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Original Research Article

Vitamin D Status and its Association with BMI in Obese and Non-Obese Children in a Tertiary Care Level Hospital

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ABSTRACT

Introduction: Vitamin D deficiency has become a worldwide problem; moreover it has been found associated with obesity in adults as well as in children. Inactivity of children and lack of sunlight exposure induce the vitamin D deficiency through decreasing the bioavailability of vitamin D. Vitamin D deficiency is more pronounced in obese in comparison of none obese due mal absorption of calcium. Relationship of vitamin D and obesity is not clear yet. Therefore the present study was designed to evaluate the relation of vitamin D, serum calcium and BMI in obese children.

Material and Method: The study included two groups of children one group was consisted 74 obese children 6 to 16 yrs of age while second group included 63 non-obese children of 6 to 16 yrs age. All the obese and non-obese children were recruited from the nearby area of Teerthanker Mahaveer University Moradabad. p-value < 0.05 was considered statistically significant.

Result: Serum calcium was significantly low in obese group 6.8 ± 0.4 mg/dl in comparison of non-obese 9.6 ± 0.3 mg/dl (p<0.001). Further, Mean serum 25-OH-vit D in the obese group 12.6 ± 4.6 ng/ml was significantly lower (P<0.0001) than that of the non-obese group 19.6 ± 7.5 ng/ml. Total cholesterol (212.1 ± 34.8 v/s 172 ± 29.2, p<0.001), triglycerides (119.6 ± 24.4 v/s 90.2 ± 18.7, p<0.001), were significantly higher in obese children in comparison of non-obese children. Though, high density lipids (35.4 ± 12.5 v/s 49.7 ± 14.2, p<0.001) was significantly low in obese children whereas low density lipids showed an insignificant difference between both groups.

Conclusion: Vitamin D insufficiency and serum calcium deficiency are common among obese children in comparison of non-obese children. However, poor vitamin D status is an effect or cause of obesity is not clear yet. Nevertheless, most of the studies suggest that either oral vitamin D intake or weight loss can improve the vitamin D level in obese children.

Key words: BMI, Serum calcium, Vitamin D, Obese.

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INTRODUCTION

42 million of infants and children were overweight in 2013and if the current trends continue more than 70 million children will be suffering with obesity.[1] Obesity has become a pandemic throughout the world. Moreover it is rising day by day in every country of world. Further risk of elevate lipid profile, cardio vascular diseases, morbidity and mortality is associated with obesity.[2] Obesity is one of the major contributing factor of onset and progression various autoimmune disorders. Adipokines secreted from adipose tissue have been found associated with pathogenesis of autoimmune diseases.[3] Serum calcium is one of the most important sources for bones growth in children.[4] 99% of total calcium of body found in bones whereas vitamin D increase the renal absorption of filtered calcium.[5] Vitamin D deficiency has become a worldwide problem; moreover it has been found associated with obesity in adults as well as in children.[6,7] Inactivity of children and lack of sunlight exposure induce the vitamin D deficiency through decreasing the bioavailability of vitamin D.[8] Vitamin D deficiency is more pronounced in obese in comparison of none obese due malabsorption of calcium.[9] Obesity leads to accumulation of fat mass which further increase adipose tissue; moreover adipose tissue acts as endocrine gland and secrets various bioactive factors known as adipokines.

Vitamin D is a fat soluble vitamin which is stored in fat cell of the body therefore, serum concentration of vitamin D is inversely related to body mass.[10] Decrease of vitamin D significantly increase the lipid profile and cardio metabolic risk.[11] Vitamin D is inversely related to obesity in adults.[12]

Moreover, decrease of vitamin D leads to decrease absorption as well bone turnover of calcium which further leads to reduce bone mineral density; however decrease bone mineral density is associated with risk of fracture as well as osteoporosis.[13] Nevertheless, relationship of vitamin D and obesity is not clear yet. Therefore the present study was designed to evaluate the relation of vitamin D, serum calcium and BMI in obese children.

MATERIAL AND METHODS

Study Population

A cross sectional type of study included two groups of children one group was consisted of 74 obese children from 6 to 16 yrs. of age while second group included 63 non-obese children of 6 to 16 yrs age. All the obese and non-obese children were recruited from the Teerthanker Mahaveer University, Moradabad, UP, INDIA.

Purpose of research was clearly narrated to every child and his/her, parents/ guardian. Written informed consent was taken from the parents or guardians of every child before taking part in this study.

Inclusion criteria for obese children was body mass index (BMI) is at or above 85th percentile of their age whereas for non-obese BMI is at or above 5th percentile and below 85th percentile of their age.[14] Rest of the inclusion and exclusion criteria were same for either group.

All the participants were non-alcoholic and none smoker. None of the child was suffering from any type of chronic disease including marasmus, tuberculosis, asthma, thyroid disorders etc. None of the child was on any type of medication or hormonal therapy.

METHODOLOGY

Anthropometric Parameters

Height: Height was measured to the nearest centimeter using a rigid stadiometer.[15]

Weight: Standard portable weighing machine was used to measure the weight.[15]

Body Mass Index: BMI was calculated using LMS method.[16]

Biochemical Parameters

Biochemical evaluations were done with fasting serum sample.

Estimation of serum calcium level: Serum calcium level was measured by Arsenazo III Method.[17]

Estimation of Vitamin D level: Vitamin D was measured by Elisa method.[17]

Estimation of Lipid Profile: Lipid profile in that serum sample was measured by serum concentrations of following parameters.

- **Serum concentration of total cholesterol** was estimated by the enzymatic CHOD-POD method.[17]
- **Serum concentration of triglycerides** was measured by the GPO-PAP method.[17]
- **Serum concentration of high density lipoprotein** was measured by CHOD-POD/ Phosphotungstate method.[17]
- **Serum concentration of low density lipoprotein** was measured by using Friedewald's formula.[17]

Statistical Analysis

The obtained value of vitamin D was considered as following sufficiency, 25(OH)D of at least 75 nmol/liter (30 ng/ml); insufficiency, less than 75 nmol/liter (30 ng/ml); and deficiency, less than 50 nmol/ liter (20 ng/ml).

One way ANOVA was used to compare the values of Vitamin D, serum calcium, lipid profile and BMI in both group. Further, Pearson correlation coefficient was used on data of either group to evaluate weather BMI is correlated with vitamin D, serum calcium and lipid profile. p-value < 0.05 was considered statistically significant. IBM SPSS Statistics 21 manufactured by IBM USA was used for entire calculations.

Table 1: Mean anthropometric data of the study and control groups.

Parameters	Obese (n = 74)	Non-obese (n =63)	P
Age (years ± SD)	13.4 ± 3.6	13.8 ±3.1	<0.84*
Height (cm)	137.4 ± 8.8	141.9 ± 10.8	<0.41*
Waist circumference (cm)	94.5 ±11.3	70.2± 13.2	<0.005**
Weight	58.7 ± 5.8	41.8 ± 4.2	<0.001***
BMI (kg/m2)	31.09 ± 5.4	20.8 ±3.7	<0.001***
BMI%	98.6 ± 15.3	77.8± 13.3	<0.001***

SD: standard deviation, BMI: body mass index, BMI SDS: body mass index standard deviation score, BMI%: body mass index percentage. *= non-significant, ** = significant, *** = highly significant.

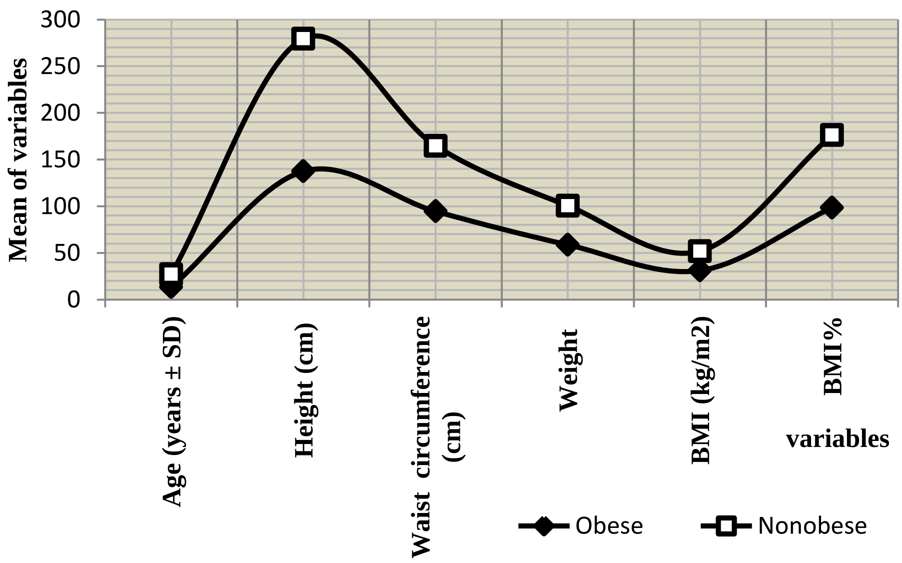

Figure 1: Mean anthropometric data of the study and control groups.

Table 2: Metabolic markers of the study and control groups.

	Obese (n = 118)	Nonobese (n = 118)	P
Glucose (mg/dL)	98.4 ± 12.5	86.4 ± 9.6	<0.27*
Serum Calcium	4.3 ± 1.9	3.3 ± 2.1	<0.001***
25-OHD (ng/dL)	12.6 ± 4.6	19.6 ± 7.5	<0.001***
Lipid Profile			
Triglyceride (mg/dL)	119.6 ± 24.4	90.2 ± 18.7	<0.001***
LDL cholesterol (mg/dL)	103.2 ± 26.4	90.6 ± 22.9	<0.001***
HDL cholesterol (mg/dL)	35.4 ± 12.5	49.7 ± 14.2	<0.001***
Total cholesterol (mg/dL)	212.1 ± 34.8	172 ± 29.2	<0.001***

*= non-significant, ** = significant, *** = highly significant.

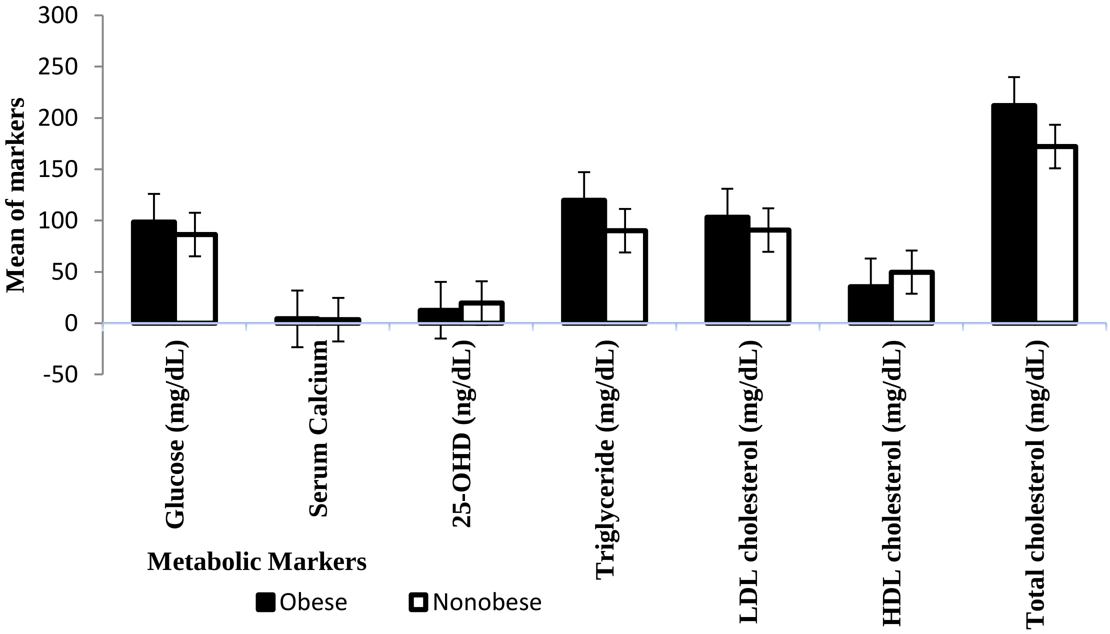

Figure 2: Metabolic markers of the study and control groups.

RESULTS

Table 1 shows that there was no significant difference between the age and height of both group children. However, a significant deference between two groups was observed for waist circumferences (p<0.001) as well as Weight (p<0.001). A significant deference of BMI 10.29 ± 1.7 kg/m^2 between two groups was recorded. Further, there was statistically significant deference 20.8 ±2 % between BMI percent of both groups.

Table 2 shows that there was an insignificant difference between fasting blood sugar level of obese children and non-obese children group. However, serum calcium was significantly low in obese group 6.8 ± 0.4 mg/dl in comparison of non-obese 9.6 ± 0.3 mg/dl (p<0.001). Further, Mean serum 25-OH-vit D in the obese group12.6 ± 4.6 ng/ml was significantly lower (P<0.0001) than that of the non-obese group 19.6 ± 7.5 ng/ml. Total cholesterol (212.1 ± 34.8 v/s 172 ± 29.2, p<0.001), triglycerides (119.6 ± 24.4 v/s 90.2 ± 18.7, p<0.001), were significantly higher in obese children in comparison of non-obese children.(Table & Figure 1,2) Though, high density lipids (35.4 ± 12.5 v/s 49.7 ± 14.2, p<0.001) was significantly low in obese children whereas low density lipids showed an insignificant difference between both groups.There was a negative association (r= - 0.41; P< 0.0001) between serum calcium and BMI whereas a negative correlation (r= -0.46; P< 0.0001) between 25-OH-vit D and BMI.

DISCUSSION

Obesity has become the foremost risk factor for various diseases including bone fracture and osteoporosis.[18] Obese subjects are more susceptible to develop vitamin D deficiency.[19] We have observed significant low level of calcium in obese children in comparison of non-obese children. Our result is consistent to previous studies of Caruth BR et al and Cunha KDA et al.[19,20] Normal level of serum calcium is essential to ensure the zenith bone mass development. However, decrease of serum calcium is associated with deficiency of vitamin D which facilitates the absorption of calcium from intestine. Therefore, decrease of vitamin D can lead to decrease serum calcium level.[21,22] Decrease calcium level may have deep effects on neurological, renal, gastrointestinal functions as well as adverse effects on bone metabolism. Nonetheless, vitamin D is required along with oral calcium to treat hypocalcaemia.[23] Moreover, calcium rich diet reduce the body fat as increased level of calcitriol enhance the conversion of cortisone to cortisol in adipocytes via stimulating 11β- hydroxysteroid dehydrogenase type 1 enzyme.[19] Further, we have observed significant decrease of vitamin D in obese children in comparison of non-obese children. (Table 1) Our findings are very similar to previous studies of Rajkumar K et al, Olson ML et al and Oleviera RM et al.[24-26] Deficiency of vitamin D in obese children seems to be due to it's a lipid soluble vitamin and it is accumulated in adipose tissue. Moreover, adipocyte is now considered as endocrine gland secretes various types of enzymes like cytokines, adipokines etc helps in further decrease of vitamin D.[27] Decrease vitamin D level leads to reduce bone mineral density which further induces the risk of fracture as well as osteoporosis especially in obese people.[28] Obesity in combination with vitamin D deficiency induces various health hazards including inflammation, reduced mineralization and compromised bone growth.[21] Furthermore, our findings reveal that Vitamin D is negatively correlated to BMI which is similar to previous studies of Cunha KDA et al.[19] and Peterson CA et al[29] as they have also observed the same correlation between vitamin D and BMI. This negative correlation may be due to increased BMI is associated with increased amount of fat accumulation; therefore decrease bioavailability of vitamin D.[30]

On the other we recorded negative correlation of serum calcium and BMI which is similar to the findings of Cunha KDA et al and Caruth BR et al.[19,20] This negative correlation between BMI and calcium suggest that decrease level of vitamin D in obese children leads to reduce serum calcium level. Further, obesity effect bone metabolism via stimulating production of co inflammatory factors like cytokines which affects osteogenesis via increasing leptin secretion.[31] Nonetheless, there is a significant difference in bone turnover of obese and non-obese children may be due to decreased of vitamin D and serum calcium. Moreover, we have recorded increased lipid profile in our study which is very similar to the previous studies of Friedland O et al and Lima SC et al.[32,33.]

Increased lipid profile might be due to increase body fat as well as weight. Moreover, increased lipid profile is directly related to increased blood pressure as well as high risk of cardiovascular diseases.[34,35] Previous studies have shown that increased lipid profile , hypocalcaemia and vitamin D deficiency are correlated as vitamin D is fat soluble thus it is sequestered and stored in adipocytes as body fat increases. Further, decrease bioavailability of vitamin d leads increased appetite, accumulation of fat and decrease serum calcium level. However, supplementation of vitamin D and calcium can decrease the body fat.[19,36]

CONCLUSION

We conclude that vitamin D insufficiency and serum calcium deficiency are common among obese children in comparison of non-obese children. However, poor vitamin D status is an effect or cause of obesity is not clear yet. Nevertheless, most of the studies suggest that either oral vitamin D intake or weight loss can improve the vitamin D level in obese children. Though, further researches are required to assess the status and mechanism of vitamin D deficiency in obese children.

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