Fatal Occupational Events in a Development Area in East China: 1991 to 1997

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Abstract: Fatal Occupational Events in a Development Area in East China: 1991 to 1997: Jinliang Zhu, et al. School of Public Health, Shanghai Medical University—We analyzed 383 occupational fatal events in a new development area in east China during the period 1991-1997. Most of the events took place during the period 1994-1997, because many large projects related to infrastructure development were ratified and implemented during that period. Extra working shifts on weekends were one of the risk factors in occupational fatalities. Falls, collisions, objects struck against, excavation cave-ins and electrocution were most important types of injury and accounted for the majority of the multiple incident accident types. The most common equipment or environment involved was the work surface, structures being built, cranes, and electric and electronic devices. The most common setting was construction and most incidents occurred in construction. We suggest that the prevention and control of occupational fatalities requires a comprehensive approach which includes improvement of product design, modification of the man-made environment, safety training, enforcement of relevant regulations and ergonomic controls. (J Occup Health 2000; 42:276-280)

Key words: Occupational injury, Fatal event, Prevention and control

Injury, including occupational injury, is now well recognized in the US and other industrialized countries as a significant public health problem, and has been identified as the leading cause of death for those from the first year life to age 44 in the US and in China¹,². In Shanghai, China, deaths due to all accidents have ranked fourth as the cause of death since the late 1980s³. There have been many studies of fatal occupational injuries in the literature, but in developing countries, including China, injury research is still sparse and few have concentrated on the analysis of events leading to unintentional fatal occupational injuries.

Monitoring occupational fatalities can provide the basis for preventing the occurrence of most workplace injuries. The purpose of this paper is to identify environmental risk factors for fatal injury in the workplace in a new development area in east China, 520 square kilometers in size with a population of 1.5 million, by analyzing 383 fatal accidents in the years 1991 through 1997.

Methods and Materials

An “event-case” in the fatal occupational injury monitoring system was defined as an unintentional injury at work that resulted in at least one death. The analysis was based on the fatal events that took place at the work sites in the development area during the 7-yr period, 1991 to 1997. All other events which involved non-occupational traumatic deaths, traffic fatalities (non-work area) and victims in which the interval between injury and death was more than 30 d were excluded.

There were several sources of information on fatal work-related injuries: Death Certificates, Medical Reports, Labor Department Investigation Reports and Workers’ Compensation Reports. The information included the classification of industries, types of enterprises, exact time of accident, victim’s name, age, sex, a description of the events that led to the fatal injury, classification and severity of the accident, type of injury, equipment and the proximal objects involved in the events. The severity of the event was indicated by a single

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or two or more victims per event. All work-related death data were coded and entered into a database.

**Results**

From 1991 to 1997, there were 383 fatal work-related incidents in all industries in this new development area. Twenty-one of these involved multiple deaths. The 383 fatal incidents resulted in the deaths of 426 workers, 412 males and 14 females. The range of the number of fatalities per incident was from 1 to 12. Fatally injured workers ranged in age from 16 to 69 yr with a mean age of 34.6 ± 11.2 (median 33) years.

Table 1 shows that construction is the most hazardous industry in this area, with accidents accounting for 47% to 62% of all fatal events from 1993 to 1997. The mortality rate was 9.1 per 100,000 workers over the 7-yr period. Mortality rates by year were highest in 1994 (13.8/100,000) and in 1995 (14.6/100,000).

The distribution of different time duration of 383 fatal incidents is shown in Table 2. The greatest number of fatal injuries occurred in summer (30.3%). The largest proportions of fatal events occurred on Sunday and Monday, 16.4% and 16.4%, respectively, and the lowest was on Thursday, 11.7%.

As indicated in Table 3, more than half of the fatal events occurred in the construction industry, and falls, collision, struck by/against and electrocution were the main fatal means of injury, accounting for 81.9% of all fatal events, whereas falls alone accounted for 32.6%.

Seventy-four percent (74%) of the fatal events involved work surfaces (such as scaffolds), exposure to construction processes, cranes, electric equipment and vehicles. Most fatal events related to the working surface and constructing building took place in other provinces' state-owned enterprises. Crane-related events occurred mainly in the Shanghai based state-owned and town/county owned enterprises. In contrast, events related to electric equipment and vehicles were nearly evenly distributed among the Shanghai based state-owned, town/county owned enterprises, and other provinces' state-owned enterprises (Table 4).

There were 21 fatal events in which two or more workers sustained fatal unintentional trauma, and 64 deaths (15% of victims) resulted from these events (Table 5). Of these, 13 events resulted in two deaths each and 5 large accidents with 4–12 victims in each. Falls were the most common type of event with multiple fatalities, and resulted in 18 deaths. The largest single event was a falling concrete bridge plate in a bridge-constructing field that cased 12 deaths.
Table 3. Fatal events by type of injury and industry, 1991–1997

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Transport, storage, mail and telecom</th>
<th>Services</th>
<th>All others</th>
<th>Sub total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls</td>
<td>18</td>
<td>92</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>125</td>
<td>32.6</td>
</tr>
<tr>
<td>Collision</td>
<td>21</td>
<td>35</td>
<td>17</td>
<td>2</td>
<td>3</td>
<td>78</td>
<td>20.4</td>
</tr>
<tr>
<td>Struck by/against</td>
<td>18</td>
<td>29</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>58</td>
<td>15.1</td>
</tr>
<tr>
<td>Electrocution</td>
<td>19</td>
<td>25</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>53</td>
<td>13.8</td>
</tr>
<tr>
<td>Excavation cave-in</td>
<td>7</td>
<td>16</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>28</td>
<td>7.3</td>
</tr>
<tr>
<td>Explosion/fire</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>3.9</td>
</tr>
<tr>
<td>Drawn</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>15</td>
<td>3.9</td>
</tr>
<tr>
<td>Poisoning</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>All others</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>2.1</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>207</td>
<td>42</td>
<td>20</td>
<td>17</td>
<td>383</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4. Job-related fatal events by equipment involved and industry, 1991–1997

<table>
<thead>
<tr>
<th>Equipment/Agent involved</th>
<th>State owned (Shanghai)</th>
<th>Town/county owned</th>
<th>State owned (non-Shanghai)</th>
<th>Foreign/private</th>
<th>Sub total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working surface (falls)</td>
<td>24</td>
<td>18</td>
<td>37</td>
<td>8</td>
<td>87</td>
<td>22.7</td>
</tr>
<tr>
<td>Structure being built</td>
<td>9</td>
<td>18</td>
<td>30</td>
<td>1</td>
<td>58</td>
<td>15.1</td>
</tr>
<tr>
<td>Electric equipment</td>
<td>13</td>
<td>16</td>
<td>16</td>
<td>3</td>
<td>48</td>
<td>12.5</td>
</tr>
<tr>
<td>Crane</td>
<td>20</td>
<td>17</td>
<td>9</td>
<td>1</td>
<td>47</td>
<td>12.3</td>
</tr>
<tr>
<td>Vehicle</td>
<td>15</td>
<td>12</td>
<td>12</td>
<td>6</td>
<td>45</td>
<td>11.7</td>
</tr>
<tr>
<td>Other machinery</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>20</td>
<td>5.2</td>
</tr>
<tr>
<td>Chemicals, gas, metals</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>16</td>
<td>4.2</td>
</tr>
<tr>
<td>Power conveyor</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>7</td>
<td>1.8</td>
</tr>
<tr>
<td>Handy tools</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>1.8</td>
</tr>
<tr>
<td>Environment</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>1.6</td>
</tr>
<tr>
<td>Animals</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1.3</td>
</tr>
<tr>
<td>Timber</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>All others</td>
<td>13</td>
<td>14</td>
<td>6</td>
<td>0</td>
<td>33</td>
<td>9.4</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>121</td>
<td>124</td>
<td>23</td>
<td>383</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Discussion

By analyzing occupational fatal events in all industries in the new development area in China over a 7 yr period, we sought to identify characteristics of the fatal events. Among the most important findings are the following: (1) most of the events occurred mainly during 1994–1997, especially in the construction industries in the years 1994 and 1995; (2) extra working shifts on weekends and bad weather conditions were two risk factors in fatal occupational events; (3) falls, collision, objects struck against and electrocution were the most important means of injuries, and were also the major causes of multiple incident accident types; and (4) the most common equipment or environment involved were the work surface, structures being built, cranes, electric and electronic devices which are most commonly found in the construction.

A common conception of an accident is something unpredictable and random, and therefore not preventable. Some consider that an accident is the result of human carelessness, and that the injured person is to blame for his or her injury. But relative lack of experience and safety training, lack of awareness and work in an unfamiliar environment, in the case of migrant workers, may also be contributing factors. Most fatal events happened in this area after 1993, especially in 1994 and 1995. Many large projects focused on infrastructure development, which included elevated roads, traffic rotary bridges, television towers, road improvements, bridges across rivers, highway bridges, mansions and apartment buildings, etc. These were ratified and implemented in this new development area during the 1993–1995 period. These projects were the important parts of the famous
target of “great changes and improvements in the face of
Shanghai by Municipality administered construction in 3 yr”. Therefore fatal occupational accidents in the
construction industry constituted more than half (54%) of the total. During 1994-1995, 10 multiple fatal
accidents occurred and resulted in 34 deaths. Thereafter,
the leaders at all levels, including the Governor and the
safety professionals, paid much attention to the
causalties, especially multiple fatal accidents and asked
employers to examine safety practices and prevention
measures. As a result, the mortality rate decreased greatly,
to about 10/100,000 during 1996-97, but was still nearly
twice as high as the 1992-96 rates in the US (5.1/
100,000). The differences between the patterns in the two countries may lie in ignorance of safety, poor preventive practices, the
equipment used (cranes and vehicles), the height of
buildings and the broad scope of the definition of
occupational death in USA which includes homicide,
suicide and traffic casualties.

Based on accident summary reports, in general, neither fall victims nor their employers had taken the time to
provide a safe work surface, safety lines were absent,
belt unused or on occasion fastened to unstable supports.
On the other hand, it is economically advantageous for a
company to comply with related labor safety regulations
after it has been found in violation because of low fines
(about RMB $5,000 to 10,000 per death). Moreover, the
enforcement of labor safety regulations appeared to be
relatively ineffectual.

In China companies are required to protect their
workers from fall hazards. Workers who are exposed to
the hazard of falling into dangerous equipment are also
required to remain vigilant with regard to falls, and to
pay more attention to self-protection. Workers should
also be able to select a fall protection system, such as a
perimeter guarding fence, personal fall arrest, safety nets,
guardrails, warning lines, controlled access zone, and
positioning devices, etc.

For the prevention of collision and struck by/against
object, safe design and operation of crane and other
machines should be a priority for reducing relevant
occupational fatalities. Special hazard warnings and
recommended operating speed should be clearly posted
on the equipment where it is visible to the operator during
machine operation.

Although electrocution ranked the fourth leading cause
of injury, the victims were mainly younger workers and
effective prevention is easily attained by appropriate
measures. Shutting off nearby power lines, task-specific
electrical safety training and using safe work practices
would have prevented electrocutions. Adequate sloping
or shoring may have been more costly or time consuming,
but it would have prevented all of the excavation cave-in
fatalities.

In brief, the most successful injury-prevention
approaches include improved product designs and

<table>
<thead>
<tr>
<th>No. of deaths</th>
<th>Type of accident</th>
<th>No. of events</th>
<th>Total no. of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Subtotal</td>
<td>15</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Object struck</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Excavation cave-in</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Crane-caused collision</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Falls</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Electrocut</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Explosion</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3 Subtotal</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Crane-caused collision</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Excavation cave-in</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4 Subtotal</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Falls</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5 Subtotal</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Poisoning and suffocation</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>7 Subtotal</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>1</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>12 Subtotal</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Falls</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Number and characteristics of events resulting in
multiple job-related deaths, 1991-1997

With regard to prevalence, in a US southern state, death
due to vehicles (26.9%), struck by objects (11.4%),
machinery (11.3%), falls (11.2%) and electrocutions (10.4%), accounted for the top five injury types. The

Although electrocution ranked the fourth leading cause
of injury, the victims were mainly younger workers and
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fatalities.

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In brief, the most successful injury-prevention
approaches include improved product designs and
modification of the man-made environment to protect everyone. Changes in the behavior of relevant workers, such as awareness of hazards and self-protection, are also important. And they promote each other. Under some circumstances, education, safety training and information programs devoted to making workers more careful are more effective than reducing exposure to job hazards, especially those unable to change environmental conditions. For greatest effectiveness, an occupational injury prevention program should include a multifaceted approach, integrating education and safety training, regulatory enforcement of relevant laws and regulations aimed at controlling occupational injury, and engineering controls, such as product design and environmental modification in protecting people effectively and automatically. Training of health professionals and other scientists in injury research and basic concepts of injury control should be considered for effective injury prevention strategies. Simultaneously, employers, safety professionals and employees must work together to get safe and healthful working conditions, and to seek new approaches to protect workers from injury and death at work.

In summary, most work-related deaths in this area could have been prevented by adopting appropriate safe work practices, prevention measures and safety education for the workers. More complete data are needed on these potentially preventable fatal injuries, such as the provision and use of personal protective equipment (e.g. safety belts). Appropriate prevention strategies and interventions should, therefore, focus more on falls, crane-caused death, and electrocution, being struck by objects and excavation cave-ins. More resources should be allocated for safety training and redesigning of equipment, and it should be advantageous to focus on the more hazardous jobs and potential environmental hazards resulting in multiple fatalities.

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References