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Epidemiology of forearm fractures in the population of children and adolescents current data from Podlaskie voivodeship, Poland

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Abstract

Forearm fractures are the most common fracture in children. The study was a retrospective review of 1806 children aged between 0 and 18 years (1138 boys and 668 girls) treated for forearm fractures in Pediatric Clinical Hospital in Białystok between 1st February 2016 to 31st November 2018. Forearm fractures occurred more commonly in boys than girls. The fracture risk increased with age in both genders and peak incidence occurred at ages 6 to 12 in girls and 8 to 14 in boys. Majority of fractures were distal radius fractures. Because forearm fractures are the most common fractures in children it is important to determine the exact causes and possibility of their elimination or reduction of their impact to the general health of population and cost of the health service.

Key words: Fractures in children; Forearm; Epidemiology

Introduction

Fractures are one of most frequent pediatric injuries and constitute 10-25% of them [1,2]. Forearm fractures are the most common fracture in children [3]. They account for 45% of all fractures in childhood and for 62% of upper limb fractures [4]. Fractures in children differ from fractures in adults because growth and remodeling continue after the fracture has healed. There is also a wide variety of fracture types in children due to greater pliability in their bones than in adults [5]. Type of fracture determines kind of treatment. Most of them are treated by close reduction and immobilization [3]. Because they occur very often and require careful clinical management they are an essential economical and clinical issue. In this work, we would like to evaluate the epidemiology of those important fractures in children and adolescents in Pediatric Orthopedic Department, University Children's Clinical Hospital of Białystok city in Poland, focusing specifically on the anatomical location of forearm.

Materials and methods

The study was a retrospective review of all patients treated for forearm fractures in Pediatric Clinical Hospital in Białystok between 1st February 2016 to 31st November 2018. Because of Pediatric Clinical Hospital in Białystok is the only paediatric hospital in Podlaskie district, collected data are representative for entire Podlaskie voivodeship. Analysis was carried out of 1806 children aged between 0 and 18 years (1138 boys and 668 girls). We analysed following data found in hospital charts: gender, age of a child at the moment of an injury, seasonality of forearm fracture and fracture location. Only fractures which were clinically documented and confirmed by radiogram (or in some specific cases confirmed by CT) have been taken into consideration. In our study fractures were classified according to the location (ICD 10, WHO classification) [6]: upper end of ulna, upper end of radius, shaft of ulna, shaft of radius, shafts of both ulna and radius, lower

end of radius, lower end of ulna, multiple fractures of forearm, other parts of forearm and unspecified fracture of forearm.

The data were analysed using Shapiro-Wilk test, the Kruskal-Wallis test and Spearman test for correlations. Significance level was accepted at $\alpha=0,05$, $p < 0,05$ was considered significant and $p < 0,001$ highly significant. All analyses were performed in Statistica 10.0 (StatSoft, Inc. Tulusa, USA).

Results

From February 2016 till 31st November 2018 total of 1806 children with forearm fracture were enrolled in the study. During the period of observation 4606 fractures were recorded. Forearm fractures were 39,2% of all and it was the most common type of fracture (Table 1). Forearm fractures occurred more commonly in boys (1138) than girls (668) (Table 2). No statistically significant correlation was found between gender and fracture location ($R=0,033$; $p=0,158$).

Table 1. Types and number of fractures treated in Pediatric Clinical Hospital in Białystok between 1st February 2016 to 31st November 2018.

<i>Fracture location</i>	<i>N</i>	<i>%</i>
<i>Fracture of rib(s), sternum and thoracic spine</i>	24	0,5%
<i>Fracture of lumbar spine and pelvis</i>	71	1,5%
<i>Fracture of shoulder and upper arm</i>	1012	22,0%
<i>Fracture of forearm</i>	1806	39,2%
<i>Fracture at wrist and hand level</i>	741	16,1%
<i>Fracture of femur</i>	90	2,0%
<i>Fracture of lower leg, including ankle</i>	543	11,8%
<i>Fracture of foot, except ankle</i>	319	6,9%
	<i>4606</i>	<i>100%</i>

The median age of the patients was 10 years and range was 0 year to 18 years. The fracture risk increased with age in both genders. Peak incidence of forearm fractures occurred at ages 6 to 12 in girls and 8 to 14 in boys (Figure 1, Table 2). Our analysis revealed the existence of the highly statistically significant ($p<0,000001$, $R=0,166$) correlation between the age and the place of fracture.

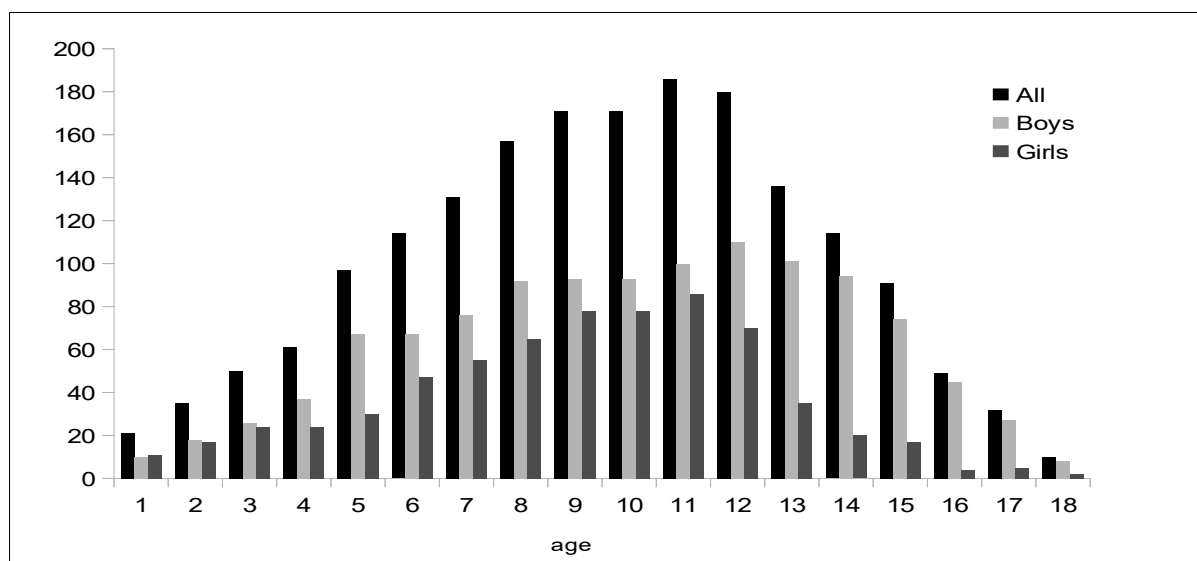


Figure 1. Age of a child at the moment of an injury.

Table 2. Age of a child at the moment of an injury.

<i>Age</i>	<i>Boys</i>		<i>Girls</i>		<i>All</i>	
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
1	10	1,0%	11	1,6%	21	1,2%
2	18	1,5%	17	2,5%	35	1,9%
3	26	2,3%	24	3,6%	50	2,8%
4	37	3,3%	24	3,6%	61	3,4%
5	67	5,9%	30	4,5%	97	5,4%
6	67	5,9%	47	7,0%	114	6,3%
7	76	6,7%	55	8,2%	131	7,3%
8	92	8,1%	65	9,7%	157	8,7%
9	93	8,2%	78	11,7%	171	9,5%
10	93	8,2%	78	11,7%	171	9,5%
11	100	8,8%	86	12,9%	186	10,3%
12	110	9,7%	70	10,5%	180	10,0%
13	101	8,9%	35	5,2%	136	7,5%
14	94	8,3%	20	3,0%	114	6,3%
15	74	6,5%	17	2,5%	91	5,0%
16	45	4,0%	4	0,6%	49	2,7%
17	27	2,4%	5	0,7%	32	1,8%
18	8	0,7%	2	0,3%	10	0,6%
	<i>1138</i>	<i>100%</i>	<i>668</i>	<i>100%</i>	<i>1806</i>	<i>100%</i>

Lower end of radius, shafts of both ulna and radius and lower end of ulna were the most common fractures in both genders (Table 3, Figure 2). In males 521 (45,8%) had fractures of lower end of radius, 226 (19,9%) had fractures of shafts of both ulna and radius and 159 (14,0%) had fractures of lower end of ulna. In females 334 (50,0%) had fractures of lower end of radius, 104 (15,6%) fractures of shafts of both ulna and radius and 85 (12,7%) fractures of lower end of ulna. Upper end of the radius was fractured in 71 (3,9%) patients, 40 (3,5%) in boys and 31 (4,6%) in girls. Upper end of ulna was fractured in 39 (2,2%) children, 23 (2,0%) in boys and 16 (2,4%) in girls. 38 (2,1%) children had a shaft of radius fractured, 24 (2,1%) in males and 14 (2,1%) in females. Shaft of ulna was involved in 24 (1,3%) of the patients, 17 (1,5%) in boys and 7 (1,1%) in girls. Only 6 (0,3%) children had multiple fractures of the forearm (1 girl and 5 boys) and 9 (0,5%) had fractured other parts of the forearm (3 boys and 6 girls). Unspecified fractures of the forearm accounted for 10,5% of all cases.

Table 3. Location of forearm fracture.

Fracture location	Boys		Girls		All	
	N	%	N	%	N	%
Upper end of ulna	23	2,0%	16	2,4%	39	2,2%
Upper end of radius	40	3,5%	31	4,6%	71	3,9%
Shaft of ulna	17	1,5%	7	1,1%	24	1,3%
Shaft of radius	24	2,1%	14	2,1%	38	2,1%
Shafts of both ulna and radius	226	19,9%	104	15,6%	330	18,3%
Lower end of radius	521	45,8%	334	50,0%	855	47,3%
Lower end of ulna	159	14,0%	85	12,7%	244	13,5%
Multiple fractures of forearm	5	0,4%	1	0,2%	6	0,3%
Other parts of forearm	3	0,3%	6	0,9%	9	0,5%
Unspecified fracture of forearm	120	10,5%	70	10,5%	190	10,5%
	1138	100%	668	100%	1806	100%

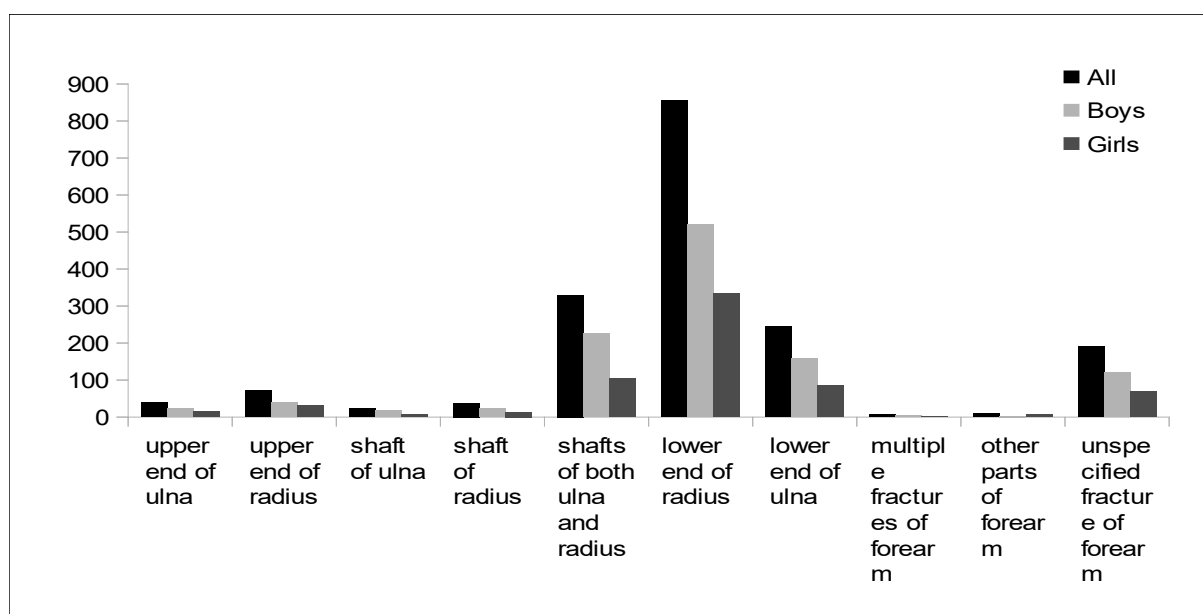


Figure 2. Location of forearm fracture.

Amount of forearm fractures has varied depending on the season. Majority of the children 702 (40%) had fractured in summer, 25,5% in spring, 22,1% in autumn and 12,3% in winter (Table 4, Figure 3). Values were very similar in both genders. Analysis shows statistically significant correlation between fracture location and the season ($R=0,046$; $p=0,049$).

Table 4. Seasonality of forearm fractures.

Season	Boys		Girls		All	
	N	%	N	%	N	%
Spring	292	25,7%	169	25,3%	461	25,5%
Summer	452	39,7%	271	40,6%	723	40,0%
Autumn	264	23,2%	135	20,2%	339	22,1%
Winter	130	11,4%	93	13,9%	223	12,3%
	1138	100%	668	100%	1806	100%

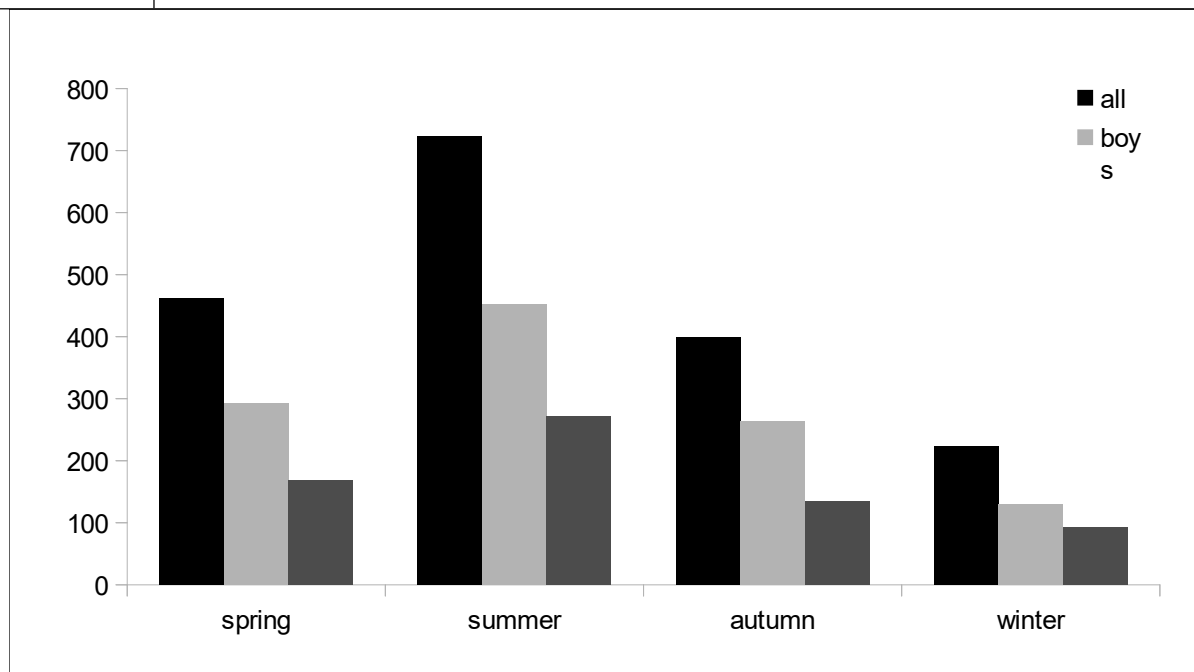


Figure 3. Seasonality of forearm fractures.

Discussion

Forearm fractures occurred nearly twice more common in boys than girls. Male patients take frequent risks and fall more often or more heavily and are more likely to fracture a bone than girls who are nimble and less adventurous. However, other researches noticed that most fractures resulted from only slight trauma, suggesting weakness of the skeleton or imbalance of body weight to skeletal strength, rather than excessive risk-taking behaviour, explained most bone breakage [7,8].

We noticed that peak incidence of fractures occurred earlier in girls than in boys and was related to maturation age. The analysis revealed the existence of the statistically significant ($p < 0,000001$, $R = 0,166$) correlation between the age and the place of fracture. Majority of fractures were distal radius fractures. Other researchers reported correlation between the peak incidence of distal radius fractures and the peak velocity of growth in children, which occurred between the ages of 11.5-12.5 years in girls and 13.5-14.5 years in boys [9]. Comparison of the fracture incidence and bone mineral density of the distal radius in Japanese children showed that the age at peak fracture incidence, 11 years in girls and 13 years in boys, coincided with the age at which the metaphyseal/diaphyseal density ratio was the lowest [10]. These studies suggest that distal forearm fractures are partly due to a temporary osteopenia of the metaphysis during rapid growth [9,10]. Kalkwarf found that children with a forearm fracture had lower cortical, total vBMD, and aBMD and smaller cortical area in the distal radius, which contribute to bone strength, compared to

children who were injured but did not fracture. They were comparing bone characteristics of children with a forearm fracture to those who were injured but did not fracture, to isolate the impact of bone characteristics associated with bone strength rather than injury risk. They suggested that the cortical shell in the metaphysis may be particularly important for bone strength during growth [11]. About 90% of radial bone growth occurs distally [12]. As the radius elongates, bone on the periosteal edge of the metaphysis is resorbed enabling maintenance of the overall shape of the metaphysis. This process results in a very thin cortical shell in the metaphysis that persists until the cessation of growth and maturation [13, 14], and helps to explain why the metaphysis and the metadiaphysis are common sites of forearm fracture in children [14].

Our research shows seasonal variation of forearm fractures. Majority of the children had fractured in summer least in winter. It probably reflects the amount of physical activity among children. In summer and during summer vacations children has a lot of outdoor activity, which could cause more risky behaviours and more accidents. Landin found the same seasonal variation [15]. Fractures occurring in other seasons could be connected with deficiency of vitamin D important for the maintenance of bone health. Low vitamin D levels cause a decreased bone mineral content. The skin production of vitamin D₃ in Polish climate is possible from May to September and only from 10:00 a.m. to 15:00 p.m. Therefore, in the remaining months we can observe deficiency of active metabolites of vitamin D. This fact combined with reduced physical activity from autumn until spring can result in the reduced mineral density of bones (Bone Mineral Density; BMD) and thus higher risk of fractures [16-18]. Less amount of fractures in winter could be explained that children's activity level is lower when they are at school and home in comparison to other more sunny and longer days.

Because forearm fractures are the most common fractures in children it is important to determine the exact causes and possibility of their elimination or reduction of their impact to the general health of the population and cost of the health service. It is known that low physical activity levels may have contributed to the adiposity and the poor skeletal growth of the children because overweight children are frequently inactive. Weight-bearing activity stimulates osteogenesis and helps burn excess calories [19-21]. Children should be encouraged to participate in regular physical activity to optimize bone development. High body weight also contributes to fracture risk in children and adolescents who fracture their forearms repeatedly [22]. Calcium intake and weight-bearing activity also influence the microarchitecture of bone [23,24]. The most important is that children should spend sufficient time outdoors to boost their vitamin D levels to ensure good alimentary absorption of calcium [25,26].

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