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Injury-related fatalities in China: an under-recognised public-health problem

SY Wang, YH Li, GB Chi, SY Xiao, J Ozanne-Smith, M Stevenson, MR Phillips

The May 2008 earthquake in Wenchuan drew attention to the important but largely unrecognised public-health problem of injury-related mortality and morbidity in China. Injuries account for more than 10% of all deaths and more than 30% of all potentially productive years of life lost due to premature mortality in China. Traffic-related injuries (mainly among cyclists and pedestrians), suicide, drowning, and falls account for 79% of all injury deaths. Rural injury death rates are double those of urban rates and male rates are double those of female rates. Despite an 81% increase in the traffic-related mortality from 1987 to 2006—associated with rapid motorisation—the overall injury mortality decreased by 17%, largely due to a surprising (and unexplained) 57% reduction in the suicide rate. Low-cost prevention measures that are most likely to produce large reductions in injury deaths include enforcement of laws for drinking and driving and for seat belt and helmet use, restriction of access to the most potent pesticides, and teaching children to swim. China needs to improve monitoring of fatal and non-fatal injuries, promote intersectoral collaboration, build institutional capacities, and, most importantly, mobilise community support and political will for investment in prevention.

Introduction

On May 12, 2008, an earthquake occurred in Wenchuan, China. More than 69 000 people were confirmed dead, more than 374 000 were seriously injured, and more than 18 000 were reported missing.¹ Intense national and international attention was focused on the rescue and reconstruction efforts, with little appreciation of the fact that these fatalities represent less than a tenth of China's yearly injury-related mortality, an under-recognised public-health problem that results in more than 800 000 deaths per year.

China's rapid economic growth has been accompanied by substantial changes in modes of transport, housing, and other ways of life, all of which affect exposure to risk factors for injury and, thus, the characteristics of injury-related mortality and morbidity in the country. In the past two decades, the main transportation mode has changed from animal carts and bicycles to motor vehicles; more than 8 million new cars are sold in China each year.² The population is ageing and rapidly urbanising; from 1982 to 2005, the proportion of the population aged 65 years and older increased from about 5% to 8% and the proportion living in urban areas more than doubled from 21% to 43%.³ Before the economic reforms, most of China's population lived in fairly similar levels of poverty, but since the reforms started in 1978 the gap between rich and poor has widened; by 2004, the gross domestic product per person in the richest province was 13 times greater than that in the poorest province.⁴ And increased access to worldwide media, exposure to western value systems, and participation in national and international web-based networking have contributed to wide-ranging changes in traditional values and cultural practices. All of these changes fundamentally alter the risk, prevalence, and demographic profile of different types of injuries.

The focus of China's health system has been on infectious and chronic diseases, but more recently health authorities have begun to recognise the importance of injury to the health and sustainable development of the country.⁵

In this paper, we describe the scope and nature of the injury problem in China in the context of epidemiological, technological, and cultural transitions. We consider all International Classification of Diseases (ICD) categories of intentional and unintentional injuries,⁶ except medical misadventure and war (table), and provide a detailed analysis of the China-specific characteristics of the three most important causes of injury-related mortality—road traffic and transport injury, suicide, and drowning.

Epidemiology of injury mortality

China has two mortality registry systems—the Ministry of Health vital registration (MOH-VR) system, covering about 8% of the population (110 million individuals), and the Disease Surveillance Points (DSP) system, covering about 1% of the population (10 million individuals).⁷ Detailed assessments of the quality of these registration systems^{8,9} have identified both strengths and weaknesses. On the positive side, both systems have restricted use of ill-defined categories, expected patterns of death by age and sex, and satisfactory consistency in cause-specific mortality with time. The DSP data are more geographically representative (which is why this system was used in the global burden of disease estimates¹⁰) but both systems have high rates of missing deaths and problems with content validity (mixing uniform death certification for deaths in institutions with verbal autopsy data for deaths at home).

Because the DSP system stopped gathering mortality data in 2000, we used data from the MOH-VR system for estimation of injury-related mortality. Since 1987 the

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Centre for Injury Prevention and Control, Medical College of Jinan University, Guangzhou, Guangdong, China

(Prof SY Wang, GB Chi MSc); Shanghai Municipal Centre for Disease Control and

Prevention, Shanghai, China (Prof YH Li MPH); School of Public Health, Central South University, Changsha, Hunan, China (Prof SY Xiao MD);

Monash University Accident Research Centre and

Department of Forensic Medicine, VIC, Australia

(J Ozanne-Smith); The George Institute for International Health, University of Sydney, NSW, Australia

(Prof M Stevenson PhD); The George Institute, China, Peking University Health Science

Centre, Beijing, China (M Stevenson); WHO

Coordinating Centre for Research and Training in Suicide Prevention, Beijing

Suicide Research and Prevention Centre, Beijing Hui Long Guan Hospital, Beijing, China (Prof MR Phillips MD);

and Departments of Psychiatry and Epidemiology, Columbia University, New York, NY, USA

(MR Phillips)

Correspondence to:

Prof MR Phillips, Beijing Hui Long Guan Hospital, Beijing 100096, China

phillipschina@yahoo.com

MOH-VR system has reported mortality data every year (according to ICD categories) by 5 year age groups for both sexes living in urban and rural areas, resulting in 72 separate cohorts.^{11,12} For each year from 1987 to 2006, we estimated the proportional mortality of each type of injury (ie, injury-specific mortality divided by all-cause mortality) in each of the 72 cohorts in the MOH-VR sample (ie, >100 million individuals). These proportions were then applied to the total number of deaths nationally in each cohort estimated from census bureau data (which provides independent estimates of total yearly mortality¹³⁻¹⁵) to generate the number of deaths for each type of injury in the whole country in each cohort for each year. The frequency of deaths in combined cohorts (eg, all individuals in urban and rural areas) are divided by the population of the corresponding cohort to generate cohort-specific rates of the different types of injury.

The census estimates of total mortality are greater than those based on projection of MOH-VR all-cause mortality rates to the population (an average of 20% during 2002-06); therefore this method of adjustment partly compensates for the absence of completeness (missing deaths) in this system. The method also partly deals with the unrepresentativeness of the MOH-VR sample because cohort-specific projections to the total population remove the effect of the excess of urban residents in the sample. However, several caveats remain, which should be considered during interpretation of the results. We

have not dealt with the difficulty of content validity (combining institutional and home-based death data). Our adjustment assumes that each of the 72 cohorts in the MOH-VR sample is nationally representative of all people in the cohort and that missing deaths are evenly distributed across causes. The definition of urban versus rural residents in the census data and the MOH-VR data are a little different, and the registry system has not yet adequately dealt with the problem of where and how to register deaths among the large floating population of rural-urban migrants. Finally, the census bureau might underestimate total deaths; our estimates of total injury deaths are slightly less than the WHO global burden of disease estimates (by 7% in 2002¹⁶) mainly because the WHO adjusts rates based on higher estimates of total deaths computed using the general growth-balance method.¹⁷

Changes in the coding of other transport injury and road traffic injury after the MOH-VR system started using the tenth version of the ICD code in 2002 made the combination of these categories (labelled traffic-related injuries) necessary to ensure consistency over time. Data for non-fatal injury in China are piecemeal and often of poor quality and so reasonable estimates of national injury morbidity cannot be generated, but we did estimate the potentially productive years of life lost (PPYLL) due to premature death for each type of injury by computing years lost before the age of 65 years. Because of the small size of some of the cohorts in the MOH-VR system and

Cause of death	Number of deaths*	Rank	Rate per 100 000† (95% CI)‡	Proportion of all deaths	Proportion of all injury deaths	PPYLL§	Proportion of all PPYLL	Proportion of all injury PPYLL
All causes of death	8 438 000	n/a	649.20 (647.63-650.78)	100%	n/a	68 317 352	100%	n/a
All injury deaths	846 510	n/a	65.13 (64.63-65.63)	10.03%	100%	20 521 321	30.04%	100%
Unintentional injuries								
Traffic-related injury¶	273 879	1	21.07 (20.79-21.36)	3.25%	32.35%	6 899 957	10.10%	33.62%
Drowning	113 068	3	8.70 (8.52-8.88)	1.34%	13.36%	4 429 830	6.48%	21.59%
Falls	82 420	4	6.34 (6.19-6.50)	0.98%	9.74%	1 259 649	1.84%	6.14%
Poisoning	38 461	5	2.96 (2.85-3.07)	0.46%	4.54%	873 016	1.28%	4.25%
Suffocation	17 658	7	1.36 (1.29-1.43)	0.21%	2.09%	697 508	1.02%	3.40%
Electrocution	14 450	8	1.11 (1.05-1.18)	0.17%	1.71%	378 497	0.55%	1.84%
Crushing injury	13 335	9	1.03 (0.96-1.09)	0.16%	1.58%	318 712	0.47%	1.55%
Fire	9661	10	0.74 (0.69-0.80)	0.11%	1.14%	175 316	0.26%	0.85%
Natural disaster	4654	11	0.36 (0.32-0.41)	0.06%	0.55%	66 756	0.10%	0.33%
Cutting injury	1634	12	0.13 (0.10-0.15)	0.02%	0.19%	48 337	0.07%	0.24%
Intentional Injuries								
Suicide	195 643	2	15.05 (14.81-15.29)	2.32%	23.11%	3 213 494	4.70%	15.66%
Murder	20 086	6	1.55 (1.47-1.62)	0.24%	2.37%	607 717	0.89%	2.96%
All other injuries	61 562	n/a	4.74 (4.60-4.87)	0.73%	7.27%	1 552 532	2.27%	7.57%

n/a=not applicable. *Mean number of deaths per year—ie, the sum of each type of injury-related death during the 5 years in all 72 age by sex by location of residence cohorts divided by five. †Mean number of deaths divided by the mean total population in the 5 years (1 299 744 000). ‡CIs based on estimated numbers of deaths in the Ministry of Health vital registration system sampling frame during the 5 years (denominator is 100 million individuals). §Years lost before age 65 years due to premature death. ¶Road traffic injury and other transport injury.

Table: Estimated mean number per year, rate, and associated potentially productive years of life lost (PPYLL) of different types of injury deaths in China during 2002-06

the unstable rates of some injury deaths in some cohorts, we used the mean values in the past 5 years for which data were available (2002–06) to provide a more stable representation of the present status of injury deaths in the country. In comparisons of rates in the total population over time, we used rates that were standardised according to the age, sex, and location of residence (urban vs rural) distribution of the population in 2000; and comparisons of cohort-specific rates with time were standardised according to the age distribution of the corresponding cohort in 2000. For comparisons of rates between the beginning and end of the 20 years, we used mean values for 1987 and 1988 versus those for 2005 and 2006.

The table shows our overall findings for 2002–06. We estimate a national injury death rate of 65 per 100 000 population and a yearly total of 846 510 injury deaths (table). These deaths account for more than 10% of all deaths and—because most of the injury deaths occur before the age of 45 years—more than 30% of the PPYLL. Rural rates were two-fold greater than urban rates (79 per 100 000 vs 37 per 100 000) and male rates were nearly two-fold greater than female rates (85 per 100 000 vs 45 per 100 000). The most common causes of injury deaths are traffic-related injury, suicide, drowning, and falls; these injuries account for 79% of all injury deaths (table). Occupational injuries are not separately identified with ICD external-cause codes so we were unable to do a detailed analysis, but the Ministry of Health⁵ estimates more than 130 000 occupational injury deaths per year—mainly among rural residents who have joined the workforce in poorly regulated private mining, construction, and manufacturing firms. Natural disasters, such as earthquakes, floods, typhoons, and droughts are fairly common in China but they usually account for less than 1% of all injury deaths; the massive Wenchuan earthquake will result in only a modest 10% increase in the total number of injury deaths for 2008.

The overall injury death rate in China is less than the worldwide average¹⁸ (65 per 100 000 vs 84 per 100 000) but almost double compared with the rates reported for most developed countries.¹⁹ The pattern of injuries in China is quite similar to the worldwide pattern—ie, worldwide injuries account for 9% of all deaths (vs 10% in China), men die of injury at twice the rate that women do (vs 1.9-fold in China) and the three leading causes of injury deaths are traffic injury (25% of all injury deaths worldwide vs 32% in China), suicide (16% vs 23%), and drowning (9% vs 13%). Compared with other WHO regions, China has low rates of deaths resulting from fire and interpersonal violence, but female mortality from suicide, drowning, and falls are among the highest in the world.¹⁸

Figure 1 shows changes in the rates of injury deaths in the four main population groups in the past 20 years. The overall injury death rate (standardised to the age, sex, and location of residence distribution of the

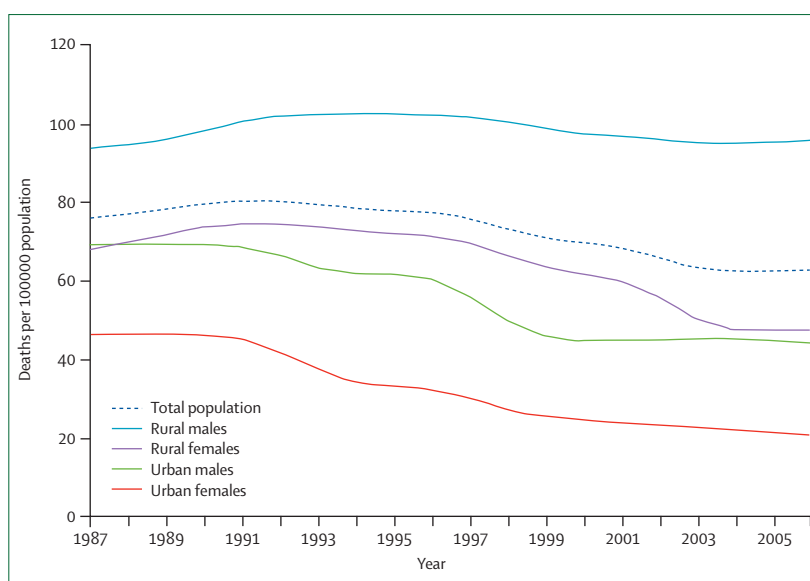


Figure 1: Rates of injury-related deaths in China during 1987–2006*

*Rates in the total population are standardised to age, sex, and location of residence (urban vs rural) distribution of the population in 2000; rates of the four cohorts are age-standardised to the age distribution of the corresponding cohort in 2000. Curves are smoothed with the T4253H smoothing function (SPSS, version 13.0).

population in 2000) decreased by 17%, from 77 per 100 000 in 1987–88 to 64 per 100 000 in 2005–06. Injury death rates were consistently highest for rural males and lowest for urban females. In the 20 years, injury-related mortality increased by 6% among rural males (from 94 per 100 000 to 100 per 100 000) but decreased by 25% among urban males (67 per 100 000 to 50 per 100 000), by 45% among urban females (47 per 100 000 to 26 per 100 000) and by 30% among rural females (71 per 100 000 to 50 per 100 000).

Figure 2 shows the substantial changes in the distribution of injury deaths in the past two decades. The proportion of all injury deaths due to traffic injuries increased from 15% in 1987–88 to 34% in 2005–06; and the corresponding death rates (standardised to the population in 2000) increased by 81% from 12.4 per 100 000 to 22.4 per 100 000. In the same period, the proportion of all injury deaths due to suicide decreased from 34% to 20%, and the standardised death rate from suicide decreased by 57% from 27.1 per 100 000 to 11.8 per 100 000. Drowning accounted for 19% of all injury deaths at the beginning of the 20 years and 13% at the end; mortality from drowning decreased by 24% from 11.9 per 100 000 to 9.1 per 100 000. The proportion of injury deaths due to falls increased from 7% to 11% but this increase was largely due to an increase in the age of the population (fatal falls are much more common in the elderly); after standardisation to the population in 2000, the death rate from falls decreased slightly from 6.6 per 100 000 in 1987–88 to 6.4 per 100 000 in 2005–06.

Figure 3 shows the proportion of all deaths attributable to injuries by age group during 2002–06. The injury

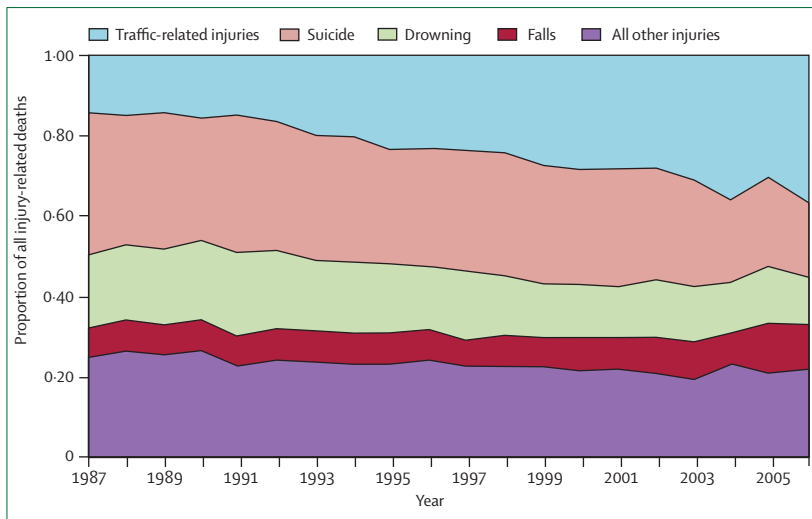


Figure 2: Contribution of different types of injury to total injury-related deaths in China during 1987–2006

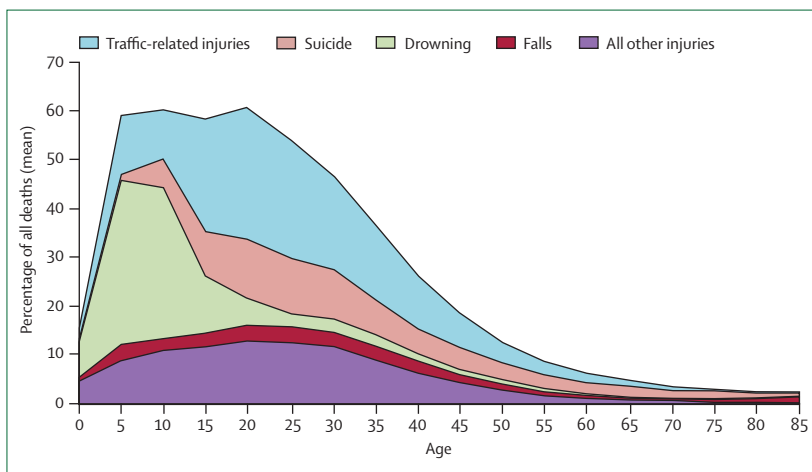


Figure 3: Injury-related deaths as percentage of all deaths according to age in China during 2002–06

death rate increases with age but injury deaths are more important in younger age groups because of the low rates of deaths from other causes. In individuals younger than 15 years, the injury death rate is 39 per 100 000, accounting for 26% of all deaths; in people aged 15–44 years, the rate is 58 per 100 000, accounting for 41% of all deaths; in people aged 45–64 years, the rate is 68 per 100 000, accounting for 10% of all deaths; and in those 65 years and older, the rate is 158 per 100 000, accounting for 3% of all deaths.

Figure 4 shows that the proportional distribution of different types of injury varies substantially by age group. In children younger than 15 years, drowning accounts for 54% of all injury deaths, and traffic-related injuries account for 16%. In young adults (15–44 years), traffic-related injuries account for 42% of all injury deaths and suicide for 20%. In middle-aged adults (45–64 years), traffic-related injury accounts for 34% of all injury deaths, suicide for 29%, and falls for 10%.

And in adults 65 years and older, suicide accounts for 34% of all injury deaths, traffic-related injuries for 20%, and falls for 19%. With the younger median ages of death for drowning (16 years [IQR 6–46]) and traffic-related injury (39 years [28–53]) compared with those for suicide (52 years [35–69]) and falls (57 years [38–78]), traffic-related injuries and drowning account for a larger proportion of the PPYLL from injury deaths (figure 5).

Traffic-related injuries

Motor vehicle production in China has tripled since the early 1990s,²⁰ so the fact that a large and increasing proportion of China's injury-related mortality and morbidity are due to traffic-related injuries is not surprising. But traffic-related mortality is not as tightly linked to economic improvement as might be expected—areas with the highest rates of traffic-related fatalities include the poor western provinces of Tibet, Ningxia, Xinjiang, and Qinghai,⁵ and most of the increased traffic-related mortality is seen in rural areas (which are much poorer than urban areas), particularly among rural males. The reasons for higher traffic-related mortality in rural communities than in urban communities are not known, but the difference may be associated with poor-quality roads, less police supervision on the roads, increased presence of vulnerable road users, insufficient emergency medical services, and higher rates of driving under the influence of alcohol.

Preventive measures should focus on high-risk demographic groups and should be adapted to the composition of the traffic-related mortality. Despite rapid motorisation throughout China, particularly along the eastern seaboard, walking and cycling still remain the predominant modes of transport in most provinces, so the fact that 60% of traffic-related deaths are pedestrians and cyclists, and 20% are motorcyclists is not surprising.⁵ China has re-engineered its road infrastructure systems based on models used in high-income countries, but these systems might not be appropriate for the traffic mix in many of China's communities. For example, the very large cities like Beijing once provided separate lanes for bicyclists and other vulnerable road users, separating them from motor vehicles. However, these designated bicycle lanes have been rapidly engineered out of the road infrastructure to make room for the ever-increasing number of cars. The irony is that high-income countries that advocated rapid motorisation are now attempting to re-engineer their own road systems to separate the vulnerable road users and to promote different modes of transport, particularly those that involve physical activity or reduce greenhouse emissions, or both.

Reversal of the inexorable increase in the numbers of traffic-related injuries will require a concerted effort on several fronts. The different government agencies responsible for transportation and road design must

ensure that safety for all road users—not just convenience of motorists—is the priority. Improved road designs that increase separation of vulnerable road users from motor vehicles, and a shift to safe modes of transport (such as public transport) without a transition through the dangerous phase of widespread motorcycle use might mitigate the expected ongoing increase in road traffic-related deaths.¹⁹ At the same time several low-technological strategies that have proven effective in reduction of traffic-related mortality elsewhere^{21,22} merit full-scale adaptation, assessment, promulgation, and enforcement; these strategies include seat belts, child safety devices, helmets for cyclists and motorcyclists, and setting legal blood alcohol limits. Some urban locations have already adopted appropriate policies but insufficient effort has been made to encourage or enforce community compliance with the measures. For example, despite the availability of seat belts in almost all motor vehicles and regulations mandating their use, rates of use are very low.^{23–25} A government-supported seat belt intervention in the southern city of Guangzhou that included enhanced police training, intensive enforcement, and social marketing to raise public awareness proved that community-based programmes can be cost-effective in China: in the 12 month study, seat-belt use increased from 50% to 62% and the cost per disability-adjusted life year (DALY) saved was only 3246 Renminbi (\$US 418).²⁶ More programmes like these are needed.

Suicide

The demographic pattern of suicide in China—with rural rates two-fold to three-fold greater than the urban rates, and female rates slightly higher than the male rates—is very different from that reported in western countries, where urban and rural rates are roughly equivalent and where male suicide rates are two-fold to four-fold higher than the female rates.²⁷ The main determinant of China's different pattern of suicidal deaths is the frequent use of highly lethal pesticides as a suicide method in rural areas.^{28,29} Many individuals, with little intention to die, who make an impulsive suicide attempt following an intense interpersonal conflict die because the method they have chosen (pesticide ingestion) is lethal and because local health services are unable to effectively manage serious pesticide poisoning. This combination increases the case fatality of suicidal behaviour in rural areas and, because more women than men engage in low-intent suicidal behaviour, increases the proportion of women among individuals who die by suicide.^{29–31} The high rate of female suicide might partly explain the higher than expected proportion of female mortality due to injuries in China (8%) compared with that predicted by cause of death models.⁹

Another important difference between China and western countries—where more than 90% of all suicidal

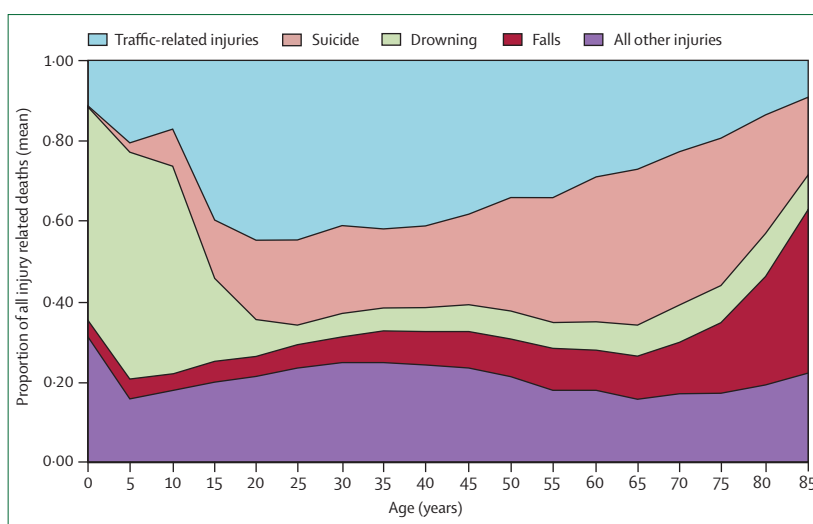


Figure 4: Contribution of different types of injury to total injury-related deaths according to age in China during 1987–2006

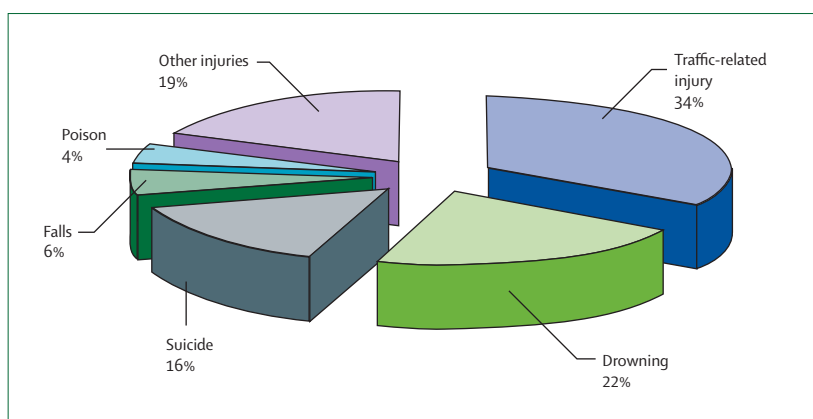


Figure 5: Mean potentially productive years of life lost for deaths attributed to different types of injuries in China during 2002–06

behaviour occurs in individuals with mental illnesses—is that even when rigorously applying culturally adapted versions of internationally accepted diagnostic criteria, about 35% of people who die by suicide in China and about 60% of those who attempt suicide do not have a diagnosable mental illness at the time of their suicidal behaviour.^{28,32,33} Depression and other mental disorders are still important risk factors for suicide, but the importance of chronic and acute psychosocial stressors (particularly family conflicts), impulsive personality traits, and poor conflict-resolution skills might be greater in China than elsewhere.³⁴

Most experts believe the pressures of modernisation lead to an increase in suicides,³⁵ so the unexplained 57% reduction in the national suicide rate in the past two decades identified in our analysis is surprising. The limitations of China's suicide mortality data due to missing deaths and both deliberate and inadvertent misclassification of suicides (usually as other accidents)³⁶

have changed little with time, thus consideration of these limitations is unlikely to explain such a large change in suicide rates. There is no evidence of a corresponding reduction in the prevalence of mental disorders³⁷ and the coverage of mental-health services, though improving, remains inadequate in rural areas.³⁸ Efforts have been made to restrict the production of the most potent organophosphate pesticides³⁹ but these measures, which have not been fully implemented, started long after the reduction in suicide rates. Two postulated factors that could account for this change are improved economic prospects for the country's poor individuals, resulting in decreased rates of suicidal behaviour; and a substantial reduction in the numbers of individuals who have ready access to lethal pesticides due to rapid urbanisation and massive rural-to-urban migration for work, which could reduce both the rates and case-fatality of impulsive suicidal behaviour.

Large differences between the characteristics of suicide in China and those reported in the west mean that the western models—in which suicide is considered the direct result of mental illness and which focus most preventive efforts on the identification and treatment of mental illnesses—might not be applicable to China.⁴⁰ Because 58% of fatal suicides are by pesticide ingestion,³² pesticide-related preventive strategies are the most likely to rapidly reduce the overall suicide rate. The characteristics of pesticide-ingestion suicides in China help define the types of interventions that could be effective: 69% of individuals use pesticides stored in the home (typically in an unlocked cupboard), 59% use WHO category I organophosphates (which WHO has recommended banning for >10 years⁴¹), and 61% receive unsuccessful resuscitation by a medical professional before death.²⁹ These characteristics indicate the need for three types of interventions—ie, reduction of access to pesticides with lockboxes, communal storage, or restricting use to licensed users;⁴² banning of the most toxic compounds;⁴³ and improved training and increased access to necessary drugs and equipment for rural primary-care health providers.⁴⁴ On the basis of the assumption that each intervention reduces deaths resulting from pesticide ingestion by 20%, we estimate that the sequential application of these three approaches across the country would result in a saving of 59 000 lives per year, 972 000 PPYLL, and \$1.7–2.0 billion in direct economic losses. These strategies will need to be integrated with other suicide-prevention activities, such as provision of social support to high-risk groups, community-based education and screening programmes, and improvement of the coverage and quality of mental health services.^{45,46}

Drowning

Like most ancient civilisations, China developed around its major waterways (the Yangtze and Yellow rivers). A substantial proportion of the population still lives close

to lakes, rivers, canals, ponds, reservoirs, or the ocean. However, only a small proportion of the population can swim and has knowledge of water survival skills⁴⁷ so the rates of drowning are high. Death by drowning is more common in southern China (where there are more waterways) and during the warmer months of April to September.⁵ Most drowning occurs in children younger than 15 years; in these young people, 14% of all deaths are due to drowning. Children aged 1–4 years most often drown in domestic water containers (many rural households have large urns for water storage) and bathing pools; children aged 5–9 years most often drown in canals, ponds, and reservoirs; and those aged 10 years and older frequently drown in ponds, lakes, and rivers.⁵ Drowning rates are three times higher in rural than in urban areas (10.7 per 100 000 vs 3.3 per 100 000), presumably because of the increased number of water hazards and insufficient supervision of children.⁴⁸ Male drowning rates are 1.7-fold greater than the female rates (10.9 per 100 000 vs 6.5 per 100 000) possibly because of increased rates of risk-taking behaviour among boys.

Evidence of the benefits of teaching children to swim is emerging from other countries,^{40–51} thus the main focus of drowning prevention in China should be on the assessment of the effectiveness of teaching children swimming skills, particularly those living in rural areas. This assessment would include identification and training of teachers, provision of safe sites to practise, allocation of school time to provide the training, and ensuring that all children participated (eg, by making swimming competence a requirement for graduation from elementary or middle school). Initial public information campaigns would be needed to reassure parents and to allay the widely prevalent fear of the water among the general population. The population-wide programme adopted in Melbourne, Australia in the 8 years following the 1956 Melbourne Olympic Games resulted in virtually all 500 000 primary school children in the state of Victoria learning to swim and was associated with a substantial reduction in the rate of drowning.⁵² Initiation and promulgation of a similar programme following the 2008 Beijing Olympics could potentially save hundreds of thousands of lives.

A comprehensive drowning prevention programme must include additional components because teaching swimming will do little to prevent the drowning of small children, drowning during floods (which perennially occur in China), and some other types of drowning deaths. The highly successful mix of interventions used in high-income countries includes the elimination of water hazards (improved infrastructure, such as piped tap water and safe bridges), lifeguard training and deployment, construction of safe places to swim, enhanced child supervision, enforced capacity limits and registration of small boats, boat-operator training and licensing, compulsory wearing of personal life vests in

small boats and when participating in water sports, and flood control. Such a systematic, multisectoral approach to drowning prevention was considered at an international workshop in Beijing in 2005⁵² but little concerted action has yet been taken.

Can China shorten the time frame for injury reduction?

The worldwide burden of injury is expected to increase during the coming decades particularly in low-income and middle-income countries^{18,19} but our analysis of injury rates during the past 20 years in China shows that despite rapid increases in traffic-related mortality, overall injury-related mortality has decreased, not increased. The reasons why China is exceptional are unclear but with more than 800 000 injury deaths and 60 million medically treated injury events per year,⁵ China has no time for complacency.

Although injury-prevention strategies are still insufficiently developed in many high-income countries, some countries have developed very successful strategies. In the past 30 years, Sweden, the Netherlands, and the UK have reduced road-traffic injury by more than 60%²¹ and in the past 100 years, Australia has reduced deaths caused by drowning by 80%.⁵³ The challenge for China is to reduce the time frame for successful injury prevention. Indigenous strategies should certainly be developed and tested in China but there are already a wide range of successful countermeasures used in high-income countries, so the identification, local adaptation, and scientific testing of those high-income country strategies that seem most appropriate in the Chinese context could greatly reduce the time needed to reach the present world best-practice standards.

Other than the potentially useful strategies from other countries already cited, many other interventions proven to be effective elsewhere are relevant to China. Development, monitoring, and, most importantly, enforcement of occupational safety measures in mines and factories could reduce the estimated 120 000 deaths per year due to occupation-related injuries. Enforcement of earthquake-resistant building standards and application of effective flood controls could reduce mortality and morbidity following natural disasters. Chinese consumers are at risk of injury from exposure to unsafe and unregulated products (eg, toys, nursery furniture, and chemicals) and, paradoxically, have restricted access to many safety products manufactured in China for export (eg, household smoke alarms, carbon monoxide detectors, and motor vehicle child restraints). Enforcement of consumer product safety standards and ensuring market supply of safety-related products could help reduce these types of injuries. Pet ownership has increased rapidly in China in the past two decades, particularly in affluent urban communities; reduction of the high rates of dog bites in children (the most common

cause of rabies) could be achieved by neutering dogs, control of stray or feral dogs, responsible pet ownership programmes, and mass dog vaccination programmes.⁵⁴ Other low-technology interventions that could potentially produce rapid results include impact-absorbing playground undersurfacing, child resistant caps on poisonous domestic chemical containers, firework bans, safe sleeping environments for infants, home visitation programmes to reduce child maltreatment, and exercise programmes to prevent falls in the elderly.

Policy changes, political will, and financial resources are necessary but not sufficient to produce the needed behavioural changes in community members. Many Chinese consider all types of accidental deaths and suicides acts of nature (similar to earthquakes, floods, and typhoons) which are beyond the power of individuals to control. This underlying fatalism, which is shared by many in the medical professions, has delayed recognition of the public-health importance of injury and undermined efforts to promote preventive strategies that depend on individuals, such as wearing seat belts, learning to swim, and storing poisons in safe locations. Movement of injury prevention beyond the policy stage and its adoption as an important goal by community members will require the development of sophisticated, target-group-specific public promotion campaigns to change these attitudes.

Injury-related mortality only represents the tip of the injury iceberg. Nationwide data on the prevalence, demographic characteristics, treatment, and outcomes of non-fatal injuries are not available in China. However, the Ministry of Health did a survey among 200 000 residents from different locations around the country from 1998 to 2005 and, based on the results, estimated 200 million injuries per year throughout the country among which 60 million require emergency medical treatment (costing 65 billion Renminbi or \$9 billion), 14 million require treatment in hospital, and 1 million result in permanent disabilities.⁵ Thus, in addition to taking steps to prevent the occurrence of injury, the public-health response to injury must also include strategies for reducing disability following injury, such as the development and long-term support of centres of excellence around the country that have rapid-response medical teams, provide training in trauma care, and develop high-quality post-injury rehabilitation programmes. This work is only just beginning.

The way forward for injury prevention in China

China has the financial resources, organisational infrastructure, and public support to rapidly apply lessons from high-income countries to achieve international best-practice standards for injury prevention and control, and to become a model for other low-income and middle-income countries that have similar difficulties. Whether or not this goal is actually realised in China will mainly depend on four factors.

Increase intersectoral collaboration

Although allocation of leadership to one governmental agency or ministry is appropriate, efforts should be made to include all relevant sectors in injury-prevention activities and for them to play their respective parts in a complementary and coordinated way. The initial focus of the Ministry of Health has appropriately been on strengthening surveillance systems, but the ministry also has an important role in policy development, primary prevention measures, services for victims, and advocacy to the community and other sectors.

Improve monitoring

The rapidly changing demographic trends for injuries and the effects of injury prevention programmes are difficult to monitor for several reasons: the absence of a national death registry system; difficulties in the representativeness, comprehensiveness, content validity, and transparency of the present sample mortality registry system; and the undeveloped state of the non-fatal injury monitoring system. The most immediately useful step to improve reporting of non-fatal injury would be to introduce external-cause coding¹⁸ alongside the routine ICD 10 diagnosis coding that is in use in Chinese hospitals. Promotion of ICD 10 place of occurrence codes and activity codes⁶ for both fatal and non-fatal injuries would help distinguish occupational injuries and provide essential information needed to target prevention strategies.

Build capacity

A cadre of injury specialists is needed to study the complex interactions of risk and protective factors for different types of injuries, develop and test specific intervention strategies, and engage the many stakeholders who need to participate in the injury prevention effort. Postgraduate training programmes and fellowships are needed to train these individuals, and sustained research funding support specifically dedicated to injury prevention will be needed to motivate highly qualified individuals to spend their careers in the specialty.

Mobilise political will

The vigorous response to the HIV/AIDS epidemic,⁵⁵ the positive changes in the infectious disease reporting system following the SARS epidemic,⁵⁶ and the massive response to the Wenchuan earthquake show the capacity of the country to mobilise resources and make rapid policy changes in response to perceived threats to national health. A similar commitment is needed for injury prevention. Establishment of a national action plan for injury prevention under the auspices of the state council (China's cabinet)—as has been done for HIV/AIDS—would help ensure the active participation of multiple stakeholders and provide access to the resources needed to implement programmes.

Conflict of interest statement

We declare that we have no conflict of interest.

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