

Epidemiological Characteristics of Pediatric Supracondylar Humerus Fractures at Tobruk Medical Center (2020–2024)

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Abstract

Background and Rationale: Supracondylar humerus fractures are the most common type of elbow fracture in children and represent a significant proportion of pediatric orthopedic injuries. These fractures often result from falls on an outstretched hand and are most frequently seen in children aged 4–10 years. Early identification of demographic and seasonal trends can aid in prevention strategies and healthcare planning. Despite the high incidence of these fractures worldwide, there is limited local data from Tobruk and Eastern Libya. This study aims to fill that gap by analyzing retrospective data over a 5-year period.

Methods: This retrospective descriptive study included children aged 0–15 years with radiologically confirmed supracondylar humerus fractures. Demographic data, Fracture laterality, mechanism of injury, seasonal variation, management, and outcomes were collected from medical records. Data were analyzed using SPSS version 23; categorical variables were presented as frequencies and percentages, and continuous variables as mean \pm SD or median (range). Statistical significance was set at $p < 0.05$.

Results: Eighty-nine children were included (56.2% males, 43.8% females) with a mean age of 4.97 ± 2.57 years. Fractures were more common on the left side (57.3%).

Most fractures were managed with closed reduction (96.6%), and the mean time from injury to surgery was 2.2 ± 2.4 days. Seasonal analysis showed highest incidence in autumn (30.3%) and summer (27%). Males were significantly older than females at the time of injury (5.5 ± 2.8 vs 4.3 ± 2.0 years, $p = 0.043$). No significant gender differences were observed in fracture laterality.

Conclusion: Pediatric supracondylar humerus fractures in Tobruk predominantly affect children under ten years, with male predominance and left-side involvement. Closed reduction is the mainstay of treatment. Peaks in incidence occur during summer and autumn, emphasizing the need for preventive strategies and timely access to care. These findings provide baseline epidemiological data to inform local healthcare planning and future multicenter studies in Libya.

Keywords: Pediatric Fractures, Supracondylar Humerus Fracture, Epidemiology, Seasonal Variation, Libya, Tobruk Medical Center

Introduction

Supracondylar humerus fractures are the most common type of elbow fracture in the pediatric population, accounting for approximately 60% of all pediatric elbow fractures and nearly 3% of all pediatric fractures overall [1]. These injuries typically occur in children between 5 and 8 years of age, with several studies reporting a slight predominance in boys, which may be related to higher levels of physical activity and risk-taking behaviors in this group [1,2].

The predominant mechanism of injury is a fall onto an outstretched hand (FOOSH), which produces an extension-type supracondylar fracture in the majority of cases. Flexion-type fractures are rare, representing less than 5% of cases, but are clinically important because they are associated with more complex surgical management and higher rates of complications [1,3].

These fractures are clinically significant because of their potential for neurovascular compromise and long-term sequelae if not properly managed. Reported

complications include injury to the brachial artery, median and ulnar nerve palsies, compartment syndrome, and malunion leading to deformities such as cubitus varus or cubitus valgus [2]. The presence of these possible adverse outcomes underscores the importance of prompt diagnosis, appropriate treatment, and long-term follow-up in affected children.

Epidemiological evidence has shown that seasonal and weather-related variations play an important role in the incidence of these fractures. A recent Turkish study of 310 pediatric patients found that supracondylar humerus fractures were most frequent in spring (28.1%) and summer (27.1%), with significant differences between age groups: children under 6 years sustained relatively more fractures in winter, while those older than 6 years were more commonly affected in summer [4]. Similarly, Finnish data demonstrated that fractures are strongly correlated with dry and warm days, particularly when snow cover is absent, further highlighting the role of climate in fracture epidemiology [5].

Despite the large number of international studies, there remains a lack of epidemiological data from North Africa and specifically Libya. Variations in cultural practices, outdoor activity patterns, healthcare accessibility, and local demographics may lead to differences in the age distribution, gender predominance, side involvement, and seasonal patterns of supracondylar humerus fractures compared with other regions [1]. Understanding these local characteristics is crucial for healthcare planning, resource allocation, and the development of community-based prevention strategies.

Given the limited availability of regional data, this study was designed to address the gap in knowledge regarding the epidemiological profile of pediatric supracondylar humerus fractures in Eastern Libya. By retrospectively reviewing cases managed at Tobruk Medical Center between 2020 and 2024, the study seeks to contribute

evidence that may support both preventive measures and healthcare planning in the region.

The primary objective of this study is to characterize the demographic distribution of supracondylar humerus fractures in children, with specific emphasis on age, sex, and laterality of the injury. The secondary objective is to analyze seasonal variation in fracture incidence, in order to explore potential environmental or behavioral risk factors associated with these injuries.

Methods

Study design and setting:

We performed a retrospective descriptive study at the Orthopedic Department, Tobruk Medical Center, Libya, covering the period January 1, 2020 through December 31, 2024. The study protocol was approved by the Institutional Review Board of Tobruk Medical Center (IRB# TMC-2024). All procedures were carried out in accordance with the Declaration of Helsinki and institutional ethical standards.

Participants and eligibility criteria:

All pediatric patients (age 0–15 years) who presented to Tobruk Medical Center with a clinical and radiological diagnosis of supracondylar humerus fracture between January 2020 and December 2024 were considered for inclusion. Inclusion criteria were: (1) age 0–15 years at time of injury; (2) supracondylar humerus fracture confirmed on radiographs; and (3) treatment and follow-up performed at Tobruk Medical Center. Exclusion criteria were: open fractures, pathological fractures, patients with prior ipsilateral elbow surgery, transfer to another facility before definitive treatment, and incomplete medical records precluding extraction of essential data (demographics, fracture classification, treatment, or outcomes).

Data sources and collection:

Medical records, radiology archives, operative notes, and outpatient clinic charts were reviewed. Collected variables included: demographic data (age, sex), date and mechanism of injury (fall from standing, fall from height, road traffic accident, sports, other), side (right/left), fracture classification according to the Gartland system (Type I, II, III), time from injury to presentation, time until surgery when applicable, treatment modality (non-operative casting, closed reduction and percutaneous Kirschner-wire pinning — CRPP, open reduction and internal fixation — ORIF), perioperative details, length of hospital stay, and in-hospital complications. Follow-up data (range of motion, radiographic union, neurovascular status, complications such as malunion, nonunion, infection, pin-tract problems, compartment syndrome, and need for reoperation) were recorded from outpatient clinic notes and radiographs.

Data extraction and quality control:

Two independent investigators (reviewers) extracted data using a standardized data collection form. Discrepancies were resolved by discussion and, when necessary, adjudicated by a third senior investigator. Where available, radiographs were re-reviewed by an orthopedic consultant to confirm Gartland classification and union status.

Outcomes and definitions:

Primary outcomes were incidence of neurovascular injury, compartment syndrome, malunion, nonunion, and requirement for reoperation. Secondary outcomes included length of hospital stay, pin-tract infection, elbow range of motion at final follow-up, and time to radiographic union. Radiographic union was defined as bridging callus across the fracture site on at least two cortices on orthogonal views. Malunion was

defined according to accepted pediatric parameters for carrying angle and sagittal/coronal alignment resulting in functional or cosmetic concern.

Follow-up:

Patients were followed clinically and radiographically for a minimum of 6 months. For patients with longer available data, follow-up extended up to 24 months; final outcome for each patient reflects the latest documented visit within this period.

Statistical Analysis

Data were collected, organized, and analyzed using the Statistical Package for Social Sciences (SPSS) software, version 23.0 for Windows (SPSS Inc., Chicago, IL, USA). The distribution of quantitative variables was assessed for normality using the Shapiro–Wilk test. Variables that followed a normal distribution were presented as mean \pm standard deviation (SD), whereas those not normally distributed were reported as median and range. Qualitative variables were expressed as absolute frequencies (n) and relative frequencies (%). Comparisons between two independent groups of non-normally distributed quantitative variables were performed using the Mann–Whitney U test. Categorical variables were compared using the Chi-square test or Fisher’s exact test when appropriate. All statistical tests were two-tailed. A p-value of < 0.05 was considered to indicate statistical significance, while a p-value ≥ 0.05 was regarded as statistically non-significant (NS).

Results

A total of 89 children diagnosed with supracondylar humerus fractures were included in the study at Tobruk Medical Center between 2020 and 2024. Among these children, 39 (43.8%) were females and 50 (56.2%) were males. Ages ranged from 1 to 14 years, with a mean of 4.97 ± 2.57 years and a median of 5 years. Most children were aged 5–10 years (53.9%), followed by those under 5 years (43.8%), while only 2.3% were older than 10 years (Table 1, Figure 1).

Table 1: Socio-demographic and clinical characteristics of children (n.89)

| Variables | | n. | % |
|---------------|----------------|-----------------|------|
| Gender | females | 39 | 43.8 |
| | Males | 50 | 56.2 |
| Age per years | <5 years | 39 | 43.8 |
| | 5-10 years | 48 | 53.9 |
| | >10 years | 2 | 2.3 |
| | Mean \pm SD | 4.97 \pm 2.57 | |
| | Median (range) | 5(1-14) | |

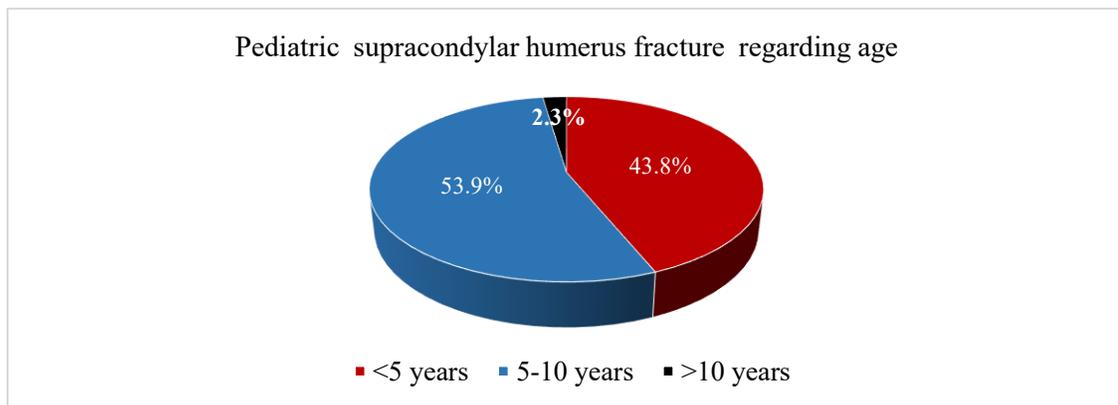


Figure 1: Percent distribution of supracondylar humerus fracture in studied children according their age (n.89)

Table 2: Clinical characteristics of supracondylar humerus fracture (n.89)

| Variables | | n. | % |
|--|-----------------|---------------|-------|
| Site of fracture | Right | 38 | 42.7 |
| | Left | 51 | 57.3 |
| Associated injuries | No | 89 | 100.0 |
| management | open reduction | 3 | 3.4 |
| | close reduction | 86 | 96.6 |
| Time lapse between fracture and operation (days) | Mean \pm SD | 2.2 \pm 2.4 | |
| | Median (range) | 2(0-16) | |

Supracondylar humerus fracture was occurred in right side in 42.7% and 57.3% in left side. No cases of supracondylar humerus fracture came to hospital with associated injuries, Time lapse between fracture and operation range from 0 days to 16 days with a median 2 days. Almost of supracondylar humerus fracture managed with close reduction of fracture (96.6%) as shown in table 2, figure 2.

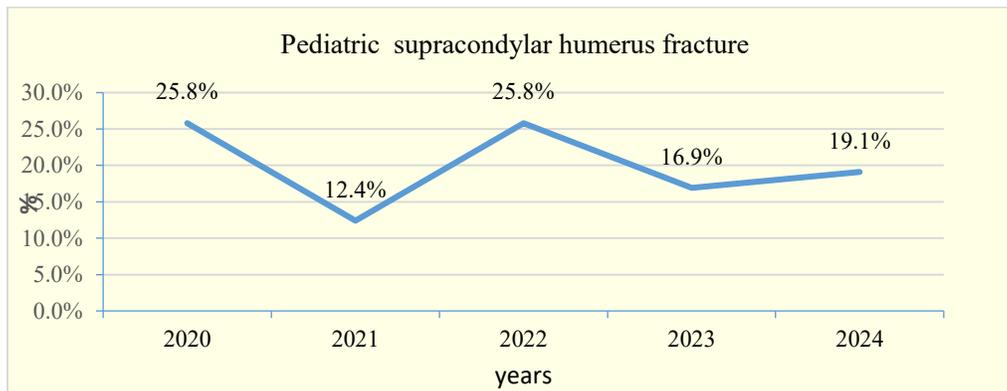
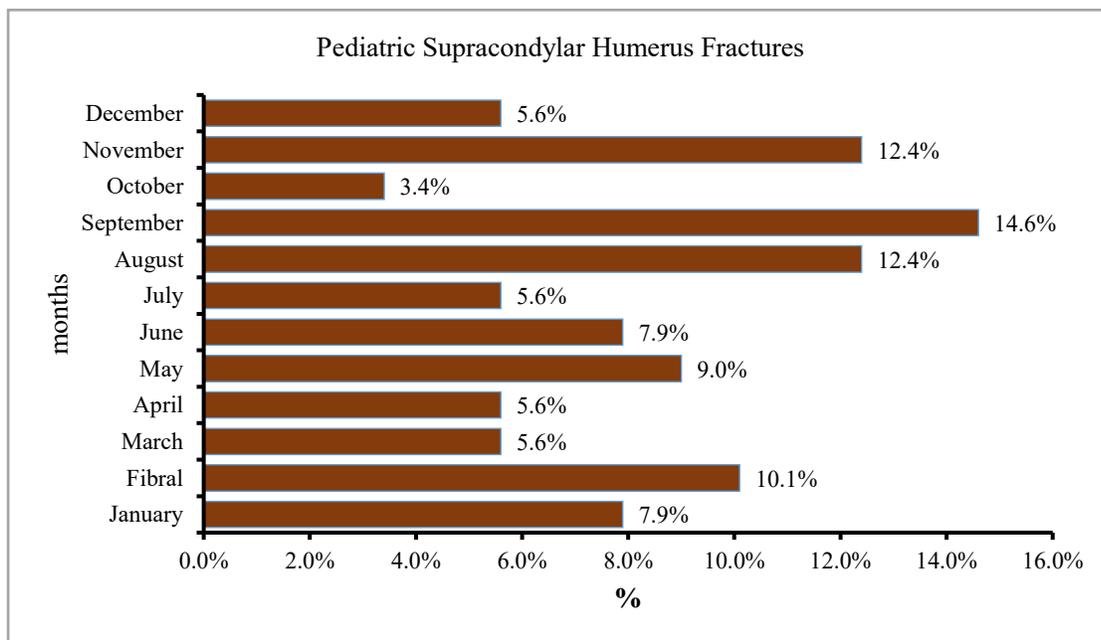


Figure 2: Percent distribution of supracondylar humerus fracture in studied children according years of study (n.89) high percent of pediatric supracondylar humerus fracture occurred mainly in years 2020,2022 (25.8%), while least percent in year 2021 may be due to movement restriction during corona virus epidemic.



| January | February | March | April | May | June | July | August | September | October | November | December |
|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|----------|
| 7 | 9 | 5 | 5 | 8 | 7 | 5 | 11 | 13 | 3 | 11 | 5 |
| 7.9% | 10.1% | 5.6% | 5.6% | 9% | 7.9% | 5.6% | 12.4% | 14.6% | 3.4% | 12.4% | 5.6% |

Figure 3: Percent distribution of supracondylar humerus fracture in studied children according months (n.89) pediatric supracondylar humerus fracture occurred mainly in September (14.6%), august (12.4%), November (12.4%), Fibril (10.1%), followed by may (9%), January (7.9%), then march, April, July, December (5.6%) in each month, least fracture was occurred in October (3.4%).

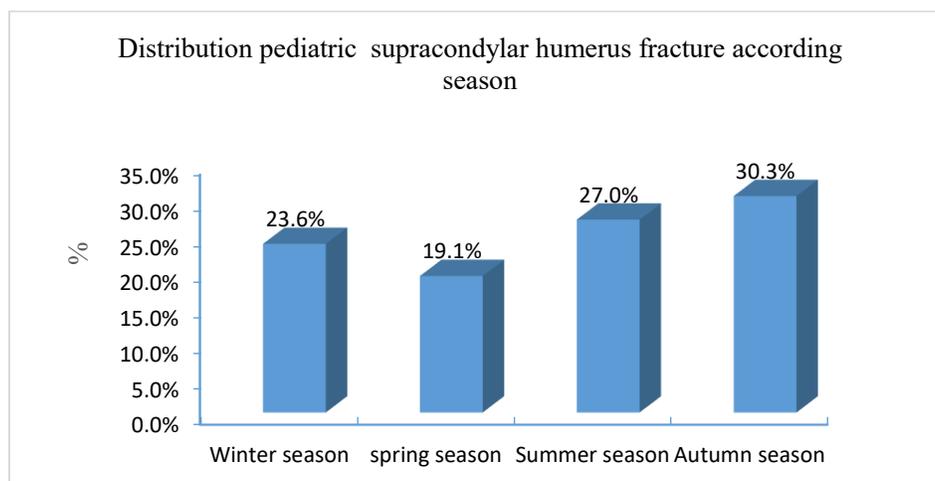


Figure 4: Percent distribution of supracondylar humerus fracture in studied children according seasons (n.89) pediatric supracondylar humerus fracture occurred mainly in autumn (30.3%), summer (27%), followed by winter (23.6%), spring (19.1%).

Table 3: Compare age of supracondylar humerus fracture according gender

| Variables | Gender | | x ² | p-value |
|------------------|---------------|-----------------|-------------------|---------|
| | Males n.50 | Females n.39 | | |
| | No. (%) | No. (%) | | |
| Site of fracture | | | | |
| Right | 22(44.0) | 16(41.0) | 0.079 | 0.778 |
| Left | 28(56.0) | 23(59.0) | | |
| Age per years | | | | |
| mean± SD | 5.5±2.8 | 4.3±2 | 2.02 ^u | 0.043* |
| median (range) | 5(1y-14y) | 4(1y+3month-9y) | | |

Chi square test (x²), Mann-Whitney Up: <0.05 significant, p: ≥0.05 no significant

Gender comparison showed that males had a significantly higher mean age at fracture (5.5 ± 2.8 years) compared to females (4.3 ± 2 years, p = 0.043). No significant differences were observed between males and females regarding fracture site (p = 0.778) (Table 3).

Discussion

In our series of 89 children with supracondylar humerus fractures, the male predominance (56.2%) was consistent with findings from several large epidemiological studies. For instance, Bashardoost et al. in Iran analyzed 1,309 pediatric cases and reported that 65% of fractures occurred in males [6]. Similarly, Anjum et al. in India reported that 59.7% of 263 patients were male [7]. In the United States, data from a large multicenter database also showed a slight male predominance (52%) [8]. These results collectively suggest that boys are at a higher risk of sustaining supracondylar fractures, most likely due to increased physical activity and higher engagement in outdoor play.

The mean age in our study was 4.97 ± 2.57 years, which is somewhat lower than most published reports. Anjum et al. found a mean age of 7.9 years in their Indian cohort [7], and Bashardoost et al. reported 7.7 ± 2.7 years in their Iranian series [6]. Likewise, Landin's classic population-based study in Sweden found the peak incidence between 5 and 7 years [9]. The relatively younger mean age in our cohort may reflect regional differences in lifestyle, earlier exposure to risk factors, or differences in referral and hospital attendance patterns.

Overall, our data align with the global epidemiologic profile of pediatric supracondylar humerus fractures characterized by male predominance and a peak in the early school years yet with a slightly younger age distribution in our setting.

In the current study, supracondylar humerus fractures were slightly more common in the left side (57.3%) compared to the right side (42.7%). This predominance of left-sided involvement is consistent with previous reports. For instance, Mangwani et al. reported that left-sided fractures were more frequent, accounting for about 60% of cases, which they attributed to the higher proportion of falls on the non-dominant hand during play activities [10]. Similarly, Houshian et al. also observed that left-

sided supracondylar fractures were more common among children [11].

Interestingly, none of the cases in our series had associated injuries, which differs from other studies where concomitant neurovascular complications have been reported in 10–20% of patients [12,13]. This difference may reflect early presentation, careful assessment, or possibly underreporting of minor complications in our setting.

Regarding the management, closed reduction and percutaneous pinning was the primary modality (96.6%), while only 3.4% required open reduction. This finding is in agreement with Wilkins and Omid et al., who highlighted that closed reduction remains the gold standard and open reduction is reserved for irreducible fractures or cases with vascular compromise [14,15].

The mean time lapse between fracture and surgery in this study was 2.2 ± 2.4 days. This short delay is comparable to findings from Leet et al., who reported a median delay of 1–2 days, emphasizing that early surgical intervention is critical to reduce complications such as compartment syndrome and malunion [16].

Overall, our findings confirm the global trends regarding the laterality, management preference, and timing of intervention in pediatric supracondylar fractures, while the absence of associated injuries in our cohort represents a distinct difference compared to previous studies.

The temporal distribution of pediatric supracondylar humerus fractures in our cohort revealed notable fluctuations across the study years. The highest incidence was observed in 2020 and 2022, whereas 2021 demonstrated the lowest percentage, which may be attributable to movement restrictions and decreased outdoor activity during the peak of the COVID-19 pandemic. Similar trends have been reported internationally; Hampton et al. observed a significant reduction in pediatric trauma admissions, particularly upper limb fractures, during lockdown periods in the United

Kingdom, highlighting the strong influence of public health measures on fracture epidemiology [17].

Monthly distribution in our study showed peaks during September (14.6%), August (12.4%), and November (12.4%), which coincides with the beginning of the school year and increased physical activity after the summer break. This finding is consistent with results from Howard et al., who demonstrated higher incidence of supracondylar fractures during late summer and early autumn months, reflecting changes in children's activity levels with return to school sports [18].

Seasonal analysis further emphasized this pattern, with autumn (30.3%) and summer (27%) recording the highest fracture rates. Comparable seasonal variations have been documented in previous studies. For instance, Farnsworth et al. reported that supracondylar fractures were more common in warmer months due to greater outdoor recreational activity [12]. Similarly, Houshian et al. found that the majority of pediatric elbow fractures occurred during summer and early autumn, supporting the hypothesis that environmental and behavioral factors significantly influence injury rates [11].

Taken together, our results align with existing literature, reinforcing that seasonal and societal factors (such as school terms, weather, and pandemic restrictions) play a pivotal role in shaping the epidemiology of supracondylar humerus fractures in children.

In our study, the mean age of males sustaining supracondylar humerus fractures was significantly higher than that of females (5.5 ± 2.8 vs. 4.3 ± 2.0 years, $p = 0.043$), suggesting that boys tend to sustain these fractures at an older age compared to girls. However, there was no significant difference between genders regarding the side of fracture, consistent with findings from previous literature.

Similar results have been reported by Houshian et al., who observed that

supracondylar fractures were slightly more common in boys and occurred at a marginally older age, although the difference was not clinically substantial [11]. In a large prospective series from India, Anjum et al. (2016) also noted a male predominance with a mean age above that of females, attributing this to greater physical activity and risk-taking behavior among boys [7]. Likewise, Mangwani et al. (2006) demonstrated that gender differences in fracture epidemiology are largely influenced by activity level and exposure to outdoor play rather than anatomical susceptibility [10].

Regarding fracture laterality, our results showed no significant gender-related difference in side involvement, which aligns with findings by Leet et al., who reported that supracondylar fractures occur almost equally in right and left extremities irrespective of sex [16].

Taken together, these findings highlight that while male children may sustain supracondylar humerus fractures at a slightly older age than females, fracture laterality does not appear to be gender-dependent. These patterns underscore the importance of considering behavioral and environmental factors, particularly outdoor activities and play habits, when interpreting the epidemiological distribution of these injuries.

Limitations

This study has several limitations. First, it is a single-center retrospective analysis, which may limit the generalizability of the findings to other regions in Libya or similar settings. Second, the sample size of 89 patients is relatively small, potentially affecting the statistical power of subgroup analyses. Third, data were extracted from medical records, which may be incomplete or subject to documentation bias, especially regarding minor associated injuries or complications. Fourth, long-term functional outcomes beyond 24 months were not assessed, limiting insights into late

complications such as malunion or growth disturbances. Finally, seasonal and environmental factors were inferred from the timing of fractures but were not directly measured, which may limit the precision of conclusions regarding environmental risk factors.

Conclusion

This retrospective study at Tobruk Medical Center (2020–2024) demonstrates that supracondylar humerus fractures are among the most common pediatric fractures in Libya, predominantly affecting children under ten years of age, with a mean age of approximately five years. Boys were more frequently affected than girls, and their mean age at presentation was slightly higher.

Most fractures involved the left elbow, and the vast majority (96.6%) were treated with closed reduction. The mean interval from injury to surgical intervention was two days, suggesting potential challenges in timely access to operative care.

Seasonal and annual variations were observed, with incidence peaks in 2020 and 2022 and clustering of cases in August, September, and November, corresponding to summer and autumn. The notable decline in 2021 likely reflects the impact of COVID-19-related restrictions on children's activities.

These results underscore the importance of preventive strategies, including parental and community awareness, child supervision, and safer environments in homes, schools, and playgrounds, particularly during high-incidence months. Furthermore, improving access to timely treatment through optimized emergency protocols and hospital preparedness is essential.

Future multicenter studies with long-term follow-up are recommended to establish a national pediatric fracture database in Libya, aiming to enhance quality of care and clinical outcomes for affected children.

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