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Original Research Article

Levels of vitamin D among overweight and obese adolescents: an observational study

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ABSTRACT

Background: Normal growth and development requires vitamin D, and its deficiency compromises long term health and increases the risk of chronic disease. Severe vitamin D deficiency include rickets, osteomalacia, osteoporosis, increased risk of fracture, tooth loss. Studies indicate that vitamin D insufficiency (less severe than deficiency) is associated with a wide range of illnesses and chronic conditions, including type 1 diabetes, hypertension, multiple sclerosis and many types of cancer. Currently world is facing an unrecognized and untreated pandemic of vitamin D deficiency. This study aims at showing the relation between Vitamin D status and obesity in adolescent children and to know the dietary factors, life style factors like physical activity contributing to overweight and obesity in adolescents.
Methods: Study design: This is an observational study of 30 overweight and obese adolescents based on BMI were studied and their Vitamin D levels were assessed.
Results: A total of 14(46.7%) overweight and 16(53.3%) obese adolescents Vitamin D levels were assessed. 20(66.7%) had vitamin D levels <20ng/ml that is in the deficiency range.
4(13.3%) had in the insufficiency range (21-30ng/ml), 6(20%) had in the sufficient range. Results shows vitamin D levels were significantly less in obese and overweight adolescents.
Conclusions: Study results confirm that Vitamin D deficiency or insufficiency is common to obese and overweight adolescents, this may help to explain the relationship between obesity and several chronic diseases that are associated with poor Vitamin D status.

Keywords: BMI, Obesity, Overweight, Sedentary life style, Vitamin D

INTRODUCTION

Both developed and developing countries of all socioeconomic groups, irrespective of age, sex or ethnicity are affected by childhood obesity. According to a major new report from the International Obesity Task Force at least 155 million school-age children worldwide are overweight or obese. Limited data is available on the prevalence of Obesity in Indian sub-continent.[1]

National representative data for childhood Obesity in India is unavailable, however available studies of Chennai and Delhi has shown that prevalence of 6.2% and 7.4% respectively.[2,3]

Both endocrine and metabolic disorders occur with obesity and it has been suggested that obesity is a risk factor for vitamin D deficiency.[4] The inverse association between higher body fat and lower vitamin D levels has

been attributed to sequestration of the fat-soluble vitamin within the plentiful adipose tissue.[5]

Deficiency of vitamin D is pandemic, and has been implicated in a wide variety of disease states. Vitamin D deficiency is associated with cardiovascular disease risk factors and impaired glucose homeostasis and are more common in overweight and obese children.[6-8]

This study has been undertaken as there were few studies and the findings were inconclusive.[9,10]

METHODS

Source of data

Study will be conducted on obese adolescent children (10 to 19yrs) coming to the paediatric adolescent clinic OPD and those admitted in the paediatric ward. Study data includes Demographic data (age, sex, race, ethnicity, medication use, smoking, illicit drug use, alcohol consumption), findings on physical examination (anthropometry and tanner staging) are assessed to determine if the adolescent children are overweight and obese or not.

Vitamin D levels will be assessed in this group of children to determine the status of vitamin D in them.

Sampling method

Study of Vitamin D status in obese and overweight adolescent children at Navodaya Medical College and Hospital.

Study design

Parents or guardian will be explained the whole procedure of the study and informed consent will be taken from them.

Vitamin D status will be measured by checking 25-hydroxycholecalciferol (25OHD) level in the obese adolescent children coming to OPD or admitted in Pediatric ward who fill the WHO criteria for overweight (BMI> 85th percentile) and obesity (BMI > 95th percentile).

Inclusion criteria

Children in the age group 10 to 19 years with overweight BMI > 85th percentile and obesity BMI 95th percentile are taken into the study.

Exclusion criteria

Children with endocrine disorders, calcium metabolism disorders, syndromal obesity, premature adrenarche, diabetes or on medications for various un-labelled disorders.

Sample size

30 obese and overweight adolescents were studied. Ethical clearance was obtained from Institutional Ethical Committee of Navodaya Medical College, Raichur.

Measurement of vitamin D levels

Vitamin D levels were measured using the form of 25-hydroxycholecalciferol (25OHD). For this venous blood was drawn and sent to lab for analysis of the level of vitamin D by chemilumescence method.

Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on

Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data is made.

Significant figures

+ Suggestive significance (p value: 0.05<p<0.10)
* Moderately significant (p value: 0.01<p≤ 0.05)
** Strongly significant (p value: p≤0.01).

Statistical software

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc.

RESULTS

A total of 30 obese and overweight adolescents were studied. 23 were in the age group 10-14 years and 7 were in the age group 15-19 years (Table 1). Among the 30 adolescents 20 were males and 10 were females (Table 2). In the study, 14(46.7%) adolescents were overweight and 8(53.3%) were obese. In 4 of the obese and overweight adolescents the waist hip ratio was ≤0.8, 0.81-0.9 in 23 adolescents and was >0.9 in 7.

Table 1: Age distribution of patients studied.

Age in years	No. of patients	%
10-14	23	76.6
15-19	7	23.3
Total	30	100

A total of 4(13.7%) of the obese and overweight adolescents had parental obesity and rest did not have. Only 5(16.7%) of the adolescents had sibling obesity. Physical activity is seen in 39 (65%) and 21(35%) did not

have physical activity. TV viewing was found in 9(30%) and 21(70%) were not. 21(70%) were fatty food consumers and 15(50%) were fast food consumers. 20(66.7%) were from urban region and 20(33.3%) were from rural region (Table 3). 22(73.7 %%) of the obese and overweight adolescents belonged to upper middle class and 8(26.7%) belonged to lower middle class (Table 4).

Table 2: Gender distribution of patients studied.

Gender	No. of patients	%
Male	20	66.6
Female	10	33.3
Total	30	100

Table 3: Variables of patients studied.

Variables		No of patients	%
Parenteral obesity	No	26	86.3
	Yes	4	13.7
Sibling obesity	No	25	83.3
	Yes	5	16.7
Diet	Non-veg	13	43.3
	Veg	17	56.7
Physical activity	No	10	33.3
	Yes	20	66.7
TV viewing	No	21	70
	Yes	9	30
Fatty food	No	9	30
	Yes	21	70
Fast food	Yes	15	50
	No	15	50
Region	Rural	10	33.3
	Urban	20	66.7

A total of 20(66.7%) had vitamin D levels <20ng/ml (deficiency range), 4(13.3%) had vitamin D levels 21- 30 ng/ml (insufficiency range) and 6(20%) had in the sufficiency range >30ng/ml (Table 5).

Table 4: Socio economic status of patients studied.

Socio economic status	No of patients	%
Upper middle class	22	73.3
Lower middle class	8	26.7
Total	30	100

Table 5: Vitamin D levels of patients studied.

Vitamin D	No. of patients	%
<20 ng/ml	20	66.7
21-30 ng/ml	4	13.3
>30 ng/ml	6	20
Total	30	100

30(72.5%) in the age group 10-14 years, had vitamin D <20ng/ml, and 8(100%) had in the range 21-30ng/ml. 5(83.3%) had in the sufficiency range that is >30ng/ml. In the age group 15-19 years, 6(27.5%) had <20ng/ml and 1(16.7%) in the sufficiency range.

Among the male adolescents, 15 (72.5%) had vitamin D levels <20ng/ml, 5(62.5%) had vitamin D levels in the range 21-30ng/ml and 4(66.7%) had >30ng/ml. 6(27.5%) had vitamin D levels in the deficiency range, 1(37.5%) had in the insufficiency range 21-30ng/ml and 9(30%) in the sufficiency range >30ng/ml. In the age group 15-19 years, 6(27.5%) had <20ng/ml and 1(16.7%) in the sufficiency range >30ng/ml.

Among the overweight 50% had vitamin D <20ng/ml, 75% had in the range 21-30ng/ml and 16.7% had >30ng/ml, among the obese adolescents, 50% of them had vitamin D <20ng/ml, 25% had in the range 21-30ng/ml and 5 of them had >30ng/ml (Table 6).

Table 6: BMI (kg/m^2) according to Vitamin D levels.

BMI (kg/m^2)	Vitamin D			
	<20 ng/mL	**21-30 ng/mL**	**>30 ng/mL**	**Total**
Overweight	10 (50%)	3 (75%)	1 (16.7%)	14 (46.7%)
Obesity	10 (50%)	1 (25%)	5 (83.3%)	16 (53.3%)
Total	20 (100%)	4 (100%)	6 (100%)	60(100%)

With a waist hip ratio ≤0.8, 10% had vitamin D <20ng/ml, 1(25%) had in the range 21-30ng/ml, and 1(16.7%) had in the sufficiency range >30ng/ml. With ratio 0.81-0.9, 15(75%) had <20ng/ml, 3(75%) had 21-30ng/ml and 4(66.7%) had in the sufficiency range with ratio >0.9, 15% had <20ng/ml and 6(100%) had >30ng/ml (Table 7).

Table 7: Waist hip ratio according to vitamin D levels.

Waist hip ratio	Vitamin D			
	<20 ng/mL	21-30 ng/mL	>30 ng/mL	Total
≤0.8	2(10%)	1(25%)	1(16.7%)	4(13.3%)
0.81-0.9	15(75%)	3(75%)	4(66.7%)	23(76.7%)
>0.9	3(15%)	0(0%)	1(16.7%)	3(10%)
Total	20(100%)	4(100%)	6(100%)	30(100%)

27.5% of those without physical activity, had <20ng/ml as their vitamin D levels, 25% had 21-30ng/ml and 66.7% had >30ng/ml. 72.5% with physical activity, had <20ng/ml, 75% had in the range 21-30ng/ml and 33.3% had >30ng/ml. p=0.043 was statistically significant.

Those not consuming fatty food had vitamin D levels <20ng/ml in 20%, and 33.3%% had >30ng/ml that was in the sufficiency range. P=0.097 was statistically significant among fatty food consumers and vitamin D was in deficient range. 80% children consuming fast food

had vitamin D <20ng/ml, 25% had in the range 21-30ng/ml and 16.7% had in the range >30ng/ml. Those not consuming fast food, 35% had vitamin D <20ng/ml, 75% had in the range 21-30ng/ml, 83.3% had in the range >30ng/ml.

Among the upper middle class, 14 had vitamin D levels <20ng/ml, 3 had in the range 21-30ng/ml and 5 had >30ng/ml. In the lower middle class, 6 had <20ng/ml, 1 had in the range 21-30ng/ml and 1 had >30ng/ml. No statistical significance noted. Those with parental obesity, 2(10%) had vitamin D levels <20ng/ml, 1(25%) had in the range 21-30ng/ml, 1(16.7%) had >30ng/ml. p=1, no statistical significance. Those who had obese siblings, 4 had vitamin D <20ng/ml and 1(8.3%) had >30ng/ml had no statistical significance. Those who had non-veg diet, 8 had vitamin D levels <20ng/ml, 2 had

21-30ng/ml and 3 >30ng/ml, p=0.411 no statistical significance noted with adolescents who had vegetarian diet. Rural area adolescents had vitamin D levels <20ng/ml in 6(30%), 1(25%) had 21-30ng/ml and 3(50%) had >30ng/ml. Urban area 14 (70%) had <20ng/ml of vitamin D, 3(75%) had in the range 21-30ng/ml, and 3(50%) had >30ng/ml. p=0.511 no statistical significance (Table 8).

Table 8: Risk factors status according to vitamin D levels.

		Vitamin D levels			
Risk factors		<20 ng/mL (n=20)	21-30 ng/mL(n=4)	>30 ng/mL(n=6)	P value
Parenteral obesity	No	18(90%)	3(75%)	5(83.3%)	1.000
	Yes	2(10%)	1(25%)	1(16.7%)	
Sibling obesity	No	16(80%)	4(100%)	5(83.3%)	0.411
	Yes	4(20%)	0(0%)	1(16.7%)	
Diet	Non-veg	8(20%)	2(50%)	3(50%)	0.395
	Veg	12(80%)	2(50%)	3(50%)	
Fatty food	No	8(20%)	0(0%)	2(33.3%)	0.097+
	Yes	12(80%)	4(100%)	4(66.7%)	
Region	Rural	6(30%)	1(25%)	3(50%)	0.511
	Urban	14(70%)	3(75%)	3(50%)	

DISCUSSION

Many countries have a rapid growing threat for Over-weight and obesity. Indeed, these are now so common that they are replacing the traditional problems such as under nutrition and infectious diseases as the most significant causes of ill health.

In our study, 14(35%) overweight and 16(65%) obese adolescent's vitamin D levels were assessed, among which 21(70%) were boys and 9(30%) were girls. 66.7% had vitamin D deficiency and 13.3% had in insufficiency range. Only 20% of the obese and overweight adolescents had vitamin D levels in the sufficiency range.

Our findings are in agreement with most studies in obese adolescent children. Adequate vitamin D concentration and bone growth are vital during the young adult years not only to help prevent osteoporosis and osteopenia later in life, but also to protect against various other diseases that vitamin D deficiency is associated with. A study conducted among 307 healthy, young adults in Boston revealed that 24.1% were deficient in vitamin D. The highest prevalence existed among African Americans. Additionally, a greater prevalence of deficiency was observed during the winter and spring months. The results of the study match with the previously studies which shows that darker skin pigmentation leads to a greater risk for vitamin D deficiency as well as the fact that less sunlight is available for vitamin D synthesis in the winter and spring months.[11]

With regards to BMI, a 1% increase in BMI is associated with a 5% decrease in serum vitamin D levels. This observation coincides with the above data that suggests excess body fat leads to decreased bioavailability of vitamin D as vitamin D is stored deep within the subcutaneous fat. Large intake of vitamin D may offer little benefit in such conditions. Increase in the prevalence of childhood obesity leads to increase in vitamin D deficiency among this population as well.[12]

Inactivity and Obesity

Obesity due to sedentary lifestyle increases the risk of vitamin D deficiency due to the fact that vitamin D is a fat-soluble vitamin and is thus stored in adipose tissue.

Retrieving of stored vitamin D becomes increasingly difficult for the body in case of obesity because it is less bioavailable when it is imbedded in deeper adipose stores.[4] Additionally, a sedentary lifestyle in which weight-bearing exercise is not used to maintain bone density leads to an increased need for vitamin D.[13]

In our study, though 19 children had physical activity, 15 in that vitamin D levels in deficiency range and 3 had in insufficiency range. Only 2 had in the sufficiency range. This could be probably due to lesser physical activity and also inadequate sun exposure.

Fast food, fatty food and obesity

A total of 70% consumed fatty food (ghee, butter, cheese) and 30% consumed fast food (chats, chips, cakes, aerated drinks) in this study. p value = p=0.097+, was statistically significant. Consumption of some types of foods are correlated to deficiency of vitamin D. A positive correlation existed between soda, fruit juice, and iced tea intake and deficiency. Vitamin D deficiency is increasing due to due to the decline of milk consumption in the adolescent population, vitamin D deficiency is on the rise. Milk is being replaced with other beverages including aerated drinks and juice, which provide little benefit to bone health.[12]

Socio-economic status and obesity

No significant statistical difference is seen in the present study, most of them either belonged to upper or lower middle class according to modified Kuppuswamy classification. However, a study by Ramachandran showed higher prevalence of obesity in the higher socio-economic groups.[13]

Kaneria et al. (2006) observed in his prevalence study, there has been increase in Overweight (4.85 per cent) and Obesity (3.73 percent) among children belonging to affluent and upper middle-class income group.[15]

Television viewing and obesity

A total of 17(28.3%) of the children had the habit of TV viewing which contributed to the sedentary life style and obesity. 16(40%) had vitamin D levels in deficiency and 1(12.5%) had in the insufficiency range.

None had in the sufficiency range. Our study shows similar results compared to the other studies. Study of TV viewing by William H. Dietz of 6-17 years old children showed children who watched more TV experienced higher rate of prevalence of obesity than children watching less TV.[16]

A study by Rose Anderson on 16 to 18 years old children in USA showed that boys and girls who watch 4 or more hours of TV each day, they had greater body fat and greater BMI than those who watched less than 2 hours per day.[17]

Parental BMI and Obesity in child

Available studies have shown the effect of parental obesity on the BMI of their child. However, no statistical significance found in this study.

Garn SM et al showed that when both parents are over-weight, 80% of their children will be obese. When one parent is obese, this incidence decreases to 40%; and when both parents are lean, obesity prevalence drops to 14%. Gray GA et al showed that there is a 75% chance that children aged 3-10 yrs will be over-weight if both parents were obese. This drops to a 25-50% chance with just one obese parent.18 This may be due to partially genetic and mostly due to similar behavioural pattern and family environment.

CONCLUSION

Over the last 20 years there is an increasing trend in childhood obesity in both developing and developed countries. Prevalence of 6.2-7.4% of obesity in children has been shown in many studies. Obesity has no longer remained a problem of only upper socio-economic class but Indian middle class has also dragged into the so called “problem of affluent.” In simple terms, obesity is a consequence of an energy imbalance; energy intake exceeds energy expenditure over a considerable period. Obesity is commonly seen as a complex multi factorial disease; it is a condition resulting from a lifestyle that promotes a positive energy balance, but also one that becomes manifest more readily in people who have an inherited susceptibility to be in positive energy balance. The results of this study confirm that Vitamin D deficiency or insufficiency is common to obese individuals and is related to the level of adiposity. It is possible that obesity itself may cause Vitamin D deficiency, and this may help to explain the relationship between obesity and several chronic diseases that are associated with poor Vitamin D status.

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