Characteristic Analysis of Unintentional Injuries in 15,773 Children: Postprint

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Abstract

Background: Unintentional injuries in children represent a major threat to children's health, yet most are preventable. The incidence and distribution characteristics vary across different regions, necessitating the development of tailored preventive measures based on local features. Therefore, this study systematically describes the clinical characteristics of unintentional injuries in children in the Ningbo region.

Objective: To analyze the clinical characteristics of unintentional injuries in children at a single center in Ningbo, providing evidence for the development of appropriate prevention and treatment strategies.

Methods: Clinical data were retrospectively collected from children aged 0–17 years with unintentional injuries who presented to the emergency department of Ningbo Women and Children's Hospital between August 2020 and July 2021 (including age, sex, household registration, mode of arrival and pre-hospital emergency care, time of presentation, duration from injury to arrival, injury location, cause of injury, injured body part, treatment outcome, length of hospital stay, and hospitalization costs). Injuries were classified according to the International Classification of Diseases (ICD-10), and patients were categorized into infancy, toddlerhood, preschool age, school age, and adolescence based on age. Statistical methods including ^{2} test and Kruskal-Wallis H test were employed to compare differences in clinical characteristics across various types of unintentional injuries.

Results: A total of 15,773 cases were collected, with a mean age of (5.30$±$3.64) years, including 9,608 males (60.91%), resulting in a male-to-female ratio of 1.56:1. The highest incidence of unintentional injuries occurred in toddlerhood (5,116/15,773, 32.44%). Falls/falls from heights, burns/scalds, foreign bodies in orifices, poisoning, blunt force injuries, and electrical injuries predominantly affected toddlers; road traffic injuries predominantly affected preschoolers; and sharp force injuries predominantly affected school-aged children. The majority

of patients had rural household registration (9,329/15,773, 59.15%). Falls/falls from heights, road traffic injuries, burns/scalds, foreign bodies in orifices, sharp force injuries, electrical injuries, and drowning predominantly occurred among children with rural household registration. Falls/falls from heights, road traffic injuries, and drowning were mainly transported by private vehicle. Falls/falls from heights, road traffic injuries, burns/scalds, poisoning, sharp force injuries, electrical injuries, and drowning predominantly had no pre-hospital emergency care. Unintentional injuries occurred most frequently in summer (4,301/15,773, 27.27%). Road traffic injuries and burns/scalds were predominant in summer; blunt force injuries and electrical injuries were predominant in autumn; and bites were predominant in spring and autumn. July and February represented the months with the highest and lowest incidence of unintentional injuries, respectively. 12:00 and 20:00 were the peak hours for emergency department visits. The duration from injury to arrival was shorter for road traffic injuries compared with other types of unintentional injuries ($P<0.05$). Unintentional injuries primarily occurred at home [14,396 cases (91.27%)]. The three leading causes of unintentional injuries in children were falls/falls from heights (12,375/15,773, 78.46%), road traffic injuries (835/15,773, 5.29%), and burns/scalds (583/15,773, 3.70%). The most common injury site was the head (5,015/15,773, 31.79%). Head injuries were predominant in infancy, preschool age, and school age, while injuries to both upper limbs were predominant in toddlerhood and adolescence. The hospitalization rate, length of hospital stay, and hospitalization costs for drowning were higher than those for other types of unintentional injuries ($P<0.05$).

Conclusion: Unintentional injuries in children in Ningbo occur most frequently in toddlerhood, predominantly among rural males, mainly comprising falls/falls from heights and road traffic injuries, with a high incidence in summer and head being the most common injury site. Different child characteristics influence the occurrence of specific unintentional injury types, and different injury types also affect the mode of arrival, duration from injury to arrival, pre-hospital emergency care, and hospitalization outcomes. Therefore, targeted education should be implemented based on children's characteristics to reduce the incidence of unintentional injuries, and reasonable clinical treatment strategies should be formulated according to injury type.

Full Text

Characteristics of Unintentional Injuries in 15,773 Children

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Abstract

Background: Unintentional injuries represent a major threat to children's health, yet most are preventable. Since the incidence and distribution characteristics vary across regions, it is necessary to formulate preventive measures adapted to local conditions. This study systematically describes the clinical characteristics of unintentional injuries among children in the Ningbo area.

Objective: To analyze the clinical characteristics of unintentional injuries in children at a single center in Ningbo, providing evidence for developing appropriate prevention and treatment measures.

Methods: We retrospectively collected clinical data from 0-17-year-old children with unintentional injuries who visited the emergency department of Ningbo Women and Children's Hospital from August 2020 to July 2021. Data included age, sex, household registration, transportation method to hospital and pre-hospital emergency care, time of visit, time from injury to admission, injury location, cause, site, treatment outcome, hospitalization duration, and costs. Injuries were classified according to the International Classification of Diseases (ICD-10), and children were grouped by age as infants, toddlers, preschoolers, school-age, and adolescents. Statistical methods including chi-square test and Kruskal-Wallis H test were used to compare differences in clinical characteristics across injury types.

Results: A total of 15,773 cases were included, with a mean age of (5.30$±$3.64) years. Male children accounted for 9,608 cases (60.91%), yielding a male-to-female ratio of 1.56:1. Toddlers had the highest incidence of unintentional injuries (5,116/15,773, 32.44%). Fall/fall injuries, burns/scalds, cavity foreign bodies, poisoning, blunt instrument injuries, and electric shock injuries predominantly occurred in toddlers; road traffic injuries mainly occurred in preschoolers; and sharp instrument injuries mainly occurred in school-age children. Most children had rural household registration (9,329/15,773, 59.15%). Fall/fall injuries, road traffic injuries, burns/scalds, cavity foreign bodies, sharp instrument injuries, electric shock injuries, and drowning predominantly occurred in children with rural registration. Fall/fall injuries, road traffic injuries, and drowning cases mainly arrived at hospital by private vehicle. Fall/fall injuries, road traffic injuries, burns/scalds, poisoning, sharp instrument injuries, electric shock injuries, and drowning cases mainly had no pre-hospital emergency care. Unintentional injuries occurred most frequently in summer (4,301/15,773, 27.27%). Road traffic injuries and burns/scalds predominantly occurred in summer; blunt instrument injuries and electric shock injuries in autumn; and bites in spring and autumn. July and February represented the peak and trough months for injuries, respectively. Daily visit peaks occurred at 12:00 and 20:00. The time from injury to admission for road traffic injuries was shorter than for other injury types ($P<0.05$). Most injuries occurred at home [14,396 cases (91.27%)]. The top three causes were falls/fall injuries (12,375/15,773, 78.46%), road traffic injuries (835/15,773, 5.29%), and

burns/scalds (583/15,773, 3.70%). The head was the most common injury site (5,015/15,773, 31.79%), with infants, preschoolers, and school-age children predominantly sustaining head injuries, while toddlers and adolescents mainly sustained bilateral upper limb injuries. Children with drowning had higher hospitalization rates, longer hospitalization times, and higher hospitalization costs than other injury types ($P<0.05$).

Conclusion: Unintentional injuries in Ningbo children occur most frequently in toddlers, predominantly affecting rural boys, with falls/fall injuries and road traffic injuries being the main types. Injuries peak in summer, with the head being the most common site. Different child characteristics influence the type of unintentional injury, and different injury types affect transportation method, time to admission, pre-hospital emergency care, and hospitalization outcomes. Therefore, targeted education should be implemented based on child characteristics to reduce unintentional injuries, and rational clinical treatment strategies should be developed according to injury type.

Keywords: Child; Unintentional injury; Characteristic analysis; Prevention; Retrospective studies

Introduction

Unintentional injury is an increasingly serious global public health problem [**?**]. Compared with adults, children are more vulnerable to unintentional injuries. Statistics show that over 6 million children worldwide are disabled or die from unintentional injuries annually [**?**], with developing countries being particularly affected. As the world's largest developing country, China estimates over 50,000 child deaths from unintentional injuries each year, making it the leading cause of death among children under 14 [**?**]. Additionally, the high disability rate associated with unintentional injuries has long-term impacts on children's development and imposes significant economic burdens and emotional trauma on families and society [**?**]. However, most childhood unintentional injuries are preventable. Due to variations in climate, environment, economy, and culture, the incidence of childhood unintentional injuries shows significant regional differences. Therefore, understanding local injury characteristics and developing corresponding preventive measures is essential. This study systematically describes the clinical features of unintentional injuries among children in Ningbo to improve understanding and provide a basis for further prevention and treatment strategies.

Methods

Study Population

We retrospectively selected children aged 0-17 years who visited the emergency department of Ningbo Women and Children's Hospital between August 2020

and July 2021. Inclusion criteria were: (1) emergency medical records indicating injury caused by accidental circumstances (determined as unintentional injury) as reported by children or parents; (2) age $\leq$ 17 years. Exclusion criteria were: (1) injuries caused by self-harm/suicide or violent attacks; (2) incomplete clinical data. This study was approved by the Ethics Committee of Ningbo Women and Children's Hospital (EC2020-066), and informed consent was waived.

Study Design

Injury Classification Referencing the International Classification of Diseases (ICD-10) [**?**] for external causes of injury and poisoning, unintentional injuries were classified as: fall/fall injuries, blunt instrument injuries, road traffic injuries, drowning, sharp instrument injuries, burns/scalds, poisoning, bites, electric shock injuries, and cavity foreign bodies.

Age Grouping According to *Zhu Futang's Practical Pediatrics* [**?**], children were divided into: infancy (<1 year), toddlerhood (1-3 years), preschool age (3 years 1 month to 6 years), school age (6 years 1 month to 10 years), and adolescence (10 years 1 month to 17 years).

Observation Indicators General clinical data were collected from the Hospital Information System (HIS), including age, sex, household registration, transportation method to hospital and pre-hospital emergency care, visit time, time from injury to admission, injury location, cause, site, treatment outcome, hospitalization duration, and costs. All information was compiled in Excel and independently verified by two researchers to ensure accuracy.

Statistical Analysis SPSS 22.0 software was used for statistical analysis. Categorical data were expressed as percentages and compared using chi-square test, corrected chi-square test, or Fisher's exact test. Normally distributed continuous data were expressed as ($\bar{x}\pm s$); non-normally distributed data were expressed as M(P25, P75) and compared using Kruskal-Wallis H test. $P<0.05$ was considered statistically significant.

Results

Study Population Characteristics

From August 2020 to July 2021, 16,187 children with unintentional injuries were treated, and 414 cases with incomplete data were excluded, leaving 15,773 cases for analysis (11.13% of total emergency visits during the same period). The mean age was (5.30$±$3.64) years. The male-to-female ratio was 1.56:1, with 9,608 male cases (60.91%). Age distribution showed toddlers had the highest incidence (5,116/15,773, 32.44%), followed by preschoolers, school-age children, adolescents, and infants.

Demographic Distribution by Injury Type

Statistically significant differences were found in age distribution across injury types (P<0.05). Fall/fall injuries (3,867/12,375, 31.25%), burns/scalds (336/583, 57.63%), cavity foreign bodies (203/491, 41.34%), poisoning (251/447, 56.15%), blunt instrument injuries (161/414, 38.61%), and electric shock injuries (17/29, 58.62%) predominantly occurred in toddlers. Road traffic injuries (314/835, 37.60%) mainly occurred in preschoolers, while sharp instrument injuries (161/417, 38.61%) mainly occurred in school-age children. No significant age distribution differences were found for bites or drowning (P>0.05) .

Regarding sex distribution, significant differences existed for cavity foreign bodies, poisoning, and sharp instrument injuries (P<0.05), with male predominance in cavity foreign bodies (278/491, 56.62%), poisoning (226/447, 50.56%), and sharp instrument injuries (286/417, 68.59%). No significant sex differences were observed for fall/fall injuries, road traffic injuries, burns/scalds, blunt instrument injuries, bites, electric shock injuries, or drowning (P>0.05) .

For household registration, significant differences were found for fall/fall injuries, road traffic injuries, burns/scalds, cavity foreign bodies, sharp instrument injuries, electric shock injuries, and drowning (P<0.05), with rural registration predominating in road traffic injuries (590/835, 70.66%), burns/scalds (403/583, 69.13%), cavity foreign bodies (323/491, 65.58%), sharp instrument injuries (215/417, 51.56%), electric shock injuries (24/29, 82.76%), and drowning (15/17, 88.24%). No significant differences were found for poisoning, blunt instrument injuries, or bites (P>0.05). Among urban children, the top five injury types were fall/fall injuries, road traffic injuries, sharp instrument injuries, poisoning, and burns/scalds; among rural children, they were fall/fall injuries, road traffic injuries, burns/scalds, cavity foreign bodies, and poisoning .

Transportation and Pre-hospital Emergency Care

Significant differences existed in transportation methods for fall/fall injuries, road traffic injuries, and drowning (P<0.05). Private vehicle was the main transportation method for fall/fall injuries (12,269/12,375, 99.14%), road traffic injuries (729/835, 87.31%), and drowning (15/17, 88.24%). No significant differences were found for burns/scalds, cavity foreign bodies, poisoning, sharp instrument injuries, blunt instrument injuries, bites, or electric shock injuries (P>0.05). The top three injury types arriving by private vehicle were fall/fall injuries, road traffic injuries, and burns/scalds; the top three arriving by ambulance were fall/fall injuries, road traffic injuries, and cavity foreign bodies .

For pre-hospital emergency care, significant differences were found for fall/fall injuries, road traffic injuries, burns/scalds, poisoning, sharp instrument injuries, electric shock injuries, and drowning (P<0.05). The majority of these cases had no pre-hospital emergency care: fall/fall injuries (12,269/12,375, 99.14%), burns/scalds (512/583, 87.82%), poisoning (420/447, 93.96%), sharp instrument

injuries (415/417, 99.02%), electric shock injuries (29/29, 100%), and drowning (12/17, 70.59%). No significant differences were found for cavity foreign bodies, blunt instrument injuries, or bites (P>0.05). The top three injury types with pre-hospital emergency care were fall/fall injuries, road traffic injuries, and burns/scalds .

Temporal and Geographic Distribution

Analysis by time of day revealed two peak visit periods: 12:00 and 20:00 [Figure 1: see original paper]. Monthly analysis showed July had the highest injury incidence, while February had the lowest [Figure 2: see original paper]. Seasonal distribution showed summer had the highest incidence, followed by spring, autumn, and winter. Significant seasonal differences existed for road traffic injuries, burns/scalds, blunt instrument injuries, bites, and electric shock injuries (P<0.05). Road traffic injuries (274/835, 32.81%) and burns/scalds (163/583, 27.96%) peaked in summer; blunt instrument injuries (133/408, 32.60%) and electric shock injuries (13/29, 44.83%) peaked in autumn; bites peaked in spring (58/171, 33.92%) and autumn (56/171, 32.75%). No significant seasonal differences were found for fall/fall injuries, cavity foreign bodies, poisoning, sharp instrument injuries, or drowning (P>0.05) .

Significant differences existed in time from injury to admission across injury types (P<0.01), with road traffic injuries having shorter times than other types (P<0.05) . Regarding injury location, most occurred at home [14,396 cases (91.27%)], followed by roads/streets [853 cases (5.40%)] and schools [328 cases (2.08%)].

Injury Causes

Road traffic injuries mainly involved cars; burns/scalds mainly involved hot liquids; cavity foreign bodies were predominantly gastrointestinal, mainly coins (101/455, 22.20%) and plastic products (59/455, 12.97%), plus batteries, fruit pits, metal hooks, nails, pencil tips, tin foil, chess pieces, pull tabs, and hairpins. Respiratory foreign bodies were mainly nuts (11/26, 45.83%). Poisoning mainly involved medications; sharp instrument injuries mainly involved scissors; blunt instrument injuries mainly involved table corner impacts; bites mainly involved insects; electric shock injuries mainly involved contact with electrical outlets; and drowning mainly occurred in bathtubs .

Injury Site Distribution by Age

The top five injury sites were head, bilateral upper limbs, face, bilateral lower limbs, and multiple injuries. Significant differences existed in injury site distribution across age groups (P<0.01). Infants (763/1,225, 65.49%), preschoolers (1,416/4,447, 33.83%), and school-age children (894/3,219, 28.67%) predominantly sustained head injuries, while toddlers (1,739/5,116, 37.37%) and adolescents (627/1,766, 36.99%) predominantly sustained bilateral upper limb injuries

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Hospitalization Outcomes

Among all children with unintentional injuries, 943 (5.98%) required observation/hospitalization, including 788 hospitalized cases (5.00%) and 155 observation-only cases (0.98%). Significant differences existed in hospitalization rates across injury types (P<0.01), with drowning having higher rates than other types (P<0.05). Among hospitalized children, 726 (92.13%) were discharged after recovery/improvement. The median hospitalization duration was 7 (4, 9) days, and median hospitalization cost was ¥6,429.65 (¥3,213.87, ¥9,748.66). Significant differences existed in both duration and cost across injury types (P<0.01), with drowning having longer durations and higher costs than other types (P<0.05) .

Discussion

Unintentional injury refers to external, sudden, unintended, non-disease events causing bodily harm [**?**]. In different countries and even different regions within the same country, climate, environment, economy, and culture significantly influence childhood unintentional injury incidence. Therefore, understanding local injury characteristics is crucial for developing appropriate preventive measures. As Ningbo's only specialized children's hospital and a critical care center for severely ill children, Ningbo Women and Children's Hospital is representative of the region.

This study found more male than female patients (ratio 1.56:1), consistent with domestic and international research [**?**]. Injury types also differed by sex, with males experiencing more sharp instrument injuries, poisoning, and cavity foreign bodies, possibly due to boys being more active, curious, and exploratory, while parents may supervise girls more closely.

The highest incidence occurred in toddlers aged 1-3 years, aligning with most domestic and international studies [**?**], as this developmental stage involves newly independent mobility and expanding activity range, but limited hazard recognition and self-protection abilities, combined with inadequate parental safety awareness. Injury incidence gradually decreases with age, likely due to improved hazard recognition and increased safety education at home and school. Therefore, enhanced safety education for parents and caregivers of toddlers is essential.

Injuries peaked in summer, particularly July, possibly because summer vacation increases home time with less parental supervision and more exposure to hazards. Seasonal patterns varied by injury type: burns/scalds were more common in summer, likely due to hot weather, lighter clothing, and more exposed skin. Bites were more common in spring and autumn, differing from some reports of summer peaks [**?**], possibly because Ningbo's mild spring and autumn weather increases outdoor activities while clothing remains relatively light. Therefore,

summer vacation presents an ideal opportunity for prevention education through schools, internet platforms, and social media to improve parent and child awareness.

Two daily peaks occurred at 12:00 and 20:00, likely because parents are busy with housework after meals while children's post-meal activities increase. Strengthening safety awareness education should include advising parents to arrange alternative caregivers when possible, or closely monitor children when not.

Home was the location for 91.27% of injuries, possibly due to increased home time during the pandemic. Although this proportion differs from reports in other developing countries [**?**], it underscores the importance of safe home environments. Home products should follow the "5S" principle (See, Strings, Size, Surface, Standard) to prevent accidents.

Fall/fall injuries were the most frequent type, similar to some regions [**?**, **?**] but differing from others where foreign bodies or poisoning predominated [**?**], likely reflecting regional socioeconomic differences. Nearly half of fall injuries were simple falls, while furniture-related falls from beds, sofas, and chairs require particular attention. Enhanced child supervision and parental safety education regarding furniture heights are needed.

Road traffic injuries were the second leading cause, predominantly affecting preschoolers and rural children, likely because preschoolers have increased independent mobility but incomplete hazard avoidance abilities. Rural areas with hilly terrain, inadequate traffic facilities, and lower parental safety awareness contribute to higher risk [**?**]. Notably, electric bicycles accounted for nearly one-quarter of road traffic injuries, correlating with their increased popularity. Implementation of the *Ningbo Non-motor Vehicle Management Regulations* may improve this situation. Additionally, electric shock injuries from contact with electric bicycle charging ports warrant increased safety education.

Head injuries were most common, consistent with children's high head-to-body mass ratio [**?**]. Upper limb injuries ranked second, likely because upper limbs are extensively involved in fine motor activities. The economic burden was substantial, with median hospitalization costs of ¥6,429.65. Drowning had the highest hospitalization costs and longest durations, reflecting greater severity. Therefore, swimming skill education and drowning first-aid knowledge are crucial, along with rational treatment strategies to reduce medical burden.

Conclusion

In Ningbo, unintentional injuries predominantly affect rural boys aged 1-3 years, with falls/fall injuries and road traffic injuries being the main types. Injuries peak in summer, with the head being the most common site. Child characteristics influence injury type, which in turn affects transportation method, time to admission, pre-hospital emergency care, and hospitalization outcomes. This

comprehensive analysis of 15,773 Ningbo children provides valuable clinical reference for understanding injury mechanisms, age distribution, prevention, and treatment strategies. However, limitations include the retrospective design with limited clinical data and single-center sampling. Therefore, family, school, and societal efforts are needed for targeted education based on child characteristics to prevent injuries and promote healthy development. Rational clinical treatment strategies should be developed according to injury type. Future multi-center cross-sectional studies should explore influencing factors to provide theoretical and clinical guidance for prevention and treatment.

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Author Contributions

SHEN Yu conceived the study, designed the protocol, and drafted the manuscript; CHEN Jian collected and organized data and performed statistical analysis; SHOU Tiejun analyzed and interpreted results; YU Beirong was responsible for quality control, revision, and overall supervision.

The authors declare no conflicts of interest.

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Note: Figure translations are in progress. See original paper for figures.