Prevalence of Vitamin D Insufficiency in African American Children with Forearm Fractures: A Preliminary Study

Leticia Manning Ryan, MD,† Cinzia Brandoli, PhD,‡ Robert J. Freishtat, MD,MPH,*§ Joseph L. Wright, MD,MPH,*†‖ Laura Tosi, MD,‡ and James M. Chamberlain, MD*†*

Objectives: Forearm fractures account for a significant proportion of childhood injuries and seem to be increasing in incidence. Poor vitamin D status increases overall fracture risk in infants with rickets and adults with osteoporosis. Children with vitamin D insufficiency (serum 25-hydroxy vitamin D level < 20 ng/mL) have decreased bone mineral density (BMD) compared with children having normal vitamin D status. The relationship between vitamin D status and childhood forearm fracture has not been investigated.

Methods: This prospective study enrolled African American children, aged 5 to 9 years, with a forearm fracture. Bone health evaluation included measurement of serum 25-hydroxy vitamin D level and BMD by dual energy x-ray absorptiometry scan. Univariable analyses were used to test the associations between fracture status and the independent variables, serum vitamin D level and BMD.

Results: Vitamin D levels were available for 17 cases. The mean (± SD) 25-hydroxy vitamin D level was 20.1 (± 7.3) ng/mL with a range of 10 to 38 ng/mL. The mean of this group was at the cut point for vitamin D insufficiency. Ten cases (59%) were vitamin D insufficient. Dual energy x-ray absorptiometry scan results for these patients were consistent with normal bony mineralization for age.

Conclusions: A significant proportion of African American children with fractures in our study have vitamin D insufficiency. Analysis of serum 25-hydroxy vitamin D levels and BMD in additional cases and controls will determine the significance of these findings.

Clinical Relevance: Vitamin D insufficiency may play a previously unrecognized role in childhood fractures. Strong consideration should be given to routine vitamin D testing in African American children with forearm fractures.

Key Words: bone health, fractures, vitamin D

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Approximately half of all children will fracture a bone during childhood; of those, nearly 40% will sustain at least 1 additional future fracture.[1] Skeletal fractures account for a significant proportion of childhood injuries[2–6] and result in substantial costs and morbidity.[7–9] Despite success in preventing other childhood injuries,[10] fracture rates seem to be increasing.[11–14]

Prior fracture is associated with an increased risk of subsequent fractures during growth.[15] Thus, there seems to be a vulnerable subset of the population at higher risk for fractures. Pediatric fractures are often attributed to normal childhood development, which makes falls and injuries common[16,17]; however, there is increasing evidence that such fractures may be related to deficient bone health. Specifically, recent studies suggest that elevated fracture risk in otherwise well children may be a function of lower bone mineralization associated with both environmental factors, including poor nutrition and physical inactivity[18–22] and genetics.[23]

Pediatric studies evaluating the role of bone health in childhood fractures have been primarily conducted in New Zealand and white children[19–21]; yet, African American children may be at higher risk of bone health deficits, including vitamin D deficiency. Darker skin pigmentation is a risk factor for vitamin D deficiency[24]; additionally, African American children have significantly lower dietary intakes of vitamin D compared with other ethnic groups.[25] Limited published data reveal a high prevalence (up to 49%) of vitamin D insufficiency (serum 25-hydroxy vitamin D level < 20 ng/mL) in otherwise healthy African American children.[26]

The relationship between low vitamin D levels and fracture risk has been studied extensively in infants[27–32] but its significance in children and adolescents has not been investigated. Recently, we have initiated a study of bone health, including environmental and genetic analysis, in African American children with an isolated forearm fracture to evaluate the relationship between bone health and pediatric forearm fractures. Our objective

From the *Division of Emergency Medicine; †Research Center for Clinical and Community Research; ‡Division of Orthopaedics and Sports Medicine; §Research Center for Genetic Medicine; and ‖Child Health Advocacy Institute, Children's National Medical Center, George Washington University School of Medicine and Health Sciences, Washington, DC.

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Reprint: Leticia Manning Ryan, MD, Division of Emergency Medicine, Children's National Medical Center, 111 Michigan Avenue, NW, Washington, DC 20010. Email: lryan@cnmc.org.

TABLE 1. Inclusion and Exclusion Criteria for Study Participants

Inclusion Criteria	Exclusion Criteria
African American/Black race per parental designation	Current underlying bone mineralization disorder (osteomalacia, osteogenesis imperfecta)
Age 5-9	Current or prior use of antiepileptic medication
Orthopaedic clinic patient	
Isolated and radiographically demonstrated forearm fracture (radius, ulna, or both)	
Parent/guardian fluent in English language	

is to determine the prevalence of vitamin D insufficiency and abnormal bone mineral density (BMD) in a sample of African American children with forearm fractures.

METHODS

A convenience sample of patients who satisfied the inclusion and exclusion criteria listed in Table 1 was enrolled between December 2005 and December 2006. This prospective study was conducted at Children's National Medical Center (CNMC), an urban pediatric medical center in Washington, DC. It represents a pilot study focusing on the enrollment of forearm fracture patients who will later represent cases in a case-control study. This subsequent case-control study will compare these patients to age-matched and race-matched fracture free controls.

Patients were recruited through the outpatient Orthopaedic Clinic and were studied in the CNMC General Clinical Research Center. This study was approved by the CNMC Institutional Review Board. All participants and/or their guardians provided informed consent and children 7 to 9 years of age provided assent.

Bone health evaluation included measurement of serum 25-hydroxy vitamin D level and BMD by dual energy x-ray absorptiometry scan. Univariable analyses were used to test the associations between fracture status and the independent variables, serum vitamin D level and BMD. Data analysis was performed with SPSS Statistics 17.0 (SPSS Inc, Chicago, IL).

RESULTS

During the study period, 17 cases have been enrolled. The mean (± SD) case age was 7.3 (± 1.3) years; age range 5 to 9 years; 53% were male. None of the patients were observed to adhere to a cultural or religious practice of wearing all enveloping clothing to cover exposed skin.

The mean (± SD) 25-hydroxy vitamin D level was 20.1 (± 7.3) ng/mL with a range of 10 to 38 ng/mL. The mean of this group was at the cut point for vitamin D insufficiency (serum 25-hydroxy vitamin D level < 20 ng/mL). Ten cases (59%) were vitamin D insufficient. The proportion of patients with vitamin D insufficiency by season of enrollment is summarized in Table 2.

TABLE 2. Proportion of Enrolled Patients With Vitamin D Insufficiency by Season of Enrollment

Season of Patient Enrollment	Proportion of Enrolled Patients With Vitamin D Insufficiency (%)
Winter	1/1 (100)
Spring	6/9 (66.7)
Summer	1/2 (50)
Fall	2/5 (40)

Dual energy x-ray absorptiometry scan results for all patients were consistent with normal bony mineralization for age (z-score > −2). The mean (± SD) total body z-score for study participants was 0.73 (± 0.8) with a range of −1.0 to 2.3.

There was no radiographic evidence of osteopenia for any of the patients.

DISCUSSION

Vitamin D is essential for calcium homeostasis and bone development/remodeling.[33,34] Vitamin D deficiency has long been recognized as a cause of increased fracture risk associated with rickets in infants and osteomalacia in adults.[33–35] This nutritional deficiency is more likely to occur in infants with darker skin, limited sun exposure, a history of breast feeding without vitamin D supplementation, and poor dietary intake of vitamin D or calcium.[24,36] This deficiency and its effects have been studied extensively in infants[27–32] but its significance in children and adolescents has not been investigated.

There is an increasing awareness of a preclinical phase of vitamin D deficiency, that is vitamin D insufficiency,[24,37] which increases the risk of osteoporotic fractures in adults.[38,39] This term describes biochemical evidence of deficiency (serum 25-hydroxy vitamin D level < 20 ng/mL) without obvious clinical signs or symptoms, such as radiographic osteopenia.[40] There is growing evidence that vitamin D insufficiency is a prevalent health problem. Surveys of other at-risk populations have shown that a significant proportion have vitamin D insufficiency,[41–44] which is associated with diminished bone mineral content.[44]

Vitamin D deficiency and/or insufficiency may also play an important but previously unrecognized role in fractures occurring in the pediatric age group. Few studies have investigated the effect of vitamin D intake, sun exposure, or vitamin D status on BMD in children and young adults. However, in a 3-year prospective study of Finnish girls aged 9 to 15 years, girls with vitamin D deficiency had a 4% lower BMD accumulation from baseline than did girls with normal vitamin D status.[45] In adults, each standard deviation decrease in BMD approximately doubles the fracture risk.[46]

African American children are likely to be at higher risk of vitamin D deficiency and/or insufficiency. African American children have significantly lower daily intake of vitamin D compared with other racial/ethnic groups.[25]

Adequate intake levels for vitamin D from food are met by less than half of African American children.[25] The higher prevalence of lactose intolerance in this population may also contribute to nutritional deficiencies. In the United States, it is estimated that up to three-fourths of African Americans have symptoms of lactose intolerance.[47] In addition, darker skin pigmentation is a risk factor for vitamin D deficiency.[24]

In our pilot data, 59% of African American children with fractures were vitamin D insufficient. This prevalence is higher than baseline levels of vitamin D insufficiency reported in comparable populations. The effect of these insufficient levels on fracture risk in otherwise healthy children merits further careful evaluation.

Interestingly, our preliminary results showed normal BMD measurements and normal bone appearance on radiographs for forearm fracture patients with and without vitamin D insufficiency. Analysis of serum 25-hydroxy vitamin D levels and BMD in additional cases and controls will determine the significance of these findings. Vitamin D insufficiency may play a previously unrecognized role in childhood fractures. Strong consideration should be given to routine vitamin D testing in African American children with forearm fractures.

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