# Prevalence and Patterns of Fractures in Children

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***Objective:*** *To study the prevalence, patterns, and causes of fractures in children at Siriraj Hospital in the years 2006, 2009, and 2012.*

***Material and Method:*** *Patient records, files, and radiographs of all children under 16 years of age who had sustained a fracture and came to Siriraj Hospital in the years 2006, 2009, and 2012 were collected. The prevalence and patterns of fractures were reviewed for details, such as age at time of injury, gender, side, location, types, and causes of fractures.*

***Results:*** *The prevalence of the fractures in children seen in the trauma unit at Siriraj Hospital were 4.7% in 2006, 5.3% in 2009, and 5.8% in 2012. There were 716 children with 718 fractures in three one-year periods, as follows: 222 in 2006, 234 in 209, and 262 in 2012. The children consisted of 68% boys and 32% girls, of which boys represented a statistically significant difference (p = 0.013). The most common and dominant age group for fractures was 10-16 years for both boys and girls, at 47.4%. The mean age ±SD of the children was 7.9±4.6 years old. The rate of fracture increased with the age of the children-a statistically significant difference (p = 0.001). The rate of open fracture was 6.7%. The rate of physeal fracture was 12.4%, of which type 2 was the most common at 11.3%. Fractures to the right side occurred in 53.8% of cases, as compared to 46.2% on the left side (p = 0.031). The most common fracture in children was distal forearm at 18.87%. The most common causes of fracture were falling (34.6%), road accident (28.4%), and falling from height (24.1%). These top three most common accounted for 87.1% of all causes of fractures.*

***Conclusion:*** *The present study described the prevalence, types, patterns, and causes of fractures in children. The results of the present study may be useful in the planning of management and prevention of fractures in children.*

***Keywords:*** *Prevalence, Fractures, Children, Patterns, Causes*

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The present study of fractures in children is important in many aspects, including prevention of fracture and creation of health care policy. There have been studies via observations on fractures of long bones in children[1], and studies done by comparing epidemiologic data of fractures among and between countries[2], and studies focusing on the epidemiologic data and patterns of fractures in children[3-8]. The differences in the outcomes of these studies came from the differences in the type of data collection which varied by the age range of patients, the purpose of the study, and the place the data was collected, among others. In Thailand, there have been few studies that have focused on the epidemiologic data of fractures in children[9,10]. The purpose of the present study was to identify the prevalence and patterns of fractures in children who came to the trauma unit of Siriraj Hospital, including both outpatients and inpatients. Further, the data and findings relating to the present study were compared to other studies in terms of age, sex, side, type of fracture, cause of fracture, and fracture-related trends over the three one-year periods of time (2006, 2009, and 2012).

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## Material and Method

After approval by the hospital research ethics committee, all charts, files, and radiographs of children aged from newborn to 16 years old with fractures from January to December in the years 2006, 2009, and 2012 were retrospectively reviewed. Diagnosis was made by pediatric orthopedic surgeons in all outpatient cases and by radiographic examination in all inpatient cases. All missing data were excluded. The demographic data of the children were recorded, including age, sex, and side (left or right) of the fracture. The cause, time, type, and level of fracture were recorded, including the types

of physeal injuries etc.

***Sample size calculation***

Using the formula for a single proportion in a rare event, if all people in our sample n are free of disease, the 100 (1-α)% confidence upper boundary for prevalence P can be computed from the relationship $\alpha = (1-p)^n$, when the true prevalence is P at a one-sided significance level of 0.05. Taking the logarithm yields $n = -\log_e(0.05)/P$ or simply $n = 3/P$.

From the study by Landin LA[3-5], the incidence of fractures in children per year was 2.1%. BUsing this percentage with $p = 0.021$, the sample size for the present study was 142 cases per year.

***Statistical analysis***

Mean and standard deviation (SD), range, frequency (%) were used to describe child demographic data. Chi-square test was used to compare categorical variables between the years. Student's t-test was used to assess differences between two means. SPSS version 18 was used to analyze the data. A *p*-value of less than 0.5 was considered to be a statistically significant difference.

**Results**

The total visits of patients, including adults and children, who had injuries and came to the trauma unit at Siriraj Hospital were 61,879 visits in 2006, 57, 397 visits in 2009, and 59,429 visits in 2012. There were 2.4 visit/patient on average. The actual total number of injured children was 18.3% of the total number of patients, on average. There were 4,715, 4,380, and 4,535 injured children in the years 2006, 2009, and 2012, respectively. Moreover, there were 222, 234, and 262 fractures in children in the years 2006, 2009, and 2012, respectively. The prevalence of the fractures in children arriving at the trauma unit at Siriraj Hospital were 4.7% (222/4715) in 2006, 5.3% (234/4380) in 2009, and 5.8% (262/4535) in 2012 (Table 1). The trend in three years of prevalence of fractures in children is shown to increase slightly.

In Table 1, 716 children with 718 fractures are identified, including 221 children in 2006, 234 children in 2009, and 261 children in 2012. The children consisted of 68% boys and 32% girls, which represented a statistically significant difference ($p = 0.013$). The most common and dominant age group was 10-16 years for both boys and girls at 47.4%. The mean age ±SD of the

**Table 1.** Characteristics of children and patterns of fractures in the years 2006, 2009, and 2012

| Topics | 2006 | | 2009 | | 2012 | | Total | | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | |
| Prevalence sex | | 4.7 | | 5.3 | | 5.8 | | | 0.068 |
| Boys | 163 | 73.8 | 143 | 61.1 | 181 | 69.3 | 487 | 68 | 0.013 |
| Girls | 58 | 26.2 | 91 | 38.9 | 80 | 30.7 | 229 | 32 | |
| Total | 221 | 100 | 234 | 100 | 261 | 100 | 716 | 100 | |
| Age (year) | | | | | | | | | |
| 0-3 | 26 | 11.8 | 50 | 21.4 | 60 | 23 | 136 | 19 | 0.001 |
| 4-9 | 67 | 30.3 | 85 | 36.3 | 89 | 34 | 241 | 33.6 | |
| 10-16 | 128 | 57.9 | 99 | 42.3 | 112 | 43 | 339 | 47.4 | |
| Total | 221 | 100 | 234 | 100 | 261 | 100 | 716 | 100 | |
| Number open fractures | 16 | 7.2 | 24 | 8.7 | 7 | 2.7 | 47 | 6.7 | 0.003 |
| Total fractures | 222 | 100 | 234 | 100 | 262 | 100 | 718 | 100 | |
| Physeal fractures | | | | | | | | | |
| Type 1 | 1 | 0.5 | 4 | 1.7 | 2 | 0.8 | 7 | 1 | |
| Type 2 | 9 | 4.1 | 20 | 8.5 | 52 | 19.8 | 81 | 11.3 | <0.001 |
| Type 3 | 0 | 0 | 0 | 0 | 1 | 0.4 | 1 | 0.1 | |
| All types | 10 | 4.5 | 24 | 10.3 | 55 | 22 | 89 | 12.4 | |
| Total | 222 | 100 | 234 | 100 | 262 | 100 | 718 | 100 | |
| Side | | | | | | | | | |
| Right | 118 | 53.2 | 141 | 60.3 | 127 | 48.5 | 386 | 53.8 | 0.031 |
| Left | 104 | 46.8 | 93 | 39.7 | 135 | 51.5 | 332 | 46.2 | |
| Total | 222 | 100 | 234 | 100 | 262 | 100 | 718 | 100 | |

children was 7.9±4.6 years old. The rate of fracture increased with the age of the children, which represented a statistically significant difference ($p$ = 0.001). The rate of open fracture was 6.7%. The rate of physeal fracture was 12.4%, of which type 2 was dominant at 11.3%. Fractures to the right side of the body were dominant at 53.8%, as compared to 46.2% on the left ($p$ = 0.031).

From Table 2, the most common fracture in children was distal forearm at 18.87%, followed by supracondylar fracture of the humerus at 16%, and fracture of the radius and ulnar shaft at 11.6%. Fractures of the patella were the most rare at only 0.3%.

From Table 3, the most common cause of fracture was falling at 34.6%, followed by road accidents at 28.4%, and falling from height at 24.1%. These top three most common causes accounted for 87.1% of all causes of fractures.

**Table 2.** Types and ranking of fractures in children in the years 2006, 2009, and 2012

| Rank | 2006 | | 2009 | | 2012 | | Total | | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | |
| 1) Distal forearm | 44 | 19.8 | 41 | 17.5 | 51 | 19.5 | 136 | 18.9 | 0.792 |
| 2) Supracondylar humerus | 33 | 14.9 | 38 | 16.2 | 44 | 16.8 | 115 | 16 | |
| 3) Radius-ulnar, shaft | 24 | 10.8 | 31 | 13.2 | 28 | 10.7 | 83 | 11.6 | |
| 4) Clavicle | 23 | 10.4 | 13 | 5.6 | 18 | 6.9 | 54 | 7.5 | |
| 5) Tibia, shaft | 12 | 5.4 | 25 | 10.7 | 17 | 6.5 | 54 | 7.5 | |
| 6) Hand, phalanges | 14 | 6.3 | 12 | 5.1 | 20 | 7.6 | 46 | 6.4 | |
| 7) Foot, phalanges | 10 | 4.5 | 11 | 4.7 | 20 | 7.6 | 41 | 5.7 | |
| 8) Femur, shaft | 17 | 7.7 | 9 | 3.8 | 12 | 4.6 | 38 | 5.3 | |
| 9) Lateral condyle humerus | 6 | 2.7 | 13 | 5.6 | 12 | 4.6 | 31 | 4.3 | |
| 10) Proximal humerus | 6 | 2.7 | 12 | 5.1 | 7 | 2.7 | 25 | 3.5 | |
| 11) Foot, metatarsal | 10 | 4.5 | 10 | 4.3 | 5 | 1.9 | 25 | 3.5 | |
| 12) Ankle | 7 | 3.2 | 2 | 0.9 | 14 | 5.3 | 23 | 3.2 | |
| 13) Olecranon | 2 | 0.9 | 7 | 3 | 3 | 1.1 | 12 | 1.7 | |
| 14) Femur, supracondylar | 1 | 0.5 | 1 | 0.4 | 4 | 1.5 | 6 | 0.8 | |
| 15) Spine | 4 | 1.8 | 1 | 0.4 | 0 | 0 | 5 | 0.7 | |
| 16) Radius, neck | 3 | 1.4 | 1 | 0.4 | 1 | 0.4 | 5 | 0.7 | |
| 17) Hand, carpals | 1 | 0.5 | 2 | 0.9 | 2 | 0.8 | 5 | 0.7 | |
| 18) Calcaneum | 2 | 0.9 | 1 | 0.4 | 1 | 0.4 | 4 | 0.6 | |
| 19) Pelvis | 1 | 0.5 | 1 | 0.4 | 2 | 0.8 | 4 | 0.6 | |
| 20) Femur, neck | 1 | 0.5 | 2 | 0.9 | 1 | 0.4 | 4 | 0.6 | |
| 21) Patella | 1 | 0.5 | 1 | 0.4 | 0 | 0 | 2 | 0.3 | |
| Total | 222 | 100 | 234 | 100 | 262 | 100 | 718 | 100 | |

**Table 3.** Causes of fractures in children in the years 2006, 2009, and 2012

| Causes | 2006 | | 2009 | | 2012 | | Total | | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | |
| Falling | 80 | 36 | 82 | 35 | 87 | 33.2 | 249 | 34.6 | 0.118 |
| Road accident | 56 | 25.2 | 72 | 30.8 | 76 | 29 | 204 | 28.4 | |
| Falling from height | 60 | 27 | 58 | 24.8 | 55 | 21 | 173 | 24.1 | |
| Sport activity | 16 | 7.2 | 11 | 4.7 | 17 | 6.5 | 44 | 6.1 | |
| Not identified | 6 | 2.7 | 9 | 3.8 | 26 | 9.9 | 41 | 5.7 | |
| Body assault | 4 | 1.8 | 2 | 0.9 | 1 | 0.4 | 7 | 1 | |
| Total | 222 | 100 | 234 | 100 | 262 | 100 | 718 | 100 | |

## Discussion

In the evaluation of several studies, the epidemiologic data of fractures in children were different regarding the time and place of the study, differences in research design, socio-clinical factors, among others. In four studies[8,11-13], there were 23,915 injured children with a 17.8% prevalence of fractures, which was higher than the prevalence in the present study. The incidence of fractures in children was 2.1% in average[3], but it was quite difficult to find the true incidence for the present study because the hospital in the present study (Siriraj Hospital) is a referral center that accepts referral cases from all over Thailand.

All the major series have demonstrated a linear increase in the annual incidence of fracture with age, similar to the present study[1-10]. For all age groups, the overall ratio of boys to girls in the other studies was 2.7:1[7], as compared to a ration of 2.1:1 in the present study. In most series[14], the ratio of left to right overall average was 1.3:1, but the present study reported a left to right ratio of 1:1.2.

The anatomic areas most affected by fractures seems to be the same in the major series and the present study. The distal radius is the most commonly fractured long bone[8,14] and the second most common is fracture of the supracondylar region of the humerus.

The incidence of physeal fracture in other studies varied from 14.5% to as high as 27.6%, with an average overall incidence of 21.7%[5,14,15]. The present study reported an incidence rate of 12.4%, which was lower than the average incidence reported in other studies. The average overall incidence of open fracture in other studies was 2.9%[11,14,15]. However, in the present study the average incidence of open fracture was 6.4%, which was higher than major series because the present study was done in the trauma center of a national referral hospital that received a high volume of open fracture cases.

The present study of the etiology of fractures in children is important for prevention[14,16,17]. Home and school environments should be prepared to prevent accidental fractures in children, like those found in the present study. The most common causes of fractures in children were from accidental trauma, such as falling. Fractures caused by road-related accidents require road safety and accident prevention programs at both the local and national levels.

## Conclusion

The prevalence, types, patterns and causes of fractures in children were described in the present study. The study results are comparable with other major studies, with some differences in the side (left or right) of fractures and the rate of open fractures in children. The information and findings in the present study may be useful in the planning of management and prevention of fractures in children.


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## Potential conflicts of interest

None.

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## *ความชุกและรูปแบบของกระดูกหักในเด็ก*

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***วัตถุประสงค์:*** *เพื่อศึกษาความชุกและข้อมูลพื้นฐานที่เกี่ยวข้องกับผู้ป่วยกระดูกหักในเด็กที่มารับการรักษาที่ตึกอุบัติเหตุ โรงพยาบาลศิริราชใน พ.ศ. 2549, พ.ศ. 2552 และ พ.ศ. 2555*

***วัสดุและวิธีการ:*** *ในการศึกษานี้ได้ทำการเก็บข้อมูลจากแฟ้มประวัติและภาพรังสีของผู้ป่วยเด็กทั้งคนไข้ในและคนไข้นอกที่มีอายุระหว่าง 0-16 ปี ที่มารับการรักษาที่ตึกอุบัติเหตุ โรงพยาบาลศิริราชใน พ.ศ. 2549, พ.ศ. 2552 และ พ.ศ. 2555 โดยบันทึกข้อมูลในเรื่องเพศของผู้ป่วย อายุในขณะที่เกิดการบาดเจ็บ ตำแหน่งและประเภทของกระดูกที่หักการบาดเจ็บและชนิดของการบาดเจ็บต่อศูนย์การเจริญของกระดูก รวมถึงสาเหตุของการบาดเจ็บที่เกิดขึ้น ข้อมูลจะถูกรวบรวมและวิเคราะห์โดยสถิติ*

***ผลการศึกษา:*** *ความชุกของกระดูกหักในเด็กเทียบกับคนไข้เด็กที่บาดเจ็บทั้งหมด = 4.7%, 5.3% และ 5.8% ในพ.ศ. 2549, พ.ศ. 2552 และ พ.ศ. 2555 ตามลำดับ มีผู้ป่วยเด็กทั้งหมด 716 รายและมีจำนวนกระดูกหัก 718 แบ่งเป็น 222, 234, และ 262 กระดูกหักใน พ.ศ. 2549, พ.ศ. 2552 และ พ.ศ. 2555 ตามลำดับ เป็นผู้ป่วยเด็กชาย 68% และเด็กหญิง 32% และเด็กชายมากกว่าเด็กหญิงอย่างมีนัยสำคัญทางสถิติ ($p = 0.013$) ช่วงอายุที่พบผู้ป่วยมากที่สุดคือกลุ่มอายุ 10 ถึง 16 ปี พบถึง 47.4% อายุเฉลี่ยเด็กฑส่วนเบี่ยงเบนมาตรฐาน = 7.9±4.6 ปี พบอัตรากระดูกหักเพิ่มขึ้นตามอายุอย่างมีนัยสำคัญทางสถิติ ($p = 0.001$) อัตราการเกิดกระดูกหักแบบเปิด 6.7% อัตราการเกิดกระดูกหักผ่านแผ่นเจริญเติบโตของกระดูกมี 12.4% ข้างขวา 53.8% มากกว่าข้างซ้ายที่มี 46.2% อย่างมีนัยสำคัญทางสถิติ ($p = 0.031$) กระดูกหักที่แขนส่วนปลายด้านล่างพบได้มากที่สุด 18.8% การหักจากการหกล้มพบมากที่สุด 34.6% รองลงมาคือหักจากอุบัติเหตุจากถนน 28.4% และตกจากที่สูง 24.1% รวมสามสาเหตุใหญ่เป็น 87.1%*

***สรุป:*** *การศึกษานี้ได้แสดงถึงความชุกของกระดูกหักในเด็กชนิดแบบแผนและสาเหตุของกระดูกหัก ซึ่งจะช่วยในการวางแผนและการป้องกันในอนาคต*

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