



# Epidemiology of unintentional injury in children admitted to ICU in China mainland: a multi-center cross-sectional study

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**Background:** To investigate the epidemiology of unintentional injury in children admitted to Intensive Care Unit (ICU) in China mainland.

**Methods:** A total of 39 hospitals in 19 provinces contributed to the 1-day point prevalence study of serious unintentional injury in children aged 0–16 years admitted to ICU.

**Results:** A total of 1,017 patients from the 39 participating ICUs on the study day were included. Among them, 56 pediatric patients were identified to be suffered from unintentional injury from 18 participating ICUs, accounting for 5.5% (56/1,017) of all the ICU patients. The percentage of boys was more than twice the percentage of girls. Most patients had an age of less than 6 years old (n=42, 75%). The leading cause of unintentional injury was fall (n=17, 30.4%). The patterns of unintentional injury in children were age-related. There were no urban-rural differences in our cohort. The injury happened on 12:00–18:00 PM in 27 cases (48.2%), and 28 patients (50%) had injuries happened at working day. 35 patients (62.5%) received primary treatment at local hospitals. Thirty-five patients (62.5%) needed resuscitation in the emergency department, 15 patients (26.8%) still needed resuscitation in ICU. These 56 children suffered from a total of 106 lesions corresponding to 1.89 lesions per patient. Respiratory failure was most commonly seen (n=18, 32.1%). There was no death in our cohort during the study. After effective treatment during their ICU stay, 45 (80.4%) patients showed improvement, with Glasgow Coma Scale (GCS), Pediatric Trauma Score (PTS) and Pediatric Risk of Mortality III (PRISM III) score significantly better than those before treatment (P<0.05).

**Conclusions:** Higher injury rates among children under 6 years old of age illustrate the need for preventive measures, especially programs and public policies targeting this high-risk group.

**Keywords:** Epidemiology; children; intensive care; unintentional injury

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## Introduction

Unintentional injury is a major public health concern globally, and attributes to the leading cause of mortality and morbidity in children. It is reported that about 875,000 children under the age of 18 years died as a result of injury or violence in 2002 (1). Data from the China National Disease Surveillance System show that accidental injuries have become the number one cause of death in the 1–14 age groups. The incidence rate of unintentional injuries in children increases rapidly at about 7–10% per year (2).

Studies on investigating child injuries worldwide have been conducted over the past few decades (3,4). Because of the vulnerability of children, accidental injuries accounted for 13% of all disability-adjusted life years globally and for 4.9% among children aged 4 to 14 years in the United Kingdom (5). Most of the epidemiological studies of injury-related child deaths that have been conducted in China are limited to single central data (6,7). However, serious unintentional injury in children has received little or no attention, especially in the context of China nationwide.

In this study, we conducted a multicenter 1-day point cross-sectional survey in the pediatric Intensive Care Unit (ICU) in China mainland. We aimed to investigate the epidemiology of serious unintentional injuries in children aged 0–16 years who were admitted to ICU in China mainland. The significance of this study and other information may help guide prevention strategies aimed at reducing the incidence of accidental injuries among children in China mainland. We present the following article in accordance with the STROBE reporting checklist (available at <https://tp.amegroups.com/article/view/10.21037/tp-21-387/rc>).

## Methods

### *Definition of unintentional injury*

Injury is defined as physical damage caused by external causes (intentional or unintentional). An unintentional injury is defined as “an unexpected, unintentional and violent event, affecting a child, with or without detectable lesions, and subsequently leading to medical attention” (3).

### *Pediatric ICU (PICU) network*

A total of 39 hospitals in 19 provinces across the country participated in this survey. Collaborative research group from 20 children’s hospitals and 19 general hospitals, all

in either municipalities (n=8), provincial cities (n=17) or the other cities (n=14) serving as regional tertiary medical/pediatric centers. Thirty-six hospitals are tertiary hospitals level A. Three hospitals are tertiary hospitals level B. Twenty-six hospitals are affiliated with university. 34 hospitals have independent PICUs (Appendix 1). The Children’s Hospital, Zhejiang University School of Medicine served as a coordinating center.

### *Inclusion criteria and study design*

A total of 39 hospitals in 19 provinces in China mainland contributed to the 1-day point prevalence study of serious unintentional injury admitted to ICU in children aged 0–16 years in China mainland. A contact doctor from each participating hospital who is responsible for collecting and filling out the unified electronic form of the children who meet the standards on the survey day, sending it back to the Children’s Hospital of Zhejiang University.

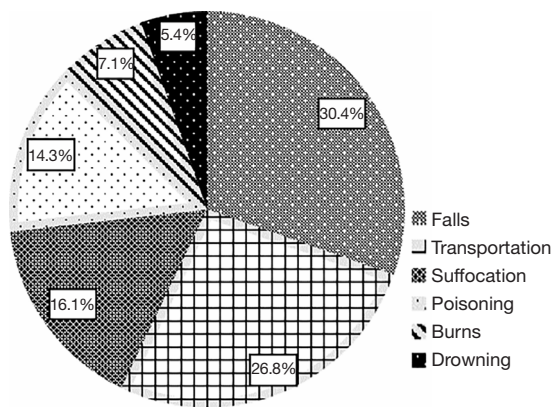
Data was collected from 0:00 to 24:00 on February 1, 2019. All pediatric patients presented in participating ICUs on the study day were included. Among them, the patients with the diagnosis of unintentional injury were analyzed in detail. Data on patient demographics, external causes of injury codes [International Classification of Diseases (ICD10)] categories of unintentional injuries, clinical manifestations, severity of illness, clinical treatment and outcomes were collected and analyzed.

### *Human rights*

All procedures performed in this study was in accordance with the Declaration of Helsinki (as revised in 2013). The institutional ethics committee at The Children’s Hospital, Zhejiang University School of Medicine approved this observational study with minimal risk and no informed consent required (No. 2017-IRB-042). The ethical agreement was adopted by each participating hospital.

### *Statistical analysis*

Continuous variables with skewed distribution are displayed by using medians [interquartile range (IQR)] and categorical variables by using as number of cases and percentage. Kolmogorov-Smirnov test or Wilcoxon rank sum test (continuous variables) and Pearson  $\chi^2$  test (categorical variables) were used to compare the difference between subgroups of patients. Statistical significance was



**Figure 1** Category of unintentional injury in children admitted to Intensive Care Unit.

**Table 1** Characteristics of the study cohort (n=56)

Characteristics	Study patients (n=56)
Age (y)	3.6 (1.0–6.7)
Male, n (%)	39 (69.6)
Weight (kg)	15.0 (10.6–21.8)
Days after injury during survey (d)	2.5 (1.0–9.0)
Category of injury, n (%)	
Falls	17 (30.4)
Transportation	15 (26.8)
Suffocation	9 (16.1)
Poisoning	8 (14.3)
Burns	4 (7.1)
Drowning	3 (5.4)
Body region of injury lesions, n (%)	
Thorax	36 (64.3)
Head	28 (50.0)
Abdomen	13 (23.2)
Extremities	10 (17.9)
Pelvis	6 (10.7)
Peripheral nerve	5 (8.9)
Spinal	4 (7.1)
Heart	4 (7.1)

Categorical data are presented as n (%). Continuous data are presented as median (interquartile range).

considered at a two-sided 5% level. All statistical analyses were conducted with SPSS Statistics® software package (Version 23, IBM Inc., Armonk, NY, USA).

## Results

### *Characteristics of serious unintentional injuries in children in China Mainland*

From 0:00 to 24:00 on February 1, 2019, a total of 1017 patients from the 39 participating ICUs in China mainland on the study day were included in this study. Eighteen of the participating 39 hospitals reported a total of 56 patients admitted to ICU because of serious unintended injury, and the other 21 hospitals reported no relevant cases. These 18 hospitals are all tertiary hospitals level A children's hospitals with independent PICU, 13 of which are children's hospitals affiliated with university (Appendix 1). The percentage of unintentional injury accounts for 5.5% (56/1,017) of all the ICU patients.

Among these 56 pediatric patients, 69.6% (39/56) were males and 30.4% (17/56) were females. The percentage of boys was more than twice the percentage of girls. They had a median age of 3.6 years (IQR, 1.0–6.7 years), and a median body weight of 15.0 kg (IQR, 10.6–21.8 kg). The leading cause of unintentional injury was fall (n=17, 30.4%), followed by transportation injury (n=15, 26.8%), suffocation (n=9, 16.1%), poisoning (n=8, 14.3%), burns (n=4, 7.1%) and drowning (n=3, 5.4%) (Figure 1, Table 1).

Children were dividing into the following groups by age: less than 1, 1–6, 6–12, and 12–16 years. The types of unintentional injury varied substantially with age. Most patients who suffered from unintentional injuries had an age of less than 6 years old (n=42, 75%). The most common cause of unintended injuries in children younger than 1y were suffocation (n=6, 37.5%), whereas falls (n=10, 38.5%) and transportation injury (n=7, 26.9%) were commonly seen in preschool children with an age of 1–6 years (Table 2).

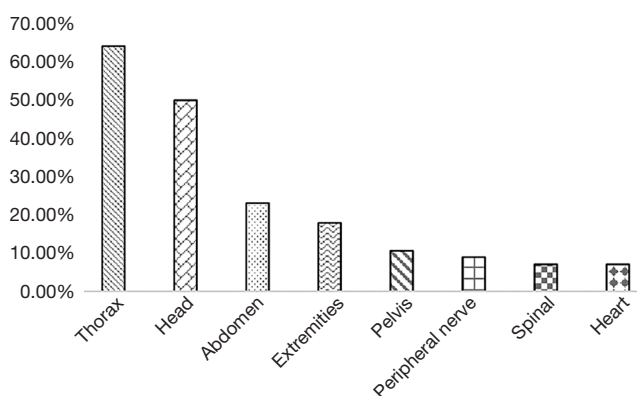
Among these 56 children with unintentional injuries, 20 (35.7%) cases lived in a rural area, 20 (35.7%) children lived in urban-rural fringe area, and 16 (28.6%) children lived in urban area (Table 2). The injury happened on 12:00–18:00 PM in 27 cases (48.2%), and 28 patients (50%) had injuries happened at working day.

These 56 children suffered from a total of 106 lesions

**Table 2** The epidemiology of serious unintentional injuries in children aged 0–16 years in China

Type of injury	Total injuries	Falls	Transportation	Poisoning	Suffocation	Drowning	Burns
Gender, n (%)							
Male	39 (69.6)	13 (33.3)	8 (20.5)	5 (12.8)	6 (15.4)	3 (7.7)	4 (10.3)
Female	17 (30.4)	4 (23.5)	7 (41.2)	3 (17.6)	3 (17.6)	0 (0)	0 (0)
Age group, n (%)							
≤1 years	16 (28.6)	4 (25.0)	3 (18.8)	0 (0)	6 (37.5)	1 (6.3)	2 (12.5)
1–6 years	26 (46.4)	10 (38.5)	7 (26.9)	4 (15.4)	3 (11.5)	1 (3.8)	1 (3.8)
6–12 years	10 (17.9)	2 (20.0)	3 (30.0)	3 (30.0)	0 (0)	1 (10.0)	1 (10.0)
12–16 years	4 (7.1)	1 (25.0)	2 (50.0)	1 (25.0)	0 (0)	0 (0)	0 (0)
Site of injury, n (%)							
City	16 (28.6)	7 (43.8)	6 (37.5)	0 (0)	1 (6.3)	0 (0)	2 (12.5)
Urban-rural fringe	20 (35.7)	6 (30.0)	4 (20.0)	3 (15.0)	4 (20.0)	2 (10.0)	1 (5.0)
Village	20 (35.7)	4 (20.0)	5 (25.0)	5 (25.0)	4 (20.0)	1 (5.0)	1 (5.0)

Categorical data are presented as n (%).



**Figure 2** Body region of unintentional injury in children admitted to Intensive Care Unit.

corresponding to 1.89 lesions per patient. The majority of lesions were to the thorax (64.3%), head (50.0%), abdomen (23.2%) and extremities (17.9%) (Figure 2). Many children had major complications when they admit to the ICU. Respiratory failure was most commonly seen (n=18, 32.1%), followed by shock (n=13, 23.2%), metabolic acidosis (n=13, 23.2%), and acute traumatic coagulopathy (n=6, 10.7%). Other complications included multiple organ failure (n=3, 5.4%) and hypothermia <35 °C (n=2, 3.6%) (Table 3).

The median score of Pediatric Risk of Mortality III (PRISM III), Glasgow Coma Scale (GCS) and Pediatric Trauma Score (PTS), on admission to ICU was 6.0 (IQR,

2.0–12.0), 13.0 (IQR, 7.0–15.0), and 7.5 (IQR, 5.0–9.0) respectively (Table 4).

### Treatment and outcomes

Thirty-five patients (62.5%) received primary treatment at local hospitals. Thirty-five patients (62.5%) needed resuscitation in the emergency department, 15 patients (26.8%) still needed resuscitation in ICU. Twenty-eight (50%) patients received fluid resuscitation, 13 (23.2%) patients underwent tracheal intubation, 3 (5.4%) patients underwent cardiopulmonary resuscitation and 2 (3.6%) patients underwent massive transfusion (Table 3).

After effective treatment during their ICU stay, 45 (80.4%) patients showed improvement, with GCS, PTS and PRISM III score significantly better than those before treatment (P<0.05). The median score of PRISM III, PTS and GCS on the survey day was 3.0 (IQR, 0.0–7.5), 9.0 (IQR, 7.0–10.0) and 15.0 (IQR, 10.0–15.0), respectively (Table 4). There were no deaths in our cohort during the survey.

### Discussion

This is a national, multi-center, observational study aiming to investigate the epidemiology of serious unintentional injury in children admitted to ICU from different

**Table 3** Treatment and outcome of the 56 patients with serious unintentional injuries

Treatment and outcome	Cases (n)	Percentage (%) or M (P25–P75)
Location receiving resuscitation		
On-site	6	10.7
Emergency room	35	62.5
ICU	15	26.8
Type of resuscitation		
Fluid resuscitation	28	50.0
Tracheal intubation	13	23.2
Cardiopulmonary resuscitation	3	5.4
Massive transfusion	2	3.6
Primary treatment in local hospital		
Yes	35	62.5
No	21	37.5
Surgery in local hospital		
Yes	2	3.6
No	54	96.4
Treatment in participating hospital		
Emergent surgery	9	16.0
Elective surgery	4	7.1
Mechanical ventilation	20	35.7
Complications on ICU admission		
Respiratory failure	18	32.1
Shock	13	23.2
Metabolic acidosis	13	23.2
Acute traumatic coagulopathy	6	10.7
Multiple organ failure	3	5.4
Hypothermia <35 °C	2	3.6
Total amount of blood products infused		
Red blood cells (U/kg)	14	0.14 (0.12–0.29)
Plasma (mL/kg)	14	20.00 (11.76–35.71)
Platelets (U/kg)	4	0.70 (0.17–1.22)
Fibrinogen (U/kg)	6	0.08 (0.03–0.33)
Prothrombin complex (U/kg)	8	15.97 (13.57–33.13)

ICU, Intensive Care Unit; U, unit; mL, milliliters; kg, kilogram.

geographic regions in China mainland. A total of 39 hospitals in 19 provinces in China mainland contributed to the 1-day point prevalence survey of serious unintentional injury in children aged 0–16 years. A total of 56 pediatric patients were identified to be suffered from unintentional injury, accounting for 5.5% (56/1,017) of all the ICU patients on the study day.

In our cohort, the first cause of unintentional injury was fall, followed by transportation injury, suffocation, poisoning, burns and drowning. It was reported that in China, drowning, traffic accidents, unintentional suffocation, poisoning and falls were the five main causes of injury death for children aged 1–4 years (8). We found falls were the first cause of injuries among children, which are similar to previous research (9,10). Unlike adults, pediatric fall injury is more often because of an accident, other than suicide. Traffic accidents in developed countries are the leading cause of accidental death among children aged 0–14 years, followed by drowning (11). China's motor vehicle production has grown rapidly since the early 1990s (12), it is therefore not surprising that the proportion of deaths and morbidity related to traffic injuries is increasing (13). The higher traffic-related mortality may be related to the fact that Chinese children use less safety seats and seat belts (14). It is very common for mothers to hold babies in the position of the co-driver. Damage caused by airbag impact is commonly seen. It is an important time to urge the government to legislate for children to use seatbelts and child restraints in vehicles (15).

Other causes of serious unintentional injuries in our study included poisoning, suffocation, drowning, and burns. These injuries had obvious regional characteristics, and the incidence rate of children living in rural or urban-rural fringe area was significantly higher than that of children living in cities. This is different from other studies which showed that the accidental injury to children is a common phenomenon caused by child abuse and ignorance (16). Childhood injury data can be used to develop appropriate intervention strategies. Effective prevention guidance depends on detailed injury data that can show how risk changes as children grow. Drowning represents the leading cause of deaths caused by unintentional injuries among children between 1 and 4 years of age in the other investigation reports (8,17). In addition, children who survive drowning may present severe long-term disabilities. Differences from other studies, there

**Table 4** The severity of disease score on survey day in children with serious unintentional injury compared with those on their ICU admission

Score	On ICU admission	On survey day	Z	P value
PRISM III	6.0 (2.0–12.0)	3.0 (0.0–7.5)	–4.63	<0.001*
GCS	13.0 (7.0–15.0)	15.0 (10.0–15.0)	–4.06	<0.001*
PTS	7.5 (5.0–9.0)	9.0 (7.0–10.0)	–3.94	<0.001*

\*, P values indicate the significance of difference between data on survey day and on ICU admission. PRISM III, Pediatric Risk of Mortality III; GCS, The Glasgow Coma Scale; PTS, Pediatric Trauma Score; ICU, Intensive Care Unit.

are only 3 cases of drowning children in our study, which may be related to the winter season of our investigation.

This study shows that the main cause of injury is age related. Previous studies have shown that in children younger than 15 years old, drowning and traffic-related injuries account for 54% and 16% of all injury deaths respectively (13). We found most patients who suffered from serious unintentional injuries in this study had an age of less than 6 years old (n=42, 75%). The leading causes of unintentional injury in infants and preschool children were falls, suffocation and transportation. In our survey, suffocation accounted for 16.1% and only occurred in children under six years old. Suffocation is the leading cause of unintentional injury death among infants under 1 year of age in most countries (18,19). Babies with unintentional suffocation is mostly being covered by quilts, mothers turning over and accidentally crushing to death, blockage of mothers' nipples and foreign bodies in the trachea. These injury deaths, often resulting from hazards within the sleep environment, are preventable. The diversity of causes of injury shows that the toddlers and preschoolers' children are vulnerable. Because non-verbal and dependent on caregivers to meet their need, infants are at increased risk of suffocation, falls and burns. Young children with curiosity, exploring behaviors, and hand-to-mouth activities often have motor skills to approach dangerous situations, but lack the perception and cognitive ability to avoid injuries. Injury-related child development characteristics should therefore be the focus of expected guidance and should be considered in all injury prevention activities.

According the latest demographic statistics in China (2021.05), the male to female ratio for children under 16 years is about 114. Our research shows that boys have 2.29 times more accidental injuries than girls (P<0.01). This ratio is higher than the gender ratio of the same age. The most common cause of injury in boys was fall injury, whereas in girls the common cause was traffic-related injury. Except for traffic-related injuries in our cohort, boys

have a higher tendency to harm in all ages than girls. These findings are consistent with other pediatric studies (9,20-22). Boys are a dangerous group of children for accidental injury, because boys are more active than girls, are more curious about their surroundings, and have more dangerous behaviors. Gender differences in child injuries exist in most countries and increase with age. However, the pattern of injury was different in children from in adults. The most common injury mechanism among male adults is a motor vehicle accident, while most female adults are victims of falls and pedestrian accidents (23).

Accidental injuries to children are often related to economic, culture, habits and living conditions. Previous research shows obvious regional and demographic characteristics (24). We studied the differences in the types and causes of accidental injuries among children in urban and rural areas. We found that the geographical difference in the proportion of unintentional injuries among children with urban and rural residence was not significant. With the economic development in China, the gap between urban and rural areas has narrowed. Another reason may be that critically ill patients in rural areas may have died on the site if they do not have the opportunity to be sent to a high degree hospital. According to another report, left-behind children (who remain in rural regions of China while their parents leave to work in urban areas, these children are taken care of by their extended families, usually by grandparents or family friends) have a significantly higher risk of injury than children in urban areas, leading to a significantly increased risk of injury (25).

We also analyzed the onset time of unintentional injuries, and found that the injury happened on 12:00–18:00 PM in 27 cases (48.2%), and 28 patients (50%) had injuries happened at working day. This means that lack of supervision is the main cause of accidents. Studies have shown that lack of regulation, insufficient safety standards for home furniture and items, limited access to safe play areas, and uneven walking surfaces are risk factors for

childhood fall in developing countries (26). More researches are needed to better understand the context of trauma and injury to children in low- and middle-income countries (27).

These 56 children suffered from a total of 106 lesions corresponding to 1.89 lesions per patient. The majority of lesions were to the thorax, head, abdomen and extremities. Most reports show head and neck and limbs as the most commonly injured body regions in adults (28). Many children had injury-related major complications. Respiratory failure was most seen, followed by shock, metabolic acidosis, and acute traumatic coagulopathy. Studies have reported that complications such as massive transfusion, invasive ventilation, and an initial GCS  $\leq 8$  had a significant impact on ICU length of stay (29). After effective treatment during their ICU stay in our study, 45 (80.4%) patients showed improvement, with GCS, PTS and PRISM III score significantly better than those before treatment. There were no deaths in our cohort during the study.

In our survey, although 35 patients received primary treatment at local hospitals, 35 patients (62.5%) also needed resuscitation in the emergency department, 15 patients (26.8%) still needed resuscitation in ICU in participating hospitals. This suggests that local hospitals have limited resources for children with unintentional injuries and there is a great risk in the process of transport. In China, there is a bias in the allocation of medical resources, and most doctors and medical institutions are located in large cities. There is a mismatch between the doctor distribution and the incidence of injuries, which are similar to the other developing countries (30). A study in Iraq shows that not only medical staff training is a long-term project, but short-term training of first-aid staff also has a significant impact on mortality in rural areas (31). Several papers on the improvement of pre-hospital and in-hospital care emphasize the need for a systematic approach based on a careful assessment of need (32). There is an urgent need for China to strengthen its survival chain, take precautionary measures, and prepare its medical system to meet this challenge. Injury prevention efforts should specifically target higher injury rates in children less than 6 years of age. Training primary medical staff first aid knowledge is also one of the urgent tasks. Research on accidental injury surveillance systems may provide more opportunities for injury and assessment of preventive measures.

### Limitation

This is a national, multicenter, observational 1-day point

prevalence study with most high degree children's hospitals in China involved. This study has several limitations. Due to the relatively small number of serious unintentional injuries, injury comparisons between different age/gender/type of injury groups may have lower testing power. In this study, the seasonal factors of injury were not reflected. The investigation date is winter, and different seasons may cause different types of injuries.

Despite its limitations, this study can serve as an important reference for further research in children. These findings still apply and can inform the development of China's future safe living environment and the development of interventions to reduce the incidence of injuries.

### Conclusions

Childhood unintentional injuries represent a major public health problem in China. Higher injury rates among children under 6 years old of age illustrate the need for preventive measures, especially programs and public policies targeting this high-risk group. This study may also provide a primitive framework to build and develop a national unintentional injury surveillance system as a major step in benchmarking actions taken.

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### Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at <https://tp.amegroups.com/article/view/10.21037/tp-21-387/rc>

*Data Sharing Statement:* Available at <https://tp.amegroups.com/article/view/10.21037/tp-21-387/dss>

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <https://tp.amegroups.com/article/view/10.21037/tp-21-387/doi>)

[com/article/view/10.21037/tp-21-387/coif](https://doi.org/10.21037/tp-21-387/coif)). The authors have no conflicts of interest to declare.

**Ethical Statement:** The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by The Ethics Committee of The Children's Hospital, Zhejiang University School of Medicine (No. 2017-IRB-042). This was an observational study with minimal risk and no informed consent required.

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