



**Assessment of some biochemical parameters (Vitamin D3 and Calcium)
for children under high school age**

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Abstract

This study assessed the effect of the deficiency in the levels of vitamin D3 and calcium on children's health and growth. The study was focused on children aged 1 day to 12 years. The results shown levels of vitamin D3 were higher for males than females, although levels of calcium were similar across both sexes. This suggests that males may have a better vitamin D3 status due to their outdoor activity. Results show that children in the younger age group were deficient in vitamin D3 and calcium Compared to controls. These findings suggest that vitamin D3 and calcium deficiency may contribute to an increased risk of rickets and osteoporosis in children, highlighting the importance of improving nutrition and sun exposure. The study recommends providing vitamin D3 and calcium supplements to children, along with strengthening awareness programs .

Keywords: Vitamin D3, Levels of Calcium, Biochemical parameters, Children's health and growth, Deficiency (VDD) and insufficiency (VDI) of vitamin D3

Introduction

Vitamin D₁, D₂, D₃ and D₄ are a fat-soluble vitamin essential for calcium and phosphorus absorption, Vitamin D₃ are crucial for healthy bones and teeth. It also strengthens the immune system and reduces the risk of chronic infections. The body obtains vitamin D₃ through sunlight exposure and certain foods, such as fatty fish and fortified dairy products.¹ Vitamin D₃ plays a key role in physiological functions within skeletal and extra-skeletal tissues. Deficiency (VDD) and insufficiency (VDI) of vitamin D₃ are linked to various acute and chronic illnesses, including calcium metabolism disorders, autoimmune diseases, certain cancers, type 1 and type 2 diabetes mellitus, cardiovascular diseases, and infectious diseases.^{2, 3} As a steroid hormone, vitamin D₃ has endocrine, paracrine, and autocrine effects. The skin produces vitamin D₃ upon exposure to ultraviolet rays, and it can also be obtained from dietary sources and supplements.⁴⁻⁶ Rickets, a common childhood malnutrition disease, results from insufficient calcium,

phosphorus, and vitamin D3, as well as inadequate sun exposure.⁷ This condition leads to skeletal deformities, such as skull, rib cage, spine, and pelvic bone abnormalities, along with bowed legs.^{7, 8} During childhood and adolescence, vitamin D3 is crucial for calcium absorption and bone development. It helps maintain normal bone turnover and mineralization in adulthood while preventing rickets in children.^{7, 9} Additionally, vitamin D3 may protect against type 1 diabetes mellitus,¹⁰ hypertension,¹¹ multiple sclerosis,¹² and cancer.¹³ Studies indicate that vitamin D3 deficiency is widespread and often unrecognized, affecting young adults, the elderly, and children in various regions.¹⁴ Despite milk fortification, subclinical vitamin D3 deficiency is common, particularly among hospitalized adults, homebound elderly individuals, postmenopausal women with hip fractures, and healthy young adults.^{14, 15} Data on the prevalence of this deficiency among healthy children and adolescents remain limited.¹⁶

The primary source of vitamin D3 is skin synthesis following exposure to ultraviolet radiation (UVR), with less than 10% obtained from dietary sources.¹⁷ The amount produced in the skin depends on factors such as sun angle, latitude, season, time of day, and duration of exposure.¹⁸ Maximum synthesis occurs when the sun is at its zenith, but during winter at latitudes above and below D3 degrees North and South, sun exposure does not produce vitamin D3. Other factors that reduce vitamin D3 production include increased skin pigmentation, aging, and the use of sunscreen^{19, 20}

Vitamin D3 is necessary for calcium absorption from the intestines and for maintaining normal calcium and phosphate levels in the blood. Vitamin D3 deficiency in children occurs when vitamin D3 levels are too low, leading to impaired calcium and phosphorus absorption, poor bone growth, and weakened immunity. This condition can cause rickets, characterized by soft, deformed bones, and results from inadequate sun exposure or dietary intake.²¹ Calcium is the main mineral in building bones and teeth and also plays an important role in regulating the heartbeat, muscle contraction and transmitting nerve signals.²²

Children need adequate amounts of calcium during the growth stage to avoid osteoporosis later on.²³ Hypocalcemia in children is a condition in which the level of calcium in the blood decreases, affecting the health of bones, muscles, and the nervous system, leading to problems such as muscle spasms, weak bones, and delayed growth.²³ This is problems happens by a deficiency of vitamin D3 and Calcium, unhealthy diet, or disorders of absorption.¹⁹ There is lack of consensus amongst clinicians and scientists on the role of

vitamin D3 supplementation in relation to extra skeletal effects particularly in pediatrics;²⁴ this Guideline therefore, does not deal with these effects of vitamin D3.²⁵ Lifestyle of children is including stay indoor without sun exposure for long time (avoiding optimal hours of sun exposure between 10 AM to 3 PM, the best time to form Vitamin D3 in the skin) further reduce the sunlight exposure and therefore rise the tendency for vitamin D3 deficiency.^{25, 26}

In addition , regularly low levels of calcium are described in children from numerous studies, especially those from lower socioeconomic country because mostly their families cannot provide healthy food for their children regularly.²⁷

Vitamin D3 deficiency occurs when serum levels of vitamin D3-25-hydroxy (25- OH) D fall below 20 ng/ml (50 nmol/L) in children. Levels between 21-29 ng/ml are considered insufficient (deficiency of Vitamin D3), while levels above 30 ng/ml are generally considered adequate. Diagnosis usually involves a blood test to measure these vitamin D3 levels.²⁸

Vitamin D3 and calcium deficiency in children poses a risk to their growth and general health. It affects the bones, muscles, and nervous system as follows:

- Rickets causes weak bones, bowed legs, and skeletal deformity.
- Muscle weakness causes delayed walking, difficulty moving, And an increased risk of falling.
- Delayed growth: may lead to short stature and delayed teething.
- Muscle cramps due to low blood calcium, which may cause painful or Serious convulsions.
- Osteoporosis increases the risk of fractures and injuries even at a young age.
- Weak immunity increases the likelihood of recurrent infections.

Vitamin D3 and calcium deficiency in children is a serious health problem that can lead to serious complications if left untreated. Early recognition and proper management are crucial to ensure healthy growth and development. Regular checkups of children can help identify nutritional deficiencies early.^{28, 29}

Methods

A set of results was collected from Al-Azhar Laboratory and Al-Thiaq Specialized Laboratory. The study included 52 test results from male and female. The children aged between one day and 12 years. 26 samples of patients and 26 samples of control groups.

All the parameters were used serum, the methodology tacked 5 ml of blood from the arm of the patient, than, sample is putted in a tube. Finaly, all the tubes sent to the laboratory for vitamin D3 and calcium analysis.

The concentration of vitamin D3 was measured using the specified analytical method [25-OH vitamin D3 total]. While, the serum total calcium level was determined using the appropriate laboratory technique. The normal range for serum calcium is 8.6-10.0 mg/dL, while vitamin D3 levels below 20 ng/mL are classified as deficient.^{30, 31}

These results were statistically analyzed based on their respective reference ranges.

Note:- 1-The samples were shown result of level VitaminD3 and Calcium in normal range, they considered as controls group; and the samples were shown result of level VitaminD3 and Calcium in lower than normal range as patient groups.

2- All the samples were talked from children don't have any other chronic disease

Results

Table 1 Presents the results of children (Control group), without vitamin D3 and calcium deficiency

Sex	Age	Vitamin D3	Calcium
Male	3 Months	45.6	9.8
Female	6 Months	60.2	9.7
Female	8 Months	80.2	9.3
Male	1 Years	50.3	9.6
Male	1 Years	70.2	9.3
Female	2 Years	74.6	9.2
Female	2 Years	60.2	9.7
Male	2 Years	30.6	9.6
Male	3 Years	42.3	9.8
Female	3 Years	22.3	9.3
Female	3 Years	50.6	9.2
Male	4 Years	40.3	9.6
Male	4 Years	36.2	9.5
Male	4 Years	40.2	9.6
Female	5 Years	32.5	9.6
Male	6 Years	20.6	9.6
Male	7 Years	23.5	9.3

Female	7 Years	52.3	9.7
Female	8 Years	60.5	9.5
Female	8 Years	56.3	9.8
Female	9 Years	50.2	9.6
Female	10 Years	30.4	9.8
Male	10 Years	70.2	9.8
Male	11 Years	30.2	8.8
Male	11 Years	22.6	9.5
Female	12 Years	50.2	8.9

Table 2 Presents the results of males (Control group) without vitamin D3 and calcium deficiency.

Sax	Age	Vitamin D3	Calcium
Male	3 Months	45.6	9.8
Male	1 Years	50.3	9.6
Male	1 Years	70.2	9.3
Male	2 Years	30.6	9.6
Male	3 Years	42.3	9.8
Male	4 Years	40.3	9.6
Male	4 Years	36.2	9.5
Male	4 Years	40.2	9.6
Male	6 Years	20.6	9.6
Male	7 Years	23.5	9.3
Male	10 Yrars	70.2	9.8
Male	11 Years	30.2	8.8
Male	11 Years	22.6	9.5

Table 3 Presents the results of females (Control group) without vitamin D3 and calcium deficiency.

Sax	Age	Vitamin D3	Calcium
Female	6 Months	60.2	9.7
Female	8 Months	80.2	9.3
Female	2 Years	74.6	9.2
Female	2 Years	60.2	9.7
Female	3 Years	22.3	9.3
Female	3 Years	50.6	9.2
Female	5 Years	32.5	9.6
Female	7 Years	52.3	9.7
Female	8 Years	60.5	9.5
Female	8 Years	56.3	9.8
Female	9 Years	50.2	9.6
Female	10 Years	30.4	9.8
Female	12 Years	50.2	8.9

Table 4 Presents the results of children with vitamin D3 and calcium deficiency

Sex	Age	Vitamin D3	Calcium
Female	1 Days	4.3	5.2
Female	2 Days	3.2	4.3
Female	3 Days	4.3	4.5
Female	3 Days	3	6.5
Female	4 Days	7.2	7.2
Female	4 Days	4.8	5.6
Female	5 Days	4.6	5.4
Male	6 Days	3.4	6.2
Female	7 Days	3.2	4.5
Male	8 Days	3.9	5.5
Female	9 Days	4.2	6.6
Male	1 Years	13.2	8.4
Male	2 Years	11.1	7.8
Female	2 Years	10.1	7.6
Female	3 Years	16	8.2
Female	3 Years	4.5	8.1
Female	4 Years	6.3	4.6

Female	5 Years	13.2	7.6
Male	5 Years	14.1	8.3
Female	6 Years	9.9	8.1
Female	7 Years	14	7.8
Male	7 Years	13.2	7.8
Male	8 Years	15.4	7.4
Female	8 Years	5.5	7.8
Female	10 Years	10.7	9.3
Male	12 Years	9	6.7

Table 5 Presents the results of males (Patients group) of vitamin D3 and calcium deficiency.

Sex	Age	Vitamin D3	Calcium
Male	6 Days	3.4	6.2
Male	8 Days	3.9	5.5
Male	1 Years	13.2	8.4
Male	2 Years	11.1	7.8
Male	5 Years	14.1	8.3
Male	7 Years	13.2	7.8
Male	8 Years	15.4	7.4
Male	12 Years	9	6.7

Table 6 Presents the results of female (Patients group) of vitamin D3 and calcium

Sex	Age	Vitamin D3	Calcium
Female	1 Days	4.3	5.2
Female	2 Days	3.2	4.3
Female	3 Days	4.3	4.5
Female	3 Days	3	6.5
Female	4 Days	7.2	7.2
Female	4 Days	4.8	5.6
Female	5 Days	4.6	5.4
Female	7 Days	3.2	4.5
Female	9 Days	4.2	6.6
Female	2 Years	10.1	7.6

Female	3 Years	16	8.2
Female	3 Years	4.5	8.1
Female	4 Years	6.3	4.6
Female	5 Years	13.2	7.6
Female	6 Years	9.9	8.1
Female	7 Years	14	7.8
Female	8 Years	5.5	7.8
Female	10 Years	10.7	9.3

Table 7 Presents the results of Calcium deficiency across different age groups (patients groups).

Number of group	Age groups	Number of patients	Number of children with Calcium deficiency	Number of healthy children
1.	1 Days - 1 Years	17	12	5
2.	2 Years - 4 Years	14	5	9
3.	5 Years - 8 Years	13	7	6
4.	9 Years - 12 Years	8	1	7

Table 8 illustrates the prevalence of vitamin D3 deficiency across different age groups.

Number of group	Age groups	Number of patients	Number of children with Vitamin D3 deficiency	Number of healthy children
1.	1 Days - 1 Years	17	12	5
2.	2 Years - 4 Years	14	5	9
3.	5 Years - 8 Years	13	7	6
4.	9 Years - 12 Years	8	2	6

Discussion

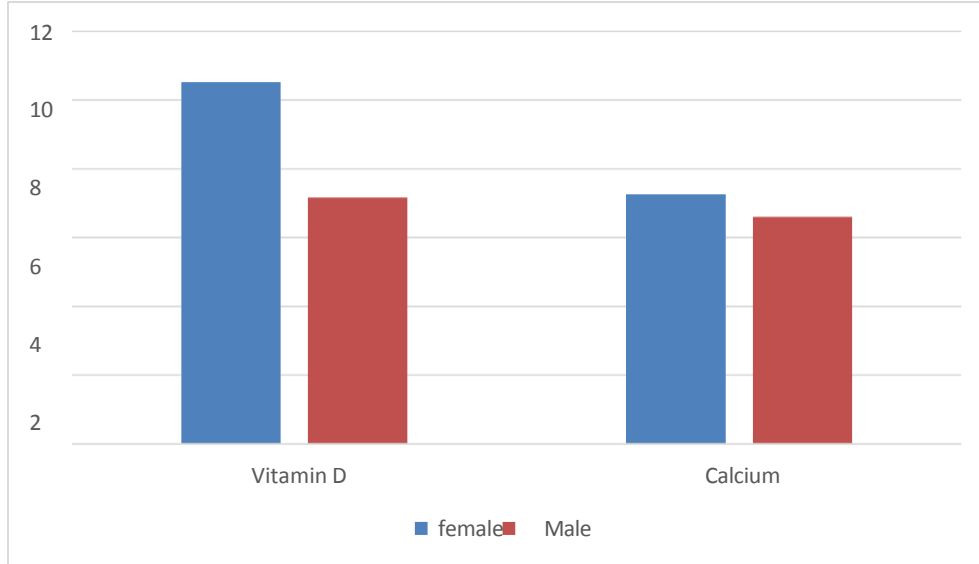


Figure 1 Calcium and Vitamin D3 Levels in Patients by Gender

In our study, vitamin D3 levels were higher in males (10) compared to females (7), while calcium levels showed a slight difference between the two genders (7 in males vs. 6 in females). This suggests that males might have better vitamin D3 status, potentially due to higher outdoor activity and sun exposure. A similar trend was reported by Alicja et al. (2022),³² who found that vitamin D3 deficiency is more prevalent in females, likely due to lifestyle and dietary differences. Their study emphasized that dietary counseling alone was insufficient to correct these deficiencies, highlighting the need for supplementation, which supports the potential necessity of targeted interventions in our population.³³

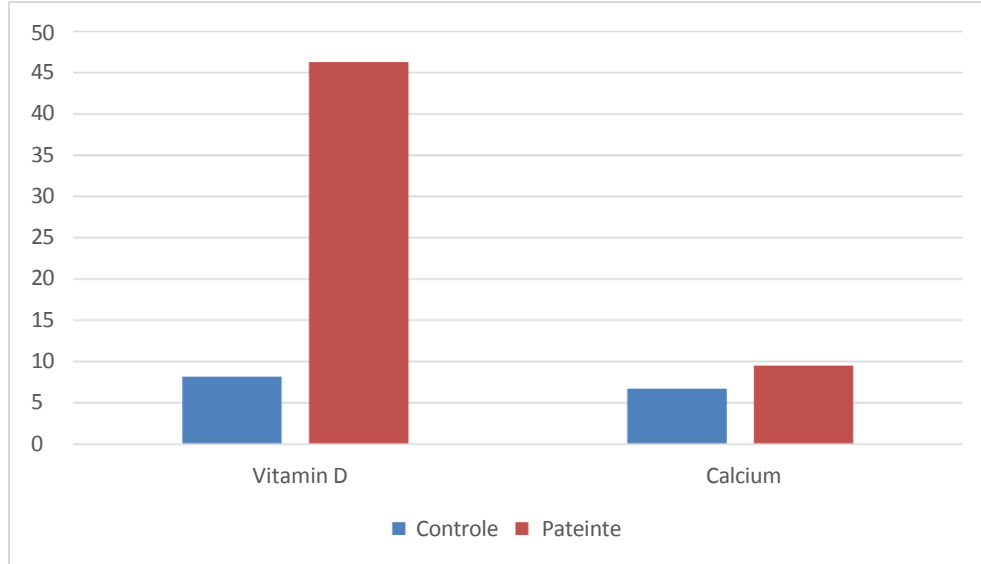


Figure 2 Calcium and Vitamin D3 Levels in Patients vs. Healthy Controls

Our study revealed that patients had significantly lower vitamin D3 levels (7) compared to healthy controls (46), while calcium levels were also lower in patients (6) than in controls (7). This finding highlights the severity of vitamin D3 and calcium deficiency in our patient group. Erick et al. (2020)³⁴ reported a similar pattern, where children with chronic illnesses had significantly lower vitamin D3 levels than healthy peers, reinforcing the role of supplementation and nutritional interventions in preventing complications such as rickets and hypocalcemia. The marked difference in our study suggests the urgent need for improved dietary intake and possibly vitamin D3 fortification strategies.³⁵

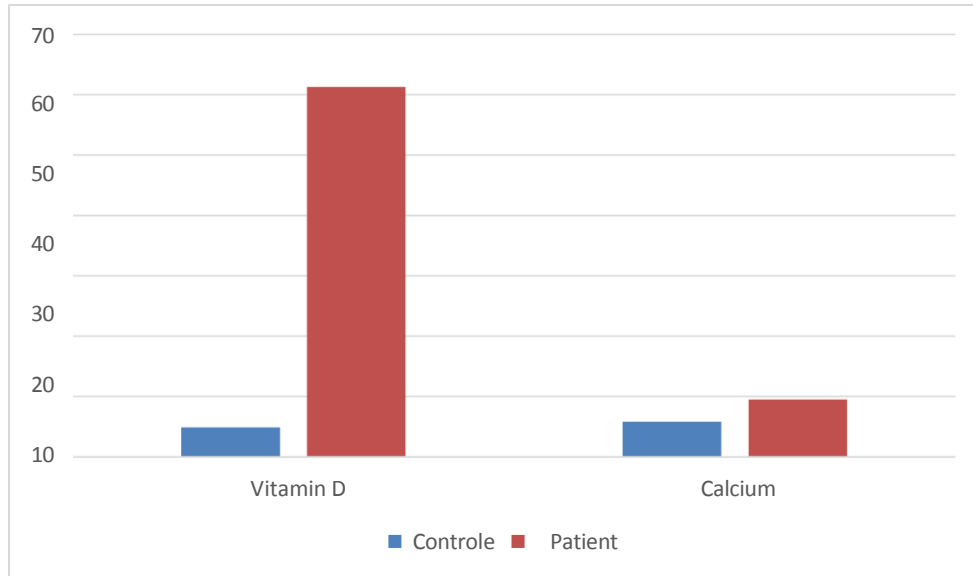


Figure 3 Calcium and Vitamin D3 Levels in the First Age Category (1 Days - 1 Years)

In the youngest age group, our study found that patients had markedly lower vitamin D3 (6) compared to controls (60), with a similar trend for calcium (5 vs. 7). This indicates that younger children are at higher risk of severe vitamin D3 deficiency. Fiscaletti et al. (2017)³⁶ emphasized that vitamin D3 deficiency is particularly critical in early childhood due to its role in skeletal growth and immune function. Their study suggested that infants and toddlers require more aggressive supplementation, which aligns with our findings and highlights the need for early intervention programs.³⁶

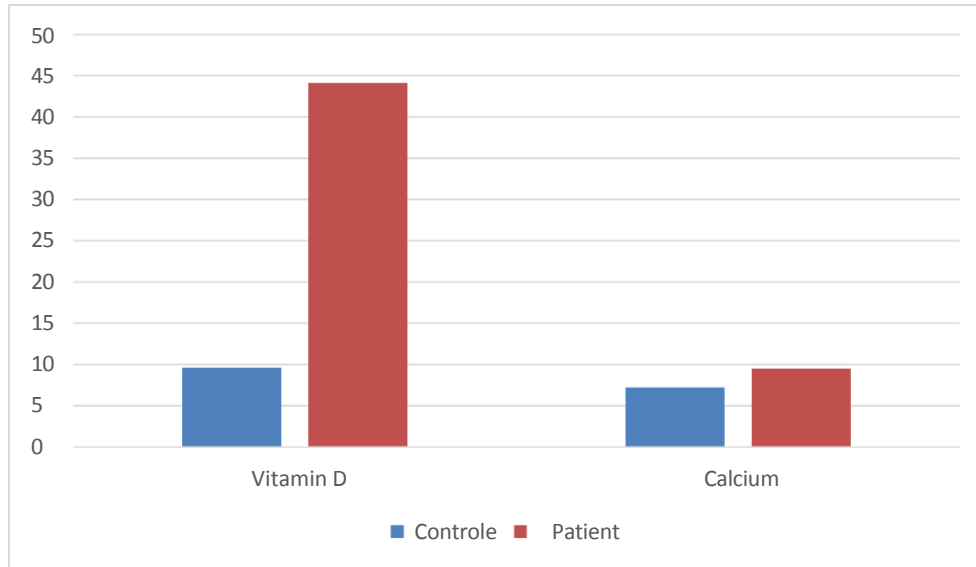


Figure 4 Calcium and Vitamin D3 Levels in the Second Age Category (2 Years - 4 Years)

Our study showed that children in the second age group had vitamin D3 levels of (7) compared to (45) in controls, while calcium levels remained lower in patients (5 vs. 7). This suggests that the deficiency persists beyond infancy. Escobedo-Monge et al. (2024)³⁷ found that children and adolescents with chronic conditions exhibit persistent vitamin D3 and calcium deficiencies mostly because of malnutrition, affecting their overall growth and metabolic health. Our findings further support the need for continued supplementation throughout childhood, particularly in at-risk populations.³⁷

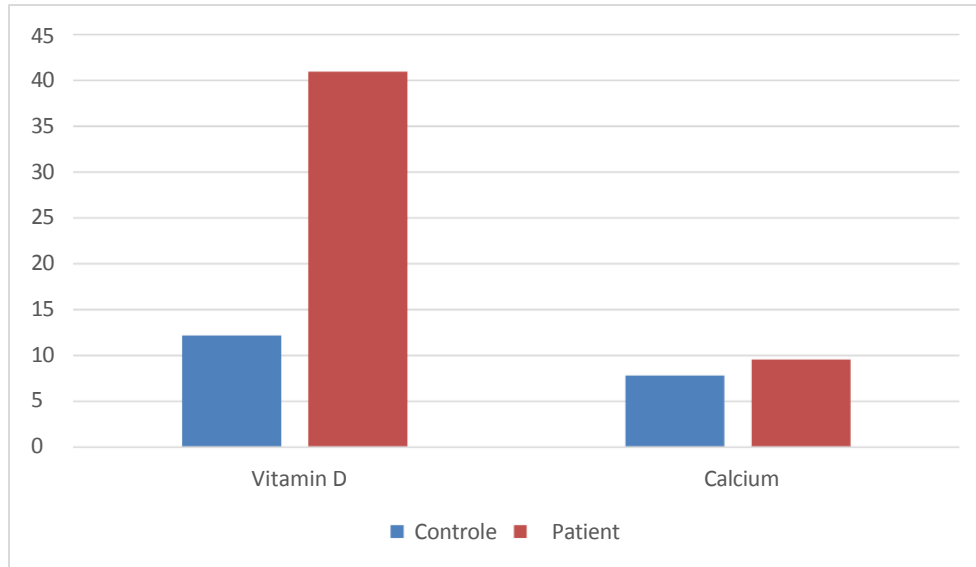


Figure 5 Calcium and Vitamin D3 Levels in the Third Age Category (5 Years - 8 Years)

In our study, older children (third category) had higher vitamin D3 (12) compared to younger groups, but still significantly lower than controls (40). Calcium levels showed slight improvement (6 vs. 7). This suggests a slight recovery with age but continued deficiency that because the children in younger age need to Calcium and VitaminD3 more than old group age, for building their bodies.³⁸ Tytusa et al. (2022)³⁹ examined vitamin D3 and calcium intake in school-aged children and found that even in older children, deficiencies were prevalent, affecting bone health. Their findings reinforce the necessity of long-term monitoring and intervention, as reflected in our data.³⁹

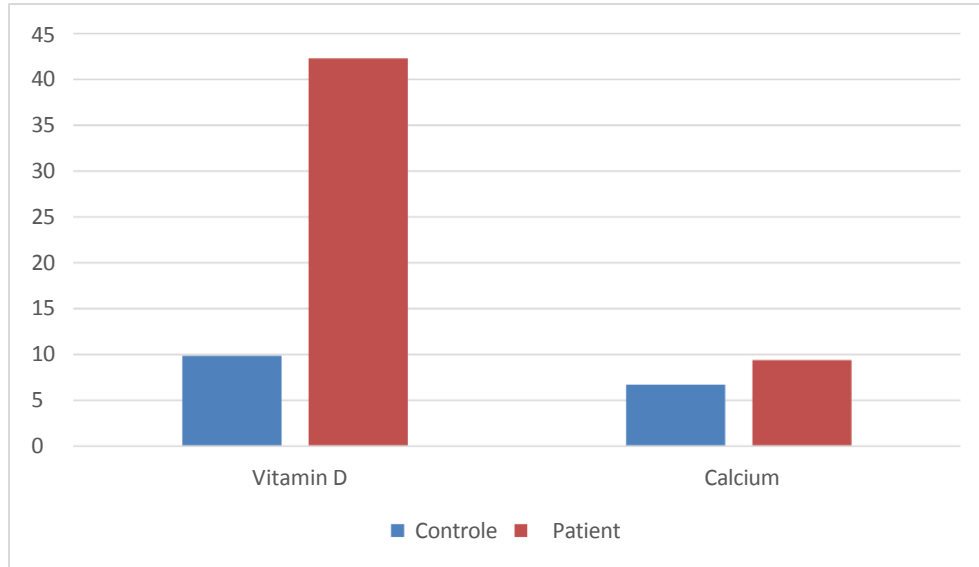


Figure 6 Calcium and Vitamin D3 Levels in the Fourth Age Category (9 Years - 12 Years)

Our study found that vitamin D3 levels (12) and calcium levels (6) in the fourth age category were still lower than in healthy controls (40 and 7, respectively). This indicates that deficiencies persist into adolescence. Bacchetta et al. (2022)⁴⁰ highlighted that adolescence is a crucial period for bone mineralization, and inadequate vitamin D3 and calcium intake increases the risk of osteoporosis later in life.⁴¹

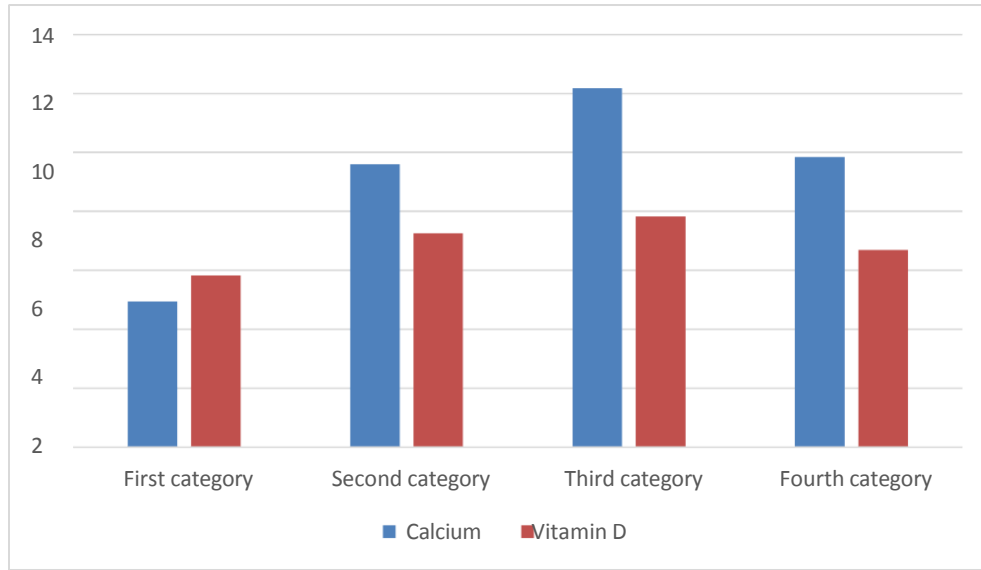


Figure 7 Calcium and Vitamin D3 Levels in Patients by Age Category

In our study, we observed that vitamin D3 levels increased slightly with age, starting at 5 in the first category, reaching 13 in the third category, and slightly decreasing to 11 in the fourth. Similarly, calcium levels showed a gradual rise from 5 in younger children to 9 in older groups. However, despite this improvement, levels remained suboptimal, indicating that age alone does not correct the deficiency. Roberto et al. (2018),⁴² who emphasized that vitamin D3 deficiency during childhood can have long-term consequences, including impaired bone mineralization and increased susceptibility to chronic diseases. Their findings suggest that relying solely on dietary intake may not be sufficient to restore adequate levels, reinforcing the necessity of continued supplementation and dietary fortification strategies, especially for at-risk pediatric populations.⁴³

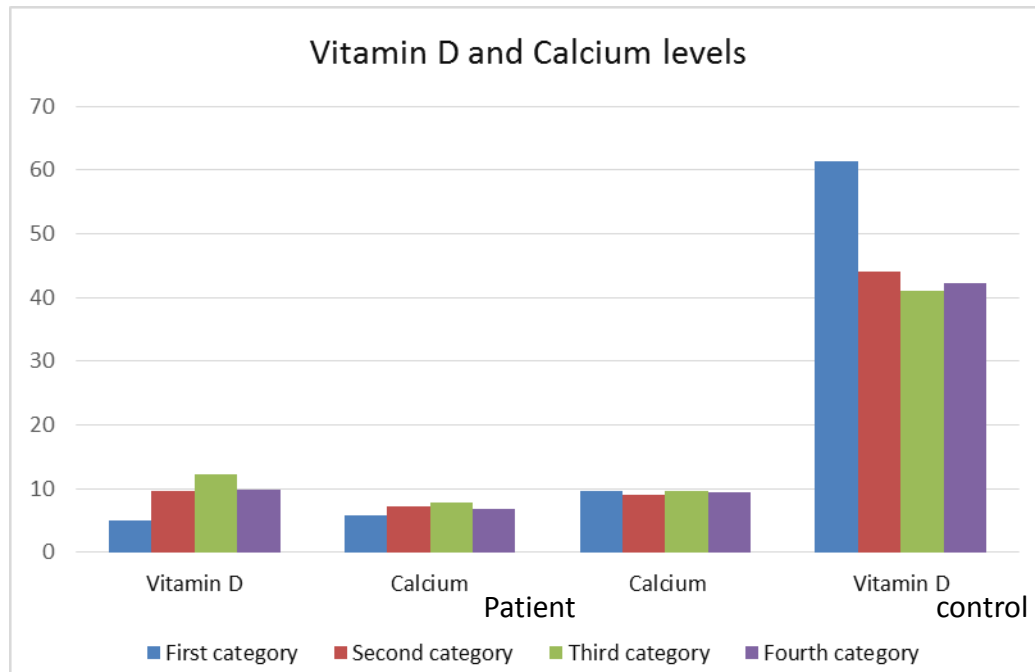


Figure 8 Vitamin D3 and Calcium Levels in Patients vs. Controls by Age Category

Our study revealed that across all age groups, patients had consistently lower vitamin D3 and calcium levels than healthy controls, demonstrating a persistent deficiency that does not resolve with age. For instance, vitamin D3 levels in patients remained around 5–13, whereas in healthy controls, they were significantly higher at 10–45. Calcium levels followed a similar trend, remaining lower in patients compared to controls. This persistent disparity aligns with the findings of Andrew et al. (2022)⁴⁴, who highlighted that vitamin D3 and calcium deficiencies are prevalent across pediatric age groups and require structured public health strategies. Their expert consensus emphasized that dietary interventions alone are insufficient, advocating for routine screening and supplementation programs to bridge the gap in nutrient intake and prevent long-term complications. Our findings reinforce this perspective, highlighting the urgency of early intervention to prevent adverse skeletal and metabolic outcomes in deficient populations.⁴¹

In our study, which included 52 children, 26 children were found to have vitamin D3 deficiency, and 25 children had calcium deficiency. This highlights the strong correlation between vitamin D3 deficiency and calcium deficiency in the body.

Vitamin D3 plays a crucial role in the absorption of calcium from the intestines, which helps maintain normal calcium levels in the blood. When vitamin D3 levels are low, calcium absorption becomes impaired, leading to a

reduction in calcium levels in the blood. To compensate for this, the parathyroid glands release parathyroid hormone, which draws calcium from the bones. As a result, bone health can deteriorate, increasing the risk of fractures.⁴¹

A study similar to the findings of our research demonstrated a significant correlation between vitamin D3 deficiency and decreased calcium levels in the blood. This study, conducted in Sebha city, found that 62.9% of the participants had vitamin D3 deficiency, while 67.7% exhibited calcium deficiency, regardless of gender.¹⁷

Conclusions

In conclusion, this study explored vitamin D3 and calcium deficiency in children from multiple perspectives. One of the key findings was the significant deficiency in vitamin D3 and calcium levels among children, exposing them to various health risks, most notably osteoporosis and rickets. This aligns with medical literature indicating that vitamin D3 and calcium deficiency are among the leading causes of bone disorders in children.

Research findings also highlight a notable deficiency in these nutrients, with lower levels observed in females and younger children, depending on age and gender. Therefore, we recommend raising awareness about the importance of adequate sun exposure and maintaining a diet rich in vitamin D3 and calcium. Additionally, appropriate supplementation under medical supervision may be necessary, particularly for children at higher risk of deficiency. Health authorities should also implement preventive programs that include regular screening for these nutrients to ensure healthy growth and prevent related health complications.

We hope this study contributes to expanding knowledge on vitamin D3 and calcium deficiency in children and paves the way for further research in the future.

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