Bone Mineral Density and Vitamin D Status Among African American Children With Forearm Fractures

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KEY WORDS

fracture, injury, bone mineral density, vitamin D deficiency

ABBREVIATIONS

BMD—bone mineral density

DXA—dual energy x-ray absorptiometry

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WHAT'S KNOWN ON THIS SUBJECT: Forearm fractures are unique injuries which are associated with lower bone mineral density in adults and white children. The relationships among bone mineral density, 25-hydroxyvitamin D status, and risk for forearm fracture have not been investigated in African American children.

WHAT THIS STUDY ADDS: Our data support an association between both lower bone mineral density and vitamin D deficiency and increased odds of forearm fracture in African American children. Promotion of bone health is indicated in this population.

abstract

OBJECTIVE: To determine whether African American children with forearm fractures have decreased bone mineral density and an increased prevalence of vitamin D deficiency (serum 25-hydroxyvitamin D level ≤ 20 ng/mL) compared with fracture-free control patients.

METHODS: This case-control study in African American children, aged 5 to 9 years, included case patients with forearm fracture and control patients without fracture. Evaluation included measurement of bone mineral density and serum 25-hydroxyvitamin D level. Univariable and multivariable analyses were used to test for associations between fracture status and 2 measures of bone health (bone mineral density and 25-hydroxyvitamin D level) while controlling for other potential confounders.

RESULTS: The final sample included 76 case and 74 control patients. There were no significant differences between case and control patients in age, gender, parental education level, enrollment season, outdoor play time, height, or mean dietary calcium nutrient density. Cases were more likely than control patients to be overweight (49.3% vs 31.4%, $P = .03$). Compared with control patients, case patients had lower whole body z scores for bone mineral density (0.62 ± 0.96 vs 0.98 ± 1.09 ; adjusted odds ratio 0.38 [0.20–0.72]) and were more likely to be vitamin D deficient (47.1% vs 40.8%; adjusted odds ratio 3.46 [1.09–10.94]).

CONCLUSIONS: These data support an association of lower bone mineral density and vitamin D deficiency with increased odds of forearm fracture among African American children. Because suboptimal childhood bone health also negatively impacts adult bone health, interventions to increase bone mineral density and correct vitamin D deficiency are indicated in this population to provide short-term and long-term benefits. *Pediatrics* 2012;130:e553–e560

Pediatric forearm fractures are increasing in incidence and result in substantial health care costs.^{1–5} In addition to the acute consequences of these injuries, including pain and functional limitation,⁶ forearm fractures are unique injuries that may have longer-term implications. In adults, forearm fractures are associated with bone health deficits, including lower bone mineral density (BMD), and are predictors of future osteoporosis-related fractures.^{7–10} Similarly, studies of predominantly healthy white children with forearm fractures demonstrate an association with lower BMD relative to peers without forearm fractures.^{11–16} Other factors associated with forearm fracture risk in white children include low dietary calcium intake,¹⁷ low dietary milk intake,¹⁷ and high BMI.^{12,13} Although low 25-hydroxyvitamin D levels are associated with lower BMD^{18–21} and increased risk of osteoporotic fractures in adults,^{22,23} the association of 25-hydroxyvitamin D status with forearm fracture risk in children has not been previously reported.

The factors associated with forearm fracture risk are comparatively more common in African American than in white children. Dietary risk factors, such as poor dietary intake of calcium and dairy products, are more prevalent in African American children.^{24–26} African American children are also more likely than white children to be overweight or obese.^{27–29} Additionally, darker skin pigmentation is a risk factor for vitamin D deficiency.³⁰ Although African American children have a relatively increased BMD in comparison with white children and studies of a South African cohort show higher fracture rates in white children, other studies show a higher incidence of femur fracture and fracture-related hospitalizations in African American children.^{31–35} Incidence of childhood forearm fracture, by race, has not been reported.

Although African American children may be a vulnerable subset of the pediatric population, the relationship between forearm fracture risk and bone health has not been investigated in this group. Our objective was to compare whole body BMD and 25-hydroxyvitamin D status in African American children with and without forearm fractures. We hypothesized that African American children with forearm fractures would have significantly lower whole body BMD and a higher prevalence of vitamin D deficiency than African American children without forearm fractures.

METHODS

Study Design

This study was a case-control study approved by the Institutional Review Board at Children's National Medical Center, Washington, DC.

Study Sample

We assembled convenience samples of case and control patients, all of whom were African American children, aged 5 to 9 years. Inclusion criteria for both groups included African American race as designated by guardians and guardian fluency in English. Cases were required to have an isolated and radiographically demonstrated forearm fracture affecting the radius, ulna, or both. Exclusion criteria for both groups included an underlying bone mineralization disorder (including osteomalacia and osteogenesis imperfecta), current or previous use of antiepileptic medication, current or previous use of daily oral steroids for ≥ 1 month, or a chronic illness potentially affecting bone density (including sickle cell disease, cancer, kidney disease, gastrointestinal malabsorption disease, and cerebral palsy). Controls were additionally required to have no self-reported history of an earlier bone fracture.

This study was conducted at Children's National Medical Center, a large urban pediatric hospital in Washington, DC, and participants were enrolled between December 2005 and May 2011. Case study participants were recruited through the outpatient orthopedic clinic, through the emergency department, and by using hospital- and community-based advertisements. Control study participants were recruited through the emergency department, including an emergency department-based asthma clinic, and using hospital- and community-based advertisements. Patients were studied in the Children's National Medical Center General Clinical Research Center. All participants and/or their guardians provided informed consent, and children aged 7 to 9 years provided assent.

Study Evaluations and Measurements

Baseline Questionnaires

Children and their parent(s) were interviewed to obtain sociodemographic information, medical history, and injury mechanism (for case patients). Weekly outdoor play time was quantified by using validated questions previously shown to correlate with physical activity levels in preschoolers as measured with an accelerometer.³⁶ In addition to assessing for differences in activity level, we also considered weekly outdoor play time as a proxy measurement of sun exposure, as sun exposure influences vitamin D status.³⁷ The interview also included the completion of a validated food frequency questionnaire (BLOCK Kids 8-17 Food Frequency Questionnaire; NutritionQuest, Berkeley, CA).³⁸

Anthropometric Measurements

Measurements included height and weight to determine BMI. These measurements were obtained by a radiology technician using standardized procedures.

Case patients were weighed without the cast/splint apparatus. BMI and BMI percentiles were determined by using the criteria of the Centers for Disease Control and Prevention and classified as overweight (BMI $\geq$ 85th percentile) or obese (BMI $\geq$ 95th percentile).³⁹

Dual Energy X-ray Absorptiometry Scan

A dual energy x-ray absorptiometry (DXA) scan was obtained by using the Hologic QDR Discovery A Densitometer (Hologic, Inc, Bedford, MA). DXA scans were obtained on case patients without the cast/splint apparatus. Whole body and lumbar spine scans were performed as these are the most accurate and reproducible pediatric skeletal sites.⁴⁰ Scans were performed by a trained radiology technician and interpreted by a single attending radiologist who was blinded to the participant's fracture status. Scores were reported as areal BMD z scores, which are the "central element used in the interpretation of DXA results" according to the International Society for Clinical Densitometry and reflect comparison with peers matched for age and gender.⁴⁰

Laboratory Assessment

Peripheral venous blood samples were shipped for analysis to Quest Diagnostics Nichols Institute (Chantilly, VA) for measurement of 25-hydroxyvitamin D levels using liquid chromatography and tandem mass spectrometry. The precision performance of this measure is $<8.3\%$ coefficient of variation. This laboratory maintains current Clinical Laboratory Improvement Amendments of 1988 licensing and is accredited by the College of American Pathologists. Vitamin D deficiency was defined as a 25-hydroxyvitamin D level ≤ 20 ng/mL.

Sample Size

Sample size was estimated based on effect size for a type I error of 5% and

power of 80%. Our calculated sample size of 65 case and 65 control patients had 80% power to detect 0.5 effect size differences between means for both areal whole body BMD z scores and 25-hydroxyvitamin D levels.

Data Analysis

Data were entered into Microsoft Access 2003 database (Microsoft Corporation, Redmond, WA) and analyzed by using SPSS Statistics 17.0 (SPSS Inc, Chicago, IL). Contingency table analysis for categorical data and analyses of variance for measurement data were used to compare, respectively, the frequency and mean levels of variables in case and control patients. A *P* value of $<.05$ was established for statistical significance.

Multivariable logistic regression was performed to test for the association of fracture status with BMD and 25-hydroxyvitamin D status while controlling for potential confounders based on previous published studies and/or emerging from groupwise comparisons. Potential confounders of forearm fracture risk and/or general injury risk include age,⁴¹ gender,⁴¹ parental education level/socioeconomic status,⁴² season,^{43,44} activity level,⁴⁵ high BMI,^{12,13} height,⁴⁶ dietary calcium intake,¹⁷ BMD,^{11–16} and 25-hydroxyvitamin D status.^{18–23} Because 25-hydroxyvitamin D status may be a strong determinant of BMD,^{18–21} we also modeled the association of fracture status with BMD separately without 25-hydroxyvitamin D. For the same reason, we also modeled the association of fracture status with 25-hydroxyvitamin D separately without BMD while controlling for the same potential confounders. In the regression models, 25-hydroxyvitamin D was analyzed both as a dichotomous variable (sufficient or deficient) and separately as a continuous variable, to determine dose-response effect.

RESULTS

The final study sample included 76 case and 74 control patients. Of the 76 case patients, 58 patients were enrolled through the orthopedic clinic, 16 patients were enrolled through the emergency department, and 2 patients were enrolled after responding to an advertisement. The fracture patterns of case patients included 37 isolated radius fractures, 1 isolated ulna fracture, and 38 radius and ulna fractures. Of 74 control patients, 37 patients were enrolled through the emergency department, 7 patients were enrolled through an asthma clinic, and 30 patients were enrolled after responding to an advertisement. Whole body DXA scans were completed on 63 case and 65 control patients. Serum 25-hydroxyvitamin D levels were obtained on 70 case and 71 control patients.

Demographic and clinical characteristics of participants are summarized in Table 1. The groups did not differ in terms of age, gender, parental education level, season of enrollment, or mean weekly outdoor play time. A lower proportion of case patients reported a medical history positive for asthma in comparison with control patients (21.1% vs 43.2%, *P* = .004), which likely represents method of control enrollment. In univariate analyses, case patients had a higher mean BMI percentile than control patients (71.1 ± 27.9 vs 60.7 ± 29.9 , *P* = .03). Case patients were more likely than control patients to be overweight (49.3% vs 31.4%, *P* = .03). The proportion of patients with obesity was also higher in the case group but this did not achieve statistical significance (22.5% vs 17.1%, *P* = .42). There was no difference in mean height between the groups.

Case patients also had a higher mean daily dietary calcium intake (886.3 ± 405.8 mg vs 680.5 ± 333.5 mg, *P* = .001) and overall mean daily calorie intake

TABLE 1 Demographic and Clinical Characteristics of Case and Control Patients

Variable	Case Patients (n = 76)	Control Patients (n = 74)	P
Demographic characteristics			
Mean age, y (SD)	6.9 (1.4)	7.0 (1.5)	.87
Gender: proportion male	44/76, 57.8%	40/74, 54.1%	.64
Parental education: Proportion of parents with high school education or less	24/70, 34.3%	21/71, 29.6%	.55
Environmental characteristics			
Proportion enrolled in each season:			
Winter	13/76, 17.1%	22/74, 29.7%	.23
Spring	19/76, 25.0%	12/74, 16.2%	
Summer	30/76, 39.5%	25/74, 33.8%	
Fall	14/76, 18.4%	15/74, 20.3%	
Mean weekly outdoor play, h (SD)	16.3 (7.1)	15.6 (7.4)	.56
Medical history			
Proportion of patients with asthma	16/76, 21.1%	32/74, 43.2%	.004
BMI and height characteristics			
Mean BMI percentile (SD)	71.1 (27.9)	60.7 (29.9)	.03
Proportion of patients with BMI ≥85th percentile	35/71, 49.3%	22/70, 31.4%	.03
Proportion of patients with BMI ≥95th percentile	16/71, 22.5%	12/70, 17.1%	.42
Mean height, cm (SD)	127.9 (9.7)	127.0 (11.0)	.60
Dietary characteristics			
Mean daily dietary calcium, mg (SD)	889.8 (405.8)	680.5 (333.5)	.001
Mean daily caloric intake in kcal (SD)	2311.9 (1117.0)	1742.0 (699.3)	<.001
Mean daily calcium nutrient density intake, mg/kcal (SD)	0.464 (0.158)	0.433 (0.172)	.25
Mean weekly number of servings of milk (SD)	7.4 (6.8)	7.0 (6.2)	.72

(2311.9 ± 1117.0 kcal vs 1742.0 ± 699.3 kcal, $P < .001$) than control patients. When daily calcium intake was divided by daily caloric intake to obtain daily calcium nutrient density intake, there was no significant difference between the groups for this measure. There was also no difference in mean weekly number of milk servings between the groups.

The mean whole body BMD z score was lower in case compared with control patients (0.62 ± 0.96 vs 0.98 ± 1.09, $P = .05$); this difference approached but did not achieve statistical significance (Table 2). The mean lumbar spine BMD

z score was also lower in case patients (0.43 ± 1.1 vs 0.65 ± 1.4, $P = .35$), but this was not statistically significant. Univariate analysis also did not demonstrate a statistically significant difference in either mean 25-hydroxyvitamin D level or proportion vitamin D deficient between the groups.

In constructing the multivariable logistic model, in addition to the potential confounders listed in the plan for data analysis, we included the proportion of patients with asthma and overall mean daily caloric intake due to the significant difference between case and control patients. This analysis showed that

whole body BMD z score (adjusted odds ratio [OR] 0.38, 95% confidence interval [CI] 0.20–0.72) was associated with odds of forearm fracture after controlling for potential confounders, including 25-hydroxyvitamin D as a dichotomous variable (Table 3). Specifically, these results indicate that for each unit increase in BMD, there was an ~62% decrease in odds of a forearm fracture. The adjusted odds of fracture for BMD were similar when 25-hydroxyvitamin D was included in the model as a continuous variable (adjusted OR 0.39, 95% CI 0.21–0.73).

In addition, vitamin D deficiency, analyzed in this same model with BMD, was significantly associated with a 3.5 times higher adjusted odds of forearm fracture (adjusted OR 3.46, 95% CI 1.09–10.94) (Table 3). Finally, 25-hydroxyvitamin D, analyzed as a continuous variable to determine dose-response effect, was significantly associated with odds of forearm fracture (adjusted OR 0.90, 95% CI 0.83–0.98). These results indicate that for each unit increase in 25-hydroxyvitamin D level, there was a 10% decrease in the odds of forearm fracture in our study population.

Whole body BMD z score remained significantly associated with odds of forearm fracture (adjusted OR 0.43, 95% CI 0.24–0.77) when 25-hydroxyvitamin D was removed from the model (Table 4). Vitamin D deficiency also remained significantly associated with increased odds of forearm fracture (adjusted OR 2.80, 95% CI 1.03–7.62) when whole body BMD z score was removed from the model. Similarly, 25-hydroxyvitamin D level, analyzed as a continuous variable, also remained significantly associated with odds of forearm fracture (adjusted OR 0.92, 95% CI 0.85–0.99) (Table 4).

DISCUSSION

These data demonstrate significant associations between both lower BMD

TABLE 2 Univariate Analysis of BMD and Vitamin D Status Among Case and Control Patients

Variable	BMD Status		P
	Case Patients (n = 63)	Control Patients (n = 65)	
Mean DXA lumbar spine z score (SD)	0.43 (1.1)	0.65 (1.4)	.35
Mean DXA whole body z score (SD)	0.62 (0.96)	0.98 (1.09)	.05
	Vitamin D Status		P
	Case Patients (n = 70)	Control Patients (n = 71)	
Mean 25-hydroxyvitamin D level, ng/mL (SD)	21.9 (7.3)	22.6 (7.2)	.59
Proportion of patients with 25-hydroxyvitamin D level ≤20 ng/mL	33/70, 47.1%	29/71, 40.8%	.45

TABLE 3 Multivariable Analyses Demonstrating Associations With Fracture, Displayed as Adjusted^a ORs With 95% CIs

Variable	Vitamin D as a Dichotomous Variable ^b	Vitamin D as a Continuous Variable ^b
Age (in years)	0.48 (0.24–0.99)	0.50 (0.25–1.03)
Male gender	0.69 (0.24–1.95)	0.71 (0.25–2.00)
Parental education of high school level or less	0.74 (0.23–2.36)	0.65 (0.20–2.08)
Season of enrollment		
Winter	0.14 (0.03–0.73)	0.10 (0.02–0.59)
Spring	0.81 (0.18–3.61)	0.76 (0.17–3.34)
Fall	0.41 (0.10–1.60)	0.34 (0.08–1.41)
Weekly outdoor play (in hours)	1.04 (0.95–1.13)	1.04 (0.96–1.13)
Medical history of asthma	0.22 (0.07–0.65)	0.22 (0.07–0.67)
BMI $\geq$ 85th percentile	6.53 (1.81–23.62)	7.20 (1.94–26.75)
Height	1.09 (0.99–1.20)	1.09 (0.98–1.20)
Daily dietary calcium intake (in mg)	1.001 (0.999–1.003)	1.002 (0.999–1.004)
Daily dietary caloric intake (in kcal)	1.001 (1.000–1.001)	1.001 (1.000–1.001)
Whole body DXA BMD score	0.38 (0.20–0.72)	0.39 (0.21–0.73)
25-Hydroxyvitamin D level $\leq$ 20 mg/dL	3.46 (1.09–10.94)	N/A
25-Hydroxyvitamin D level (continuous)	N/A	0.90 (0.83–0.98)

^a Adjusted for all covariates, including vitamin D as indicated.

^b Column 2 depicts the model with vitamin D as the dichotomous variable “sufficient” or “deficient.” Column 3 depicts the model with vitamin D as a continuous variable.

TABLE 4 Multivariable Analyses Demonstrating Associations With Fracture, Displayed as Adjusted^a ORs With 95% CIs

Variable	BMD Without Vitamin D ^b	Vitamin D (Dichotomous) Without BMD ^b	Vitamin D (Continuous) Without BMD ^b
Age (in years)	0.51 (0.26–1.02)	0.85 (0.48–1.51)	0.87 (0.49–1.55)
Male gender	0.83 (0.31–2.20)	0.62 (0.25–1.56)	0.63 (0.25–1.60)
Parental education of high school level or less	0.68 (0.22–2.13)	1.23 (0.47–3.25)	1.11 (0.43–2.90)
Season of enrollment			
Winter	0.24 (0.06–1.03)	0.12 (0.03–0.48)	0.09 (0.02–0.40)
Spring	1.60 (0.42–6.12)	0.72 (0.20–2.63)	0.69 (0.19–2.53)
Fall	0.45 (0.12–1.74)	0.46 (0.14–1.51)	0.41 (0.12–1.40)
Weekly outdoor play (in hours)	1.03 (0.95–1.11)	1.02 (0.95–1.10)	1.02 (0.95–1.10)
Medical history of asthma	0.24 (0.08–0.68)	0.19 (0.07–0.53)	0.20 (0.07–0.57)
BMI $\geq$ 85th percentile	6.03 (1.80–20.18)	2.55 (0.94–6.90)	2.80 (1.01–7.77)
Height	1.07 (0.97–1.18)	1.02 (0.94–1.10)	1.02 (0.94–1.11)
Daily dietary calcium intake (in mg)	1.001 (0.999–1.003)	1.001 (1.000–1.003)	1.002 (1.000–1.004)
Daily dietary caloric intake (in kcal)	1.001 (1.000–1.002)	1.001 (1.000–1.001)	1.000 (1.000–1.001)
Whole body DXA BMD score	0.43 (0.24–0.77)	Not included	Not included
25-Hydroxyvitamin D level $\leq$ 20 mg/dL	Not included	2.80 (1.03–7.62)	N/A
25-Hydroxyvitamin D level	Not included	N/A	0.92 (0.85–0.99)

^a Adjusted for all covariates (age, gender, parental education, enrollment season, weekly outdoor play, medical history of asthma, BMI $\geq$ 85th percentile, height, daily dietary calcium intake, daily dietary caloric intake, BMD as indicated, and vitamin D as indicated).

^b Column 2 depicts the model with BMD included and vitamin D excluded. Column 3 depicts the model with vitamin D included as a dichotomous variable and BMD excluded. Column 4 depicts the model with vitamin D included as a continuous variable and BMD excluded.

and vitamin D deficiency and increased odds of forearm fracture in African American children. To our knowledge, this is the first study in which the association between lower BMD and increased odds of forearm fracture risk has been shown in African American

children, a pediatric population that may be at higher risk for bone health deficiencies and fractures.^{24–26,32,33} Our results add to the growing body of literature, which previously has shown a difference in BMD between generally healthy and largely white

children with and without forearm fractures.^{12–16}

Similarly, this is the first study in which vitamin D deficiency has been associated with increased odds of forearm fracture in any pediatric population. Our results also support a dose-dependent relationship between forearm fracture risk and serum 25-hydroxyvitamin D levels.

These data also show an association between overweight status and increased odds of forearm fracture in children. These results are consistent with other data from case-control studies showing this association in white children,^{12,13,15} although some cohort studies have not supported this association.^{14,47} Although the specific pathophysiology has not been determined, potential mechanisms include increased exposure to falls due to poor motor coordination, high prevalence of vitamin D deficiency, and relative deficiencies in bone density and strength for patient weight.^{48–51} Thus, our data also provide additional rationale for reducing obesity in this population but additional study is needed to confirm and explain this relationship.

Other statistically significant clinical differences between the groups included a higher daily calcium dietary intake in case patients. We suspect that the difference in daily calcium intake likely reflects the increased overall caloric intake in the case patients. When the daily calcium intake was expressed as a proportion of daily kilocalorie intake (as calcium nutrient density), there was no longer a significant difference present between the groups. Although calcium intake has been associated with forearm fracture risk in children,¹⁷ other studies have not supported this association.¹²

This study has several limitations. First, the single site design, exclusion of non-English speakers, and racial uniformity of the African American study sample may limit generalizability of the results.

However, the intent of this analysis was to focus on a potentially vulnerable population that had not been well represented in previous studies. Second, although our control group did not differ from the case group in race, age, gender, or parental education level, there were significantly more children with asthma in the control group, which likely represents method of control enrollment. Of note, given that asthma in children is associated with obesity and may be associated with vitamin D deficiency,^{52,53} the higher prevalence of asthma among control patients potentially biased against our findings. Third, as our control group included emergency department patients and patients who proactively responded to an advertisement, this group may not be truly reflective of the overall population at risk for forearm fractures. Fourth, measurements based on interview were subject to the inherent limitations of recall and reporting biases. Finally, although we were able to control for many confounders that may contribute to fracture risk in children, we did not include a measure of pubertal status in our clinical evaluation. Bone quality changes as children progress into puberty and a differential vulnerability to fracture is present that is related to bone characteristics in prepubescent versus peripubescent populations.^{54–56} Our study age group of 5 to 9 years, with a mean participant age in both groups just under age 7 years, is likely to have included a predominantly prepubescent population as most recent data indicate that the mean age of pubertal onset is 8.9 years in African American girls and 9.5 years in African American boys.^{57,58} Forearm fractures in adults, particularly when associated with minor

trauma, are considered to be indicators of poor bone health and predictors of future osteoporosis-related fractures.^{7,8} Our data, as well as those of previous studies, suggest that a forearm fracture during childhood may be a similar pediatric marker indicative of suboptimal bone health status.

Prevention efforts targeting childhood injuries have generally focused on educational/primary prevention, engineering, or behavioral approaches.^{59–61} Because a large proportion of injury mechanisms resulting in forearm fracture are minor, these specific injuries may be less amenable to primary injury prevention strategies focusing on mechanism.⁶² The unique public health aspects of forearm fracture injuries merit broadening the concept of injury prevention to include bone health promotion in at-risk pediatric populations. As approximately half of all children will fracture a bone during childhood, and as nearly 40% of those will sustain at least one additional future fracture,⁶³ both first and repeat fractures could be targeted with such preventive efforts.

Given that 90% of peak bone mass is achieved by the age of 18, deficient bone health in childhood also negatively impacts adult bone mineralization and may increase the risk of adult osteoporosis and related fracture.^{64–66} BMD is a function of peak bone mass and the rate of subsequent bone loss, which are risk factors for fracture later in life.⁶⁶ Thus, an intervention in childhood to maximize peak bone mass in high-risk individuals could have potential long-term beneficial effects in adults by minimizing the impact of later bone loss.⁶⁷ As the costs of osteoporosis and related fractures currently exceed

\$6 billion per year in the United States,^{68,69} successful interventions could have substantial economic implications.

Our study results show that a similar relationship between lower BMD and forearm fractures demonstrated in white children is also present in African American children. Although the prevalence of osteoporosis and related fragility fracture is lower in African American women compared with white women, osteoporosis is not uncommon in the African American adult population^{70,71} and may be underdiagnosed.⁷² Additional study is needed to better understand and improve bone health in the African American population given our study findings of an increased prevalence of factors associated with forearm fracture risk,^{24–30} higher rates of some fractures,^{32,33} and the apparent paradox of a relatively increased BMD in comparison with white children.³¹

CONCLUSIONS

These data support an association between both lower BMD and vitamin D deficiency and increased odds of forearm fracture in African American children. Additionally, our results show a dose-dependent relationship between forearm fracture risk and serum 25-hydroxyvitamin D levels. Our results add to the growing body of literature demonstrating that a forearm fracture during childhood may be a pediatric marker indicative of suboptimal bone health status. Because forearm fracture rates in children are increasing and bone health status in childhood may directly impact adult bone health, opportunities to intervene during childhood should be pursued.

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