Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 7
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

A Study on the Correlation between Levels of 25-Hydroxyvitamin D and Parathyroid Hormone and the Degree of Skeletal Development in Children

Yong Gao, Xuebing Zhang, Caisu Qin*

The First People's Hospital of Lanzhou New Area, Lanzhou 730070, Gansu, China

Author to whom correspondence should be addressed.

Abstract: *Objective:* To analyze the correlation between 25-hydroxyvitamin D (25(OH)D) and parathyroid hormone (PTH) levels and bone development in children. *Methods:* 85 healthy children who underwent routine physical examination in our hospital from January 2022 to December 2023 were selected as the research objects. All children received bone mineral density measurement. According to the results, they were divided into the normal skeletal development group (Z value -1–1) and the skeletal dysplasia group (Z value < -1). The clinical general data and laboratory examination results of the two groups were compared. A multivariate logistic regression model was used to analyze the influencing factors of children's skeletal development. *Results:* The level of 25 (OH) D in the skeletal dysplasia group was lower than that in the normal skeletal development group, and the level of PTH was higher than that in the normal skeletal development group. There were differences in body mass index (BMI), exercise frequency, eating habits, 25 (OH) D, and PTH between the two groups ($p < 0.05$). Multivariate logistic regression analysis showed that it was a risk factor for children with skeletal dysplasia (OR > 1). *Conclusion:* The degree of skeletal development in children is correlated with 25 (OH) D and PTH levels. According to the changes of the above indicators, it can guide the clinical supervision of children's body mass, establish good diet and exercise habits, and promote the normal development of children's bones.

Keywords: 25-hydroxyvitamin D; Parathyroid hormone; Children; Bone development

Online publication: Jul 31, 2026

1. Introduction

During skeletal development, osteoblasts and osteoclasts facilitate bone resorption, maintaining a balance between bone formation and bone destruction. In childhood, bone formation is crucial for skeletal development. Deficiencies in certain elements or diseases can lead to bone loss or increased bone resorption, resulting in deterioration of the bone microstructure, bone pain, bone deformities, and other clinical symptoms [1]. Currently, factors such as the natural environment and genetic predisposition are common influences on skeletal development. Studies have shown that 25-hydroxyvitamin D (25(OH)D), a fat-soluble vitamin, enhances calcium and phosphorus absorption, while parathyroid hormone (PTH) increases osteoclast activity and number, thereby elevating blood calcium levels [2]. Both levels impact the normal development of children's skeletons [3]. Bone mineral density (BMD) is a primary indicator for assessing skeletal development. Recent studies suggest a certain correlation between 25(OH)D, PTH, and skeletal development [4]. To further understand and analyze this, this article examines the BMD measurement results of 85 healthy children who underwent physical examinations between 2022 and 2023, exploring their skeletal development status. The findings are reported as follows:

2. Materials and methods

2.1. General information

Eighty-five healthy children who underwent routine physical examinations at our outpatient clinic from January 2022 to December 2023 were selected as the study subjects. This study was approved by the hospital's ethics committee and conducted with the consent and voluntary participation of the guardians.

2.1.1. Inclusion criteria

(1) Aged 3–14 years
(2) Complete data available;
(3) Able to communicate normally.

2.1.2. Exclusion criteria

(1) Long-term use of medications affecting skeletal development;
(2) Congenital skeletal dysplasia;
(3) Presence of other major diseases;
(4) Withdrawal from the study midway.

2.2. Methods

2.2.1. Survey methods

A self-designed general information survey form was used to collect basic data on the children, including gender, age, height, and body mass; lifestyle factors (exercise frequency, sleep patterns); dietary habits (whether picky eaters, dietary preferences); and laboratory indicators: 25(OH)D, PTH levels, and BMD.

2.2.2. Relevant definitions

(1) Height and weight measurement

Height and weight were measured using a standard stadiometer. Children stood barefoot with their eyes level, and readings were taken in centimeters. Three measurements were taken and averaged. Body mass was measured with shoes and outerwear removed, recorded in kilograms (kg) to two decimal places, and averaged over three measurements. Body mass index (BMI) was calculated as weight/height^2, and BMI

Z-scores (BMI-Z) were computed based on the World Health Organization's child growth reference standards [5]. A score of $1 < \text{BMI-Z} \leq 2$ indicated overweight/obesity.

(2) Lifestyle

Exercise frequency of moderate intensity lasting over one hour, including running and swimming, was categorized as frequent (≥ 5 times/week), moderate (2–4 times/week), or infrequent (≤ 1 time/week). Dietary habits, based on the intake of vegetables, fruits, meat, eggs, milk, and soy products, were classified as regular (≥ 6 times/week) or occasional (≤ 5 times/week).

(3) Laboratory indicators: 25(OH)D and PTH levels: Four milliliters of venous blood were drawn in the morning on an empty stomach, allowed to clot, and then centrifuged at 3000 r/min for 10 minutes. The supernatant was stored in a -25 °C refrigerator and measured within 2 hours using an electrochemiluminescence assay (Roche COBAS E601). Criteria for determination: 25(OH)D ≥ 30 ng/ml indicated sufficiency, while levels below this range indicated deficiency/insufficiency; PTH: normal range for children was 15–65 pg/ml. BMD: Measured at the distal one-third of the medial aspect of the left tibia using a dedicated ultrasound bone densitometer (OSTEOKJ3000+), with data recorded. Criteria for determination: BMD Z-scores between -1 and +1 were considered the parameter confidence interval, with 0 as the standard value. Scores between 0 and +1 indicated above standard, while scores between -1 and 0 indicated below standard.

2.2.3. Observation indicators

A Z-score between -1 and 1 was defined as normal skeletal development, while a Z-score < -1 indicated skeletal dysplasia. General data and laboratory results were compared between the two groups to understand the correlation between children's skeletal development and 25(OH)D and PTH levels.

2.3. Statistical analysis

SPSS 22.0 statistical software was used. Continuous variables were expressed as mean ± standard deviation and compared using *t*-tests. Categorical variables were expressed as percentages and compared using χ^2 tests. Multivariate logistic regression analysis was used to identify factors influencing children's skeletal development; $p < 0.05$ was considered statistically significant.

3. Results

3.1. BMD measurement results

Among the 85 healthy children who underwent BMD examinations, 36.47% (31/85) showed skeletal dysplasia and were included in the skeletal dysplasia group, while 63.53% (54/85) had normal skeletal development and were classified as the normal skeletal development group.

3.2. Comparison of general data between the normal skeletal development group and the skeletal dysplasia group

Significant differences were observed between the two groups in terms of BMI, exercise frequency, dietary habits, 25(OH)D, and PTH levels ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of general data between the normal skeletal development group and the skeletal dysplasia group

General information		n	Dysplastic bone group (n = 31)	Normal bone group (n = 54)	χ^2	*p*
Gender (n)	Male	45	18	27	0.514	0.473
	Female	40	13	27		
Age (years)	≤ 5	42	16	26	1.893	0.388
	6–10	17	8	9		
	≥ 11	26	7	19		
BMI (kg/m²)	Normal	53	9	44	23.080	< 0.001
	Overweight/ Obesity	32	22	10		
Exercise frequency (times/ week)	Frequent	22	5	17	9.435	0.009
	Moderate	45	14	31		
	Rare	18	12	6		
Dietary habits (times/week)	Often	53	12	41	11.620	< 0.001
	Occasionally	32	19	13		
25(OH)D (n)	Sufficient	40	8	32	8.846	0.003
	Deficient/ Insufficient	45	23	22		
PTH (n)	Above normal	48	23	25	6.235	0.013
	Below normal	37	8	29		

3.3. Comparison of 25(OH)D and PTH levels between the two groups

The 25(OH)D level in the skeletal dysplasia group was lower than that in the normal skeletal development group, while the PTH level was higher in the skeletal dysplasia group compared to the normal skeletal development group ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of 25(OH)D and PTH levels between the two groups ($\bar{x} \pm s$)

Group	25(OH)D (ng/mL)	PTH (pg/mL)
Skeletal dysplasia group (n = 31)	27.26 ± 4.26	66.96 ± 5.26
Normal skeletal development group (n = 54)	33.63 ± 5.26	54.26 ± 4.11
t	5.743	12.362
p	< 0.001	< 0.001

3.4. Multivariate logistic analysis of factors influencing children's skeletal development

Children with abnormal skeletal development were designated as the dependent variable (abnormal = 0, normal = 1), while BMI, exercise frequency, dietary habits, 25(OH)D, and PTH were assigned as independent variables. Through multivariate logistic regression analysis, the results indicated that BMI, exercise frequency, dietary habits, 25(OH)D, and PTH were all risk factors for children with abnormal skeletal development (OR values > 1), as shown in **Table 3** and **Table 4**.

Table 3. Assignment table for multivariate variables

Variable	Assignment
BMI	Measured value
Exercise frequency	0 = single lesion, 1 = multiple lesions
Dietary habits	0 = stage I–II, 1 = stage III–IV
25(OH)D	0 = no, 1 = yes
PTH	0 = yes, 1 = no

Table 4. Multivariate logistic analysis of factors influencing children's skeletal development

Factor	β value	SE	Wald χ^2	*p*	OR	OR 95% CI
BMI	0.307	0.169	3.230	< 0.05	1.058	1.014–1.958
Exercise frequency	0.337	0.078	18.667	< 0.05	1.956	1.548–2.545
Dietary habits	0.324	0.119	7.413	< 0.05	1.158	1.058–1.589
25(OH)D	0.374	0.111	11.353	< 0.05	1.758	1.458–1.986
PTH	0.382	0.092	17.241	< 0.05	1.911	1.586–2.458

4. Discussion

Skeletal development is a crucial part of children's growth and development. However, during this period, deficiencies in vitamin D and calcium can adversely affect skeletal development, leading to conditions such as rickets that impact children's physical and mental health. Understanding the risk factors influencing children's skeletal development and proposing corresponding preventive interventions are of significant clinical importance in reducing the incidence of bone destruction and osteoporosis, thereby ensuring healthy growth in children.

This study indicates that BMI, exercise frequency, dietary habits, 25(OH)D, and PTH are all risk factors for children with abnormal skeletal development.

(1) BMI

In obese individuals, mesenchymal stem cells tend to differentiate into adipocytes rather than undifferentiated osteoblasts. This imbalance affects bone formation, leading to an increase in bone marrow fat. Additionally, reduced physical activity in obese children enhances osteoclast activity, inhibits the pathway of osteoprotegerin, and increases bone resorption.

(2) Exercise frequency

In addition to maintaining BMD, appropriate physical exercise is essential for preventing skeletal diseases such as osteoporosis. Studies have shown that physical exercise can improve BMD levels in adolescents [6]. However, some scholars believe that high-intensity sports activities are associated with changes in hip BMD and structure in children and adolescents, and long-term low-intensity activities may not benefit BMD. Therefore, further research is needed to confirm these findings.

(3) Dietary habits

Research on dietary and nutritional factors in adolescent growth and development has increased significantly, particularly regarding the role of calcium, vitamin D, and protein in skeletal and dental development. These nutrients play a significant role in maintaining BMD levels and preventing fractures [7]. If children are picky eaters, have an unbalanced diet, or prefer snacks, their dietary structure becomes unreasonable, affecting healthy skeletal development.

(4) 25(OH)D

25(OH)D serves as an early screening indicator for rickets in children. Insufficient vitamin D levels in the body can lead to the inability of bone salts to deposit, resulting in bone decalcification and hyperplasia of bone-like tissue, which affects BMD and causes osteoporosis. 25(OH)D is a common evaluation indicator, and vitamin D deficiency can affect the normal absorption of bone structure, such as phosphorus absorption in bones and calcium deposition, leading to bone deformation and reduced bone mass over time, thereby lowering BMD.

(5) PTH

PTH regulates blood calcium levels. A deficiency in vitamin D can cause abnormalities in serum calcium, phosphorus, and bone metabolism, affecting intestinal calcium absorption. PTH is an important component in promoting the formation of active vitamin D, and calcium is an indispensable element for maintaining normal growth and development in the body [8]. Abnormal PTH metabolism can affect children's skeletal development and, in severe cases, even impact their intelligence and cognitive abilities. In this study, it was mentioned that 25(OH)D levels in patients with skeletal dysplasia were lower than those in the normal skeletal development group, while PTH levels were higher, with $p < 0.05$. These results suggest that elevated PTH levels and decreased 25(OH)D levels indicate abnormal skeletal development in patients. Based on these findings, they can serve as important diagnostic references for children's growth and development, enabling the proposal of corresponding interventions to ensure healthy growth in children.

5. Conclusion

In summary, there is a correlation between 25(OH)D, PTH, and children's skeletal development. During children's growth and development stages, parents should conduct regular physical examinations, pay attention to nutritional deficiencies, and promptly supplement vitamin D. They should also manage diet and exercise coordination effectively and control weight to promote healthy skeletal development in children.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zhang Y, Lu Y, Liu Y, 2024, Relationship Between Serum 25-Hydroxyvitamin D, Calcium, Zinc Levels, and Children's Growth and Development. Journal of Kunming Medical University, 45(7): 126–131.

[2] Wang H, Luan S, 2024, Correlation Between Short Stature in Children and 25-Hydroxyvitamin D, IGF-1, and IGFBP-3. Guizhou Medical Journal, 48(1): 78–79.

[3] Liu H, Wei Y, Cao X, et al., 2021, Effect of Tiaozhong Zhuyun Decoction on Serum 25-Hydroxyvitamin D and Zinc Levels in Children with Growth Retardation. Journal of Hebei Traditional Chinese Medicine, 36(3): 43–46.

[4] Luo Q, Fu X, 2021, Changes and Clinical Value of Serum 25-Hydroxyvitamin D and Bone Mineral Density Levels in Obese Children. Journal of Practical Laboratory Physicians, 13(2): 80–83.

[5] Onis M, Onyango A, Borghi E, et al., 2007, Development of a WHO Growth Reference for School-Aged Children and Adolescents. Bulletin of the World Health Organization, 85(9): 660–667.

[6] Chang J, Lin C, 2023, Effect of Combined Hemoperfusion on Parathyroid Hormone in Elderly Patients with Renal Osteodystrophy Undergoing Hemodialysis. Chinese Journal of Geriatrics, 42(5): 535–539.

[7] Chen T, Wang H, Chen J, 2023, Correlation Between Vitamin D Levels and Children's Growth and Development. Progress in Clinical Medicine, 13(12): 19136–19142.

[8] Miao J, Zhang Z, 2024, Efficacy of Parathyroid Hormone (1–34) in Elderly Patients with Femoral Neck Fractures Complicated by Osteoporosis. Shenzhen Journal of Integrated Traditional Chinese and Western Medicine, 34(2): 118–120.