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Status of Vitamin D in Overweight and Obese Children

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Abstract

Introduction: *Obesity and overweight are increasingly reported in pediatric population in recent times. Various studies report that one of the most common endocrine abnormalities associated with obesity are high PTH levels and low circulating concentration of 25(OH) vitamin D. Since these important public health problems of obesity, overweight and vitamin D deficiency/ insufficiency are increasingly reported in countries like India, there is a need to study the associations between them and their implications to promote better health in children.*

Methods and Materials: *It was a descriptive study done in obese children attending Outpatient Department of Paediatrics, Government Medical College and Hospital, Vellore, Tamil Nadu from June 2016 to October 2016.Using anthropometry, 138 children aged 2-12 years were classified into overweight and obesity based on WHO child growth charts. Laboratory evaluation including the routine work up for evaluation of obesity and 25 (OH) vitamin D, S.Calcium, S.phosphrous, S.Alkaline phosphatase, fasting, blood sugar and thyroid function tests (S.T3,S.T4 &TSH) were done using appropriate assays.*

Results: *Mean BMI of the subjects was found to be 24.09 +-2.612with no significant difference in the BMI and Tanner stage between male and female subjects. The mean serum concentration of calcium was 9.634 +-0.9961 mg/dl with significant difference between obese and overweight. The mean serum level of S. Phosphorus was 4.795 +-0.8157 mg/dl; with no significant difference between overweight and obese children. The mean serum concentration of Alkaline Phosphatase was 212.99 +-75.375IU/L with significant difference between obese and overweight. The mean serum level of S. 25(OH) Vitamin-D was 15.63 +-4.3 ng/ml; with significant difference between obese and overweight. Those who are overweight are found to have high levels of vitamin D than those who are obese. 70.5% of the obese category had mild vitamin D deficiency and 28.6% of them had vitamin D insufficiency. Only 1% had normal vitamin D status. The prevalence of hypovitaminosis D among the total 138 subjects, was 87.7%.*

Conclusion: *There was a strong negative correlation between BMI and Vitamin D level, as BMI increased, there was a decrease in Vitamin D levels.*

Keywords: *overweight, obesity, vitamin.*

Introduction

Obesity and overweight are increasingly reported in pediatric population in recent times [(1)]. Studies report that these conditions are associated with wide array of metabolic and cardiovascular complications in adult life, since they tend to tract

to adulthood. The reported morbidities include, Impaired fasting glucose, hypertension, insulin resistance and metabolic syndrome. India, like many developing countries face this epidemic of childhood obesity as a public health problem [2].

Various studies report that one of the most common endocrine abnormalities associated with obesity are high PTH levels and low circulating concentration of 25(OH) vitamin D.Several studies document high prevalence of vitamin D insufficiency in developing countries, like India, across all age groups. Recent studies report that vitamin D deficiency is associated with many non-skeletal conditions such as Type 1 DM, carcinomas of prostate and breast , and chronic inflammatory conditions like Inflammatory bowel disease(IBD) and many auto immune disorders [3].

The association between vitamin D deficiency, insufficiency and obesity could be due to various physiological considerations. First, in vitro studies prove that vitamin D receptors (VDR) are expressed not only in tissues involved in calcium/phosphorous metabolism but also, in other tissues such as adipocytes and lymphocytes [4]. The physiology of vitamin D and PTH are found to be altered in overweight and obese population. The plausible mechanisms that may explain this association are decreased bio availability of vitamin D in obese people due to increased sequestration in adipocytes and inadequate sunlight exposure [5]. Since these important public health problems of obesity, overweight and vitamin D deficiency/ insuffi-ciency are increasingly reported in countries like India, there is a need to study the associations between them and their implications to promote better health in children.

Materials and Methods

Children aged 2-12 years attending the Outpatient Department of Pediatrics who were fulfilling the criteria of overweight and obese as per the WHO definition [6] were included in the study. The parents/caregivers of the study subjects were explained about the purpose of the study and informed written consent was obtained at the time of inclusion. Relevant history wasobtained from study subjects and clinical examination was performed.Anthropometric evaluation was done using standard methods. BMI of children were calculated using height and body weight. 2 ml of venous blood sample was obtained from all the subjects and laboratory evaluation including the routine work up for evaluation of obesity and 25 (OH) vitamin D, S.Calcium, S.Phosphrous, S.Alkaline Phosphatase, fasting, blood sugar and thyroid function tests (S.T3,S.T4 &TSH) were done using appropriate assays.Children on Calcium/vitamin D supplements, children with chronic hepatic and renal disorders and with history of drug intake (glucocorticoids, anticonvulsants and anti tubercular drugs) were excluded from the study.The status of vitamin D in the subjects was classified based on the serum levels of 25 (OH) vitamin D as per the American Academy of Pediatrics (AAP) [7].

Table 1. Classification of Vitamin D status

Category of vitamin D status	Serum 25(OH) vitamin D level
Severe deficiency	<5 ng/ml
Mild deficiency	5-15 ng/ml
Insufficiency	15-20 ng/ml
Normal	20-100 ng/ml
Excess	>100-150 ng/ml
Toxicity	>150 ng/ml

Table 2. Metabolic Parameters of S. Calcium, S. Phosphorus and S. Alkaline Phosphatase according to Laboratory Reference Value

Parameter	Normal Value
S.Calcium	8.8 -11 mg/dl
S. Phosphorous	2-5mg/dl
S. Alkalinehosphatase	60-320 IU/L(Birth to 5 years of age) 100-370 IU/L (5-12 years of age)

Data obtained were entered in Microsoft Excel spread sheet and then analyzed using the statistical software SPSS version 21.0.The appropriate descriptive statistics viz.,mean,median,standard deviation,percentage were used for analyzing quantitative data. Chi-square test, ANOVA, Levene's test, student's t tests were used wherever

applicable. Correlation between quantitative variables were done using Pearson correlation co-efficient. Statistical significance was accepted if p value ≤ 0.05.

Results

Relationship between age, sex and category of obesity was analyzed. Statistical analysis of anthropometry and measured serum values were done.

Table 3: Relationship of Age with category of obesity

Category of Obesity		Age Group (in Years)			Total
		3 – 6	6 – 10	10 – 12	
Overweight	Count (%)	7 (21.2%)	10 (30.3%)	16 (48.5%)	33
Obese	Count (%)	4 (3.8%)	40 (38.1%)	61 (58.1%)	105
Total	Count (%)	11 (8.0%)	50 (36.2%)	77 (55.8%)	138

The children in the age group 10-12 years constituted 48.5% of all the overweight children and 58.1% of all the obese children.

Table 3: Relationship of Sex with category of obesity

Category of Obesity		Sex		Total
		Male	Female	
Overweight	Count (%)	11 (33.3%)	22 (66.7%)	33
Obesity	Count (%)	62 (59.0%)	43 (41.0%)	105
Total	Count (%)	73 (52.9%)	65 (47.1%)	138

The major proportion of overweight children were girls i.e., 66.7% than boys at 33.3%.On the contrary, boys constituted the major proportion of obese group (59%) than the girls at 41%.

Table 4: Anthropometric characteristics

Anthropometric characteristic.	Number	Minimum	Maximum	Mean	Std. Deviation
Height	138	108	167	145.62	13.439
Weight	138	25	72	52.01	11.706
BMI	138	17.0700	30.2300	24.087899	2.6117635

Table 5: Laboratory analysis of Serum sample of the study group

Parameter	Mean	Median	Std. Deviation	Range	Minimum	Maximum
S. Calcium	9.634	9.800	0.9961	4.2	7.5	11.7
S. Phosphous	4.795	4.850	0.8127	4.5	2.9	7.4
S. Alkaline Phosphatase	212.99	207.50	75.375	650	112	762
S. 25(OH) Vit D.	15.630		4.307		8.5	32.65

Table 6: Metabolic parameters and categories of obesity

Group Statistics					
Parameter	Category of Obesity	N	Mean	Std. Deviation	Std. Error Mean
S.calcium	Overweight	33	10.342424	0.6959842	0.1211553
	Obesity	105	9.410476	0.9731910	0.0949737
S. Phosphorus	Overweight	33	4.581818	0.7522693	0.1309533
	Obesity	105	4.861905	0.8229147	0.0803083
S.ALP	Overweight	33	183.64	45.943	7.998
	Obesity	105	222.21	80.470	7.853
S. 25(OH) Vitamin D	Overweight	33	20.889091	4.2478402	0.7394541
	Obesity	105	13.977524	2.7129425	0.2647561

Table 7. Statistical Analysis of metabolic parameters using t-test for Equality of Means

Independent Samples Test								
Parameter		t-test for Equality of Means						
		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
S.calcium	Equal variances assumed	5.101	136	.000	.9319481	.1827129	0.5706222	1.2932739
	Equal variances not assumed	6.054	74.729	.000	.9319481	.1539435	0.6252586	1.2386375
S.phosphorus	Equal variances assumed	-1.739	136	.084	-.2800866	.1610201	-0.5985137	.0383405
	Equal variances not assumed	-1.823	58.068	.073	-.2800866	.1536170	-0.5875767	.0274035
Alkaline phosphatase	Equal variances assumed	-2.619	136	.010	-38.573	14.731	-67.704	-9.442
	Equal variances not assumed	-3.441	95.997	.001	-38.573	11.209	-60.822	-16.324
S. 25OHVit.D	Equal variances assumed	11.022	136	.000	6.9115671	.6270954	5.6714478	8.1516864
	Equal variances not assumed	8.800	40.525	.000	6.9115671	.7854222	5.3248104	8.4983238

There was a significant difference in the S. calcium and S. Alkaline phosphatase levels between the subjects who were obese and overweight. Overweight children had higher levels of S. Calcium than obese.Obese children had higher levels of alkaline phosphate than overweight children. There was no significant difference in the S. Phosphorus levels between obese and overweight children.There was a significant difference in the 25 (OH) Vitamin D levels between obese and overweight children with overweight children having higher levels of vitamin D than those who were obese.

Table 8. Vitamin D status among overweight and obese children

		Vitamin D Status			Total	Chi square value	p value
		Mild Deficiency	Insufficiency	Normal			
Overweight	Count (%)	3 (9.1%)	14 (42.4%)	16 (48.5%)	33	64.518	0.000
Obesity	Count	74 (70.5%)	30 (28.6%)	1 (1.0%)	105		
Total	Count	77	44	17	138		

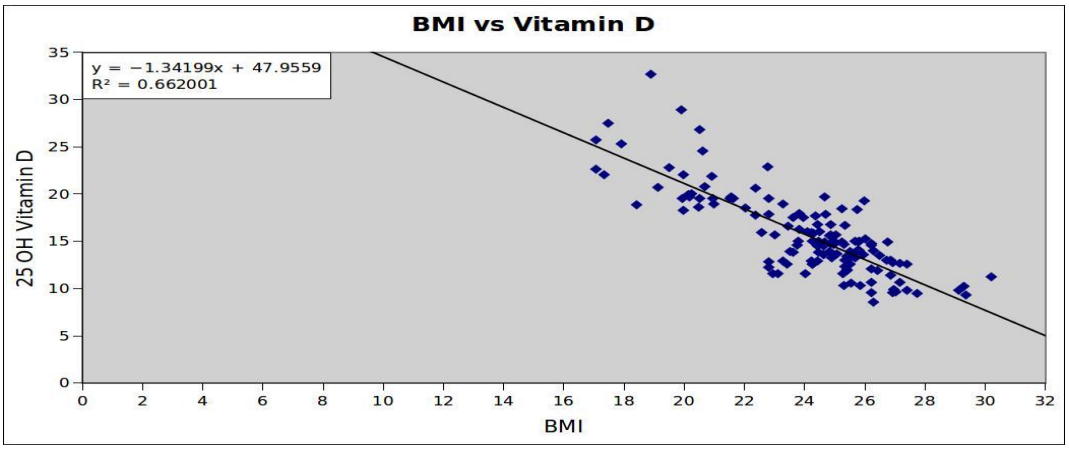
70.5% of the obese category had mild vitamin –D deficiency and 28.6% of them had vitamin D insufficiency. Only 1% had normal vitamin D status. 48.5% of the overweight category had normal vitamin D status, 42.4% had vitamin insufficiency and 9.1% had mild deficiency.

Table 9. Prevalence of Hypovitaminosis among overweight and obese children

Category of obesity		Vitamin D level (ng/ml)		Total
		20 or more	Less than 20	
Overweight	Count	16 (48.5%)	17 (51.5%)	33
Obesity	Count	1 (1.0%)	104 (99.0%)	105
Total	Count	17 (12.3%)	121 (87.7%)	138

The prevalence of hypovitaminosis D among the total 138 subjects, was 87.7%. 99% of the obese category had serum 25 (OH) vitamin D levels <20 ng/ml. Only 1% had normal vitamin D status. 51.5% of the overweight category had hypovitaminosis-D. But, 48.5% of them had normal vitamin D status.

Pic 1. Scatter plot diagram and regression line showing the correlation between S.25 (OH)Vitamin D and BMI.



Pearsons correlation: -0.814,p value -0.000

There was a strong negative correlation between BMI and Vitamin D level and as BMI increased there was a decrease in Vitamin D levels.The change in vitamin D level is 66.2% predicted by the change in BMI as shown in scatter plot and R square value.

Discussion

Studies done on overweight and obese adult population have documented the high prevalence of vitamin D deficiency/insufficiency in such population and its association with cardiovascular risks and the development of Type 2 diabetes mellitus [(8)]. Small number of such studies done in pediatric population also suggest increased risk of development of components of metabolic syndrome in children with vitamin deficiency and insufficiency [(9)]. This study examined the status of vitamin D in such children of a south Indian city.

Majority of subjects in this study were of age group 10-12 years (55.8%) and this correlated with the peak age of childhood obesity.The mean levels of S.calcium, phosphorous and S.ALP were 9.634 mg/dl,4.795mg/dl and 212.99 IU/L respectively. Status of vitamin D, as assessed by serum concentration of 25(OH)vitamin D, was 13.97+-2.71 ng/ml in obese and 20.88+-4.24 ng/ml in overweight children. 87.7%. of the overweight and obese children were found to have hypovitaminosis-D. This finding is similar to a study done in Turkey (65%) [(10)].

Statistical analysis done on these data revealed that obese children had a significant hypovitaminosis- D when compared to overweight children (p=0.005). Further analyses were done to determine the association between 25(OH) vitamin D status and other variables like, BMI, Ser. calcium, phosphorous, alkaline phosphatase, fasting blood sugar, lipid profile, and thyroid function test. There was a strong negative correlation between BMI and Vitamin D level, as BMI increased there was a decrease in Vitamin D levels with Pearsons correlation = -0.814,p value -0.000. This was similar to finding as in studies conducted in NewYork [(11)] and Turkey [(10)].

This study reiterated that Indian children had high prevalence of vitamin insufficiency and deficiency. The obese group (70.5%mild deficiency &28.6% insufficiency) had significantly higher prevalence of hypovitaminosis D, compared to overweight children (42.4% and 9.1% respectively).

Conclusion

Obese children had significantly low serum levels of 25 (OH) vitamin D, when compared to overweight children. There was a strong negative correlation between BMI and Vitamin D level and as BMI increased, there was a decrease in Vitamin D levels.

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