A Review on the Master Micronutrient- Vitamin D

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Abstract- *Vitamin D is a steroid hormone that primarily acts to increase transcription of Vitamin D responsive genes primarily in the small intestine. These genes mediate increased absorption of calcium and phosphorous in the gut. Vitamin D plays a role in maintaining normal neuromuscular function and immunity. Vitamin D deficiency causes osteomalacia in which bone mineralization is defective. In children Vitamin D deficiency causes rickets. In adults this causes fragility of the bones which can lead to fractures. Other symptoms of vitamin D deficiency include diffuse body aches and muscle weakness. This paper reviews the importance of the micronutrient Vitamin D.*

Keywords- Vitamin D, deficiency

I. INTRODUCTION

The modern lifestyle has a great impact on the nutrition and health of human beings. The nutrient deficiency in all groups of people has become a world scenario. Unfortunately, today's world has been adapted to a system of consumption of foods which has several adverse effects on human health. Lifestyle changes has compelled us so much that one has no time to really think what we are eating is a healthy diet! Lack of an eco-friendly lifestyle and consumption of unhealthy diet is the main facts that lead to the Vitamin Deficiency. Vitamins are micronutrients that allow the body to grow and develop. They also play important roles in bodily functions such as metabolism, immunity and digestion. Vitamin A, B, C, D, E and K vitamins are the essential vitamins required by all group individuals. A balanced intake of all these vitamins is an adequate necessity. All the above mentioned vitamins are abundantly available from the natural sources itself except Vitamin D. As only a very few natural sources are proved to possess it, it's not very easy to obtain Vitamin D from foods alone, and isn't the best way to meet your overall needs. Meanwhile, finding of new sources of Vitamin D has become alarming as it has a crucial role in public health and survival.

Vitamin D is a fat-soluble vitamin that is naturally present in very few foods, added to others, and available as a dietary supplement. It is a group of fat-soluble secosteroids responsible for increasing intestinal absorption of calcium, magnesium, and phosphate, and multiple other biological effects. In humans, the most important compounds in this group are Vitamin D_3 (Cholecalciferol) and Vitamin D_2 (Ergocalciferol). Cholecalciferol and Ergocalciferol can be ingested from the diet and from supplements. As only a few foods contain Vitamin D, the major natural source of this vitamin is synthesis of cholecalciferol in the skin from cholesterol through a chemical reaction that is dependent on sun exposure. When the UV rays from sun strikes the skin, it trigger the endogenous synthesis of Vitamin D from the cholesterol precursor. But, Vitamin D synthesis from the diet or skin is biologically inactive, thereby enzymatic conversion (hydroxylation) in the liver and kidney is required for its activation. This biologically active form of Vitamin D is known as calcidiol (Institute of Medicine, 2010). Although a sufficient sun exposure can ensure the endogenous synthesis of Vitamin D, it may not be possible to suggest a particular amount of sun exposure, as that can cause other hazardous cases of skin cancer due to the direct incidence ultraviolet radiations on skin, where lies the adequacy of finding new and sources of this essential micronutrient.

II. ROLE OF VITAMIN D IN HEALTH

Discovery of Vitamin D was due to effort to find the dietary substance lacking in children with rickets (the childhood form of osteomalacia and the lacking substance which has found to be the causative of rickets was Vitamin D (Hollis B W., 2004). Vitamin D supplements are given to treat or to prevent osteomalacia and rickets. Vitamin D has a significant role in calcium homeostasis and metabolism. It promotes calcium absorption in the gut and maintains adequate serum calcium and phosphate concentrations to enable normal mineralization of bone and to prevent hypocalcemic tetany. It is also needed for bone growth and bone remodeling. Without sufficient vitamin D, bones can become thin, brittle, or misshapen. Vitamin D sufficiency prevents rickets in children and osteomalacia in adults. Together with calcium, vitamin D also helps protect older adults from osteoporosis (Institute of Medicine, 2010). Vitamin D has other roles in the body, including modulation of cell growth, neuromuscular and immune function, and reduction of inflammation. Many genes encoding proteins that regulate cell proliferation, differentiation, and apoptosis are modulated in part by vitamin D and many cells have vitamin D receptors (Holick M F, 2006).

III. REFERENCE INTAKES

Intake reference values for vitamin D and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine of The National Academies (formerly National Academy of Sciences) (Institute of Medicine, Food and Nutrition Board., 2010). DRI is the general term for a set of reference values used to plan and assess nutrient intakes of healthy people. These values, which vary by age and gender, include:

- Recommended Dietary Allowance (RDA): average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%–98%) healthy people.
- Adequate Intake (AI): established when evidence is insufficient to develop an RDA and is set at a level assumed to ensure nutritional adequacy.
- Tolerable Upper Intake Level (UL): maximum daily intake unlikely to cause adverse health effects.

The FNB established an RDA for vitamin D representing a daily intake that is sufficient to maintain bone health and normal calcium metabolism in healthy people. RDAs for vitamin D are listed in International Units (IUs); the biological activity of 40 IU is equal to 1 mcg (micrograms).

TABLE 1: RECOMMENDED DIETARY ALLOWANCES (RDAS) FOR VITAMIN D

AGE	MALE	FEMALE	PREGNANCY	LACTATION
0–12 months	400 IU	400 IU	-	-
1–13 years	600 IU	600 IU	-	-
14–18 years	600 IU	600 IU	600 IU	600 IU
19–50 years	600 IU	600 IU	600 IU	600 IU
51–70 years	600 IU	600 IU	-	-
Above 70 years	800 IU	800 IU	-	-

IV. SOURCES OF VITAMIN D

Food Sources

Very few foods in nature contain vitamin D. The flesh of fatty fish (such as salmon, tuna, and mackerel) and fish liver oils are among the best sources (U.S. Department of Agriculture, 2011). Small amounts of vitamin D are found in beef liver, cheese, and egg yolks. Vitamin D in these foods is primarily in the form of vitamin D_3 (Ovesen *et al.*, 2003).

Food fortification is the process of adding nutrients to natural food products by artificial means. Fortified foods provide most of the vitamin D required by the body. In the 1930s, a milk fortification program was implemented in the United States to combat rickets, then a major public health problem. Other dairy products made from milk, such as cheese and ice cream, are generally not fortified. Ready-to-eat breakfast cereals (fortified cereals) often contain added vitamin D, as do some brands of orange juice, yogurt, margarine and other food products (Ovesen *et al.*, 2003).

Plant Sources

The only dietary recommendation to deal with Vitamin D deficiency is to consume natural sources of Vitamin D and also calcium rich foods. As both in plants and animal the only source of Vitamin D is the sun exposure, it is not very easy to obtain Vitamin D from plants, and isn't the best way to meet the overall needs of body. Fortified plant products can impair adequate concentrations. But the stored Vitamin D is available only in a few plants. The two plant sources of Vitamin D are mushrooms and soy milk.

MUSHROOMS

Some mushrooms provide vitamin D2 in variable amounts. Exposing mushrooms to UV light causes measurable increases in the vitamin D2 content; amount of vitamin D2 will vary depending on the type of light and duration of exposure. Mushrooms with enhanced levels of vitamin D2 from being exposed to ultraviolet light under controlled conditions are the best alternate source of Vitamin D (U.S. Department of Agriculture, 2011).

SOY MILK

Soy milk is a very nutritious drink 6made from soaking, grinding and then boiling soy beans with water. It is naturally high in fatty acids, proteins, fiber, vitamins and minerals. These nutrients are known to provide energy and maintain bodily functions. It contains as the same proportion of protein as cow's milk. Soy milk can be prepared at home with traditional kitchen tools or with a soy milk machine. It is commonly available in vanilla and chocolate flavors as well as its original unflavored form. It is slightly sweet, also beany and gritty in taste (NDTV-FOOD).

SUN EXPOSURE

Most people meet at least some of their vitamin D needs through exposure to sunlight. Ultraviolet B radiation from sunlight can convert some components of animal cholesterol into Vitamin D_3. Season, time of day, length of day, cloud cover, smog, skin melanin content, and sunscreen are among the factors that affect UV radiation exposure and vitamin D synthesis. Exposure to sunlight during the spring, summer, and fall months can improve the Vitamin D synthesis. But nowadays, due to excessive atmospheric pollution and global warming resulting into ozone layer depletion, the direct penetration of harmful part of UV radiations of sunrays can cause skin cancer, sunburn and other skin diseases, where lies the importance of finding some alternate source of Vitamin D.

VITAMIN D DEFICIENCY

Nutrient deficiencies are usually the result of dietary inadequacy, impaired absorption and use, increased requirement, or increased excretion. Vitamin D deficiency can occur when usual intake is lower than recommended levels over time, exposure to sunlight is limited, the kidneys cannot convert provitamins to its active form, or absorption of vitamin D from the digestive tract is inadequate. Vitamin D insufficiency can reveal itself in these symptoms:

- Bone pain.
- Muscle weakness.
- Depression – Vitamin D deficiency recently linked to cognitive impairment.
- Fatigue.
- Weak immune system– frequent colds, infections.
- Chronic skin breakouts – psoriasis, rashes.
- Swollen, bleeding gums.
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Realizing these health symptoms the Vitamin deficiency can be predicted and can take preventions from being addicted for chronic diseases. Such Vitamin D deficient disorders includes Rickets, Osteomalacia, Skin Pigmentation and Osteoporosis.

RICKETS

Rickets, a childhood disease, is characterized by impeded growth and soft, weak, deformed long bones that bend and bow under their weight as children start to walk. This condition is characterized by bow legs (IARCWGUS, 2006), which can be caused by calcium or phosphorus deficiency, as well as a lack of vitamin D; today, it is largely found in low-income countries in Africa, Asia, or the Middle East (American Academy of Dermatology, 2008) and in those with genetic disorders such as pseudovitamin D deficiency rickets (Wagner C L and Greer F R, 2008).

Vitamin D deficiency remains the main cause of rickets among young infants in most countries, because breast milk is low in vitamin D and social customs and climatic conditions can prevent adequate sun exposure. In sunny countries such as Nigeria, South Africa, and Bangladesh, where rickets occurs among older toddlers and children, it has been attributed to low dietary calcium intakes, which are characteristic of cereal-based diets with limited access to dairy products (American Academy of Pediatrics Committee on Environmental Health, 1999).

OSTEOMALACIA

Osteomalacia is a disease in adults that results from vitamin D deficiency. Characteristics of this disease are softening of the bones, leading to bending of the spine, bowing of the legs, proximal muscle weakness, bone fragility, and increased risk for fractures (National Institutes of Health, 2010). Osteomalacia reduces calcium absorption and increases calcium loss from bone, which increases the risk for bone fractures. Osteomalacia is usually present when Vitamin D levels are less than about 10 mgs. Although the effects of osteomalacia are thought to contribute to chronic musculoskeletal pain, there is no persuasive evidence of lower vitamin D levels in chronic pain sufferers or that supplementation alleviates chronic nonspecific musculoskeletal pain (National Institutes of Health, 2011).

SKIN PIGMENTATION

Dark-skinned people living in temperate climates have been shown to have low vitamin D levels but the significance of this is not certain. Dark-skinned people may be less efficient at making vitamin D because melanin in the skin hinders vitamin D synthesis (Bischoff *et al.*, 2009).

OSTEOPOROSIS

It is a disease characterized by low bone mass and structural deterioration of bone tissue that increases bone fragility and significantly increases the risk of bone fractures (National Institutes of Health, 2010). Osteoporosis is most often associated with inadequate calcium intakes, but insufficient vitamin D contributes to osteoporosis by reducing calcium absorption. Although rickets and osteomalacia are extreme examples of the effects of vitamin D deficiency, osteoporosis is an example of a long-term effect of calcium and vitamin D insufficiency. Adequate storage levels of

vitamin D maintain bone strength and might help prevent osteoporosis (Heaney, 2003).

V. RISK OF VITAMIN D INADEQUACY AT DIFFERENT GROUPS OF INDIVIDUALS

Obtaining sufficient vitamin D from natural food sources alone is difficult. For many people, consuming vitamin D-fortified foods and, arguably, being exposed to some sunlight are essential for maintaining a healthy vitamin D status. In some groups, dietary supplements might be required to meet the daily need for vitamin D.

Breastfed infants

Vitamin D requirements cannot ordinarily be met by human milk alone, which provides only 25 IU/L to 78 IU/L. The vitamin D content of human milk is related to the mother's vitamin D status, so mothers who supplement with high doses of vitamin D may have correspondingly high levels of this nutrient in their milk (Wagner and Greer, 2008). A review of reports of nutritional rickets found that a majority of cases occurred among young, breastfed infants (Weisberg *et al.,* 2004). A survey of Canadian pediatricians found that almost all those with rickets had been breast fed. Exclusively and partially breastfed infants be supplemented with 400 IU of vitamin D per day, the RDA for this nutrient during infancy (Ward *et al.,* 2007).

Older adults

Older adults are at increased risk of developing vitamin D insufficiency in part because, as they age, skin cannot synthesize vitamin D as efficiently, they are likely to spend more time indoors, and they may have inadequate intakes of the vitamin (Cranney *et al.,* 2007).

People with limited sun exposure

Homebound individuals, women who wear long robes and head coverings for religious reasons, and people with occupations that limit sun exposure are unlikely to obtain adequate vitamin D from sunlight (Webb *et al.,* 1990) Because the extent and frequency of use of sunscreen are unknown, the significance of the role that sunscreen may play in reducing vitamin D synthesis is unclear (Webb *et al.,* 1988). Ingesting RDA levels of vitamin D from foods and/or supplements will provide these individuals with adequate amounts of this nutrient.

People with dark skin

Greater amounts of the pigment melanin in the epidermal layer result in darker skin and reduce the skin's ability to produce vitamin D from sunlight (Institute of Medicine, Food and Nutrition Board, 2010). Various reports consistently show lower Vitamin D levels in persons identified as black compared with those identified as white. Ingesting RDA levels of vitamin D from foods and/or supplements will provide these individuals with adequate amounts of this nutrient.

People with inflammatory bowel disease and other conditions causing fat malabsorption

Because vitamin D is a fat-soluble vitamin, its absorption depends on the gut's ability to absorb dietary fat. Individuals who have a reduced ability to absorb dietary fat might require vitamin D supplementation. Fat malabsorption is associated with a variety of medical conditions, including some forms of liver disease, cystic fibrosis, celiac disease, and Crohn's disease, as well as ulcerative colitis when the terminal ileum is inflamed. In addition, people with some of these conditions might have lower intakes of certain foods, such as dairy products fortified with vitamin D (Pappa *et al.,* 2008).

People who are obese or who have undergone gastric bypass surgery

A body mass index ≥30 is associated with lower Vitamin D levels compared with non-obese individuals. People who are obese may need larger than usual intakes of vitamin D levels comparable to those of normal weight. Obese individuals who have undergone gastric bypass surgery may become vitamin D deficient over time without a sufficient intake of this nutrient from food or supplements, since part of the upper small intestine where vitamin D is absorbed is bypassed and vitamin D mobilized into the serum from fat stores may not compensate over time (Compher *et al.,* 2008).

VI. CONCLUSION

Vitamin D is the master vitamin for all groups of individuals regardless of their age, health conditions, gender, location and diet they follow. Even though sun exposure is the major source of this vitamin, it is not possible for any physician to suggest a particular amount of sun exposure, as that can cause other hazardous cases of skin cancer due to the direct incidence ultraviolet radiations on skin, where lies the adequacy of finding new and sources of this essential micronutrient. Natural food sources can be fortified for the improved Vitamin D content. Mushrooms and soy milk naturally contain Vitamin D micronutrient, but more research are needed for making better predictions regarding with the

use of these plant products for Vitamin D supply. However, Vitamin D plays a better role in human body, thereby finding new sources will be a challenge to the researches.

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