

## Editorial

# Vitamin D Deficiency in South Asian Populations: A Serious Emerging Problem

Vitamin D, which is described as ‘the Sun Vitamin’, is essential for growth and development of the body. It has been estimated that almost one billion people in the world suffer from vitamin D deficiency or insufficiency.<sup>1</sup> Vitamin D deficiency is a global public health concern, even in tropical regions where the risk of deficiency was previously assumed to be low due to cutaneous vitamin D synthesis stimulated by exposure to sun. Poor vitamin D status, as indicated by low serum concentrations of 25-hydroxyvitamin D [25(OH)D], has been observed in South Asian populations. Unfortunately, there is high prevalence of vitamin D deficiency due to lack of proper diet, social customs and remaining confined within the four walls of primitive housing that deprives the elderly, children and female population of the benefit of the sunshine. However, limited information is available on the vitamin D status in this region.

### Incidence

It is our general belief that vitamin D deficiency is prevalent only in western countries, but actual condition is reverse. It is surprising that in South Asia, 80% of the apparently healthy population is deficient in vitamin D (<20 ng/mL) and up to 40% of the population is severely deficient (<9 ng/mL).<sup>2</sup> Rickets, a consequence of vitamin D deficiency, is still widespread in regions, such as northern China where 42% of infants were found to suffer from this disease during the winter/spring period.<sup>3</sup> Sachan et al<sup>4</sup> investigated hypovitaminosis D in Lucknow, India and found that eighty four percent of pregnant women had 25(OH)D values below 22 ng/mL (the cut-off point in their research). Siddiqui and Rai<sup>5</sup> found that in Northern Pakistan where sunlight was available in abundance, rickets was a common problem in infants and children. They attributed the hypovitaminosis D to malnutrition, lack of awareness and antenatal factors. Atiq et al<sup>6</sup> investigated hypovitaminosis D in healthy breast-fed children and nursing mothers at a major teaching hospital in Karachi, Pakistan and found that 55% of infants and 45% of mothers had very low serum

25(OH)D levels (<25 nmol/L or 10 ng/mL). A preliminary study in Sylhet during the winter dry season revealed that the vitamin D status of young infants in rural Bangladesh might be poor enough to put many at risk of rickets and other potential vitamin D-related health consequences. Applying a very conservative definition of vitamin D deficiency [25(OH)D <25 nmol/L], they estimated that about one-third of infants aged 1–6 months may be vitamin D-deficient.<sup>7</sup> To our knowledge, this is the first report of vitamin D status in young infants in Bangladesh.

### Requirement of vitamin D

The mean serum concentration of 25(OH)D of 30 ng/mL is considered desirable for health.<sup>1</sup> A level of 20 ng/mL is considered as minimum acceptable.<sup>1,8</sup> The recommended daily intakes for vitamin D for infants, children and adults up to 50 years is 200 IU (5 g) per day, and for adults between 50–70 years, it should be 400 IU (10 g). Several investigators have suggested that these values are insufficient, especially for pregnant females, sick adults and older adults.<sup>11</sup> Perhaps all the adults need 800–1000 IU daily. This estimate is based on serum level of 25-hydroxyvitamin D [25(OH)D] of 30 ng/mL. Hypovitaminosis D has been defined by Thomas et al as serum levels of 25(OH)D less than 15 ng/mL (37 nmol/L). When the levels of 25(OH)D are between 8–15 ng/mL (20–37 nmol/L), the condition is called “moderate hypovitaminosis D”. When the levels of 25(OH)D become less than 8 ng/mL (20 nmol/L), the condition is regarded as “severe hypovitaminosis D”. However, investigators in general consider levels of 25(OH)D less than 20 ng/mL (50 nmol/L) as vitamin D deficient states.<sup>1,8</sup> Vitamin D intoxication, however, occurs when serum levels of 25(OH)D are greater than 150 ng/mL.

### Biological functions of vitamin D

Vitamin D is actually a steroid that has a hormone like function. It facilitates calcium and phosphorus absorption through the small intestine. Vitamin D from dietary sources and from sun exposure of skin

is stored in fat cells and is brought into circulatory system by vitamin D binding protein. Vitamin D<sub>3</sub> (cholecalciferol) is biologically inactive and must be metabolized to 25-(OH)D<sub>3</sub> in the liver and then to its biologically active form 1,25-dihydroxycholecalciferol [1,25-di(OH)D<sub>3</sub>] in kidney.<sup>9</sup> In this form, vitamin D has been found to regulate functioning of over 200 genes, including the genes involved in cellular proliferation, apoptosis, differentiation and angiogenesis. However, 25(OH)D<sub>3</sub> is the predominant form of vitamin D in plasma and the major storage form as well.

### Causes of vitamin D deficiency in South Asians

**Poverty and illiteracy:** Poverty is one of the major reasons for most of the ills of the society including poor health. A vast majority of people are illiterate and are not aware of the importance of balanced diet. Moreover, the dietary habits are also to blame as food is often overcooked destroying most of the vitamins and micronutrients in it.

**Social and religious customs:** Many women stay at home which is almost closed to sunlight. Infants of these women also stay indoors and receive little or no exposure to sunlight. The old and weak persons also have no exposure to sunlight as they spend almost all of their time inside the tiny huts or houses. Most of the garment workers are engaged in duty from dawn to night, so they are not exposed to sunlight at all and they are unable to take balanced diet. The middle class urban population is now increasingly living in densely populated apartment blocks with very little natural light.

**Skin pigmentation:** The color of skin of South Asian populations varies from light brown to almost dark. Dark pigmentation has been found to decrease skin synthesis of vitamin D because UV light cannot reach the appropriate layer of the skin. Compared to the Caucasian population, healthy African Americans have also been found more likely to be vitamin D deficient regardless of age.<sup>10</sup>

**Addictive habits:** A recent study on South Asian communities in UK by Ogunkolade et al has shown that chewing betel nut (*Areca catechu*), an addictive habit common among South Asians, contributes to hypovitaminosis D by modulating the enzymes which regulate circulating levels of 1,25di(OH)D.<sup>11</sup>

### Impact of vitamin D deficiency

#### *Bone mineral density*

Vitamin D deficiency is associated with secondary

hyperparathyroidism with consequent ill effects on bone mineral density. Marwaha et al<sup>12</sup> studied vitamin D deficiency and its effects on bone mineral density in Indian adolescents of 10–18 years of age and concluded that metabolic bone disorders secondary to vitamin D deficiency continue to be prevalent in the Indian subcontinent and are more prevalent in lower socioeconomic population. Roy et al<sup>13</sup> have reported that in South Asian women, a decrease in serum 25(OH)D level <15 ng/mL is associated with a progressive reduction in bone mass at the hip and wrist.

#### *Osteomalacia and rickets*

While rickets is a consequence of vitamin D deficiency in infants and children, older adults can suffer from osteomalacia due to loss of bone density causing pain and soft bones. The problem of rickets among infants and children is widespread in cooler northern areas of South Asia.<sup>8,9</sup> Rickets remains one of the major causes of infant mortality in South Asia.<sup>5</sup> Vitamin D deficiency in infants can often be traced to maternal nutritional status.<sup>7</sup> Neonatal concentrations are normally 60–70% of maternal vitamin D levels. In case of maternal deficiency, the neonate's low reserves of vitamin D can cause hypocalcemic symptoms in the first six months of infant's life. Finch et al<sup>14</sup> claimed that osteomalacia was underdiagnosed in South Asians living in UK. They found that 22% of subjects in their study had varying degrees of osteomalacia.

#### *Osteoporosis*

Postmenopausal women are known to be prone to vitamin D deficiency causing an early onset of osteoporosis. The tendency to the deficiency is universal as 28.4% postmenopausal women have been found to be deficient in vitamin D [25(OH)D, < 20 ng/mL] in most parts of the world.<sup>8</sup> However, this percentage increased to 30% in a population from Southern India.<sup>4</sup>

#### *Vitamin D deficiency and other diseases*

Over 200 of human genes have receptors for vitamin D, making vitamin D deficiency a contributory factor to a wide variety of other human diseases. Johnson argues “that vitamin D is important for much more than just bones; the vitamin seems to have a role in preventing colorectal and other cancers, diabetes, arthritis and even multiple sclerosis (MS)”.<sup>15</sup>

Recently, an inverse association between plasma 25(OH)D levels and risk of hypertension has been

reported.<sup>16</sup> Wang et al more recently, in a prospective study on 1739 participants and a mean follow-up of 5.4 years, showed vitamin D deficiency to be a risk factor for cardiovascular disease in participants with hypertension.<sup>17</sup> Cardiomyopathy due to vitamin D deficiency in infants is a rare but potentially fatal manifestation of hypovitaminosis D.<sup>18</sup> Richard and his associates have shown beneficial effects of vitamin D against aging and inflammation.<sup>19</sup> In a study at the Alzheimer's Disease Research Center, St Louis, USA, vitamin D deficiency was found to be associated with psychiatric and neurological disorders. In another report, vitamin D deficiency was implicated in depression.<sup>20</sup> Bottela-Carretero et al found an association between vitamin D deficiency and metabolic syndrome in obese patients.<sup>21</sup> Patients with vitamin D deficiency had significantly lower levels of HDL-cholesterol and hypertriglyceridemia compared to patients with normal levels of vitamin D.<sup>21</sup>

### Recommendation

Vitamin D deficiency is widespread in South Asian populations and is contributing to burden of disease in this region. It is suggested that the governments in South Asia should implement a mandatory vitamin D supplementation program of selected foodstuff, at least during the winter months. Vitamin D supplement and an annual intramuscular injection of a large single dose of vitamin D need to be considered for the special risk groups. The program needs to be reinforced through a mass awareness campaign over the electronic media informing importance of absorbing direct sunlight for at least 30 minutes a day.

The adequate vitamin D daily intake for South Asians also needs to be set at least twice that of the above mentioned recommended intakes for Western populations.<sup>22,23</sup>

Pregnant women in South Asia are advised 400 IU (10 g) daily intake of vitamin D, but compliance to this recommendation is often very poor.<sup>24</sup>

Experience with Indian and Pakistani populations in developed countries and in India and Pakistan suggests that for conventionally dressed pregnant women

receiving insufficient sunlight, a 1000 IU (25 g) daily intake of vitamin D is more appropriate.<sup>25</sup>

Due to low level of compliance to recommended daily intake of vitamin D, Lawson and Thomas<sup>26</sup> advocate an annual intramuscular booster of 150,000 IU for children of Asian origin up to the age of five years. In order to build vitamin D store of infants, it is now a standard practice in France to give pregnant women a single large intramuscular dose of vitamin D of 100,000 to 150,000 IU during the 7th month of pregnancy.<sup>10</sup> A similar policy for children and pregnant women in this subcontinent needs to be considered.

### Conclusion

Vitamin D deficiency has again become a major public health interest with its association with osteoporosis, osteomalacia, fractures, and more recently with prevention of cancer, diabetes, heart disease and other chronic illnesses. Regular sun exposure has decreased due to changing lifestyles. Vitamin D deficiency is especially prevalent in dark skinned children and adults living in northern latitudes, and obese children and adults. Though sunlight is God-gifted in this region, proper utilization of this resource must be done. Improving the vitamin D status worldwide would have dramatic effects on public health, and reduce healthcare costs for many chronic diseases. The most cost-effective way to remedy this deficiency is to increase food fortification with higher levels of vitamin D along with sensible sun exposure, and adequate vitamin D supplementation.

### HAM Nazmul Ahasan

Professor

Department of Medicine

Dhaka Medical College & Hospital, Dhaka

### Aparna Das

Assistant Professor

Department of Medicine

Dhaka Medical College & Hospital, Dhaka

Email: aparna\_0191@yahoo.com

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