

## Research Article



## A Cross Sectional Study on 25(OH) Vitamin D<sub>3</sub> Levels in Healthy Obese Individuals Attending a Community Care Centre in Chennai, Tamilnadu

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### ABSTRACT

25(OH) Vitamin D is the circulating form of vitamin D which is measurable in the blood. There is evidence of aberrations in the vitamin D-endocrine system in obese subjects. Vitamin D insufficiency has been defined as serum 25-hydroxyvitamin D [25(OH)] levels below 30 ng/mL and is common among patients with obesity. Our aim was to investigate clinically the status of 25(OH)D in obesity. Serum 25(OH) vitamin D and body mass index [body mass index (BMI; in kg/m<sup>2</sup>) ≥ 30] were determined in 50 healthy Obese individuals attending a community care centre. The mean ± SD values for serum 25(OH) D levels of obese with BMI (36 ± 1.77kg/m<sup>2</sup>) were 25.6±12.6 ng/ml. The results of the study revealed a statistically significant negative correlation between serum 25 (OH) D levels and body mass index of obese patients (r=0.243, p<0.01). The association between low serum 25(OH) D levels and higher BMI in study population may be inscribed into the wider context portraying Obesity - associated vitamin D insufficiency is likely due to the decreased bioavailability of 25(OH) vitamin D<sub>3</sub> from cutaneous and dietary sources, because of its deposition in body fat compartments.

**Keywords:** Vitamin D, BMI, obesity.

### INTRODUCTION

Obesity is a metabolic disorder which is an emerging health problem of growing importance. Various factors play a role in the calcitropic hypovitaminosis prevalent in obesity. Vitamin D is derived from 7 dehydro cholesterol or ergosterol by UV radiation<sup>1</sup>. Cholecalciferol is hydroxylated at the 25<sup>th</sup> position in the liver to form 25 hydroxy cholecalciferol. This is the major transport form of the vitamin. It then gets hydroxylated at the first position to form calcitriol which is the active form of vitamin D<sup>2, 3</sup>. Various definitions for vitamin D insufficiency have appeared in the literature; the best established one pertains to serum levels below 30 ng/mL<sup>4</sup>. A recent meta-analysis has demonstrated that low vitamin D levels in middle-aged and elderly populations and represent a risk factor for type 2 diabetes mellitus (DM), cardiovascular disease and metabolic syndrome<sup>5</sup>.

Interestingly many studies reveal aberrations in the vitamin D-endocrine system in obese subjects<sup>6</sup>, such as increases in serum parathyroid hormone (PTH), urinary cyclic adenosine 3,5'-monophosphate (cAMP), renal tubular reabsorption of calcium, and circulating 1α, 25-hydroxyvitamin D<sub>3</sub> (1,25OHD<sub>3</sub>) and a decrease in serum 25-hydroxyvitamin D<sub>3</sub> (25OHD) levels. In young adults, the dietary supplemental vitamin D intake was inversely related to the development of metabolic syndrome over 20 years of follow-up<sup>7</sup>. Vitamin D deficiency is an independent risk factor for obesity and abdominal obesity in women<sup>8</sup>. Obese women transfer less 25(OH) D to offspring than normal-weight women, despite similar

serum levels; maternal obesity and vitamin D sufficiency are associated with cord-blood vitamin D insufficiency<sup>9</sup>. Visceral adipose tissue is negatively associated with plasma 25(OH)D concentrations in South Asians<sup>10</sup>. Vitamin D deficiency has been associated with obesity, visceral obesity, hypertriglyceridemia, and metabolic syndrome in Korean children<sup>11</sup>. Body mass index (BMI) is inversely associated with the increase in the serum 25(OH)D levels in response to vitamin D supplementation<sup>12</sup>.

The expression of vitamin D-metabolizing enzymes has been demonstrated in human adipose tissue. Plasma 25(OH) D increased by 27% after weight loss in the obese individuals. The expression levels of the 25-hydroxylase CYP2J2 and the 1α-hydroxylase CYP27B1 were decreased by 71% and 49%, respectively, in the subcutaneous adipose tissue of obese subjects<sup>13</sup>, suggesting that adipose tissue, which can be dynamically altered during obesity and weight loss, has the capacity to metabolize vitamin D locally. Furthermore, calcitriol directly regulates adipocyte 11β-hydroxysteroid dehydrogenase type 1 (11β-HSD-1), generating active cortisol from inactive cortisone, with expression and cortisol production in human adipocytes *in vitro*<sup>14</sup>, suggesting a potential role for calcitriol in visceral adiposity. In a 12-week double-blind randomized clinical trial, cholecalciferol supplementation resulted in a statistically significant decrease in body fat mass in healthy and obese women compared with the placebo group<sup>15</sup>. In addition, vitamin D<sub>3</sub> supplementation also improved insulin sensitivity in apparently healthy, middle-aged, centrally obese men<sup>16</sup>.



Several genetic studies have linked VDR polymorphisms with obesity and data confirm an important role of the VDR in the control of adipocyte metabolism and the regulation of energy metabolism. Variations at the VDR locus have been associated with susceptibility and progression to several diseases. VDR gene polymorphisms have been linked to higher susceptibility to vitamin D deficiency in children and adolescents<sup>17</sup>. The VDR TaqI allele is associated with obesity<sup>18, 19</sup>; BsmI and Apal VDR genes are also significantly associated with overweight and obesity<sup>20</sup>, and the BsmI VDR polymorphism appeared to influence body mass index. These observations suggested that alterations of VDR function may play a role in patients with obesity.

This paper reviewed the relationship between vitamin D and obesity. Genetic studies should be performed to determine which proteins link vitamin D to obesity pathology. Vitamin D is also able to act through numerous non-genomic mechanisms, including protein expression, oxidative stress, inflammation, and cellular metabolism. These findings suggest that vitamin D plays a role in obesity. Interestingly, Vitamin D is fat-soluble vitamin which is sequestered after absorption and stored in tissues such as fat and muscle. This fate of vitamin D has been demonstrated by injecting radio-labeled vitamin D<sub>3</sub> into individuals and monitoring the highest levels of biological activity and radioactivity in the fat tissue<sup>21</sup>. Calcitriol therapy in obesity has not been reported whilst the results of trials of cholecalciferol supplementation have so far been limited. Therefore, further investigation of calcitriol in obese patients is needed.

## MATERIALS AND METHODS

Blood sample (5ml) was obtained from 50 obese healthy individuals [body mass index (BMI; in kg/m<sup>2</sup>) ≥ 30] of age (44.32 ± 7.787 years) and BMI (36 ± 1.77kg/m<sup>2</sup>) without any complications or comorbid illnesses were recruited from a tertiary community care centre, Chennai, India and all participants were interviewed at baseline and BMI measured by the same investigator (to assess sunlight exposure). 25(OH)D was measured by direct ELISA KIT (Immunodiagnostik). Hypercalcemia, intake of vitamin D for osteoporosis in dietary supplements, other orthopedic problems like rickets, osteomalacia or end-stage renal failure, pregnancy or any chronic illness were excluded from the study.

**The vitamin D status was assessed according to the following criteria:** Severe deficiency- below 10 ng/ml, insufficiency- 10-25 ng/ml and sufficiency - >25-150 ng/ml. A cutoff point of <30 ng/ml of 25(OH) D was used to classify patients as on low vitamin D status. All data were analyzed using the Statistical Package for Social Sciences (SPSS), version 16. Student t-test was used to assess differences in serum analytes among groups. The statistical significance, direction and strength of linear correlation between two quantitative variables were measured by using Pearson's correlation coefficient test. Categorical variables were compared by Chi-square test.

This study was approved by Institutional Ethical committee of Sree Balaji Medical College and Hospital. Informed consent was obtained from all the study participants both in English and vernacular language.

## RESULTS AND DISCUSSION

The general characteristics of the individuals have been described in [Table/Fig-1].

Parameters	Healthy obese (n=50)	p-value	r-value
Age (years)*	44.32 ± 7.787		
BMI (Kg/m <sup>2</sup> )*	36 ± 1.77	<0.001	r=0.243
25(OH) D (ng/ml)*	18.49 ± 3.497		

The age of the participants ranged between 44.32 ± 7.787 years with 25(OH)D insufficiency (18.49 ± 3.497 ng/ml) and the BMI range was 36 ± 1.77kg/m<sup>2</sup>. Low serum vitamin D was negatively correlated with obesity. The mean serum 25(OH) D level was significantly lower (p<0.01) for obese. There was a trend towards an inverse 25(OH) D - BMI association, which did not show statistical significance, most probably due to relatively small sample size.

The present study observed that individuals with obesity showed vitamin D insufficiency. The present study of the synthesis and processing of vitamin D confirmed that obese patients have lower basal 25(OH)D<sup>22-26</sup>. Because vitamin D is fat soluble and is readily stored in adipose tissue, it could be sequestered in the larger body pool of fat of obese individuals. It is possible that the subcutaneous fat, which is known to store vitamin D<sub>3</sub>, sequestered more of the cutaneous synthesized vitamin D<sub>3</sub> in the obese because there was more fat available for this process. Though BMI was inversely correlated with calcitriol the orally supplied vitamin D<sub>2</sub> was more bioavailable, probably because after absorption into the lymphatic system and transfer into the bloodstream.

Although the mechanism for how low serum 25(OH) D levels might increase the incidence of obesity is not well understood, our findings have biologic plausibility. In vitro, experimental studies suggest that 1, 25-dihydroxyvitamin D [1, 25(OH)<sub>2</sub>D] favors lipogenesis and inhibits lipolysis, and it also modulates the distribution of fat<sup>27,28</sup>. Subjects with clinically important low vitamin D status (which is defined as serum 25(OH)D level <50 nmol/L) often have secondary hyperparathyroidism and elevated levels of parathyroid hormone and 1,25(OH)<sub>2</sub>D<sup>29,30</sup>. Parathyroid hormone itself has also been suggested to play a role in fat accumulation by increasing the risk of insulin resistance and inhibiting lipolysis, and it may be mediated by 1,25(OH)<sub>2</sub>D<sup>31,32</sup>. This might help to explain why serum 25(OH) D levels less than 30 nmol/L were most strongly associated with obesity.



## CONCLUSION

To summarize, obesity is widely recognized to lower vitamin D status in the body because of the fat-soluble property of vitamin D and other factors. This inference was mainly made from cross-sectional associations and a few prospective observations and clinical trials<sup>33</sup>. The detrimental effects of overall obesity have been shown worldwide. Central obesity is an important component of and risk factor for the metabolic syndrome<sup>34</sup>. Recent research has also provided evidence for multiple adverse effects of central abdominal obesity. Thus, the implications could be profound if improvement of vitamin D status could reduce both overall and central obesity. We suggest that there might be a harmful cycle (i.e., low vitamin D → obesity → low vitamin D) that complicates obesity prevention and treatment efforts. Moreover humans obtain most of their vitamin D requirement from casual exposure to sunlight, the >50% decreased bioavailability of cutaneously synthesized vitamin D<sub>3</sub> in the obese subjects could also account for calcitropic hypovitaminosis in obesity. Oral vitamin D should be able to correct the vitamin D deficiency associated with obesity, but larger than usual doses may be required for very obese patients. This possibility merits further research in well-designed large prospective studies.

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