Unnatural Deaths Among Children and Adolescents in Isfahan Province, Iran: A Forensic Epidemiology Study of Postmortem Data

Kourosh Holakouie-Naieni, Steven A. Koehler, Roya Karimi, Fardin Mardani, and Jalal Karimi

ABSTRACT

Introduction: The issue of child and adolescent injury and violence is often absent from discussions and is largely invisible in public health policies. The purpose of this study was to describe the frequency and pattern of unnatural deaths during childhood and adolescence in Isfahan province in Iran. Materials and Methods: This retrospective, descriptive study involved unnatural deaths among individuals under the age of 20 years who died from unnatural causes as determined by a forensic autopsy at the Legal Medicine Center of Isfahan. During the study period, 8,010 unnatural deaths occurred, 1,222 of which were individuals under 20 years old. Results: All 1,222 of these unnatural deaths were identified through autopsy. Among the 1,222 cases, 895 (73.2%) were male, and 327 were female (26.8%). Accidental deaths were found to be the most frequent manner of death comprising 1,029 (83.96%) cases, followed by suicide (120, 9.82%), undetermined cause of death (39, 3.19%), and homicide (9, 2.86%) cases. Road traffic accidents were the number 1 cause of death (597, 49%), followed by burns (122, 10%) and hanging (90, 7.4%). Discussion: Injuries and violence that occur during childhood and adolescence represent a global public health problem, especially in low- and middle-income regions, and require urgent action.

KEY WORDS:
Forensic autopsy; forensic epidemiology; medicolegal case; unnatural death

Urgent attention is required to tackle the problem of injury and violence among children and adolescents occurring throughout the world. There has been a considerable shift in the epidemiological patterns of childhood deaths. Although great progress has been made in preventing infectious diseases, the exposure of children and adolescents to the risks of injury and violence appears to be increasing and is projected to continue in the future. Internationally, the focus of child health interventions has been on reducing mortality among children under the age of 5 years to achieve the Millennium Development Goals, specifically “Goal 4: Reduce Child Mortality” and “Target 5: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate” (World Health Organization [WHO], 2005; see Table 1). With this focus on children under the age of 5 years, children between the ages of 5 and 18 years unfortunately receive limited attention, which is of particular concern, given that injuries during this period constitute the greatest burden. Indeed, across the whole age spectrum of childhood and adolescence, the issue of child and adolescent injuries is often absent from discussions and is largely invisible in public health policies (Harvey, Towner, Peden, Soori, & Bartolomeos, 2009). Globally, approximately one million children and young people under the age of 18 years
die every year because of injury and violence. Unintentional injuries account for almost 90% of these cases. In addition to death, millions of children experience various degrees of disability because of their injuries. Improving adolescent health becomes vital in achieving the Millennium Development Goals, particularly Goal 4, which addresses the reduction of child mortality; Goal 5, which focuses on the improvement of maternal health; and Goal 6, which speaks to combating HIV/AIDS, malaria, and other diseases (Peden, Oyegbite, Ozanne-Smith, Hyder, et al., 2008; WHO, 2005).

In Iran, there are an estimated 24 million children and adolescents, comprising one third of the total population. Of these children, almost 1.4 million reside in the Isfahan province (Statistics NN, 2011). The purpose of this study was to describe the frequency and pattern of medicolegal deaths conducted on individuals under the age of 20 years in the Isfahan province between the years 2011 and 2014. This study was approved by the ethical committee of Legal Medicine Center of Isfahan province. All the information provided has been taken under the consideration of the ethical committee.

### Materials and Methods

The Legal Medicine Center of Isfahan serves a total population of around 5,000,000 people in 26 townships. All violent, unnatural, and undetermined deaths are referred to this center to undergo a forensic investigation. An inquest takes place when the cause of death remains undetermined or is deemed to be unnatural. In this retrospective, descriptive study, data were collected on all unnatural deaths among individuals aged 19 years and under who underwent a medicolegal forensic investigation performed from January 1, 2011, to December 31, 2014, in the Isfahan province. During this study period, 1,222 individuals (895 males and 327 females aged under 20 years) underwent a forensic postmortem examination. Medical records and other investigative reports were also collected and reviewed on each case.

The deaths were classified into four age groups—≤4, 5–9, 10–14, and 15–19 years—and by gender. The causes of death were broadly divided into 15 groups such as road traffic accident (RTA), burns, drowning, drug-induced deaths (including legal and illegal drugs), carbon monoxide poisoning, blunt force trauma, poisoning, electrocution, firearm, strangulation, stabbing, and suffocation. Deaths were classified in four manner of death categories: accident, suicide, homicide, and undetermined (Koehler & Brown, 2010). The data were analyzed by cause and manner of death, age, and gender. Data were collected and analyzed using SPSS Statistics Version 20.

### Results

A retrospective, descriptive analysis of unnatural deaths between 2011 and 2014 among those under 20 years in the province of Isfahan, Iran, and who underwent a postmortem examination revealed 1,222 cases. Among these deaths, 895 (73.2%) were male, and 327 (26.8%) were female (see Table 2). The greatest number of deaths was among those between 15 and 19 years old (53.92%).

### TABLE 1. Health in the Millennium Development Goals

<table>
<thead>
<tr>
<th>Goal number</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eradicate extreme poverty and hunger</td>
</tr>
<tr>
<td>2</td>
<td>Achieve universal primary education</td>
</tr>
<tr>
<td>3</td>
<td>Promote gender equality and empower women</td>
</tr>
<tr>
<td>4</td>
<td>Reduce child mortality</td>
</tr>
<tr>
<td>5</td>
<td>Improve maternal health</td>
</tr>
<tr>
<td>6</td>
<td>Combat HIV/AIDS, malaria, and other diseases</td>
</tr>
<tr>
<td>7</td>
<td>Ensure environmental sustainability</td>
</tr>
<tr>
<td>8</td>
<td>Develop a global partnership for development</td>
</tr>
</tbody>
</table>


### TABLE 2. The Leading Causes of Death by Number and Gender: Isfahan, 2011–2014

<table>
<thead>
<tr>
<th>Gender number</th>
<th>Cause of death</th>
<th>Male No. of cases</th>
<th>Male No. of cases</th>
<th>Female No. of cases</th>
<th>Total No. of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Road traffic accident</td>
<td>461</td>
<td>136</td>
<td>597</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Burn</td>
<td>58</td>
<td>64</td>
<td>122</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Hanging</td>
<td>72</td>
<td>18</td>
<td>90</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Others</td>
<td>51</td>
<td>20</td>
<td>71</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Drowning</td>
<td>57</td>
<td>10</td>
<td>67</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fall from height</td>
<td>50</td>
<td>16</td>
<td>66</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Drug-induced deaths (includes legal and illegal drugs)</td>
<td>38</td>
<td>23</td>
<td>61</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Carbon monoxide poisoning</td>
<td>22</td>
<td>9</td>
<td>31</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Blunt force trauma</td>
<td>25</td>
<td>3</td>
<td>28</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Poisoning</td>
<td>14</td>
<td>12</td>
<td>26</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Electrocution</td>
<td>19</td>
<td>2</td>
<td>21</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Firearm</td>
<td>9</td>
<td>4</td>
<td>13</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Strangulation</td>
<td>8</td>
<td>4</td>
<td>12</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Stabbing</td>
<td>8</td>
<td>3</td>
<td>11</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Suffocation</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>895</td>
<td>327</td>
<td>1,222</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
followed by those 4 years old and under (21.93%) and then 5–9 years old (14.56%). Males marginally outnumbered the females in all age groups. Accidental deaths were found to be the most prevalent manner of death comprising 1,029 (83.96%) cases, followed by suicide (120, 9.82%), undetermined cause (39, 3.19%), and homicide (9, 2.86%; see Table 3).

RTAs accounted for the most frequent cause of death with 597 (49%) cases (see Table 4). RTAs were more significant among male (77.34%) compared with females (22.65%). The mean age significantly differed between males and females (t test, p = 0.0001, 95% CI [1.85, 3.24]). In both genders, the maximum numbers of deaths because of RTA were seen in the 15- to 19-year age group (50%), followed by 4 years and under (23%), but the age has a bimodal distribution in males. Among RTA, 139 (23.32%) were pedestrians, 220 (36.9%) were in motorcycles (driver or passenger), 212 (35.6%) were in the car (driver or passenger), and 26 (4.4) were categorized as “other.”

Burns accounted for 122 (10%) deaths. Females in the 15- to 19-year age group accounted for 35.24% of the total deaths from burning. Ten deaths (eight Females and two males) were because of suicide. Death because of hanging caused 90 deaths (7.4% of total deaths), of these 77 (85%) were suicides. Drowning accounted for 67 (5.5%) deaths, with most (85%) involving male suicides. Falls caused 66 (5.4%) deaths, all of which were accidental deaths (50 males and 16 females). Drug-induced deaths (including legal and illegal drugs) caused 61 (5%) deaths, of which 50 males and 16 females.

Carbon monoxide, blunt force trauma, and poisoning accounted for 31 (2.5%), 28 (2.3%), and 26 (2.1%) of the suicides, respectively (see Table 5).

### Discussion

A fundamental lesson emerging from this study is that estimates of child mortality from unnatural causes may tell only a small part of the relevant story: morbidity must also be considered. Understanding child death is critical, but more crucial is the recognition that, when these deaths are the result of injury or violence, the impact has a far greater reach, transcending the individual, family, and society at large. Therefore, it is important to analyze the causes of such unnatural deaths to plan preventive strategies appropriate for the region. The unnatural death rate in Iran is 629 of 1,000,000, whereas in the Isfahan province, it is 577 of 1,000,000 (Moradi & Khademim, 2014). Among unnatural deaths, 15.3% occur among those less than 19 years old. These results were greater than the 13.4% reported in a study conducted by Kumar, Pandey, and Singh (2014) among children in the Varanasi Area of India. In our 4-year study, 1,222 cases were identified as being under the age of 20 years and referred to the Legal Medicine Center of Isfahan province for an autopsy. RTA was found to be the most frequent cause of death followed by burns, hanging, drowning, and falls.

RTAs are the most frequently cited cause of adolescent death in the medical literature globally (Chandran, Hyde, & Peek-Asa, 2010). In recent decades, the rapid increase in mechanization has resulted in an increase number of automobiles and motorcycles. Fast moving vehicles, unskilled or semiskilled drivers, impaired driving, ignorance and intentional violation of traffic rules, and the woefully inadequate road system have caused a manmade epidemic in Iran. Impaired driving puts not only the driver but also the passengers and others who share the road at risk. Motor vehicle crashes were the leading cause of death among those aged 19 years and under. As in other parts of the world, teens are more likely than older drivers to underestimate or not recognize dangerous driving situations. They are also more likely to speed and allow less distance between vehicles, and their lack of driving experience combined with drug use often results in tragedy (National Center for Statistics and Analysis, 2015; National Highway Traffic Safety Administration, 2015). In addition, affordable, domestically manufactured cars are of low quality, lacking many safety features. The combination of all these factors results annually in the deaths of more than 25,000 people in the country of Iran. Although most of these contributing factors are preventable, a commitment by government, industry, communities, and individuals is required for the achievement of a safe and stress-free environment for children to grow (Centers for Disease Control and Prevention & National Center for Injury Prevention and Control, 2012). Chandran et al. (2010), in their meta-analysis of the South Asia region, found that

<table>
<thead>
<tr>
<th>Manner of deaths</th>
<th>0–4</th>
<th>5–9</th>
<th>10–14</th>
<th>15–19</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental</td>
<td>164 (94%)</td>
<td>92 (98%)</td>
<td>104 (92%)</td>
<td>59 (92%)</td>
<td>1029</td>
</tr>
<tr>
<td>Homicide</td>
<td>4 (2%)</td>
<td>2 (2%)</td>
<td>5 (4%)</td>
<td>3 (5%)</td>
<td>34</td>
</tr>
<tr>
<td>Suicide</td>
<td>0</td>
<td>0</td>
<td>11 (1%)</td>
<td>2 (5%)</td>
<td>28</td>
</tr>
<tr>
<td>Undetermined</td>
<td>6 (4%)</td>
<td>0</td>
<td>11 (10%)</td>
<td>4 (9%)</td>
<td>39</td>
</tr>
</tbody>
</table>

**Table 3. Manner of Death by Age and Gender: Isfahan, 2011–2014**

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22% of all the RTAs occurred with children and adolescents. RTAs are not only responsible for a significant number of mortalities but contribute in a major way to increased morbidity both physically and psychologically (Di Gallo, Barton, & Parry-Jones, 1997).

Drowning was the second most frequent cause of unintentional deaths in our study. Approximately every hour of every day, more than 40 people lose their lives to drowning. Drowning creates a similar challenge today as diseases such as diarrhea and measles produced in the 1970s and 1980s (WHO, 2014). Falls were the third leading cause of unintentional injury deaths in our study. Each year, an estimated 4,240,000 individuals die from falls, over 80% of which occurred among living in low- and middle-income countries (Peden et al., 2008; WHO, 2007).

The high mortality rate among drug addicts is an important public health problem. Deaths because of drug addiction are not homogeneous and could be divided into two main groups: those using legal drugs (prescription pharmaceuticals) and those using illicit drugs (opiates and others). Illicit drug users in particular have an extremely high mortality, and because they often live criminal and dangerous lives, it is important to acquire knowledge of causes of death in this group. In our study, there were 61 (38 male, 23 female) deaths because of drug abuse, 50 of which were attributed to illicit drugs, and an additional 11 deaths that involved legal drugs (see Table 2).

It is essential to educate the public that teenage substance abuse is a public health problem and that addiction is a complex brain disease that, in most cases, originates during adolescence. Our health systems must work to prevent or delay the onset of substance use through effective public health measures (National Center on Addiction and Substance Abuse, 2011).

It is widely recognized that official suicide rates conceal the real scale of nonaccidental self-injurious fatal

<table>
<thead>
<tr>
<th>Rank</th>
<th>Age &lt; 1</th>
<th>1–4</th>
<th>5–9</th>
<th>10–14</th>
<th>15–19</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RTA: 24 (37%)</td>
<td>RTA: 110 (54%)</td>
<td>RTA: 95 (53%)</td>
<td>RTA: 65 (42%)</td>
<td>RTA: 302 (48.5%)</td>
</tr>
<tr>
<td>2</td>
<td>BFT: 3 (5%)</td>
<td>Burn: 22 (11%)</td>
<td>Burn: 18 (10%)</td>
<td>Drowning: 19 (12.5%)</td>
<td>Hanging: 75 (12%)</td>
</tr>
<tr>
<td>3</td>
<td>Burn: 2 (3%)</td>
<td>Fall: 18 (9%)</td>
<td>Fall: 13 (7%)</td>
<td>Burn: 16 (12.5%)</td>
<td>Burn: 69 (11%)</td>
</tr>
<tr>
<td>4</td>
<td>Strangulation: 2 (3.1%)</td>
<td>Drowning: 14 (7%)</td>
<td>Drowning: 12 (6.7%)</td>
<td>Hanging: 15 (10%)</td>
<td>DiD: 33 (5%)</td>
</tr>
<tr>
<td>5</td>
<td>Fall: 1 (1.5%)</td>
<td>DiD: 5 (2.5%)</td>
<td>DiD: 9 (5%)</td>
<td>Fall: 7 (4.5%)</td>
<td>Fall: 27 (4%)</td>
</tr>
</tbody>
</table>

RTA = road traffic accident; DiD = drug-induced deaths (includes legal and illegal drugs).

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Cause of death</th>
<th>Accident</th>
<th>Homicide</th>
<th>Suicide</th>
<th>Undetermined</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Road traffic accident</td>
<td>595</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>597</td>
</tr>
<tr>
<td>2</td>
<td>Burn</td>
<td>111</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>122</td>
</tr>
<tr>
<td>3</td>
<td>Hanging</td>
<td>1</td>
<td>3</td>
<td>77</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>Others</td>
<td>62</td>
<td>4</td>
<td>0</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>5</td>
<td>Drowning</td>
<td>63</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>Fall from height</td>
<td>60</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>66</td>
</tr>
<tr>
<td>7</td>
<td>Drug-induced deaths</td>
<td>51</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>61</td>
</tr>
<tr>
<td>8</td>
<td>Carbon monoxide</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>9</td>
<td>Blunt force trauma</td>
<td>25</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>Poisoning</td>
<td>3</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>11</td>
<td>Electrocution</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>12</td>
<td>Firearm</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>13</td>
<td>Strangulation</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>14</td>
<td>Stabbing</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>15</td>
<td>Suffocation</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>No. of cases</td>
<td>1,029</td>
<td>34</td>
<td>120</td>
<td>39</td>
<td>1,222</td>
</tr>
</tbody>
</table>

% 84.20 2.78 9.82 3.2
behavior among children and young people. There are many reasons for this including the constraints of registration policy and practice; uncertainty about the circumstances surrounding a death; an unwillingness, often for the family’s sake, to affix a suicide label on a child; and stigma (Madge & Harvey, 1999). In our study, methods of suicide included hanging, poisoning (because of aluminum phosphide, organophosphates, and legal drugs), burning, and firearms. Aluminum phosphide is an inorganic phosphide used to control insects and is a highly effective insecticide and rodenticide frequently used to protect stored grain. Acute poisoning with these compounds is common in countries like India and Iran and represents a serious health problem. In Iran, it is known as a “rice tablet” for its use to preserve rice (Hosseinian, Pakravan, Rafiei, & Feyzbakhsh, 2011; Khanjani, Nabavi, & Jalili, 2015). Suicide by burning is among the most dramatic of all forms of suicide and is particularly a known phenomenon in Iran, especially among women (Taghaddosinejad, Sheikhazadi, Behnoush, Reshadati, & Sabery, 2010). In this study, eight (22%) female individuals aged 10–19 years killed themselves by burning.

## Conclusions

Children represent our investment in tomorrow’s society. Rapid and unplanned urbanization continues to produce squatter camps, slums, and informal urban settlements, which pose high risks of injury and violence for children across the developing world (WHO, 2005, 2016). The process of motorization also affects child injury risk. The exposure of children and adolescents to the risks of injury and violence appears to be increasing and is projected to increase in the future. If the groundwork to prevent this problem is not laid down now, the processes that currently drive change in our world are likely to exacerbate the problem (WHO, 2016). This study depicts the magnitude of the problem to draw the attention of policy makers, academics, and developmental partners. The science of forensic nursing can provide unprecedented assistance in combating these preventable deaths through a universal presence, co-existing with public health, forensic medical science, and criminal justice systems.

## Acknowledgments

The authors would like to thank the staff of Legal Medicine Center of Isfahan province for their valuable support and full assistance in data collection from the autopsied cases.

## References


