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"STUDY OF INCIDENCE OF VITAMIN D DEFICIENCY IN OBESE ADULTS"

Medicine

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ABSTRACT

BACKGROUND:- Vitamin D (VD) is one of the important keys for the bone health and it alsi helps in the homeostasis of the calcium and phosphorus. Role of multi-functional receptors of VD found in various body tissues has been advocated. Due to its endogenous synthesis, VD has been contemplated as hormone not long ago.Apart from reducing PTH (parathyroid hormone) production, reviving calcium absorption, osteoclastic bone resorption , osteoblastic role; 1,25(OH) 2D (active structure of VD) has extra-skeletal role including triggering cell differentiation ,insulin production , immune system and reducing collagen type 1 production. A shortage of VD is correlated with increased bone turnover increasing chances of bone fractures whereas grave insufficiency of VD leads to osteomalacia in adults and rickets in children. Of late, Vitamin D deficiency is defined when the level of serum 25(OH) D is below 20 ng ml. this manifest with the disorders such as depression, obesity, dementia, psychiatric disorders others.4Obesity can be regarded as pandemic impinging five million people in most developed nations5. BMI more than or equal to 30 kg/m2 is considered as the obesity as per the WHO. old age people with increased BMI are highly susceptible to develop coronary heart disease, DM, osteoarthritis and Hypertension and other possible comorbidities.6Strong relationship exists between higher amount of abdominal fat and low vitamin D concentration suggesting that individual with larger waist line have a potential for developing vitamin D deficiency.Hence the present study was done at our tertiary care center to assess the incidence of vitamin D deficiency in obese adults and to study the relation between Vitamin D levels and BMI and waist circumference in obese adults. **METHODOLOGY-**The study was done at our tertiary care center in the department of General Medicine,MGM Medical College&Hospital, Aurangabad on attending OPD/IPD after due permission from the Institutional Ethics Committee and Review Board and after taking Written Informed Consent from the patients.After approval from the Institutional Ethics Committee a valid informed consent was taken. Once the patients were enrolled for the study, a thorough history and physical examination was done as per proforma. An informed consent was taken in written from patients or patient's attendant.A comprehensive data was recorded which included the sociodemographic data, height, weight, medical history, drug intake general examination and Systemic examination. After completing the questionnaire serum vitamin D level was measured in nmols/l using Elescys vitamin D Assay. Serum vitamin D level below 20ngms/ml (50 nmols/l) was considered as vitamin D deficiency. The serum vitamin D levels were repeated to validate the results. Vitamin D level≤12.5 nmols/l was classified as severe vitamin D deficiency, 12.5-25 nmols/l was classified as moderate vitamin deficiency and >25 nmols/l was classified as mild vitamin D deficiency.16 After measuring the height in cm and weight in kg, Body Mass Index (BMI) was calculated. The weight was measured with light clothing and no shoes.The formula used for calculating BMI was Mass(Kilograms)/Height (Meters)2. Women having BMI in the range of 18.5-24.9 was considered as normal weight BMI in the range of 25-29.9 was considered as overweight,>30 was considered obese. Women having BMI below18.5 were considered underweight. Obese women weredivided into three groups, Class1 (BMI=30-34.9), Class II(BMI=35-39.9) and class III (BMI≥40.0) according to WHO classification. **RESULTS-** A hospital based cross sectional, observational study was conducted with 212 patients to study the incidence of vitamin D deficiency in obese adults.Majority of the subjects (33.9%) were in the age group of 41-50 years followed by 29.3% in the age group of 51-60 years, 19.8% in the age group of 31-40 years, 12.3% in the age group of 21-30 years and 4.7% in the age group of 18-20 years with mean age of the subjects being 42.92 ± 11.01 years.There were 140 (66.1%) male patients while female patients constituted 33.9% of the study population.The mean BMI and waist circumference of patients was 29.01±3.32 kg/m2 and 95.77±6.52 cm respectively. The mean Waist Hip Ratio (WHR) of patients was 0.94±0.09.Increased WHR was present in 100 (71.4%) male patients while 40 (28.6%) male patients had normal WHR. Increased WHR was present in 57 (79.2%) female patients while 15 (20.8%) female patients had normal WHR.7 (3.3%) and 62 (29.3%) patients had Vitamin D severe deficiency and deficiency respectively while 54 (25.5%) and 89 (41.9%) patients had Vitamin D insufficiency and sufficiency respectively. The mean Vitamin D level of patients was 26.05 ± 10.00 ng/ml.The mean BMI was significantly greater in patients with Vitamin D severe deficiency (31.15±3.95kg/m2) and Vitamin D deficiency (30.63±2.95kg/m2) compared to patients with insufficient Vitamin D (28.23±3.09kg/m2) and sufficient Vitamin D (28.18±3.21kg/m2) as per ANOVA test ($p<0.05$). The mean waist circumference (WC) was significantly greater in male patients with Vitamin D severe deficiency (101.88±1.25cm) and Vitamin D deficiency (99.20±4.36cm) weighed to patients with insufficient Vitamin D (97.81±3.63cm) and sufficient Vitamin D (95.78±3.91cm) as per ANOVA test ($p<0.05$).The mean waist circumference (WC) was significantly greater in female patients with Vitamin D severe deficiency (95.83±7.22cm) and Vitamin D deficiency (91.31±8.03cm) weighed to patients with insufficient Vitamin D (89.64±6.57cm) and sufficient Vitamin D (88.83±6.33cm) as per ANOVA test ($p<0.05$).It was observed that Vitamin D level was positively and significantly correlated with BMI ($r=0.95$; $p<0.05$), Waist Circumference (WC) of male patients ($r=0.48$; $p<0.05$) and WC of female patients ($r=0.53$; $p<0.05$).**CONCLUSION-**Vitamin D (Vit D) deficiency is considered as a health problem worldwide. Our study showed that Vitamin D deficiency is more in obese patients and severity of Vitamin D deficiency increased with increasing BMI and Waist Circumference. Vitamin D level positively and significantly correlated with BMI and Waist Circumference (WC).

KEYWORDS

INTRODUCTION

Vitamin D (VD) is one of the important keys for the bone health and it alsi helps in the homeostasis of the calcium and phosphorus. Role of multi-functional receptors of VD found in various body tissues has been advocated. Due to its endogenous synthesis, VD has been contemplated as hormone not long ago.Apart from reducing PTH (parathyroid hormone) production, reviving calcium absorption, osteoclastic bone resorption , osteoblastic role; 1,25(OH) 2D (active structure of VD) has extra-skeletal role including triggering cell differentiation ,insulin production , immune system and reducing collagen type 1 production. A shortage of VD is correlated with increased bone turnover increasing chances of bone fractures whereas grave insufficiency of VD leads to osteomalacia in adults and rickets in children. Of late, Vitamin D deficiency is defined when the level of serum 25(OH) D is below 20 ng ml. this manifest with the disorders such as depression, obesity, dementia, psychiatric disorders others.4 Obesity can be regarded as pandemic impinging five million people in most developed nations5. BMI more than or equal to 30 kg/m2 is considered as the obesity as per the WHO. old age people with increased BMI are highly susceptible to develop coronary heart

disease, DM, osteoarthritis and Hypertension and other possible comorbidities.6 VD is associated with many non-communicable diseases lately. Unfavorable metabolic phenotypes like insulin resistance,diabetes mellitus and stroke are associated with both overweight and obesity and Vitamin D deficiency (25-hydroxyvitamin D (25(OH)D) < 25–30 nmol/l) and its sub-optimal status (25(OH)D < 50–100 nmol/l) .Pilot studies conducted over the vitamin D deficiency in patients with increased BMI had shown various results as regarding, the relationship between the BMI and vitamin D levels. Multiple and different prospects were made regarding the variations in the vitamin D cycle in obese people. Those various prospects include negative feedback mechanism, storage in adipose tissue and dilution in volumetric proportion from excessive circulating 1,25-dihydroxyvitamin D3. Decreased sun exposure and limiting endogenous synthesis of cholecalciferol in the skin7due to more clothing in obese along with lesser outdoor tasks in obese can be the other possible reasons.Chiefly four mechanisms proposed to delineate the low concentrations of vitamin D in obese are reduced sunlight exposure in obese,increased 1,25(OH)D2 resulting in reduced 25(OH)D by negative feedback stemming, the vitamin D assimilation in adipose tissues and the volumetric dilution of reduced 25(OH)D levels.A constant relation between rising BMI and lower serum 25-hydroxyvitamin D (25D) levels has been observed in literature.In early days, obesity was connected with low levels of serum 25 D and high levels of (1,25D) and PTH. However, larger trials reported that obesity was related to reduced 25D levels, higher PTH levels and lower 1,25D levels. Body fat content has been inversely associated with serum 25D levels by studies, with the conclusion that this correlation being stronger than those between 25D and BMI and body weight.8 It has been shown in a genetic study that patient with higher BMI resulted to have low levels of 25D9.Thoughthere is an established relationship between the BMI and the Vitamin D, still there prevails a dilemma in the mechanism for low levels of 25D. A trial was designed to study the correlation of 25-OH vitamin D concentrations and markers of adiposity including waist circumference, percentage of body fat and BMI to delineate the mechanism of correlation between metabolic syndrome and vitamin D deficiency. However, inconsistent results were obtained. Some authors related the controversy to racial, gender, or age differences.10,11Overall, immense evidence supports an inverseassociation between adiposity and vitamin D levels in adults, mostly attributable to volumetric dilution, and perhaps seclusion in adipose tissue to some extent. Optimal vitamin D levels in the body appear to be protective against weight gain . Else ways, little evidence currently supports a direct causal link allying vitamin D and weight or FM loss and this requires further investigation.Number of studies have found that serum vitamin D concentration islinked to obesity among population health and patients.12-14 Strong relationship exists between higher amount of abdominal fat and low vitamin D concentration suggesting that individual with larger waist line have a potential for developing vitamin D deficiency.

Hence the present study was done at our tertiary care center to assess the incidence of vitamin D deficiency in obese adults and to study the relation between Vitamin D levels and BMI and waist circumference in obese adults.

MATERIAL AND METHODS

A hospital based cross sectional, observational study was conducted with 212 patients to study the incidence of vitamin D deficiency in obese adults.

Study Design:
A hospital based prospective cross sectional, observational study.

Study Duration: 18months

Study Area:
The study was done at our tertiary care centre in the department of general medicine, MGM Medical College&Hospital, Aurangabad on attending OPD/IPD.

Study Population:
AllObese adults aged between 18-60 years attending OPD or admitted in MGM Hospital who fulfilled the inclusion criteria.

Sample Size: 212 patients

Considering a confidence level of 95% and confidence interval of 6.7 the number of patients in our study to achieve statistical significance is 212. This was calculated by Survey System (http://www.surveysystem.com/sscalc.htm#one). The Survey System ignores the population size when it is "large" or unknown. Population size is only likely to be a factor when you work with a relatively small and known group of people (e.g., the members of an association). Hence a sample size of 212 patients was considered adequate for our study.

Inclusion Criteria:
- Individuals falling in category of obese as per WHO Asian pacific guidelines for BMI (BMI of 25kg/sqmtrs and above) and waist circumference of more than 90 cm for men and 80cm for women.
- Obese individuals willing to give written informed consent.

Exclusion Criteria
- Obese individuals with following conditions shall be excluded from the study
- Diabetes mellitus
- Chronic kidney disease
- Chronic liver disease
- Obese individuals not willing to give the consent

METHODOLOGY

The study was done at our tertiary care center in the department of General Medicine,MGM Medical College&Hospital, Aurangabad on attending OPD/IPD after due permission from the Institutional Ethics Committee and Review Board and after taking Written Informed Consent from the patients.After approval from the Institutional Ethics Committee a valid informed consent was taken. Once the patients were enrolled for the study, a thorough history and physical examination was done as per proforma. An informed consent was taken in written from patients or patient's attendant.A comprehensive data was recorded which included the sociodemographic data, height, weight, medical history, drug intake general examination and Systemic examination. After completing the questionnaire serum vitamin D level was measured in nmols/l using Elescys vitamin D Assay. Serum vitamin D level below 20ngms/ml (50 nmols/l) was considered as vitamin D deficiency. The serum vitamin D levels were repeated to validate the results. Vitamin D level≤12.5 nmols/l was classified as severe vitamin D deficiency, 12.5-25 nmols/l was classified as moderate vitamin deficiency and >25 nmols/l was classified as mild vitamin D deficiency.16 After measuring the height in cm and weight in kg, Body Mass Index (BMI) was calculated. The weight was measured with light clothing and no shoes.

Interpretation Of Body Mass Index (BMI kg/sqmt)

Weight Classification	ASIAN PACIFIC CRITERIA	WHO CRITERIA
Underweight	<18.5	< 18.5
Normal	18.5-22.9	18.5 – 24.9
Overweight	23-24.9	25.0 – 29.9
Obese	≥25	≥30.0

Interpretation Of Waist Circumference

ABDOMINAL OBESITY	ASIAN PACIFIC CRITERIA	WHO CRITERIA
MEN	WC ≥90CM	WC≥102CM
WOMEN	WC≥80cm	WC ≥88CM

Interpretation Of Vitamin D Levels

VITAMIN D LEVELS (ng/ml)	VITAMIN D STATUS
10	Severe deficiency
10-20	Deficiency
21-29	Insufficiency
30	Sufficiency

The formula used for calculating BMI was Mass(Kilograms)/Height (Meters)2. Women having BMI in the range of 18.5-24.9 was considered as normal weight BMI in the range of 25-29.9 was considered as overweight,>30 was considered obese. Women having BMI below18.5 were considered underweight. Obese women weredivided into three groups, Class1 (BMI=30-34.9), Class II(BMI=35-39.9) and class III (BMI≥40.0) according to WHO classification.

Statistical Analysis-
Quantitative data is presented with the help of Mean and Standard deviation. Comparison among the study groups is done with the help of unpaired t test as per results of normality test. Qualitative data is

presented with the help of frequency and percentage table. Association among the study groups is assessed with the help of Fisher test, student 't' test and Chi-Square test. 'p' value less than 0.05 is taken as significant.

Pearson's chi-squared test

$$X^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Where X2 = Pearson's cumulative test statistic.
Oi = an observed frequency;
Ei = an expected frequency, asserted by the null hypothesis;
n = the number of cells in the table.
Results were graphically represented where deemed necessary.

Appropriate statistical software, including but not restricted to MS Excel, SPSS ver. 20 will be used for statistical analysis. Graphical representation will be done in MS Excel 2010.

OBSERVATIONS AND RESULTS

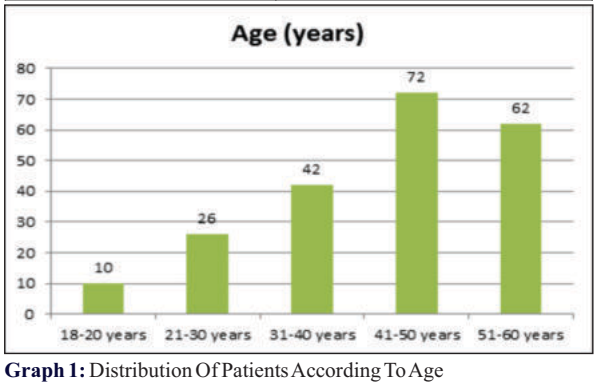
A hospital based cross sectional, observational study was conducted with 212 patients to study the incidence of vitamin D deficiency in obese adults.

Distribution Of Patients According To Age

Majority of the patients (33.9%) were in the age group of 41-50 years followed by 29.3% in the age group of 51-60 years, 19.8% in the age group of 31-40 years, 12.3% in the age group of 21-30 years and 4.7% in the age group of 18-20 years. The mean age of the patients was 42.92 ± 11.01 years.

Table 1: Distribution Of Patients According To Age

Age (years)	N	%
18-20 years	10	4.7%
21-30 years	26	12.3%
31-40 years	42	19.8%
41-50 years	72	33.9%
51-60 years	62	29.3%
Total	212	100%
Mean ± SD	42.92 ± 11.01	



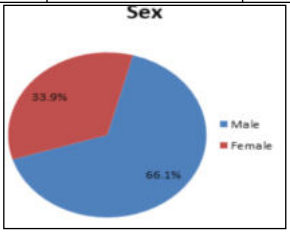
Graph 1: Distribution Of Patients According To Age

Distribution Of Patients According To Sex

There were 140 (66.1%) male patients while female patients constituted 33.9% of the study population.

Table 2: Distribution Of Patients According To Sex

Sex	N	%
Male	140	66.1%
Female	72	33.9%
Total	212	100%



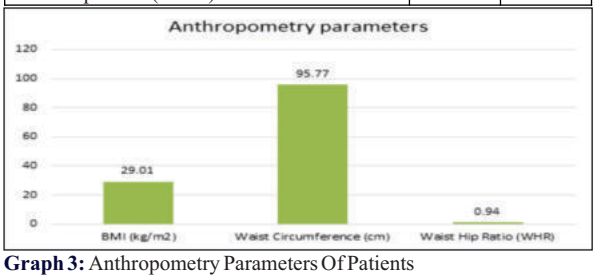
Graph 2: Distribution Of Patients According To Sex

Anthropometry Parameters Of Patients

The mean BMI and waist circumference of patients was 29.01±3.32 kg/m^2 and 95.77±6.52 cm respectively. The mean Waist Hip Ratio (WHR) of patients was 0.94±0.09.

Table 3: Anthropometry Parameters Of Patients

Anthropometry parameters	Mean	SD
BMI (kg/m^2)	29.01	3.32
Waist Circumference (cm)	95.77	6.52
Waist Hip Ratio (WHR)	0.94	0.09



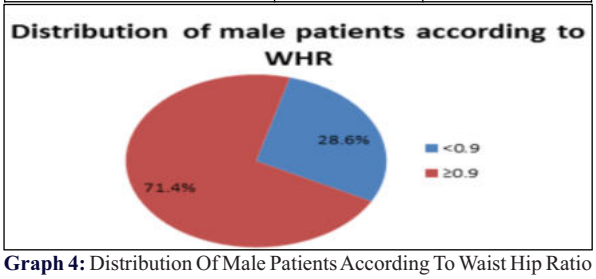
Graph 3: Anthropometry Parameters Of Patients

Distribution Of Male Patients According To Waist Hip Ratio (WHR)

Increased WHR was present in 100 (71.4%) male patients while 40 (28.6%) male patients had normal WHR.

Table 4: Distribution Of Male Patients According To Waist Hip Ratio (WHR)

WHR	N	%
<0.9	40	28.6%
≥0.9	100	71.4%
Total	140	100%



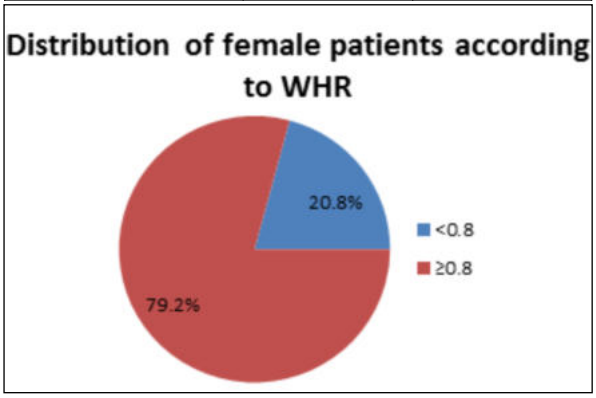
Graph 4: Distribution Of Male Patients According To Waist Hip Ratio (WHR)

Distribution Of Female Patients According To Waist Hip Ratio (WHR)

Increased WHR was present in 57 (79.2%) female patients while 15 (20.8%) female patients had normal WHR.

Table 5: Distribution Of Female Patients According To Waist Hip Ratio (WHR)

WHR	N	%
<0.8	15	20.8%
≥0.8	57	79.2%
Total	72	100%



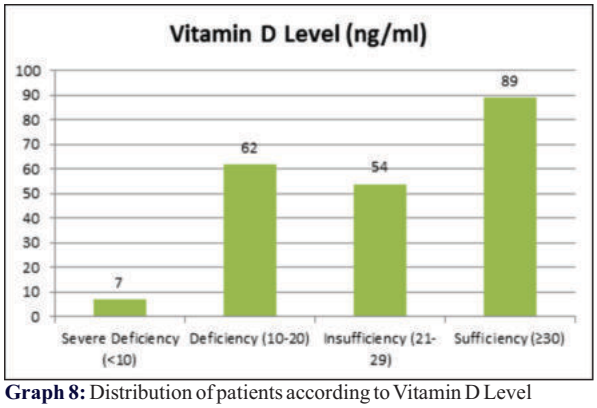
Graph 5: Distribution Of Female Patients According To Waist Hip Ratio (WHR)

Distribution Of Patients According To Vitamin D Level

7 (3.3%) and 62 (29.3%) patients had Vitamin D severe deficiency and deficiency respectively while 54 (25.5%) and 89 (41.9%) patients had Vitamin D insufficiency and sufficiency respectively. The mean Vitamin D level of patients was 26.05 ± 10.00 ng/ml.

Table 8: Distribution Of Patients According To Vitamin D Level

Vitamin D Level (ng/ml)	N	%
Severe Deficiency (<10)	7	3.3%
Deficiency (10-20)	62	29.3%
Insufficiency (21-29)	54	25.5%
Sufficiency (≥30)	89	41.9%
Total	212	100%
Mean ± SD	26.05 ± 10.00	



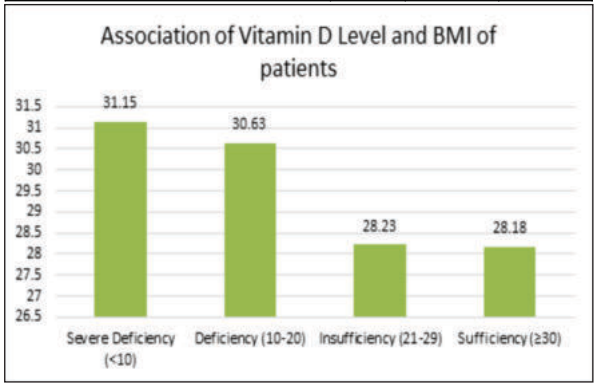
Graph 8: Distribution of patients according to Vitamin D Level

Association Of Vitamin D Level And BMI Of Patients

The mean BMI was significantly greater in patients with Vitamin D severe deficiency (31.15±3.95kg/m^2) and Vitamin D deficiency (30.63±2.95kg/m^2) compared to patients with insufficient Vitamin D (28.23±3.09kg/m^2) and sufficient Vitamin D (28.18±3.21kg/m^2) as per ANOVA test (p<0.05).

Table 9: Association Of Vitamin D Level And BMI Of Patients

Vitamin D Level (ng/ml)	Mean	SD	p Value
Severe Deficiency (<10)	31.15	3.95	<0.05
Deficiency (10-20)	30.63	2.95	
Insufficiency (21-29)	28.23	3.09	
Sufficiency (≥30)	28.18	3.21	



Graph 9: Association Of Vitamin D Level And BMI Of Patients

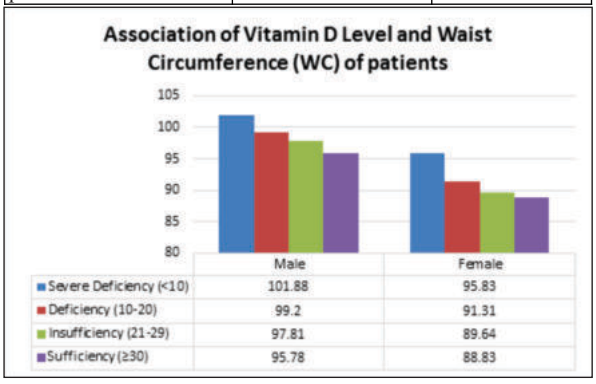
Association Of Vitamin D Level And Waist Circumference (WC) Of Patients

The mean waist circumference (WC) was significantly greater in male patients with Vitamin D severe deficiency (101.88±1.25cm) and Vitamin D deficiency (99.20±4.36cm) compared to patients with insufficient Vitamin D (97.81±3.63cm) and sufficient Vitamin D (95.78±3.91cm) as per ANOVA test (p<0.05).

The mean waist circumference (WC) was significantly greater in female patients with Vitamin D severe deficiency (95.83±7.22cm) and Vitamin D deficiency (91.31±8.03cm) compared to patients with insufficient Vitamin D (89.64±6.57cm) and sufficient Vitamin D (88.83±6.33cm) as per ANOVA test (p<0.05).

Table 10: Association Of Vitamin D Level And Waist Circumference (WC) Of Patients

Vitamin D Level (ng/ml)	Male		Female	
	Mean	SD	Mean	SD
Severe Deficiency (<10)	101.88	1.25	95.83	7.22
Deficiency (10-20)	99.20	4.36	91.31	8.03
Insufficiency (21-29)	97.81	3.63	89.64	6.57
Sufficiency (≥30)	95.78	3.91	88.83	6.33
p Value	<0.05		<0.05	



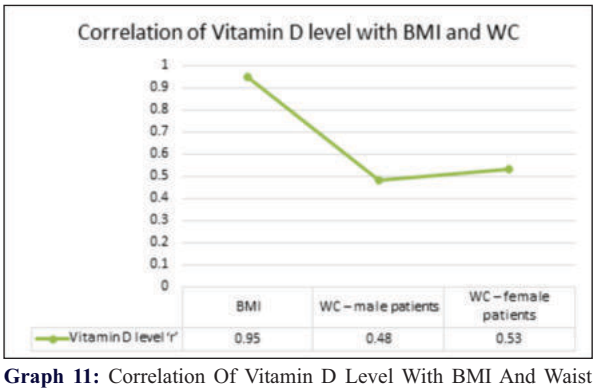
Graph 10: Association Of Vitamin D Level And Waist Circumference (WC) Of Patients

Correlation Of Vitamin D Level With BMI And Waist Circumference (WC)

It was observed that Vitamin D level was positively and significantly correlated with BMI (r=0.95; p<0.05), Waist Circumference (WC) of male patients (r=0.48; p<0.05) and WC of female patients (r=0.53; p<0.05).

Table 11: Correlation Of Vitamin D Level With BMI And Waist Circumference (WC)

Parameters	Vitamin D level	
	'r'	p Value
BMI	0.95	<0.05
WC – male patients	0.48	<0.05
WC – female patients	0.53	<0.05



Graph 11: Correlation Of Vitamin D Level With BMI And Waist Circumference (WC)

DISCUSSION

A hospital based cross sectional, observational study was conducted with 212 patients to study the incidence of vitamin D deficiency in obese adults.

In many nations, the prevalence of obesity has become an issue of public health, as phenomenologic approaches to obesity awareness have not had any long-term impact on prevention or treatment.95

The broad organ distribution of the vitamin D receptor indicates that vitamin D metabolites are not only essential for homeostasis (bone), but also for many other systems proper functioning.96In accordance to its well-known role in osteogenesis, the vitamin D receptor and its ligand have an effect on lipid aggregation and gene expression in adipose tissue. Both white and brown adipocytes express the vitamin D receptor, and vitamin D and its metabolites are contained in adipose

tissue.I97 Recent Surveyshave shown thatthe 1,25(OH)2D3 regulated, secreted bone protein osteocalcin mediates effects on adipose tissue, β-cells, and energy metabolism98.

In the present study, maximum number of the patients (33.9%) were in the age group of 41-50 years followed by 29.3% in the age group of 51-60 years, 19.8% in the age group of 31-40 years, 12.3% in the age group of 21-30 years and 4.7% in the age group of 18-20 years. The mean age of the patients was 42.92 ± 11.01 years. There were 140 (66.1%) male patients while female patients constituted 33.9% of the study population. This is similar to the studies of Foong-Ming M et al99 and MirhoseiniM et al100.

Foong-Ming M et al99 analytical cross sectional study assessing the prevalence of 25-hydroxyvitamin D with metabolic risk factors found 380 study participants with 58.4% being females. Their mean age was 48.5 ± 5.2 years with males being considerably older.

MirhoseiniM et al100 study investigating the prevalence of vitamin D deficiency in obese individuals found average age of the participants was 51.37±19.22 years.

In our study, the mean BMI and waist circumference of patients was 29.01±3.32 kg/m2 and 95.77±6.52 cm respectively. The mean Waist Hip Ratio (WHR) of patients was 0.94±0.09. This is comparable to the studies ofFoong-Ming M et al99, Adikaram SGS et al101, Al Hayek S et al102 and Oommen A et al103.

Foong-Ming M et al99 analytical cross sectional study found more than 80% of study population was either overweight or obese.

Adikaram SGS et al101 study found WC was high in 193 (96.5%) and fat mass was high in 196 (99%) of the sample. Percentage fat mas was high in 197 (99.5%), the mean being 42.53%.

Al Hayek S et al102 cross-sectional study which examined the relationship between percent body fat and vitamin D status found more than one third of the participants were of normal weight (35.5%),and the rest ofstudt population was overweight and obese (64.0%).

Oommen A et al103studying whether vitamin D deficiency can be the major causative factor for obesity found (69%) had obesity (BMI>30), 23% were overweight (BMI between 25 and 29.9) and 8% had normal body weight (BMI between 18.5 and 24.9). 84% (n=58) of the obese women had vitamin D deficiency (<50 nmols/l), 43.5% (n=30) of obese women had diabetes, 44.9% (n=31) of obese women had hypertension.

It was observed in our study that increased WHR was present in 100 (71.4%) male patients while 40 (28.6%) male patients had normal WHR. Increased WHR was present in 57 (79.2%) female patients while 15 (20.8%) female patients had normal WHR.This is concordant to the study of BorzoueiS et al104.

BorzoueiS et al104 study revealed that people with vitamin D deficiency had a higher chance of metabolic syndrome development, with significantly higher waist size in the patients than in the healthy group.

In the present study, 7 (3.3%) and 62 (29.3%) cases had Vitamin D severe deficiency and deficiency respectively while 54 (25.5%) and 89 (41.9%) cases had Vitamin D insufficiency and sufficiency respectively. The mean Vitamin D level of patients was 26.05 ± 10.00 ng/ml. This is in concordance to the studies ofFoong-Ming M et al99, MirhoseiniM et al100, Adikaram SGS et al101 and Al Hayek S et al102.

Foong-Ming M et al99 analytical cross sectional study found only one third of the participants had sufficient levels of vitamin D (≥ 50 nmol/L). More females (87%) had insufficient levels of 25 OH Vitamin D compared to males (41%) (p<0.001).

MirhoseiniM et al100 study investigating the prevalence of vitamin D deficiency in obese individuals observed prevalence of vitamin D deficiency was 58.85%. A mean vitamin D levels of 18.88 ± 1.24 ng/mL was found in subjects with metabolic syndrome. The vitamin level in the obese group without metabolic syndrome was 40.38 ± 2.15 ng/mL.

Adikaram SGS et al101 study on Vitamin D analysis showed that most of the children (n = 152, 75.2%) had levels lower than 20 ng/ml (deficient range) and 43 (21.3%) had insufficient (21–30 ng/ml) levels. Only 7(3.5%) had normal values ranging from 30.5 ng/ml to 39.3 ng/ml, which were close to the lower normal range. Mean Vitamin D level of the study sample was 17.4 ng/ml (SD - 5.6). The minimum value reported was 6.7 ng/ml and the highest was 39.3 ng/ml.

Al Hayek S et al102 cross-sectional study found mean vitamin D serum concentration was 28.2 ± 13.9 ng/mL. There were no major differences between sexs. Among study subjects, 37.5% had serum 25(OH)D concentrations ≥30 ng/mL, 31.7% had serum 25(OH)D concentrations < 20 ng/mL. Further, 9.7% of cases had 25(OH)D concentrations < 12 ng/mL. There was no major difference in vitamin D status between men and women.

In our study, the mean BMI was significantly greater in patients with Vitamin D severe deficiency (31.15±3.95kg/m2) and Vitamin D deficiency (30.63±2.95kg/m2) compared to patients with insufficient Vitamin D (28.23±3.09kg/m2) and sufficient Vitamin D (28.18±3.21kg/m2) as per ANOVA test (p<0.05). This finding was consistent with the studies of Vashi PG et al105, Snijder MB et al106, MirhoseiniM et al100, Oommen A et al103 and Onal HY et al91.

Vashi PG et al105 studyexhibited that 1 kg/m raie in BMI was associated with significantly reduced vitamin D level (42% ng/ml). Snijder MB et al106 study reported a substantial inverse association after altering all confounding that associated with vitamin D and BMI.

MirhoseiniM et al100 study observed BMI remained almost constant with increasing serum vitamin D concentations with no significant relationships (P=0.999).

Oommen A et al103 study found 11 of the obese females had severe vitamin D deficiency (≤12.5 nmols /l), 20 had moderate vitamin D deficiency (12.5-25 nmols/l), 27 had mild vitamin D deficiency (>25 nmols/l and <50 nmols/l) while 11 had vitamin D concentration>50 nmols/l.Onal HY et al91 study assessing the effect of weight reduction on vitamin D concentrations in obese females with vitamin D deficiency foundassociation between vitamin D and BMI values and a positive correlation (r=0.52) in the 5-10% weight loss group and negative correlation (r=-0.52) in the >10% weight loss group.It was observed in our study that the mean waist circumference (WC) was significantly greater in males with vitamin D severe deficiency (101.88±1.25cm) and Vitamin D deficiency (99.20±4.36cm) compared to cases with insufficient Vitamin D (97.81±3.63cm) and sufficient Vitamin D (95.78±3.91cm) as per ANOVA test (p<0.05). The mean waist circumference (WC) was significantly greater in females with Vitamin D severe deficiency (95.83±7.22cm) and Vitamin D deficiency (91.31±8.03cm) compared to cases with insufficient Vitamin D (89.64±6.57cm) and sufficient Vitamin D (88.83±6.33cm) as per ANOVA test (p<0.05). Foong-Ming M et al99 and MirhoseiniM et al100 noted similar observations in their studies.

Foong-Ming M et al99 analytical cross sectional study reported men were found to have substantially higher measurements in waist circumference, blood pressure readings, triglycerides and 25 OH Vitamin D levels compared to their counterpart (p < 0.05).where as,women had substantially higher mean BMI and HDL-cholesterol levels than men (p < 0.05).

MirhoseiniM et al100 study found the waist size was not significantly correlated with increased serum vitamin D levels (P=0.825).It was observed in our study that Vitamin D level was positively and significantly correlated with BMI (r=0.95; p<0.05), Waist Circumference (WC) of male patients (r=0.48; p<0.05) and WC of female patients (r=0.53; p<0.05). Similar observations were noted in the studies of Foong-Ming M et al99, MirhoseiniM et al100, Adikaram SGS et al101, Khosravi ZS et al107, Al Hayek S et al102, Oommen A et al103, Khorvash F et al89, Ibrahim Al Asoom L et al90, Sousa-Santos AR et al92 and Duan L et al94.

Foong-Ming M et al99 analytical cross sectional study observed obesity as measured by BMI andwaist circumference was closely linked with Vitamin D levels. The mean BMI and waist circumference was substantially greater in the vitamin D insufficient group. In crude analysis; age, female, BMI, waist circumference and HDL-cholesterol were found to be substantially correlated with vitamin D insufficiency

(< 50 nmol/l). The elderly subjects had lower odds of having vitamin D insufficiency, while women had 8.68 times odds of having vitamin D insufficiency.Even obese subjects had considerably higher risk of having low vitamin D.

MirhoseiniM et al100 study investigating the prevalence of vitamin D deficiency in obese individuals reported the level of vitamin D was not significantly correlated with waist and BMI.

Adikaram SGS et al101 study reported that Vitamin D levels linked with anthropometric and biochemical parameters showed negative associations while HDL was positively associated. The following parameters had significant negative association - subscapular SFT, biceps SFT, supra iliac SFT, central SFT, Fasting and 2-hr Insulin,LDL-C, Serum cholesterol, hs-CRP and PTH.

Khosravi ZS et al107 double-blind clinical trial assessing effect of vit D supplementation on weight reduction among overweight and obese females documented a decline in WC, and body mass index (BMI) and subsequent rise in serum vitamin D levels after supplementing for 6 weeks,as compared to control group. Other parameters like TC, TG, LDL-c, HDL-c, FBS, CRP, ins, and waist to hip ratio (WHR) did not alterconsiderably.

Al Hayek S et al102 cross-sectional study concluded that the mean Percent BodyFat was low in subjects with sufficient vitamin D levels(27.2 ± 7.5%) contrary to those with insufficient levels (31.2 ± 7.5%). Only 20.3% subjects with potential high WC had sufficient vitamin D levels whereas 79.7% had insufficient vitamin D levels. It was reported that for every 1% rise in body fat, subjects were 8% more liable to have insufficient vitamin D levels.

Oommen A et al103 study analyzing if vitamin D deficiency can be the major causative factor for obesity elicitedthat no significant relation between vitamin D deficiency and obesity, hypertension and obesity and diabetes and obesity existe.

Khorvash F et al89 cross-sectional study examining the relationship between serum vitamin D status withobesity inferred that there was association between the two.Although, a substantial relationship was seen between waist circumferences (WC) with body mass index (BMI). 25-OH-D serum levels were unrelated to WC and BMI.

Ibrahim Al Asoom L et al90 studiedthe relationship between vitamin D status and parameters of adiposity and concluded that a negative relation exists between 25-OH vitamin D/body weight and waist circumference and waist/stature ratio. No significant disparity was seen between the groups of BMI with respect to questionnaire data or 25-OH vitamin D/body weight. The relative value of vitamin D to body weight is a better determinant of vitamin D status notably in obese subjects and it is negatively relatedto adiposity parameters including waist circumference and waist/stature ratio.

Sousa-Santos AR et al92 study analyzing the relation between frailty, obesity indices and serum 25(OH)D levels proposed that BMI, WC, BRI and ABSI, were affiliated with low 25(OH)D serum levels.

Duan L et al94 meta-analysis determining if vitamin D supplementation modulated obesity indices in apparently healthy subjectsinferred that no substantial decline in BMI, WC or WHR was found with vitamin D supplementation as compared with placebo. However, in the subgroups of women, intervention period ≥6 months, a favorable and notabledecline in BMI and WC was noted. On the contrary, pooled results showed that there was a considerable rise in serum 25(OH)D concentration after vitamin D intervention

CONCLUSION

Vitamin D (Vit D) deficiency is considered as a health problem worldwide. Our study showed that Vitamin D deficiency is more in obese patients and severity of Vitamin D deficiency increased with increasing BMI and Waist Circumference. Vitamin D level positively and significantly correlated with BMI and Waist Circumference (WC).

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