

# Social and environmental risk factors for accidental drowning of children under five in China

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## Research article

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# Abstract

**Background:** Accidental drowning of children under five is a serious problem in China. This study analyzed data on environmental, sociodemographic factors, and primary caregivers of drowned children in order to understand factors that may contribute to this problem.

**Methods:** This study collected information on 563 cases of drowning that appears involving children under five from October 1, 2015 to September 30, 2016 in 334 sampling districts in China. Primary caregivers were interviewed one-on-one based on the Drowning Mortality among Children under 5 Questionnaire.

**Results:** The majority of drowned children under five years old were boys, and 71.58% lived within 100 m of a water body. The drownings occurred mainly in ponds, canals, rivers, and wells, while over 90% of these water bodies had no safety measures. There were 28.06% of primary caregivers did not provide full-time care for the children, and 83.13% of them had no knowledge of first aid skills for drowning.

**Conclusion:** Encouraging kindergarten enrollment and providing safety education for children may reduce drowning among children under five years of age. Public water body protection measures should be strengthened to prevent children from drowning. Encouraging primary caregivers to care full-time for their children and learning first aid skills against drowning could also help reduce fatalities.

## Background

Drowning is a serious contributor to mortality and disability. With nearly 372,000 deaths reportedly due to drowning each year worldwide, it is one of the leading causes of child mortality <sup>[1]</sup>. If it does not end in death, drowning can lead to cognitive difficulties, hypoxic-ischemic brain injury, cardiac abnormalities, and, later in life, adult respiratory disease syndrome <sup>[2-4]</sup>. Although the mortality rate due to drowning is decreasing <sup>[5]</sup>, the associated economic burden is still significant. For example, the combined effects of fatal and non-fatal drowning in 2017–2018 cost 1.47 billion AD (over 7.1 billion Chinese renminbi) <sup>[6]</sup>

The main cause of accidental deaths among children worldwide under five years of age is drowning <sup>[7]</sup>. As the world's largest developing country, China has a large population and abundant water bodies in most regions, and, as a result, child drowning is a major problem in China as well. In response, China has made many efforts to reduce the accidental drowning mortality rate among children; relevant health education is actively carried out at the national level. The National Health Commission of the People's Republic of China released the "Chinese citizens' health literacy: basic knowledge and skills guidelines in 2015", which called for strengthening child supervision and education to prevent children from approaching dangerous waters <sup>[8]</sup>. Furthermore, some regional governments have issued a number of safety documents, including "Notice on the prevention of drowning in adolescents and children in 2019" and "Notice on doing a good job in preventing drowning of adolescents and children in 2019" <sup>[9-10]</sup>. The Education Bureaus of many provinces have also issued notices on the prevention of drowning, such as

the “Notification of education on swimming safety for primary and middle school students” and the “Prohibition of bathing in rivers during summer vacation” [11].

Despite these and other preventative efforts, drowning remains an important cause of unintentional deaths in Chinese children [12–17]. Given the absence of national-level data, we conducted one-to-one interviews with primary caregivers of drowned children from various parts of the country (registered in the National Maternal and Child Health Surveillance System) in order to elucidate characteristics and risk factors of drowning deaths among children under five. Our results may help improve preventive measures and recommendations to reduce drowning mortality in this vulnerable age group.

## Methods

### Study Subjects

The survey covered all 334 districts in the National Maternal and Child Health Surveillance System (NMCHSS) covering 31 provinces, autonomous regions and municipalities of China. The NMCHSS helps the national and local provincial health management departments supervise and guide health surveillance. Further details about the NMCHSS have been described elsewhere [18]. Study subjects were children under five years of age from the 334 districts who died due to drowning between October 1, 2015 and September 30, 2016.

### Questionnaire

We collected information about the drowned and control children from the Drowning Mortality among Children under 5 Questionnaire, designed by the Chinese National Health Commission and UNICEF, which was filled out by the children’s primary caregivers or other family members. The questionnaire contains four parts: basic information about children, caregivers and families, and the circumstances of drowning. All respondents provided informed consent for their anonymized responses to be analyzed and published.

### Data collection and quality control

A trained investigator of each district branch of the National Maternal and Child Health Surveillance System were responsible for the implement and conduct of the survey, as well as for quality control of the data and reporting of the results. The interviews with respondents were conducted within three months after the child’s death. At the beginning the interview, the investigator needs to read the questionnaire description and corresponding notes to the respondent, and was allowed to call the person in charge at any time if he or she had any questions. The same investigator checked the completeness and reliability of the data after the interview. The completed questionnaires were submitted stepwise via district-level, county, prefecture, city and provincial-level maternal and child health care centers to the National Office of Maternal and Child Health Surveillance.

### Statistical analysis

Results were collected in Microsoft Excel and analyzed using SPSS 22.0 (IBM, Armonk, NY, USA). SPSS 22.0 was used to establish a database, conduct descriptive statistics.

## Results

### 1. *Sociodemographic variables associated with children under five who drowned in 334 districts in China*

#### 1.1 *The descriptive characteristics of drowned children*

The investigation included 563 children under 5 who drowned in 334 counties in China. The proportion of male to female children who drowned was approximately 3:2 (348:214). Among these children, 1~ and 2~ age group children each represented over 30%, and 3~ age group children were the next highest group at 17.58%. Although 3 years was the age required to enroll in kindergarten, 55.15% of drowned children aged 3 and over were not enrolled in kindergartens. (See **Figure 1**)

#### 1.2 *Safety education and risky drowning behaviors of children*

The investigation also collected the safety education status of children at one year and older. The safety education including knowing places happened drowning frequently, avoiding risky drowning behaviors, understanding how to saving themselves after drowning, and understanding how to seek help when others drowning. However, only 20.66% of children have received safety education. Since playing near water body may increase the risk of drowning, the investigation also surveyed risky drowning behaviors of all children. The result suggested that 3.55% of children always play near water body, and 55.24% of children sometimes play near water body. Moreover, 75.67% of children were playing near the water body at the time of downing, and 4.62% of children were playing in the water body. (See **Table 1**)

### 2. *Characteristics of caregivers of drowned children under five in China*

#### 2.1 *Sociodemographics of primary caregivers*

We examined the primary caregivers for each of the 563 drowned children, and found that most of them (69.98%) were aged between 20 and 40 years old, while 20.96% were over 50 years old. A significant proportion of primary caregivers (70.69%) were the mother, and approximately a quarter (24.16%) were grandparents. Only 2% of caregivers held some form of a college degree. The vast majority (90.23%) attained a junior high school education or less. The definition of drowning first aid skills in this investigation is that the primary caregivers can notice signs of drowning, and can also complete first aid for drowning, which including removing foreign body in respiratory, helping extract fluid, and

cardiopulmonary resuscitation. Drowning first aid skills were mostly lacking, with 83.13% of primary caregivers reported having received no training. \*

## *2.2 Activities of primary caregivers at the time of drowning*

Fully 28.06% of primary caregivers reported failing to provide full-time (which defined as the caregiver has no permanent job and only look after one child) care to the child, which may help explain why 43.34% of children were alone at the time of drowning (See **Figure 2**). Smaller proportions were accompanied by a primary caregiver (21.85%) or other children (20.25%). Regarding those primary caregivers with the child at the time of drowning, only 12.77% of them were looking after the child, whereas 47.87% were doing house work and 20.21% were using the phone or socializing.

## *3. Environmental characteristics of children under 5 who drowned in 334 districts in China*

### *3.1 Locations and types of water body*

Ponds, canals, rivers and wells accounted for the most drowning locations (80.82%), followed by home (12.08%) (See **Table 2**). The results also shows the age difference among drowning water body with the age increasing, the proportion of bathtub and water tank/bucket have decreased, while the proportion of ponds, canals, rivers and wells were significant increased.

Moreover, a higher percentage of older children drowned away from home (87.72% of 4~ age group children vs. 47.62% of 0~ age group children), while younger children were more likely to drown at home (42.86% of 0~ age group children vs. 5.26% of 4~ age group children) (See **Table 2**).

### *3.2 Environmental risk factors for drowning near children's living places*

The survey indicated that 403 drowned children (71.58%) lived within 100 m of water body (See **Figure 3**). Approximately 90% of these water bodies were openly accessible without any fencing. For the public water body, 80.69% of them lacked any warning signs. For the water bodies located further than 100 m from the children's homes, only 8 of 563 could be completely covered to provide protection (See **Table 3**). Of the 62 bodies of water that had warning signs, the signs were difficult to see at more than half the sites.

### *3.3 Environmental risk factors for drowning at home*

Water containers were stored in the homes of 234 (41.56%) drowned children families (See **Figure 4**). Of those, 56.41% always stored water, 31.20% occasionally stored water, and fewer than 12% never stored water. No safety measures such as fences were implemented at around half (46.58%) of these water containers.

## Discussion

This study suggests the following characteristics of drowning of Chinese children under 5. First, children aged 1 to 2 years old are more likely to drown, as are older children who are not enrolled in kindergarten. Second, training in drowning first aid appears to be critical for both the child and primary caregiver to prevent drowning. Third, children typically drown in water bodies within 100 m of their home, and younger children tend to drown at home, whereas older children are more likely to drown outside the home, such as ponds, rivers, and canals. This is most likely due to the mobility of older children. In most drowning cases, the children are playing next to the body of water and not in the water. Fourth, safety measures are markedly lacking in a majority of drowning cases. Finally, less educated caregivers are responsible for most drowned. Caregivers are attending to other chores and not minding the child when many drowning occur, such that nearly half of all children are alone when they drown. These findings in combination with a previous study in Hunan Province <sup>[19]</sup>, indicate that full-time caregivers, accidental injury safety training, and water safety measures are important for drowning prevention.

The study have found that g great many of drowned children lived within 100 m of water body, and most of these water body have no fences. The majority of public water body lack warning signs. For those public water body with warning signs, half of warning signs were not easy to notice. Since most of children accidental drowning occurred at ponds, canals, rivers and wells, which shows the incompleteness of safety measures in living environment is an important risk factor for children accidental drowning. Therefore, in parallel with drowning prevention education, physical prevention measures are also needed. Our study underscores the urgent need for fences and visible warning signs around bodies of water. Local governments should be encouraged to enact regulations and policies requiring that warning signs and protective barriers be installed near public water bodies.

One major insight generated by this study is the role of the primary caregivers. The results suggest that primary caregivers' education level and the level of mindfulness strongly affect the risks of child drowning. In the survey, primary caregivers were paying full attention to the child in only 12.77% of drowning cases when the primary caregiver was present. This indicates neglect by a majority of caregivers.

A study in Australia showed that inadequate care and lapses in supervision, such as indoor housework, outdoor house work and talking/socializing, are a major contributor to child drowning <sup>[20]</sup>. We also found that caregivers were occupied with housework and phone calling or socializing at the time of drowning. In addition, an Australia-based study of accidental drowning of children from 0 to 17 years old between 2002 and 2014 found that all children who drowned were unsupervised <sup>[21]</sup>. Therefore, it is important to

educate primary caregivers about the prevention of accidental drowning in children. Local communities can promote the benefits of full-time parental care within their jurisdictions, and use health education programs to help parents learn about child drowning prevention as well as first aid information for drowning. Sending injury prevention knowledge via SMS or voice messages to parents' mobile phones may effectively raise awareness and reduce the risk of drowning, as suggested by a study in Bangladesh [22]. Indeed, such strategies have proven effective in Jiangsu province in China, where parental awareness of, and behaviors to prevent, accidental suffocation and drowning of rural children changed significantly after health education programs were enacted [23].

Raising awareness of drowning prevention may also prove beneficial when provided not only to the caregivers, but also to the child. One way to raise awareness of kindergarten-aged children would be for the local government to strengthen safety education training in the classroom and encourage kindergarten enrollment, as we found that over half of drowned children were not enrolled in kindergarten despite being of school age. Similarly, a study in Greater Athens found that school-based intervention resulted in considerable positive changes in knowledge and attitudes among very young pupils [24].

We propose teaching children to avoid unprotected water bodies in order to help reduce drowning mortality rate. As children become older, more mobile and independent, emphasis should be shifted from safety around water containers in the home to safety around open water bodies outdoors. Moreover, prevention programs should reinforce that a child should always seek adult supervision when playing in and around water bodies. To be most effective, such prevention programs should be age-appropriate.

## Conclusions

To our knowledge, this study is the most extensive so far to survey characteristics around the drowning deaths of children under five in China. These data suggest several key risk factors, which may help guide the design and improvement of child drowning prevention programs.

## Abbreviations

AD

Australian Dollar

NMCHSS

the National Maternal and Child Health Surveillance System

UNICEF

the United Nations Children's Fund

SMS

Short Message Service

## Declarations

### *Ethics approval and consent to participate*

This study was approved by the Ethics Committee of West China Second University Hospital, Sichuan University, China.

### *Consent for publication*

Not applicable

### *Availability of data and materials*

This study used data from the NMCHSS. This system is co-established by the National Health and Family Planning Commission of the People Republic of China and Sichuan University, and finally owned by National Health and Family Planning Commission of the People Republic of China. The researchers did not obtain consent to publicly share data. The de-identified data set is available upon request to interested researchers. For data requests, please contact the Department of Science and Technology of West China Second University Hospital, Sichuan University, at:fu2yuankjb@163.com. This department is in charge of all the programs in the hospital, including the data management. One staff from the department (named Xian He) monitors this email.

### *Competing interests*

The authors declare that they have no competing interests

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### *Author contributions*

Surveying was carried out by HL, YW, and LK. MW and YL performed data analysis, using software optimized by CH, LK and QL. JZ, JL, LM, JH, and XH curated the data. The manuscript was written by

MW, then reviewed and edited by MW, YL, HL and YW.

All authors have read and approved the manuscript.

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## Tables

Table 1. Safety education status and activities of children under five in China

	N(%)
<b>Accidental injury safety education (<math>\geq 1</math> years), N=542</b>	
Yes	112(20.66)
No	384(70.85)
Unknown	23(4.24)
Not Answered	23(4.24)
<b>Playing near water body, N=563</b>	
Always	20(3.55)
Sometimes	311(55.24)
Never	206(36.59)
Unknown	21(3.73)
Not Answered	5(0.89)
<b>Activities of children under five years old at the time of drowning, N=563</b>	
Playing near water body	426(75.67)
Playing in water body	26(4.62)
Slip during wading	11(1.95)
Playing on the frozen river/lake	3(0.53)
On the way to and from kindergarten	2(0.36)
Bathing	2(0.36)
Swimming	1(0.18)
Other	43(7.64)
Not Answered	9(1.6)
Refused to Answer	8(1.42)
Unknown	32(5.68)

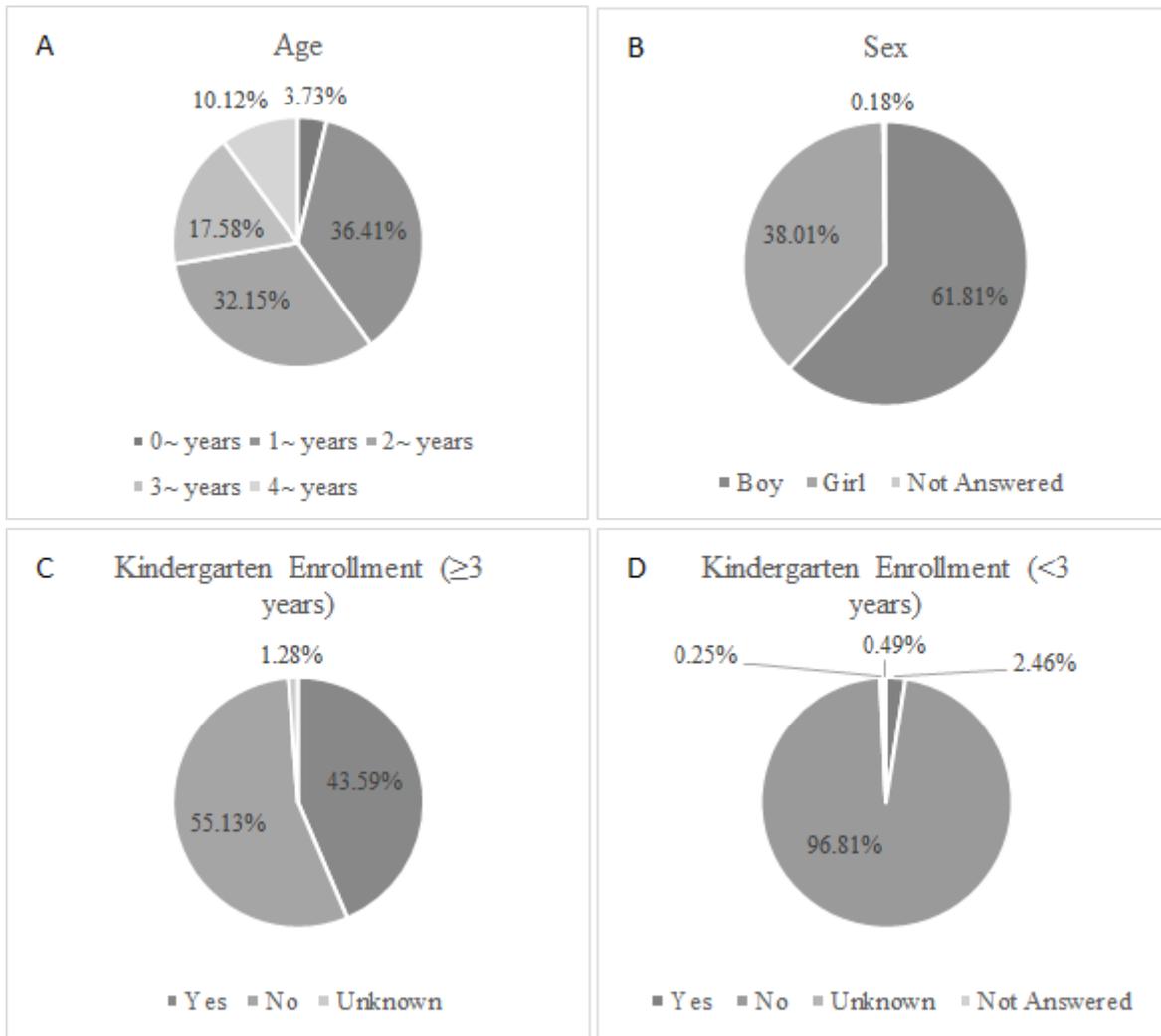
Table 2. Location and type of water body involved in drowning of children under 5 years old in 334 districts in China, n(%)

Variable	Age, year					Total
	0~	1~	2~	3~	4~	
<b>Location of drowning</b>						
Ponds, canals, rivers, wells	10(47.62)	164(80)	148(81.77)	83(83.84)	50(87.72)	455(80.82)
Home	9(42.86)	29(14.15)	14(7.73)	13(13.13)	3(5.26)	68(12.08)
Farm (excluding home)	0(0)	3(1.46)	5(2.76)	1(1.01)	1(1.75)	10(1.78)
Factory or construction site	1(4.76)	0(0)	2(1.1)	1(1.01)	0(0)	4(0.71)
School (including kindergarten)	0(0)	0(0)	1(0.55)	0(0)	0(0)	1(0.18)
Sport place	0(0)	0(0)	0(0)	0(0)	1(1.75)	1(0.18)
Traffic place (such as station/ferry/pier)	0(0)	0(0)	1(0.55)	0(0)	0(0)	1(0.18)
Other	0(0)	7(3.41)	9(4.97)	0(0)	2(3.51)	18(3.2)
Not Answered	1(4.76)	1(0.49)	0(0)	1(1.01)	0(0)	3(0.53)
Unknown	0(0)	1(0.49)	1(0.55)	0(0)	0(0)	2(0.36)
<b>Total</b>	21(100)	205(100)	181(100)	99(100)	57(100)	563(100)
<b>Type of water body</b>						
Ditch	6(28.57)	66(32.2)	44(24.31)	31(31.31)	11(19.3)	158(28.06)
Pool (fishpond)	4(19.05)	56(27.32)	42(23.2)	25(25.25)	15(26.32)	142(25.22)
River /lake/sea	2(9.52)	12(5.85)	34(18.78)	18(18.18)	18(31.58)	84(14.92)
Reservoir	0(0)	15(7.32)	18(9.94)	9(9.09)	7(12.28)	49(8.7)
Well	0(0)	6(2.93)	13(7.18)	5(5.05)	0(0)	24(4.26)
Water tank/bucket	3(14.29)	13(6.34)	2(1.1)	0(0)	0(0)	18(3.2)
Open cesspool	2(9.52)	4(1.95)	5(2.76)	3(3.03)	2(3.51)	16(2.84)
Bathtub	1(4.76)	4(1.95)	1(0.55)	0(0)	0(0)	6(1.07)
Swimming pool	0(0)	0(0)	0(0)	0(0)	1(1.75)	1(0.18)
Other	1(4.76)	21(10.24)	21(11.6)	7(7.07)	3(5.26)	53(9.41)
Not Answered	2(9.52)	7(3.41)	1(0.55)	0(0)	0(0)	10(1.78)
Unknown	0(0)	1(0.49)	0(0)	1(1.01)	0(0)	2(0.36)
<b>Total</b>	21(100)	205(100)	181(100)	99(100)	57(100)	563(100)

Table 3. Safety precautions for bodies of water in China where a child under five years old drowned

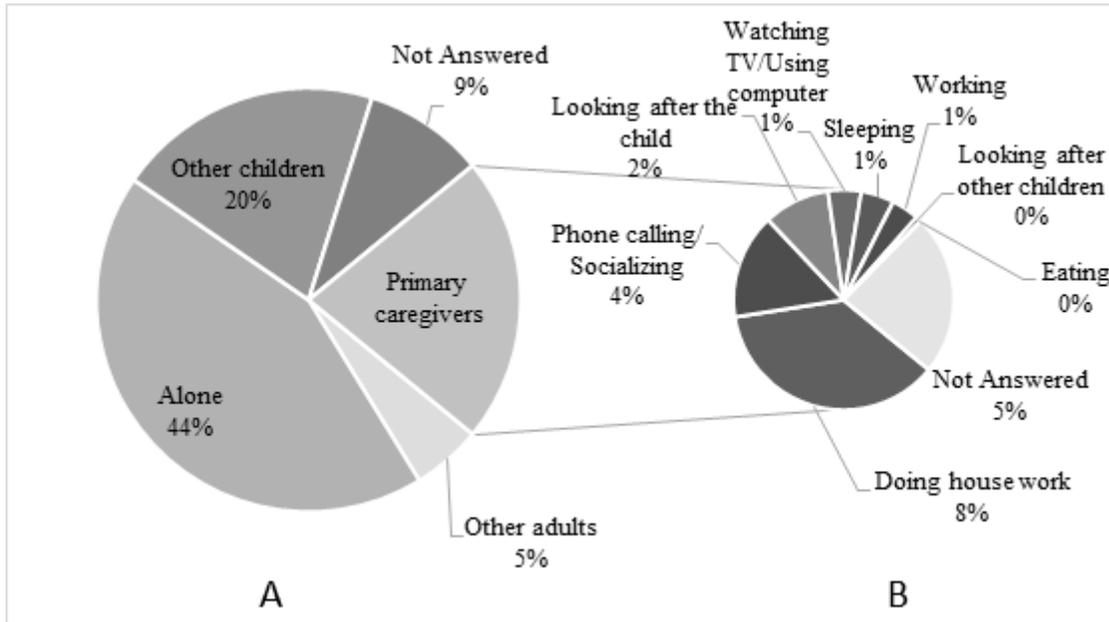
Safety precaution	N(%)
<b>Presence of fence (except river /lake/sea) , N=479</b>	
Yes	23(4.80)
No	442(92.28)
Not Answered	7(1.46)
Unknown	7(1.46)
<b>Covered, N=563</b>	
Uncovered	314(55.77)
Cannot be covered	210(37.30)
Covered partly	18(3.20)
Completely covered	8(1.42)
Other	1(0.18)
Not Answered	10(1.78)
Unknown	2(0.36)
<b>Warning signs (public bodies of water) , N=563</b>	
Yes, the signs are easy to notice	28(4.97)
Yes, the signs are not easy to notice	34(6.04)
No	465(82.59)
Not Answered	13(2.31)
Unknown	23(4.09)

## Figures



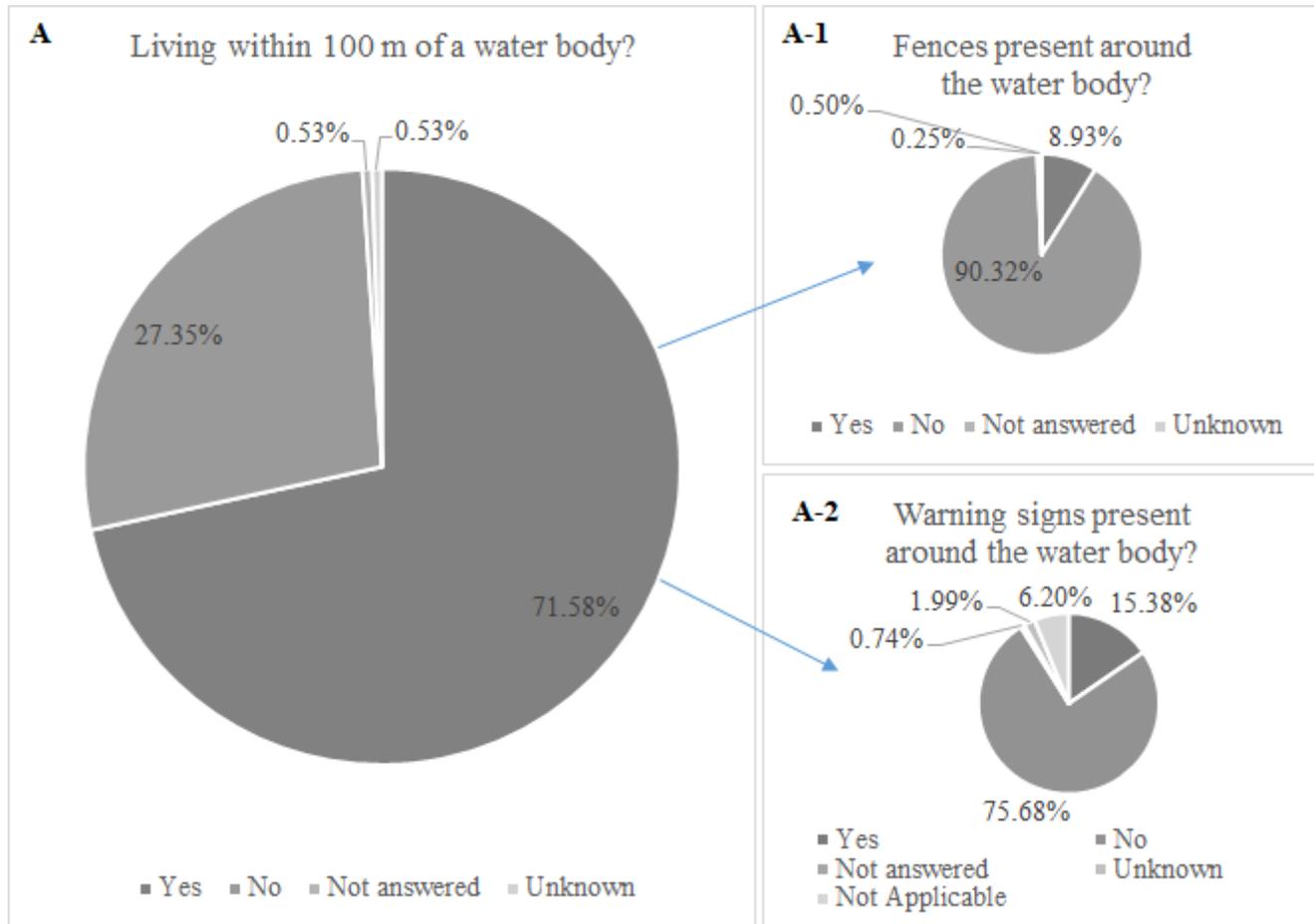
**Figure 1**

The descriptive characteristics of drowned children



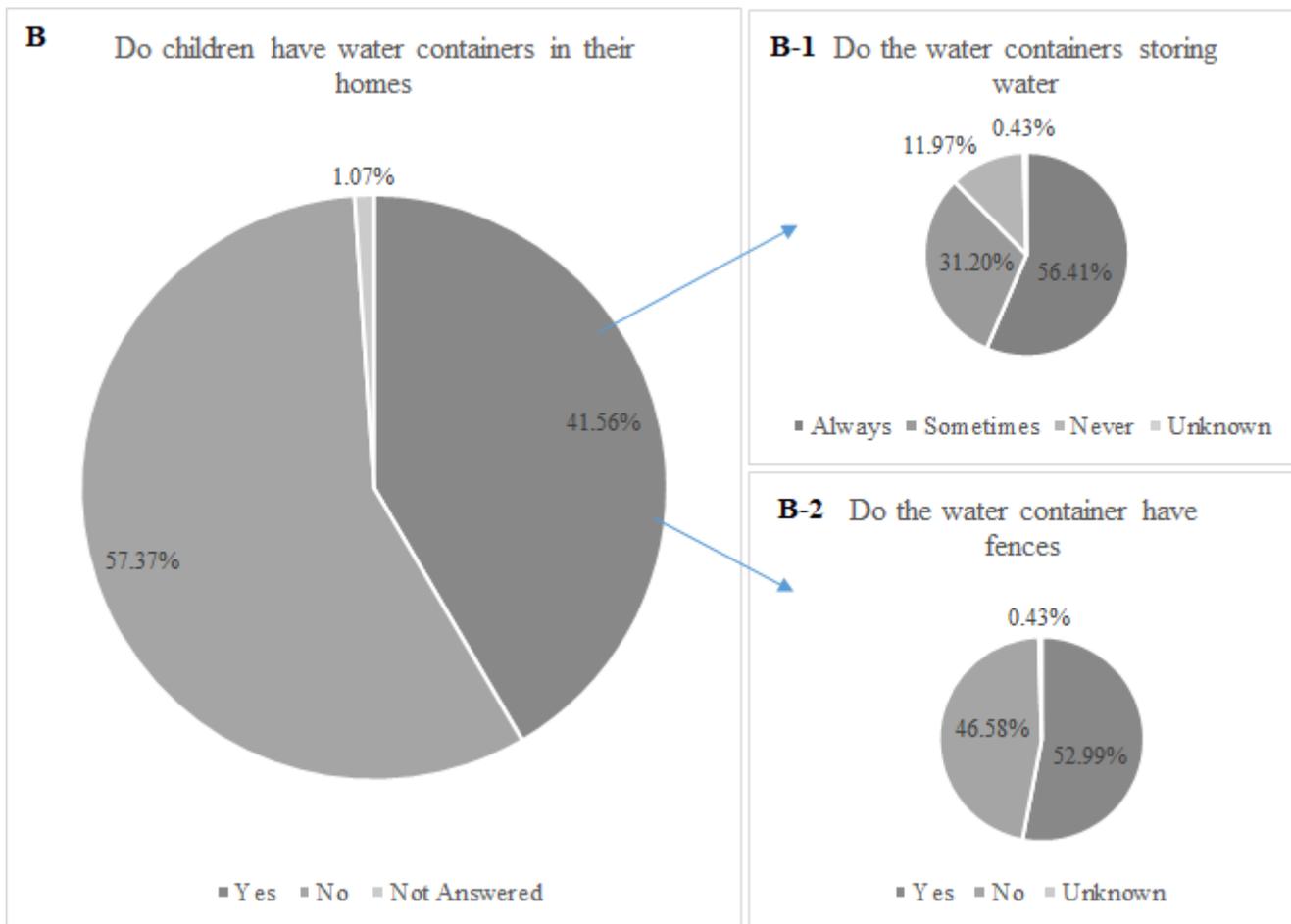
**Figure 2**

Caregiver presence and engagement at the time of drowning of Chinese children under five years old. A) Who was present during the child's drowning. B) The behavior of the primary caregiver in the time of child's drowning.



**Figure 3**

Characteristics of water body within 100 m of the homes of drowned children under 5 in China



**Figure 4**

Water containers and safety measures in the houses of drowned Chinese children under five years old.