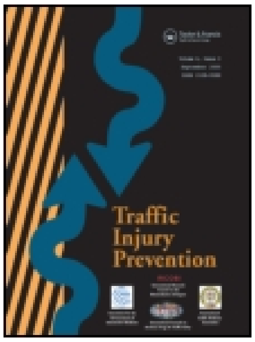

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Road Traffic Injury in China: A Review of National Data Sources

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Objective: *Road traffic injury (RTI) has become one of the leading causes of deaths in China, yet numbers on road traffic deaths are often inconsistent. This study sought to systematically review 4 national-level data sources that can be used to estimate burdens of RTI, including mortality, injury, and crashes in China.*

Methods: *We conducted structured literature reviews in PubMed, using combined key words of injury or fatality or injury surveillance and traffic and China in order to identify relevant studies (in both English and Chinese) and data sources. We also conducted interviews and hosted seminars with key researchers from the Chinese Center for Disease Control and Prevention (Chinese CDC) to identify potential useful data sources for injury surveillance. We then extracted key information from publicly available reports of each data source.*

Results: *Four national-level data sources were reviewed and compared: Ministry of Health-Vital Registration (MOH-VR) System, Chinese CDC-Disease Surveillance Points (DSP), Chinese CDC-National Injury Surveillance System (NISS), and police reports. Together they provide a complementary yet somewhat contradictory epidemiological profile of RTIs in China. Estimates on road traffic fatalities obtained from MOH-VR and police reports are often used by researchers and policymakers, whereas DSP and NISS, both with great merits, have virtually not been used for RTI research. Despite the well-documented problems of underreported deaths with both MOH-VR and DSP, estimated road traffic deaths from both systems were 3 times those reported by the police.*

Conclusions: *As the foundation of injury prevention, national-level data sources and surveillance systems were reviewed in the study. Existing data infrastructures present the Chinese government a great opportunity to strengthen and integrate existing surveillance systems to better track road traffic injury and fatality and identify the population at risk.*

Keywords Road traffic injury; road traffic fatality; injury surveillance; China

INTRODUCTION

China has experienced an average annual growth in its gross domestic product (GDP) of 8.7 percent per year since 1978. The strong economic growth has been accompanied by a rapid rise in motorization. The number of motor vehicles has also increased significantly, from 42 million in 1997 to 145 million in 2006. In addition, the length of express highways nearly tripled in just 6 years, from 19,500 km in 2001 to 53,000 km in 2007 (Zhang et al. 2010). In early 2009, China became the world's largest automobile market, surpassing the United States for the first time in total car sales (Overholt 2010). In 2010, the total sales were 18.1 million, a 32.4 percent increase from 2009.

Corresponding to the rapid growth in road construction and number of vehicles, road traffic injury (RTIs) have become a serious public health problem in China. Wang et al. (2008) estimated that deaths from vehicle collisions increased 97-fold from 1951 to 1999; and RTIs have become a leading cause of death, accounting for 3.25 percent of all deaths and one third of all injury-related deaths between 2002 and 2006. In 2010, there were 65,225 road traffic deaths, according to the Traffic Management Bureau of the Ministry of Public Security (MPS; 2010). Researchers have found that high death rates occurred in both developed coastal provinces (such as Jiangsu Province) and underdeveloped western provinces with low population density such as Tibet (Hu, Bakar, et al. 2008). Additionally, it has been estimated that motor vehicle crashes caused 25 percent of total productive years lost from all injuries (Zhou et al. 2003).

In addition to researchers, the country's leaders have also come to realize the magnitude and consequences of RTIs. In 2007, the Development and Research Center of the Chinese State Council published a report that identified several major problems of RTIs in China, including high fatality rates for vulnerable road users, poor road safety awareness, lack of safety

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Table I Key national traffic injury data sources and RTI indicators in China

Data systems	MOH-Vital registration data (MOH-VR) (Ministry of Health China 2009)	Disease Surveillance Points (DSP) (Chinese Center for Disease Control and Prevention 2010)	National Injury Surveillance System (NISS) (Chinese Center for Disease Control and Prevention 2010)	Police-reported (Traffic Administration Bureau of the Public Security of PRC 2010)
Source	Ministry of Health (MOH)	CDC Information Center	CDC Chronic and Non-communicable Disease Control and Prevention (NCNCD)	Ministry of Public Security
Start year	1987	1990	2006	1995
Frequency	Annual	Annual	Annual	Annual
Reports	*China Statistical Yearbook of Health*	DSP Annual Report	NISS Annual Report	Yearbook of China Transportation and Communication
Population coverage	41 Urban and 85 rural centers, covers 8–10% of total population	161 Surveillance points, covers 73 million (6% of total population)	129 Hospitals in 43 counties/cities from 36 provinces, municipalities, autonomous regions and separate planning cities;	Nationwide
Aggregated report	ICD-10 by age, gender, and region	ICD-10 by age, gender, and region	Detailed injury types by age, gender, and region	Aggregated by crash causes
RTI indicators				
Crashes				X
Nonfatal injuries			X	X
Fatal injuries	X	X	X	X
Geographical location	X	X	X	X
Cause of RTI	X	X	X	X
Outcome of nonfatal injuries			X	
Cost data				X
Number of registered vehicles				X
Road usage data				X

standards in road construction, and deficiencies in road safety laws and regulations (Development and Research Center of State Council 2007).

Though injuries, and RTIs in particular, arise as an emerging public health concern, injury surveillance systems could provide unbiased information on who are injured, the circumstances and nature of the injuries, the use or the lack of protective devices, and the consequences (Horan and Mallonee 2003). The capacity for national-level injury surveillance has grown in recent decades in developed countries (Rivara 2003), yet it remains a major challenge among developing countries (Pressley and Mello 2010). China has established several national-level surveillance systems in the past decade. A growing body of studies has used these data sources to make national-level estimates of mortality and morbidity; however, no study has systematically reviewed these data sources for RTI research. Therefore, in this study, we intend to systematically review 4 national-level data sources that can be used to estimate the burden of RTIs, including mortality, injury, and crashes. We will also discuss the advantages and limitations of each data source, identify the discrepancies between data sources, and discuss how the data systems can be improved.

METHODS

We conducted structured literature reviews in PubMed, using combined key words of injury or fatality or injury surveillance and traffic and China in order to identify relevant studies (in both English and Chinese) and data sources. We also conducted interviews and hosted seminars with key researchers from the Chinese Center for Disease Control and Prevention (Chinese CDC) to identify potential useful data sources for injury surveillance. We then extracted key information from publicly available reports of each data source. Finally, we developed an evaluation matrix to systematically review and compare the 4 data sources and systems for surveillance of RTIs in China, including the primary aspects of each of the data sources, including data collectors, years, population coverage, and publicly available reports (Table I). Table I also demonstrated the availability of various key indicators pertaining to RTI by these data sources. Finally, we estimated and compared the key indicators of RTI fatality from different data sources.

RESULTS: REVIEW OF DATA SOURCES AND RTI INDICATORS

The results section is structured as follows: we first present the description and our evaluation of each data source and then we present the estimated burden of RTI in China by mortality injury, and crash from the 4 national data sources.

Ministry of Health-Vital Registration (MOH-VR) System

China's health sector has 2 mortality registry systems that include fatal injuries. The first system is the Ministry of Health vital registration (MOH-VR) system, covering about 10 percent of the total population (110 million) in 2000. MOH-VR was established by MOH in 1987 to collect facts and causes of death. Currently, it covers 41 urban (15 large cities and 21 middle/small cities) and 85 rural centers, most of which are located in provinces in the eastern and central China. Only a few are located in the western regions (Yang et al. 2005). The diagnosed causes of death come from physicians' death certificates, which classify RTIs according to the International Classification of Diseases (ICD-10) codes. The MOH-VR aggregated data are publicly available in the *China Health Statistics Yearbook*.

There are a number of limitations of this data source: MOH-VR reports age-adjusted mortality for 14 selected causes of injury, far fewer than the complete causes of injury recommended by the International Classification of Diseases (Hu, Wen, et al. 2008). Nonfatal injuries are also unavailable through this registration system. A major limitation of this system is that birth registration is not included, and therefore infant deaths cannot be linked to births, and there are high rates of missing deaths, especially among infants and young children. Additionally, the coverage of this system is not geographically representative and is biased toward the more affluent urban and eastern China. The underrepresentation of rural areas in results in lower death rates of road traffic injury death rate as the rate is higher in less affluent areas in China.

Chinese CDC-Disease Surveillance Points (DSP)

The second death registration system is the DSP system. DSP was launched in 1978 and became nationally representative in 1990. It was revised in 2005. This system was designed to be a sample-based system to collect data on births, causes of death, and the incidence of diseases (Yang et al. 2005). To better represent the characteristics of the general population from different geographic locations, DSP uses a multistage cluster probability sampling strategy with stratification according to 3 major indicators. The first indicator is the 3 geographic regions (east, west, and central areas) and the 3 municipalities (Beijing, Shanghai, and Tianjin); the second indicator for stratification is the local gross domestic product (GDP) and proportion of rural dwellers; and the third indicator is the total population of local areas, based on the 2000 Census (Zhou et al. 2010). Currently, DSP has 161 surveillance points, covers a population of 73 million (approximately 6% of the total population), and represents the national population (Zhou et al. 2010). The diagnosed causes of death also come from physicians' death certificates, which classify RTIs according to the ICD-10 codes.

The DSP aggregated data are publicly available in the *Dataset of National Disease Surveillance Points System*. DSP was introduced to generate cause-specific mortality statistics, and it uses independent resurveys (every 3 years) and statistical techniques to estimate the completeness of registration. The mortality rates of the DSP system were found to reflect the broad cause, group-specific mortality distribution more accurately, especially in rural areas, than MOH-VR and therefore have been used to estimate disease burden (Lopez et al. 2006). However, DSP also suffers from high rates of missing deaths (Rao et al. 2005), particularly among young children. Nonfatal injuries are also unavailable through this registration.

Chinese CDC-National Injury Surveillance System (NISS)

The National Center for Chronic and Non-communicable Disease Control and Prevention (*NCNCD*) established a hospital-based National Injury Surveillance System (NISS) in 2006, which collects information about first-visit patients treated in the hospitals and diagnosed as injury. Currently, this system covers 129 hospitals in 43 counties (surveillance points) and cities from 31 provinces and 5 municipalities. It used the DSP's 3-level sampling strategies to select hospitals in order to better represent rural and urban areas. In each of the 43 surveillance points, 3 hospitals were selected to represent first-tier, second-tier and third-tier hospitals and clinics (Duan et al. 2010). NCNCD designed and disseminated a "national injury surveillance report card." Trained doctors and nurses at each hospital were responsible for completing the report cards. The report card includes patients' demographic information (name, gender, age, ID, education, and occupation), circumstances of the injury (event, time, place, cause, and intention), and nature of the injury (clinical diagnosis, severity, consequences, and body parts), using ICD-10 codes. Compared to MOH-VR and DSP, hospital-based NISS is newly established and has smaller population coverage, but it can provide valuable and unique data on nonfatal injuries, severity of injuries, and treatment outcomes.

Police-reported data

Police-reported data represent the main source of crash data for road safety research worldwide. Their comprehensiveness, accuracy and reliability, and comparability are of great interest to researchers (Loo and Tsui 2007). In China, the Ministry of Public Security (MPS) is in charge of the transportation police, and police-reported data are extracted from police records on a standardized, closed-ended data collection form (Hu et al. 2011). All individuals who die of traffic-related injuries within 7 days of the incident are recorded as road traffic fatalities (Zhang et al. 2004). National police-reported aggregated data are publicly available in the *China Statistical Yearbook of Communication and Transportation,* published by the National Road Traffic Bureau. This data source has been used to make the "official" estimates of road traffic fatalities in China and is approved to use in international scenarios by Chinese governments (World Health Organization [WHO] 2009).

Burden of RTI

We present the estimated burden of RTIs in China by mortality, injury, and crash from the 4 national data sources discussed above. In all cases, the latest year available has been presented, unless indicated otherwise.

Mortality

All 4 data sources reported road traffic mortality. Because NISS is newly established and has limited coverage, we will focus

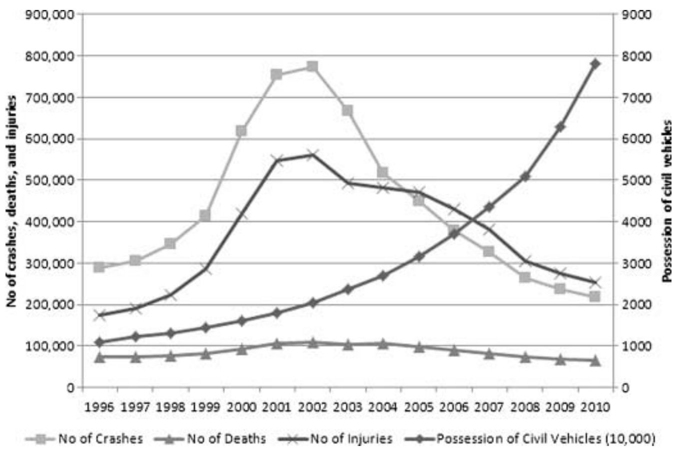
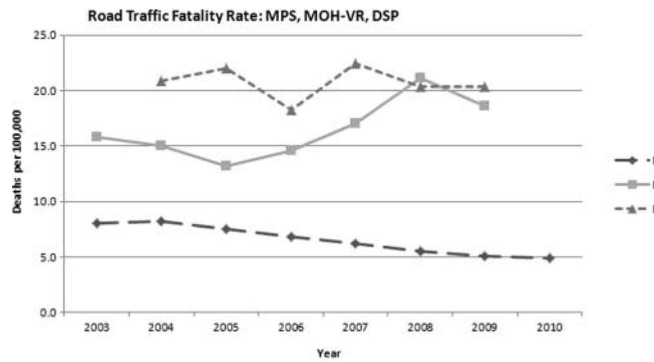


Figure 1 Police-reported of road traffic injury data and number of total registered vehicles, 1996–2010.



Note: MOH-VR: MOH-Vital registration data; DSP: Disease Surveillance Points; MPS: Ministry of Public Security

Figure 3 Comparisons of road traffic fatality rate from 3 data sources.

on comparing the other 3 data sources for estimates on road traffic mortality. According to the police data, the total number of road traffic mortalities peaked in 2002 at 109,381 and then started to continuously decrease to 67,759 in 2009. Road traffic mortality rates over time show a bell shape (Figure 1): peaking in 2002 at 109,381 and decreasing to 65,225 in 2010. Crashes and fatalities have decreased since 2002, though the total number of cars continuously grew rapidly during the same time period (Fig. 1); this apparent contradiction needs to be explored further.

Both MOH-VR and DSP also have data on road traffic deaths and have used the ICD-10 coding system since 2002, which allows us to extract aggregated data on traffic-related deaths, total deaths, and all injury-related deaths. Because DSP is reported to be more representative of the whole nation, we therefore present fatalities by age, gender, and location using DSP 2008 data (Fig. 2). Overall, there were a total of 15,012 road traffic deaths from DSP in 2008 (covering about 5.5% population), among which 11,603 were male (77%) and 3,409 were female (23%); 3876 deaths (26%) occurred in urban areas and 11,136 (74%) in rural areas. The highest incidence of road traffic deaths (RTDs) occurred among young adults aged 20 to 45, particularly males, and in rural areas.

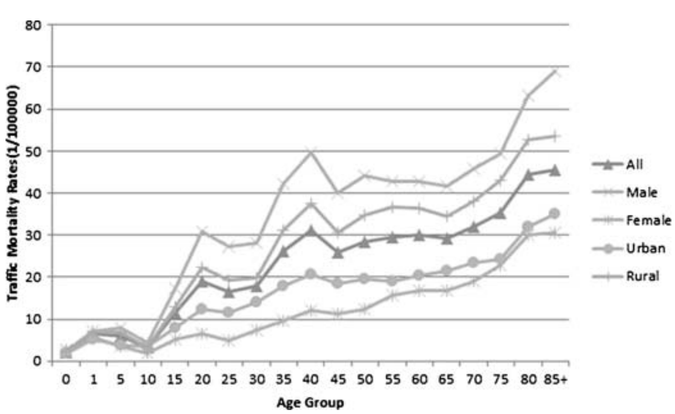


Figure 2 Rate of road traffic deaths (per 100,000), by age, gender, and rural/urban areas in China, 2008. Data source: Disease Surveillance Points (DSP) 2008.

Others have documented underreporting in police estimates of road traffic deaths when compared to the health sectors in many countries including China (Dandona et al. 2008; Jeffrey et al. 2009; Loo and Tsui 2007; McDonald et al. 2009). Hu and colleagues (2011) reported that from 2002 to 2006 the police-reported rate of road traffic deaths was consistently less than 62 percent of the rate obtained from MOH-VR. Replicating Hu et al.'s contribution, we estimated rates of road traffic deaths from MOH-VR, DSP and from police data, respectively (Fig. 3). The rates of traffic death reported by MOH-VR and DSP are much higher than that obtained from the police. The rate from DSP is even higher than that of MOH-VR between 2004 and 2006. Between 2007 and 2008, the 2 health sectors' rates of road traffic mortality virtually converged.

Injury

Both police-reported data and NISS have information on RTIs. Police-reported data show that the number of RTIs also peaked in 2002, as did the number of crashes. In 2002, there were 562,074 overall RTIs and 0.73 injuries per crash. The total number of RTIs started to decline from 2003 and reached 254,075 in 2010 (Fig. 1.), but injuries per crash continued to increase to 1.15 in 2009. That means that the decline in RTIs is slower than the declination in total number of crashes over the same time period. Again, it is unclear why there was such decrease in overall RTIs since 2002.

The NISS data shows there were 109,312 RTIs in the 129 hospitals in 2008. RTI was the second cause of all types of injuries that resulted in emergency department visits, constituting 21 percent of all injuries (n = 520,535). Among all RTIs between 2006 and 2009, the majority of injuries (59%) resulted in contusion or bruise, 16 percent led to fractures, 9 percent resulted in brain concussion, and 8 percent led to sharp instrument injuries (Fig. 4). A majority of the patients (62%) were treated and returned home, 37 percent were hospitalized, and less than 1 percent died.

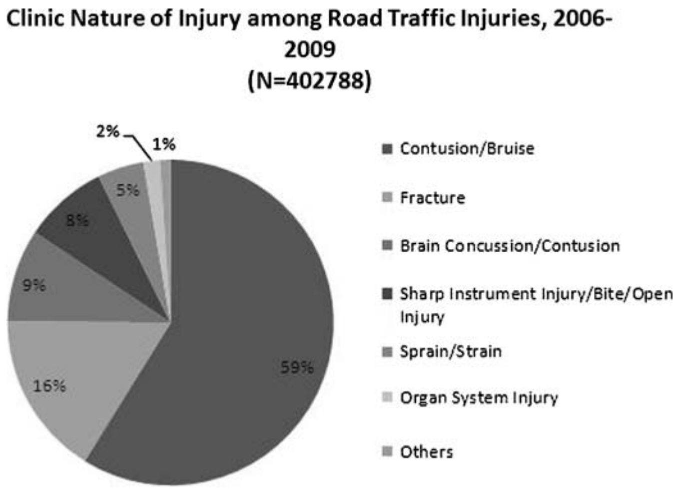


Figure 4 Clinic nature of road traffic injuries, 2006–2009. Data source: China Injury Surveillance 2006–2009.

Crash

Only MPS data have information on the number of crashes. We extracted relevant data from the *China Statistics* yearbooks from 1996 to 2009. However, the publicly available data do not allow disaggregated analysis by age, gender, or areas. The total number of crashes peaked in 2002 at 773,137 nationwide and then continuously declined to 219,521 in 2010 (Fig. 1), which was even lower than the number in 1996 (287,685). It is unclear why there has been such a decreasing trend, given that the number of vehicles kept increasing during the same period. We projected the number of crashes based on the ratio of number of deaths per crash from the police data and total number of road traffic deaths from DSP and concluded that the actual number of crashes could be between approximately 973,237 and 1,314,143 per year, which could be more than a 4-fold difference from the police-reported number of crashes.

In summary, Table I systematically evaluates characteristics (source, year, frequency, population coverage) and RTI indicators for each data source. Three data source have annual national data (MOH-VR, DSP, and police data); all 4 data sources have fatal injuries and causes of fatal injuries, but only 2 data sources have nonfatal injuries (NISS and police data); only police data have information on crashes, cost, number of vehicles, and road use.

DISCUSSION

This study introduces readers to 4 national data sources that contain key indicators of RTIs. There are a number of strengths of the existing data systems: MOH-VR and DSP both use ICD-10 coding systems, which can provide detailed information on the epidemiology of RTI fatalities by road user category (motor vehicle drivers, passengers, cyclists, pedestrians, etc.), age groups, gender, and location. Such information could enable researchers to calculate loss of life expectancy due to RTIs and identify the population at risk for RTIs. Additionally, both death surveillance systems have been in place for more than a decade, which provides an opportunity to observe trends in mortality due to RTIs. Comparison of road traffic deaths from the 2 data sources can provide researchers a sense of lower and upper bounds for the burden. DSP, in particular, uses a nationally representative sampling strategy and has better national representation of geographic locations. For RTI research, this is particularly important, because rural areas are repeatedly found to have higher RTI mortality rates than those in urban areas in China (Hu et al. 2006; Li and Baker 1991). Disproportionally underrepresenting the rural areas will lead to an underestimate of the overall mortality rate of RTIs. From the perspective of prevention efforts, it is equally important to gain a better understanding as to why rural areas bear such disproportionally high mortality rate of RTIs, considering that only 50 percent of Chinese population resides in rural areas (China Academy of Social Sciences 2011). One hypothesis could be that the high fatality rate is a result of lower access to urgent care and/or poor quality of care in the rural areas.

Despite DSP's several merits, we found that it had not been widely used for RTI research. We identified 8 articles published in English that focused on general RTI mortality in China (Dong et al. 2010; Hu et al. 2011; Hu, Bakar, et al. 2008; Jiang et al. 2011; Li and Baker 1991; Wang et al. 2003, 2008; Zhang et al. 2010). None of them used DSP data. Nevertheless, our review points out that DSP data have great potential for RTI research. The caveat of using both data sources is that they are both known for having high rates of missing deaths. One study used both general growth balance and synthetic extinct generations methods to evaluate the underreporting of deaths in DSP and found that the underreporting rate could be between 11 and 48 percent, with higher rates among younger age groups (Wan et al. 2009). Therefore, it is necessary to use demographic methods to adjust for underreports.

The Chinese CDC's NISS has many unique strengths: despite its rather short history (5 years to date), it collects data through specifically designed forms that contain thorough information on causes, medical nature, severity, and consequences of injury, which other data sources lack. Given time, it could become a valuable source of RTI research.

Despite the apparent underreports of road traffic crashes, injuries, and deaths, the police-reported data have several merits. Police data are the only data source for any information on crashes and direct economic losses due to crashes. According to the police report cards, detailed information such as weather, road conditions, time, and number of cars involved are all recorded and potentially allow further analysis. A concern regarding using the police data comes from the fact that the police report cards list more than 20 causes of crashes, including speeding, drink/drunk driving, taking wrong turns, and driving in the wrong direction. Police officers are expected to check the most "direct" cause of the crash from the list, so a driver under the influence of alcohol who took a wrong turn would be listed as "wrong direction" rather than "drink/drunk driving," even though the in influence of alcohol is the fundamental reason. Therefore, crashes or RTIs due to speeding or drink/drunk driving could be potentially underestimated.

Finally, in this study we only discussed aggregated data from publicly available reports of each data source. The actual microdata have much richer and detailed information that can be very informative. For example, both MOH-VR and DSP use ICD-10 coding, which means one ought to be able to estimate road traffic fatalities by road user types and the clinical nature of fatalities. The existing data sources have not been fully explored and utilized for RTI research or to inform policy. Additionally, despite the abundant information from the 4 data sources, some information about RTIs is still not available. These 4 data sources do not measure long-term consequences like disability, hospitalization data (such as length of stay and medical expenditures), and road users' knowledge, attitudes, and behaviors. Complementary data sources such as national and local household surveys, hospital surveys, hospital chart reviews, and roadside observations and surveys would be needed to close the gaps in missing information.

In summary, we provide the following framework for researchers and policy makers who are interested in using China's national data sources: to make national estimates of road traffic fatalities and causes of fatalities, because DSP's sampling strategy is reported to be most representative, it should be used but needs to be adjusted to represent the whole population. If possible, statistics from MOH-VR should be reported as well as complementary measures. To make national estimates of nonfatal road traffic injuries and number of crashes, one can apply the ratio of nonfatal injuries to fatalities and the ratio of crashes to fatalities from the police data to DSP's fatalities.

CONCLUSION

RTIs have become the leading cause of injury deaths in China. As the foundation of injury prevention, national-level data sources and surveillance systems were reviewed in the study. Existing data infrastructures, although imperfect, offer a good foundation for the Chinese government to strengthen and integrate existing surveillance systems to better track RTIs and fatalities, and identify the population at risk.

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