provincial disparities in mortality and mortality changes in China. These findings, which match reports concerning urban–rural and within-country disparities from the USA,[35] Peru,[36] and India,[37] could reflect a combination of risk factors in rural areas and underdeveloped provinces. These factors include poor road infrastructure and road traffic control, lagging economic development, lower quality of prehospital trauma aid and hospital treatment, different commuting methods, diverse population density, different policies for road traffic management (eg, the Chinese Government prohibited riding motorcycles in most large and medium-sized cities but encouraged automobiles and motorcycles in rural areas from 2009 to 2013),[38,39] but also less stringent road traffic policies and enforcement, and comparatively frequent law violations and risky behaviours.[25,33]

Another notable finding from our study is that vulnerable road users (ie, pedestrians, motorcyclists, and pedal cyclists) accounted for more than 70% of road traffic deaths in China. This figure is in line with data from other low-income and middle-income countries but is higher than data from high-income countries, where more road traffic deaths are reported for car occupants.[28] In particular, vulnerable road users such as pedestrians, motorcyclists, and pedal cyclists in rural areas and some provinces of China had very high mortality rates and significant increases in mortality between 2014 and 2016. The data patterns reinforce the urgency of efforts to protect vulnerable road users in China.

Finally, we found that occupants of cars and three-wheeled motor vehicles were the predominant road traffic mortality victims among vehicle occupants. This result is not surprising. Cars constitute most registered motor vehicles in China (84% of registrations in 2016).[25] Three-wheeled motor vehicles—although rarer in China—are easily flipped, and jeopardise the safety of their drivers and passengers.[40] Along with their risk of flipping, three-wheeled vehicles also usually do not have safety devices such as air bags, antilock brake systems, and seatbelts, and they are typically poorly maintained and overloaded.[40]

Potential actions to reduce road traffic mortality include city and transport planning,[41] protective policies for vulnerable road users,[24] improved post-crash responses,[1,28] infrastructure for pedestrians (eg, construction of side-walks, raised crossings, traffic signals, and refuge islands), and legislation and law enforcement to prohibit risky behaviours (such as drinking, speeding or failure to use helmets, seatbelts, or child restraints).[28] If fully implemented, proven solutions recommended by WHO[1,28] could reduce road traffic injuries substantially in China.

Also needed are efforts to address emerging trends in road safety risk. Recent transport innovations in China—including electric bicycles, shared bicycle apps, and app-based taxi hailing services—challenge current road traffic safety laws and regulations. Electric bikes typically operate at higher speeds than do traditional bicycles, but Chinese law does not require riders of electric bikes to register their bikes, obtain driver's licences, or wear helmets.[42]

Our study has some limitations. The disease surveillance points system does not gather information on travel exposure, non-fatal road traffic injury, or relevant factors such as road environments, circumstances of crashes (eg, violation of laws when the crash occurred, or use of helmets, seatbelts, or child restraints). Such information is obtained by police reports and other sources in some cases and would be valuable to integrate into findings from the disease surveillance points system in future research. Because of scant data about road traffic exposure (eg, the number of motor vehicles or million miles travelled for the national disease surveillance points), we did not assess progress in road traffic injury prevention based on exposure data; our findings should be interpreted with caution in view of not considering road traffic exposure in this study. Further, our results are probably affected by the incompleteness and misclassification of disease surveillance points data, although these data are routinely checked and corrected through many internal procedural checks and independent sample surveys.[19] Efforts should be made to continue to improve the validity and timeliness of road traffic injury data in China, and to translate epidemiological results into prevention practice to reduce injuries.

In conclusion, road traffic mortality in China has been decreasing since 2011, but progress is inadequate for China as a nation to achieve the global SDG target of halving deaths by 2020 without new and substantial efforts to accelerate progress. Large urban–rural disparities remain and there are wide variations in mortality rates and mortality changes across provinces. Very high mortality rates exist among vulnerable road users, particularly pedestrians and occupants of cars and three-wheeled motor vehicles. Actions, such as those recommended by WHO, should be implemented across China to accelerate progress in reducing the burden of road traffic injuries on public health.

Contributors

GH, MZ, PN, and LW developed the ideas for this research and drafted the initial report. PN analysed data. GH, DCS, and PN wrote the final version of the report. PY, JL, YW, YL, JQ, and XZ collected and checked data. GH, MZ, LW, PN, and PC interpreted data. All authors reviewed and approved the final version.

Declaration of interests

We declare no competing interests.

Data sharing

Data used in this study can be accessed by contacting the Division of Vital Registration and Cause of Death Surveillance, National Center for Chronic and Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention (email crvsdata@chinacdc.cn).

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