Unintentional injuries in children in the south of Iran, 2004–2019: a trend analysis of mortality rates

Habibollah Azarbakhsh,1,2 Fatemeh Rezaei,3 Andishe Hamedi,1 Jafar Hassanzadeh,4 Ahmadreza Razeghi,5 Alireza Mirahmadizadeh

ABSTRACT

Introduction Injury is one of the main causes of death and disability in the world. This study was designed to determine the trend of mortality rate and years of life lost (YLLs) due to unintentional injuries in children in southern Iran. Method In this cross-sectional study, we extracted all death reports due to unintentional injuries based on age, gender and the year of death based on International Classification of Diseases (ICD-10) from the Electronic Death Registration System. The YLL analysis due to premature death related to unintentional injuries was executed by the 2015 YLL template from the WHO using the Excel V.2016 software. To examine the trend of crude mortality rate and YLL rates for different years, jointpoint regression was used based on the log-linear model. Results During the 16-year study period (2004–2019), 6590 deaths due to unintentional injuries in children aged 0–19 years have occurred. The total YLLs due to unintentional injuries were 138,482 in males and 53,168 in females. The three main causes of YLLs in our study were transportation injuries (67.37%), drowning (7.19%) and burns (6.70%). According to the jointpoint regression analysis, the 16-year trend of YLL rate due to premature mortality was decreasing; the annual per cent change was −5.2% (95% CI −6.5% to −3.9%, p<0.001) for males and −4.3% (95% CI −5.7% to −3.0%, p<0.001) for females. Conclusion Based on the findings of this study, the trend of mortality and YLL rate has been decreasing. Road traffic injuries were the most frequent injuries and the most common cause of death. Mortality rates fell by half. To improve child survival, injuries must now be recognised as a major child health problem, and to prevent deaths from injuries in children, early and preventive measures should be taken into account.

INTRODUCTION

Injury is ‘the sudden exposure of the human body to amounts of energy that exceed the physiological threshold’. Injury is one of the main causes of death and disability in the world. It was responsible for mortality of more than 4.4 million people in 2017 and imposed a significant burden on global health. Injury can be intentional, like in cases of assault, suicide and self-harm, or it can be unintentional, such as injuries from motor vehicle accidents, poisoning, drowning, fire, burns, falls or suffocation.

Unintentional injuries, in particular, are a growing concern. Deaths from unintentional injuries account for 10% of all deaths in low-income and middle-income countries, while intentional injuries cause 3% of all deaths in these countries. The long-term cost of injuries in low-income and middle-income countries includes adverse effects on health and productivity and the resulting pressure on social systems leading to an annual decrease of 1–3% of gross domestic product due to road traffic injuries. If other unintentional injuries are to be considered, this loss will be even greater. Injuries, especially unintentional injuries, are one of the main causes of death among children and adolescents and are considered a serious public health problem worldwide. The results of a study in China in the age group of 0–14 years showed that injury incidence in children increases rapidly by about 7–10% per year. Injury is one of the most common and costly childhood
problems worldwide, imposing great economic losses on society, ranging from US$516,998 to US$9,550,704 per year. According to the estimates from the WHO Global Burden of Disease Study (GBD) 2017, unintentional injuries are responsible for approximately 855,000 deaths in children and youth under 18 years of age. In addition, the burden of disability adds to the problem because it is higher among children, and they have more years to be affected by their disability.6

Years of life lost (YLL) is one way of measuring the impact of mortality, which, compared with the death rate, can better represent the impact of disease mortality on the community. It gives more weight to deaths at younger ages (premature death) and is useful in prioritising public health interventions. YLL describes healthy life years lost due to disease and death. It enables direct comparison of different diseases and injuries, tracking differences in trends in countries and over time, and makes it possible to prioritise preventive and interventional measures. Since death from childhood injury deprives society of many productive years, the calculation of YLL can provide a more comprehensive picture of the public health burden compared with mortality rates.9 The burden of injury is disproportionately distributed worldwide, and due to a lack of safety measures and appropriate health facilities, most injuries occur in low-income and middle-income countries.10 Moreover, the annual number of injuries varies between different provinces, and considering the fact that unintentional injury is one of the most common and preventable causes of death in childhood, healthcare providers and health policy managers need up-to-date and reliable information on causes of death to develop healthcare facilities, guide primary prevention, allocate budgets and promote public health. From the aspect of identifying the disease burden of unintentional injuries, including the important YLL index for children, understanding the epidemiology is very important in order to prioritise health plans for injury control, since it can provide a picture of public health and economic burden. Besides that, it can help identify and reduce risk factors while increasing protective factors. Therefore, in the present study, we analysed the trend of mortality rate and YLLs due to unintentional injuries in children in southern Iran.

METHOD

In this cross-sectional study, which was conducted in Fars province during the years 2004–2019, all deaths from unintentional injuries in people under 20 years of age were extracted from the population-based Electronic Death Registration System (EDRS) based on age, sex and year of death using the ICD-10 codes. In the population-based EDRS, all available sources have been used to detect, record and collect information related to death.11 EDRS is a web-based registration system that allows users to create and edit death certificates online. In this system, computers are used to enter and maintain the data rather than the traditional method of paper death certificates.12

Codes used in this study were as follows: transport injuries (V01–V99), fall (W00–W19), exposure to inanimate mechanical forces (W50–W64), accidental drowning and submersion (W65–W74), accidental threats to breathing (W75–W84), electric current (W85–W99), burn (X00–X19), contact with venomous animals and plants (X20–X29), exposure to forces of nature (X30–X39), accidental poisoning by and exposure to noxious substances (X40–X49), overexertion, travel and privation (X50–X57), accidental exposure to other and unspecified factors (X58–X84).

Death incidents that were repeated were excluded from the study based on the similarity of the father’s name and national ID number. The total population of Fars province has been estimated using the basic data of health centres and the population and housing census from 1996 to 2016, for which the annual population growth was taken into account. For standardisation, the standard population in 2013 for low-income and moderate-income countries was used.

Data analysis

To begin with, the crude and standardised mortality rates of unintentional injuries were calculated during the study years according to sex and year of death. Subsequently, in order to calculate YLLs, calculation was performed using the standard life table and determining life expectancy for different age and sex groups as well as the number of deaths due to unintentional injuries in each age and sex group based on the following formula14:

\[
\text{YLL} = \frac{N (\beta r a) e^{-(\beta r a)}}{[\beta r a + (1 - \beta r a)]} 
\]

Where:

- \(N\) is the number of deaths in a certain age and sex group.
- \(L\) is the standard life expectancy of the deceased in the same age and sex group.
- \(r\) is the discounting rate, which is equal to 0.03.
- \(\beta\) is the conventional rate in calculating the age value, which is equal to 0.04.
- \(C\) is an adjusted fixed value equal to 0.1658.
- \(a\) is age at the time of death.
- \(e\) which is constant and equal to 2.71 was considered.

The GBD applied a 3% time discount rate to YLLs in the future to estimate the net present value of YLL. \(\beta\) determines the importance of age weights. \(C\) is an adjustment constant, chosen so that the introduction of age weights does not alter the total number of YLLs.15

The YLL has been calculated according to the age groups of 0–4, 5–9, 10–14 and 15–19 years.

The analysis of the number of YLLs due to premature death from unintentional injuries was done using the YLL WHO template of 2015 in an Excel V.2016 spreadsheet.
To examine the trend of crude and standardised mortality rate and YLL rate for different years, joinpoint regression based on the log-linear model was used. Joinpoint regression analysis describes the changing trends over successive segments of time and the amount of increase or decrease within each segment. The resulting line segment between joinpoints is described by the annual per cent change (APC) that is based on the slope of the line segment and the average APC (AAPC). Joinpoint Regression Program V.4.9.1.0 carried out the analysis for the trend.16

A joinpoint of zero indicates a straight line, and the optimal number of joinpoints was identified using the Monte Carlo permutation method.16

### RESULTS

During the 16-year study period (2004–2019), 6590 deaths due to unintentional injuries in children aged 0–19 years have occurred in Fars province, from which 72.7% (4794 cases) were male and 46.2% (3047 cases) were in the age group of 15–19 years. When considering the proportions, the highest mortality rate among males (compared with females) was from the 0–4 years age group (60% vs 40%) (table 1).

The crude mortality rate due to unintentional injuries in males decreased from 64.7 (per 100,000 population) in 2004 to 37.1 (per 100,000 population) in 2019 (p for trend<0.001, AAPC=−5.3), and in females, it decreased from 23.2 (per 100,000 population) in 2004 to 13.6 (per 100,000 population) in 2019 (p for trend<0.001, AAPC=−4.3) (figure 1). The average rate of injury mortality in males and females was 47.26 and 18.42, respectively (table 1).

### Temporal trends of unintentional injury mortality by age groups

In the 0–4 age group, the unintentional injury mortality rate had a decreasing trend in males (AAPC=−4.6%, p<0.001) and females (AAPC=−6.8%, p<0.001).

In the 5–9 age group, there were decreasing trends in males (AAPC=−7.5%, p<0.001) and females (AAPC=−8.0%, p<0.001).

In the 10–14 age group, there were decreasing trends in males (AAPC=−5.3%, p<0.001) and females (AAPC=−5.6%, p=0.006).

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**Table 1** Number of deaths, mortality rate (per 100 000 population) and years of life lost due to unintentional injuries in children according to age and sex groups in Fars province during 2004–2019

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number of deaths</th>
<th>Mortality rate per 100 000</th>
<th>Years of life lost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
</tr>
<tr>
<td>0–4</td>
<td>1076</td>
<td>692</td>
<td>1768</td>
</tr>
<tr>
<td>5–9</td>
<td>573</td>
<td>327</td>
<td>900</td>
</tr>
<tr>
<td>10–14</td>
<td>612</td>
<td>263</td>
<td>875</td>
</tr>
<tr>
<td>15–19</td>
<td>2533</td>
<td>514</td>
<td>3047</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years</td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
</tr>
<tr>
<td>2004</td>
<td>471</td>
<td>161</td>
<td>632</td>
</tr>
<tr>
<td>2005</td>
<td>479</td>
<td>142</td>
<td>621</td>
</tr>
<tr>
<td>2006</td>
<td>445</td>
<td>165</td>
<td>610</td>
</tr>
<tr>
<td>2007</td>
<td>384</td>
<td>153</td>
<td>537</td>
</tr>
<tr>
<td>2008</td>
<td>391</td>
<td>131</td>
<td>522</td>
</tr>
<tr>
<td>2009</td>
<td>329</td>
<td>109</td>
<td>438</td>
</tr>
<tr>
<td>2010</td>
<td>304</td>
<td>111</td>
<td>415</td>
</tr>
<tr>
<td>2011</td>
<td>270</td>
<td>130</td>
<td>400</td>
</tr>
<tr>
<td>2012</td>
<td>238</td>
<td>122</td>
<td>360</td>
</tr>
<tr>
<td>2013</td>
<td>241</td>
<td>87</td>
<td>328</td>
</tr>
<tr>
<td>2014</td>
<td>180</td>
<td>85</td>
<td>265</td>
</tr>
<tr>
<td>2015</td>
<td>205</td>
<td>76</td>
<td>281</td>
</tr>
<tr>
<td>2016</td>
<td>212</td>
<td>83</td>
<td>295</td>
</tr>
<tr>
<td>2017</td>
<td>242</td>
<td>93</td>
<td>335</td>
</tr>
<tr>
<td>2018</td>
<td>178</td>
<td>69</td>
<td>247</td>
</tr>
<tr>
<td>2019</td>
<td>225</td>
<td>79</td>
<td>304</td>
</tr>
<tr>
<td>Total</td>
<td>4794</td>
<td>1796</td>
<td>6590</td>
</tr>
</tbody>
</table>
In the 15–19 age group, there were decreasing trends in males (AAPC=−2.7%, p=0.024) and females (AAPC=−4.9%, p=0.001) (figures 2 and 3).

The total YLLs due to unintentional injuries during the 16-year study period were 138,482 (13.7 per 1000 people) in males, 53,168 (5.5 per 1000 people) in females and 191,650 (9.6 per 1000 people) in both sexes (male/female ratio, 2.6) (table 1).

The three main causes of YLLs in our study were transportation injuries (67.37%), drowning (7.19%) and burns (6.70%) (table 2). The average YLLs were 28.9 years for males and 29.6 years for females.

According to the joinpoint regression analysis, the 16-year trend of YLL rate due to premature mortality was decreasing; the APC was −5.2% (95% CI −6.5% to −3.9%, p<0.001) for males, −4.3% (95% CI −5.7% to −3.0%, p<0.001) for females and −5.0% (95% CI −6.1% to −3.8%, p<0.001) for both sexes. The model did not show any joinpoint; hence, the AAPC is the same as APC (figure 4).

DISCUSSION

In this study, the trend of mortality rate due to unintentional injuries and YLLs in a 16-year period (2004–2019) was evaluated in the age group 0–19 years. The results showed that the crude mortality rate caused by unintentional injuries in males and females had a significant decreasing trend from 2004 to 2019. Moreover, the highest number of deaths occurred in the age group 15–19 years in males and in the age group 0–4 years in females. Although YLLs have been decreasing in both sex groups, the decrease was higher in males than in females.

The results showed that most of the deaths occurred in males. The total YLL from unintentional injuries during the 16-year period was 9.6 per 1000 persons. YLL was higher in males than females so the sex ratio of YLL was 2:6. The average YLL, however, was higher in females than in males (29.6 vs 28.9).

It has been shown that unintentional injuries are the main cause of death in America regardless of age, sex,
ethnicity and socioeconomic status. In other studies, in Iran, it has been shown that injuries are the second cause of death in the age group 0–4 years and the first cause of death in the age group 5–14 years. The three main causes of YLLs in our study were traffic injuries (67.37%), drowning (7.19%) and burns (6.70%), respectively. In this study, the first cause of YLLs in children was transportation injuries. It has been estimated that road traffic injuries constitute more than 70% of unintentional injuries. To reduce death and injuries caused by road traffic, a combination of measures including improving vehicle engineering, making the roads safer, training to change people’s behaviour and improving secondary prevention through better trauma care and economic factors is needed. Policy-related prevention efforts during the time period which are likely to reduce mortality include the adoption of child restraint laws, the construction of safer roads and the implementation of graduated driver licensing programmes.

According to the Haddon matrix, some of the strategies, programmes and interventions to reduce injuries caused by transportation as well as improving road traffic include reducing the risk of exposure to injury, preventing injuries, reducing the number of bodily injuries and reducing the effects of injuries with the improvement of post-accident medical care.

Also, increasing safety culture by educating this group, providing a safe environment for them, training children in traffic safety rules, training younger kids in safe bicycling and helmet use, and enforcement of traffic police of seat belt and helmet use and overspeeding rules are essential. Moreover, bad road conditions should be improved and appropriate street lights should be provided.

**Table 2** Years of life lost (YLL) due to unintentional injuries in children according to sex and type of injuries in Fars province during the years 2004–2019

<table>
<thead>
<tr>
<th>Cause of unintentional injury</th>
<th>Number of deaths</th>
<th>YLL</th>
<th>YLL ratio</th>
<th>% of total YLL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
<td>Male</td>
</tr>
<tr>
<td>Transport injuries</td>
<td>3414</td>
<td>1041</td>
<td>4455</td>
<td>98274</td>
</tr>
<tr>
<td>Burns</td>
<td>215</td>
<td>226</td>
<td>441</td>
<td>6257</td>
</tr>
<tr>
<td>Drowning</td>
<td>356</td>
<td>114</td>
<td>470</td>
<td>10395</td>
</tr>
<tr>
<td>Falls</td>
<td>144</td>
<td>55</td>
<td>199</td>
<td>4184</td>
</tr>
<tr>
<td>Electric current</td>
<td>129</td>
<td>53</td>
<td>182</td>
<td>3742</td>
</tr>
<tr>
<td>Accidental threats to breathing</td>
<td>116</td>
<td>97</td>
<td>213</td>
<td>3456</td>
</tr>
<tr>
<td>Poisoning</td>
<td>113</td>
<td>75</td>
<td>188</td>
<td>3254</td>
</tr>
<tr>
<td>Exposure to inanimate mechanical forces</td>
<td>80</td>
<td>20</td>
<td>100</td>
<td>2306</td>
</tr>
<tr>
<td>Contact with venomous animals and plants</td>
<td>12</td>
<td>8</td>
<td>20</td>
<td>354</td>
</tr>
<tr>
<td>Exposure to forces of nature</td>
<td>17</td>
<td>3</td>
<td>20</td>
<td>490</td>
</tr>
<tr>
<td>Overexertion, travel and privation</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>149</td>
</tr>
<tr>
<td>Other</td>
<td>193</td>
<td>102</td>
<td>295</td>
<td>5621</td>
</tr>
<tr>
<td>Total</td>
<td>4794</td>
<td>1796</td>
<td>6590</td>
<td>138482</td>
</tr>
</tbody>
</table>
The second cause of YLLs was drowning (13,793). The sex ratio of YLLs caused by drowning was 3.05. Males suffered from drowning more than females. In Iran, another study showed that drowning was the third cause of death between 2004 and 2010. In the USA, accidental drowning was the most common type of fatal unintentional injury in children under 12 years of age. Drowning is an important cause of childhood death in many parts of the world. Increasing children’s awareness and using life jackets can be effective in preventing drowning. Also, parents/caregivers’ education about drowning prevention is needed. Based on the Haddon matrix, for decreasing and preventing drowning, some drowning prevention approaches are essential including protecting children at risk, training children, training and supervising parents, creating protective measures, removing the risk factors, and monitoring and securing the water environment.

The third cause of YLLs was burn. However, burns were the second cause of YLLs in another study. The sex ratio of burns was 0.94 in males compared with females. Burn injuries can happen while cooking and doing activities with cooking tools at home. According to the WHO report and Toon et al’s study, burns are the third most common type of injury worldwide and the cause of the longest hospitalisation in childhood.

The results showed that in the 16-year study period, the unintentional injury mortality rate in males and females of the studied age groups, including 0–4 years, 5–9 years, 10–14 years and 15–19 years, significantly decreased. As has already been mentioned, the first cause of YLLs in this study was transport injuries. There are many deaths caused by road traffic injuries in Iran. As a study in Iran showed, from 2006 to 2016, there were 226,514 deaths due to road traffic injuries.

On 1 April 2019, law enforcement was implemented to reduce the number of driving-related crimes. Some of the most important laws were on speeding, overtaking and drunk driving. In addition, since 1 March 2016, traffic ticket fines have increased. For example, the fine for drunk driving has quadrupled (from 1 million rails to 4 million rails). Therefore, it is possible that law enforcement to reduce the number of driving-related crimes has been effective in reducing the number of deaths, as the result of a study in Iran showed that in the period of 2009–2016, law enforcement was only successful in reducing the number of deaths, while there was no obvious change in the number of total injuries. Unfortunately, there is no child safety seat law in Iran. Establishing a child safety seat law can be effective in reducing child deaths, as it was shown in the USA that this law saves up to 39 children annually.

However, training programmes and harm reduction approaches in Iran must be done accurately.

The strength of this study is that it calculates YLLs and unintentional injury mortality in a long period of time. Registration of deaths is mandatory in all provinces of Iran and as a result, missing data were minimal in this study. However, the possibility of wrong coding that leads to incorrect classification cannot be ruled out, although the death registration is done accurately.

Conclusion
In this study, the mortality rate and YLLs due to unintentional injuries in males and females, as well as in the age groups under study, have been significantly reduced.
Traffic injuries, drowning and burns were reported to have been the three main causes of YLLs. To improve child survival, injuries must now be recognised as a major child health problem. To prevent deaths from injuries among children, early and preventive measures should be taken into account.

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Data availability statement Data are available upon reasonable request.

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REFERENCES