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Correlation of body mass index and serum 25-hydroxy vitamin D3 levels: A cross sectional study

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Abstract
Background: Problem of obesity is growing as pandemic around the world. Recent studies have investigated the role of vitamin D and obesity but found conflicting results. The aim of this present study is to examine the relationship between serum 25-hydroxy vitamin D3 levels with Body mass index (BMI).
Methods: In this cross-sectional study, a total no of 141 patients aged 19-70 years were enrolled for analysis. A complete history and physical examination was done and serum vitamin D levels were measured.
Results: There were 54 men with age (Mean±SD) 36.6 ± 14.06 years and 87 women with age (Mean±SD) 35.72±12.28years. There were 19.1% overweight and 10.6% participants had obesity. Regarding serum vitamin D status among males and females, 87.1% of men and 93.1% of women and have serum vitamin D levels less than 30ng/ml. Whereas, patients with BMI (<25) had 5.4%and 86.8% deficiency and insufficiency respectively. Overweight and obese patients had 6.6%vs7.4%and 80%vs77.7% had deficiency and insufficiency, respectively. A significant inverse association was found between serum 25-hydroxy vitamin D3 levels and BMI($p<0.05$).
Conclusion: In the present study, we concluded that serum 25-hydroxy vitamin D3 levels had inverse significant correlation with body mass index.

Keywords: Vitamin D, obesity, body mass index

1. Introduction
Problem of obesity is growing as pandemic around the world [1]. Obesity is linked to many diseases like increased risk of cardiovascular disease, hypertension, diabetes mellitus, gallbladder disease, arthritis and cancer [2].
The prevalence of vitamin D deficiency is 30-80% among children and adult world-wide [2]. In India, prevalence of vitamin D deficiency has been observed on apparently healthy controls is ranging from 50% to 94%.[3-6] Prevalence of 25(OH)D3 estimated in urban population was 75% in females and 62% in males, whereas the prevalence of Vitamin D deficiency was slightly lower in a rural area as 70% in females and 44% in males [7].
Reduced Vitamin D levels is associated with a lot of diseases like cardiovascular disorders, kidney disorders, diabetes mellitus, autoimmune disorders, musculoskeletal disorders and infections etc [8, 13]. Recent studies have investigated the role of vitamin D and obesity but found conflicting results [14, 23]. Thus, the aim of present study was to investigate the association between serum 25-hydroxy vitamin D3 levels and Body mass index.

2. Material and Methods
This was a cross sectional study. A total of 141 subjects were included in this. They were recruited in Lab medicine department of Pathology, in our hospital during the period from Feb 2020 to May 2020. Written informed consent was taken from all participants of the study.
Exclusion criteria: Age <18 years, pregnancy, history of malabsorption disorder, H/o chronic kidney, liver, thyroid disease, on vitamin D and calcium supplementation, H/o diabetes mellitus, dermatological disease, rheumatological disease and alcoholics. Not willing to participate in the study. Inclusion criteria: Age >18 years, nonpregnant, no history of chronic illness.
A complete history, examination, weight, height, waist circumference (WC), body mass index (BMI), education level, medical history, the use of vitamin and mineral supplements were gathered. Weight was determined (within 0.5 kg) using analog scale in light clothes and without shoes. Height was determined (within 0.5 cm) with tape measure without shoes. General obesity was assessed using BMI. Overweight and obesity was defined as BMI ≥ 25 and BMI ≥ 30, respectively. BMI was obtained through weight (kilogram) divided into height (meter squared). BMI category was determined as: underweight (values < 18.5); normal weight (values 18.5-24.9); overweight (values 25-29.9) and obesity (values ≥ 30).

3. Laboratory investigations
For measuring 25(OH)D3: After overnight fasting for 10–12 hours and after aseptic precaution, blood sample was collected by venepuncture. The serum was separated by centrifugation and then stored at –80oC for a week until analysed. Vitamin D status was evaluated by measurement of serum 25(OH)D3 levels with a chemiluminescent immunoassay method (Seimens Adivacenture CP system). Serum 25(OH)D3 levels were considered as deficient when it is <10ng/ml and insufficient between 10-30ng/ml, 30-100ng/ml sufficient and >100ng/ml as intoxication.

4. Statistical Analysis
Data were statistically analysed by SPSS version-23 for Windows. The mean and the standard deviation (SD) for all the variables were calculated. The differences between mean values for each tested variable have been tested by student's "t" test. The correlations between serum 25(OH)D3 levels, age and BMI were presented by

correlation coefficient (r2). Results considered significant when p value is < 0.05.

5. Results

In the study 141 subjects were included for analysis. There were 54 men with Mean±SD age of 36.6 ± 14.06years and 87 women with Mean±SD age of 35.72±12.28years. Mean±SD of BMI was found to be higher among males. (Table 1)

Table 1: Demographical characteristics of patients

Variants	Male n= 54 (Mean±SD)	Female n=87 (Mean±SD)	Total n=141 (Mean±SD)	t test	p value
Age (years)	36.13± 14.06	35.72±12.28	35.88±12.94	-1.697	0.096
BMI (kg/m^2)	24.2±3.6	23.92±3.6	24.63±3.45	-2.787	0.07
25(OH)D3 (ng/ml)	20.8±7.8	19.86±6.95	20.16±7.29	-1.246	0.218

Deficiency, insufficiency, and sufficiency of vitamin D were observed 5.6%, 85.1%, and 9.2% among all participants, respectively. Regarding serum vitamin D status among males and females, 87.1% of men and 93.1% of women and have serum vitamin D levels less than 30ng/ml. (Table 2)

Table 2: Serum 25(OH)D3 levels according to sex

Serum 25(OH)D3	Male n=54 (38.3%)	Female n=87 (61.7%)	Total n=141
Deficiency(<10ng/ml)	3(5.6%)	5(5.7%)	8(5.6%)
Insufficiency(10-30ng/ml)	44(81.5%)	76(87.4%)	120(85.1%)
Sufficiency(30-100ng/ml)	7(13%)	6(6.8%)	13(9.2%)

There were 19.1% overweight and 10.6% participants had obesity. The participants with BMI (<18.5) had 100% vit D insufficiency. Whereas patients with BMI (<25) had 5.4%and 86.8% deficiency and insufficiency respectively. Overweight and obese patients had 6.6%vs7.4%and 80%vs77.7% had deficiency and insufficiency respectively. Higher BMI was seen with increase with age in both female and males. (Table 3)

Table 3: Serum 25(OH)D3 status according to body mass index category

Variants	BMI (<18.5) n=8(5.67%) (F/M)5/3 (Mean±SD)	BMI (18.5-24.9) n=91 (64.5%) F/M=51/40 (Mean±SD)	BMI (25-29.9) n=27(19.1%) F/M=19/8 (Mean±SD)	BMI (>30), n=15 (10.6%) F/M=12/3 (Mean±SD)
AGE (years) F/M*	25.40±3.6/39.0±26.8	32.08±10.71/33.45±12.99	42.84±12.82/43.5±9.35	44.25±10.3/49.33±16.86
Serum25(OH) D3(ng/ml) F/M	18.12±4.2/16.96±2.45	22.73±8.4/23.6±9.38	18.09±6.07/25.73±4.50	18.75±6.57/20.15±7.8
Deficiency	0(0%)	5(5.4%)	1(6.6%)	2(7.4%)
Insufficiency	8(100%)	79(86.8%)	12(80%)	21(77.7%)
Sufficiency	0(0%)	7(7.6%)	2(13.3%)	4(14.8%)

F=FEMAL, M=MALE*

Significant inverse association was found between serum 25(OH)D3 levels and BMI (Table 4).

Table 4: Correlation between 25 (OH) vitamin D and other variables in participants

Variable	R	p value
Age	0.135	0.111
BMI	-0.998	.036

6. Discussion

Vitamin D plays a crucial role in bone metabolism and calcium homeostasis [24]. Reduced vit D levels may be attributed to many factors like limited exposure to sunshine, obesity, old age, inadequate dietary intake and the increased use of sun blocking agents that lessen cholesterol metabolism in the skin.

In our study we found Vitamin D deficiency and insufficiency were observed 5.6% and 85.1%, among over all participants, respectively. Regarding serum vitamin D status among males and females, 87.1% of men and 93.1% of women have serum vitamin D levels less than 30 ng/ml. Our results are in agreement with the community-based Indian studies done on apparently healthy controls who reported a prevalence of vitamin D deficiency is ranging from 50% to 94% [3, 6]. Prevalence of 25(OH)D3 estimated in urban population was 75% in females and 62% in males, whereas the prevalence of Vitamin D deficiency was slightly lower in a rural area as 70% in females and 44% in males [7].

In currant study 19.1% subjects were overweight and 10.6% were obese. According to WHO 2019, 39% of women and 39% of men >18 are overweight (BMI>25) and 15% of women and 11% of men were obese (BMI>30) globally [25]. The prevalence of overweight/obese among women and men >20% and 19.6%respectively men in India [1]. In our study group the prevalence of overweight and obesity little less than the general population.

In present study significant inverse relationship was observed between BMI serum levels of vitamin D. Our results are in agreement with study by Lagunova Z *et al*, Parikh SJ *et al*, Konradsen S *et al*, Tamer G *et al*, Lee SH *et al* and Vashi PG *et al* who in their studies have shown an inverse relationship between serum levels of vitamin D and general obesity among population health and patients [14, 18, 20, 21]. The study conducted by Miñambres I *et al* on overweight/obese patients, low vitamin D levels was associated with the degree of obesity, importantly in patients with BMI >40. Patients with vitamin deficiency had higher BMI and WC [26].

Study done by Lagunova Z *et al*, concluded that prevalence of vitamin D deficiency was the highest among patients with BMI more than or equal to 40 and inverse association was found between serum vitamin D with BMI [15]. Khor *et al*. in their study among children aged 7-12 years, inverse

relationship was observed between vitamin D status and BMI, but only in boys [27].

Similarly, Saliba *et al*. in their study observed inverse relationship was between serum vitamin D levels and BMI [28]. Similarly study by Lagunova Z *et al* found that 1,25(OH)2D concentrations was 25.4 pmol/l lower in lowest quartile compared to highest quartile of 25-OH-D. A unit increase in BMI was associated with decreased (1 nmol/l) in 25-OH-D and decreased (0.9 pmol/l) in 1, 25-(OH)2-D among obese patients [14].

However, contrary to our results, Baradaran A, *et al* and Moy FM *et al* in their research have shown no association between vitamin D levels and obesity [22, 23]. Another study by Vilarrasa *et al*. observed inverse correlation between serum vitamin D levels with weight, BMI and body fat. However, after adjustment for confounder variables, no relationship was seen between serum vitamin D and BMI [29]. Jungert A *et al* in their study found higher levels of 25-OH-D3 was inversely associated with BMI, hip circumference and total body fat (TBF) among women but not in men. However, after adjustments for confounder variables, no association between 25(OH)D3 and BMI was found [30].

There are few mechanisms and hypothesis to determine the relationship between serum vitamin D levels with obesity. According to them, there may be inadequate intake of vitamin D, exposure to sun light may be less and reduced bioavailability of vitamin D among obese patients [26]. Vitamin D is fat-soluble vitamin which is mainly sequestered in adipose tissue. This may attribute to low serum vitamin D levels in obese patients [23, 31].

7. Conclusions

To conclude, there is a significant inverse association was observed between serum 25(OH)D3 levels with Body mass index. But vitamin D deficiency is cause of or consequence of obesity cannot be established.

8. Limitations and Recommendations

This is cross-sectional study; hence we cannot determine a causal link. The sample size of this study is small and more studies are recommended with greater sample size.

10. Financial Support and Sponsorship

Nil.

11.Conflicts of Interest

There are no conflicts of interest.

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