

Incidence of femoral fractures in children and adolescents in Finland and Sweden between 1998 and 2016: A binational population-based study

Anne Salonen^{ID}, Elina Laitakari, Hans E. Berg, Li Felländer-Tsai, Ville M. Mattila and Tuomas T. Huttunen

Abstract

Background and objective: Femoral fractures in children have significant impact for patients, family, and trauma resources as they usually require hospitalization and surgical treatment. The aim of this study was to determine the incidence and trends of femoral fractures among children and adolescents hospitalized between 1998 and 2016 in Finland and Sweden.

Methods: All patients younger than 17 years of age in Finland and Sweden with a femoral fracture treated surgically between 1998 and 2016 were included in the study. Data were collected from National Hospital Discharge Registries. Patients were classified by gender and age into four groups. The annual incidences per 100,000 were calculated using annual mid-year population census data obtained from the Official Statistics of Finland and Sweden.

Results: In total, 6410 patients younger than 17 years of age diagnosed with femoral fracture were included in this study. The total incidence per 100,000 femoral fractures was 13.3 in Finland and 11.0 in Sweden. The incidence of femoral fractures decreased during the study period in all age groups, except for teenage Finnish girls. Most of the fractures were located in femoral shaft. Fractures of the upper and distal femur were rare. Male predominance was detected in all age groups older than 1 year.

Conclusions: The incidence of femoral fractures decreased in all age groups except in teenage Finnish girls. Majority of femoral fractures were located in femoral shaft with male predominance. In children younger than 1 year of age, female predominance was found.

Keywords

Femoral, fracture, children, epidemiology

Date received: 4 October 2021, accepted: 3 February 2022

Introduction

Trauma is the leading cause of death and disability in children.¹⁻³ Although femoral fractures account for only 2% of all pediatric fractures,

they have a significant impact on patients, their families, and hospital resources, as femoral fractures always require inpatient care and treatment.³⁻⁸ In total, 70% of all closed femoral fractures are fractures of the femoral shaft, 12%

Scandinavian Journal of Surgery
January-March 2022: 1-8
© The Finnish Surgical Society 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/14574969221083133
journals.sagepub.com/home/sjs

Corresponding author:

Anne Salonen

Department of Pediatric and Adolescent Surgery, Pediatric Clinic and Pediatric Research Centre, Tampere University Hospital, Elämäntie 2, 33520 Tampere, Finland.

anne.v.salonen@pshp.fi

Elina Laitakari

Department of Pediatric and Adolescent Surgery, Pediatric Clinic and Pediatric Research Centre, Tampere University Hospital, Tampere, Finland

Hans E. Berg

The Division of Orthopedics and Biotechnology, Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institute, Stockholm, Sweden

Li Felländer-Tsai

The Division of Orthopedics and Biotechnology, Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institute, Stockholm, Sweden

Ville M. Mattila

Department of Orthopaedics and Traumatology, Tampere University Hospital, Tampere, Finland

Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland

Tuomas T. Huttunen

Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland
Tampere University Heart Hospital, Tampere University Hospital, Tampere, Finland



are fractures of the femoral neck or trochanter, and 18% of femoral fractures are distal.^{8,9} Fractures of the femoral neck or trochanter are more common in children older than 6 years of age,⁸ and boys are more affected (70%) than girls.^{8,9} Furthermore, up to 80% of femoral fractures may be non-accidental in children younger than 1 year of age.^{10–12} The most common injury mechanisms causing femoral fractures in children younger than 6 years of age are falls, whereas motor vehicle collision is the most common mechanism in older children, especially adolescents.^{4,8,13} The reported incidence of femoral fractures varies from 11.8 to 20 per 100,000, and it seems that the annual incidence is decreasing.^{4,14,15} The treatment of femoral fractures is determined by the age, size, fracture type, and individual circumstances of the patient and therefore all femoral fractures require stabilization.^{16–18}

The aim of this study was to assess the nationwide incidence of primary femoral fractures treated surgically in Finland and Sweden between 1998 and 2016 and to determine the changes in incidence of hospitalizations among children aged from 0 to 16 years.

Methods

This study covered the entire pediatric and adolescent population aged younger than 17 years in Finland and Sweden with a primary diagnosed femoral fracture during an 18-year study period between 1 January 1998 and 31 December 2016. Femoral fracture data were obtained from the National Hospital Discharge Registers of Finland (FNHDR) and Sweden (SNHDR). In both countries, the registers include all hospitalized children, and diagnoses are coded according to the International Classification of Diseases (ICD-10 since 1997).

The main outcome variables in this study were the number of individual patients who were hospitalized with a main diagnosis of a femoral fracture and treated in operating room with a primary femoral fracture procedure. The femoral fracture ICD-10 diagnosis codes used in this study were S72.0 (fracture of head and neck of femur), S72.1 (peritrochanteric fracture of femur), S72.2 (subtrochanteric fracture of femur), S72.3 (shaft fracture of femur), and S72.4 (fracture of lower end of femur). To ensure only primary hospitalization and care, the femoral fracture ICD-codes were matched with the femoral procedure codes (NFJ40, NFJ42, NFJ50, NFJ52, NFJ54, NFJ60, NFJ62, NFJ64, NFJ70, NFJ86, NFJ99 in Finland and NFJ09, NFJ19, NFJ29, NFJ39, NFJ49, NFJ59, NFJ69, NFJ79, NFJ89, NFJ99 in Sweden). This study did not include newborn infants with femoral fractures at birth (ICD-10 code P13.4), as birth traumas are recorded to the National Birth Registry in both countries. Moreover, infants with femoral fracture, who were treated with Pavlik Harness or von Rosen splint, did not meet the inclusion criteria as procedure codes related to bracing treatment are not registered. In addition, older children who have not been treated in the operating room were excluded from the study.

For further analysis, we classified patients into four age groups: patients younger than 1, 1–6.99, 7–11.99, and 12–16.99 years of age. The fracture codes were divided into three groups: upper femoral fractures (S72.0, S72.1, and S72.2), femoral shaft fractures (S72.3), and distal femoral fractures (S72.4).

To calculate the incidence rates of primary femoral fractures, the annual mid-year population of Finland and Sweden was obtained from the Official Statistics of Finland and Sweden, which serve as electronic national population registers.^{19,20} The annual incidences per 100,000 were calculated using annual mid-year population census data obtained from the Official Statistics of Finland and Sweden. All analyses were performed using R version 4.0.5 (R Foundation for Statistical Computing, Vienna, Austria). Thus, the incidence figures were the true results of the entire adolescent population in Finland and Sweden rather than cohort-based estimates with sampling variability, and therefore 95% confidence intervals were not calculated.

In 1998, Finland had a population of 5.16 million persons (2.64 million female and 2.52 male), of which 1.09 million were younger than 17 years of age (0.54 million girls and 0.55 million boys). In 1998, Sweden had a population of 8.9 million persons (4.52 million female and 4.38 male), of which 1.85 million were younger than 17 years of age (0.90 million girls and 0.95 million boys). In 2016, Finland had a population of 5.50 million persons (2.79 million female and 2.71 million male), of which 1.01 million were younger than 17 years of age (0.49 million girls and 0.52 million boys). In 2016, Sweden had a population of 9.92 million persons (4.98 million female and 4.94 million male), of which 1.97 million were younger than 17 years of age (0.95 million girls and 1.02 million boys).^{19,21} The annual pediatric population and the yearly incidence of fractures are described in Supplemental Appendix 1.

All data were stored in accordance with the General Data Protection Regulation (GDPR). The regional ethical committee approved the study (Reference Nos. 2013/581-31/5 and 2016-2251-32, 2018/1823-32, 2020-04776, and 2020/06182) which was performed in line with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Results

During the 18-year study period, 6410 patients younger than 17 years of age with femoral fracture were hospitalized and surgically treated in operating room in Finland ($n=2611$) and Sweden ($n=3799$). Fractures were more common among boys (Finland: $n=1914$, 73%, Sweden: $n=2637$, 69%) than girls (Finland: $n=697$, 27%, Sweden: $n=1162$, 31%). The mean incidence per 100,000 of all femoral fractures was 13.3 in Finland and 11.0 in Sweden (Fig. 1). Two-thirds of the fractures were in the femoral shaft (Sweden: 73%, Finland: 70%). The incidence (1/100,000) of all fractures between 1998 and 2016 divided by country and gender in all age groups is represented in Fig. 1 and Table 1.

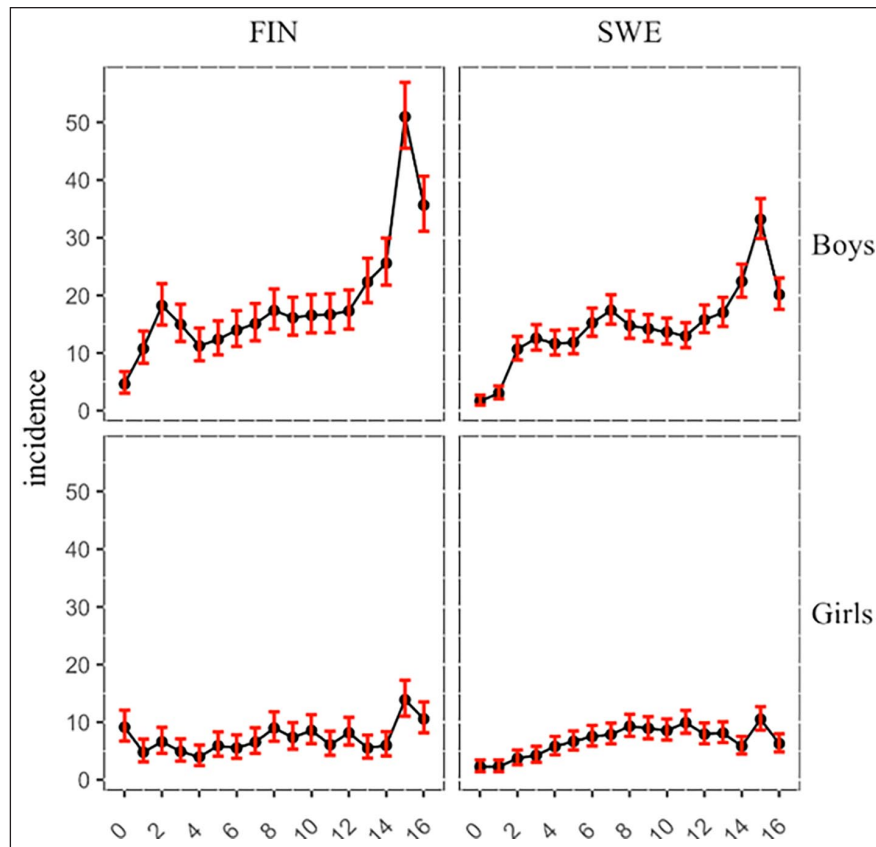


Fig. 1. The incidence (1/100,000) of femoral fractures in all age groups between 1998 and 2016 divided by country and gender.

Table 1. Mean percentages and incidences (1/100,000) of different fracture types divided by country, age, and gender.

Finland	Femoral fracture	<1 year		1.0–6.99 years		7.0–11.99 years		12.0–16.99 years	
		Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
S72.0–S72.2	Proximal	0.56 (6.1%)	0.36 (7.7%)	0.97 (18.3%)	0.87 (8.5%)	1.58 (21.0%)	1.78 (10.9%)	1.47 (16.6%)	3.93 (12.9%)
S72.3	Diaphyseal	4.85 (53.1%)	1.96 (42.3%)	3.50 (66.3%)	11.64 (85.7%)	4.80 (64.0%)	12.67 (77.4%)	6.05 (68.3%)	19.22 (63.1%)
S72.4	Distal	3.73 (40.8%)	2.32 (50.0%)	0.81 (15.4%)	0.78 (5.7%)	1.12 (15.0%)	1.92 (11.7%)	1.33 (15.1%)	8.33 (24.1%)
Sweden	Femoral fracture	<1 year		1.0–6.99 years		7.0–11.99 years		12.0–16.9 years	
		Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
S72.0–S72.2	Proximal	0.62 (27.3%)	0 (0%)	0.65 (12.9%)	0.86 (7.9%)	1.91 (21.4%)	1.83 (12.5%)	1.77 (22.9%)	3.65 (16.8%)
S72.3	Diaphyseal	1.13 (50.0%)	1.46 (88.2%)	3.89 (77.2%)	9.46 (87.3%)	5.9 (66.1%)	11.5 (78.8%)	4.95 (64.0%)	14.13 (65.1%)
S72.4	Distal	0.51 (22.7%)	0.19 (11.8%)	0.5 (9.9%)	0.52 (4.8%)	1.11 (12.5%)	1.26 (8.7%)	1.01 (13.1%)	3.94 (18.2%)

Fig. 2A to C present the incidence of proximal, diaphyseal, and distal femoral fractures in different age groups.

Fractures in children younger than 1 year of age

A total of 114 children (Finland: $n=75$ and Sweden: $n=39$) younger than 1 year of age were hospitalized with femoral

fracture and treated with casting during the 18-year study period. The incidence of all femoral fractures per 100,000 persons was 6.8 in Finland and 2.0 in Sweden in this age group (Figs 1 and 2). Most of the fractures were located in the femoral shaft, with the incidence of 3.4 in Finland and 1.3 in Sweden. The incidence of femoral shaft fractures was lower in Finnish boys, 2.0, than in Finnish girls, 4.9. In Sweden, however, the incidence of femoral shaft fractures was higher

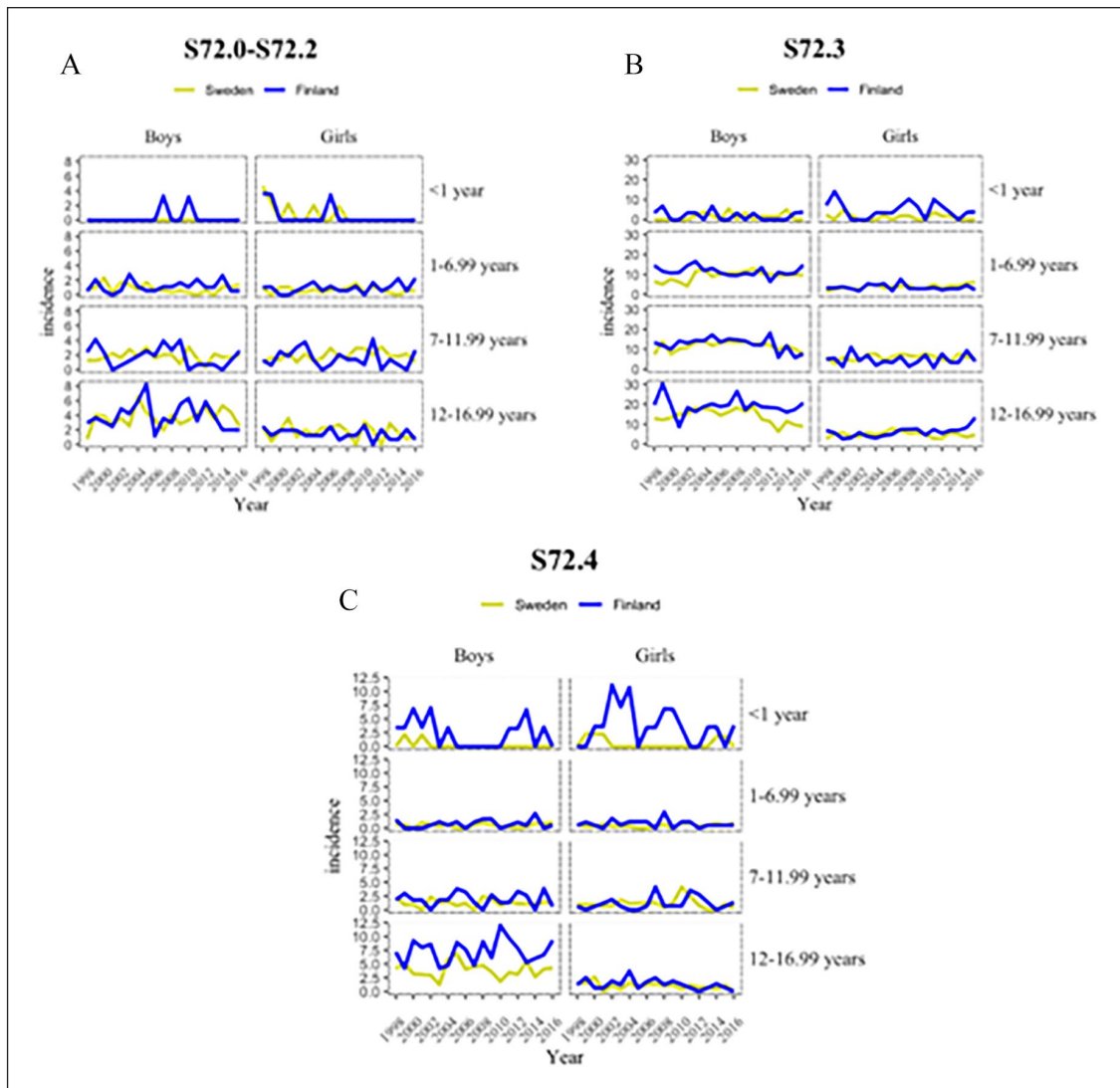


Fig. 2. (A) The incidence (1/100,000) of proximal femoral fractures in children and adolescents between 1998 and 2016 divided by country, age, and gender. (B) The incidence (1/100,000) of diaphyseal femoral fractures in children and adolescents between 1998 and 2016 divided by country, age, and gender. (C) The incidence (1/100,000) of distal femoral fractures in children and adolescents between 1998 and 2016 divided by country, age, and gender.

in boys, 1.5, than in girls, 1.1. In Finland, the incidence of femoral shaft fractures in boys increased during the study period from 3.5 in 1988 to 6.8 in 2005, but subsequently decreased to 3.7 in 2016. In Finnish girls, the incidence of femoral shaft fractures decreased from 7.2 to 3.8 during the study period, although an increasing trend was seen between the years 1998 and 2011 (from 7.2 to 10.1). In Sweden, the incidence of femoral shaft fractures in girls decreased from 2.3 to 0 and remained at a steady level in Swedish boys. The incidence of upper femoral fractures in Finland was very low, 0.5 (0.6 in girls and 0.4 in boys). In Sweden, the corresponding incidences were 0.3, which included only fractures in girls. The incidence of distal femoral fractures was higher than upper femoral fractures, with incidence in Finland of 3.0

(girls 3.7 and boys 2.3). The corresponding incidence in Sweden was 0.4 (girls 0.5 and boys 0.2).

Fractures in children aged 1.0–6.99 years

In this study group, the total number of fractures was 1606 (Finland: $n=645$, Sweden: $n=961$) with male dominance (Finland 73%, Sweden 69%). The majority of fractures were located in the femoral shaft. The incidence per 100,000 femoral shaft fractures among boys in Finland was 11.6 and 9.5 in Sweden. In girls, the incidence in Finland was 3.5 and 3.9 in Sweden. In this age group, we did not detect significant changes in the incidence of femoral shaft fractures during the 18-year study period. Although the incidence of proximal

femoral fractures was low with incidence in Finnish boys of 1.2 and 0.9 in Swedish boys, the incidence of fractures increased slightly from 0.9 to 1.4 in Swedish boys during the study period. Among Swedish girls, the incidence of upper femoral fractures was 0.7 and decreased from 1.0 to 0.6. There were no changes in the incidence of distal femoral fractures among girls and boys in Finland.

Fractures in children aged 7.0–11.99 years

In this age group, 1421 primary femoral fractures were recorded (Finland: $n=514$, Sweden: $n=907$) with a male dominance (Finland 73%, Sweden 67%). The incidence of all femoral fractures remained at steady level. Most of the fractures were located in the femoral shaft. The incidence of femoral shaft fractures in boys was 12.7 in Finland and 11.5 in Sweden. In girls, the incidence was 4.8 in Finland and 5.9 in Sweden. There were no significant changes in the incidence of femoral shaft fractures during the study period. The incidence per 100,000 proximal femoral fractures in Finland was 1.8 in boys and 1.6 in girls. In Sweden, the incidence was 1.8 in boys and slightly higher at 1.9 in girls. The incidence of distal femoral fractures in Finnish girls was 1.1 and 1.9 in Finnish boys. The corresponding incidence in Swedish girls was 1.1 and 1.3 in Swedish boys. The incidence of distal femoral fractures in boys decreased in Finland from 1.8 to 0.6 and in Sweden from 2.3 to 1.3. In girls, the incidence of distal femoral fractures increased in Finland from 0.3 to 1.3 but decreased in Sweden from 1.0 to 0.4.

Fractures in adolescents aged 12.0–16.99 years

The total number of femoral fractures was the highest in the adolescent group, 2766 (Finland: $n=1190$, Sweden: $n=1576$), with a male prevalence (Finland 78%, Sweden 75%). Two-thirds of the fractures were located in the femoral shaft. The incidence of femoral shaft fractures in girls was 6.0 in Finland and 5.0 in Sweden. The corresponding incidence in boys was 19.2 in Finland and 14.1 in Sweden. The incidence of femoral shaft fractures in Swedish boys first increased from 12.9 in 1998 to 18.6 in 2008, and then decreased markedly to 8.9 in 2016. In Swedish girls, the incidence trend increased during the early 2000s from 2.8 in 1988 to 7.8 in 2006, and then remained at a steady level with incidence of 4.7 between 2007 and 2016. In Finland, the incidence of femoral shaft fractures remained at a steady level in boys, increasing from 19.6 in 1987 to 30.3 in 1999, and then decreasing to a steady level of between 16.1 and 20.6 in 2016. In Finnish girls, the incidence almost doubled from 6.9 to 13.3. The incidence of proximal and distal femoral fractures remained at a steady level. The incidence of proximal femoral fractures was 1.5 in Finnish girls and 3.9 in Finnish boys. In Sweden, the corresponding rates were 1.8 in girls and 3.6 in boys. The

incidence of distal femoral fractures was 1.4 in Finnish girls and 7.3 in Finnish boys. In Sweden, the corresponding incidence was 1.0 in girls and 3.9 in boys.

Discussion

Femoral fractures in children have significant impact for patients, family, and trauma resources as they require hospitalization and often surgical treatment in operating room. Based on earlier studies, the incidence of upper extremity fractures is increasing.² The aim of this study was to determine whether the same trend is seen in femoral fractures. This study covers the hospitalization incidence and trends of femoral fractures treated in operating room in children and adolescents younger than 17 years of age in Finland and Sweden over a period of 18 years. In both countries, femoral shaft fractures were the most common in all age groups. We are unaware of the previous studies that have reported the incidence of proximal and distal femoral fractures. Male preponderance occurred in all age groups, except in the children younger than 1-year age group. In children younger than 1 year of age, the incidence of femoral shaft fractures was higher in girls than in boys. Although the overall femoral fracture incidence decreased, the incidence of femoral shaft fractures increased in teenagers, especially among girls. In the oldest study group, adolescents aged from 12 to 16.99 years, the incidence of femoral shaft fractures decreased in Swedish boys but increased noticeably in Finnish and Swedish girls. The incidence of femoral shaft fractures was slightly lower in Swedish boys than in Finnish boys. The total incidence per 100,000 femoral fractures in Finland was 13.3 and 11.0 in Sweden. In this study, the incidence of femoral fractures is in line with that reported in earlier studies (from 11.8 to 20 per 100,000).^{4,14,15}

In this study, the incidence of femoral fractures in children younger than 1 year of age decreased in both Finnish boys and girls. In Swedish girls, the incidence also decreased, but a slight increase was seen in Swedish boys. In this youngest age group, the incidence of fractures was higher in girls in both Finland and Sweden.

Children younger than 1 year of age are a specific group, as they are very dependent on their parents or caregivers. The dependence of the child, especially a child younger than 6 months of age, encompasses mobility, eating, drinking, and the avoidance of potentially hazardous situations.

In our study, we discovered a higher incidence of femoral fractures in infant girls than in boys. This finding may be coincidental because of the low number of patients, but other studies have reported similar findings concerning intentional traumas.¹² Bridgman et al. found the incidence of femoral fractures to be similar in girls and boys in the first year of life, whereas Heideken et al. reported a slight girl predominance (51% versus 49%) in a Swedish study of femoral shaft

fractures.^{4,22} Hinton et al. also reported a higher femoral shaft fracture rate among girls younger than 2 years of age, although the fracture rate decreased with age.¹⁴

The etiology of fractures varies between the patients of different ages. In walking children, the most common cause of femoral fracture is a fall from a height of less than 1 m. In non-ambulatory children, the rate of non-accidental femoral shaft fracture rates is estimated to vary from 11% to 80%.^{8,11,14,23} Femoral shaft fractures are the most common location of femoral fracture in both abused and non-abused children.¹¹ Young age is a strong determinant of non-accidental injury when a non-ambulatory child presents with a femoral fracture.²⁴ In toddlers, the protective reflexes are still developing, and physical capability often outweighs judgment skills in assessing potentially dangerous situations and activities.¹⁴

According to Hinton et al., compromising the multiple regression analysis, a lower socioeconomic status and a greater overcrowding of housing structures were the strongest predictors of femoral fracture.¹⁴ Owing to data protection legislation in Finland, we had no information concerning the ethnic background of the patients and their families. However, earlier studies have shown that ethnic background has an impact on femoral fracture risk.⁸ Sweden was the first country in the world to prohibit the corporal punishment of children in 1979. Since then, there have been continuous campaigns and education programs, especially in maternity and children's clinics, to reduce child abuse in both countries.⁴

In this study, the highest number of femoral fractures occurred in the oldest age group, adolescents aged from 12 to 16.99 years. Surprisingly, the incidence of femoral shaft fractures in girls increased in both countries during the 18-year study period, especially in Finnish girls. In Sweden, sports-related accidents were the most frequent cause of femoral fractures in children aged between 4 and 12 years, whereas traffic accidents were the leading cause of femoral fractures in adolescents.^{4,13}

In Finland, adolescents can obtain a moped driver's license after turning 15 years of age (maximum speed of 40 km/h). In 2016, 17,500 moped driver's licenses were issued in Finland, and 38% of these licenses were issued to girls.²⁵ Between 2003 and 2016, the number of moped-related accidents reached a peak in 2011. In that year, a total of 305 accidents occurred (45% of the injured were girls) that required hospitalization. Between 2003 and 2016, the portion of injured girls varied from 17% to 45%, being highest in 2011 and 2016.¹⁹ The number of registered mopeds between 1998 and 2016 varied from 1343 to 5740, with the number being highest in 2011, the same year the peak of moped-related accidents occurred.²⁵ In 2011, the moped/scooter license requirements have been updated. Driver's education, including theoretical instruction and practical driving lessons, has been increased. Kosola et al. detected that enhanced driver's education may reduce the incidence and severity of moped and scooter accidents in adolescents.²⁶ Recently, Unkuri et al. investigated moped/motorized scooter

and bicycle-related traumas in children aged 7–15 years in Finland. They found that moped/scooter riders had an eight-fold higher incidence of injuries compared with bicycle riders. Furthermore, up to 50% of those injured suffered fractures. Most cyclists were injured after a fall, and most moped/scooter riders were injured in a collision, most often with a heavier motorized vehicle. Moreover, up to 8% of moped/scooter riders suffered a femoral fracture.²⁷

In Sweden, the incidence of femoral shaft fractures among teenage girls was lower than in Finland, but we noticed an increasing trend. Engström et al. studied the epidemiology of femoral fractures in Sweden between 2015 and 2018.²⁸ Based on the findings of their study, traffic-related accidents were the most common cause of femoral fractures in 13- to 15-year-old teenagers. Most of the fractures were caused by motorcycle accidents, followed by bicycle accidents. Over 90% of the patients were drivers.

The strength of this study is the similarity of the FNHDR and SNHDR, both providing excellent databases of patients treated in hospital.^{29,30} Hospitalization and treatment are equal for all patients living in Finland and Sweden. Poor or absent recording of the external causes of fractures and other missing or incorrectly recorded events are the most obvious weaknesses of this study. A major limitation of this study is the unknown number of individual infants with femoral fractures who were treated with Pavlik Harness or von Rosen splint, as there is no recorded procedure code for bracing. Also, those individual patients treated with cast or traction without treatment in operating room were excluded from the study. This study also includes patients with osteogenesis imperfecta, cerebral palsy, metabolic, and other diseases known associated with increased fracture risk.

To summarize, femoral shaft fractures with male predominance represent the majority of femoral fractures in children and adolescents. The incidence of femoral fractures decreased during the 18-year study period in all age groups, except teenage girls. Fractures in the upper and distal femur are rare and, to our knowledge, data concerning the location of femoral fractures have not been reported earlier. During the study period, the increasing number of registered mopeds and scooters in Finland may have had an impact on the increased incidence of femoral shaft fractures in girls. In children younger than 1 year of age, the incidence of femoral shaft fractures was higher in girls than in boys. For future, studies concerning injury side codes, treatment, and possible non-accidental traumas of this specific age would be valuable.

Acknowledgements

The authors thank our registry coder Topias Koukkula for his excellent work in accurately analyzing data from National Hospital Discharge Register (NHDR).

Author contributions

A.S., E.L., T.T.H., H.E.B., L.F.-T., and V.M.M. participated in study design; A.S., E.L., and V.M.M. performed the data acquisition,

analysis, and interpretation of data; A.S., E.L., and V.M.M. participated in drafting of the article; A.S., E.L., T.T.H., H.E.B., L.F-T., and V.M.M. participated in critical revision of the article; A.S. participated in figure and table design; E.L. contributed as co-writer; T.T.H., H.E.B., and L.F-T. were the responsible authors of National Hospital Discharge Register in Finland and Sweden; V.M.M. was the responsible person in Orthopedics and Traumatology Research Center at Tampere University Hospital. All authors have provided final approval of the submitted article.

Compliance with ethical standards funding statement

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

In Finland, ethical approval was not required as this article does not contain any studies with human participants or animals performed by any of the authors. Informed consent was not required as the study is completely anonymized register study. For the Swedish data, ethical approval was necessary and also granted. The ethical grant numbers are 2013/581-31/5, 2016/2251-32, 2018/1823-32, 2020-04776, and 2020/06182.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ICMJE conflict of interest statement

None declared.

OA license text

This article is distributed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International (CC BY-NC 4.0) license (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction, and distribution of the work without further permission, provided the original work is attributed.

ORCID iD

Anne Salonen  <https://orcid.org/0000-0003-3454-2003>

Supplemental material

Supplemental material for this article is available online.

References

- Galano G, Vitale M, Kessler M et al: The most frequent traumatic orthopaedic injuries from a national pediatric inpatient population. *J Pediatr Orthop* 2005;25(1):39–44.
- Suominen JS, Pakarinen MP, Kääriäinen S et al: In-hospital treated pediatric injuries are increasing in Finland: A population based study between 1997 and 2006. *Scand J Surg* 2011;100(2):129–135.
- Heyworth B, Suppan C, Kramer D et al: Management of pediatric diaphyseal femur fractures. *Curr Rev Musculoskelet Med* 2012;5(2):120–125.
- Heideken J, Svensson T, Blomqvist P et al: Incidence and trends in femur shaft fractures in Swedish children between 1987 and 2005. *J Pediatr Orthop* 2011;31(5):512–519.
- Cox PJ, Clarke NM: Improving the outcome of paediatric orthopaedic trauma: An audit of inpatient management in Southampton. *Ann R Coll Surg Engl* 1997;79(6):441–446.
- McCartney D, Hinton A, Heinrich SD: Operative stabilization of pediatric femur fractures. *Orthop Clin North Am* 1994;25(4):635–650.
- Nafei A, Teichert G, Mikkelsen SS et al: Femoral shaft fractures in children: An epidemiological study in a Danish urban population, 1977–86. *J Pediatr Orthop* 1992;12(4):499–502.
- Loder R, O'Donnell PW, Feinberg JR: Epidemiology and mechanisms of femur fractures in children. *J Pediatr Orthop* 2006;26(5):561–566.
- Mäyränpää MK, Mäkitie O, Kallio PE: Decreasing incidence and changing pattern of childhood fractures: A population-based study. *J Bone Miner Res* 2010;25(12):2752–2759.
- Beals RK, Tufts E: Fractured femur in infancy: The role of child abuse. *J Pediatr Orthop* 1983;3(5):583–586.
- Kemp AM, Dunstan F, Harrison S et al: Patterns of skeletal fractures in child abuse: Systematic review. *BMJ* 2008;337(7674):859–862.
- Leventhal JM, Martin KD, Asnes AG: Incidence of fractures attributable to abuse in young hospitalized children: Results from analysis of a United States database. *Pediatrics* 2008;122(3):599–604.
- Hoffmann CR, Traldi EF, Posser A: Epidemiological study of children diaphyseal femoral fractures. *Rev Bras Ortop* 2012;47(2):186–190.
- Hinton RY, Lincoln A, Crockett MM et al: Fractures of the femoral shaft in children: Incidence, mechanisms, and sociodemographic risk factors. *J Bone Joint Surg Am* 1999;81(4):500–507.
- Naranje S, Stewart M, Kelly D et al: Changes in the treatment of pediatric femoral fractures: 15-year trends from United States kids' inpatient database (KID) 1997 to 2012. *J Pediatr Orthop* 2016;36(7):e81–e85.
- Beatty JH: Operative treatment of femoral shaft fractures in children and adolescents. *Clin Orthop Relat Res* 2005;434:114–122.
- Musgrave D, Mendelson S: Pediatric orthopedic trauma: Principles in management. *Crit Care Med* 2002;30:S431–S443.
- Roaten J, Kelly D, Yellin J et al: Pediatric femoral shaft fractures: A multicenter review of the AAOS clinical practice guidelines before and after 2009. *J Pediatr Orthop* 2019;39(8):394–399.
- Official Statistics of Finland: Official Statistics of Finland, 2020, www.stat.fi
- Socialstyrelsen: The National Board of Health and Welfare, <https://www.socialstyrelsen.se/en/>
- Statistics Sweden: Population statistics, <https://www.scb.se/>

22. Bridgman S, Wilson R: Epidemiology of femoral fractures in children in the West Midlands region of England 1991 to 2001. *J Bone Joint Surg Br* 2004;86:1152–1157.
23. Hui C, Joughin E, Goldstein S et al: Femoral fractures in children younger than three years: The role of nonaccidental injury. *J Pediatr Orthop* 2008;28(3):297–302.
24. Clarke NM, Shelton FR, Taylor CC et al: The incidence of fractures in children under the age of 24 months: In relation to non-accidental injury. *Injury* 2012;43(6):762–765.
25. Finnish Transport Communication Agency, <https://traficom.fi>
26. Kosola S, Salminen P, Kallio P: Driver's education may reduce annual incidence and severity of moped and scooter accidents. *Injury* 2016;47(1):239–243.
27. Unkuri J, Salminen P, Kallio P et al: Teens on wheels and consequences: A six-year population-based study of bicycle and moped injuries. *Eur J Pediatr Surg* 2021;31(3):266–272.
28. Engström Z, Wolf O, Hailer YD: Epidemiology of pediatric femur fractures in children: The Swedish Fracture Register. *BMC Musc Dis* 2020;21:1–8.
29. Sund R: Quality of the Finnish Hospital Discharge Register: A systematic review. *Scand J Publ Health* 2012;40(6):505–515.
30. Aro S, Koskinen R, Keskimäki I: Reliability of hospital discharge data concerning diagnosis, treatments and accidents. *Duodecim* 1990;106(21):1443–1450.