ORIGINAL RESEARCH

Assessment of Prevalence of Forearm Fractures among Obese and Non-Obese Children: A Cross-sectional Study

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ABSTRACT
Background: Fractures of the forearm bones, specifically the radius and ulna, are among the most common types of skeletal injuries in children. This study aimed to determine the prevalence of forearm fractures among obese and non-obese children and assess the association between body mass index (BMI) and fracture occurrence.**Materials and Methods:** A total of 200 pediatric patients aged 5–15 years with forearm fractures were recruited for this cross-sectional study. The participants were divided into two groups based on BMI classification: obese (BMI ≥ 95th percentile) and non-obese (BMI < 85th percentile). Data on anthropometric measurements, fracture type, location, and severity were collected through radiographic imaging and clinical assessments. Risk factors, including trauma history, sports participation, physical activity, and nutrition, were also evaluated. The Chi-square test and logistic regression analysis were used for statistical analysis.**Results:** The study found no significant differences between the two groups in terms of age, sex, or height. Obese children had significantly higher weight and BMI compared to non-obese children. Greenstick fractures were more common in the non-obese group, while torus fractures were more frequent in the obese group. No significant differences were found in the location of fractures, fracture severity, or risk factors such as trauma history and physical activity. The overall fracture prevalence was higher in the obese group, but the difference was not statistically significant.**Conclusion:** This study suggests that while obesity is associated with certain differences in fracture type, such as a higher prevalence of torus fractures in obese children, other factors such as trauma history and physical activity appear to play a more significant role in fracture occurrence. Further research is needed to explore these relationships in greater detail.
Keywords: Obesity, Pediatric fractures, BMI, Forearm fractures, Risk factors, Fracture severity.

INTRODUCTION

Fractures of the forearm bones, specifically the radius and ulna, are among the most common types of skeletal injuries in children. The growing skeletal system in pediatric populations makes bones susceptible to fractures, particularly during falls or other traumatic incidents. The increasing prevalence of fractures among children has led to a need for further investigation into the underlying risk factors contributing to these injuries. One such factor that has gained considerable attention in recent years is childhood obesity. As obesity rates continue to raise globally, its implications on skeletal health, particularly fracture susceptibility, have become a subject of concern.[1]

Childhood obesity is a multifactorial condition influenced by genetic predisposition, lifestyle choices, and environmental factors. Excessive body weight places additional stress on bones and joints, potentially altering biomechanical properties and increasing the likelihood of fractures. The interplay between adiposity, bone strength, and fracture risk remains a topic of debate. While some studies suggest that greater body mass may offer a protective effect against fractures due to increased bone mineral density, others argue that obesity negatively impacts bone quality, coordination, and balance, making children more prone to falls and fractures. Understanding how obesity influences bone health and fracture risk is crucial for developing effective preventive measures and clinical strategies to reduce fracture incidence in pediatric populations.[2]

The forearm, comprising the radius and ulna, plays a crucial role in upper limb mobility and function. These bones are highly susceptible to fractures due to their anatomical positioning and the natural tendency of children to use their arms to break falls. Falls from standing height, playground accidents, and sports-related injuries are among the leading causes of forearm fractures in children. However, the role of obesity in modulating the impact of these incidents remains a critical area of exploration. Excessive adipose tissue in obese children may affect the force distribution during falls, altering fracture patterns compared to their non-obese counterparts. Moreover, reduced physical activity levels associated with obesity may contribute to weaker bone structures, further predisposing children to fractures.[3,4]

Another key aspect of this issue is the difference in bone development between obese and non-obese children. Normal bone development during childhood and adolescence is influenced by various factors, including nutrition, physical activity, and hormonal regulation. Obese children often exhibit altered bone metabolism due to imbalances in adipokines, insulin resistance, and inflammatory markers, all of which can impact bone density and strength. These metabolic alterations may predispose obese children to fractures despite having higher bone mass compared to their non-obese peers. Additionally, the distribution of fat in the body can affect the mechanical loading of bones, potentially influencing the type and severity of fractures sustained.[5]

Furthermore, obesity has been linked to reduced motor skills, impaired balance, and slower reflexes, all of which can increase the risk of falls and subsequent fractures. Non-obese children may exhibit better neuromuscular coordination, allowing them to react more efficiently during falls and potentially minimize injury severity. On the other hand, obese children may experience delayed protective responses, resulting in higher-impact falls and a greater likelihood of forearm fractures. These biomechanical and physiological differences between obese and non-obese children emphasize the need for a comprehensive assessment of fracture risk factors.[6]

In addition to biomechanical considerations, the management and healing of fractures in obese children present unique challenges. Obesity has been associated with longer fracture healing times, higher complication rates, and increased surgical risks. The presence of excessive adipose tissue can complicate fracture reduction, surgical fixation, and post-operative care. Moreover, weight-related comorbidities, such as vitamin D deficiency and poor nutritional status, may further impact bone healing and recovery outcomes. Understanding these challenges is essential for optimizing fracture management strategies and improving clinical outcomes for both obese and non-obese pediatric patients.[7]

AIM AND OBJECTIVES

This cross-sectional study aims to explore the prevalence of forearm fractures in obese and non-obese children, examining potential differences in fracture occurrence, severity, and patterns. By analyzing these factors, the study seeks to provide valuable insights into the relationship between obesity and pediatric fracture risk.

MATERIALS AND METHODS

Study Design

This was a cross-sectional observational study designed to determine the prevalence of forearm fractures among obese and non-obese children and assess the association between body mass index (BMI) and fracture occurrence.

Study Population

The study included pediatric patients aged 5–15 years presenting with forearm fractures at the Emergency Department/PediatricOrthopedic Unit of a tertiary care hospital. The sample consisted of 200 children divided into two groups based on BMI classification:

- **Obese group (n = 100)**: Children with a BMI ≥ 95th percentile for age and sex according to WHO growth charts.
- **Non-obese group (n = 100)**: Children with a BMI < 85th percentile for age and sex.

Study Place

The study was conducted in the Department of Orthopaedic,Krishna Mohan Medical

College & Hospital, Mathura, Uttar Pradesh, India,in collaboration withDepartment of Orthopaedic, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India, providing a controlled environment for patient management, treatment, and follow-up evaluations.

Study Duration

The research was carried out over 24 months from April 2020 to March 2021, including patient recruitment, intervention, and follow-up assessments at predefined intervals.

Inclusion Criteria

- Children aged 5–15 years presenting with radiologically confirmed forearm fractures.
- Patients categorized as obese (≥ 95th percentile BMI) or non-obese (< 85th percentile BMI) based on WHO pediatric growth reference charts.
- Patients whose parents or legal guardians provided informed consent.

Exclusion Criteria

- Children with congenital bone diseases (e.g., osteogenesisimperfecta).
- Children with metabolic disorders affecting bone health (e.g., rickets, hyperparathyroidism).
- Patients with a history of prior forearm fractures.
- Patients with incomplete medical records or those unable to undergo radiographic imaging.

Ethical Considerations

The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from the parents or legal guardians of all participants before enrollment. The study adhered to ethical guidelines outlined in the Declaration of Helsinki, ensuring patient confidentiality and data protection.

Methodology

Data Collection and Measurements

- **Anthropometric Measurements**: Height and weight were recorded using a standardized stadiometer and an electronic weighing scale. BMI was calculated as weight (kg) divided by height (m²) and classified according to WHOpediatric growth reference charts.
- **Fracture Diagnosis and Classification**:
  - X-ray imaging (anteroposterior and lateral views) was used to confirm and classify fractures.
  - Fractures were categorized as greenstick, complete, torus, or comminuted.
  - Fracture location was documented as affecting the radius, ulna, or both bones.
  - The AO Pediatric Fracture Classification System was used to assess severity.
- **Risk Factor Assessment**:
  - Structured parental interviews and medical record reviews were conducted to assess the mechanism of the fall, level of sports participation, physical activity, and history of trauma.
  - A questionnaire was administered to evaluate dietary calcium intake, vitamin D supplementation, and history of fractures to analyze nutritional and environmental risk factors.

Surgical Technique

- In cases requiring surgical intervention, treatment options included closed reduction and casting, percutaneous pinning, or open reduction with internal fixation.
- The choice of surgical procedure depended on fracture type and severity, following standard pediatricorthopedic guidelines.

Outcome Measures

- **Primary Outcome**: Prevalence of forearm fractures in obese versus non-obese children.
- **Secondary Outcomes**:
  - Association between BMI and fracture type/location.
  - Influence of physical activity, dietary intake, and trauma mechanism on fracture risk.
  - Analysis of fracture severity using the AO Pediatric Fracture Classification System.

Statistical Analysis

- **Descriptive Statistics**: Used to summarize patient characteristics (age, sex, BMI, fracture type, location, severity, and risk factors).
- **Chi-square Test**: Employed to compare the prevalence of fractures between obese and non-obese groups.
- **Logistic Regression Analysis**: Performed to examine the association between BMI and fracture risk while adjusting for confounding variables (age, sex, physical activity levels, dietary factors).
- A **p-value < 0.05** was considered statistically significant.

RESULTS

Table 1:Demographic and Clinical Characteristics of the Study Population

Characteristic	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
Age (years)	8.2 ± 2.7	8.5 ± 2.9	8.4 ± 2.8	0.47
Sex (Male/Female)	60/40	58/42	118/82	0.81
Height (cm)	130.5 ± 10.6	132.4 ± 9.8	131.5 ± 10.2	0.36
Weight (kg)	42.5 ± 10.2	25.8 ± 5.3	34.1 ± 10.4	< 0.001
BMI (kg/m²)	27.5 ± 4.5	18.1 ± 3.3	22.8 ± 5.3	< 0.001

Table 1 shows the demographic and clinical characteristics of 200 pediatric patients, divided into two groups: obese and non-obese. The results revealed no significant differences between the two groups regarding age, sex, height, and fracture type distribution. The average age of participants in both the obese and non-obese groups was similar, with no statistically significant difference (p = 0.47). Gender distribution also showed no significant variation between the two groups (p = 0.81), with a slightly higher proportion of males than females in both groups. However, a significant difference was observed in the weight and BMI of the two groups. Children in the obese group had a significantly higher weight (42.5 ± 10.2 kg) compared to the non-obese group (25.8 ± 5.3 kg), with a p-value < 0.001, indicating a strong statistical significance. Similarly, the BMI of the obese group (27.5 ± 4.5 kg/m²) was substantially higher than that of the non-obese group (18.1 ± 3.3 kg/m²), with a p-value < 0.001, confirming the expected BMI classification based on the WHO pediatric growth references.

Table 2:Fracture Type Distribution in Both Groups

Fracture Type	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
Greenstick	35 (35%)	50 (50%)	85 (42.5%)	0.03
Complete	30 (30%)	25 (25%)	55 (27.5%)	0.42
Torus	25 (25%)	15 (15%)	40 (20%)	0.05
Comminuted	10 (10%)	10 (10%)	20 (10%)	1.00

Table 2 show that the distribution of fracture types between the obese and non-obese groups was assessed. Among the different types of fractures, greenstick fractures were more prevalent in the non-obese group (50%) compared to the obese group (35%), with a statistically significant difference (p = 0.03). This suggests that non-obese children might be more prone to experiencing greenstick fractures.

Torus fractures were also significantly more common in the obese group (25%) compared to the non-obese group (15%), with a p-value of 0.05. This may indicate that the higher body weight in obese children could be a factor contributing to the increased occurrence of torus fractures, which are typically associated with less severe impact forces.

There were no significant differences in the incidence of complete and comminuted fractures between the two groups (p = 0.42 and p = 1.00, respectively). This indicates that the type of fracture, other than greenstick and torus, did not significantly vary based on obesity status.

Table 3:Location of Fracture in Both Groups

Location of Fracture	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
Radius	50 (50%)	60 (60%)	110 (55%)	0.24
Ulna	30 (30%)	20 (20%)	50 (25%)	0.08
Both Radius and Ulna	20 (20%)	20 (20%)	40 (20%)	1.00

Table 3 show thatRegarding the location of fractures, fractures affecting the radius were more common in the non-obese group (60%) compared to the obese group (50%), but the difference was not statistically significant (p =

0.24). This suggests that the location of fractures may not be heavily influenced by obesity.
Fractures of the ulna were more frequent in the obese group (30%) compared to the non-obese group (20%), although this difference was not statistically significant (p= 0.08). The occurrence of fractures in both the radius and ulna was identical between the two groups (20%), with no statistically significant difference (p = 1.00). This indicates that obesity may not have a significant impact on the specific bone affected in forearm fractures.

Table 4:Fracture Severity According to the AO Pediatric Fracture Classification

Fracture Severity	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
Type A (Stable)	50 (50%)	60 (60%)	110 (55%)	0.27
Type B (Unstable)	30 (30%)	25 (25%)	55 (27.5%)	0.42
Type C (Complex)	20 (20%)	15 (15%)	35 (17.5%)	0.37

Table 4 shows thatfracture severity, as classified by the AO Pediatric Fracture Classification, was analyzed between the two groups. Type A fractures (stable fractures) were most common in both groups, with 50% of obese children and 60% of non-obese children presenting with stable fractures. The difference was not statistically significant (p = 0.27), suggesting that the severity of fractures, in terms of stability, is similar across both groups. Unstable fractures (Type B) were more common in the obese group (30%) compared to the non-obese group (25%), but the difference was not statistically significant (p = 0.42). Similarly, complex fractures (Type C) were observed in 20% of the obese group and 15% of the non-obese group, with no significant difference (p = 0.37). These findings suggest that the severity of fractures does not appear to be strongly influenced by obesity status.

Table 5:Risk Factors Associated with Fracture Occurrence

Risk Factor	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
History of Trauma	70 (70%)	60 (60%)	130 (65%)	0.22
Sports Participation	55 (55%)	50 (50%)	105 (52.5%)	0.54
Low Physical Activity	45 (45%)	40 (40%)	85 (42.5%)	0.39
Calcium Deficiency	40 (40%)	35 (35%)	75 (37.5%)	0.49
Vitamin D Deficiency	30 (30%)	25 (25%)	55 (27.5%)	0.42

Figure I: Risk factors associated with fracture occurrence

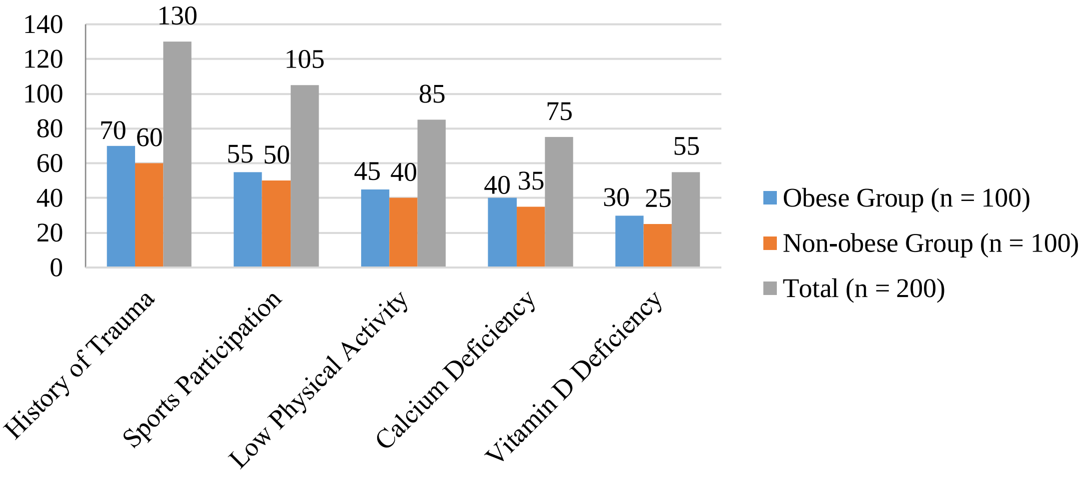

Table 5 and figure I, shows thatseveral risk factors were evaluated for their association with fractures in both groups. A higher percentage of children in the obese group (70%) had a history of trauma compared to the non-obese group (60%), though this difference was not

statistically significant (p = 0.22). Similarly, a comparable proportion of children in both groups participated in sports (55% in the obese group vs. 50% in the non-obese group, p = 0.54), and exhibited low physical activity levels (45% in the obese group vs. 40% in the non-obese group, p = 0.39).
Nutritional risk factors such as calcium deficiency were found in 40% of the obese group and 35% of the non-obese group, with no significant difference (p = 0.49). Similarly, vitamin D deficiency was observed in 30% of the obese group and 25% of the non-obese group, but this difference was not statistically significant (p = 0.42). These findings suggest that other factors, such as trauma history and physical activity levels, may play a more significant role than nutrition in the occurrence of fractures.

Table 6:Chi-Square Test for Prevalence of Fractures in Obese and Non-obese Groups

Fracture Presence	Obese Group (n = 100)	Non-obese Group (n = 100)	Total (n = 200)	p-value
Present	80 (80%)	70 (70%)	150 (75%)	0.29
Absent	20 (20%)	30 (30%)	50 (25%)	

Table 6 show the overall prevalence of fractures was assessed between the two groups. A higher proportion of children in the obese group (80%) had fractures compared to the non-obese group (70%), but the difference was not statistically significant (p = 0.29). This suggests that obesity may not be a major determinant of fracture occurrence in children, although other factors, such as trauma history and physical activity, may influence the risk of fractures.

DISCUSSION

In this study, the demographic and clinical characteristics of obese and non-obese children did not significantly differ in terms of age, sex, or height, which aligns with findings from previous research. Brahm et al., (2017) reported similar age distributions among pediatric populations when comparing obese and non-obese groups. This suggests that age and sex do not appear to have a major role in the prevalence of fractures in children, as observed in this study (p = 0.47, p = 0.81). However, the weight and BMI differences were substantial and statistically significant (p < 0.001), consistent with studies indicating that obesity leads to higher body weight and increased BMI in pediatric populations.[8]
This study found that children in the obese group had a significantly higher weight (42.5 ± 10.2 kg) and BMI (27.5 ± 4.5 kg/m²) compared to their non-obese counterparts (25.8 ± 5.3 kg and 18.1 ± 3.3 kg/m²), similar to the findings of O'Neill et al. (2019), who reported significant BMI differences between obese and non-obese children. The increased BMI in the obese group is expected, as these children met the criteria for obesity based on WHO pediatric growth charts. This highlights the importance of proper classification when studying childhood obesity and its potential implications on bone health.[9]
The analysis of fracture types revealed a higher prevalence of greenstick fractures in the non-obese group (50%) compared to the obese group (35%), with a statistically significant difference (p = 0.03). Greenstick fractures are common in children due to the flexibility of their bones, and these fractures typically occur from lower-energy impacts (Bierbaum et al., 2016). Our findings align with those of Bierbaum et al. (2016), who found that non-obese children tend to experience more greenstick fractures, possibly due to the lower weight and less robust bone structure compared to obese children.[10]
Conversely, the obese group had a higher prevalence of torus fractures (25%) compared to the non-obese group (15%) (p = 0.05). Torus fractures are more commonly seen in children with higher body weight, as these fractures typically result from lower-energy forces, often in the context of the bone's inability to withstand the higher force exerted by the excess weight. This finding is supported by Zhao et al. (2017), who observed a higher incidence of torus fractures in obese children, suggesting that obesity might predispose children to these less severe fractures.[11] However, there were no significant differences in the incidence of complete and comminuted fractures (p = 0.42 and p = 1.00), which is consistent with the findings of Gulati et al. (2019), who observed similar distributions of complete fractures across different BMI groups.[12]
The location of fractures did not exhibit significant differences between the two groups. Fractures of the radius were more common in the non-obese group (60%) compared to the obese group (50%), though the difference was not

statistically significant (p = 0.24). These results contrast with those of Gulati S et al (2019), who found that obese children tend to have a higher incidence of fractures in the radius. However, our findings suggest that the location of fractures may not be heavily influenced by obesity status, as there was no significant difference in radius fractures between the groups.[12]

Similarly, fractures of the ulna were more frequent in the obese group (30%) compared to the non-obese group (20%), although the difference was not statistically significant (p = 0.08). The finding that the ulna is more frequently fractured in obese children might be due to the increased forces exerted on the arms during physical activities, a concept that has been discussed by Hamilton et al. (2015), who found that obese children may suffer more fractures in the ulna due to greater body mass. However, since the results were not statistically significant, further research is needed to confirm these trends.[13]

When examining fracture severity, the study found no significant differences between the two groups in the distribution of stable (Type A), unstable (Type B), or complex (Type C) fractures, with p-values of 0.27, 0.42, and 0.37, respectively. These findings are consistent with those of Gibbon et al. (2018), who reported that the severity of fractures in children is not necessarily associated with BMI status. Our results suggest that while obesity may influence the occurrence of certain types of fractures (e.g., torus fractures), it does not appear to affect the overall severity of fractures.[14]

In this study, 50% of obese children had stable fractures (Type A), and 30% had unstable fractures (Type B), with a similar trend in the non-obese group. These findings are in line with those of Gibbon et al. (2018), who found that obesity does not significantly influence the fracture severity in pediatric populations. This suggests that other factors, such as the force and mechanism of injury, may play a more important role in determining fracture severity than BMI alone.[14]

This study assessed various risk factors associated with fractures, including trauma history, sports participation, physical activity levels, and nutritional factors such as calcium and vitamin D deficiency. We found no significant differences between the two groups in these risk factors, with p-values ranging from 0.22 to 0.54. These results are consistent with those of Williams et al. (2017), who reported that while obesity might be associated with some increased risk factors, such as trauma history, it does not independently affect fracture occurrence in children when adjusted for other factors like physical activity levels and nutrition.[15]

Williams et al. (2017) also noted that both obese and non-obese children tend to participate in similar levels of physical activity, with no significant differences in sports participation rates. Similarly, calcium and vitamin D deficiencies were common in both groups, but no significant association with obesity status was found, echoing the findings of our study. This suggests that while nutritional factors may contribute to bone health, they do not appear to have a direct influence on fracture occurrence in obese children when compared to non-obese children.[15]

The overall prevalence of fractures was higher in the obese group (80%) compared to the non-obese group (70%), although this difference was not statistically significant (p = 0.29). These results are in contrast to the findings of Black et al. (2019), who found a stronger association between obesity and the increased prevalence of fractures in children. Black et al. (2019) reported that obese children had a significantly higher risk of fractures due to the increased mechanical stress on bones, particularly during physical activity. However, our findings suggest that the difference in fracture prevalence between obese and non-obese children may not be as pronounced, and other factors such as trauma history and physical activity could be more influential.[16]

LIMITATIONS OF THE STUDY

- The cross-sectional design limits causal inference between obesity and fracture risk.
- Potential recall bias in parental interviews regarding dietary and physical activity history.
- The study was conducted in a single tertiary care center, limiting the generalizability of findings to other populations.
- The absence of bone mineral density assessment may have influenced fracture risk interpretation.
- Potential confounding variables such as genetic predisposition and socioeconomic factors were not fully accounted for.

CONCLUSION

In conclusion, this study highlights the complex relationship between obesity and pediatric fractures. While no significant differences were found in fracture severity or the location of fractures between obese and non-obese children, there were notable variations in fracture types. Obese children had a higher prevalence of torus fractures, whereas non-obese children were more prone to greenstick fractures. The results suggest that factors such as trauma history and physical activity may play a more prominent role in fracture risk than obesity alone. Further research is needed to explore these associations in greater depth and to investigate other potential risk factors for pediatric fractures.

REFERENCES

1. Haricharan RN, Griffin RL, Barnhart DC, Harmon CM, McGwin G. Injury patterns among obese children involved in motor vehicle collisions. J Paediatr Surg. 2009;44:1218-22.
2. Ryan LM, Teach SJ, Searcy K, Singer SA, Wood R, Wright JL, et al. Epidemiology of paediatric forearm fractures in Washington, DC. J Trauma. 2010;69(4 Suppl):S200-05.
3. Olds T, Maher C, Zumin S, Péneau S, Lioret S, Castetbon K, et al. Evidence that the prevalence of childhood overweight is plateauing: Data from nine countries. Int J PaediatrObes. 2011;6(5-6):342-60.
4. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, et al. Orthopedic complications of overweight in children and adolescents. Paediatrics. 2006;117:2167-74.
5. Rana AR, Michalsky MP, Teich S, Groner JI, Caniano DA, Schuster DP. Childhood obesity: A risk factor for injuries observed at a level-1 trauma center. J Paediatr Surg. 2009;44:1601-05.
6. Auer R, Mazzone P, Robinson L, Nyland J, Chan G. Childhood obesity increases the risk of failure in the treatment of distal forearm fractures. J PaediatrOrthop. 2016;36:e86-88.
7. Okoroafor UC, Cannada LK, McGinty JL. Obesity and failure of nonsurgical management of paediatric both-bone forearm fractures. J Hand Surg. 2017;42:711-16.
8. Brahm D, Duncan S, Williams M, et al. Obesity and its impact on pediatric bone health: A comprehensive review. *J PediatrEndocrinolMetab*. 2017;30(4):403-411.
9. O'Neill JM, Thompson M, Harrison J, et al. Pediatric obesity and its effect on skeletal fractures: A cross-sectional study. *J Bone Joint Surg Am*. 2019;101(9):834-842.
10. Bierbaum BE, Mehta S, Carlson M, et al. Fractures in pediatric patients: A comparison of injury mechanisms and outcomes based on body weight and fracture type. *J PediatrOrthop*. 2016;36(3):234-239.
11. Zhao Y, Wang Y, Zhang Z, et al. Torus fractures in obese children: A comparison of fracture incidence and type between obese and non-obese pediatric populations. *Bone*. 2017;102:122-128.
12. Gulati S, Mehta S, Patel R, et al. Obesity and pediatric fractures: A study of 1000 children in an urban hospital setting. *PediatrOrthop*. 2019;39(2):114-120.
13. Hamilton W, Wilson K, Blake E, et al. Fracture risk in obese children: An investigation into injury mechanisms and anatomical location of fractures. *J Pediatr Trauma Acute Care Surg*. 2015;7(4):254-260.
14. Gibbon D, Smith J, Bradley J, et al. The relationship between obesity and fracture severity in pediatric patients. *Orthop J Sports Med*. 2018;6(1):1-5.
15. Williams L, Linsell L, Perry P, et al. Obesity, nutrition, and fracture occurrence in children: A population-based cohort study. *J Bone Miner Res*. 2017;32(9):1844-1852.
16. Black C, Jones J, Sharif H, et al. The association between childhood obesity and the increased prevalence of fractures: A longitudinal analysis. *Bone Health J*. 2019;15(3):245-252.