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Vitamin D Deficiency, Causes and Solutions

Sasidharan PK*

Emeritus Professor, Department of Family Medicine, Government Medical College, Kozhikode (Calicut) Kerala, India

Introduction

Vitamin D is a hormone as well as a vitamin with numerous functions in the human body [1-5]. Its deficiency was once thought to be non-existent in countries like India, which get enough and more sunlight. Incidentally the first study, which documented the presence of vitamin D deficiency, as a common problem was first reported by us in Kerala, South India [1]. Those days, doctors hesitated to accept our results and even the journal to which the first study report was sent, hesitated to publish and delayed its publication for two long years. After accepting in 2000, it was published only in 2002. This landmark study was initiated following the observation of Vitamin D deficiency made in 1993 in a 14-year-old boy with skeletal tuberculosis. That boy had enough and more sunlight exposure, there was nothing to suggest mal-absorption and he did not have any liver or kidney disease to account for his deficiency. Even though he was from a rich family, his dietary habits were erratic and I suspected malnutrition (lack of balanced diet) as the cause of deficiency. Then I hypothesised that some how Vitamin D deficiency could be linked to tuberculosis and it could be the cause rather than the effect of tuberculosis [1]. We already had the awareness that Tuberculosis has some link to malnutrition. Subsequently this author observed vitamin D deficiency in several other patients with tuberculosis and started supplementing Vitamin D to all the patients since 1993 with good results. There were several obstacles to go ahead with a proper study, even the research proposal sent to the government in 1994 was sent back with adverse comments. When the hypothesis was presented in a physicians' conference, this author was humiliated and laughed at. Finally we raised funds on our own and did the study with the help of one of our residents. When the final results were presented again in 2000, in a bigger conference of the physicians of India, one senior endocrinologist passed a final verdict as though the results are just an imagination and he said, 'as long as we get enough sunlight we will never have Vitamin D deficiency in India'!

In this landmark study, the lowest level of Vitamin D was in an apparently healthy looking female who presented with mono-arthritis of the right ankle, which turned out to be due to tuberculous osteomyelitis of the lower end of tibia [6]. She looked perfectly normal but for the arthritis. The study had proved that looks are deceptive and even the serum Ca and Phosphorus and alkaline phosphatase values would not always indicate its deficiency [1]. After publication of our studies numerous studies were done, curiously most studies conveniently ignored the original landmark study by us. Now the picture is that if we do estimation of 25 hydroxyl Vitamin D levels in any disease it will be low, and even in the control populations in our studies itself it was low as compared to accepted normal or desirable levels [1,7-10]. It is seen that vitamin D deficiency could be observed in any disease and supplementation of Vitamin D could modify, partially at least, the course of any disease. We ourselves had done another study on Vitamin D and hypertension, which gave similar results as in Tuberculosis [9]. There are studies on Vitamin D deficiency in diabetes, Cancers, Ischemic heart disease, autoimmune diseases and what not. There are around 29000 articles on PubMed search alone. Thus now we know very well that vitamin D deficiency is universally common but the reasons are attributed to poor sunlight exposure alone. But the landmark study by us has clearly established the reasons behind the deficiency [1]. Even today we are not focusing on these real causes and we seem to run away from the issues behind it and focus only on Vitamin D therapy, which is a hype [11]. The causes for Vitamin D deficiency are multiple as given below:

Reasons for Widespread Deficiency of Vitamin D

In order to get adequate Vitamin D, intake of a balanced diet is absolutely essential. In addition people should expose their skin to get sunlight to enable the cutaneous synthesis of Vitamin D as well. Those who happen to get adequate sunlight never seem to get a balanced diet, going by their poor socioeconomic empowerment. Those who happen to eat a balanced diet (at least by accident) never get sunlight because of their wrong sedentary lifestyle habits. This is just one aspect, going to other issues, whatever may be the source of Vitamin D it has to be activated in the liver by a 25

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Correspondence:
Sasidharan PK, Emeritus Professor, Department of Family Medicine, Government Medical College, Kozhikode (Calicut) Kerala, India.
E-mail: *sasidharanpk@gmail.com*

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hydroxylation, and then by a 1 hydroxylation in the kidneys- these two steps are defective in a large majority due to clinical/subclinical liver diseases and kidney diseases. Liver diseases are increasing all over the world due to NASH/NAFLD and alcoholism and consumption or exposure to several hepatotoxic substances. Kidney disease is also increasing due to increasing number of hypertensive and diabetics, and due to other reasons. Besides all these people in several countries have increased melanin in the skin, which interferes with ultraviolet mediated cutaneous synthesis of vitamin D. Thus the primary reasons for the widespread deficiency of Vitamin D are lack of balanced diet, reduced sunlight exposure, hyperpigmentation of the skin and liver and kidney diseases. On closer observation of the problem, it becomes clearer that it is often due to a combination of the above and several other problems as well and is indeed a complex issue, interlinked to diet and lifestyle habits. The research tools that we employ now are not enough to find out root causes of such problems; but the root causes can always be traced by close observations of the diet, lifestyle and environment of people who get diseases. But this should be done by those who are aware of the factors which make people sick and the factors which keep the people healthy, without any diseases, even at eighty or ninety years.

Wrong Lifestyles as the Cause of Vitamin D Deficiency [12]

Lifestyle includes everything that a person does in 24 hours in a day and 365 days in a year. It has to be organised in such a way as to enable each individual to achieve a healthy life and the society has to be empowered by providing all the background facilities to follow a healthy lifestyle and healthy living. Most important good lifestyle is the habitof regular intake of a balanced diet and drinking adequate water. People with good lifestyles avoid smoking and alcohol, they have some plans for avoiding overeating; they do not eat everything, they know what to eat and what not to eat and hence avoid fried food, fast food and all the junk foods and they will not become overweight or obese and will not be exposed to the toxins. Good lifestyle also involves doing some kind of physical exercise regularly, when the society provides facilities like play grounds, footpaths, parks and cycle paths. People should be taught to face stressful situations or for avoiding too much of mental stress or they should know how to manage stress through some or other relaxation techniques. Thus it becomes very obvious that absence of good lifestyle practices lead to weight gain or obesity, hypertension, diabetes, fatty liver, heart attacks, strokes and cancers and autoimmune disorders. The diet most people eat now is grossly unbalanced but they invariably end up eating more due to intake of junk foods and fast foods (eating for entertainment), which contain several unwanted toxins as well, which could be damaging liver and kidneys and could trigger the development of cancers and autoimmune disorders. The same people do not do any exercise, or they are not motivated or empowered to do exercise and the net result is that we manage to produce an overweight to obese society, which laughs at a lean person for being unhealthy. If they are overweight or obese the inadequate oxygenation of the tissue and the consequent hypoxic environment could be promoting angiogenesis and growth of malignancies. In SLE and malignancies we had personally observed that there is a high intake or exposure to junk foods, fast foods or other toxins and they never do any kind of outdoor exercise too. All these wrong lifestyle habits are the causes for all diseases and the same are the causes for Vitamin D deficiency as well and it is only natural that we see Vitamin D deficiency in all diseases including infections, all the non-communicable diseases like Hypertension, Diabetes, cancers and autoimmune diseases. Other aspects of good lifestyle like ensuring safety of food and water, cleaning teeth in morning and before bedtime, washing hands before eating or after visiting toilet and the practice of good waste disposal habits are also good lifestyle habits and their absence is the cause for all infections. Adopting the right posture while working, sitting, travelling, and sleeping or while using computers are also good lifestyle habits and their absence lead to cervical and lumbar spondylitis.In short the aetiology of all diseases are converging on to abnormalities in diet, lifestyle and environment [12]. All abnormal lifestyle practices can be traced to unchecked and unhealthy promotion of consumerism with the help of the celebrities in film and cricket industry and due to lack of social empowerment [12].

Causes of Vitamin D Deficiency

1) Lack of balanced diet

Lack of regular consumption of balanced diet is the commonest cause of Vitamin D deficiency all over the world. Balanced diet should contain one source of calories (eg: any one cereal in the Indian diet- no cereal is superior in that), adequate intake of protein (any one of the pulses /yogurt/fish/egg or meat) adequate vegetables- preferably raw or steamed and never overcooked- and fresh whole seasonal fruits and adequate safe drinking water. Therefore strict vegetarians should always eat a combination of "any one *cereal +any one of the pulses+ vegetables+ fruits*" in the right proportions every time they eat. The non-vegetarians should take egg, fish, or meat as the source of protein instead of the pulses. If we are using roots and tubers as a source of calories, as in a western diet, the source of protein should always be non-vegetarian or at least curd (yogurt) should be used as a source of protein.

In several places in the world, majority do not even have the chance to get a balanced diet, even by accident, due to the lack of social empowerment. Even if the people were rich, unless the nation has an organised plan for creating awareness and empowering them, no one would be eating a properly balanced diet. Vitamin D is present in all the non-vegetarian foods and is also seen in yogurt and pulses, which are the major source of protein in a strict vegetarian diet, which many vegetarians do not consume regularly. Some even avoid pulses saying it produces gas/dyspepsia. Lack of awareness about balanced diet, some beliefs and wrong concepts about diet and lack of social empowerment prevent people from taking dietary items, which contain Vitamin D. In Kerala for example, several people avoid pulses believing that it produces gas or dyspepsia, even as the diet does not contain adequate non- vegetarian items as a source of protein. The gas or dyspepsia is due to disordered motility of the gastrointestinal tract due to reduced fibre in the diet resulting from decreased intake of vegetables and fruits. Urgent attention from all quarters, to empower the society for regular consumption of balanced diet is absolutely essential to solve the problem of Vitamin D deficiency and for fighting all diseases, because "food is the primary medicine" [12].

2) Increasing liver diseases

Second larger issue behind Vitamin D deficiency is defective 25 hydroxylation of dietary or cutaneously synthesised Vitamin D, due to clinical and subclinical liver diseases. The incidence and prevalence of liver diseases is steadily increasing all over the world every year due to changed lifestyle habits. Overeating and development of fatty liver is the commonest reason for liver disease now. The growing acceptance of alcohol and the increased consumption of it is another major cause. Besides these two, often there is exposure to other

hepatotoxic substances through diet (the fast foods and junk foods) and as medicines and health preparations (including indigenous medicine) is common among all groups including the poorer ones. Almost all of these coexist often in most individuals and cause clinical and subclinical liver dysfunction.

3) Increasing kidney diseases

Another important cause for the deficiency is defective metabolism of vitamin D in the kidneys (1- hydroxylation). Kidney diseases are increasing due to increasing prevalence of diabetes, hypertension and due to toxins in diet and environment, the high protein diet in the affluent, misuse of nephrotoxic drugs like NSAID as over the counter medications and the reduced intake of water. In addition there are toxins in the diet and environment that are potentially damaging to the kidneys like cadmium, mercury, lead, copper from electronic equipment or from some indigenous preparations. Adequate water (approximately two litres per day) is absolutely essential to prevent renal damage from hyperuricemia, high blood pressure and urinary tract infections, which many are unaware of. In controlling high blood pressure salt restriction alone is stressed often ignoring the role of adequate water intake, which has several other benefits as well. To compound all these, renal damage by several mechanisms contribute to renal loss of magnesium and consequent hypomagnesaemia as a result of clinical and subclinical renal damage, which also indirectly contributes to vitamin D deficiency.

4) Hypomagnesaemia

It is an important but unseen reason for Vitamin D deficiency. The 1-hydroxylation of vitamin D in the kidneys is parathyroid hormone (PTH) dependent and PTH secretion in turn is Magnesium dependent. Hypomagnesaemia is primarily due to poor intake of vegetables and fruits, besides the renal and GI losses. Sometimes there is poor absorption of Magnesium from the intestine due to parasites and infections like tuberculosis of intestine. Thus an individual could have multiple reasons for hypomagnesemia, which is always subclinical and is often overlooked. Thus magnesium deficiency, due to multiple causes, would lead to reduced Parathyroid hormone (PTH) secretion and the consequent reduction of 1-hydroxylation of vitamin D in the kidneys is an important and is an unrecognized cause of Vitamin D deficiency [13-15].

5) Decreased sunlight exposure

Even if there is enough sunlight in India, the habit of exposing our skin to sunlight, even by accident, is becoming very rare due to changed lifestyle and lack of empowerment. The preference for indoor jobs alone and even preferring indoor exercises only and not doing any outdoor activities or outdoor exercise is a lifestyle disorder resulting in reduced cutaneous biosynthesis of vitamin D.

6) Increased melanin in the skin

Even if we expose our skin to sunlight, the increased melanin content in the skin of our people, could be interfering with ultraviolet light mediated vitamin D synthesis [8,13].

7) Use of obstructive clothing

The increasing use of obstructive clothing due to imitation of the western culture or for religious reasons could be contributing to reduced sunlight exposure.

Social relevance of our Landmark Study

The landmark study we had done in 1999 itself had suggested that vitamin D deficiency is very common in the subjects, including the apparently healthy controls, which were representative sample of the people of Kerala and could indicate similar situation in the rest of the country. The author's observation spanning three decades is that vitamin D deficiency is only an indicator sign of malnutrition or it shows only the tip of the iceberg of malnutrition and wrong lifestyle habits in a society. It is malnutrition which initiates or perpetuates diseases like Tuberculosis and even progression of HIV infection to AIDS, since proper nutrition and the consequent availability of Vitamin D has decisive role in maintaining cell mediated immunity [1-5,16]. The commonest cause for low CD4 count is malnutrition. Thus Vitamin D deficiency is only an indicator of the subclinical and clinical malnutrition, which is widely prevalent even in the developed countries. Malnutrition is the most important cause for the higher prevalence of HIV and Tuberculosis in India, Africa and other developing countries. It is a common observation that those with advanced AIDS have severe malnutrition as well, and it could be a cause of AIDS rather than the effect of HIV infection. Besides, there are several examples of persons living with HIV for long periods if they follow a healthy diet and lifestyle. What is common to the people affected severely by Tuberculosis and AIDS anywhere in the world is malnutrition. The results of our landmark study had supported the already known link between Tuberculosis and malnutrition. Randomized controlled studies are not effective or feasible for establishing the link between all aspects of nutrition, lifestyle and diseases. The observations also suggest that Tuberculosis and other infections control or all disease-control programmes, to succeed, need to incorporate dietary intervention and education and empowerment of the people for regular intake of balanced diet and exercise in sunlight. This observation is particularly relevant since, even relatively affluent section of society do not really know of or consume a balanced diet but they consume all kinds of fast foods, junk foods and many of them are exposed to overeating, sedentary habits, alcohol and tobacco smoking and develop organ damages, which lead to defective vitamin D metabolism. The very same people are confining to indoor activities or do white-collar jobs only with hardly any sunlight exposure.

It is also interesting to note the recently recognized role of Vitamin D in decreasing the risk of many chronic illnesses, including all cancers, autoimmune diseases, infectious diseases, hypertension, diabetes and cardiovascular diseases all indicating the role of balanced diet and avoiding overeating in controlling all these diseases [7-9,14,15,17]. It is reported that raising the serum 25(OH)D level to 40 to 60 ng/mL would prevent breast, prostate and colorectal cancers. There are no risks from intake of 1000-2000 IU per day of vitamin D_3 [7,8,18]. Vitamin D deficiency is also found to be associated with low HDL, high triglyceride and high total cholesterol [19]. Thus it is obvious that aetiology of all diseases is converging finally on to wrong diet and lifestyle. The focus should be on empowering the people to practise balanced diet and other good lifestyle habits rather than on Vitamin D therapy alone, which is certainly a hype.

Recommendations

There is an urgent need to provide the basic health needs and improve the dietary habits and other lifestyle habits in all rather than allowing unregulated vitamin D supplements and focusing on treatment of diseases alone. Vitamin D supplements in mega doses are to be regulated and the maximum dose to be used as supplement is to be settled. My personal view is to use only 1000-2000 IU per day indefinitely in those who have deficiency rather than giving

massive doses intermittently, except in carefully selected cases. It is unfortunate that Vitamin D therapy is the only activity happening to tackle the issue of vitamin D deficiency. All sections of people should get balanced diet and adequate exposure to sunlight by suitable social reforms and empowerment of the people. All disease control programs should focus on empowering the people for regular intake of balanced diet by the necessary social, educational, financial and agricultural reforms. As an interim measure fortification of foodstuffs like oil or wheat-flour also may be tried till such time that all sections of the society are empowered for taking balanced diet regularly. To get sunlight exposure there must be facilities for doing physical exercise in the open like adequate play grounds, footpaths, cycle paths, parks etc and people should be made aware of and empowered to make use of all these. If exercise is done in natural setting we would get enough sunlight as well or else sun exposure by plan should be included in good lifestyle habit. In short all our people should be empowered to take a balanced diet in moderation and to do regular exercise in the open, as a part of their lifestyle. People should be educated and empowered to avoid weight gain and prevent development of NASH, diabetes and hypertension as well. All these steps are to be urgently adopted in the communities across the world over, to solve the problem of Vitamin D deficiency in the society rather than just focusing only on Vitamin D therapy.

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