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ASSOCIATION BETWEEN VITAMIN D AND OBESITY- A REVIEW

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ABSTRACT

Obesity is one of the most common disorders in today's day and age. It is defined as the abnormal accumulation of fat in the body that leads to impairment of health. It arises due to the sedentary lifestyle of the individual or due to the genetic heritage or the consumption of foods high in fat and sugar. It is predicted to rise in the upcoming years and is an emerging problem in developing countries. Vitamin D is a fat soluble vitamin, which is derived endogenously from sunlight or can be obtained by the consumption of oil-rich fish, egg, milk, etc. It is a secosteroid that has two biological compounds - Vitamin D_3 (cholecalciferol) and Vitamin D_2 (ergocalciferol). Vitamin D is required by the body for the regulation of calcium and phosphorus levels. The daily allowance of vitamin D is 40 to 80 ng/mL. Deficiency of vitamin D in the body occurs due to poor absorption, increased need or reduced intake. This leads to an increased incidence of disease such as diseases of the cardiovascular system, cancers of ovary and breast, and obesity. Recent findings have concluded the association between obesity and the levels of vitamin D in the body. This article reviews the association of vitamin D and obesity. The review also explores treatment of obesity with supplementation of Vitamin D. Clear studies for examining the role of Vitamin D in obesity correctly is required to properly treat obesity.

Keywords: Vitamin D; Metabolism; Supplementation; Calcium; Obesity; Overweight

INTRODUCTION

The world health organisation defines obesity as the BMI (body mass index) being 30kg/m2 or more. It is rapidly affecting numerous people around the globe **[1]**. The elderly with excessive body fat are more prone to develop coronary heart disease, hypertension, diabetes and other grave disorders **[2]**. Studies previously done, have found a steady association between the rising BMI and reduced Vitamin D serum levels in the body. There has also been studies pointing to the increased PTH (Parathyroid Hormone) and Vitamin D **[3]**. Vitamin D is a fat soluble prohormone that was discovered in the early 20th century **[4]**. Biologically, vitamin D has two precursors- Vitamin D3 which is cholecalciferol and Vitamin D2 which is ergocalciferol. The main source of Vitamin D is obtained from sunshine and dietary intake **[4, 5]**.

With the growing threat of obesity, the public have resorted to the consumption of natural products rather than synthetic drugs. Many plants are used for their antimicrobial, antidiabetic and anticancer activities such as *Caralluma fimbriata* **[6, 7]**, *Azadirachta indic*a **[8]**, *Acacia catechu* **[9, 10]** and Coumarin **[11]**. Reactive Oxygen species causing oxidative stress **[12, 13]** are also responsible for triggering some harmful effects on the body. Some recent advances in research include nanobased formulations for the treatment of various diseases. Nanoparticles of Selenium **[14]**, Zinc oxide and silver nanoparticle **[15-17]** have wide application in the field of medicine. Drug delivery for cancer is modified with the use of nanoparticles **[18, 19]**. As some of the drugs have the ability to produce free radicals and oxidative stress many researches are also focused to alleviate oxidative stress induced hepatotoxicity and other organ damage **[20]** and hence, for the management of obesity, natural plant based products are also used. Obesity and vitamin D deficiency have grown incidentally over the past few years and has become an increasing epidemic. One plausible reason is increased levels of the former leading to reduced levels of the latter. Though there is an increasing level of evidence pointing to the association, it is unclear whether obesity causes vitamin D deficiency or vitamin D deficiency causes obesity.

METABOLISM OF VITAMIN D:

The main source of Vitamin D production is mainly derived from the exposure of skin to sunlight **[21]**. Additionally, Vitamin D is also obtained from dietary sources such as oily fish (eg. Salmon or sardines), egg, etc. Foods

such as milk and orange juice also contain good levels of vitamin D **[5]**. Around 80% of the body concentration of Vitamin D3 is obtained from the epidermis where the 20% remaining is obtained from diet consisting of animals or plants and additionally through drug supplementation **[5, 22]**. A wide range of environmental factors affect the formation of pre-D3; for example the pigmentation of skin, the type of clothing worn and if any sunscreen is used. It also greatly depends on the time of exposure to the sun **[23]**.

VITAMIN D AND ITS FUNCTION:

The most important biological role of Vitamin D is the maintenance of normal calcium and phosphate levels in the body. This aids in absorption of calcium for formation and maintenance of bones. Other functions of Vitamin D include the regulation of cell proliferation, differentiation and immune modulation **[23, 24]**. The 'sunshine vitamin' has been reported to suppress cell cycle progression by arrest at G0-G1 phase. It assists in the regulation of the differentiation of malignant or benign cells as well as normal cells. Increased concentration of Vitamin D is associated with a decreased risk of multiple sclerosis.

COMPLICATIONS OF VITAMIN D:

Deficiency of Vitamin D occurs when individuals have reduced exposure to the sunlight or have a decreased intake of Vitamin D (through dietary sources). The causes of Vitamin D deficiency could be either due to UVB-related deficiency or medical/physical condition related deficiency. UVB-related Vitamin D deficiency could be present in- the elderly (due to the decreased presence of 7-dehydrocholesterol in skin); in individuals with dark skin (due to the increase in presence of melanin pigment in skin); in those that use sunscreen (which prevents the 7-dehydrocholesterol and UVB-rays interaction) **[25, 26]**.

Medical/Physical condition related deficiency of Vitamin D is widely seen in- fat malabsorption (Cystic fibrosis, Crohn's disease); anticonvulsant use (usage of antiepileptic drugs); individuals with chronic kidney disease and those with obesity **[26, 27]**. Reduced levels of Vitamin D hampers the normal calcium, phosphorus absorption and the bone formation **[5, 28]**. This results in an increased PTH levels in the body leading to osteoclastic activity and finally, the decreased bone mineral density (BMD) **[24]**. This occurrence in young children can result in rickets **[24, 29]**. Decreased Vitamin D concentrations in individuals are more prone to development of hypertension **[30]** and obesity **[31, 32]**.

OBESITY:

Obesity is a common but often underestimated condition of clinical and public health importance in many countries around the world. Obesity is defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health is impaired **[33]**. The amount of excess fat in absolute terms, and its distribution in the body - either around the waist and trunk or peripherally around the body. In general, obesity is associated with an increased risk of disability or premature death due to type 2 diabetes mellitus and cardiovascular diseases such as hypertension, stroke and coronary heart disease as well as gallbladder disease, certain cancers and non-fatal conditions including gout, gastro-esophageal reflux disease and infertility. Obesity also carries serious implications for psychosocial health. A central distribution of body fat is related to a better risk of morbidity and mortality than a more peripheral distribution. Furthermore, individuals with cardiovascular disease having risk factors such as type 2 diabetes mellitus, hypertension and smoking are exposed to significant health risks at lower levels of obesity. It is therefore imperative to assess individuals who are overweight or obese not only to determine the extent of adiposity, but also for the body fat distribution and the presence of co-morbid factors **[34]**.

IMPACT OF OBESITY:

Physical Impact:

Physical morbidities related to overweight and obesity include cancers (cancers of breast, endometrial, ovarian, colorectal, esophageal, kidney, pancreatic, prostate), Type 2 diabetes, hypertension, stroke, Coronary Artery Disease, Congestive Heart Failure, asthma, chronic back pain, osteoarthritis, pulmonary embolism, gallbladder disease, and also an increased risk of disability **[34, 35]**. This leads to more than three million deaths worldwide annually **[36]**. Yet another related health problem due to increasing prevalence of obesity will be the number of years that patients suffer from obesity-related morbidity and disability which would also increase significantly. Studies have confirmed that obesity may be a major public ill health which ends up in decreased anticipation especially in younger age groups. Obesity has a strong association with the occurrence of chronic medical problems, impairment of health-related quality of life, and increasing the health care and medication spending, the related health care costs for obesity-related problems, for

both individuals and health care systems, are substantial.

Impact in Mental Health:

Obesity discrimination by the society and being overweight in general may lead to some mental health problems. It is said to increase the risk of low self-esteem, mood disorder, motivational disorders, eating problems, impaired body image, interpersonal communication problems and all these directly or indirectly affect the quality of life **[36, 37]**. Some studies show that obese men and women have poor sexual health.

REASONS FOR REDUCED VITAMIN D DEFICIENCY:

One of the main reasons of Vitamin D decreased in obese individuals is due to the reduced dietary intake. The other reasons include decreased cutaneous synthesis, reduced intestinal absorption and altered behavior **[38-41]**. Membrane and nuclear receptors of Vitamin D are demonstrated in adipocytes or fat cells **[42]**. Vitamin D or 1,25-D has been shown to have some anti-inflammatory effect (in vitro) on fat cells. In a particular study done with 2460 adults, the baseline Vitamin D concentrations and the incidence of development of obesity was observed **[43]**.

ADMINISTRATION OF VITAMIN D AND CALCIUM:

Vitamin D is essential for calcium metabolism and it is the most important biological function. Changes in weight, fat mass and visceral fat area were differentiated among college students (that were obese). These individuals were given a calorie restricted diet with and without calcium supplementation adding Vitamin D daily. This study (calorie restricted) was carried out for 12 weeks. At the end of the study, it was revealed that the group was given the supplements had a subsequent decrease in visceral fat area and fat mass. Limitation of the study was the use of Vitamin D dosage and lack of Vitamin D measurement **[43, 44]**. Another double-blind randomised 16 week study showed a reduction in adiposity (viscerally) but the limitation was again the unmeasured 25-D (this study also has obese adults given calcium-with or without along with Vitamin D supplementations) **[45]**.

ADMINISTRATION OF VITAMIN D ALONE:

In a randomised study conducted in 77 obese individuals that received Vitamin D daily and a cohot without, it revealed that Vitamin D supplementation showed reduced effect in the body mass and rise in the 25-D concentrations that were significantly low at

the start of the study **[45, 46]**. Another study observed that the 25-D concentration and changes in fat mass were inversely proportional **[47]**. This therefore shows that Vitamin D with or without the calcium supplementation has no definite effect in weight changes but causes some change in fat mass and distribution **[47, 48]**.

CONCLUSION

Vitamin D is one of the most important vitamins regulating calcium and phosphate absorption and the maintenance of appropriate levels in the body. Reduced 25-D concentrations and obesity are very common nowadays. There are various mechanisms suggesting that vitamin D supplementation reduces weight but it is hard to understand whether it is due to the sole activity of vitamin D or its activity with calcium. The studies are inconclusive as some suggest weight loss due to vitamin D supplementation and others suggest no weight loss but a decrease or change in the fat mass. However, clear studies are required to report the accurate role of vitamin D supplementation and obesity levels, which otherwise remains uncertain.

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