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Pattern of Fractures Across Pediatric Age Groups: Analysis of Individual and Lifestyle Factors in an Urban Pakistani Population

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ABSTRACT

Objective: To evaluate the association between paediatric fracture patterns, developmental stages, and lifestyle determinants such as screen time, nutritional supplementation, and injury energy levels, within an urban Pakistani population.

Methodology: This prospective analytical cross-sectional study was conducted at the Children's Emergency Department of the Pakistan Institute of Medical Sciences, Islamabad, from October 2024 to April 2025. Using simple random sampling, 520 paediatric patients (N=520) aged 0–12 years with radiologically confirmed acute fractures were enrolled. Data on demographics, injury mechanism (high-energy vs. low-energy trauma), daily screen time, and Vitamin D/Calcium supplementation were collected. Statistical analysis was performed using IBM SPSS v.31.0.2.0, employing Pearson Chi-square tests ($p < 0.05$).

Results: The mean age of the study population was 7.74 ± 3.30 years, with a male predominance (68.5%). Supracondylar fractures were the most common injury (29.6%). High-energy trauma was significantly more frequent in children aged 6–12 years (60.7%) compared with those aged 0–5 years (27.6%; $p < 0.001$). Males sustained a higher proportion of high-energy injuries than females (56.7% $vs.$ 34.1%; $p < 0.001$). A large proportion of patients had high screen time (> 4 $hours/day$; 75.8%) and lacked regular nutritional supplementation (71.9%).

Conclusions: Paediatric fracture patterns in Islamabad are strongly influenced by age and gender, with a clear shift toward high-energy trauma in older children. The high prevalence of sedentary behaviour and inadequate nutritional supplementation highlights the need for targeted public health strategies to improve paediatric bone health.

Keywords: Child; Bone Fractures; Lifestyle; Sedentary Behaviour; Vitamin D

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Introduction

Paediatric fractures represent a significant global public health challenge, accounting for approximately 25% of all paediatric injuries and nearly 10% to 15% of emergency department presentations worldwide.[1–3] Childhood fractures have traditionally been regarded as accidental events related to normal play and developmental activities. However, growing international evidence suggests a shift in the epidemiological patterns of paediatric fractures.[4] Recent studies from Europe and North America indicate that modern lifestyle factors, including increased sedentary behaviour, excessive digital screen exposure, and changing nutritional practices, contribute to bone fragility and increase the risk of traumatic fractures in children.[3,5] Regionally, South Asian populations are experiencing a rapid change in childhood activity patterns due to urbanization and the sedentary lifestyle trend. In Pakistan, particularly in large urban centres such as Islamabad, electronic device use among children has increased substantially, often replacing traditional outdoor physical activity. At the same time, national health surveys have demonstrated a high prevalence of vitamin D deficiency and inadequate

calcium intake among Pakistani children, further compromising musculoskeletal health.[6,7]

Despite managing a large volume of paediatric trauma cases at tertiary care hospitals, there remains limited local evidence linking specific lifestyle factors with fracture patterns in Pakistani children. Most existing national studies primarily emphasize surgical management and clinical outcomes, with relatively little focus on preventive lifestyle determinants.[8,9] Understanding how age-specific behaviours, including screen time intensity and physical activity habits, influence fracture distribution is essential for developing effective public health strategies and structured parental counselling initiatives.

The objective of this study is to analyse paediatric fracture patterns across different age groups and to evaluate their association with lifestyle factors, including sedentary behaviour and nutritional practices. By conducting this study at the Children's Emergency Department of the Pakistan Institute of Medical Sciences in Islamabad, we aim to establish a locally relevant baseline to support paediatric trauma prevention efforts within the Pakistani socio-cultural context.

Methodology

Ethical approval for this prospective analytical cross-sectional study was obtained from the Institutional Review Board of the Pakistan Institute of Medical Sciences (PIMS), Islamabad. The study was conducted at the Children's Emergency Department of PIMS over a period of seven months, from October 1, 2024 to April 30, 2025.

A total sample size of 520 patients was calculated using the standard formula for prevalence of paediatric fracture patterns (Equation 1), assuming a 95% confidence level, a margin of error of 5%, and an anticipated prevalence of 75% based on literature reported by Mansoor et al.10 The calculated minimum sample size was 288, which was increased to 520. Probability sampling was employed, and participants were selected using simple random sampling from the emergency department trauma register to minimize selection bias.

Where, n is the required sample size, Z is the standard normal deviate corresponding to a 95% confidence level, P is the anticipated prevalence, and d is the margin of error.

Children of both genders aged zero to twelve years presenting with radiologically confirmed acute fractures were included in the study. Exclusion criteria comprised patients with known metabolic bone disorders such as osteogenesis imperfecta, pathological fractures secondary to malignancy or bone cysts, and children older than twelve years. Patients presenting with old or healing fractures, defined as injuries sustained more than fourteen days prior to presentation, were also excluded. Additional exclusions included incomplete medical records and cases in which legal guardians declined to provide informed consent.

Data were collected using a structured proforma designed to document demographic characteristics, fracture site, mechanism of injury, screen-time habits, and nutritional supplementation status. Mechanism of injury was categorized into low-energy trauma and high-energy trauma. Low-energy trauma included simple falls during routine play, falls from furniture, or slipping at ground level. High-energy trauma comprised road traffic accidents, falls from height, and similar mechanisms associated with greater kinetic impact. High screen time was operationally defined as the use of electronic devices such as mobile phones, televisions, or laptops for more than four hours per day.

The study population consisted of 520 children, including 356 males and 164 females. Among male participants, 120 were younger than five years and 236 were between five and twelve years of age. Among female participants, 54 were younger than five years, and 110 were between five and twelve years of age. The mean age of the participants was 7.74 ± 3.30 years.

Statistical analysis was performed using IBM SPSS Statistics version 31.0. Descriptive statistics were applied to summarize demographic variables and fracture frequencies. Pearson Chi-square test was used to assess associations between categorical variables, including fracture site, injury energy level, screen-time category, age group, and gender. A p-value less than 0.05 was considered statistically significant.

Results

A total of 520 paediatric patients with acute fractures were included in the analysis. The demographic characteristics of the study population are summarized in Table I. The cohort showed a marked male predominance, with males accounting for 68.5% of cases. The clinical characteristics of the study population are summarized in Table 1. Children aged six to twelve years constituted the majority of the study population. Supracondylar fractures were the most frequently observed fracture type overall.

A significant association was identified between fracture site and age group (Table II). Overall supracondylar fractures were most commonly observed fractures followed by distal radius. While femoral shaft fractures predominated in children aged six to twelve years when compared with zero to five age

group. This difference in fracture distribution across age groups was statistically significant ($p < 0.001$). Fracture site distribution also varied significantly by gender, with males sustaining a higher proportion of femoral shaft fractures compared to females ($p = 0.005$).

Table I: Demographic and Clinical Profile of the Study Population. (N=520)

Variable	Category	(n)	(%)
Gender	Male	356	68.5
	Female	164	31.5
Age Group	*0+5 years*	174	33.5
	6–12 Years	346	66.5
Fracture Site	Supracondylar (Humerus)	154	29.6
	Distal Radius	134	25.8
	Femur	25	4.8
	Other Sites	207	39.8

Table II: Association of Fracture Site with Age Group and Gender.

Fracture Site	0–5 Yrs	6–12 Yrs	Male	Female
Supracondylar	85	69	105	49
Distal Radius	70	64	92	42
Femur	4	21	17	8
Other Sites	15	192	142	65
p-value	**<0.001***		**0.005***	

The relationship between the mechanism of injury and demographic variables is presented in Table III. Low-energy trauma was more common among younger children, whereas high-energy trauma predominated in older children. This age-related variation in injury energy was statistically significant ($p < 0.001$). Similarly, males were significantly more likely to sustain high-energy injuries compared to females ($p < 0.001$).

Table III: Injury Energy Level Stratified by Age and Gender.

	Gender		Age Group	
	Male	Female	0–5 Years	6–12 Years
Low-Energy (%)	154 (43.3%)	108 (65.9%)	126 (72.4%)	136 (39.3%)
High-Energy (%)	202 (56.7%)	56 (34.1%)	48 (27.6%)	210 (60.7%)
p-value	< 0.001*		< 0.001*	

Table IV: Prevalence of Lifestyle Risk Factors (N=520)

	Screen Time		Supplements	
	Low screen time	High screen time	No Supplements	Supplements
N	126	394	374	146
%	24.2	75.8	71.9	28.1

The prevalence of selected lifestyle factors is presented in Table IV. A substantial proportion of children were exposed to high daily screen time, and the majority were not receiving regular calcium or vitamin D supplementation. These lifestyle factors demonstrated notable variation in relation to fracture characteristics.

Discussion

The findings of this study provide important insights into the evolving patterns of paediatric trauma in an urban Pakistani setting. The primary objective was to evaluate whether developmental stage and modern lifestyle behaviours are associated with specific fracture patterns. The results demonstrate a clear age-related transition toward high-energy trauma in older children, supporting the study hypothesis. A substantially higher proportion of high-energy injuries was observed among children aged six to twelve years compared with younger children, which is consistent with increased outdoor exposure and involvement in higher-risk activities with advancing age. Our initial hypothesis that older children (6–12 years) sustain significantly more high-energy fractures due to a combination of high screen time, sedentary habits, and trauma exposure was found to be true. Statistical analysis confirmed that 60.7% of fractures in the 6–12-year age group resulted from high-energy trauma, compared to only 27.6% in younger children ($p < 0.001$).

When comparing our results with local literature, notable differences emerge. In the study by Mansoor et al. conducted in Karachi, fractures of the radius and ulna were the most common (16.9%), followed by the distal radius (14.6%).[10] In contrast, our cohort demonstrated a much higher prevalence of supracondylar fractures of humerus, which accounted for 29.6% of all cases. Furthermore, our data showed that 56.7% of males sustained high-energy injuries, significantly higher than females (34.1%), aligning with local studies observing a clear male predominance in paediatric trauma exposure.[10]

The high prevalence of sedentary behaviour observed in this study represents a significant public health concern. We found that 75.8% of children reported high screen time. A majority of children were exposed to prolonged daily screen use, a pattern that has been increasingly documented in both local and international paediatric populations. Reduced physical activity and limited sunlight exposure associated with excessive screen time may

negatively influence musculoskeletal health and bone strength.[5] When children with sedentary habits are exposed to sudden high-impact activities or accidental

falls, the risk of sustaining severe fractures may increase. This vulnerability is further compounded by the nutritional gap identified in the present cohort, as a large proportion of children were not receiving regular vitamin D or calcium supplementation. These findings are consistent with national data indicating a high prevalence of vitamin D deficiency among urban Pakistani children.[7,11]

An important contribution of this study is the categorization of paediatric trauma according to injury energy in relation to modern sedentary digital habits. While international literature has long discussed neurological consequences associated with excessive video use, such as video game–related epilepsy, the present findings suggest a more direct musculoskeletal impact. Prolonged sedentary behaviour related to excessive video and screen exposure may render children physiologically vulnerable, increasing susceptibility to high-energy trauma when exposed to falls or high-impact activities. This effect appears particularly pronounced in older children, as demonstrated by the higher number of femoral shaft fractures in the six to twelve-year age group when compared with younger ones. This indicates the clinical severity and socioeconomic burden of high-energy paediatric trauma in the modern urban context, often necessitating prolonged hospitalization and extended rehabilitation.

The strengths of this study include its prospective design and a large, robust sample size (N=520) recruited from a premier national tertiary care centre. Furthermore, the use of standardized energy-level trauma categories provides a clear framework for future local injury prevention research. However, certain limitations must be acknowledged. This was a single-centre study, and the results may not be generalizable to rural Pakistani populations where lifestyle and trauma mechanisms differ significantly. Additionally, data regarding screen time and nutritional adherence were based on parental recall, which may introduce recall bias. Finally, as an analytical cross-sectional study, we can demonstrate significant associations but cannot definitively establish a causal relationship between screen time and bone fragility without direct bone mineral density (BMD) measurements.

Conclusion

This study concludes that there is a significant age-related shift in the mechanism and pattern of paediatric fractures within the urban Pakistani population. Older children (6–12 years) are significantly more prone to high-energy trauma, whereas younger children (0–5 years) primarily sustain low-energy injuries. These trauma patterns are strongly associated with a high prevalence of sedentary lifestyle factors, including excessive daily screen time and a widespread lack of routine Vitamin D and Calcium supplementation. These findings underscore the need for targeted safety and nutritional interventions to mitigate the risk of high-energy paediatric injuries.

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