

## **Dietary Supplementation of Vitamin D to Curb Rickets in Children under Five Years in India**

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**Purpose:** Rickets is a common disorder among children under five years mostly in the developing countries. It negatively affect normal growth and development of children thereby reducing their genetic potential. The purpose of this study was to analyze the cause of rickets in children under five years and solutions available.

**Methodology:** This study employed a descriptive cross-sectional approach and was conducted in the pediatric outpatients department of the Guru Tegh Bahadur (GTB) Hospital & University College of Medical Sciences (UCMS) Delhi. The study period was one year from September 2021 to September 2022 on 130 diagnosed cases of the rickets. Patients were enrolled via non-probability convenient sampling technique and a set developed inclusion and exclusion criteria. Data was collected through self-structured questionnaire after taking informed consent. Data analysis was done using SPSS version 26.

**Findings:** The study found out that giving getting enough of both vitamin D and calcium is crucial to maintaining bone health and protecting against disorders like osteoporosis, a condition that is characterized by weak, brittle bones. While the daily value (DV) of vitamin D is 800 IU per day, the recommended dietary allowance (RDA) differs slightly depending on your age. Children and adults ages 1–70 need approximately 600 IU of vitamin D per day. This can come from a combination of food sources and sunlight. Adults over 70 should aim for at least 800 IU (20 mcg) of vitamin D per day. The RDA for calcium also varies by age. Children ages 4–8 need about 1,000 mg of calcium daily. Children ages 9–18 need approximately 1,300 mg daily. Adults ages 19–50 need about 1,000 mg daily. Over the age of 50, most people need 1,200 mg per day.

**Conclusion:** The study conclude that children aged between one and three years are more susceptible to rickets than children between four and five years. The study also conclude that lower socioeconomic background, male gender, exclusive breastfeeding, unbalanced nutrition and mother's poor nutritional status all contribute to high incidences of rickets in children under five years. Vitamin D is necessary for calcium absorption in your body. This plays a key role in maintaining bone strength and skeletal integrity.

**Recommendations:** Supplements should be added in the diet of children during breastfeeding. Also, there should be adequate sunlight exposure of children. Finally, malnutrition of both children and mothers should be treated.

**Keywords:** *Rickets, nutrition, children, supplements.*

## INTRODUCTION

According to Prentice (2013), rickets is a condition associated with bone-deformity due to inadequate mineralization in growing bones. While some cases relate to hereditary syndromes, renal disease, or use of medication, rickets in the world mostly stems from nutritional insufficiency Mughal (2011). Nutritional rickets is prevalent throughout much of the developing world and is again being increasingly seen in more developed countries. Rickets is a skeletal disorder that's caused by a lack of vitamin D, calcium, or phosphate. These nutrients are important for the development of strong, healthy bones. People with rickets may have weak and soft bones, stunted growth, and, in severe cases, skeletal deformities. Vitamin D helps your body absorb calcium and phosphate from your intestines. People can get vitamin D from various food products, including milk, eggs, and fish. Your body also produces the vitamin when you're exposed to sunlight (Munns et al., 2016). A vitamin D deficiency makes it difficult for human body to maintain sufficient levels of calcium and phosphate. When this occurs, human body produces hormones that cause calcium and phosphate to be released from bones. When human bones lack these minerals, they become weak and soft.

Rickets has become common in some parts of India during the past two decades (Carpenter et al., 2017). The clinical features of rickets are similar around the world, but the age of presentation and the risk of hypocalcaemic symptoms, such as tetany, vary depending on the age of presentation and the relative importance of vitamin D (versus calcium) deficiency in different populations. In areas where vitamin D deficiency is more common, rickets usually presents in the first year of life often with clinically-significant hypocalcaemia. In parts of Africa and in India (where calcium deficiency accounts for much of the prevalent nutritional rickets), rickets usually presents from the second year of life, and hypocalcaemic tetany is much less commonly seen.

Where rickets is a result of calcium deficiency, growth plates become soft as a result of diminished mineralization. With weight-bearing, gravitational pressure causes soft bones to curve in response to forces exerted across joints. Thus, the long bones of the leg curve becoming 'bow legs' or, show up later onset of rickets in the form of 'knocked knees' (Aggaral al et ., 2012). Metaphyses expand laterally such that wrists and ankles can be palpably widened. Costochondral junctions also expand with demineralized bone structures, and beading or pearly of the chest-wall is noted. Fontanelles close late, and teeth erupt later than in other children. Children affected by rickets potentially experience delays in learning to walk, pain and fractures, and crippling deformities. In addition, rickets dramatically increases the risk of pneumonia (Shaw, 2016) a condition which accounts for significant amounts of childhood mortality in developing regions of the world.

### **Factors Accelerating Rickets in Children**

Rickets is most common in children who are between 6 and 36 months old. Children are at the highest risk of rickets because they're still growing. During this time period, children usually experience rapid growth. This is when their bodies need the most calcium and phosphate to strengthen and develop their bones. According to Chanchlani et al. (2020), rickets is rare in the most developed countries and it mostly disappeared in these countries during the 1940s due to the introduction of fortified foods, such as cereals with added vitamin D. Diet is another factor that contribute to rickets in children. Children have a higher risk of developing rickets if they eat a vegetarian diet that doesn't include fish, eggs, or milk. They're also at an increased risk if they have trouble digesting milk or have an allergy to milk sugar (lactose). Infants who are only fed

breast milk can become deficient in vitamin D as well. Breast milk doesn't contain enough vitamin D to prevent rickets. Another factor that accelerates rickets is skin color. As stated by Mittal et al., (2014). Children of African, Pacific Islander, and Middle Eastern descent are at the highest risk for rickets because they have dark skin. Dark skin doesn't react as strongly to sunlight as lighter skin does, so it produces less vitamin D. Additionally, geographic location is a predisposing factor for rickets to children. Human bodies produce more vitamin D when they're exposed to sunshine, so children are more at risk for rickets if they live in an area with little sunlight. Furthermore, genes are also a factor that accelerates rickets in children. One form of rickets can be inherited. This means that the disorder is passed down through child's genes. This type of rickets, called hereditary rickets, prevents child's kidneys from absorbing phosphate.

Symptoms of rickets include pain or tenderness in the bones of the arms, legs, pelvis, or spine stunted growth and short stature, bone fractures, muscle cramps, teeth deformities and skeletal deformities (Bjelakovic et al., 2014). Teeth deformities that can manifest when a child has rickets are delayed tooth formation, holes in the enamel, abscesses, defects in the tooth structure, an increased number of cavities. Skeletal deformities that can manifest when a child has rickets are an oddly shaped skull, bowlegs, or legs that bow out, bumps in the ribcage, a protruding breastbone, a curved spine, and pelvic deformities.

## **METHODOLOGY**

The researcher were able to diagnose rickets by performing a physical examination. They checked for tenderness or pain in the bones by lightly pressing on them. The researchers also ordered certain tests to help make a rickets diagnosis, including blood tests to measure the levels of calcium and phosphate in the blood, bone X-rays to check for bone deformities. In rare cases, a bone biopsy was performed. This involved the removal of a very small section of bone, which was sent to a laboratory for analysis. Treatment for rickets focused on replacing the missing vitamin or mineral in the body. This focused on eliminating most of the symptoms associated with rickets. If a child had a vitamin D deficiency, the doctors likely wanted them to increase their exposure to sunlight, if possible. They also encouraged them to consume food products high in vitamin D, such as fish, liver, milk, and eggs. Calcium and vitamin D supplements were also used to treat rickets. The doctors also advised about the correct dosage as it can vary based on the size of the child. Too much vitamin D or calcium can be unsafe.

If skeletal deformities were present, such children needed braces to position their bones correctly as they grow. In severe cases, the researchers recommended such children to undergo corrective surgery. For hereditary rickets, a combination of phosphate supplements and high levels of a special form of vitamin D were required to treat the disease.

## **FINDINGS**

The researchers found that increasing vitamin D, calcium, and phosphate levels did help correct the disorder. Most children with rickets experienced improvements in about one week. Skeletal deformities improved or disappeared over time because rickets was corrected while the children were still young. However, some children with skeletal deformities became permanent when the disorder wasn't treated during a child's growth period. Some children recovered from rickets with moderate sun exposure. According to the National Health Service of England (NHS), human only need to expose their hands and face to sunlight a few times a week during the spring and summer

months to prevent rickets. Most adults get enough exposure to sunlight. It's important to note that too much sunlight can damage child's skin, and sunscreen should be applied to prevent burns and skin damage. Sometimes, the use of sunscreen can prevent child's skin from producing vitamin D, so it's beneficial to give foods that contain vitamin D or to take vitamin D supplements. These preventive measures can significantly lower child's risk of developing rickets. To reduce the risk of skin cancer, it's smart to cover up, wear sunscreen, and avoid allowing children being outside during peak sun hours. The study found out that it's best to get vitamin D from food or supplements. The healthy foods that the researchers found were very significant in supplementing high vitamin D were salmon, herring and sardines, cod liver oil, canned tuna, egg yolks, mushrooms, and vitamin D fortified foods.

According to the food analysis that was conducted by the United States Department of Agriculture (USDA) Food Composition Database, one 3.5-ounce (100-gram) serving of farmed Atlantic salmon contains 526 IU of vitamin D, or 66% of the DV. Whether the salmon is wild or farmed can make a big difference in the vitamin D content. This study found out that on average, wild-caught salmon has more vitamin D. The amount of vitamin D will vary depending on where the salmon is caught and the time of year. This findings confirmed a study by Pludowski et al. (2018) which showed that the vitamin D content of salmon caught in the Baltic sea ranged from 556–924 IU of vitamin D per one 3.5-ounce (100-gram) serving, providing 70–111% of the DV. Another food supplement that was found useful to revert rickets in children was herring. Herring is a fish eaten around the world. It is often smoked or pickled. This small fish is also a great source of vitamin D. Fresh Atlantic herring provides 214 IU per 3.5-ounce (100-gram) serving, which is 27% of the DV (Stockton et al., 2011). Children who refused to eat fresh fish were served with pickled herring as a good source of vitamin D, providing 113 IU per 3.5-ounce (100-gram) serving, or 14% of the DV. Pickled herring also contains a high amount of sodium, at 870 mg per serving. It may not be a great option if you are trying to lower your salt intake (Aggarwal et al., 2013).

The study also found out that cod liver oil is an important and a popular vitamin D supplement. Children who don't like fish can be fed with cod liver oil as another way to get nutrients that are hard to get otherwise. During the study, it was found out that cod liver oil is an excellent source of vitamin D. At about 450 IU per teaspoon (4.9 mL), it clocks in at a massive 56% of the DV. It has been used for many years to treat vitamin D deficiency. It also has a history of being used as part of treating rickets, psoriasis, and tuberculosis (Stockton et al., 2011). Cod liver oil is also very high in vitamin A, with 150% of the DV in just a single teaspoon (4.9 mL). Vitamin A can be toxic in high amounts. The safe upper limit (UL) for vitamin A is 3,000 mcg. A single teaspoon (4.9 mL) of cod liver oil contains 1,350 mcg of vitamin A.

The study also found out that egg yolks or whole eggs are another good source of vitamin D as well as a wonderfully nutritious food. Most of the protein in an egg is found in the white, and the fat, vitamins, and minerals are found mostly in the yolk. According to Elder and Bishop (2014) the yolk from one large egg contains 37 IU of vitamin D, or 5% of the DV. It was also found out that a few factors affect the vitamin D level of egg yolks. Sun exposure for the chicken, the vitamin D content of the chicken feed, and exposing liquid yolk to UV light will increase vitamin D in the egg. When given the same feed, pasture-raised chickens that roam outside in the sunlight produce eggs with levels 3–4 times higher. Additionally, eggs from chickens given vitamin D enriched feed may have up to 34,815 IU of vitamin D per 100 grams of yolk. So if one yolk is about 17 grams, which means you'll get around 2.5 times the DV of vitamin D in a single egg.

Finally, the study found out that vitamin D fortified foods can be a great source of vitamin D where natural sources of vitamin D are limited, especially if a family is vegetarian or don't like fish. Fortunately, some food products that don't naturally contain vitamin D are fortified with this nutrient. Cow's milk is a naturally good source of many nutrients, including calcium, phosphorous, and riboflavin (Prentice, 2013). Some store-bought cow's milk bought during the study were found to be fortified with vitamin D. One cup of fortified cow's milk found to contain 115 IU of vitamin D per cup (237 mL), or about 15% of the DV. One cup of fortified wheat bran flakes contained 145 IU of vitamin D, equal to 18% of the DV. One cup of fortified crisp rice cereal had 85 IU of vitamin D, or 11% of the DV.

## CONCLUSION

Wild salmon typically contains more vitamin D than farmed salmon, but both are good sources of vitamin D. In a 3.5-ounce (100-gram) serving, farmed salmon contains around 66% of the DV and wild salmon can contain up to 160% of the DV. Cod liver oil contains 450 IU of vitamin D per teaspoon (4.9 mL), or 56% of the DV. It is also high in other nutrients, such as vitamin A and omega-3 fatty acids. In addition, cod liver oil is high in omega-3 fatty acids. Omega-3s may play a role in heart health and may reduce inflammation in the body. Along with fatty fish, cod liver oil is another source of these fatty acids. If you don't eat fish, it can be hard to get enough omega-3 in your diet (14Trusted Source). Sun exposure for the chicken, the vitamin D content of the chicken feed, and exposing liquid yolk to UV light will increase vitamin D in the egg. When given the same feed, pasture-raised chickens that roam outside in the sunlight produce eggs with levels 3–4 times higher. Choosing eggs either from chickens raised outside or marketed as high in vitamin D can be a great way to meet your daily requirements. Finally, foods such as cow's milk, soy milk, orange juice, cereals, and oatmeal are sometimes fortified with vitamin D.

## RECOMMENDATION

The study found out that giving vitamin D from food or supplements is best. The researchers recommend a daily value (DV) for vitamin D of 800 IU (20 mcg). The vitamin D content is listed as a percentage of the DV on the nutrition facts label on food packages. This tells what amount of child's daily vitamin D requirement the food will provide. The study also recommend parents to make sure that they aren't exceeding the upper limit with cod liver oil or any other vitamin D supplements. The study recommend parents to raise free range hens at home to offer vitamin D supplement through eggs. Eggs from commercially raised hens contain about 37 IU of vitamin D per yolk. However, eggs from hens raised outside or fed vitamin D enriched feed contain much higher levels. Finally, the study recommend consumers to check the labels to find out the vitamin D content as it can vary widely. If the product is not fortified, it won't be a source of vitamin D.

## REFERENCES

- Aggarwal, V., Seth, A., Aneja, S., Sharma, B., Sonkar, P., Singh, S., & Marwaha, R. K. (2012). Role of calcium deficiency in development of nutritional rickets in Indian children: a case control study. *The Journal of Clinical Endocrinology & Metabolism*, 97(10), 3461-3466.
- Aggarwal, V., Seth, A., Marwaha, R. K., Sharma, B., Sonkar, P., Singh, S., & Aneja, S. (2013). Management of nutritional rickets in Indian children: a randomized controlled trial. *Journal of tropical pediatrics*, 59(2), 127-133.



- Al Rekhawi, H. A., Abu Ayyad, A., & Abu-Naser, S. S. (2017). Rickets expert system diagnoses and treatment.
- Bitzan, M., & Goodyer, P. R. (2019). Hypophosphatemic rickets. *Pediatric Clinics*, 66(1), 179-207.
- Bjelakovic, G., Gluud, L. L., Nikolova, D., Whitfield, K., Wetterslev, J., Simonetti, R. G., ... & Gluud, C. (2014). Vitamin D supplementation for prevention of mortality in adults. *Cochrane database of systematic reviews*, (1).
- Carpenter, T. O., Shaw, N. J., Portale, A. A., Ward, L. M., Abrams, S. A., & Pettifor, J. M. (2017). Rickets. *Nature Reviews Disease Primers*, 3(1), 1-20.
- Chanchlani, R., Nemer, P., Sinha, R., Nemer, L., Krishnappa, V., Sochett, E., ... & Raina, R. (2020). An overview of rickets in children. *Kidney International Reports*, 5(7), 980-990.
- Elder, C. J., & Bishop, N. J. (2014). Rickets. *The Lancet*, 383(9929), 1665-1676.
- Mittal, H., Rai, S., Shah, D., Madhu, S. V., Mehrotra, G., Malhotra, R. K., & Gupta, P. (2014). 300,000 IU or 600,000 IU of oral vitamin D3 for treatment of nutritional rickets: a randomized controlled trial. *Indian pediatrics*, 51(4), 265-272.
- Mughal, M. Z. (2011). Rickets. *Current osteoporosis reports*, 9(4), 291-299.
- Munns, C. F., Shaw, N., Kiely, M., Specker, B. L., Thacher, T. D., Ozono, K., ... & Högl, W. (2016). Global consensus recommendations on prevention and management of nutritional rickets. *Hormone research in paediatrics*, 85(2), 83-106.
- Pludowski, P., Holick, M. F., Grant, W. B., Konstantynowicz, J., Mascarenhas, M. R., Haq, A., ... & Wimalawansa, S. J. (2018). Vitamin D supplementation guidelines. *The Journal of steroid biochemistry and molecular biology*, 175, 125-135.
- Prentice, A. (2013). Nutritional rickets around the world. *The Journal of steroid biochemistry and molecular biology*, 136, 201-206.
- Shaw, N. J. (2016). Prevention and treatment of nutritional rickets. *The Journal of steroid biochemistry and molecular biology*, 164, 145-147.
- Stockton, K. A., Mengersen, K., Paratz, J. D., Kandiah, D., & Bennell, K. L. (2011). Effect of vitamin D supplementation on muscle strength: a systematic review and meta-analysis. *Osteoporosis international*, 22(3), 859-871.