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Analysis of characteristics and forecast of unintentional injury deaths of children under age 5 from 2013 to 2019 in Sichuan, China

Jinnuo Hu, Min Luo, Linkun He and Ziling Zhao*

Abstract

Objective: Through the study of death characteristics and trend prediction, it is hoped that key populations, regions and seasons can be identified, thereby providing evidence support for the efficient prevention and control management of unintentional injury deaths.

Method: We collected information on 8630 unintentional deaths of children under age 5 from local surveillance systems, analyzed by chi-square test and predicted by the seasonal ARIMA model.

Results: About 33.1% of child deaths were under the age of 1, 60.5% were boys, 37.6% were in urban areas, 2.6% were among ethnic Tibetans, 6.8% were among ethnic Yi, and 46.6% died inside houses. The top three of total deaths were accidental drowning (35.0%), accidental suffocation (32.7%) and traffic accident (15.5%). The ratio of males to females in traffic accidents (1.28:1) and poisoning (1.30:1) deaths was relatively lower than accidental falls (1.62:1) and drowning (1.85:1). The causes of death ratio in rural and urban areas were: drowning (1.83:1), poisoning (1.75:1), suffocation (1.62:1), traffic (1.41:1), and falling (1.24:1). Children's deaths of ethnic minority groups of Tibetan and Yi increased year by year ($\chi^2=75.261, P<0.001$). Tibetan and Yi groups had the most deaths in summer, and Han in winter ($\chi^2=29.093, P<0.001$). Accidental suffocation accounted for 78.2 percent of the total unintentional deaths of children under age 1. And drowning accounted for only 2.4 percent. The model SERIMA (1, 1, 2) (2, 0, 0) [12] is suitable for describing and predicting unintentional injury deaths of children under age 5.

Conclusion: We should combine death surveillance with qualitative investigation or in-depth quantitative investigation to further analyze unintentional injury deaths in children.

Keyword: Unintentional injury death, Children under five years old, Characteristic, Ethnic, Rural, ARIMA

Key messages

What is already known on this topic

Most child deaths occur in children younger than 5 years of age, and unintentional injuries are the leading

cause of death, mainly in low- or middle-income areas. Sichuan is one of China's most impoverished provinces, with a high number of child injury deaths each year.

What this study adds

Children's deaths of ethnic minority groups of Tibetan and "Yi" increased as years went ($\chi^2=75.261, P<0.001$). The model SERIMA (1, 1, 2) (2, 0, 0) [12] is suitable for describing and predicting unintentional injury deaths of children under age 5.

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How this study might affect research, practice or policy

This study will make up for the lack of comprehensive analysis and visualization of the characteristics of unintentional injury deaths among children in Sichuan and provides evidence-based support for efficient prevention and control management of unintentional injury deaths.

Introduction

More than 5 million children die every year around the world, and more than 80% of those aged under 5 [1]. Unintentional injuries are the main causes of children's death, resulting in more than half deaths of children in some countries [2]. As the leading killer of child deaths [3], unintentional injuries are more common in less developed regions. And according to WHO, more than 80% of the unintentional injuries occurred in low or middle-income countries [4]. As one of the largest developing countries in the world, China more than 200,000 child deaths each year as a result of unintentional injuries. And as one of China's most impoverished provinces, Sichuan nearly has the country's highest child mortality rate.

There have been numerous studies about injury deaths of children under age 5 around the world [5–23]. The characteristics of unintentional injury deaths in children in these studies vary considerably across populations, regions and time periods. Besides, studies in Sichuan are not comprehensive or sufficient and need updating [6].

Reducing children's deaths is part of the Millennium Development Goals (MDG) [7]. The United Nations Sustainable Development Goals propose that preventable deaths of children under 5 years of age should be eliminated by 2030, and every country should strive to reduce the mortality rate to less than 25‰ of children under 5 [8]. Reducing unintentional injury deaths in children, is vital for reducing child mortality.

This study intend to study temporal, regional, and demographic distributional characteristics and use scientific methods to predict trends, which will make up for the lack of comprehensive analysis and visualization of the characteristics of unintentional injury deaths among children in Sichuan.

Objectives

Through analysis of the information in Sichuan, this study hopes to find out the epidemiological characteristics of unintentional injury deaths in local children under age 5, to identify the focus of injury prevention in people of different nationalities, genders, ages and etc., and to make scientific prediction of short-term death trends. And it is hoped that key populations, key regions and key seasons can be identified to provide evidence-based

support for efficient prevention and control management of unintentional injury deaths.

Methods

Data sources

Data on child deaths in Sichuan Province from 2013 to 2019 used in this study came from the local maternal and child health surveillance system, which collects relevant data in accordance with Chinese regulations.

We applied for 8630 pieces of information of children died of unintentional injuries in all, including cities of death (a total of 21), the household registration (urban and rural), gender (male and female), ethnic gathering area (ethnic-minority areas of Tibetan and Yi and non-minority areas as Han group), the cause of death (drowning, suffocation, traffic accident, poisoning, falls, others), age (≥ 0 and < 1 , ≥ 1 and < 2 , ≥ 2 and < 3 , ≥ 3 and < 4 , ≥ 4 and < 5), year of death (2013–2019), season (March–May as spring, June–August as summer, September–November as autumn, December–February as winter) and place of death (inside the house, in the hospital and others).

Data analysis

The "hchinamap" package in RStudio v1.0.143 was used to map the number of accidental child deaths in Sichuan Province. Excel was used to draw circle diagram to reflect the composition of accidental death causes, and the composition ratio of the top four causes was marked. The chi-square test was used to compare the epidemiological characteristics of unintentional deaths by gender, region and ethnicity. The seasonal ARIMA model is used to predict the future trend of total injury deaths per month. $P < 0.05$ is considered statistically significant.

Results

Causes of death by region

The unintentional injury deaths of children under the age of five in Sichuan are mainly in the more densely populated eastern regions. Chengdu, the capital city of Sichuan, had the most children's deaths (915). Western areas with higher elevations and lower population densities had the least deaths, such as Ganzi city (108) and Aba city (126).

The leading causes of unintentional injury deaths in virtually every city are suffocation and drowning. Areas from northern Mianyang city (36.3%) to southern Zigong city (51.7%) and eastern Guangyuan city (31.9%) to western Meishan city (40.1%) mainly had drowning deaths. The numerous rivers in these above-mentioned areas create additional conditions for drowning. Ganzi (40.7%), Aba (40.5%) and Liangshan (36.1%) in the western areas are gathering places of ethnic minority

groups with Tibetans and Yi people, where children are mainly killed by accidental suffocation. Details can be seen in Fig. 1.

Trends of different causes of death

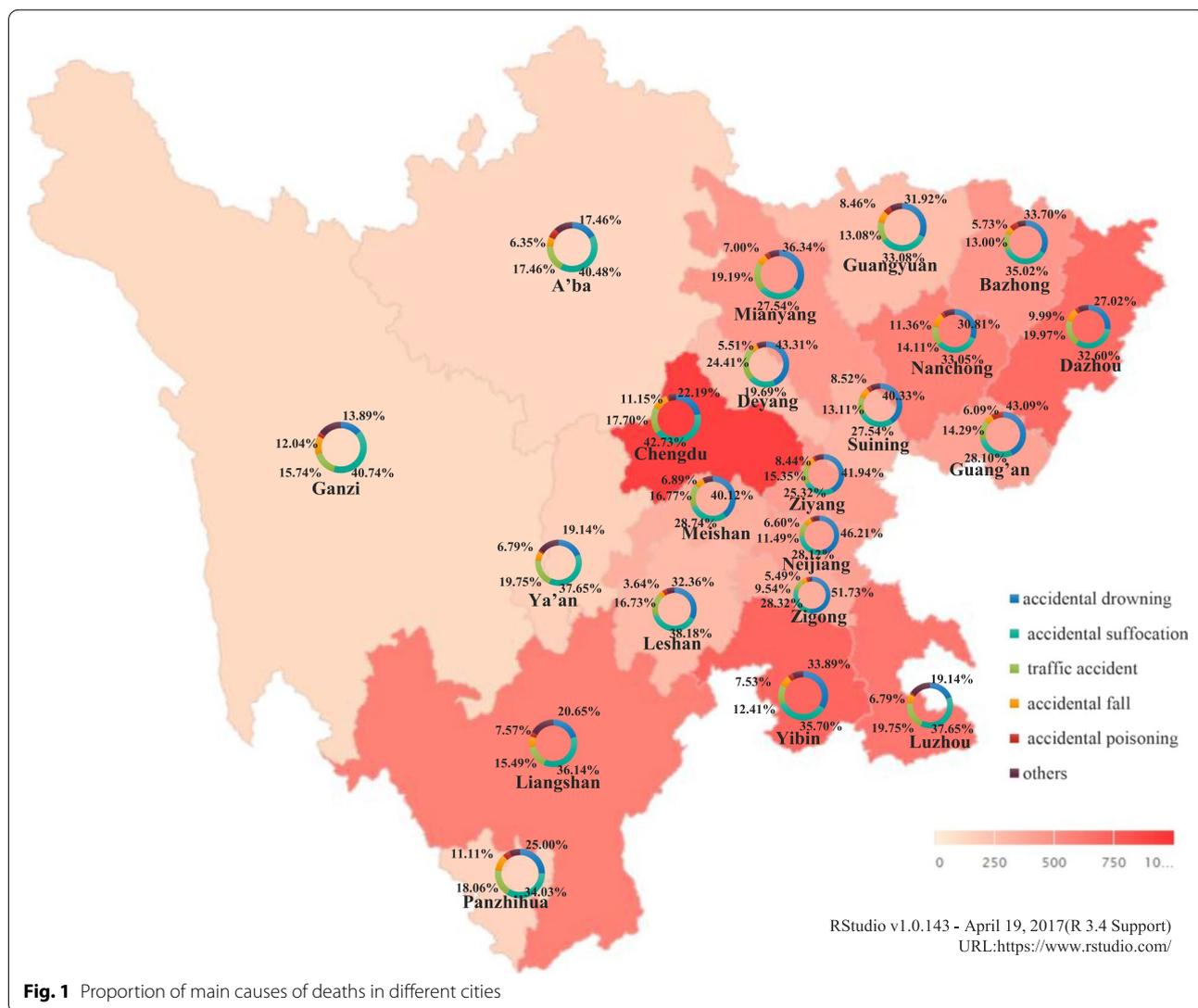
Total unintentional injury deaths among children under the age of five in Sichuan have been decreasing year on year from 2013 to 2019. Total deaths happened higher in cold weather (around January). Suffocation deaths occur significantly more commonly in winter and drowning deaths occur more generally in summer. Suffocation and drowning deaths are both on a year-on-year downward trend. However, other causes of death do not fluctuate seasonally, and their long-term trends are relatively stable. Details can be seen in Fig. 2 and Table 1.

Characteristics of unintentional deaths in children

Of the 8,360 unintentional injury deaths of children under the age of five in Sichuan from 2013 to 2019, 33.1% were under the age of one, 60.5% were boys, 37.6% were in rural areas, 2.6% were ethnic Tibetan, and 6.8% were ethnic Yi. The main causes of total death were accidental drowning (35.0%), accidental suffocation (32.7%) and traffic accident (15.5%). A total of 46.6% of children died in the house and 26.0% in hospital.

Comparison between different gender

About three-fifths of the children who die each year or season from unintentional injuries are boys. Nor does the ratio of boys to girls change by year or season. The proportion of male children’s deaths increased with age ($\chi^2=30.078$, $P<0.001$) among children who died unintentionally under 5 years old. There are significant gender differences in the



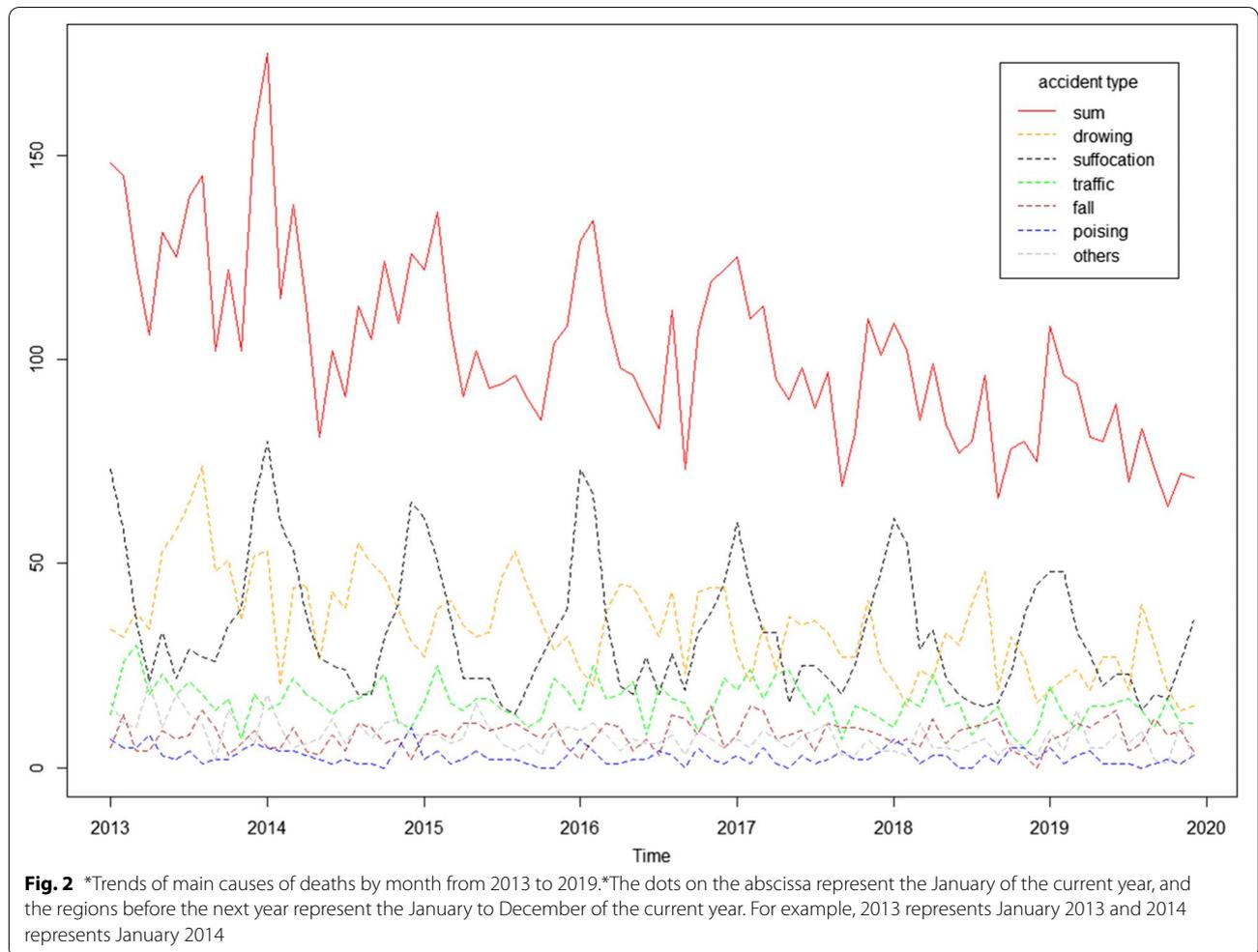


Table 1 Total child deaths per month, 2013–2019

| Variables | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|-----------|------|------|------|------|------|------|------|
| January | 148 | 175 | 122 | 129 | 125 | 109 | 108 |
| February | 145 | 115 | 136 | 134 | 110 | 102 | 96 |
| March | 123 | 138 | 108 | 112 | 113 | 85 | 94 |
| April | 106 | 113 | 91 | 98 | 95 | 99 | 81 |
| May | 131 | 81 | 102 | 96 | 90 | 84 | 80 |
| June | 125 | 102 | 93 | 89 | 98 | 77 | 89 |
| July | 140 | 91 | 94 | 83 | 88 | 80 | 70 |
| August | 145 | 113 | 96 | 112 | 97 | 96 | 83 |
| September | 102 | 105 | 90 | 73 | 69 | 66 | 73 |
| October | 122 | 124 | 85 | 107 | 82 | 78 | 64 |
| November | 102 | 109 | 104 | 119 | 110 | 80 | 72 |
| December | 156 | 126 | 108 | 122 | 101 | 75 | 71 |
| Sum | 1545 | 1392 | 1229 | 1274 | 1178 | 1031 | 981 |

Table 2 Chi-square test of characteristics of unintentional injury deaths

| Variables | Gender | | | | | Areas | | | | |
|------------------------|-------------------|------------|---------------|---------------|--------|--------------------|--------------|---------------|------------|--------|
| | Male | Percentage | Female | Percentage | M:F | Rural | Percentage | Urban | Percentage | R:U |
| Year of death | | | | | | | | | | |
| 2013 | 920 | 17.6% | 625 | 18.3% | 1.47:1 | 989 | 18.4% | 556 | 17.1% | 1.78:1 |
| 2014 | 828 | 15.9% | 564 | 16.5% | 1.47:1 | 929 | 17.3% | 463 | 14.3% | 2.01:1 |
| 2015 | 733 | 14.0% | 496 | 14.5% | 1.48:1 | 843 | 15.7% | 386 | 11.9% | 2.18:1 |
| 2016 | 806 | 15.4% | 468 | 13.7% | 1.72:1 | 847 | 15.7% | 427 | 13.1% | 1.98:1 |
| 2017 | 704 | 13.5% | 474 | 13.9% | 1.49:1 | 708 | 13.2% | 470 | 14.5% | 1.51:1 |
| 2018 | 635 | 12.2% | 396 | 11.6% | 1.60:1 | 559 | 10.4% | 472 | 14.5% | 1.18:1 |
| 2019 | 595 | 11.4% | 386 | 11.3% | 1.54:1 | 506 | 9.4% | 475 | 14.6% | 1.07:1 |
| | $\chi^2 = 6.436$ | | $P = 0.376$ | | | $\chi^2 = 122.961$ | | $P < 0.001^*$ | | |
| Season of death | | | | | | | | | | |
| Spring | 1300 | 24.9% | 820 | 24.1% | 1.59:1 | 1357 | 25.2% | 763 | 23.5% | 1.78:1 |
| Summer | 1226 | 23.5% | 835 | 24.5% | 1.47:1 | 1271 | 23.6% | 790 | 24.3% | 1.61:1 |
| Autumn | 1195 | 22.9% | 741 | 21.7% | 1.61:1 | 1184 | 22.0% | 752 | 23.1% | 1.57:1 |
| Winter | 1500 | 28.7% | 1013 | 29.7% | 1.48:1 | 1569 | 29.2% | 944 | 29.1% | 1.66:1 |
| | $\chi^2 = 3.392$ | | $P = 0.335$ | | | $\chi^2 = 4.076$ | | $P = 0.253$ | | |
| Age of death | | | | | | | | | | |
| [0,1) | 1629 | 31.2% | 1224 | 35.9% | 1.33:1 | 1773 | 32.9% | 1080 | 33.2% | 1.64:1 |
| [1,2) | 1130 | 21.6% | 762 | 22.4% | 1.48:1 | 1192 | 22.2% | 700 | 21.5% | 1.70:1 |
| [2,3) | 1135 | 21.7% | 693 | 20.3% | 1.64:1 | 1123 | 20.9% | 705 | 21.7% | 1.59:1 |
| [3,4) | 771 | 14.8% | 424 | 12.4% | 1.82:1 | 756 | 14.0% | 439 | 13.5% | 1.72:1 |
| [4,5) | 556 | 10.6% | 306 | 9.0% | 1.82:1 | 537 | 10.0% | 325 | 10.0% | 1.65:1 |
| | $\chi^2 = 30.078$ | | $P < 0.001^*$ | | | $\chi^2 = 1.474$ | | $P = 0.831$ | | |
| Causes of death | | | | | | | | | | |
| Accidental fall | 417 | 8.0% | 258 | 7.6% | 1.62:1 | 374 | 7.0% | 301 | 9.3% | 1.24:1 |
| Accidental poisoning | 129 | 2.5% | 99 | 2.9% | 1.30:1 | 145 | 2.7% | 83 | 2.6% | 1.75:1 |
| Accidental suffocation | 1643 | 31.5% | 1176 | 34.5% | 1.40:1 | 1745 | 32.4% | 1074 | 33.1% | 1.62:1 |
| Traffic accident | 752 | 14.4% | 586 | 17.2% | 1.28:1 | 783 | 14.6% | 555 | 17.1% | 1.41:1 |
| Accidental drowning | 1898 | 36.4% | 1027 | 30.1% | 1.85:1 | 1890 | 35.1% | 1035 | 31.9% | 1.83:1 |
| Others | 382 | 7.3% | 263 | 7.7% | 1.45:1 | 444 | 8.3% | 201 | 6.2% | 2.21:1 |
| | $\chi^2 = 42.077$ | | $P < 0.001^*$ | | | $\chi^2 = 40.571$ | | $P < 0.001^*$ | | |
| Places of deaths | | | | | | | | | | |
| Inside the house | 2432 | 46.6% | 1591 | 46.7% | 1.53:1 | 2618 | 48.7% | 1405 | 43.2% | 1.86:1 |
| In the hospital | 1231 | 23.6% | 836 | 24.5% | 1.47:1 | 1167 | 21.7% | 900 | 27.7% | 1.30:1 |
| Others | 1558 | 29.8% | 982 | 28.8% | 1.59:1 | 1596 | 29.7% | 944 | 29.1% | 1.69:1 |
| | $\chi^2 = 1.524$ | | $P = 0.467$ | | | $\chi^2 = 43.550$ | | $P < 0.001^*$ | | |
| Sum | 5221 | 60.5% | 3409 | 39.5% | | 5381 | 62.4% | 3249 | 37.6% | |
| Variables | Ethnics | | | | | | Sum | | | |
| | Tibetan | Percentage | Yi | Percentage | Han | Percentage | T: Y: H | | | |
| Year of death | | | | | | | | | | |
| 2013 | 33 | 14.5% | 72 | 12.3% | 1440 | 18.4% | 0.02: 0.05:1 | 1545 | 17.9% | |
| 2014 | 34 | 14.9% | 55 | 9.4% | 1303 | 16.7% | 0.03: 0.04:1 | 1392 | 16.1% | |
| 2015 | 31 | 13.6% | 71 | 12.1% | 1127 | 14.4% | 0.03: 0.06:1 | 1229 | 14.2% | |
| 2016 | 23 | 10.1% | 110 | 18.8% | 1141 | 14.6% | 0.02: 0.10:1 | 1274 | 14.8% | |
| 2017 | 33 | 14.5% | 100 | 17.1% | 1045 | 13.4% | 0.03: 0.10:1 | 1178 | 13.7% | |
| 2018 | 31 | 13.6% | 92 | 15.7% | 908 | 11.6% | 0.03: 0.10:1 | 1031 | 11.9% | |
| 2019 | 43 | 18.9% | 86 | 14.7% | 852 | 10.9% | 0.05: 0.10:1 | 981 | 11.4% | |
| | $\chi^2 = 75.261$ | | | $P < 0.001^*$ | | | | | | |

Table 2 (continued)

| Variables | Ethnics | | | | | | | Sum | |
|------------------------|--------------------|------------|-----|---------------|------|------------|--------------|------|-------|
| | Tibetan | Percentage | Yi | Percentage | Han | Percentage | T: Y: H | | |
| Season of death | | | | | | | | | |
| Spring | 60 | 26.3% | 153 | 26.1% | 1907 | 24.4% | 0.03: 0.08:1 | 2120 | 24.6% |
| Summer | 74 | 32.5% | 165 | 28.2% | 1822 | 23.3% | 0.04: 0.09:1 | 2061 | 23.9% |
| Autumn | 45 | 19.7% | 136 | 23.2% | 1755 | 22.5% | 0.03: 0.08:1 | 1936 | 22.4% |
| Winter | 49 | 21.5% | 132 | 22.5% | 2332 | 29.8% | 0.02: 0.06:1 | 2513 | 29.1% |
| | $\chi^2 = 29.093$ | | | $P < 0.001^*$ | | | | | |
| Age of death | | | | | | | | | |
| [0,1) | 94 | 41.2% | 252 | 43.0% | 2507 | 32.1% | 0.04: 0.10:1 | 2853 | 33.1% |
| [1,2) | 40 | 17.5% | 96 | 16.4% | 1756 | 22.5% | 0.02: 0.05:1 | 1892 | 21.9% |
| [2,3) | 47 | 20.6% | 90 | 15.4% | 1691 | 21.6% | 0.03: 0.05:1 | 1828 | 21.2% |
| [3,4) | 26 | 11.4% | 78 | 13.3% | 1091 | 14.0% | 0.02: 0.07:1 | 1195 | 13.8% |
| [4,5) | 21 | 9.2% | 70 | 11.9% | 771 | 9.9% | 0.03: 0.09:1 | 862 | 10.0% |
| | $\chi^2 = 49.529$ | | | $P < 0.001^*$ | | | | | |
| Causes of death | | | | | | | | | |
| Accidental fall | 24 | 10.5% | 45 | 7.7% | 606 | 7.8% | 0.04: 0.07:1 | 675 | 7.8% |
| Accidental poisoning | 10 | 4.4% | 18 | 3.1% | 200 | 2.6% | 0.05: 0.09:1 | 228 | 2.6% |
| Accidental suffocation | 92 | 40.4% | 214 | 36.5% | 2513 | 32.2% | 0.04: 0.09:1 | 2819 | 32.7% |
| Traffic accident | 35 | 15.4% | 92 | 15.7% | 1211 | 15.5% | 0.03: 0.08:1 | 1338 | 15.5% |
| Accidental drowning | 38 | 16.7% | 116 | 19.8% | 2771 | 35.5% | 0.01: 0.04:1 | 2925 | 33.9% |
| Others | 29 | 12.7% | 101 | 17.2% | 515 | 6.6% | 0.06: 0.20:1 | 645 | 7.5% |
| | $\chi^2 = 164.098$ | | | $P < 0.001^*$ | | | | | |
| Places of deaths | | | | | | | | | |
| Inside the house | 117 | 51.3% | 326 | 55.6% | 3580 | 45.8% | 0.03: 0.09:1 | 4023 | 46.6% |
| In the hospital | 40 | 17.5% | 95 | 16.2% | 1932 | 24.7% | 0.02: 0.05:1 | 2067 | 24.0% |
| Others | 71 | 31.1% | 165 | 28.2% | 2304 | 29.5% | 0.03: 0.07:1 | 2540 | 29.4% |
| | $\chi^2 = 33.445$ | | | $P < 0.001^*$ | | | | | |
| Sum | 228 | 2.6% | 586 | 6.8% | 7816 | 90.6% | | 8630 | |

* Ethnics is defined in terms of agglomeration areas

ratio of different causes of death ($\chi^2 = 42.077, P < 0.001$). And the ratio of males to females in traffic accidents (1.28:1) and poisoning (1.30:1) deaths was relatively lower than accidental falls (1.62:1) and drowning (1.85:1).

Comparison between rural and urban areas

In 2013, the number of urban deaths was approximately twice as high as in rural areas. And in 2019, the number of deaths in urban and rural areas was nearly the same. Urban areas have always had more deaths than rural areas, but the gap between them narrowed as the year goes ($\chi^2 = 122.961, P < 0.001$). Urban deaths are 1.5 times higher than rural deaths, regardless of season or age group. The causes of death in urban and rural areas were significantly different ($\chi^2 = 40.571, P < 0.001$). The top three causes of death in cities, from most to least, were drowning, suffocation and traffic. The top three

causes of death in rural areas are: suffocation, drowning and traffic. The causes of death ratio in urban and rural areas were: drowning (1.83:1), poisoning (1.75:1), suffocation (1.62:1), traffic (1.41:1), and falling (1.24:1). There are more deaths at home in rural areas and fewer in hospitals than in urban areas ($\chi^2 = 43.550, P < 0.001$).

Comparison among different ethnic groups

The number of child deaths among ethnic Tibetan and Yi people has increased year on year. However, deaths of non-minority group Han decreased ($\chi^2 = 75.261, P < 0.001$). Tibetan and Yi groups had the most deaths in summer, and Han in winter ($\chi^2 = 29.093, P < 0.001$). Children under the age of one accounted for more than 40 percent of children under the age of five in the Tibetan and Yi ethnic-minority groups, and only about 30 percent in the Han non-minority group.

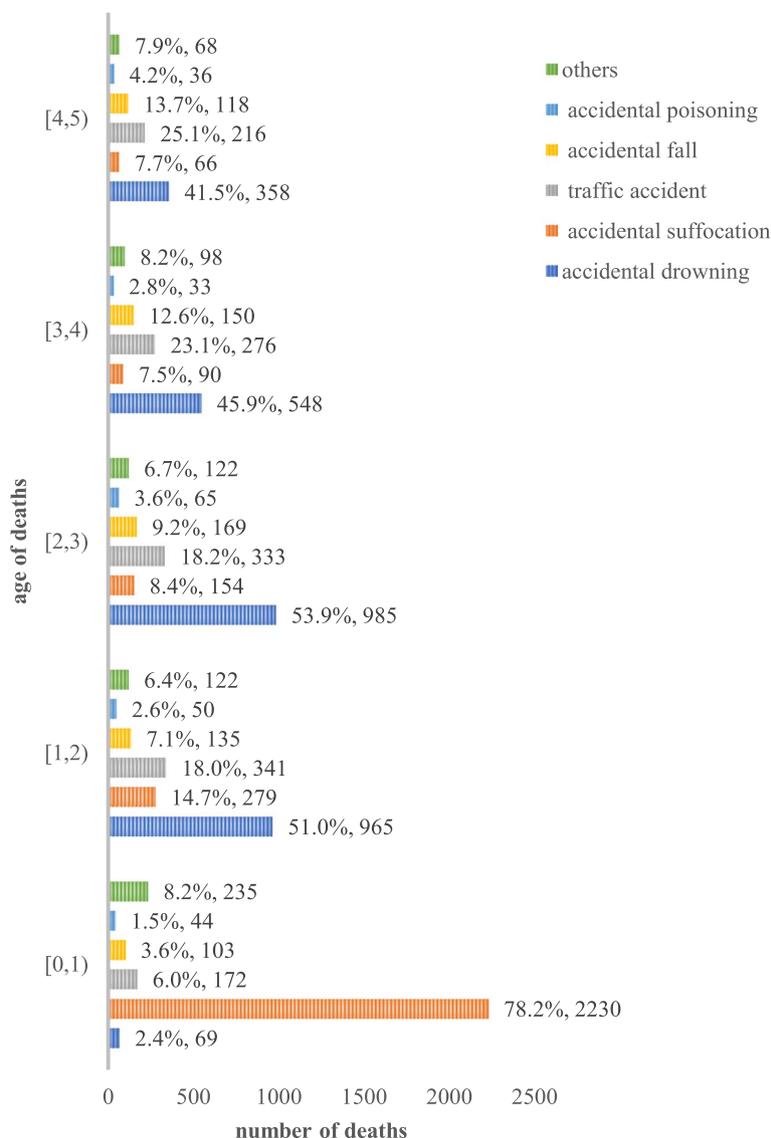


Fig. 3 Causes of deaths of children under 5 years old by age

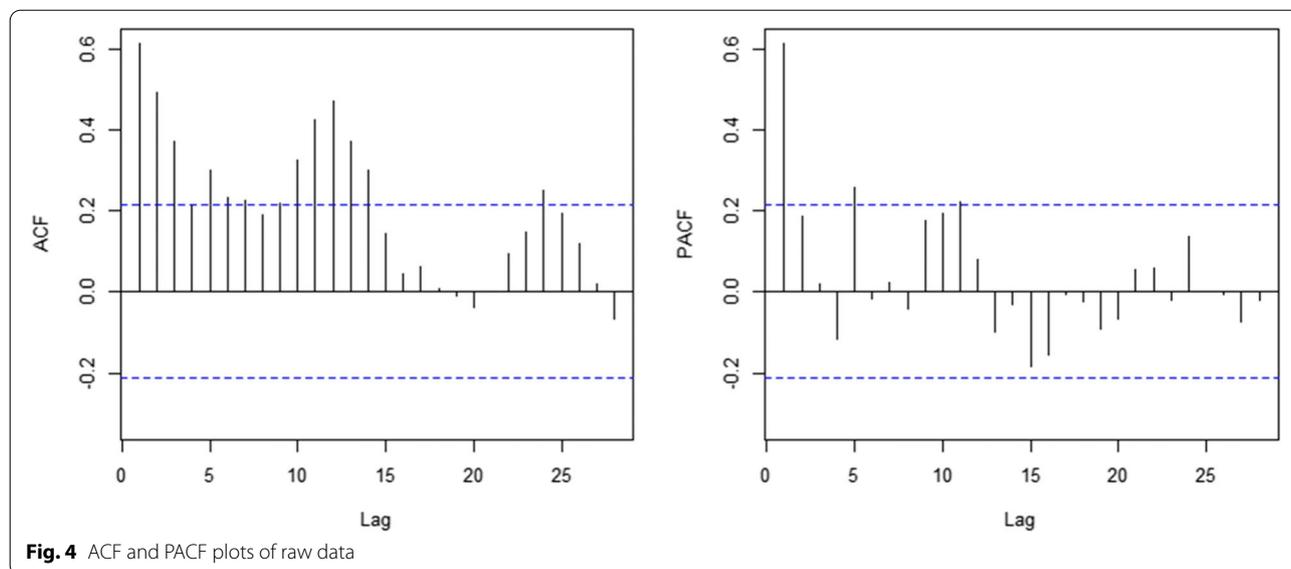
($\chi^2 = 49.529, P < 0.001$). There were statistically significant differences in the composition of causes of death among different ethnic groups ($\chi^2 = 164.098, P < 0.001$). The top three causes of death for Tibetans and Yi were: suffocation, drowning and traffic, while for Han: drowning, suffocation and traffic. Forty percent of the children died from accidental suffocation and about 17 percent from drowning among the ethnic Tibetan group, compared with 32 percent and 36 percent for the non-minority Han group. Tibetans and Yi people die more at home and less in hospitals than Han people ($\chi^2 = 33.445, P < 0.001$). Details can be seen in Table 2.

Comparison among different age groups

Accidental suffocation accounted for 78.2 percent of the total unintentional deaths of children under age 1. Drowning accounted for only 2.4 percent of deaths. Among unintentional deaths in children older than 1, drowning accounted for half of the causes of death and accidental suffocation accounted for about 10 percent. Details can be seen in Fig. 3.

Prediction of unintentional deaths in children

We use time series to analyze the sum of unintentional injury deaths per month. The series is not white noise, with a downward trend and seasonal fluctuations, as



can be seen in Fig. 2. Therefore, we use the seasonal ARIMA model to build the prediction model. On the basis of the ACF and PACF Figures (Fig. 4, Fig. 5) of the original series and difference series as references, the model SERIMA (1,1,2) (2,0,0) [12] is finally formed (details can be seen in Fig. 6) with model AICc = 599.81. The Box.test results show $X\text{-squared} = 0.097078$ with $p\text{-value} = 0.7554$ and the residuals are independent. The results of the Kolmogorov–Smirnov nonparametric test show that $W = 0.99232$ with $p\text{-value} = 0.9062$ and the residuals of the model are normally distributed.

Discussion

Compared with a study of China 10 years ago [9] which showed that drowning and traffic accidents were the first two causes of total unintentional injury death, this study shows that leading causes are drowning (35%) and suffocation (32.7%). The result is different from that in Turkey [10] whose leading causes are traffic injuries (36.5%) and falls (12.0%) and in Pakistan [11] whose leading causes are drowning (22%), traffic injuries (12%). Results declared in this study that female children who died more and the death proportion of rural areas is higher are similar to that of many other China’s studies [12, 13], as well as to that of Japan [14] and Iran [15] in Asia, etc.. This study shows that the leading cause of unintentional death under age 1 was suffocation and the proportion of children injured to death under 1 year old was larger than other age groups, which is similar to that of Brazil [16] and the United States [17]. In the study, rural children accounted for the majority of deaths from each cause. A study in India [18] shows similar results. However, an Egyptian study [19] shows different results. More children die from

unintentional injuries in rural areas than in urban areas. Given the relatively higher rates of intra-household deaths in rural and ethnic minority areas, it can be speculated that there may still be significant gaps in access to health services between urban and rural areas, and between different ethnic groups in Sichuan. Unintentional death differences exist in children of different ethnics in America where non-Hispanic black children died more compared with non-Hispanic white and Hispanic children [20, 21]. Results that children in ethnic minority groups are more inclined to die of unintentional injuries appear in Bernard SJ [22] and Gilchrist J’s [23] studies where American Indian/Alaska Natives (AI/ANs) and blacks had consistently more total injury death than the White. In this study, children of ethnic groups “Yi” and “Tibetan” died more compared with the largest ethnic group “Han” in China.

In recent years, the total number of unintentional injury child deaths in Sichuan has dropped significantly. Drowning and suffocation deaths declined the most, which may be related to previously higher numbers of drowning and suffocation deaths, suggesting that prevention and control of the leading cause of death has achieved great results. However, their rate of decline is becoming slower and seasonal fluctuations remain. Suffocation was the leading cause of death for both rural areas and ethnic minorities in the study, while drowning was the leading cause of death for urban areas and ethnic Han. In accordance with the characteristics that suffocation deaths mainly occur within 1 year old and in cold season as well as drowning deaths occur at 1 year old and above and summer, it’s necessary to pay special attention to the prevention of suffocation deaths in infants in winter and drowning deaths in older children in summer. We need to strengthen the

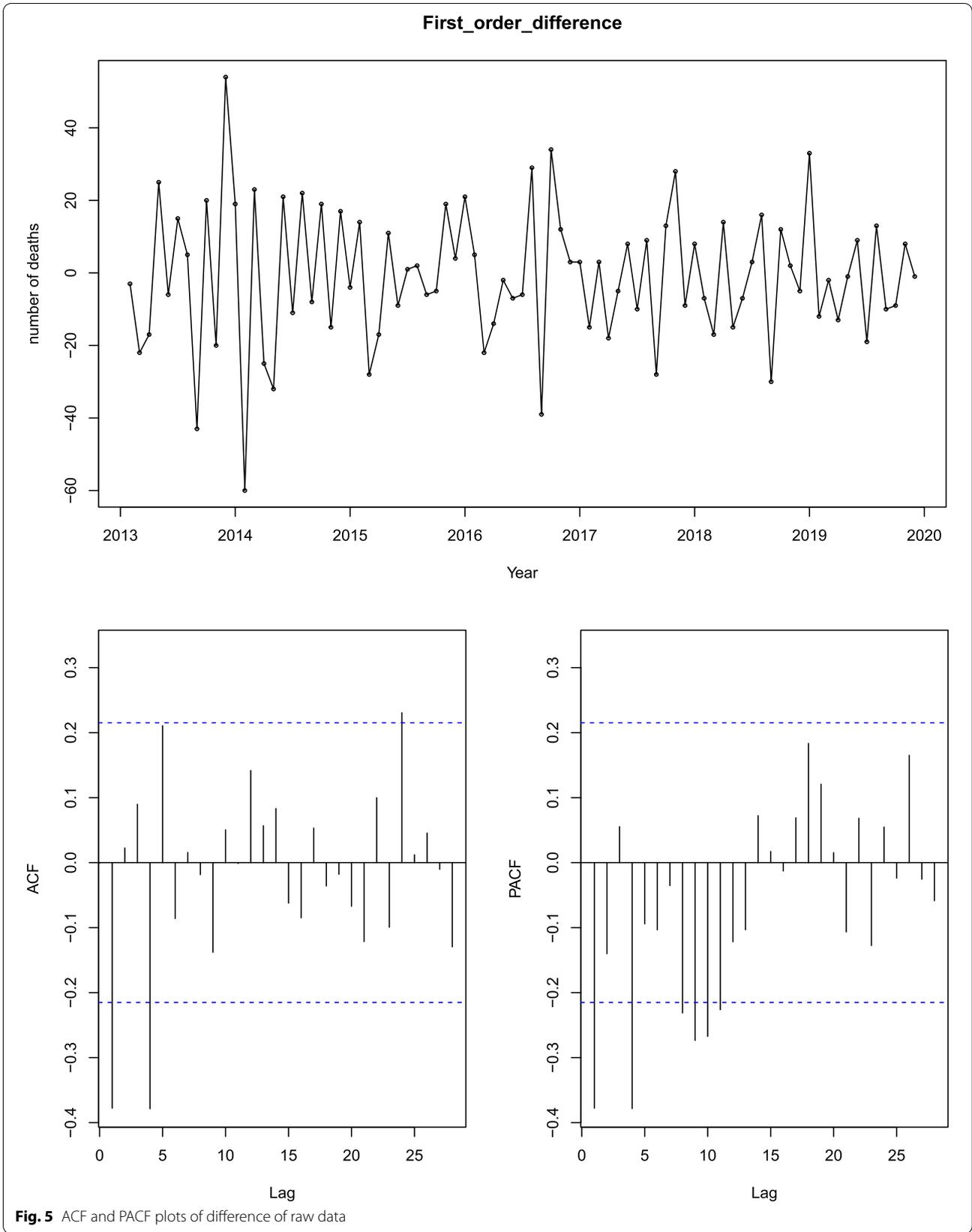
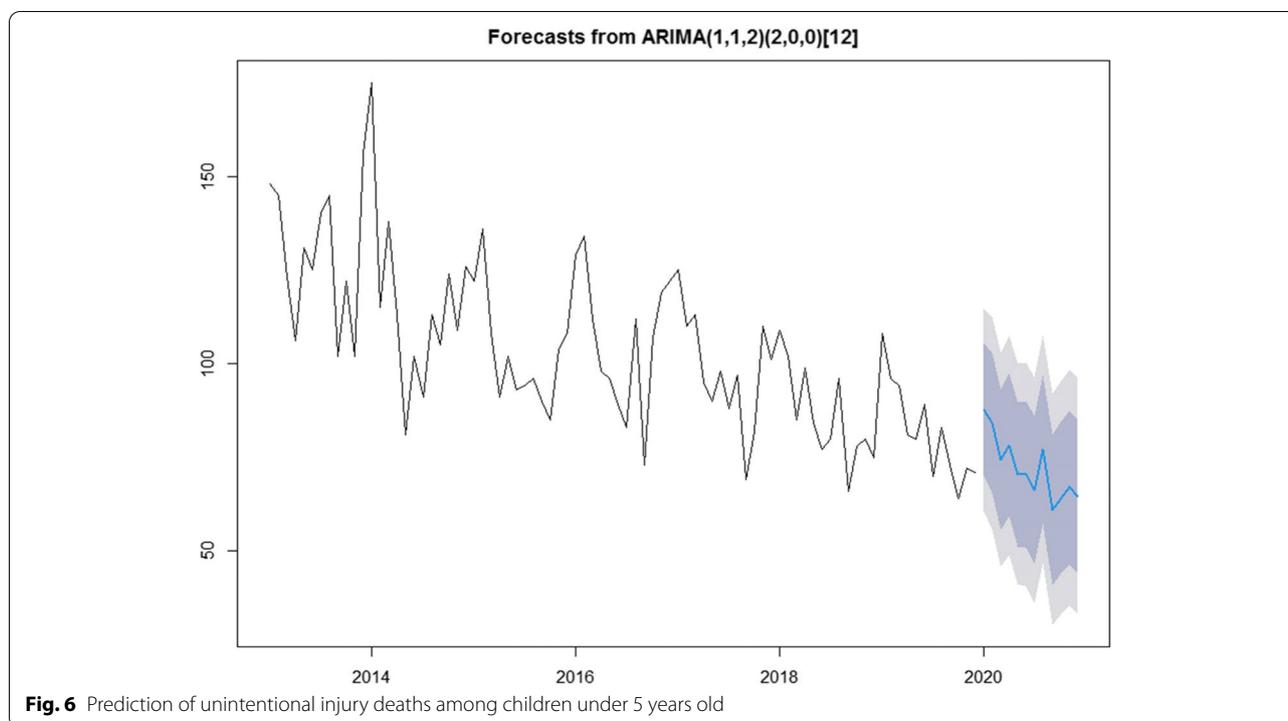


Fig. 5 ACF and PACF plots of difference of raw data



prevention of suffocation in ethnic minority areas and the prevention of drowning in urban and Han areas. In addition, child deaths from poisoning, falls and traffic accidents have not changed much over the years. And with the rapid decline of drowning and suffocation deaths, the proportion of deaths from other causes must increase, and that should be given equal attention, too.

Conclusion

This study clarifies the timing, location, and demographic characteristics of children who died from unintentional injuries in Sichuan, making up for the lack of such a complete study in Sichuan. However, despite the large amount of data used in this study, we did not explore the causes in sufficient depth, such as the lack of analysis on emergency treatment measures and the lack of analysis on the construction of accidental injury prevention facilities. In the future, we should combine death surveillance with qualitative surveys or in-depth quantitative surveys to further provide evidence for reducing unintentional injury deaths in children.

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Authors' contributions

J.H and Z.Z were responsible for the study conception and design. M.L helped with drafting the manuscript. L.H performed the data collection. J.H and M.L performed the statistical analysis. All the authors reviewed and approved the final manuscript.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The data on accidental deaths of children under 5 years old in Sichuan Province from January 2013 to December 2019 used in this study comes from a monitoring network established by government organizations. The collection of relevant data by this network is regular work led by the Chinese government. All data were fully anonymized before accessed. Therefore, this study does not need to go through ethical approval and consent to participate.

Consent for publication

Not applicable.

Competing interests

The authors have declared that no competing interests exist.

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