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Are Indian obese children and adolescents at increased risk for Vitamin D deficiency?

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ABSTRACT

Objectives: Obesity has been mentioned as a high risk factor for Vitamin D deficiency (VDD) requiring supplementation in Indian children.

Material and Methods: Forty obese and age-matched non-obese subjects (age 5–18 years) were assessed for lifestyle parameters, metabolic profile, and serum 25-hydroxyvitamin D (25OHD). VDD was defined as serum 25OHD < 12 ng/mL.

Results: Mean 25OHD was comparable among obese and controls (15.0 ± 9.95 and 15.1 ± 4.79 ng/mL; $P = 0.97$) with VDD seen in 82% of cases and 85% of controls. Pubertal cases had lower 25OHD values than prepubertal obese cases (10.78 ± 4.69 and 17.2 ± 11 ng/mL; $P = 0.06$). Mean duration of physical activity (<2 h/week) and screen time (>2 h/day) was similar across prepubertal and pubertal groups and between obese and controls. Obesity was not associated with risk for VDD among cases and controls (odds ratio 0.83, 95% C.I. 0.25–2.7, $P = 0.76$).

Conclusion: Obese pubertal subjects were more at risk for VDD than prepubertal subjects. Routine Vitamin D supplementation to obese Indian children may be considered during adolescence.

Keywords: Body mass index, Vitamin D deficiency, Lifestyle, Puberty, Adolescent, Metabolic

INTRODUCTION

Obesity and Vitamin D deficiency (VDD) have been recognized as significant health burden among children over the past decade.[1,2] The risk of long-term complications of obesity such as metabolic syndrome and cardiovascular disease is reported higher in VDD among Asian Indians.[3] A large meta-analysis reported an inverse association between body fat and serum Vitamin D concentrations recommending a higher dose of Vitamin D supplementation in them.[4,5] However, there is lack of robust scientific evidence to support routine Vitamin D supplementation for prevention of obesity-related complications.[6]

The recently published guidelines by Indian Academy of Pediatrics recommend routine Vitamin D supplementation in obese children and adolescents.[7] Adolescence accounts for peak bone mass accrual and is a vulnerable stage for lifestyle disorders due to changes in metabolic and hormonal milieu, peer pressure, poor sleep hygiene, erratic timings, and nutritive content of meals.[8] VDD has been reported in maximum proportion among adolescents than other age groups in recently conducted Comprehensive National Nutrition Survey, 2016–2018.[9] Therefore, whether only obese Indian children and adolescents require Vitamin D supplementation or whether adolescent Indian children irrespective of their body mass index (BMI) need to be identified as a high-risk group for Vitamin D supplementation, is a matter of contention. The current study was undertaken to compare the Vitamin D status and lifestyle in obese children and adolescents with apparently healthy children and assess VDD among pubertal subjects.

MATERIAL AND METHODS

The study was a case–control study in the department of pediatrics of a tertiary level hospital between June and November in North India (28.6°N). Study cases comprised children and adolescents with constitutional obesity (aged 5–18 years). Any subject with known hypothyroidism, diabetes, hypothalamic obesity, genetic syndromes, chronic endocrine or systemic illness or with a history of intake of Vitamin D, anticonvulsants, or glucocorticoids in the past 6 months was excluded from the study. Age- and sex-matched apparently healthy children and adolescents with normal

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BMI were recruited as controls. Written informed consent was taken from parents with verbal assent from subjects older than 7 years. The study was approved by the Institutional Ethics Committee.

Clinical history including a 24 h dietary recall (estimation of calories) and duration of outdoor sun exposure (hours/day) for Vitamin D status was recorded as an average of the past 3 days. Lifestyle parameters recorded included daily screen time (hours/day) and duration of physical activity (hours/week) in the past 1 week by recall. A daily screen time of maximum 2 h and physical activity of minimum 60 min is recommended.[10] Anthropometric parameters including weight, height, and BMI were measured and interpreted as per IAP growth charts 2015.[7] Weight was measured with digital weighing machine in minimal clothing without footwear and corrected to the nearest 0.5 kg. Height was measured with wall mounted Holtain's stadiometer (Holtain Inc., Crymych, Pembs, UK) with the measurement corrected to the nearest 3 mm. BMI was calculated as weight (kg) divided by square of height in meter. Clinical examination for pubertal staging and measurement of blood pressure was performed. Prader orchidometer was used to measure testicular volume (TV) in boys and to categorize as prepubertal if TV < 4 ml with no pubarche and pubertal for TV > 4 ml as per Tanner staging.[11] Puberty in girls was considered if thelarche was observed, that is, sexual maturity rating stage 2.[12]

Five milliliters of blood were collected after overnight fast for the estimation of blood glucose (0 min), lipid profile (serum cholesterol, triglycerides, high-density lipoproteins, and low-density lipoproteins), and bone mineral metabolism (serum calcium phosphorus, alkaline phosphatase [ALP], 25-hydroxyvitamin D [25(OH)D], and parathyroid hormone [PTH]). Blood glucose values at 120 min were collected after glucose challenge (1.75 gm/m^2), estimated using glucose peroxidase method, and interpreted as per definitions of the American Diabetes Association.[13] Lipid profile values were estimated on autoanalyzer and interpreted as per published reference ranges.[14] Serum calcium and phosphate were analyzed on autoanalyzer. Serum 25(OH)D was estimated by chemiluminescence (Diasorin, Stillwater, M N, USA) and PTH using electrochemiluminescence method (Roche Diag). Intra- and interassay coefficient of variation was 3.5% and 5% for serum 25(OH)D and 2.4% and 3.6% for PTH. Vitamin D status was defined as deficiency if ≤12 ng/mL, insufficient 12–20 ng/mL, and sufficient >20 ng/mL.[7]

Statistical analysis

All data were analyzed on SPSS version 21. Sample size calculation was performed using OpenEpi software. The mean serum 25(OH)D was taken as 11.4 (5.8) ng/mL based on an earlier study in similar region.[15] The sample size required to detect 10% difference in mean serum Vitamin D between obese and control population with power 90% and type 1 error as 5%, was calculated as 39. Thus, 40 cases and 40 controls were recruited.

Descriptive analysis was carried out to summarize the study population, check for normal distribution, and identify potential confounders and interaction of variables. Comparison of means was done using *t*-test. Mann–Whitney U-test was used for non-parametric parameters. Correlation (r) between variables was assessed using Pearson's correlation. Odds ratio (OR) was calculated to assess risk association. Categorical variables were compared using Chi-square test.

RESULTS

The mean age of cases (n = 40; 26 boys) and controls (n = 40; 26 boys) was comparable (9.42 ± 2.48 and 9.41 ± 2.46 years; P = 0.1). Cases had higher BMI than controls (27.92 ± 2.83 and 16.01 ± 1.22 kg/m^2; P < 0.001). The mean laboratory parameters between both groups are summarized in Table 1. VDD was present in 82% of cases and 85% of controls. Obesity was not a risk factor for VDD (OR 0.83, 95% C.I. 0.25–2.7, P = 0.76). Serum 25(OH)D had significant negative correlation with PTH (P = 0.02), ALP (P < 0.001), and total cholesterol (P = 0.03) but poor correlation with BMI, screen time, physical activity, sunlight exposure, blood glucose, and lipid profile (P > 0.05).

Table 2 shows the lifestyle and laboratory parameters of obese cases categorized according to puberty. Mean serum 25(OH)D levels were lower in pubertal obese cases (n = 13; 10.78 ± 4.2) than prepubertal obese cases (n = 27; 17.03 ± 11.03) ng/mL; mean difference 6.42, 95% C.I. −0.05 to 12.89; P = 0.06. The serum lipid parameters were higher in pubertal cases than prepubertal obese cases (P > 0.05). Similarly, pubertal controls (n = 14) had lower levels of serum 25(OH) D than prepubertal controls (n = 26) (13.92 ± 4.4 and 15.53 ± 4.8 ng/mL; P = 0.38, respectively; difference 1.61, 95% C.I. −1.52 to 4.74). Obese pubertal subjects had lower S. 25(OH) D levels than pubertal controls (mean difference 3.14, 95% CI -0.27 to 6.55; P = 0.07). The caloric intake and BMI were significantly lower in prepubertal than pubertal controls (P < 0.001). The physical activity, screen time, outdoor sun exposure time, serum lipid profile, and blood glucose were similar in prepubertal and pubertal controls (data not shown).

The mean daily caloric intake was higher among cases than controls (1904.7 ± 322.86 and 1678.3 ± 309.66 calories, respectively; P = 0.003). Parameters comparable among cases and controls were duration of physical activity (1.73 ± 0.57 and 1.65 ± 0.50 h/week) and screen time (2.42 ± 0.59 and 2.17 ± 0.59 h/day) and duration of outdoor sunlight exposure (1.28 ± 0.36 and 1.23 ± 0.35 h/day); P > 0.05.

Table 1: Laboratory parameters among cases and controls.

Parameter	Obese *n*=40	Controls *n*=40	*P* value
Blood glucose 0 min (mg/dL)	94.3±6.86	92.4±6.19	0.18
Bl. glucose 120 min (mg/dL)	114.8±6.78	110.2±6.47	0.07
Serum cholesterol (mg/dL)	145.5±18.04	139.6±16.74	0.13
Serum LDL (mg/dL)	75.8±23.37	75.8±11.31	0.98
Serum triglycerides (mg/dL)	134.1±42.88	91.4±16.22	<0.001*
Serum HDL (mg/dL)	48.3±7.93	54.3±9.41	<0.001*
Serum calcium (mg/dL)	9.8±0.37	9.8±0.45	0.69
Serum phosphorus (mg/dL)	4.9±2.07	4.9±0.70	0.56
Serum ALP (IU/L)	303.2±58.17	231.1±65.57	<0.001*
Serum 25 (OH) D (ng/mL)	15.0±9.95	15.01±4.79	0.97
Serum iPTH (pg/mL)	60.1±43.75	65.34±44.28	0.66

All values expressed as Mean±Standard deviation. *P<0.05 significant. HDL: High-density lipoprotein, LDL: Low-density lipoprotein, ALP: Alkaline phosphatase, iPTH: Intact parathyroid hormone

DISCUSSION

The present study found a similar high prevalence of VDD (<12 ng/mL) among both Indian obese and non-obese children. Mean serum 25(OH)D levels were significantly lower in pubertal than prepubertal age group indicating need to address optimum nutrition during adolescence which is a period of maximum bone mass accrual.

There has been a rise in the burden of overweight and obesity among Indian children in the past decade.[16] The high prevalence of VDD in the current study is similar to earlier reports from North India irrespective of BMI status.[17,18] An inverse association of serum 25(OH)D levels with body fat has also been concluded.[4,5,19] The present study, however, did not find BMI as a risk factor probably due to the high baseline rate of VDD as was also evident in the control population.

Recent community-based studies in Indian schoolchildren (<12 year) show high prevalence of VDD or insufficiency[19,20] which were lower (24% and 40%) than our hospital-based study, as has been noted earlier.[17] Puberty was a vulnerable period for VDD in our cohort similar to earlier reports.[8,15,18] An effect of BMI on VDD was, however, not reported in these earlier studies. VDD is reported to be highest among 10–19 years age Indian adolescents (girls > boys) in the recent nationwide CNNS survey. Almost one in every three adolescent girl in VDD (urban > rural).[9] Thus, probably an age-wise stratification instead of BMI wise stratification for identifying children who need routine Vitamin D supplementation would be more prudent. Adolescence is also a period of peak bone mass accrual where optimal Vitamin D and calcium intake are mandatory to optimize long-term skeletal health. A close monitoring of weight and diet is probably more crucial than Vitamin D alone during peripubertal years to prevent excessive caloric intake and increase in BMI.[8]

Table 2: Lifestyle and laboratory parameters in obese children and adolescents.

Parameter	Prepubertal *n*=27	Pubertal *n*=13	*P* value
Age	8.0±1.3	12.38±1.21	<0.001*
Body mass index (kg/m^2)	26.57±1.8	30.73±2.41	<0.001*
Caloric intake (kcal/day)	1730.5±143.01	2266.23±276.09	<0.001*
Physical activity (hours/week)	1.62±0.57	1.96±0.49	0.11
Screen time (hours/day)	2.37±0.63	2.5±0.48	0.72
Outdoor sun exposure time (hours/day)	1.16±0.32	1.20±0.18	0.28
Blood glucose 0 min (mg/dL)	93.11±7.0	96.84±5.47	0.15
Bl. glucose 120 min (mg/dL)	112.51±5.27	119.69±6.76	0.2
Serum cholesterol (mg/dL)	140.7±12.06	155.46±18.82	0.56
Serum LDL (mg/dL)	69.88±16.74	88.15±28.62	0.11
Serum triglycerides (mg/dL)	122.77±35.77	157.3±45.31	0.17
Serum HDL (mg/dL)	43.14±7.33	45.23±8.62	0.17
Serum calcium (mg/dL)	9.79±0.33	9.77±0.44	0.82
Serum ALP (IU/L)	295.29±52.16	319.46±66.09	0.32
Serum 25 (OH) D (ng/mL)	17.03±11.03	10.78±4.19	0.06
Serum iPTH (pg/mL)	63.47±46.18	52.92±35.17	0.23

All values expressed as Mean±Standard deviation. *P<0.05 significant. HDL: High-density lipoprotein, LDL: Low-density lipoprotein, ALP: Alkaline phosphatase, iPTH: Intact parathyroid hormone

The present study cohort recorded unsatisfactory lifestyle parameters among prepubertal and pubertal age groups. Thus, correcting Vitamin D alone without modifying lifestyle practices will result in unsatisfactory health outcomes in obese children.

The present study had certain limitations. There was no prospective evaluation of obesity related complications among those with VDD. Obesity was evaluated only on the basis of BMI without measurement of central adiposity or fat mass,

and laboratory markers of inflammation were not evaluated. A larger sample size for subgroup comparison would have been ideal. The present study concluded a high prevalence of VDD and poor lifestyle measures among urban Indian children, irrespective of their BMI, which has not been corroborated earlier in literature. The severity of VDD was further aggravated during puberty which is the period for peak bone accrual.

Thus, it may be advisable to target obesity prevention strategies and healthy lifestyle in both obese and non-obese Indian children, especially during adolescence. VDD remains an issue to be addressed in a tropical country like ours irrespective of child's BMI.

CONCLUSION

The above study highlights the existent burden of poor lifestyle measures and vitamin D deficiency in children and adolescents in a hospital setting. There is a need to monitor and ensure optimum bone health during pubertal years.

Key messages

1. VDD affected higher proportion of children during pubertal years than prepubertal period.
2. Lifestyle practices were dismal across all age groups indicating the need to emphasize healthy behaviors in children.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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