

Prevalence of Vitamin D Deficiency in Korean Children Presenting with Nonspecific Lower-Extremity Pain

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Purpose: Although interest in the role played by vitamin D in bone health is increasing, little is known about the role of this vitamin in musculoskeletal pain in children. This study aimed to assess the prevalence of vitamin D deficiency in children presenting with nonspecific lower extremity pains.

Materials and Methods: From 2011 to 2012, 183 children underwent evaluation for nonspecific lower-extremity pains. Patients with valid causes, such as fractures or transient synovitis, were excluded, as were those with underlying medical conditions, such as cerebral palsy and metabolic disease. Ultimately, 140 patients met the inclusion criteria. Levels of serum 25-hydroxy vitamin D [25-(OH)D], the ideal indicator of vitamin D status, were measured in these children.

Results: Eighty-seven boys (62.1%) and 53 girls (37.9%) were included. The mean age at presentation was 5.2 years (range, 2-15). Serum 25-(OH)D levels were <10 ng/mL in 5.7% of patients, 10 to <20 ng/mL in 51.4%, 20 to <30 ng/mL in 37.9%, and ≥30 ng/mL in only 5.0%. Most patients visited the hospital in the winter (41.4%) (summer, 12.9%), and serum 25-(OH)D levels were also lowest in the winter (17.2±5.5 ng/mL).

Conclusion: This study found a high prevalence of vitamin D deficiency or insufficiency in Korean children with nonspecific lower-extremity pains, indicating a positive association between vitamin D deficiency and growing pains. More attention should be directed toward vitamin D and its role in the optimization of bone health.

Key Words: Musculoskeletal pain, vitamin D deficiency, children

INTRODUCTION

Nonspecific lower-extremity pains, so-called "growing pains," are intermittent pains in both legs that generally occur late in the day or at night. These pains are diagnosed when other causes of recurrent limb pain have been ruled out. Their prevalence ranges widely, from 2.6% to as high as 49.4%, likely reflecting the diversity of selection criteria in different studies.¹⁻⁴

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There are several causes of growing pains, namely, relative local overuse syndrome, decreased bone strength, and a low pain threshold.²⁻⁴ However, the etiology of growing pains is not fully understood as yet.

Vitamin D is a fat-soluble vitamin that promotes the efficient absorption of dietary calcium and phosphorus and is therefore essential for bone growth and mineralization. Vitamin D is synthesized in the skin on exposure to ultraviolet-B radiation from sunlight, and only small amounts can be obtained (<10%) from dietary intake.⁵ Skeletal complications of vitamin D deficiency include rickets, bone deformity, osteoporosis, and fracture. Vitamin D deficiency is also known to be associated with cardiovascular disease, diabetes mellitus, cancer, infection, autoimmune disease, and schizophrenia.⁵

Interest in the role played by vitamin D in bone health is increasing. However, little is known about the association between vitamin D deficiency and musculoskeletal pain in children. Recent studies have shown that vitamin D receptors are present in both the nuclei and plasma membranes of skeletal

muscle cells in mammals, indicating an association between vitamin D and skeletal muscle.⁶ The purpose of the present study was to assess the prevalence of vitamin D deficiency in Korean children presenting with nonspecific lower-extremity pain and the associations among vitamin D deficiency, demographic factors, and nonspecific lower-extremity pain in children.

MATERIALS AND METHODS

This retrospective study was approved by our Institutional Review Board. From 2011 to 2012, 183 children with frequent nonspecific lower-extremity pain underwent tests for various parameters, including serum 25-hydroxy vitamin D [25-(OH)D] levels, at our institution. All of the children had recurrent pain episodes of the lower extremities, most recently within one week before the visit. The Peterson criteria were used to diagnose growing pains.¹ The inclusion criteria were intermittent pain occurring in the late afternoon or evening, with some pain-free days and nights; pain in the anterior thighs, calves, or posterior knee muscles; normal results on physical examination, without swelling, erythema, tenderness, reduced joint range of motion, or limping; and normal results in laboratory tests or imaging studies. The laboratory tests included complete blood count, erythrocyte sedimentation rate, C-reactive protein, creatinine phosphokinase, rheumatoid factor, peripheral blood smear, and 25-(OH)D. To ensure patient homogeneity, we excluded patients who had medical conditions such as neuromuscular disorders, congenital disorders, and metabolic disease. Ultimately, 140 patients met the inclusion criteria. Serum 25-(OH)D levels, which are known to be the best indicator of vitamin D

status, were measured using a chemiluminescent immunoassay. A level of <10 ng/mL was considered deficient; a level of 10–20 ng/mL, insufficient; a level of 20–30 ng/mL, adequate; and a level of >30 ng/mL, optimal.⁷ Patients' demographic data, such as age, sex, and date of presentation, were collected from their medical records. Given that studies have shown that older children are more likely to be 25-(OH)D deficient, the patients were divided into two groups according to age: a younger group, with children who were less than 10 years old, and an adolescent group. As serum vitamin D levels are closely related to the amount of sunshine, the date of presentation was categorized into four seasons: spring (March to May), summer (June to August), fall (September to November), and winter (December to February).

RESULTS

The study included 87 boys (62.1%) and 53 girls (37.9%) with a mean age of 5.2 years (range, 2–15 years). Most patients (90%) were less than 10 years old. The date of presentation was mostly in the winter (41.4%), followed by fall (28.6%), spring (17.1%), and summer (12.9%). Age and seasonal distribution were similar for boys and girls (Table 1). The average serum 25-(OH)D level was 19.1±5.8 ng/mL. Seven patients (5.0%) had serum 25-(OH)D levels >30 ng/mL, while 53 patients (37.9%) had levels between 20 and 30 ng/mL. Eighty patients (57.1%) had serum 25-(OH)D levels <20 ng/mL, among which 72 (51.4%) had levels between 10 and 20 ng/mL and 8 (5.7%) had levels <10 ng/mL (Table 2). Adolescents had a lower average serum 25-(OH)D level than younger children (15.5±6.0 ng/mL vs. 19.7±6.9 ng/mL) (Fig. 1).

Table 1. Patient Demographics

	Boys (n=87)	Girls (n=53)	Total (n=140)
Age (yrs)			
<10	79 (90.8%)	47 (88.7%)	126 (90%)
≥10	8 (9.2%)	6 (11.3%)	14 (10%)
Season*			
Winter	34 (39.1%)	24 (45.3%)	58 (41.4%)
Spring	18 (20.7%)	6 (11.3%)	24 (17.1%)
Summer	11 (12.6%)	7 (13.2%)	18 (12.9%)
Fall	24 (27.6%)	16 (30.2%)	40 (28.6%)

*The seasons include spring (March to May), summer (June to August), fall (September to November), and winter (December to February).

Table 2. Distribution of Serum 25-Hydroxy Vitamin D Levels of Patients Grouped According to Sex

Serum 25-(OH)D (ng/mL)	Boys (n=87)	Girls (n=53)	Total (n=140)
<10	4 (4.6%)	4 (7.5%)	8 (5.7%)
10 to <20	45 (51.7%)	27 (50.9%)	72 (51.4%)
20 to <30	35 (40.2%)	18 (34.0%)	53 (37.9%)
≥30	3 (3.4%)	4 (7.5%)	7 (5.0%)

Serum 25-(OH)D, serum 25-hydroxy vitamin D.

The average serum 25-(OH)D level was lowest in the winter (17.2±5.5 ng/mL) and highest in the fall (22.7±8.4 ng/mL) (Fig. 2). Among the 58 patients who presented with growing pains in winter, 5 (8.6%) had serum 25-(OH)D levels <10 ng/mL, 39 (67.2%) had levels between 10 and 20 ng/mL, 14 (24.1%) had levels between 20 and 30 ng/mL, and no patient had a serum level >30 ng/mL. In contrast, among 18 patients who visited in the summer, 2 patients (11.1%) had serum 25-(OH)D levels >30 ng/mL, 8 patients (44.4%) had levels between 20 and 30 ng/mL, 8 patients (44.4%) had 25-(OH)D levels between 10 and 20 ng/mL, and no patient had a level <10 ng/mL (Fig. 3).

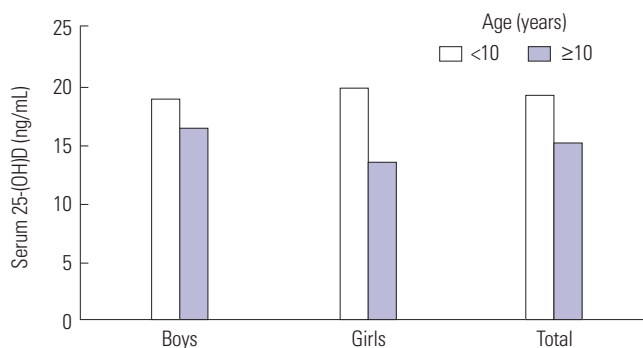


Fig. 1. Levels of serum 25-hydroxy vitamin D according to age group.

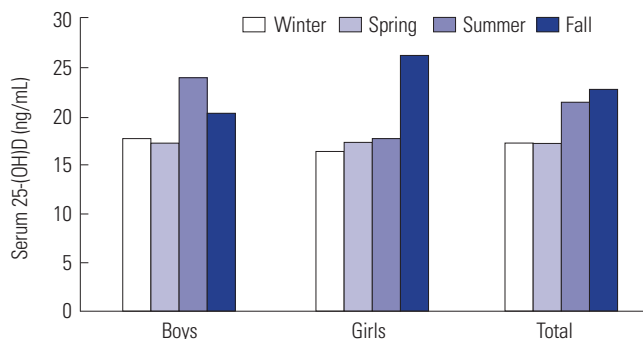


Fig. 2. Levels of serum 25-hydroxy vitamin D according to sex and season.

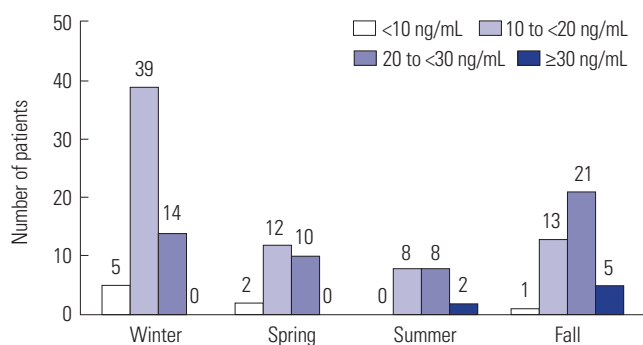


Fig. 3. Distribution of serum 25-hydroxy vitamin D levels of patients grouped according to season.

DISCUSSION

Our study results suggested a positive relationship between vitamin D deficiency and musculoskeletal pain in children. The mean serum 25-(OH)D level in our study population was 19.1 ng/mL, and the prevalence of vitamin D insufficiency [25-(OH)D <20 ng/mL] among our patients was 57.1%. Korean children are believed to be at risk for vitamin D deficiency due to the high latitude at which they reside (34° to 38° N), increased use of sunscreen, reduced outdoor activity, and lack of vitamin D-fortified foods. The prevalence of vitamin D insufficiency in the present study was unexpectedly higher than that reported for cohorts in the United Kingdom (40%) and Canada (39.7%), who live at a higher latitude (UK: 51.5° N, Canada: 45.4° N) than our patients (34° to 38° N).^{7,8} In 2011, Yoon, et al.⁹ measured the serum vitamin D levels in 171 Korean children aged <2 years, and they found the prevalence of vitamin D insufficiency (serum level <30 ng/mL) to be 29.8%. Furthermore, Kim, et al.¹⁰ evaluated the prevalence and risk factors of vitamin D deficiency in 2062 Korean adolescents and found that the mean serum vitamin D level in this group was 17.68 ng/mL. Additionally, 13.4% patients had serum 25-(OH)D levels <10 ng/mL, while 68.1% had levels <20 ng/mL. The average serum 25-(OH)D level among the adolescents in the present study was 15.5 ng/mL, lower than that reported previously in a national survey.¹⁰ Moreover, the prevalence of vitamin D deficiency or insufficiency was higher among our patients than among those in the study by Kim, et al.¹⁰ (78.6% vs. 68.1%). Unfortunately, no data is available on the prevalence of vitamin D deficiency in Korean children aged 2–10 years. However, since the abovementioned studies indicate that older children are more likely to be vitamin D deficient, we presume that the prevalence of vitamin D deficiency in children aged 2–10 years will be higher than that in children <2 years old and lower than that in adolescents.

Consistent with other studies, our study found that the mean serum 25-(OH)D levels were lowest in the winter and spring and highest in the summer.¹¹ Given that vitamin D levels depend on season, time of day, duration of exposure to the sun, use of sunscreens, skin pigmentation, and latitude, synthesis is extremely limited or even impossible during winter months. In the present study, children mostly presented with growing pains in the winter (41.4%), followed by fall (28.6%), spring (17.1%), and summer (12.9%). Our results are similar to those of a study by McNally, et al.,⁸ who reported the clinical characteristics and serum vitamin D levels of 730 Canadian children with unexplained arthralgia. They found that children presented with arthralgia more often in the fall (29.9%) and winter (29.1%) than in the spring (23%) and summer (18%). Further, they measured 25-(OH)D levels in 73 of these children, of which 29 (39.7%) had levels <20 ng/mL. The higher prevalence of symptom onset in the winter confirms that seasonal factors are associated with the onset of growing pains, and this prevalence could be explained by poor sunlight exposure in the winter and the resul-

tant decline in vitamin D levels. With activity and inflammation, the poorly mineralized bone matrix hydrates and expands, causing an outward pressure on the periosteum, leading to pain.^{8,12}

Several studies have suggested that vitamin D deficiency is associated with decreased muscle strength. Ward, et al.¹³ measured the jumping power, velocity, and jumping height using jumping mechanography as well as the serum 25-(OH)D levels of 99 postmenarchal girls and found a positive relationship between vitamin D and both muscle power and force in this population. Similarly, in their study of 301 healthy Chinese adolescent girls, Foo, et al.¹⁴ found that handgrip strength was decreased in patients with vitamin D deficiency. Other studies have also shown that vitamin D deficiency is related to musculoskeletal pain. Plotnikoff and Quigley measured the 25-(OH)D levels in 150 mostly adult patients with persistent nonspecific musculoskeletal pain and found that 93% of patients had levels <20 ng/mL.¹⁵ Additionally, Heidari, et al.¹⁶ compared serum 25-(OH)D levels between 276 adult patients with nonspecific skeletal pain and 202 controls. They grouped the patients according to the anatomical regions of pain and found that the 25-(OH)D levels in the patient group were significantly lower than those in the control group (23.8 ng/mL vs. 33.1 ng/mL) and that the prevalence of 25-(OH)D deficiency was higher in the patients (63.4% vs. 36.1%). They also found that the risk of skeletal pain was 2.9 times higher in subjects with serum 25-(OH)D levels <20 ng/mL than in those with serum 25-(OH)D levels >20 ng/mL and that 25-(OH)D deficiency and skeletal pain were positively associated; the strongest association was between 25-(OH)D deficiency and leg pain.

The results of our study contradict those of Szalay, et al.,¹⁷ who found no association between vitamin D deficiency and nonspecific musculoskeletal pain in children. They evaluated the serum vitamin D levels of 88 children in Albuquerque, New Mexico, USA, a city that has year-round sunshine and where outdoor recreational activities are possible in all seasons. The average level of vitamin D was 29.1 ng/mL in the pain group (n=42) and 32.4 ng/mL in the control group (n=46), and no significant difference in vitamin D levels was observed between these groups. Given that Albuquerque is sunny, only 14% of patients in the study by Szalay, et al.¹⁷ had a serum vitamin D level <20 ng/mL. It is possible that serum vitamin D levels were not so low as to cause pain even in the pain group in this study. Further, as the authors stated, the differences in ethnicity between the patient and control groups (there were more whites in the control group) could also explain their findings.

Our study has several limitations. First, there was no healthy control group (children without growing pains), and no 25-(OH)D measurements from a healthy control cohort of Korean children were available for comparison. Second, due to the retrospective nature of this study, we were not able to collect other parameters such as body mass index or the severity of the pain, which may have affected the results. Finally, the etiol-

ogy of growing pains is multifactorial rather than unifactorial; however, the scope of the present study is limited to vitamin D deficiency as the cause.

In summary, this study found a high prevalence of vitamin D deficiency or insufficiency in Korean children who presented with nonspecific lower-extremity pains, and we believe that vitamin D deficiency is an important contributor to growing pains in children. Although vitamin D is essential for bone growth and mineralization in children, the focus of research on the role of vitamin D status in orthopedics has primarily been on the treatment of rickets. Greater attention should be directed toward vitamin D and its role in the optimization of bone health.

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