Trend analysis and prediction of injury death in Xi’an city, China, 2005-2020

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Abstract

Background: Injury is an important cause of death in China. In the present study, we systematically analyzed the epidemiological characteristics and trends of injury death in Xi’an residents from 2005 to 2020.

Methods: Data on injury deaths from 2005 to 2020 were obtained from the “Xi’an Center for Disease Control and Prevention”, injury deaths were classified according to the International Classification Disease-10th Revision (ICD-10). The data were stratified by gender, age groups, injury types, and then overall and type-specific injury mortality rates were estimated. Joinpoint regression analysis was conducted to estimate annual percent change (APC). The grey interval predicting method was used to predict the future characteristics of injury deaths in Xi’an city.

Results: From 2005 to 2020, injury caused 32,596 deaths (5.79% of all deaths; 35.71/100000 population). Injury mortality rates were higher among males than females. Motor vehicle traffic accidents were the commonest injury type. The highest injury mortality rates were in those aged 85 years or older. Overall, Joinpoint regression analysis revealed that injury mortality had significantly (p < 0.05) decreasing trends. GM (1,1) model estimated that injury mortality will be on a declining curve.

Conclusions: Motor vehicle traffic accidents, transport accidents other than motor vehicles, unintentional falls, suicide, and accidental poisoning are the main causes of injury. The injury death rate is projected to decline over the next decade.

Keywords: Injury, Mortality, Rank, Distribution, Trend, Prediction

Background

International (homicide and suicide) and unintentional injuries are major causes of death in many countries, and they can stymie society’s economic progress through direct and indirect costs [1]. Injury is now considered a worldwide epidemic and affects families and communities in dramatic ways [2]. Every day, almost 16,000 individuals die from injuries all around the world. In China, injuries are expected to claim 700,000 lives per year, accounting for 9% of all-cause deaths and ranking as the fifth-greatest cause of death [3]. According to indirect estimates from the World Health Organization (WHO) and the Global Burden of Diseases Study (GBD), unintentional injuries cause 3.9 million fatalities globally, with 90% of those deaths occurring in low- and middle-income countries [4]. Road traffic injuries falls, drowning, poisoning, and burns account for the majority of these deaths [4]. The national impact, particularly on healthcare and insurance expenditures, is enormous. The effects on communities, on the other hand, are massive and multifaceted. Communities are affected not only by the emotional and psychological consequences of injury-related deaths but also by the economic and social consequences of injury-related disabilities. Job loss, injury care, rehabilitation costs,
family disruption, medical care visits, insurance claims, and marital troubles all carry enormous economic and social costs [2]. In terms of disability-adjusted life years lost, traumatic injuries account for 8.5% of mortality and 12% of the worldwide burden of diseases [5]. Road traffic injuries are responsible for about a quarter of all deaths from external causes worldwide, with an estimated 1.25 million deaths in 2013, or 24,1 deaths per 100,000 people [6–8]. The specific sorts of injuries that occur, as well as their risk factors, occurrences, and effects, vary between societies and even within subgroups within the same society, making detailed studies of injury patterns essential for proposing effective remedies [9]. The world health organization in the global road safety situation (2018) report [10], the damage caused by road traffic accident death toll continued to climb, the death toll at about 1.35 million people a year, and the road traffic injuries is 5 ~ 29 children first cause of death among young people. If it is not the current road traffic accidents that take corresponding prevention measures, by 2030 it will be the fifth leading cause of death globally.

In their influential study, Kim et al. first proposed Joinpoint regression model in 1998 [11]. The core idea of this model is to establish segmented regression according to the time characteristics of disease distribution, divide the study time into different intervals through several connection points, and conduct trend fitting and optimization for each interval. Furthermore, the characteristics of different interval-specific disease changes in the global time range were evaluated in more detail. This method is particularly useful in the research field of mortality trends.

The grey series prediction model GM (1,1) is a common analysis method based on the time-series data, which transforms the irregular original sequence, establishes the regular regression equation of the generated sequence, and uses the equation to predict the dynamic development trend of the disease. GM (1,1) often be selected for its reliability and validity. A major advantage of GM (1,1) is that it can be used for recent, short-term, and long-term predictions.

A prefecture, the provincial capital, a sub-provincial city, and a megalopolis, Xi’an is the core city of Guan Zhong Plain urban agglomeration, an important city in the province of Shanxi. The development of Xi’an is of special significance to Shanxi Province and northwest China, and its death situation is of representative significance. Injury is the fifth biggest cause of death and disability in Xi’an; it is also a prominent source of premature mortality and disability. To deeply understand the injury death status of permanent residents in Xi’an city and provide a scientific basis for formulating injury prevention and control measures, this paper analyzed the injury death data of permanent residents in Xi’an city, Shanxi Province from 2005 to 2020.

**Methods**

**Data collection**

Population-wide mortality data were collected from the “Xi’an Center for Disease Control and Prevention”, which includes the name, sex, age, death event, death time, death place, occupation, direct cause of death, root cause of death, etc. Population data from Xi’an Public Security Bureau. Chinese population data came from United Nations Population Division.

All methods used in this study were carried out in accordance with relevant guidelines and regulations. This study was approved by the Ethics Committees of Xi’an Center for Disease Control and Prevention (CDC) and Capital Medical University.

**Classification of injury deaths**

Injury-related deaths were classified according to the *International Classification of Diseases, Tenth Revision (ICD-10)* [12]. The codes identified the fourteen major causes of death (V01-Y98): motor vehicle traffic accidents, motor vehicles outside of transportation accidents, accidental poisoning, unintentional falls, fires, accidents caused by natural environmental factors, drowning, accidents of mechanic asphyxia, batter to death, caused by the mechanical cutting and piercing tools of accident, electric shock, accidents, and other harmful effects, suicide, and homicide.

**Statistical analysis**

The data was collected and analyzed using SPSS 26.0 and Excel 2019. Number of deaths, mortality, standardized mortality, constituent proportion, the rank of death cause, average number of years of life lost (AYLL), potential years of life lost rate (PYLLR), and the rank of life lost by injury are some of the statistical analysis indicators. To compare injury mortality data between various groups in different eras and with varied features, the $\chi^2$ test or *Fisher's exact probability test* was utilized. *Fisher’s exact probability test* was used to compare the data of injury mortality between different groups in different periods and with different characteristics, with a level $\alpha = 0.05$. The injury mortality is the ratio of total injury deaths during the year to the average annual total population, expressed as 100,000. Joinpoint Regression Program (V.4.7.0.0, National Cancer Institute, 2019) was used to analyze and test the time variation trend of injury mortality. With injury
mortality as the dependent variable and the year as the independent variable, the linear regression model was fitted to analyze and the annual percent change (APC) was obtained. \[ \text{APC} = \left( \frac{y_{x+1} - y_x}{y_x} \right) \times 100 = (e^{\beta_1} - 1) \times 100. \]

In the formula, \( y \) is the mortality rate, \( x \) is the year, and \( \beta_1 \) is the regression coefficient. The \( t \)-test was adopted, and the statistical significance of APC was used as the criterion for trend judgment. This analysis’ results are classified as significant \( (p < 0.05) \), marginally significant \( (0.05 < p \leq 0.10) \), or nonsignificant otherwise [13].

**Quality control method**
The correctness of the cause-of-death codes extracted by the cause-of-death surveillance system was further checked before analyzing the data [14].

**Results**

**Injury death profile**

Table 1 presents an overview of injury death in Xi'an. During the 16 years, a total of 562,219 deaths were recorded in Xi'an. Injury-related deaths account for approximately 5.79% of all deaths due to all causes. The injury mortality of permanent residents in Xi'an city ranges from 15.56/100000 (2020) to 47.78/100000 (2011). The average injury mortality was 35.71/100000. Males tended to have higher injury mortality than females each year. \( (P < 0.05) \). Compared with nationwide, the injury mortality rates in Xi'an were significantly lower in 2005, 2015, 2019 and higher in 2010 (Fig. 1a-c Comparison of injury mortality between Xi'an and China).

**Analysis of life lost by injury**

AYLL, PYLLR, and rank of life lost by injury from 2005 to 2020 were presented in Fig. 2a-c (Analysis of life lost...)

**Table 1** Injury death profile of permanent residents in Xi'an, 2005-2020 (N, 1/100000)

| Year   | Average Population | Total Death toll | Injury mortality | Total Male Death toll | Injury mortality | Male Female | \( \chi^2 \) | \( P \) value |
|--------|--------------------|------------------|------------------|-----------------------|------------------|------------|----------|-------------|
| 2005   | 2,962,802          | 1083             | 36.55            | 783                   | 51.61            | 300        | 192.944   | <0.05       |
| 2006   | 3,621,722          | 1387             | 38.21            | 984                   | 53.95            | 403        | 357.276   | <0.05       |
| 2007   | 3,777,757          | 1782             | 47.17            | 1290                  | 66.23            | 492        | 310.976   | <0.05       |
| 2008   | 4,310,677          | 1742             | 40.38            | 1252                  | 56.15            | 490        | 284.356   | <0.05       |
| 2009   | 4,289,191          | 1995             | 46.35            | 1373                  | 61.96            | 622        | 246.616   | <0.05       |
| 2010   | 4,358,204          | 1962             | 44.91            | 1296                  | 57.66            | 666        | 167.695   | <0.05       |
| 2011   | 4,610,259          | 2203             | 47.78            | 1564                  | 66.19            | 639        | 343.897   | <0.05       |
| 2012   | 4,959,830          | 1739             | 35.06            | 1194                  | 46.98            | 545        | 211.239   | <0.05       |
| 2013   | 6,274,832          | 2523             | 40.21            | 1775                  | 55.71            | 748        | 386.836   | <0.05       |
| 2014   | 6,985,866          | 2682             | 38.39            | 1869                  | 52.08            | 813        | 366.528   | <0.05       |
| 2015   | 7,112,866          | 2460             | 34.59            | 1647                  | 45.22            | 813        | 244.020   | <0.05       |
| 2016   | 8,249,323          | 2562             | 31.06            | 1710                  | 40.38            | 852        | 243.569   | <0.05       |
| 2017   | 8,450,861          | 2968             | 35.12            | 1979                  | 45.72            | 989        | 284.012   | <0.05       |
| 2018   | 9,616,700          | 2065             | 21.47            | 1446                  | 29.42            | 619        | 279.218   | <0.05       |
| 2019   | 10,003,681         | 1854             | 18.53            | 1263                  | 24.33            | 591        | 195.889   | <0.05       |
| 2020   | 10,213,704         | 1589             | 15.56            | 1111                  | 20.99            | 478        | 208.558   | <0.05       |
| Total  | 99,798,275         | 32,596           | 35.71            | 22,536                | 48.41            | 10,060     | 1100.203  | <0.05       |

Fig. 1 Comparison of injury mortality between Xi'an and China
caused by injury in Xi’an). The graph shows that there has been a decrease in AYLL and PYLLR caused by injury in Xi’an city. And the rank of life lost by injury has been in the top 2 for 16 years.

**Injury deaths by age group**
During the 16 years, the injury mortality ranges from 158.67/100000 (10-year-old group) to 8249.32/100000 (85-year-old group). As shown in Additional Table 1, in the age trend, the overall injury mortality decreased first and then increased from 15-year-old.

**Major injury deaths**
Broad categories of external causes of death can be defined based on the nature of the causes of injuries, and include motor vehicle traffic accidents, motor vehicles outside of transportation accidents, accidental poisoning, unintentional falls, fires, accidents caused by natural environmental factors, drowning, accidents caused by the mechanical cutting and piercing tools of accident, electric shock, accidents and other harmful effects, suicide and homicide 14 categories. From 2005 to 2020, the top five causes of injury death among the permanent population in Xi’an were motor vehicle traffic accidents, transport accidents other than motor vehicles, unintentional falls, suicide, and accidental poisoning. The mean mortality rates were 140.04/100000 (24.41%), 116.67/100000 (20.34%), 95.86/100000 (16.54%), 58.67/100000 (10.23%) and 46.63/100000 (8.13%), respectively. The top five causes of injury death of different genders were similar to that of the general population (Additional Table 2).

**Ranks in different age groups**
The main causes of injury death were also different among different ages (Additional Table 3). In the 0-year-old group, accidental mechanical asphyxia was the leading cause of injury fatality. Motor vehicle traffic accidents are the leading cause of injury mortality among persons aged 5 to 84, and they rank among the top three causes of injury death for people of all ages. Unintentional falls are the leading cause of death among people aged 85 and up, and the elderly are particularly vulnerable to them. Additional Fig. 1 provides the age distribution for the top five causes of injury mortality.

**Seasonal distribution of mortality of various injury types in Xi’an city**
As can be seen from Fig. 3 (Seasonal distribution of injury mortality in Xi’an), there was no significant difference between seasons in the overall injury. In terms of injury types, 43.87% of drowning accidents, 39.68% of accidents were caused by natural environment factors and 50.16% of electric shock accidents occurred in summer, accounting for a large proportion. The main injury types in winter were accidental poisoning (37.85%) and fire (39.22%).

**Location of injury deaths in Xi’an city**
The study listed the locations of death events in all study samples and the corresponding constituent ratios, including hospital, emergency clinic, home or on the way to hospital, overseas and others, family inpatient ward and not quite clear. The ranking is based on respective fatality rates for each type of injury, as shown in additional Figs. 2 and 3. The majority of deaths occurred at home or on the way to hospital, accounting for 56.04% of the total. 21.15% of deaths occurred in hospitals, followed by Emergency clinics, overseas, others, and family inpatient wards.

**Occupational distribution of injury-related deaths in Xi’an city**
The distribution of injury-related deaths was further analyzed according to occupation (Additional Figs. 4 and 5). Occupational classifications include technicist, office clerk, infants, preschool children or students, out of work, peasant, worker, and unknown or other workers. In the overall injury, the proportion of death caused

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**Fig. 2** Analysis of life lost caused by injury in Xi’an
by injury was the highest among peasants (62.28%), followed by the unemployed, workers, students, and office clerks, and the proportion of death caused by injury was the least among technicians.

**Trends in injury mortality for the top five causes of injury, 2005-2020**

Figure 4 (Trends in mortality rates by injury types in Xi'an) shows the 16-year trend of death rates for each injury type. Joinpoint Regression Program (V.4.7.0.0, National Cancer Institute, 2019) was used to analyze the time series trend of the overall injury from 2005 to 2020 and the injury mortality of the top five injury causes (Table 2, Additional Tables 4, 5, 6, 7, 8 and 9). The result reflects a decreasing trend over 16 years (Overall, 2009-2017: APC = -5.0, 2017-2020: APC = -22.3)

**Prediction of injury mortality in Xi'an City, 2021-2030**

The GM (1,1) model was established based on the injury death data from 2005 to 2020 to predict the injury death rate from 2021 to 2030. After model construction, a posterior error ratio C value is obtained, which is the residual variance/data variance. It is used to measure the fitting accuracy of the model, and the smaller the C value is, the better, generally less than 0.65. For mortality prediction, after calculation and selection, we found the best model of disease to predict its future mortality. It can be considered that the model fits well, the model error is relatively small, and the prediction result is relatively accurate. The overall injury death rate, motor vehicle traffic accident death rate, transportation accident death rate other than motor vehicle, suicide death rate, and accidental poisoning death rate were all qualified. In the model of unintentional falls mortality, whether total, male or female, the posterior error ratio C value was greater than 0.65 (0.7846, 0.6614, 0.9083), and grade accuracy was all unqualified. Therefore, data from 2005 to 2009 was removed, and the unintentional falls mortality rate was modeled and predicted again with the data from 2010 to 2020. The accuracy of the obtained model was qualified. The injury mortality is projected to continue...
decreasing in the future (Table 3, Additional Tables 10, 11, 12, 13 and 14).

Discussion
In the present study, we systematically analyzed the epidemiological characteristics and trends of injury death in Xi’an residents from 2005 to 2020. There were 32,596 people who died of injuries during the 16 years, with annual injury mortality of 35.71/100000, lower than the injury mortality reported in the third National Inquest of Deaths (61.51/100,000) [15], ranking the fifth in the order of causes of death among permanent residents in Xi’an from 2005 to 2020. Studies both in China and other nations have shown that there are differences in mortality and patterns of injury in men and women [16, 17]. It can be seen that although the AYLL and PYLLR caused by injury in Xi’an are decreasing in recent years, the injury situation is still severe, and injury has become one of the important public health problems endangering the life safety of Xi’an residents.

The annual mortality rate in males is significantly higher than that of female mortality, which is consistent with other domestic results [18–22]. This discrepancy
could be attributed to occupation. Their work may be risky, and their life and work pressure lead to psychological strains. Mental pressure is more likely too large to produce self-harm behavior. Males also exhibited stronger risk-taking behaviors than females [19]. Therefore, it is critical to improving male health education.

From 2005 to 2020, the top five causes of injury death among the permanent population in Xi’an were motor vehicle traffic accidents, transport accidents other than motor vehicles, unintentional falls, suicide, and accidental poisoning. The top five causes of injury are the same for both males and females. Motor vehicle traffic accidents were the leading cause of injury among permanent residents in Xi’an from 2005 to 2020. Therefore, the prevention of motor vehicle traffic accidents is the primary task of injury prevention in Xi’an city. The situation of death caused by traffic accidents for all ages is serious, and residents’ awareness of civilized driving and safe driving should be strengthened. Unintentional falls were the leading cause of death in the 85 and older group, and the elderly are the high-risk group for unintentional falls. Falls are commonly connected with severe morbidity and are a symptom of poor health and diminishing function [23]. In contrast to children, elderly individuals who fall are 10 times more likely to be hospitalized and 8 times more likely to die as a result of a fall [24]. Simultaneously, suicide is one of the leading causes of injury death, coming in fourth place. Suicide is a global public health epidemic that kills an estimated 800,000 people each year, with 85% of deaths happening in low- and middle-income nations. Suicides may be far more common than this figure, as they are frequently under-reported for a variety of societal, economic, and political reasons (Patton et al., 2009 and Soron, 2018a) [25]. Suicide is often the result of comprehensive effects of many factors [26]. The mortality rate of male suicide is higher than that of female suicide. A possible explanation for this might be that men are facing greater employment and life pressure. Therefore, special attention should be paid to the male group when carrying out suicide prevention intervention, and targeted intervention measures should be taken.

Drowning, accidents caused by natural environmental factors, and electric shock mainly occur in summer (June, July, and August), which may be related to the extreme weather in summer. The main injury types in winter were accidental poisoning and fire. In winter (December, January, and February), gas combustion is not good to bring about toxic gas cannot be discharged in time, easy to produce poisoning. Inferior electrical appliances and combustible objects promote the cause of fire.

The occupational distribution of the death group of each injury type was similar, except that students had the second-highest mortality rate in drowning accidents. Government should strengthen peasant injury protection. Summer is the peak season for drowning accidents. According to incomplete figures from the National Health Commission and the Ministry of Public Security, 57,000 people die of drowning in China every year, among which children and teenagers account for 56% of the total, with an average of 88 children dying from drowning every day [27]. Therefore, drowning is known as “the number one killer of unnatural death of primary and secondary school students in China” [28].

Overall injury mortality was on the decline, following a similar pattern to the national and other areas [19, 27, 29–32]. The decrease in the injury mortality of residents in Xi’an indicates that the effect of injury prevention and control is relatively remarkable in recent years. It seems possible that the result is due to the improvement of injury prevention awareness and medical aid level of the local population. Time series trend analysis and grey model prediction results showed that the overall injury mortality and the top five injury mortality in Xi’an were on a downward trend from 2005 to 2020, and may continue to decline in 2021-2030. But the injury mortality situation is still very serious. The government should pay attention to injury-related deaths and take different prevention and control measures for different groups. The grey model utilized in this study, however, can only reflect the data’s regularity; it needs to be refined and evaluated in conjunction with the actual situation. To improve forecast accuracy, new data should be regularly integrated into the follow-up for rapid illness monitoring and dynamic model prediction.

Although the occurrence of injury will be affected by age, gender, race, injury type, injury location, injury location and other factors [33, 34], according to the trend of injury mortality in recent years, using accurate models to predict future mortality can well predict the future trend of injury events based on existing prevention and control measures, and provide a basis for the government to implement targeted injury prevention and control strategies. To better reduce the incidence of injury deaths in the future, which has good public health significance.

Conclusions
Taken together, these results suggest that injury remains a leading cause of death in Xi’an. Motor vehicle traffic accidents, transport accidents other than motor vehicles, unintentional falls, suicide, and accidental poisoning are the main causes of injury and they should be the priorities of intervention. Over the next decade, injury death rates are predicted to decline. To reduce injury mortality in Xi’an, China, policies focusing on the main causes of death determined by research should be implemented.
Abbreviations
AYLL: Average number of years of life lost; PYLLR: Potential years of life lost rate; APC: Annual percent change.

Supplementary Information
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Additional file 1: Additional Fig. 1. Age-distribution of injury mortality in Xi’an, 2005–2020
Additional file 2: Additional Fig. 2. Location of total injury deaths in Xi’an
Additional file 3: Additional Fig. 3. Location of death events of various injury types in Xi’an
Additional file 4: Additional Fig. 4. Occupational distribution of total injury deaths in Xi’an
Additional file 5: Additional Fig. 5. Occupational distribution of death population of various injury types in Xi’an
Additional file 6: Additional Table 1. Injury mortality by age group in Xi’an, 2005–2020
Additional file 7: Additional Table 2. Injury mortality by cause in Xi’an city, 2005–2020
Additional file 8: Additional Table 3. Rank of injury among residents of different ages in Xi’an city, 2005–2020
Additional file 9: Additional Table 4. Top five Injury deaths among permanent residents in Xi’an, 2005–2020 (1/100000)
Additional file 10: Additional Table 5. Time series trends in motor vehicle traffic accidents mortality in Xi’an
Additional file 11: Additional Table 6. Time series trends in transport accidents other than motor vehicles mortality in Xi’an
Additional file 12: Additional Table 7. Time series trends in unintentional falls mortality in Xi’an
Additional file 13: Additional Table 8. Time series trends in unintentional mortality in Xi’an
Additional file 14: Additional Table 9. Time series trends in accidental poisoning mortality in Xi’an
Additional file 15: Additional Table 10. Motor vehicle traffic accidents mortality prediction in Xi’an
Additional file 16: Additional Table 11. Transport accidents other than motor vehicles mortality prediction in Xi’an
Additional file 17: Additional Table 12. Unintentional falls mortality prediction in Xi’an
Additional file 18: Additional Table 13. Suicide mortality prediction in Xi’an
Additional file 19: Additional Table 14. Accidental poisoning mortality prediction in Xi’an

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Authors’ contributions
YYX, MLL, and ZX contributed to conceptualization and methodology. ZXY and WDD carried out data curation. ZXY and MLL contributed to the review and editing process. ZXY and MLL contributed equally to this work and are co-first authors. All authors read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate
Not applicable.

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Competing interests
The authors declare that they have no competing interests.

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References
1. Richman M, Shayne P, Heron S, Lowery D, Todd KH. Injury control in Honduras: a survey of injury mortality. Ann Emerg Med. 2000;36:333–9.
2. Sleet DA, Moffett DB. Framing the problem. Fam Community Health. 2009;32:88–97.
3. Li GH, Baker SP. A comparison of injury death rates in China and the United States, 1986. Am J Public Health. 1991;81:605–9.
4. Organization WH: World Health Organization. The Global Burden of Disease: 2004 Update. 2008.
5. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the global burden of disease study 2015. Lancet. 2016;388:1459–544.
6. Michael M, Benarie. World health statistics report—water and sanitation: Vol. 29. No. 10. World Health Organization, Geneva, Switzerland, 1976, pp. 544–631; text in English and French. Sci Total Environ. 1977;8:285.
7. Ubschwitz SC. World Health Organization Geneva; 2010.
8. Organization WH: World health statistics 2016 monitoring health for the SDGs, sustainable development goals. 2016.
9. Organization WH. WHO | injuries and violence: the facts 2014. World Health Organization, 2014.
10. Chimney P, Shigera H, Sangolla N, Manoharan J, Gopinath P. An insight of World Health Organization (WHO) accident database by cluster analysis with self-organizing map (SOM). Traffic Inj Prev. 2018;19:515–20.
11. Kim HJ, Fay MP, Feuer EJ, Midhune DN. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med. 2000;19:335–51.
12. Zhang L, Li Z, Li X, Jie Z, Li J. Study on the trend and disease burden of injury deaths in Chinese population, 2004-2010. PLoS One. 2014;9:e85319.
13. Olsson-Collentine A, Assem MV, Hartgerink C. The prevalence of marginally significant results in psychology over time. Psychol Sci. 2019;30:576–86.
14. Sun L, Xiao Q, Xue-Yun LI. Analysis of death causes among residents in Shenzhen in 2005. Modern Prev Med. 2009;36:1955–7.
15. Ming WJ, Zhou YJ, Zhou MH. The mortality and leading causes of death in Jiangsu Provincean analysis on the data of the third death retrospectivesurvey. China Cancer. 2011;20:326–30.
16. Yan CK, Dong HM, Xu YL, Zhang SY, Liang XL. A cross-sectional study on injuries in the residents of Shijiazhuang city. Chin J Prev Med. 2000;34:206–8.
17. Sorenson SB. Gender disparities in injury mortality: consistent, persistent, and larger than you’d think. Am J Public Health. 2011;101(Suppl 1):S553.
18. Xing XY, Wang P, Xu Z, He Q, Hu W. Mortality and disease burden of injuries from 2008 to 2017 in Anhui Province, China. Biomed Res Int. 2020;2020:1–10.
19. Meng R, Xu X, Xu Y, Luo C, Xu H, Wang Y, et al. Epidemiological characteristics of injury mortality in Guangdong Province, China, 2015. BMC Public Health. 2019;19:142.
20. Li H, Zhou DD. Analysis of epidemiological trend of injury cases treated for the first time in sentinel hospitals in Songjiang District of Shanghai City, 2007-2010. Chin J Dis Contrl Prev. 2012;16:670–3.
21. Chen L, Tang J, Zhao G. Study on Epidemiological Trend and Disease Burden of Injury Death from 1992 to 2006 in Minhang District, Shanghai. Chin J Health Stat. 2009;26:135–8.
22. Fangrong F, Huxin L, Sequoia L, Yichong L, Ruying. Suicide rates in Zhejiang Province, China, from 2006 to 2016: a population-based study. J Epidemiol Community Health. 2019;73:745–9.
23. Fuller GF. Falls in the elderly. Am Fam Physician. 2000;61:2159.
24. Runge JW. The cost of injury. Emerg Med Clin North Am. 1993;11:241–53.
25. Soron TR, Islam S. Suicide on Facebook—the tales of unnoticed departure in Bangladesh. Global Mental Health. 2020;7:e12.
26. Park C, Lee JW, Sang YL, Moon J, Yong MA. Suicide risk factors across suicidal ideators, single suicide attempters, and multiple suicide attempters. J Psychiatr Res. 2020;131:1–8.
27. Yang H, Li W, Xiang Y, Zhang D, Liu X, Wang Y. Analysis of injury death trends among women in Macheng City, China, 1984-2008. BMC Public Health. 2011;11:1–6.
28. Ramos W, Bealle A, Chambers P, Dalke S, Wernicki P. Primary and secondary drowning interventions: the American red Cross circle of drowning prevention and chain of drowning survival. Int J Aquatic Res Educ. 2015;9:89–101.
29. Yang J, Feng L, Zheng Y, Yu H. Estimation on the indirect economic burden of disease-related premature deaths in China, 2012. Zhonghua Liu Xing Bing Xue Za Zhi. 2014;35:1256–62.
30. Liu Q, Lan Z, Li J, Zuo D, Kong D, Shen X, et al. The gap in injury mortality rates between urban and rural residents of Hubei province, China. BMC Public Health. 2012;12:180.
31. Yang GH, Huang ZJ, Tan J. Priorities of disease control in China—analysis on mortality data of National Disease Surveillance Points System. Chin J Epidemiol. 1996;17:199–202.
32. Zhu Y, Jiang X, Li H, Wang Y, Xu G. Demographic factors associated with leading causes of injury mortality in Ningbo, China. 2004-2013. Asia Pac J Public Health. 2016;28:706–16.
33. Garnett MF, Spencer MR, Hedegaaard H. Urban-rural Differences in Unintentional Injury Death Rates Among Children Aged 0-17 Years: United States, 2018-2019. NCHS Data Brief: National Center for Health Statistics (US). 2021.
34. Jarman MP, Porter KP, Curriero FC, Castillo RC. Factors mediating demographic determinants of injury mortality. Ann Epidemiol. 2019;34:58–64.

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