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Analysis of the burden and trend of injury in Sichuan, China, from 2006 to 2015: results from the national injury surveillance system

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ABSTRACT

Objective This study investigates the distribution, burden and trends of injuries in Sichuan, China.

Design A surveillance study using injury data collected by the National Injury Surveillance System.

Setting and participants 312 511 injury cases reported in the National Injury Surveillance System in Sichuan, China, from 2006 to 2015.

Primary outcome measures Years of potential life lost (YPLL) were calculated to determine the disease burden from injuries. Trend analysis was performed to assess the trends in specific injuries over time.

Results A total of 312 511 injury cases were reported in the last 10 years in Sichuan with 192 904 (men: 58.58%) and 119 607 (men: 67.11%) cases from the urban and rural surveillance hospitals, respectively. The annual number of injury cases increased from 21 257 in 2006 to 44 112 in 2015 with an average annual increase of 8.45%. The top three common causes of injury were fall (29.3%), animal-related injury (19.1%) and road-related injury (14.6%) in the urban area and fall (38.4%), road-related injury (17.2%) and blunt injuries (16.0%) in the rural area. YPLLs from injuries accounted for 13% of the total YPLLs in the urban area.

Conclusions The number of injury cases varied according to rural/urban areas and gender and increased sharply in Sichuan over the last decade. It is necessary to develop targeted prevention and control measures to reduce the disease burden of injuries.

Strengths and limitations of this study

- This study examined the distribution, burden and trend of injuries in the Sichuan over a 10 year period based on a surveillance system with strict quality control.
- One limitation is that this study uses data from a facility-based surveillance system, and population-based incidence rates cannot be generated easily based on this data.
- Moreover, deaths that occurred outside hospitals were not captured in the current study, and injury-related deaths were underestimated.

INTRODUCTION

The WHO estimates that injuries cause over 58 million deaths each year that accounts for 10% of all global deaths. Injuries are the leading cause of death in the population aged 5 to 44 years.[1] According to the Global Burden of Diseases (GBD) 2010 report, injury-related disability-adjusted life years (DALYs) account for 12.4% of all-cause DALYs globally.[2–4] In China, 200 million injury events occur each year that leads to 14 million hospitalisations and one million disabilities. Injuries affect the health and welfare of all age groups because of disability, medical costs and premature death.[5–8] Estimating injury-related incidence and mortality is essential for raising awareness of injury burden and proposing effective policies and strategies to reduce this public problem.

Injury surveillance systems are essential to identify at-risk populations, support prevention efforts and evaluate the effects of prevention strategies.[9] The WHO recommended that countries and regions should establish and maintain injury surveillance systems to systematically collect injury data based on their available resources.[10] The WHO published injury surveillance guidelines that aim to guide healthcare professionals with practical assistance to develop and maintain injury surveillance systems.[10] Many developed countries, including the USA and Canada, have set-up national surveillance systems for injuries.[11 12] The lack of high-quality data on injuries to inform decision-making leads to less advanced injury prevention efforts in low- and middle-income countries, including China, than in developed countries.[9 13 14]

The National Injury Surveillance System (NISS), the first hospital-based national system in China, was established in 2006 to understand the burden of injuries.[15] Sichuan

Province, located in southwestern China, has a population of 83.41 million and covers an area of 486 000 km^2. Injuries are the fourth leading cause of death both in Sichuan and in China. Results from the study in Sichuan will serve to inform the development of local injury prevention strategies and facilitate targeted injury prevention policies. The objectives of this study were to track the burden and trend of injuries in Sichuan using data from the NISS collected between 2006 and 2015.

METHODS

Surveillance hospitals

The surveillance hospitals were from the NISS in Sichuan.[15] The NISS was established in China in 2006, and 126 hospitals from 43 sample locations, including 23 rural and 20 urban sites, were recruited.[15] There were two sample locations in Sichuan: the Qingyang District in Chengdu (urban) and Miyi County in Panzhihua (rural). In the Qingyang, the largest tertiary hospital and two secondary hospitals were selected as urban surveillance hospitals. In Miyi County, the hospital with the largest number of outpatients in the local area and two general township health centres were selected as rural surveillance hospitals.

Case recruitment

In the surveillance hospitals, an injury case was defined as the first hospital visit or presentation due to an injury event to an emergency room, outpatient department or other clinical departments. Cases were excluded if they were transferred from other medical institutions or were repeat visits to the same hospital for the same injury event. An injury was defined as damage to the physical body by acute exposure to energy or due to a lack of a vital element with the International Classification of Diseases (ICD) codes of S00 to T98.

Data collection

The National Injury Surveillance Form was used to collect information for all eligible injury cases between 1st January, 2006, and 31st December, 2015. This included patient demographics, basic information regarding the injury event and clinical information associated with the event (table 1). Trained doctors and nurses recorded injury and medical information of the patients using the NISS surveillance form. Subsequently, the forms were collected and archived by the prevention and health protection department of each hospital and reported to the local county or district Centres for Disease Control and Prevention (CDC) every month. In the county or district CDC office, the data were entered into a database using a uniform and specialised software (National Injury Information System). The electronic data were reported to the provincial CDC each quarter.[15]

External causes of injury were classified based on the International Classification of External Causes of Injury.[16] The severity of the injuries were classified into three categories with the following definitions: (1) Minor injury: no apparent or just slight or superficial injury, for example, bruises and minor cuts; (2) Moderate injury: required sutures or skilled treatment, for example, fractures; (3) Severe injury: required intensive medical or surgical management, for example, internal haemorrhage, punctured organs and severed blood vessels.

Table 1 Data elements of national injury surveillance form

Category	Example elements
Demographics	Age, sex, occupation, ID, education level and occupation
Basic information of the injury event	Time of injury occurrence, time of treatment, mechanism, place and activity of injury occurrence and intent of injury
Clinical information of the injury event	Nature of injury, body part injured, severity, clinical diagnosis and disposition of injury
Other information	Name of data reporter and date of reporting

Quality control

The data accuracy and completeness of our study were ensured with the following strategies. First, face-to-face training sessions were held with item-by-item explanations of all data elements at all provincial and local CDCs and surveillance hospitals. All trainees received a working manual of the project with details regarding data entry. All trainees were tested, and those who failed were retrained. Additionally, after the establishment of the NISS, quality control efforts focusing on data collection, processing, entering and reporting at different levels were established.[15]

Statistical analyses

Categorical variables were reported as numbers and proportions. X^2 tests were used to calculate the significance of the differences between groups. Years of potential life lost (YPLL) were calculated to evaluate the disease burden from injuries. A two-sided p value<0.05 was considered statistically significant. All statistical analysis was performed with SAS 9.2 and JMP 10.0 software (SAS Institute Inc, Cary, North Carolina, USA).

Patient and public involvement

Patients and the public were not involved in the design and conception of this study.

RESULTS

Injury case demographics

A total of 312 511 injury cases were reported over the last 10 years from 2006 to 2015 in Sichuan with 192 904 (men: 58.58%) and 119 607 (men: 67.11%) from urban and rural surveillance hospitals, respectively (table 2). There were more men than women in both the urban and

Cai P, *et al*. *BMJ Open* 2019;**9**:e031184. doi:10.1136/bmjopen-2019-031184

Table 2 Proportion of injury cases reported in Sichuan Province by year and region, 2006 to 2015

Year	Urban					Rural					Total				
	Male		Female		Total	Male		Female		Total	Male		Female		Total
	N	%	N	%		N	%	N	%		N	%	N	%	
2006	8824	62.45	5306	37.55	14 130	4966	69.68	2161	30.32	7127	13 790	64.87	7467	35.13	21 257
2007	8951	61.96	5496	38.04	14 447	5425	68.92	2447	31.08	7872	14 376	64.41	7943	35.59	22 319
2008	8620	61.49	5398	38.51	14 018	7545	68.54	3463	31.46	11 008	16 165	64.59	8861	35.41	25 026
2009	6673	60.42	4371	39.58	11 044	6733	68.55	3089	31.45	9822	13 406	64.25	7460	35.75	20 866
2010	8366	59.66	5657	40.34	14 023	7182	67.80	3411	32.20	10 593	15 548	63.16	9068	36.84	24 616
2011	9638	60.20	6371	39.80	16 009	8433	66.84	4183	33.16	12 616	18 071	63.13	10 554	36.87	28 625
2012	14 377	57.65	10 563	42.35	24 940	9492	66.85	4707	33.15	14 199	23 869	60.99	15 270	39.01	39 139
2013	15 818	56.98	11 944	43.02	27 762	10 309	66.30	5240	33.70	15 549	26 127	60.32	17 184	39.68	43 311
2014	15 360	56.54	11 809	43.46	27 169	10 573	65.79	5498	34.21	16 071	25 933	59.97	17 307	40.03	43 240
2015	16 374	55.77	12 988	44.23	29 362	9606	65.13	5144	34.87	14 750	25 980	58.90	18 132	41.10	44 112
Total	113 001	58.58	79 903	41.42	192 904	80 264	67.11	39 343	32.89	119 607	193 265	61.84	119 246	38.16	312 511

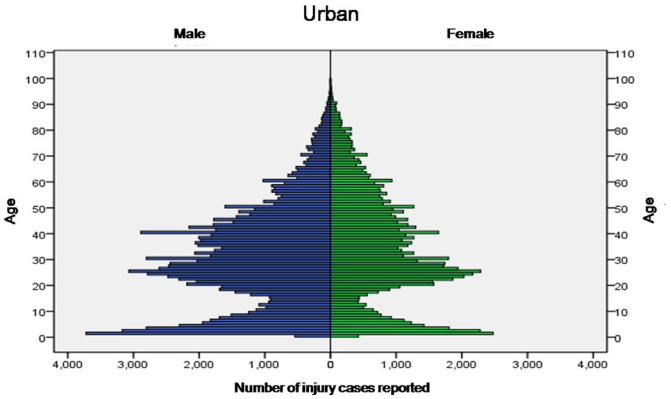

Figure 1 Age-specific and gender-specific proportions of injury from the urban area.

rural areas. The proportion of men was higher in rural than in urban surveillance hospitals (67.11% vs 58.58%, p<0.001). Age-specific and gender-specific proportions of injury from the urban and rural areas are presented in figures 1 and 2, respectively. There were peaks in the injury rates at 0 to 4 and 20 to 29 years of age in urban residents and at 35 to 44 years of age in rural residents (table 3).

Trends in injury cases from 2006 to 2015

The annual number of injury cases reported increased from 21 257 in 2006 to 44 112 in 2015 with an annualised rate of increase of 8.45%. The annualised rate of increase was 8.47% and 8.42% in the urban and rural areas, respectively. From 2006 to 2015, the proportion of women increased from 35.13% to 41.10%. This trend was observed in both the rural and urban areas.

Mechanisms of injury

The three leading causes of injury in the urban area were fall (29.3%), animal-related injury (19.07%) and road-related injury (14.56%) and in the rural area were fall (38.38%), road-related injury (17.17%) and injury by blunt object (16.03%) (table 4). The causes of injury were different in rural and urban areas. Fall was the primary cause of injury in both the urban and rural areas, especially in children and older people. Falls accounted for

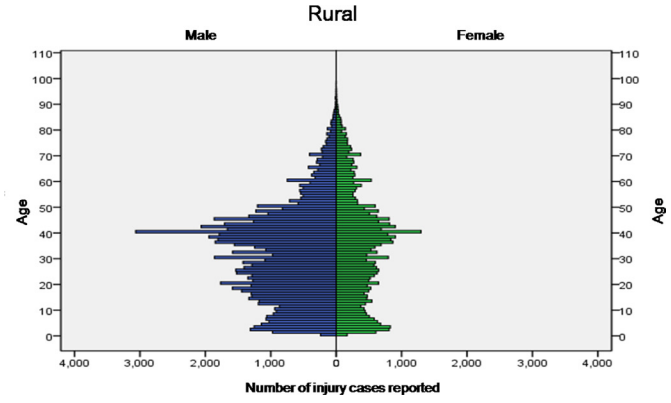

Figure 2 Age-specific and gender-specific proportions of injury from the rural area.

Table 3 Proportion of injury cases reported in Sichuan Province by age and region, 2006 to 2015

Age, years	Urban						Rural						Total					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0–4	12 539	11.10	8407	10.52	20 946	10.86	4928	6.14	3089	7.85	8017	6.70	17 467	9.04	11 496	9.64	28 963	9.27
5–14	13 278	11.75	7312	9.15	20 590	10.67	10 559	13.16	4888	12.42	15 447	12.91	23 837	12.33	12 200	10.23	36 037	11.53
15–24	18 745	16.59	12 869	16.11	31 614	16.39	14 131	17.61	5273	13.40	19 404	16.22	32 876	17.01	18 142	15.21	51 018	16.33
24–44	42 658	37.75	27 388	34.28	70 046	36.31	32 211	40.13	14 354	36.48	46 565	38.93	74 869	38.74	41 742	35.00	116 611	37.31
45–64	19 446	17.21	16 652	20.84	36 098	18.71	14 489	18.05	7902	20.08	22 391	18.72	33 935	17.56	24 554	20.59	58 489	18.72
65–105	6335	5.61	7275	9.10	13 610	7.06	3946	4.92	3837	9.75	7783	6.51	10 281	5.32	11 112	9.32	21 393	6.85
Total	113 001	100.00	79 903	100.00	192 904	100.00	80 264	100.00	39 343	100.00	119 607	100.00	193 265	100.00	119 246	100.00	312 511	100.00

Table 4 Causes of injury reported in Sichuan Province by sex and region, 2006 to 2015

Cause of injury	Urban						Rural						Total	
	Male		Female		Total		Male		Female		Total			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Road injury	16 362	14.48	11 717	14.67	28 079	14.56	14 241	17.75	6287	15.98	20 528	17.17	48 607	15.55
Fall	34 474	30.51	22 496	28.15	56 970	29.53	29 445	36.69	16 468	41.86	45 913	38.39	102 883	32.92
Injury by blunt object	12 994	11.50	5701	7.13	18 695	9.69	14 661	18.27	4508	11.46	19 169	16.03	37 864	12.12
Knife/sharp injury	14 020	12.41	6665	8.34	20 685	10.72	10 552	13.15	4920	12.51	15 472	12.94	36 157	11.57
Fire/heat	4286	3.79	3835	4.80	8121	4.21	1973	2.46	795	2.02	2768	2.31	10 889	3.48
Suffocation /hanging	172	0.15	145	0.18	317	0.16	33	0.04	19	0.05	52	0.04	369	0.12
Drowning	15	0.01	8	0.01	23	0.01	31	0.04	25	0.06	56	0.05	79	0.03
Poisoning	1428	1.26	1454	1.82	2882	1.49	3009	3.75	2628	6.68	5637	4.71	8519	2.73
Animal injury	16 587	14.68	20 200	25.28	36 787	19.07	3305	4.12	2447	6.22	5752	4.81	42 539	13.61
Others	7987	7.07	5037	6.3	13 024	6.76	2057	2.57	769	1.95	2826	2.37	15 850	5.08
Unknown	4676	4.14	2645	3.31	7321	3.80	957	1.19	477	1.21	1434	1.20	8755	2.80
Total	113 001	100.00	79 903	100.00	192 904	100.00	80 264	100.00	39 343	100.00	119 607	100.00	312 511	100.00

53.7%, 47.5%, 25.1%, 24.8%, 30.7% and 48.9% of the total injuries in people aged 0 to 4, 5 to 14, 14 to 24, 25 to 44, 45 to 64 and over 65 years, respectively. The severity of injuries was different according to regions and gender. The proportion of moderate-to-severe injuries was higher in the rural area than in the urban area (26.15% vs 20.58%, p<0.001) and was higher in men than in women (24.53% vs 19.76%, p<0.001). The proportion of severe injuries was higher in urban areas than in rural areas (4.67% vs 1.71%), as shown in online supplementary table 1. Motor vehicle injuries were the leading cause of severe injuries (24.90%) followed by falls (24.26%); For moderate injuries, falls were the leading cause (33.32%) followed by other injuries (data shown in online supplementary figures 1, 2).

Disease burden from injuries

In the Qingyang District, Chengdu, the disease burden analysis in urban surveillance hospitals was calculated using YPLL up to 70 years based on the Chinese National Disease Surveillance Points data from 2010 to 2014. In total, the estimated YPLL was 83 063. Injuries accounted for 12.7% (10 578) of the total YPLL from 2010 to 2014. Injury-related, age-standardised YPLL in the standard Chinese population in 2010 accounted for 13.1% of the total age-standardised YPLL.

Working Years of Potential Life Lost (WYPLL) were calculated based on the Chinese National Disease Surveillance Points data from 2010 to 2014 using the upper age limit of 60 (the retirement age in China). In total, the estimated WYPLL was 40 701. Injuries accounted for 16.7% (6791 WYPLL) of the total WYPLL from 2010 to 2014. The injury-related, age-standardised WYPLL in the standard Chinese population in 2010 accounted for 17.5% of the total age-standardised WYPLL. Injuries accounted for a higher proportion of WYPLL than YPLL (17.5% vs 13.1%, p<0.01), implying that injury-related deaths occurred more in the labour force than the rest of the population and thus, were an economic burden.

DISCUSSION

Main findings

In this study, we examined the distribution, burden and trend of injuries in Sichuan using data from the NISS during a 10 year period (2006 to 2015). Additionally, we conducted detailed subanalyses by gender, age and urban/rural residence. Our results indicated that injuries are an increasingly alarming public health problem in China over the last 10 years. Moreover, our study highlighted the high-risk population groups prone to injury which is useful for guiding prevention strategies and developing important public health initiatives.

Previous information in the literature

Decreasing the injury burden is a major public health challenge for China in the upcoming decades.[17 18] The first step to address the injury burden is to understand the magnitude and the distribution of causes.[19] Before the establishment of the NISS in Sichuan, the regional injury burden data were collected mainly by the National Disease Surveillance Points System which provided only a partial description of the true size of the injury problem.[14] A comprehensive surveillance system for injuries was desperately needed to guide the control of injury burden.[20] In 2006, the establishment of an injury surveillance system in Sichuan supported the development of an epidemiological study on injuries, injury prevention and control measures. It is an irreplaceable part of the disease monitoring system in this province as it monitors injuries and death and is the most reliable source of injury data.[15]

What this study adds

In the last decade, the annual number of reported injuries in Sichuan increased from 21 257 in 2006 to 44 112 in 2015, with an average annual rate of increase of 8.45%. This is in line with reported studies from the NISS and death registration data.[15 21] Haagsma's study from GBD reported a decline in unintentional injury from 1990 to 2013, including in China,[3] but the current study found that the annual number of reported injuries increased from 2006 to 2015 in Sichuan. The difference between the two studies may be explained partly by the disparity in study design between the two studies. In our study, only injured patients visiting hospitals were captured, and deaths that occurred outside hospitals were not reported. However, in Haagsma's study from GBD, they collected death information from vital registration cases as well as cases with injuries that did not receive care.[3]

Injuries are the fourth leading cause of death for residents in Sichuan and account for 13.1% of the total age-standardised YPLL. It is associated with a 0.5 year reduction in life expectancy and ranks second after non-communicable diseases in regional disease burden aetiologies. Therefore, undertaking injury prevention and control projects can be economically convenient and effective to reduce the burden of disease in the region and improve life expectancy.

According to Zhou's study, the annual potentially productive years of life lost from injury were 12.6 million years, more than that from any disease group in China.[22] Moreover, the annual economic costs of injury are almost four times the total government public health expenditure. In our study, the average annual increase in injury of 8.45% is a huge threat to economic development. In recent years, because of an increase in migration to urban areas for work, the population in rural years has severely decreased. An increase in injury-related YPLL will further lead to a loss in the labour force in rural areas which increases the burden on the agricultural economy and national vitals. Moreover, there is a disparity in access to medical care between urban and rural areas. Urban populations account for only 30% of the total population but use 80% of total health resources.[23] The difference in medical welfare may cause more labour loss and deaths in rural areas than in urban areas.

The occurrence of injuries is not simply accidental and can be prevented and avoided. Injury prevention and control can be accomplished by social system engineering based on the epidemiological characteristics of the injuries such as the causes and distribution of injuries between genders, age and location. Since the patterns of different causes of injury are diverse, the injury prevention strategies should be developed accordingly. For instance, fall prevention should be emphasised in children and older people, and traffic safety initiatives should target adults. High animal bites in urban areas suggest these are from domestic animals, and therefore, presentations at emergency rooms are likely to reduce the threat to life and fear of rabies. This study collected information from outpatient and emergency departments and set-up the first comprehensive surveillance system in Sichuan. Based on NISS, our study clarified the epidemiological characteristics of and factors influencing injury events such as the burden of injuries in urban and rural areas of Sichuan. These results provide local governments with valuable scientific information that can be used to develop prevention and control policies and strategies.[18 22]

Limitations of the study

This study has several limitations. First, NISS is a facility-based, surveillance system and population-based incidence rates cannot be easily generated, similar to other surveillance systems.[18] Second, specialist hospitals were not included in the sample, for example, children's and military hospitals, and thus, the data could be skewed. Third, only the alive, injured population visiting hospitals was captured, and deaths that occurred outside hospitals were not reported. Thus, injury-related deaths may be underestimated in our study.

CONCLUSIONS

Injury control and prevention should be of high priority among public health initiatives in Sichuan. Our study has provided important information to help develop policies and programme that can deliver effective measures and disseminate information for injury prevention in high-risk populations and to the entire populace to decrease the burden of injuries.

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Contributors PC, XW and RL conceived the study idea. PC and XW conducted the data analyses. PC and ZL conducted the literature review and drafted the manuscript. PC, XW, ZL, YD, XC, GY, JX, SH and RL contributed to refining the analytical framework and data interpretation. This final manuscript was read and approved by all authors.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study was approved by the Ethical Review Committee of the National Center for Chronic and Non-communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, People's Republic of China.

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Data availability statement Data may be obtained from a third party and are not publicly available.

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