

Original article:

Status of Vitamin D and Its Association with Serum Calcium and BMI in Obese V/s. Non-Obese School Going Children

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Abstract

Introduction: Vitamin D deficiency is more pronounced in obese in comparison of none obese due malabsorption of calcium. Relationship of vitamin D and obesity is not clear yet. Therefore the present study was designed to evaluate the relationship of vitamin D, serum calcium and BMI in obese children.

Materials and Methods: All the obese and non-obese children were recruited from the teerthankermahaveer university. BMI was calculated using LMS method. All the biochemical evaluations were done with fasting serum sample. Serum calcium level was measured by Arsenazo III Method. Vitamin D was measured by Elisa method. Serum concentration of total cholesterol was estimated by the enzymatic CHOD-POD method. Serum concentration of triglycerides was measured by the GPO-PAP method. A p-value < 0.05 was considered statistically significant.

Results: However, a significant difference between two groups was observed for waist circumferences (p<0.004) as well as Weight (p<0.002). Further, there was statistically significant difference between BMI percent of both groups. Mean serum 25-OH-vit D in the obese group 11.6 ± 3.4 ng/ml was significantly lower (P<0.004) than that of the non-obese group 18.1 ± 9.6 ng/ml. Total cholesterol, triglycerides, were significantly higher in obese children in comparison of non-obese children.

Conclusion: Vitamin D insufficiency and serum calcium deficiency are common among obese children in comparison of non-obese children.

Key words: Serum Calcium, Vitamin D, Obese, Non-Obese, BMI.

INTRODUCTION

The prevalence of type 2 diabetes among children and adolescents has increased at an alarming rate during the last two decades, with the highest prevalence among African American adolescents.¹ Vitamin D deficiency and childhood obesity have been classified as epidemics throughout the world, and both share some common risk factors including poor diet and inactivity. Observational and clinical studies show that vitamin D status and fat mass are inversely correlated. It is not clear whether vitamin D deficiency contributes to, or is a consequence of obesity, or whether there are regulatory interactions between excess adiposity and vitamin D activity. The effects of this deficiency in childhood obesity appear to have negative influences on overall health, including insulin resistance, inflammation, and impeded bone mineralization, as well as increased future risk of type 2 diabetes, cardiovascular disease, and osteoporosis.^{2,3} 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 secretes 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 cardiometabolic 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 In the present study we evaluate the relationship of vitamin D, serum calcium and BMI in obese children.

MATERIALS AND METHODS

A cross sectional type of study conducted in Teerthanker Mahaveer University, Moradabad, Uttar Pradesh. The present study included two groups of children one group was consisted 26 obese children from 6 to 16 yrs of age while second group included 22 non-obese children of 6 to 16 yrs age. 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. 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. Height was measured to the nearest centimetre using a rigid stadiometer. And Standard portable weighing machine was used to measure the weight.¹⁵ BMI was calculated using LMS method.¹⁶ All the biochemical evaluations were done with fasting serum sample. Serum calcium level was measured by Arsenazo III Method. Vitamin D was measured by Elisa method.¹⁷ 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. Serum concentration of triglycerides was measured by the GPO-PAP method. Serum concentration of high density lipoprotein was measured by CHOD-POD/ Phosphotungstate method. Serum concentration of low density lipoprotein was measured by using Friedewald's formula.¹⁷ 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).

Statistical Analysis

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

RESULTS

The present study shows that the mean age in obese group was 10.3 ± 2.6 and non-obese was 12.3 ± 9.2 and there was no significant difference between the age and height of both group children (Table 1). However, a significant difference between two groups was observed for waist circumferences ($p < 0.004$) as well as Weight ($p < 0.002$). Further, there was statistically significant difference between BMI percent of both groups. Mean Anthropometric value shown in table 1, figure 1.

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 in comparison of non-obese ($p < 0.001$). Further, Mean serum 25-OH-vit D in the obese group 11.6 ± 3.4 ng/ml was significantly lower ($P < 0.004$) than that of the non-obese group 18.1 ± 9.6 ng/ml. Total cholesterol, triglycerides, were significantly higher in obese children in comparison of non-obese children. (Table 1,2) Though, high density lipids was significantly low in obese children whereas low density lipids showed an insignificant difference between both groups.

There was a negative association ($r = -0.39$; $P < 0.001$) between serum calcium and BMI whereas a negative correlation ($r = -0.48$; $P < 0.005$) between 25-OH-vit D and BMI.

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

SD: standard deviation, BMI: body mass index, BMI SDS: body mass index standard deviation score, BMI%:

	Obese (n = 26)	Non-obese (n =22)	P
Age (years ± SD)	10.3 ± 2.6	12.3 ± 9.2	$<0.28^*$
Height (cm)	118.4 ± 8.8	128.4 ± 1.3	$<0.35^*$
Waist circumference (cm)	98.5 ± 9.2	68.2 ± 10.3	$<0.004^{**}$
Weight	54.4 ± 7.9	39.9 ± 4.5	$<0.002^{***}$
BMI (kg/m²)	29.08 ± 3.9	19.8 ± 4.2	$<0.001^{***}$
BMI%	94.1 ± 8.6	71.2 ± 7.1	$<0.003^{***}$

body mass index percentage. * = non significant, ** = significant, *** = highly significant.

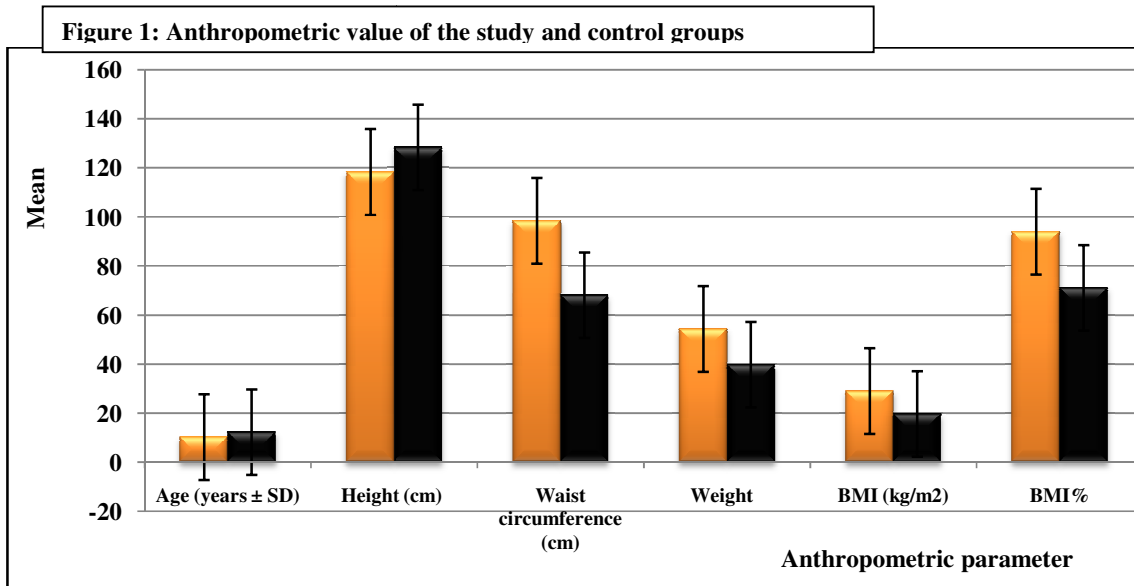


Table 2: Metabolic markers of the study and control groups.

	Obese (n = 26)	Nonobese (n = 22)	P
Glucose (mg/dL)	95.3 ± 9.9	79.4 ± 7.65	<0.31*
Serum Calcium	3.9 ± 7.3	3.1 ± 4.2	<0.001***
25-OHD (ng/dL)	11.6 ± 3.4	18.1 ± 9.6	<0.004***
Triglyceride (mg/dL)	112.6 ± 31.5	87.6 ± 13.8	<0.002***
LDL cholesterol (mg/dL)	100.9 ± 18.6	89.3 ± 19.1	<0.001***
HDL cholesterol (mg/dL)	31.8 ± 10.2	47.5 ± 20.8	<0.001***
Total cholesterol (mg/dL)	209.8 ± 24.7	168 ± 34.9	<0.001***

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

DISCUSSION

The present study shows that the mean age in obese group was 10.3 ± 2.6 and non-obese was 12.3 ± 9.2 and there was no significant difference between the age and height of both group children (Table 1). However, a significant difference between two groups was observed for waist circumferences ($p < 0.004$) as well as Weight ($p < 0.002$). Further, there was statistically significant difference between BMI percent of both groups. 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.^{18,19} 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.^{20,21} 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 hypocalcemia.²² Moreover, calcium rich diet reduce the body fat as increased level of calcitriol enhance the conversion of cortisone to cortisol in adipocytes via stimulating 11 β - hydroxysteroid dehydrogenase type 1 enzyme.¹⁸ 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.²³⁻²⁵ 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. ²⁶ 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.²⁷ Obesity in combination with vitamin D deficiency induces various health hazards including inflammation, reduced mineralization and compromised bone growth.²⁰ 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 al²⁸ 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 increase amount of fat accumulation; therefore decrease bioavailability of vitamin D.²⁹ 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.^{18,19} 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.³⁰ 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.^{31,32} 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.³³

CONCLUSION

We found that vitamin D insufficiency and serum calcium deficiency are common among obese children in comparison of non-obese children. 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 of vitamin D deficiency in obese children.

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