

Deficiency Of Vitamin D In India

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Abstract

Vitamin D deficiency (VDD) is a global health issue that affects both industrialized and emerging countries. With prevalence rates across all age categories in India, vitamin D deficiency is across the entire Indian continent. Regardless of the fact that there is sufficient sunlight in India which is required for endogenous vitamin D synthesis. Nutrient D inadequacy is probably going to play a significant part in the exceptionally high pervasiveness of osteoporosis, rickets, cardiovascular disease, diabetes, sicknesses and contaminations like tuberculosis in India. In India, regularly consumed foods only occasionally contain vitamin D supplements such as in dairy products. Numerous factors might contribute to vitamin D deficiency, such as skin color, lack of sunshine exposure, vegetarian eating habits, and low consuming of meals enriched with vitamin D. A sufficient amount of sun exposure, eating dietary sources of vitamin D, and fortifying foods with vitamin D can all help avoid VDD.

INTRODUCTION

Vitamin D is also termed as fat-soluble vitamin. It facilitates the body's absorption of nutrients like calcium. There is a resemblance in the structure of Vitamin D and sterols. Contrarily, it performs hormone-like activities. Vitamin D was named calciferol by Angus (1931), who isolated it.

The amount of vitamin D₃ synthesized in the skin is directly proportional to solar exposure.

CHEMISTRY

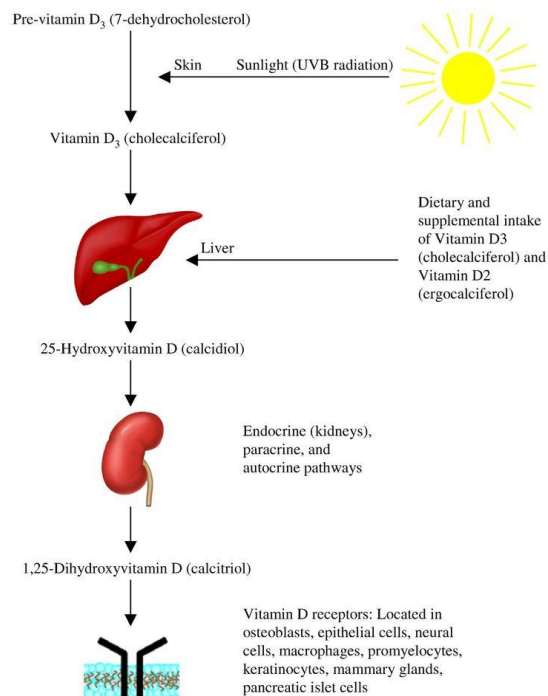
Ergocalciferol i.e. vitamin D₂ is produced from ergosterol. It is found in plants. And Cholecalciferol i.e. vitamin D₃ appears in animals. The structures of both sterols are similar. The only difference between the two sterols is that Ergocalciferol has an extra methyl group and a double bond. Vitamin D activity is derived from Ergocalciferol and cholecalciferol. [1]

7-dehydrocholesterol is generated as an intermediary during the production of cholesterol. The "sunshine vitamin" is another name for vitamin D.

METABOLISM

If the flesh is exposed to sufficient sunshine (UVB rays), the majority of Craniates can produce enough vitamin D. Most animals need enough vitamin D to survive, either by their nutrition or by getting adequate sun exposure. Vitamin D alludes to the molecules vitamin D₃ (cholecalciferol) and vitamin D₂ (ergocalciferol) (Ergocalciferol). Vitamin D₃ is produced when the skin is exposed to daylight.[2] Vitamin D₃ is synthesized from 7-dehydrocholesterol by

exposing the skin to Ultraviolet light. Animal foods consisting vitamin D3 include cod liver oil, oily fish (salmon, mackerel, and tuna), milk, and other dairy products. Yeast and mushrooms that have been exposed to sunlight are both good sources of vitamin D2.



Interestingly, most food sources are lacking in vitamin D levels. Prior to attaining its physiologically active form, 1,25(OH)₂D, Vitamin D (in both D₃ and D₂) is a prohormone that undergoes two hydroxylations. The initial hydroxylation takes place in the liver at position C₂₅, producing 25-hydroxyvitamin D, often termed as 25(OH)D or calcidiol. 25(OH)D is the most common form of vitamin D in circulation. The later hydroxylation takes place at position C₁ and it results in the production of 1,25(OH)₂D, commonly termed as calcitriol. The kidneys predominantly (but not solely) generate 1,25(OH)₂D. Once in the circulation, 1,25(OH)₂D binds to vitamin D binding protein (DBP). Then it uses the vitamin D receptor to reach its target tissues and carry out its endocrine functions there. [2]

1,25(OH)₂D is generated in various extrarenal tissues for both paracrine and autocrine activities. Vitamin D receptors are present in nearly all cells throughout the body. 1,25(OH)₂D is generated by many different types of cells. Involved in cell

development and differentiation are numerous genes that can be controlled by calcitriol.

BIOCHEMICAL FUNCTIONS

The physiologically active form of vitamin D is calcitriol (1,25-DHCC). It controls phosphate and calcium levels in the blood. Calcitriol (1,25-DHCC) maintains plasma calcium levels (normal 9–11 mg/dl) at three separate levels (intestine, kidney, and bone). [1]

1. Calcitriol's effect on the intestine:

Calcitriol boosts calcium and phosphate absorption in the intestine. Calcitriol forms a calcitriol-receptor complex in intestinal cells when it interacts with a cytosolic receptor. The complex then moves on to the nucleus, where it engages with a specific DNA sequence and generates a calcium-binding protein. This protein improves the gut's ability to absorb calcium. The target tissue (intestine) is affected by calcitriol's action by a process resembling that of a steroid hormone.

2. The effects of calcitriol on the bones are as follows:

In bone osteoblasts, calcium is more readily absorbed and then deposited as calcium phosphate. Consequently, the formation of new bone tissue depends on calcitriol. The bone stores a significant amount of calcium and phosphate. The mobilization of phosphate and calcium from the bones is aided by calcitriol when combined with parathyroid hormone.

3. Calcitriol's effect on the kidneys:

By reducing excretion and promoting reabsorption, calcitriol also aids in reducing calcium and phosphate excretion through the kidney.

Another vitamin D metabolite is 24,25-Dihydroxycholecalciferol (24,25-DHCC). 24-hydroxylase synthesizes it in the kidneys as well. It is unknown what 24,25-DHCC's specific function is. When calcitriol levels are high enough, 24-hydroxylase is thought to occur, resulting in the formation of the less significant molecule 24, 25-DHCC. The production of 24,25-DHCC is also crucial to maintaining calcium homeostasis in this fashion.

RECOMMENDED DIETARY ALLOWANCE (RDA)

The recommended everyday intake of vitamin D is 400 International Units (IU), or 10 milligrams of cholecalciferol. The RDA for vitamin D in places with adequate sunshine (such as India) is 200 IU (or 5 mg of cholecalciferol). [3]

DIETARY SOURCES

The body can receive vitamin D in three different ways.

1. Daytime exposure to sun to promote vitamin D production
2. consuming organic food
3. Irradiating foods that contain precursors to vitamin D, such as yeast, and fortifying meals (milk, butter, etc.)

The skin's endogenous synthesis of vitamin D after being exposed to Type B ultraviolet (UVB) radiation with a wavelength of 290–320 nm is the chief source of vitamin D. Among other foods, fatty fish, fish liver oil, as well as egg yolks are excellent sources of vitamin D. On the other hand, vegetables and grains are insufficient suppliers. Vitamin D is not well-sourced in milk. The skin's endogenous formation of vitamin D after exposure to ultraviolet B (UVB) radiation with a wavelength of 290–320 nm is the leading source of this vitamin. Among other foods, fatty fish, cod liver oil, and egg yolks are excellent sources of vitamin D. Vegetables and grains are inadequate suppliers of Vitamin D. [3],[4]

NUTRITIONAL FACTORS CONTRIBUTING TO INDIA'S HIGH RATE OF VITAMIN D DEFICIENCY

For Indians, the only effective tactics is to consume enough dietary vitamin D. However, this method has a slew of issues of its own. [3]

1. Most food sources contain relatively little vitamin D. The bulk of foods high in vitamin D are those with an animal basis. Vegetarianism is practiced by the majority of Indians. For vegetarians, milk is a typical source of nourishment for vitamin D (if vitamin D supplements have been added to the milk). Milk rarely has vitamin D added to it in India. Milk that has not been fortified has inadequate levels of vitamin D (2 IU/100 mL). Furthermore, those who are economically vulnerable cannot bear to spend on milk and milk products. The rampant adulteration and/or diluting of milk and milk products in India is alarming to note.[4]

2. Genetic factors that cause vitamin D insufficiency in Indians may not be ruled out because their influence on gene expression modulates vitamin D metabolism. Polymorphisms in 7 dehydroxylase reductase, 1 alpha hydroxylase, DBP, 25 hydroxylase, VDR, and 24 hydroxylase have been examined as genetic factors. However, a conclusive connection between these polymorphisms and vitamin D insufficiency has not yet been established. In this case, epigenetic variables may also play a role. Heritable variations in gene expression brought on by epigenetic factors take place excluding changing the DNA sequence. Post-translational changes of histones, including methylation, acetylation, and phosphorylation, as well as abnormal microRNA production, are all possible. There has been research on the interaction of genetic and environmental variables, which are influenced by epigenetic factors. More research is required because the evidence for a connection between genetic and/or epigenetic factors and vitamin D levels is not clear.[4]

3. Poverty causes protein deficiency and poor overall nutrition:

Inevitably, in the bleak background of poverty, a focus on a well-balanced diet takes a second seat. It is often easier to blame food habits or cooking traditions than to face the harsh realities of poverty.

In reality, for the poor, a well-balanced meal is merely a once-in-a-while indulgence. "When a poor guy eats chicken, one of them becomes sick," goes the traditional proverb.[5]

4. Culinary styles and practices in India:

Regardless of where they go, Indians generally stick to traditional cooking methods and traditions. Perishable foods spoil fast in a tropical environment.

For instance, there are no observable government regulations in India regarding the sanitation and microbiological quality assurance of fresh product that is delivered to the final consumer.

Undercooked fresh fruit, particularly vegetables, milk, and other foods are frequently discouraged from consumption. Slow cooking is popular in India as it is across the rest of the globe. However, given the heat instability of several vitamins, this culinary approach is not recommended. At temperatures over 200 °C, vitamin D is damaged. Temperature and time have an inverse relationship with their thermal stability.

At 100 degrees Celsius, water boils. Baking is often done at temperatures exceeding 175°C; however, due to the food's lower internal temperature during baking, the stability of vitamin D is under justifiable limits. Most cooking oils and fats have smoke temperatures exceeding 180 °C, which makes them perfect for shallow and deep frying. Deep and shallow frying of food is immensely common across the nation.

Foods that are fried lose their vitamin D content because it is thermally damaged when it is released into the frying medium. Depending on how much pressure the cooker can handle, pressure cooking temperatures can range from 100 °C to 120 °C.

In order to preserve as a conservative estimate some of the thermally less fugacious and significant components in prepared food, just like vitamin D, pressure cooking for a brief length of time (as little as feasible) is strongly advised.[4],[5]

5. Calcium equilibrium is determined by dietary calcium intake and excretion. Indian food is low in calcium, while also being low in protein, which means it produces less endogenous acid, which may aid to lower urinary calcium loss. Changes in calcium homeostasis caused by proteins have been linked to increases in endogenous acid generation and net acid excretion owing to the oxidation of the component sulfur-containing amino acids (and perhaps bone mass). At the same time, the increased salt concentration in Indian food is probably going to encourage the ejection of calcium through the urine. A link has been shown between high salt consumption and a decrease in bone mass.[6]

6. Calcium deficiency in the Indian diet:

Secondary hyperparathyroidism is linked to a calcium deficit diet, along with a scarceness of vitamin D. The increased degradation of 25(OH)D and 1,25(OH)2D by 24 hydroxylase exacerbates SHPT.

The major enzyme in vitamin D catabolism, 24 hydroxylase, is influenced by levels of 1,25(OH)2D, PTH, and FGF23 (Fibroblast Growth Factor 23). Phosphate regulator FGF23 is a protein that regulates the amount of phosphate in the body. Through the effect of 1,25(OH)2D, high serum phosphate levels enhance FGF23 synthesis in bone osteocytes.

FGF23 thereby prevents the formation of PTH and 1,25(OH)₂D, as well as renal phosphate resorption and indirect intestinal phosphate absorption. Increased morbidity linked with vitamin D insufficiency can be caused by the overproduction of FGF23.

This regulating mechanism could explain why rural patients with high phytate and/or reduced amount of calcium diets have low 25(OH)D levels despite receiving ample of sun exposure. The RDA (Recommended Daily Allowance) for calcium, as determined by the ICMR (Indian Council of Medical Research), was reported in the majority of research. Only two studies found that people get enough calcium. The study participants in each of these papers were paramilitary troops. According to the ICMR, India's RDA for calcium consumption is not as much as that of the Western world.[6]

7. India has a comparatively high level of tea and coffee consumption of caffeine. The majority of Indians pair their tea or coffee with milk. These beverages have an extremely low milk content. As a result, calcium consumption from these beverages is minimal. Cooking does not affect vitamin D levels. It can withstand temperatures of up to 200 degrees Celsius. On the other hand, temperature and time have an inverse relationship with the thermal stability of vitamin D. In India, milk must be boiled for a long time before consumption. Milk is boiled twice or three times before it is taken as a whole. The majority of beverages in India, amongst other, coffee and tea, are stewed for many minutes to achieve the ideal piquancy.

The amount of vitamin D that was still available in the milk after it had been boiled may be reduced by this boiling. As a result, these beverages might not considerably increase Indians' consumption of vitamin D or calcium. Vitamin D is a powerful nutrient. The above assertions concerning heat deterioration were given as a preventative measure to avoid exaggerating the micronutrient's thermal resilience. Additionally, studies reveal that middle-aged women who use a lot of coffee have an enhanced vulnerability of osteoporosis, low bone mineral density, and osteoporotic fractures. This issue is made worse in women who consume inadequate amounts of calcium, especially thin ones.[7]

8. In India, lactose intolerance is very common, which makes it difficult for people to consume milk, which reduces their consumption of vitamin D and calcium. It was discovered that lactose intolerance varies by location and ethnicity, with an eminent pervasiveness in Eastern India and Southern (Dravidian ancestry) than in North India (Aryan descent) [8]

9. The amount of phytate in Indian food is substantial. Phosphorus is stored in many plant tissues as phytate, peculiarly in the portion of bran of various seeds and grains. Humans are unable to metabolize phytate. Phytates chelate micronutrients, including iron and calcium, reducing their absorption in the intestine. Due to their agrarian lifestyle, respondents in rural areas reported significantly greater 25(OH)D levels. The majority of people's levels, nevertheless, were yet meager, perhaps as a result of a diet heavy in phytates. Despite receiving plenty of sun exposure, proper nutrition, and physical activity, vitamin D insufficiency may have been caused by phytate-rich foods in the troops' diets in northern India.[9]

10. It's remarkable that a high phytate/calcium consumption ratio was discovered in practically every study on vitamin D status in salubrious individuals. Indians would need to consume more calcium in their diets to reduce the calcium /phytate consumption ratio. In India, dietary patterns have shifted to ameliorate the fluffiness and texture of rotis (unleavened flat bread). White bread gourmandizing is also relatively more. Processed, split, and polished pulses are preferred by the majority of consumers over whole seeds because they are simpler to prepare and need less cooking time than whole seeds. This lowers the cost of cooking fuel. All socioeconomic groups, with the exception of the destitute, are eating more quick (or not) burgers and noodles. All socioeconomic disparities, except for those who are impecunious, are experiencing an increase in the consumption of instant noodles and hamburgers.[10]

11. The urgent need for adequate calorie intake is the primary cause of the higher phytate content in the Indian diet, specially among the lowest socioeconomic strata. Compared to vegetables, milk, and other dairy products, cereals and

legumes are less expensive and more readily available. Additionally, they deliver protein to vegetarians. Calcium is also found in many grains; however, its bioavailability is restricted owing to phytate chelation.[11]

12. Fluoride and other environmental toxins make matters worse when combined with a diet high in phytates, inadequate calcium consumption, as well as vitamin D insufficiency. Toxins like fluoride significantly impact bone metabolism when combined with insufficient calcium intake, especially in youngsters.[11],[12]

CONSEQUENCES OF VITAMIN D DEFICIENCY

Skeletal Manifestations

Rickets in children as well as osteomalacia and osteoporosis in adults are linked to vitamin D deficiency. Due to an imbalance of calcium and phosphorus in the bone, it prevents bone mineralization, which leads to rickets and external skeletal abnormalities in children. Muscle weakness and bone discomfort are also common side effects.

Adults who don't get enough vitamin D in their diets face difficulty in absorption of calcium from food, which leads to osteoporosis and osteomalacia, as well as increased calcium loss from the bones and kidneys and a decline in bone mineral density. They also have weaker muscles and a higher risk of falling. The risk of falling is thought to be reduced by vitamin D because it promotes muscular strength. Numerous studies have associated low vitamin D levels to an elevated threat of fractures and falls in elderly people. [13]

Parkinson's disease

People who have Parkinson's disease go through a neurological condition.

In individuals with Parkinson's disease, vitamin D deficiency was observed. Evidence shows that VDR is a hereditary health hazard for Parkinson's disease, emphasizing the function of Vitamin D in illness. Vitamin D is a potential preventive/therapeutic method for this illness because it is a controllable factor. However, more research on VDR and its relationship with Vitamin D levels in people with Parkinson's disease is needed.[14]

A contagious sickness

Infectious diseases that are easily transmitted (i.e., communicated) by contact (direct or indirect) with an infected individual are referred to as contagious diseases.

People with an insufficiency of vitamin D are more susceptible to contract infectious diseases like TB and viral upper respiratory tract infections like influenza. [15],[16]

Autoimmune illnesses

They are a kind of autoimmune disease. A condition when the immune system of the body targets healthy cells.

Vitamin D is a potent immune system controller that affects cell differentiation and proliferation. Vitamin D deficiency was indicated to be much greater in Type 1 diabetes children (91%) compared to nondiabetic children (85%) in a case-control study. With vitamin D supplementation, the danger of having Type 1 diabetes mellitus was reduced by 30%. vitamin D deficit has been linked with Rheumatoid arthritis.[17],[18]

Coronary artery disease

The Framingham Heart Study found that patients with reduced levels of vitamin D (15 ng/ml) had a 60% greater chance of developing heart condition (through the renin-angiotensin hormone pathway) than those with elevated concentrations. [28] Acute myocardial infarction patients often have severe Vitamin D inadequacy, which is linked to a number of causative factors.

CVDs, such as coronary artery and heart failure disease, is a leading reason of mortality and morbidity across the world. CVDs are linked to vitamin D insufficiency, according to expanding epidemiological data from observational

research. Greater latitudes have been associated with a higher incidence of hypertension. A 25(OH)D level of not more than 21 ng/mL was linked with a serious threat of cardiovascular death and excessive triglyceride levels as well as hypertension, diabetes, obesity.

Several studies have found lower 25(OH)D levels in patients with prior or current cerebrovascular or cardiovascular disease.

[18],[19]

Diabetes Type 1

The autoimmune loss of pancreatic cells causes type 1 diabetes (T1D), which progresses to insulin-dependent diabetes. T1D incidence was shown to be greater at higher latitudes across the world. There was apparently an epidemiological link between vitamin D consumption and a lower rate of occurrence of T1D. In accordance to a meta-analysis of observational studies, children who took vitamin D supplementation had a 30% lower risk of type 1 diabetes (T1D).

Obesity

According to the World Health Organization, being overweight or obese is the accumulation of abnormally high levels of fat that could impair one's health.

In consequence of extreme metabolic procedures, enzymatic abnormalities, and reduced action of alpha-hydroxylase, the major enzyme in the biotransformation of calciferol in a fat-infiltrated liver, buildup of inactive forms and lower bioavailability of vitamin D arise from vitamin D insufficiency and excessive fat accumulation. Vitamin D has an impact on systemic inflammation, insulin secretion, and tissue sensitivity to insulin in obese people.

Although age, lean body mass, and vitamin D consumption are all positively correlated with 25(OH) D levels, body mass index, body fat and waist circumference, are all adversely correlated.

[20],[21],[22]

Diabetes mellitus type 2

Vitamin D inadequacy has been connected with a substantial threat of type 2 diabetes, insulin resistance, in addition to reduced insulin secretion, making it a candidate for syndrome X.

In a three-year study of nondiabetic people aged 65 and over, those who got 700 IU of Vitamin D (with calcium) had a lower increase in fasting plasma glucose than those who received a placebo. Vitamin D has been proven to lessen the threat of type 2 diabetes mellitus progression and development.

Insulin resistance is a symptom of type 2 diabetes (T2D) (IR). Adipose, hepatic, and skeletal muscle target cells are unable to efficiently use the insulin that pancreatic cells produce either adequately or excessively during insulin resistance (IR). Hyperinsulinemia, which is commonly suggestive of a pre-(T2D) stage, is produced when cells increase insulin synthesis even further in response to hyperglycemia. Hyperinsulinemia is linked to high blood pressure, obesity, dyslipidemia, and glucose intolerance, among other things. The term "metabolic syndrome" refers to the combination of these disorders. In accordance with a meta-analysis of observational studies, insulin resistance and hyperglycemia were inversely associated with 25(OH)D levels as well as calcium status. Improvements in glucose levels were seen in this meta-analysis when both nutrients were supplemented.

[23]

Depression

Depression is a prevalent and significant medical condition that has an adverse effect on your feelings, thoughts, and actions.

Patients who were vitamin D deficient took much longer to recover than those who were not. It emphasizes the need to address hypovitaminosis D for successful depression therapy.

[24]

Cancer

Vitamin D promotes apoptosis and inhibits angiogenesis, which protects specific organs. Lung, breast, colorectal, prostate, ovarian, pancreatic, and esophageal cancers have all been associated to reduced doses of vitamin D in storage. Vitamin D promotes cell differentiation while inhibiting cell growth. It is anti-inflammatory and prevents the growth of new blood vessels. According to retrospective and prospective epidemiologic studies, there was a 30–50% higher chance of contracting and passing away from colorectal, breast, prostate, pancreatic, as well as esophageal cancer when 25(OH)D levels were less than 20 ng/mL.[25]

STUDIES OF VITAMIN D AT DIFFERENT STAGES

[26]

Pregnant moms and their newborns' vitamin D levels

Vitamin D insufficiency (20 ng/ml) has been seen in expectant mothers and their newborns in studies from northern India.

One study found that mothers-to-be in the winter had increased 25(OH)D levels than those in the summer. Surveys from Tirupati, India, demonstrate a similar pattern.

Children's and adolescent vitamin D levels

It's critical to understand this age group's vitamin D status because this is when bone growth and peak bone mass occur. In this area, there is various research from both north and south India.

These studies unequivocally demonstrate that between 75 and 85 percent of the populations studied suffer from varied degrees of vitamin D inadequacy or insufficiency (hypovitaminosis D). Another important finding from this study is that vitamin D level in the population is positively influenced by food quality and sun exposure. In one study, dietary calcium supplementation had a positive impact on a group of children.

Vitamin D deficiency in middle-aged people (20 to 45 years)

Since peak bone mass has been reached in this group (up to 30 years of age), adequate vitamin D consumption is essential. In addition to enhance bone mass, women's parity along with nutritional status influence the pattern of postmenopausal bone loss and age-related osteoporosis (bone health). All of the findings that have been made public so far demonstrate that these people have widespread vitamin D insufficiency and hypovitaminosis. In comparison to the urban population, rural residents had higher vitamin D levels.

Agriculture laborers, who are exposed to more sunshine, make up the majority of the rural employees in this research. It's worth noting that soldiers and subjects in Indian paramilitary forces who do a lot of outdoor activity in the sun and eat a lot of calcium have better vitamin D levels.

Postmenopausal women's vitamin D levels

Vitamin D levels starts to deteriorate in postmenopausal women There are studies that suggest a in D. It has significant denouement for bone mineral density interpretation and treatment of postmenopausal osteoporosis.

Vitamin D deficiency in rural and urban areas

The vitamin D levels of the inhabitants of the cities is clearly less than that of the rural dwellers, according to studies. This is due to differences in clothes and employment, as well as extended periods of exposure to sunshine. Vitamin D levels are more significant at higher altitudes and latitudes. Clouds attenuate 10% of the sun's rays, snow soaks up

20% and reflects the remaining 20%, and UV-B rays increase by 10% for every km above sea level although the sun's zenith angle is obtuse at these locations. The vitamin D status of the group tested was found to be poorer in research from the Kashmir valley.

INDIAN FOODS THAT MAY BE VITAMIN D-FORTIFIED

[27],[28]

1. Milk:

A wide range of milk grades, including skim milk, double-toned, toned and whole milk, might be fortified.

2. Yogurt with milk curd

3. Formulas for infants.

4. Butter, oils and ghee (clarified butter) which can be used as spreads or to flavor cooked meals.

5. Lactose intolerant people and those sensitive to milk proteins may benefit from the fortification of soy curd (tofu), soy milk, mango juice, as well as orange juice. Processed cheese is also low in lactose and high in calcium, and it may be fortified to help lactose-intolerant people. These fortified meals will give the general people healthier options as a result of increased ubiquity of dyslipidemia, cardiovascular disorders and metabolic syndrome in India. [29]

6. Widely consumed and reasonably priced staples like wheat flour, maida (all-purpose flour) utilized in the preparation of bread in addition to diverse bakery items), rice flour and rice could be excellent fortification targets in India. [30]

DISCUSSION

Vitamin D deficiency affects people with liver, kidney, and skin disorders, in addition to low dietary intake. There are a variety of reasons why Vitamin D insufficiency is so besetting in our country.

People are exposed to less sunlight as a result of more people living indoors. This predominantly affects the city dwellers owing to modernization. Due to contamination, UV radiation can hinder the skin's proficiency to produce Vitamin D. In view of altered eating habits, there is a low dietary calcium and vitamin D consumption. A high-fiber diet's phosphate and phytate content can increase calcium needs and deplete Vitamin D stores. Use of sunscreen and increased skin pigmentation. Examples of cultural traditions include the burqa and purdah systems. Unplanned and closely spaced pregnancies in women with dietary deficiencies might worsen the mother's and the child's vitamin D status. [31],[32],[33]

For the majority of Indians, exposure to the sun is not an option.

Despite the brightly beaming sun, vitamin D insufficiency is a big risk of well-being in India. Uncertainty exists regarding the "adequacy of exposure of a person's naked skin to sunlight" required for vitamin D photosynthetic activity. Melanin, which is abundant in darker skin, functions as a natural sunscreen. As a result, persons with darker complexion generate substantially less vitamin D than those with lighter complexion, for instance Caucasians. Thus, for Indian skin tones, daily "unhindered solar exposure" exceeding 45 minutes to the sun's UV rays (wavelength 290–310 nm) is necessary. With the exclusion of those who are compelled to work outside in the sun, the majority of Indians cease to receive enough contact with the sun to produce enough vitamin D endogenously. The majority of a person's body must be covered, irrespective of their gender, in accordance with Indian social and religious standards about community decency.

The not-so-D-lightweight cost of urbanization is that most individuals in big cities reside in areas that are exceedingly densely inhabited. They are compelled to reside in cramped, three to four storey high tenements. As a result, most of the homes do not receive direct sunshine, prohibiting a person from getting any sun light in the comfort of their own home. Furthermore, due to a shortage of area, outdoor activities are limited. The amount of pollution in the atmosphere of urban India has influenced vitamin D levels. Sunscreen creams as well as umbrellas are also ineffective.[34],[35]

The tremendous anguish of the oppressive heat synchronous with the Indian hot weather and (not to add) the unquenchable yearning of many Indians to achieve a lighter complexion make escaping the sun one's top priority. These two issues take primacy in India's oppressive heat, and the pursuit of adequate vitamin D always takes a back place. As a result, enough vitamin D levels cannot be obtained in India only from sensible sun exposure.[36-40]

CONCLUSION

It is clear that India has a large vitamin D deficiency problem. In truth, the majority of Indians find it impossible to get enough vitamin D by hours of sunshine. The issue is made worse by inadequate vitamin D levels and low calcium intake. It is imperative and vital that the vitamin status of the Indian residents be improved.

The Indian jurisdiction needs to act decisively in this regard. It is necessary to update the RDA for calcium along with vitamin D. In order to quickly identify patients who, need medical intervention due to vitamin D deficiency, superior conveniences and technologies should be made accessible across the nation. Population-based programs must be developed at the national level to enhance cognizance of the issue, provide India's population with cost-effective vitamin D pills, as well as supply vitamin D enriched foods.

The subsequent precautionary actions can be used:

- At least 30 minutes per day should be spent in direct sunshine.
- good calcium intake from food (on an equal footing with one liter of milk and milk products).
- supplements for breast feeding women.
- Added artificial nutrients to baby food commodities.
- making daily physical education for students in schools a requirement.
- If taking supplements, verify the ideal dosage.
- Consideration may need to be given to the food product's artificial fortification.
- Prior to making a choice on this matter, economics is the main constraint. Given the significant expense, it makes sense to promote and advocate for direct exposure to vitamin D-rich sunshine and to fortify food with calcium.
 - a. Food augmentation with the wholesome mid-day meal program.
 - b. Supplements for expectant and nursing mothers
- SPF greater than 6 sunscreen should be worn as a preventative measure.
- Physical activity should be made mandatory in schools on a daily basis.
- Outdoor activities of the elderly and aged.

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