



# Vitamin D Paradox in Plenty Sunshine in Rural India -An Emerging Threat

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Medical historian R Bivins from Cardiff University's School of History and Archaeology wrote a paper "The English disease" or "Asian rickets"? Medical responses to postcolonial immigration which centers round the problem of vitamin D deficiency in the British South Asian Communities in the 1960's.<sup>1</sup> His case study of the medical and political responses to vitamin D deficiency among Britain's South Asian communities since the 1960s suggested that in these contexts, diet frequently became a proxy or shorthand for culture (and religion, and race), while disease justified pressure to assimilate.<sup>1</sup> He addresses the an interesting issue of the former colonizing powers, like their former colonies, have "postcolonial medicine," and if so, where does it take place, who practices it, and upon whom?<sup>1</sup> He also looks at how medicine in United Kingdom responded to the huge cultural shifts represented by the rise of the New Commonwealth and associated postcolonial immigration?<sup>1</sup> It all centers round a new emerging global threat called vitamin D deficiency which is not merely rickets or osteomalacia but a huge hidden problem now being unravalled and is reaching epidemic proportions both in the developed and developing world alike.

Vitamin D has been traditionally even nicknamed the sunshine vitamin. However in India despite of plenty of sunlight both in urban and surprisingly even in rural India may be vitamin D deficient which is paradoxical to conventional science as reported by Goswami Kochipillai et al in adult North Indian villagers in this issue of JAPI.<sup>2</sup> This stems from the fact that vitamin D is one of the most underrated nutrient and its time to take note. Technically Vitamin D is not really a vitamin but an hormone viz vitamin D is in a class by itself and its predominantly renal metabolic product, calcitriol, is actually a secosteroid hormone that targets over 1000 genes in the human body. This old hormone has been produced by lifeforms since last 750 million years with most plants and animals that are exposed to sunlight have a capacity to make vitamin D. In humans we know know that Vitamin D is critically important for development, growth and maintenance of health at all times during the life cycle from birth till old age. There is now a vast body of evidence to suggest that vitamin D deficiency as a major factor in the pathology of at

least 17 varieties of cancer as well as heart disease, stroke, hypertension, autoimmune diseases, diabetes, depression, chronic pain, osteoarthritis, osteoporosis, myopathies, birth defects, periodontal disease, and many more diseases. This is beyond the conventionally known rickets and osteomalacia. Vitamin D's influence on key biological functions vital to one's health and well-being mandates that vitamin D no longer be ignored by the physicians striving to achieve and maintain better health.

To understand the vitamin D endocrine system one needs to be familiar with the different forms of vitamin D, namely cholecalciferol, calcidiol (25-OHD), and calcitriol (1,25-OHD). Cholecalciferol is the naturally occurring form of vitamin D. Cholecalciferol is made in large quantities in skin when sunlight is exposed to it. Enormous quantities of cholecalciferol are rapidly made in the skin summer and direct sun exposure. Prof. Michael Hollick of Boston has done lifetime research and has shown that a few minutes in the summer sun produces 100 times more vitamin D than the recommended daily allowance.<sup>3</sup> Fur bearing animals and many birds make cholecalciferol in their fur or feathers as sunlight can not get to their skin. Interestingly, mammals and birds then eat the cholecalciferol by licking their fur (grooming) or rubbing their beaks on their feathers (preening). Calcidiol (25-hydroxyvitamin D) is a prehormone which is directly made from cholecalciferol. This is what is tested routinely for vitamin D deficiency. Calcitriol (1,25-dihydroxy-vitamin D) is made from calcidiol in both the kidneys and in other tissues and is the most potent steroid hormone derived from cholecalciferol. After it is made in the skin or taken by mouth, cholecalciferol is transported to the liver where it is metabolized into calcidiol or 25(OH) D. Calcidiol has also got to have steroid like properties. But calcidiol's main importance is that it is the storage form of vitamin D. After hepatic conversion of cholecalciferol into calcidiol, calcidiol follows one of two pathways. One responsible for bone and other for cellular effects.

Calcitriol the active form of vitamin D has now been shown to have anti-cancer properties Calcitriol levels are not used for vitamin D deficiency. The first pathway leads to the kidney, where calcidiol is turned into calcitriol. Calcitriol is a potent steroid hormone. It has endocrine, autocrine and paracrine function. The second vitamin D pathway leads to the tissue action. All of the amazing health benefits of vitamin D discovered in the last decade are from

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vitamin D going down the second pathway. This path is only now being fully understood and is causing excitement all around the world, especially concerning cancer. These are the autocrine and paracrine functions of the vitamin D system. These functions are crucial to understanding why the vitamin D level should be maintained. During vitamin D deficiency no tissue calcitriol is available. But when a person has sufficient vitamin D then the left over calcidiol goes to the many cells in the body that are able to make their own calcitriol to fight cancer. The more calcidiol they get, the more calcitriol they make. The step is not rate limited by its product (calcitriol) and is thus uncontrolled. No other steroid hormone system in the body works this way; the manufacture of calcitriol in the tissues is unique. This is the second most important fact about vitamin D. Throughout the entire range of normal calcidiol levels, tissue calcitriol levels continue to increase. This has implications for the normal homeostasis, so as 25 (OH) D levels are low in blood, a natural consequence in low calcitriol levels in tissue which may have oncogenic potential. Tissue calcitriol plays an important role in basic cell biology and is self regulated.

In normal humans, the more cholecalciferol in the blood, the more calcidiol the liver makes. So, in the natural state, what limits the amount of cholecalciferol in the blood? What is the rate limiting step for the production of calcitriol in the tissues? The human skin! This is nature's method of limiting cholecalciferol. Only about 20,000 units can be made in the skin every day because the same sunlight that makes it, begins to break it down. After your skin turns dark (tan) even less cholecalciferol is made, maybe 10,000 units. Thus the melanin content of skin may regulate cholecalciferol production. Humans have a natural system in the skin that prevents toxicity. This vitamin D level normally is a way to maintain tissue calcitriol requirement.

Humans make at least 10,000 units of vitamin D within 30 minutes of full body exposure to the sun (minimal erythemal dose). Vitamin D production in the skin occurs within minutes and is already maximized before your skin turns pink. Fear of the fatal form of skin cancer, malignant melanoma, keeps many people out of the sun. Due to real fears of overexposure to sunlight for the fear of sunburns and melanomas the use of sunscreens has become rampant. All sunscreens block the vitamin D production totally.

It is now prudent to have even healthy people (those without the diseases of vitamin D deficiency) have 25(OH) D level measured and seek advice if deficient. If levels are below 30 ng/mL one needs enough sun, artificial light, oral vitamin D3 supplements, or some combination of the three, to maintain 25(OH)D levels between 30–70 ng/mL year around. There are two vitamin D tests — 1,25(OH)D and 25(OH)D. 25(OH)D is the better marker of overall D status. There is a difference between normal level and optimal level of 25(OH) D and an optimally healthy level has to be maintained. The optimal levels, methodologies, ethnic and seasonal variations make uniform levels of 25 (OH)D normal in India difficult. It seems more than reasonable to assume

that these values are in fact reflective of an optimal human requirement. The optimal 25-Hydroxyvitamin D Values are 45-50 ng/ml or 115-128 nmol/l and the normal values are 20-56 ng/ml 50-140 nmol/l. The vitamin D levels should be kept above 30 ng/dl seems to be a scientifically rational advice for Asian Indians.

Vitamin D status is measured by looking at blood levels of 25-hydroxyvitamin D3. There are many methods used for measuring vitamin D3 like LC-MS/MS. This test measures 25-hydroxyvitamin D2 and D3 separately and is available only in select laboratories in the world like the Mayo Clinic, etc. Most of the regular laboratories use RIA which accurately measures total 25 (OH) D or Liaison—a more recently developed automated immunoassay that may replace the RIA. Recent developments in 2008 have made it clear that there are irregularities in the values obtained from the different testing methods. Although results from any of these assays may be analytically accurate, they might not be clinically accurate. Since the RIA assay was used in the major clinical studies that led to the recommended vitamin D levels, any lab using the LC-MS/MS method need to make sure their test correlate with the RIA test values in order to accurately determine your vitamin D status. Many labs may be using an assay that is analytically accurate as but may give vitamin D values that are consistently about 25-40 percent higher than the RIA assay. Otherwise the vitamin D levels may be vastly overstated, in some cases by as much as 40 percent and may be falsely reassured by their test results.

Ideally, the best place to get vitamin D is from your skin being exposed to the UV-B that is in normal sunlight. UV light is divided into three bands, or wavelength ranges, which are referred to as UV-A, UV-B and UV-C. UV-B (also nicknamed by some as the “burning ray”) is often the cause of sunburn caused by overexposure to sunlight. The amount produced depends on exposure time, latitude and altitude of location, season, amount of skin surface exposed, and skin pigmentation. A special angle called the solar “zenith angle” determines at different times of the year depending on the latitude and location as well as duration of the UV exposure which actually determine the amount of vitamin D production. UV-B also stimulates the production of MSH. However, UV-B does not penetrate very deeply into your skin. The darker the pigmentation or more tanned your skin, the less UV-B penetrates. So possibly for the dark skinned Indians it may be that the melanin in the Indian skin acts like a sunscreen and blocks the production of vitamin D. Other things that influence UV-B penetration include window glass and use of sunscreen. Window glass allows only 5 percent of the UV-B light range that produces vitamin D to get through your home or car. Sunscreen can block UV-B penetration drastically or entirely.<sup>3,4</sup>

The timing of your sun exposure is also a major factor. Sun exposure must take place when UV-B is present. The actual dosing of your sun exposure is quite complex, since it involves knowing the amount of UV-B present, and is

dependent on your skin colour. The amount of UV-B is not a constant. It is a major variable and is influenced by a number of factors: Latitude — the further north you are the less UV-B there is Time of Year — virtually none available in winter in continental U.S. ; Clouds — can block UV-B ; Pollution — smog and ozone can block UV-B ; Altitude — the higher up you are, the more UV-B reaches you; Age – elderly have substantially less efficiency at producing vitamin D ; Skin pigmentation – darker skin takes longer to acquire UVB to produce vitamin D.<sup>3,4</sup> A solar “Zenith angle” calculation can be done via several websites for your part of the country to know seasonally how much vitamin D is likely to be produced by UVB exposure, the duration as well as the time of the day.

Hollick et al had predicted that the zenith angle of the UV rays as well as the effects of diet, exposure to sunlight etc. can impact the vitamin D in the tropical countries like India where melanin works like a natural sunscreen. Hollick’s theory that throughout evolution, exposure to sunlight and the photosynthesis of vitamin D<sub>3</sub> in the skin has been critically important for the evolution of land vertebrates.<sup>5</sup> During exposure to sunlight, the solar UVB photons with energies 290-315 nm are absorbed by 7-dehydrocholesterol in the skin and converted to previtamin D<sub>3</sub>. Previtamin D<sub>3</sub> undergoes a rapid transformation within the plasma membrane to vitamin D<sub>3</sub>. Excessive exposure to sunlight will not result in vitamin D intoxication because both previtamin D<sub>3</sub> and vitamin D<sub>3</sub> are photolyzed to several noncalcemic photoproducts. During the winter at latitudes above approximately 35 degrees , there is minimal, if any, previtamin D<sub>3</sub> production in the skin. Altitude also has a significant effect on vitamin D<sub>3</sub> production. At 27 degrees N in November, very little ( approximately 0.5%) previtamin D<sub>3</sub> synthesis was detected in Agra (169 m) and Katmandu (1400 m). There was an approximately 2- and 4-fold increase in previtamin D<sub>3</sub> production at approximately 3400 m and at Everest base camp (5300 m), respectively. Increased skin pigmentation, application of a sunscreen, aging, and clothing have a dramatic effect on previtamin D<sub>3</sub> production in the skin. It is estimated that exposure in a bathing suit to 1 minimal erythemal dose (MED) is equivalent to ingesting between 10,000 and 25,000 IU of vitamin D<sub>2</sub>. The importance of sunlight for providing most humans with their vitamin D requirement is well documented by the seasonal variation in circulating levels of 25(OH)D. The major cause of vitamin D deficiency globally is an under appreciation of sunlight’s role in providing humans with their vitamin D<sub>3</sub> requirement. Very few foods naturally contain vitamin D, and those that do have a very variable vitamin D content. Recently it was observed that wild caught salmon had between 75% and 90% more vitamin D<sub>3</sub> compared with farmed salmon.<sup>5</sup> Traditional Indian foods are poor sources of Vitamin D.

Studies from different parts of India are being reported in the last decade to indicate the wide prevalence of vitamin D deficiency (VDD) in our country.<sup>6</sup> VDD has been

reported in all age groups including toddlers, school children, pregnant women and their neonates and adult males and females residing in rural and urban India.<sup>6</sup> It is just not north India but even work from south India has shown similar results. Harinarayan et al has studied a total of 943 healthy urban and 205 rural adult subjects and 76 urban and 70 rural healthy children from Andhra Pradesh.<sup>7</sup> Their daily dietary calcium intake of both the urban and rural population was low compared to that of recommended daily/dietary allowances (RDA) issued by Indian Council of Medical Research (ICMR). Dietary calcium and phosphorus were significantly lower ( $p < 0.0001$ ) in both the rural adult and children compared to that of the urban adult and children. The dietary phytate to calcium ratio was significantly ( $p < 0.0001$ ) higher in rural adult and children compared to that of urban adult and children. N-tact PTH levels negatively correlated with 25(OH)D in rural ( $r = -0.24$ ;  $p < 0.002$ ), in urban adult subjects ( $r = -0.12$ ;  $p < 0.0001$ ) and in rural and urban children ( $r = -0.2$ ;  $p < 0.05$ ). The 25(OH) D levels of rural adult subjects were significantly higher ( $p < 0.001$ ) than that of urban adult subjects in both males and female groups. The 25(OH)D levels of both the urban and rural children were low.<sup>7</sup>

Sahu et al from Lucknow have reported Vitamin D deficiency in rural girls and pregnant women despite abundant sunshine in northern India.<sup>8</sup> They reported a higher prevalence of vitamin D deficiency among pregnant women and adolescent girls from a rural Indian community with boys being relatively protected and a seasonal variation in serum 25 OHD which was significant at latitude 26 degree North. In this context the current paper of Goswami and Kochupillai make it one of the early studies in rural north Indian village which break the myth of the Indian sunshine. 70 percent of rural village residents in Bulandhar in Uttar Pradesh despite of plenty sunlight are VDD is indeed an eye-opener. Multitude of factors apart from dark skin, pollution, dietary malabsorption may play a role. The authors also make a strong case which is strongly supported by many of us for vitamin D fortification on a priority. This is a complex issue as unlike iodine where salt is an efficient vehicle it is difficult to get a vehicle to fortify for vitamin D except for milk and dairy products. With milk habits declining even if fortified, it makes the issue further difficult. This study thus is a classical vitamin D deficiency paradox despite of plenty sunshine and warns medical community about dangers of vitamin D deficiency epidemic which may not only swarm urban but even rural Indian adults. But some urgent reappraisal for vitamin D sufficiency and fortification is needed for vulnerable Indians. There is a need to evolve consensus guidelines for normal vitamin D levels and deficiency for India. Its time to screen vitamin D levels as well as treat them aggressively.

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## Announcement

### Election Results of API/ICP



The election results of the Office Bearers, Members of the Governing Body of the Association of Physicians of India and the Officer Bearers, Members of the Faculty Council of Indian College of Physicians for 2009-2010.

#### Results of the API elections

The following members were declared elected:-

President Elect : Dr. Murlidhar S Rao - Gulbarga (Unopposed)  
Vice President : Dr. Shashank R Joshi - Mumbai (Unopposed)  
Hon. Treasurer : Dr. Milind Y Nadkar - Mumbai (Unopposed)

Governing Body members : Dr. Shyam Sunder - Varanasi  
Dr. BB Rewari - New Delhi  
Dr. YSN Raju - Hyderabad  
Dr. Girish Mathur - Kota

#### Results of the ICP elections

Faculty Council members : Dr. Rita Sood - New Delhi  
: Dr. BR Bansode - Mumbai  
: Dr. BN Jha - Muzaffarpur  
: Dr. AK Vaish - Lucknow  
: Dr. Subhash Chandra - New Delhi

Dr. Sandhya A Kamath  
Hon. General Secretary