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Evaluation of Relation between Vitamin D Deficiency and Body Composition Indices of Indian Women in Child Bearing Age

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Abstract: ***Vitamin D deficiency is a globally public health problem. The objective of this study was to find the correlation between 25 (OH) D and indices of body composition. The study 49 women were divided in three groups vitamin D insufficient (25 (OH) D ≥20 & <30 ng/ml), deficient (25 (OH) D ≥10 & <20 ng/ml) and severe deficient (25 (OH) D <10ng/ml). Among the study women 14.3% were vitamin D insufficient, 65.3% deficient and 20.4% severe deficient. Women were stratified according to their body mass index (BMI) into underweight with <18.5 kg/m^2, normal weight with BMI ≥ 18.5 & <25 kg/m^2, over weight with BMI≥ 25 kg/m^2 & <28 kg/m^2 and obese with BMI≥ 28 kg/m^2. The present study showed that 12% women under weight, 52% normal weight, 26% overweight and 10% obese. No correlation was not observed between 25 (OH) D levels and with BMI and FFMI of the study women. Only FMI was correlated with 25 (OH) D level (p<0.05). In conclusion, individuals with lower 25 (OH) D levels had a higher percentage of BMI, FMI and FFMI of child bearing aged Indian women. There is a statistically significant and inverse relation between vitamin D level and body fat mass of the Indian women of child bearing age.***

Keywords: Vitamin D Deficiency, 25 Hydroxy vitamin D, Correlation, Body mass index, Fat mass index

1. Introduction

Vitamin D is the sunshine vitamin that has been produced on this earth for more than 500 million years. Vitamin D deficiency and insufficiency are a major public health problem globally irrespective of age, even in populations residing in countries where it is assumed that UV radiation is adequate and in industrialized countries where fortification has been implemented for years [1].

In West Bengal Vitamin D deficiency as determined by low blood level of 25 (OH) D is common both in under five children and their mothers. This is similar to the situation in many regions of India. Tests were conducted on families from low socio- economic group (urban poor) from the Metropolitan City of Kolkata. Diet in this populations provides little if any vitamin D or its precursors. Exposure to sunlight is minimal and is avoided by most people in India.

Measurement of serum 25 hydroxyvitamin D (25 (OH) D) concentration is the best indicator to assess vitamin D status. The prevalence of low vitamin D status is increasing globally. Levels of 25 (OH) D<10 ng/ml in adults were most common in Asia (78%) compared to Europe (2 - 30%), and North America (13%) [2].

Vitamin D is a fat soluble that can be synthesized in the skin as a result of sun exposure or can be obtained from foods containing the nutrients naturally (e. g. cod liver oil, fatty fishes and eggs), vitamin D fortified products and vitamin D supplements [3]. Hypovitaminosis D is a widespread public health problem with approximately over 1 billion people globally has vitamin D deficiency [4]. A major cause of Vitamin D deficiency is insufficient exposure to sunlight, wearing of covering clothes and using sunscreen and it depends on the activity of the enzymes responsible for its final hydroxylation [5]. The high prevalence of obesity and low vitamin D status was associated of overweight and obesity [6].

Our goals were to investigate the relationship between vitamin D deficiency and anthropometric parameters, as well as the relationship with body composition indices among the women of child bearing age of Kolkata, India. As a result, we expected that women with high body composition indices would have lower serum vitamin D levels.

2. Materials & methods

A total of 49 women were recruited in our study. Women were attending the family welfare clinic at the Infectious Diseases and Beleghata General Hospital, Kolkata, India. This is a large charitable Government hospital in the city of Kolkata where the treatment is free or subsidized and serves the urban poor. The eligibility criteria for inclusion in the study were women 18 - 40 yrs old, family lives within 10 km radius of the study center and the exclusion criteria were: not willing to give a written informed consent. Written informed consent was obtained from themselves. Baseline history and clinical examination results on the women enrolled were recorded on a pre - tested data collection form. Additional inclusion criteria were no antibiotics during past one month, no sign and symptoms of chronic systematic.

These included age, height, weight, socioeconomic indicators, sun exposure, rooming condition etc. The tests were done at admission to the study included determination of serum 25 (OH) D, calcium (Ca) and Alkaline Phosphatase (ALP). This study was approved by the Ethical Review Committee of Society for Applied Studies, Kolkata, India. Laboratory tests included serum Ca level evaluated by SPECTROPHOTOMETRY, normal level between 8.8 to

10.8 mg/dl. Serum ALP measured by SPECTROPHOTOMETRY, normal level (145 - 320) U/L. Serum 25 (OH) D measured by Chemiluminescence. Vitamin D assays are standardized to be in alignment with the ID - LC/MS/MS 25 (OH) Vitamin D Reference Method Procedure, the reference procedure for the vitamin D standardization program. Vitamin D cut off point level of 25 (OH) D; 25 (OH) D<10 ng/ml = Severe Deficiency, 25 (OH) D≥10 ng/ml & <20 ng/ml =Deficiency, 25 (OH) D≥20 ng/ml & <30 ng/ml =Insufficiency, 25 (OH) D≥30 ng/ml =Sufficiency [7].

Measurement of weight were obtained an electronic platform balance (Avery India Limited, model no. L111A) with a precision of 10 gm. The balance was checked regularly for accuracy using standard weights. Measurement of height was obtained to the nearest 0.1 cm, the following procedure was used; no wearing of shoes, heals, which head in contact with the horizontally oriented Stadio Meter's Rular. Using anthropometry measurement

Percent of Body Fat =1.20×BMI+0.23×Age - 10.8× Sex (Male=1, Female=0) - 5.4 [8].

Statistical analysis

All statistical analyses were performed using stata version 11.2. The results were described as median (minimum and maximum), mean, and standard deviation values for quantitative variables, or as frequency and percentage values for categorical variables. Two samples Kolmogorov Smirnov test were used to estimate the correlation between quantitative variables. One - way analysis of variance (ANOVA) was used to compare groups defined by vitamin D levels (severe deficient, deficient and insufficient) concerning quantitative variables. A p - value of less than 0.05 was considered statistically significant. Data were analyzed using simple linear regression analysis, multiple regression analysis.

3. Results

The study sample included 49 women, with mean age 25.6 ± 4.08 yrs. Average BMI of these women were 23.56± 4.56 kg/m^2, FMI was 7.02±2.73 kg/m^2 and FFMI was 16.53±1.88 kg/m^2. A total of these women 12% were underweight, 52% normal weight, 26% overweight and 10 % obese. In the total sample, the median of 25 (OH) D concentration was 16.86± 5.05 ng/ml, range (5.43 - 29.26) ng/ml. The median of 25 (OH) D concentration of underweight, normal weight, overweight and obese women was 16.16 ng/ml, 17.63 ng/ml, 14.92 ng/ml and 15.9 ng/ml respectively. So, normal weight women had comparatively higher vitamin D level than underweight, overweight or obese women. The mean 25 (OH) D concentrations was 15.91±5.05 ng/ml. The prevalence of vitamin D with severe deficiency, deficiency and insufficiency were 20.4%, 65.3% and 14.3% respectively. In our study, 66% women had junior high school or below Madhyamik, 54% women's husband had junior high school or below Madhyamik. Eighty four percent women told that their occupation were only housewife, so they didn't earn money and only 16% women earned money and worked by housekeeping, tailoring, tuition etc. Among the household head, only 4.2% were Govt. employee, 31.3% had worked in private company, 25% driver, 18.7% daily labour, 20.8% business. Only 18.9% women were lived in floor pacca, wall pacca and roof pacca house. Only 39.6% family's monthly income had Rs 10000 and above. All study women were no smoking and did not addicted alcohol. But among the husbands of these women, 46% addicted alcohol and 48% were smoker.

Table 1: Body composition data (Mean±SD) according to vitamin D deficiency group.

Variables	Total (n=49) (Median±SD)	Insufficient (n=7)	Deficient (n=32)	Sever Deficient (n=10)	p - value
Height (cm)	150±5.94	153.83±6.98	150.99±5.38	148.5±6.53	0.06
Weight (kg)	53±11.53	48.57±5.67	54.56±12.04	55.08±12.77	0.13
BMI (kg/m^2)	23.19±4.56	20.52±2.05	23.83±4.77	24.79±4.52	0.096
% FM	28.08±5.69	24.81±2.04	29.13±5.97	30.38±5.60	0.03
%FFM	71.92±5.69	75.19±2.05	70.87±5.97	69.62±5.60	0.03
FFMI (kg/m^2)	16.51±1.88	15.40±1.14	16.62±1.92	17.04±2.00	0.33
FMI (kg/m^2)	6.60±2.73	05.13±0.92	7.22±2.90	7.75±2.57	0.02
FM/FFM	0.39±0.41	0.33±0.04	0.42±0.12	0.44±0.11	0.015

Table 1 represents the relationship between body composition and vitamin D deficiency groups. The concentration of 25 (OH) D were directly correlated with sun exposure ($p<0.05$). Percent of fat mass (%FM) were significantly higher in deficient group than the insufficient group ($p<0.05$), %FFM were significantly lower in vitamin D deficient group than the insufficient group ($p<0.05$,). Similarly ratio of FM and FFM were inversely and significantly higher in deficient group than the insufficient group ($p<0.05$). None of the women had an abnormal ALP concentration; the highest value for ALP was 179 U/L. A significant inverse correlation was found between 25 (OH) D and ALP (r=0.3, p=0.03). So ALP values were higher in deficient group than the insufficient group (deficient 96.21±25.34, insufficient 84.54±30.33, p=0.18). The analysis of body composition showed that individuals with lower 25 (OH) D levels had a higher percentage of FM, BMI, weight. Spearsman rank correlation test determined that serum 25 (OH) D levels are inversely correlated with %FM, ratio of FM with FFM and FMI. There were no correlation between vitamin D levels with BMI and FFMI ($p>0.05$). Height and %FFM were positively correlated with 25 (OH) D levels ($p<0.04$). Actually, a scatter plot is a visual representation of correlation between vitamin D levels and body composition parameters.

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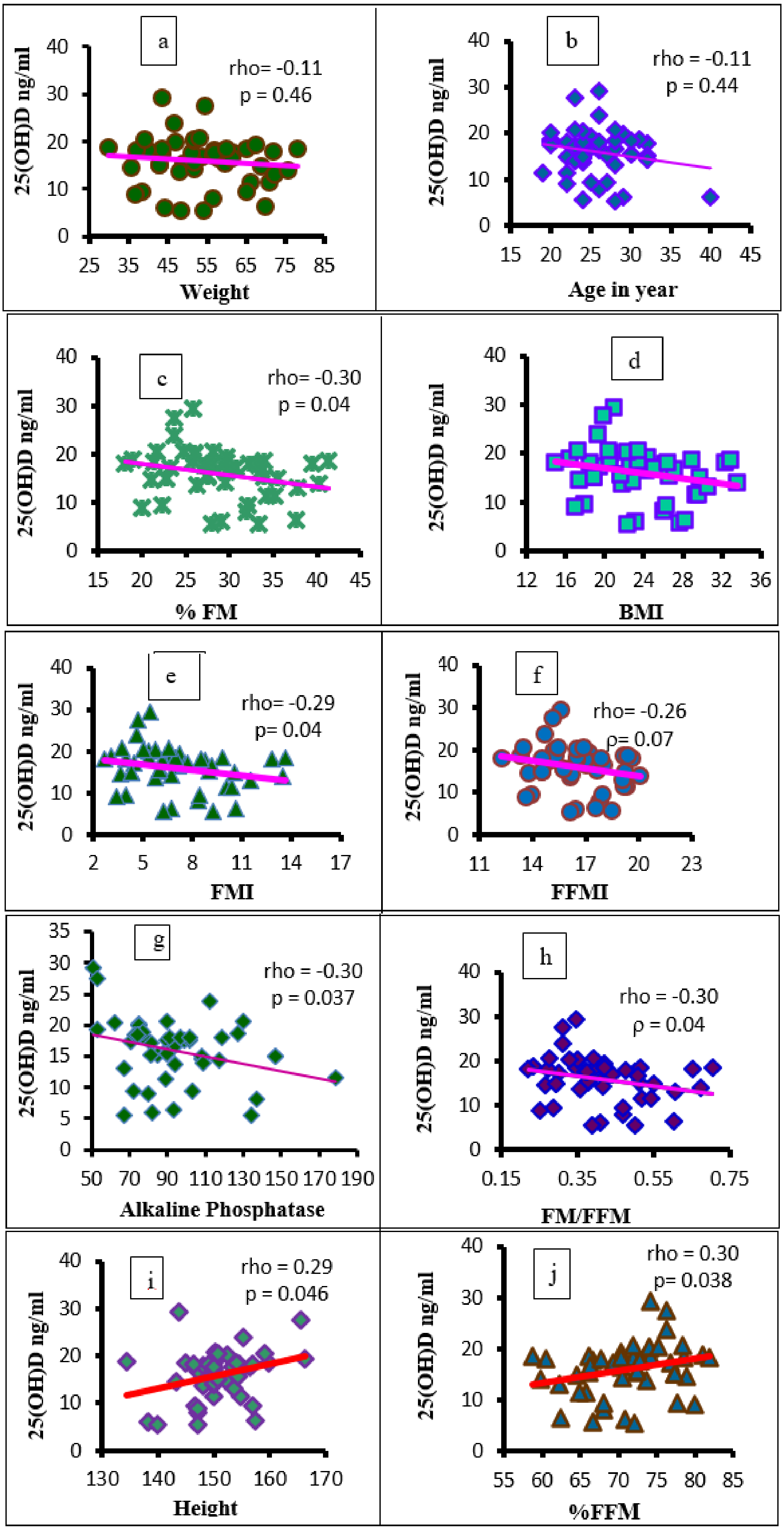

Figure 1: Correlation between vitamin D levels anthropometry measurement and body composition indices in women.

The above scatter plots (**Figure 1 (a, b, c, d, e, f, g, h))** represent that there was a negative/ inverse relationship between 25 (OH) D with anthropometric measurement variables. Similarly, **Figure 1 (i, j)** represent a positive correlation between 25 (OH) D level with height and 25 (OH) D with %FFM. The pinc/ red line is referred to as a line of best fit and it is a linear fit on the scatter plot. FMI and %FM significantly higher in deficient group than the insufficient group (p=0.045). BMI and FFMI were not significantly higher in deficient group than the insufficient group (p>0.05).

4. Discussions

Overall, the study findings indicate that FMI were associated with Vitamin d status. Results from the earlier findings, it had been shown higher BMI with lower vitamin D deficiency in adults. In the multivariate analysis, higher %FM was associated with lower 25 (OH) D and a high risk of vitamin d deficiency. The present study showed an overwhelming prevalence of hypovitaminosis D in a child bearing aged women of Kolkata, India. The prevalence of hypovitaminosis D ranged from 80 - 90% [9]. Biben and colleagues showed that high percentage of hypovitaminosis D influenced by age and body composition. Age is also a risk factor for the affects of vitamin D levels that may cause decreasing the concentrations of 25 (OH) D level [4]. In our study, vitamin D was not associated with age. Here we saw that higher age group had a lower level of vitamin D (p=0.085).

Vitamin D deficiency is common in worldwide, including in the South Asian Country. Inadequate exposure to sunlight is the major cause of vitamin D deficiency [10]. In our study only 64% women used sun exposure. Hydroxy vitamin D is common both in under five children and their mothers and prevails in epidemic proportions all over the Indian subcontinent with a prevalence rate of 70% - 100% in the general populations [11]. Vitamin D is produced by the body during exposure to sunlight, but it is also found in oily fish, eggs and food products [12]. Indian socio religious and cultural practices do not facilitate sun exposure. Diet in this population provides little vitamin D or its precursors. Exposure to sunlight is minimal and is avoided by most people in India. Because maximum Indian women think their skin colour will be blackish by sun exposure directly. So they avoided sun exposure.

The prevalence of vitamin D deficiency in our country is very high. In our study found that the prevalence of vitamin D insufficiency and deficiency among women of childbearing age were 14.3% and 85.7% respectively. Compared to Western countries, prevalence of vitamin D insufficiency in our study was lower than the Western country (USA, 36%, Cambodia, 35.6%, China was 20.16%). In our study Vitamin d deficiency was higher than the Western country (USA 42%, Cambodia 29%, China 47.80%) [13 - 15]. In our previous study, prevalence of vitamin D insufficiency and deficiency was 28% and 72% respectively [16]. In fact, the prevalence of severe vitamin d deficiency (<10 ng/ml) in our study was 20.4%, with a median 8.51 ng/ml.

Accordingly, more researcher showed that vitamin D significantly correlated with BMI (p<0.05), which is similar in many studies [17 - 21]. But Wang and colleagues showed that there was no relation between Vitamin D and BMI (p=0.75) [22]. Some researchers showed that BMI is also associated with insufficient serum 25 (OH) D [23]. Also, in our study, we saw that BMI was not associated with vitamin D (p=0.06). In our study, we saw that FFMI was not associated with vitamin D (p=0.07) but FMI was significantly associated with lower vitamin D (p=0.04) concentrations. In India vitamin D deficient was 84% and in nearest country Bangladesh 88%, Sri Lanka 58% [11]. The range of prevalence rates varied among studies due to the different study populations, education levels, season, BMI, age, body composition, gender, cut off for vitamin D status. Many researchers showed that obesity is associated with vitamin D deficiency ([24, 25]. Pereira - Santos and colleagues showed that lower vitamin D concentrations have been associated with vitamin D deficiency with greater BMI in meta - analysis [26]. In our study, the woman of child bearing age indicates a strong inverse correlation between FMI and 25 (OH) D.

The body composition data in the present study showed an inverse relationship between 25 (OH) D levels and different body composition indices (BMI, FMI and FFMI) (**Figure: - 2**).

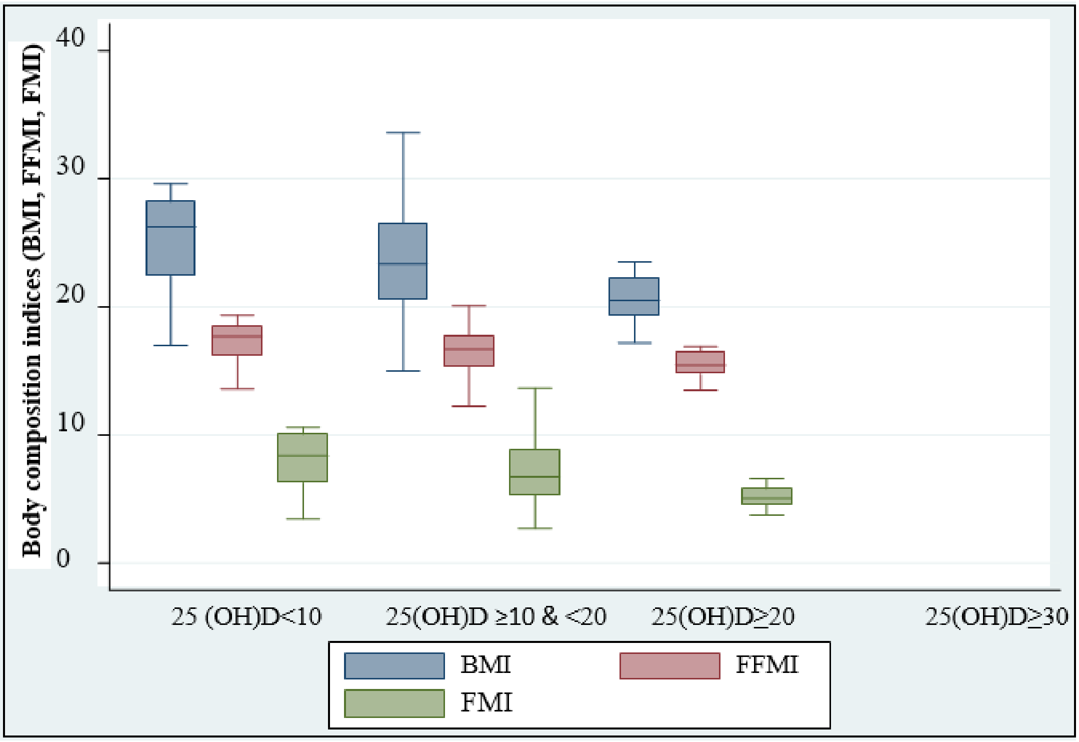

Figure 2: Box plots of BMI, FFMI and FMI, according to the vitamin D deficiency (VDD) groups of women have shown. The VDD groups are 25 (OH) D<10 ng/ml=1, 25 (OH) D≥10 & <20ng/ml=2, 25 (OH) D≥20 & <30 ng/ml=3 and 25 (OH) D≥30 ng/ml=4. The line in the middle of the box represents the median. The box extends from the 25th percentile to 75th percentile. The lines emerging from the box are upper or lower adjacent rules which extend ±1.5 times the interquartile range.

The association between sun exposure and vitamin D status was inconsistent, because several factors depend on the affect of cutaneous synthesis and bio availability of vitamin D, such as the time of day, the use of sunscreen and skin pigmentation [27, 28]. Measures of adiposity including %FM were inversely associated with Vitamin D status. Kremer et al. showed that a significant positive correlation found between height and vitamin D (r=0.26, p=0.014) [29]. This was also similar in our study Vitamin D level was positively correlated with height (r=0.3, p=0.036). Also Percent of FFM were positively correlated with vitamin D level (r=0.26, p=0.038).

A significantly inverse correlation was found between 25 (OH) D and alkaline phosphatase (ALP) (r= - 0.3, p=0.037). So ALP values were higher of severe deficient women than deficient and insufficient women. Rajab showed that the mean level of vitamin D decreases and mean level of ALP increases (r= - 0.18, p=<0.001) [30]. Several studies showed that ALP levels were not correlated with low vitamin D levels [31, 32]. Alsharif and colleagues showed that there was no correlation between ALP and vitamin D (r=0.05, p=0.2) [33]. Similarly, Shaheen and colleagues showed that serum ALP were not correlated with vitamin D level (r=0.05, p=0.593) [34]. Veldhuis and colleagues showed that concentrations of 25 (OH) D were more likely to be lower (<30 ng/ml) in those with greater BMI z - score and FM but not FFM [35]. Overall the study findings indicate that FMI were associated with vitamin D status. In the multivariate analysis, higher %FM was associated with lower 25 (OH) D and a higher risk of vitamin D deficiency.

So, there is a significant relationship between vitamin D deficiency and FMI. There exists a medium strong and inverse connection between vitamin D level and FMI. This means that as FMI increases and vitamin D level decreases. Therefore, according to this relationship between FMI and vitamin D levels, overweight and obese women have lower levels of vitamin D than underweight women.

The coefficient of determination (R^2) of the regression model is 0.0617 and this means that 6.17% of the variability in vitamin D levels is explained by percent of FMI (FMI%) holding other factors constant.

The null and alternative hypothesis of linear regression had shown below:

Null hypothesis, H0: there exists no statistically significant linear regression between vitamin D and FMI (β≠0).

From the linear regression results, the p - value is 0.0456 which is less than 0.05. Hence we reject the null hypothesis and established that there is a significant regression between FMI%. The equation of the linear regression model is as follows:

Vitamin D = - 0.459×FMI+19.15

From the regression equation we conclude (i) a unit change in FMI leads to decrease in vitamin D by 0.459 units, when FMI is 0, the value of vitamin D is 19.15.

We found a strong positive correlation between 25 (OH) D with height and %FFM. Using anthropometric measurement (height, weight) and age, we determined %FM which is inversely correlated with 25 (OH) D. In our study, we saw that a significant positive correlation between height and 25 (OH) D which is similar to other study [29].

5. Conclusion

In conclusion, our study indicates that vitamin D deficiency is extremely common the women of child bearing age in India. Vitamin D deficiency is a risk factor for increased body fat mass or increased body fat mass is a risk factor of vitamin D deficiency. A statistically significant inverse correlation was found between FMI and vitamin D deficiency among the women of child bearing age. But in our study, Vitamin D was not associated with FFMI and BMI of child bearing age of Indian women.

6. Future scope

Some limitation inherent to the current study's design may have influenced the over all findings. First, the sample size was very small. Second, the recruited subjects were child bearing aged (18 - 40 yrs) non pregnant women only. Third, a seasonal variation in vitamin D has been reported, suggesting that the time of sample collection can be important but this was not considered in this analysis. Fourth, the study was conducted on low socio economic status women who lived 10 km radius of our study area, the Govt. Hospital of Kolkata, India. These limits generalized in a small population. So, above all these limitations should be considered in our future study.

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