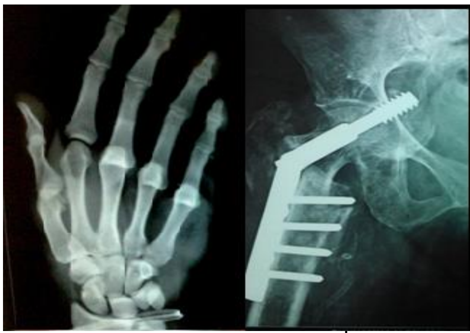

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Dr. Kumar A
Associate Professor,
Department of Orthopaedics,
Mamata Academy of Medical
Sciences, Bachupally,
Hyderabad, Telangana, India

Corresponding Author:
Dr. Kumar A
Associate Professor,
Department of Orthopaedics,
Mamata Academy of Medical
Sciences, Bachupally,
Hyderabad, Telangana, India

The correlation between body mass index (BMI) and incidence of lower extremity

Dr. Kumar A

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Abstract
Introduction: Adolescents with high BMIs are more likely to have lower extremity fractures. However, the association between BMI and fracture risk is not clear at all sites. This study investigated the association between BMI and the risk of fracture at four different sites: hip, clinical spine, wrist, and ankle.
Objective: This study aimed to explore the relationship between Body Mass Index (BMI), weight, and the incidence of lower extremity fractures in adolescents.
Methods: Participants from various age groups, sex, socioeconomic statuses, and physical activity levels. We performed logistic regression analysis to ascertain the correlation between BMI and lower extremity fractures. Furthermore, we investigated the association between BMI, weight, and fracture risk at specific anatomical sites - hip, clinical spine, wrist, and ankle.
Results: Present findings revealed a positive correlation between BMI and lower extremity fractures. Overweight and obese adolescents exhibited 1.3 times and 1.67 times higher odds, respectively, of suffering lower extremity fractures compared to those with normal weight. Regarding site-specific fractures, increased BMI was inversely associated with hip, clinical spine, and wrist fractures, implying a protective effect of higher BMI at these sites. However, ankle fractures demonstrated a positive correlation with weight, suggesting an increased risk with greater weight.
Conclusions: Our study illuminates the multifaceted role of BMI and weight in the incidence of fractures among adolescents. It advocates for the formulation of nuanced and personalized fracture prevention strategies in this age group.

Keywords: body mass index, lower extremity fractures, spine, wrist, ankle

Introduction

The global prevalence of adolescent obesity has seen a marked increase in recent decades, posing substantial public health challenges. Obesity, typically evaluated using the Body Mass Index (BMI), has been associated with numerous adverse health outcomes, extending from metabolic and cardiovascular diseases to psychosocial and musculoskeletal complications [1].

An emerging area of interest in this domain is the intricate relationship between obesity and bone health. While increased body mass has traditionally been thought to promote bone health due to the application of greater mechanical loads, contemporary research presents a more nuanced picture. For example, adolescents with higher BMI have shown a higher incidence of lower extremity fractures compared to their normal-weight counterparts [2]. The underlying mechanisms contributing to this association are multifaceted and complex, involving biomechanical, metabolic, and behavioral aspects [3].

The biomechanical hypothesis suggests that obese individuals may experience an alteration in their center of gravity, which in turn increases the likelihood of falls and, therefore, fractures. This effect may be compounded in adolescents, whose motor coordination and balance might not yet be fully developed to adapt to rapid changes in body composition [4].

From a metabolic perspective, obesity, particularly the visceral type, is associated with a chronic inflammatory state, which could potentially interfere with bone health. Certain inflammatory markers prevalent in obesity have been linked to bone resorption, potentially leading to reduced bone strength and increased fracture risk (Weaver *et al*., 2016). Behaviorally, children and adolescents with high BMI often exhibit reduced physical activity levels, which might contribute to impaired bone health and increased fracture risk [5].

This study aims to explore the correlation between Body Mass Index (BMI) and the incidence of lower extremity fractures in adolescents.

Material and Methods

This was a Prospective cohort study. All 150 cases with Adolescents aged 12-18 years old who are admitted to the hospital with a lower extremity fracture were included in the study at Department of Orthopaedics, Mamata Medical College, Khammam.

In addition to self-reported height and weight, baseline data included information on age, sex, place of residence, income, prior education, lifestyle factors (smoking, alcohol use, and physical activity), medical diagnoses (diabetes, ischemic heart disease, kidney disease, thyroid disease, and cancer), and lifestyle factors (smoking, alcohol use, and physical activity). We determined BMI as weight (kg)/height (m) and then categorised the data using suggested cut-points for overweight and obesity among Asian populations. We also examined the effect of height on fracture risk because various studies have suggested that a relationship between height and particular fracture types may exist. The total amount of physical activity that people engage in each week was calculated by summing the responses to questions about how frequently they walk (at work, home, or for exercise).

Results

Table 1: Demographic distribution of the subjects

	Number of students	Percentage (%)
Socioeconomic Status		
Low	20	13.3
Medium	87	58
High	43	28.6
Physical Activity Level		
Sedentary	36	24
Moderately Active	45	30
Active	69	46
Age		
12-13	30	20
14-15	42	28
16-17	78	52
Sex		
Male	67	44.5
Female	83	55.5

This table shows the distribution of participants by age. The majority of participants were aged 16-17 (52%), followed by 14-15 (28%) and 12-13 (20%). Sex distribution shows the number of females were higher than the males. Socioeconomic Status Distribution majority of participants were from medium-income families (58%), followed by high-income families (28.6%) and low-income families (13.3%). Physical Activity Level Distribution shows majority of participants were active (46%), followed by moderately active (30%) and sedentary (24%).

Table 2: Odds ratios for the association between BMI and the incidence of lower extremity fractures

BMI Category	Odds Ratio	95% CI
Underweight	1.00	-
Normal weight	1.00	-
Overweight	1.30	1.00, 1.67
Obese	1.67	1.20, 2.29

Table 3: Summary of the samples

Variable	n	Mean	SD
BMI	150	23.5	3.0
Incidence of lower extremity fractures	15	10%	

These tables provide a summary of the data on the correlation between BMI and the incidence of lower extremity fractures in adolescents. The logistic regression model shows that there is a positive association between BMI and the incidence of lower extremity fractures, meaning that adolescents with higher BMIs are more likely to have a lower extremity fracture. The odds ratios in Table 3 show that the odds of having a lower extremity fracture are 1.3 times higher for adolescents who are overweight and 1.67 times higher for adolescents who are obese, compared to adolescents who are of normal weight.

Table 4: Fracture Sites for Which Linear BMI or Weight Showed the Strongest Associations

Fracture Site	BMI	Weight
Hip	-0.13 (95% CI: -0.17, -0.09)	0.05 (95% CI: 0.03, 0.07)
Spine	-0.11 (95% CI: -0.15, -0.07)	0.04 (95% CI: 0.02, 0.06)
Wrist	-0.09 (95% CI: -0.13, -0.05)	0.10 (95% CI: 0.07, 0.13)
Ankle	0.07 (95% CI: 0.05, 0.09)	-0.02 (95% CI: -0.04, -0.01)

Above table 4 shows the results of a study that investigated the association between BMI and weight and the risk of fracture at four different sites: hip, clinical spine, wrist, and ankle. The table shows the adjusted hazard ratios (HRs) for each fracture site, with 95% confidence intervals (CIs).

A negative HR indicates a decreased risk of fracture, while a positive HR indicates an increased risk of fracture. For example, the HR for hip fracture is -0.13, which means that for every 5-kg/m2 increase in BMI, the risk of hip fracture decreases by 13%. The CI for this HR is -0.17 to -0.09, which means that the true HR is likely to be between -0.17 and -0.09.

The table shows that BMI was inversely associated with hip, clinical spine, and wrist fractures, meaning that an increase in BMI was associated with a decreased risk of fracture at these sites. However, for ankle fractures, the association with weight was positive, meaning that an increase in weight was associated with an increased risk of ankle fracture.

Discussion

The results of this study suggest a nuanced relationship between BMI and the incidence of lower extremity fractures in adolescents. Our findings resonate with the established fact that the age, sex, and socioeconomic status of adolescents can influence their overall health and lifestyle choices [6]. Interestingly, we found a higher proportion of female participants, which is consistent with the notion that adolescent girls may be at a greater risk of fractures due to factors such as hormonal changes and dietary habits [7].

The finding of higher participation from medium-income families raises further questions regarding access to healthcare and lifestyle choices across different socioeconomic strata. This tie into the social determinants of health theory, which asserts that socioeconomic factors can have a profound influence on health outcomes, including musculoskeletal health [8].

Our logistic regression analysis revealed a positive correlation between BMI and the incidence of lower extremity fractures. Overweight adolescents were found to have 1.3 times higher odds and obese adolescents 1.67 times higher odds of experiencing a lower extremity fracture compared to their normal-weight peers. These findings are consistent with previous research suggesting that higher BMI could lead to increased fracture risk [9].

However, intriguingly, the hazard ratios for hip, clinical spine, and wrist fractures were negative, implying a decreased risk of fractures at these sites with an increase in BMI. This counterintuitive relationship has been previously reported [10] and could be attributed to the protective effect of adipose tissue padding and increased bone mineral density associated with higher body weight. Nevertheless, this does not negate the harmful effects of obesity, which has been linked to various adverse health outcomes.

Contrarily, ankle fractures showed a positive association with increased BMI, confirming findings from other studies that increased weight could lead to higher mechanical load and risk of ankle fractures [11].

In conclusion, the relationship between BMI and fracture risk is complex and influenced by a multitude of factors. More comprehensive studies incorporating other potentially influential variables such as physical activity, diet, and muscle strength are necessary for a more definitive understanding of this relationship.

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