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Original Article

Evaluation of vitamin B12 and vitamin D levels in primary school-age children according to different body mass index percentages

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Abstract

Objective: Objective: It is known that serum levels of various vitamins are low in obese children. We aimed to evaluate whether serum vitamin B12 and vitamin D levels in primary school children aged 7-12 years differ according to body mass index (BMI) percentiles and whether vitamin supplementation should be considered in cases of low vitamin levels.

Methods: The study retrospectively included 129 children admitted to our hospital. Sixty percent of the children were girls and 40% were boys. Their mean age was 8.74±4.86 years. Considering their weight percentiles, 29% of the children were above 95th percentile and 34% were in the 50th percentile. Weight and height were measured while the participants were wearing light clothes and without shoes. Body weight was measured using a digital scale, and BMI (kg/m^2) was calculated by dividing weight in kg by the square of height in meters. Demographic and laboratory data (hemoglobin, ferritin, vitamin B12 and vitamin D) were obtained from the laboratory information management system. The results were compared statistically.

Results: The mean vitamin B12 level of children below the 95th percentile was 383.20±162.79 ng/L, and the mean vitamin B12 level of children above the 95th percentile was 328.75±154.59 ng/L (p=0.020). In addition, the mean vitamin D level of children below the 95th percentile was 22.38±10.26 µg/L, and the mean vitamin D level of children above the 95th percentile was 16.00±8.06 µg/L (p=0.001).

Conclusion: According to our study findings, vitamin B12 and vitamin D levels of children above the 95th percentile were lower. Vitamin B12 and vitamin D levels should be measured in obese patients within the scope of preventive health services. Also, necessary vitamin supplementation should be performed upon confirmation of low levels.

Keywords: Children, obesity, vitamin B12, vitamin D.

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INTRODUCTION

Obesity is an important public health issue with an increasing prevalence worldwide and affects approximately 25-30% of children (1). It is characterized by excessive accumulation of lipids and adipose tissue, which cause ectopic fat accumulation in different tissues. Complications including insulin resistance, type 2 diabetes mellitus, hepatosteatosis, atherosclerosis and hypertension may occur in patients with obesity (2). In obesity, mild chronic inflammation occurs with an increase in proinflammatory cytokine levels in serum (3). Studies have shown that vitamin D3 regulates calcium and phosphorus metabolism by acting in tissues such as bone, intestine and kidney (4) and plays different roles in the prevention of many cancers, autoimmune diseases, cardiovascular diseases, and infections (5). If the 25-hydroxyvitamin D3 level is lower than 20 µg/L, vitamin D3 deficiency is diagnosed. In vitamin D3 deficiency, calcium absorption decreases, leading to a decrease in the mineral content of bone and causing rickets to occur in children (5). Since vitamin D3 is stored in adipose tissue and cannot be used systemically in obese patients, the levels of this vitamin are lower compared to patients with normal body mass index (6). Vitamin B12 is a water-soluble vitamin, which is mainly synthesized by microorganisms. Humans cannot synthesize vitamin B12. The most important function of vitamin B12 is its role in DNA synthesis. This is necessary for cell division and proliferation. Dietary deficiency of vitamin B12 is not observed in people who are typically fed animal foods. However, vitamin B12 deficiency is observed if dietary intake is not sufficient (7). In the case of deficiency, vitamin B12-supplemented foods and vitamin B12 supplements can be taken in addition to animal-derived foods (8). The excessive food intake in obese children may lead to the misperception that there is no nutrient deficiency within their families. However, especially during adolescence, when children begin to feed independently from their families, a carbohydrate and fat-dominant diet may lead to deficiencies in terms of micronutrients. Deficiency of vitamin B12, which is an essential vitamin and is found especially in foods of animal origin, is a significant issue in obese individuals (9,10).

We aimed to evaluate whether serum vitamin B12 and vitamin D levels in primary school children aged 7-12 years differ according to BMI percentiles and whether vitamin supplementation should be performed in cases of low vitamin levels.

MATERIALS AND METHODS

The study is a retrospective that included 129 pediatric patients aged 7-12 years. The data were obtained from the laboratory information management system after obtaining the necessary consent from the parents of the children who were admitted to the Private Florya Hospital Pediatrics outpatient clinic between March 2023 and May 2023 following the principles of the Helsinki Declaration of Patient Rights. Weight and height were measured with the participants wearing light clothing and without shoes. Body weight was measured with a digital scale. BMI (kg/m^2) was determined as weight in kg divided by the square of height in meters. Obesity was defined as a body mass index (BMI) above the 95^{th} percentile for age and sex (11). The patients were of Turkish ethnic origin. Patients who had additional chronic disease, used metformin or antacids-like drugs or smoked were excluded from the study.

Serum vitamin B12, 25-hydroxy vitamin D and ferritin levels were measured by the chemiluminescent immunoassay method in an autoanalyzer (Roche, Cobas 8000, California, USA). Hemoglobin levels were measured by Mindray BC 6800 (Mindray Building, China).

Statistical analysis

The IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp.; Armonk, NY, USA) software was utilized for statistical analyses. The compliance with a normal distribution was determined by the Kolmogorov–Smirnov test. The Mann–Whitney-Whitney U test was used to examine the relationship between BMI percentage values and vitamin values of the children. It was further used to examine the relationship between BMI- Standard deviation (BMI-SD) values and vitamin values. The Kruskal–Wallis test was used to examine the relationship between weight percentiles of children and vitamin values. It was further utilized to examine the relationship between the height percentiles and vitamin values of the children. The significance was evaluated at the $p<0.05$ level.

RESULTS

Of the children, 60% were girls and 40% were boys. The mean age of the children was 8.74±4.86 years. Table 1 provides their distribution according to their body mass indexes.

Table 1. BMI distribution of children

	n	Percentage (%)
BMI Percentage		
Below 95 percent	89	69.0
Over 95 percent	40	31.0
Total	129	100.0

Abbreviation: BMI: Body mass index

The mean hemoglobin value was 12.87±1.35, and 95% of the children had values above 11. The mean ferritin value was 33.13±19.9, and 84% of the children had values above 15. The mean vitamin B12 value was 366±164, and 95% of the children had values above 200. The mean vitamin D value was 20.4±10.05, and 52% of the children had values below 20 (Table 2). Table 3 presents the distribution of laboratory values of the study group.

Table 2. Laboratory data of the children

	n	Mean± SD	Min	Max
Hemoglobin (g/dL)	129	12.87±1.35	9	22
Ferritin (ug/L)	129	33.13±19.97	1	103
Vitamin B12 (ng/L)	129	366.32±164.68	100	1112
Vitamin D (ug/L)	129	20.40±10.05	3	52

Hemoglobin values of children do not differ statistically according to BMI percentage values at the 95% confidence level (p=0.802). However, the ferritin values of the children differed significantly at the 95% confidence level according to BMI percentile values (p=0.015). Accordingly, the mean ferritin value of the children with a BMI below 95% was 28.85±13.53, and the mean ferritin value of those with a BMI above 95% was 42.65±27.58.

The vitamin B12 values of the children differed significantly at the 95% confidence level according to BMI percentage values (p=0.020). Accordingly, the mean vitamin B12 value of the children with a BMI below 95% was 383.20±162.79, and the mean vitamin B12 value of those with a BMI above 95% was 328.75±154.59.

The vitamin D values of the children differed significantly at the 95% confidence level according to BMI percentage values (p=0.001). Accordingly, the mean vitamin D value of children with a BMI below 95% was 22.38±10.26, and the mean vitamin D value of those with a BMI above 95% was 16.00±8.06 (Table 4).

Table 3. Distribution of laboratory data of children

	Frequency	Percentage (%)
Hemoglobin		
Below 11	7	5.4
Over 11	122	94.6
Total	129	100.0
Ferritin		
Under 15	21	16.3
Over 15	108	83.7
Total	129	100.0
Vitamin B12		
Under 200	6	4.7
Over 200	123	95.3
Total	129	100.0
Vitamin D		
Under 20	67	51.9
Over 20	62	48.1
Total	129	100.0

Table 4. The relationship between BMI values of children and parameters

Parameters		**n**	**Mean±SD**	**p**
Hemoglobin	Below 95 percent	89	12.93±1.42	0.802
	Over 95	40	12.75±1.16	
Ferritin	Below 95 percent	89	28.85±13.53	**0.015***
	Over 95	40	42.65±27.58	
Vitamin B12	Below 95 percent	89	383.20±162.79	**0.020***
	Over 95	40	328.75±154.59	
Vitamin D	Below 95 percent	89	22.38±10.26	**0.001***
	Over 95	40	16.00±8.06	

Abbreviations: SD: Standard deviation. *p<0.05

DISCUSSION

Childhood obesity and its complications are important in terms of morbidity and mortality. Vitamin B12 is a water-soluble vitamin with important cellular functions. Vitamin B12, also known as cobalamin, plays a crucial role in nucleic acid and protein synthesis, carbohydrate and lipid metabolism, mitochondrial functions, and nerve myelination (12). Vitamin B12, which cannot be synthesized endogenously, is essential for humans, and its source is animal foods (13). Vitamin B12 deficiency can stem from various reasons. Socioeconomic reasons in developing countries and absorption disorders in developed countries account for inadequate dietary intake of vitamin B12 (14). Currently, it is observed quite frequently in children due to changes in lifestyle and dietary habits (14). Vitamin B12 deficiency mostly causes anemia in children, and complete recovery is observed with treatment (15). However, since vitamin B12 has an important role in the development of the nervous system, it is known that its long-term deficiency causes permanent neurological damage (16). Therefore, early detection and early treatment of the deficiency are vital, particularly for children in rapid growth periods, such as infancy and adolescence. In the present study, the mean vitamin B12 levels of children above the 95th percentile were lower than those of the other group. Our results are compatible with the results of many studies in the literature. Gunanti et al. (17) found an inverse relationship between BMI and vitamin B12 levels in obese children. In the study of Pinnas-Hamiel, vitamin B12 levels were measured between normal weight children and adolescents (BMI <95p) and obese (BMI >95p) groups; vitamin B12 levels were low in 10.4% of obese and 2.2% of normal weight children. Among 12 children with vitamin B12 deficiency, eight were obese (4.9%), and four were of normal weight (1.8%) (18). In another study, 4.6% vitamin B12 deficiency was found when vitamin B12 levels were investigated. Vitamin B12 deficiency was found to be higher in obese patients than in the population with normal BMI (19). In addition to vitamin B12, vitamin D levels are known to be low in those with high BMI. Obesity is another important health issue influenced by vitamin D (20). In the present study, the mean vitamin D levels of children above the 95th percentile were lower than those of the other group. In many studies conducted in overweight children, there has been a relationship between obesity and low serum vitamin D levels (21,22). In a study conducted in obese children of different ethnic origins, the rate of those with sufficient vitamin D remained at 17.8% (23). In the same study, this rate was found to be 14.4% in Turkish children. It is not clear that vitamin D deficiency causes obesity or that correcting the deficiency eliminates obesity. Among the reasons for vitamin D deficiency in obese people, it is also considered that increased adipose tissue leads to higher storage of vitamin D. Vitamin D supplementation of 600-1000 IU/day is recommended for children aged 6-18 years who are at risk of vitamin D deficiency, including those who are overweight (24). In obesity that develops as a result of uniform nutrition, low vitamin levels may be observed, similar to our study. Obese pediatric patients should definitely undergo routine health checks, and primary health care institutions in Turkey should act sensitively in terms of nutrition education and psychological counseling. This issue should remain a priority on our national agenda. The development of health policies for the prevention of obesity should continue with determination.

Limitations:

First, the sample size could have been larger. Second, our study had a retrospective design. In addition, we were unable to provide regular access to other routine biochemical parameters from patient files. Nevertheless, our study data are valuable for providing vitamin support to obese children as part of preventive health services.

CONCLUSION

According to our study findings, vitamin B12 and vitamin D levels of children above the 95th percentile were found to be lower. Vitamin B12 and vitamin D levels should be measured in obese patients within the scope of preventive health services, and necessary vitamin supplementation should be performed upon confirmation of low levels.

Conflict of interest: The authors declare that there is no conflict of interest.
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Peer-review: Externally peer-reviewed.
Ethical approval: The study was conducted in accordance with the conditions recommended by the Helsinki Declaration. Informed consent was obtained from all subjects involved in the study and their parents.
Authorship contributions: Concept, Design, Supervision, Funding, Materials, Data collection &/or processing, Analysis and/or interpretation, Literature search, Writing and Critical review: M.D.

References

1. Aragón-Vela J, Alcalá-Bejarano Carrillo J, Moreno-Racero A, Plaza-Diaz J. The role of molecular and hormonal factors in obesity and the effects of physical activity in children. Int J Mol Sci. 2022;23:15413.
2. Calcaterra V, Vandoni M, Marin L, Carnevale Pellino V, Rossi V, Gatti A, et al. Exergames to limit weight gain and to fight sedentarism in children and adolescents with obesity. Children. 2023;10:928.
3. Martinez-Martinez E, Cachofeiro V, Rousseau E, Alvarez V, Calvier L, Fernandez- Celis A, et al. Interleukin-33/ST2 system attenuates aldosterone-induced adipogenesis and inflammation. Mol Cell Endocrinol. 2015;411:20-7.
4. Bikle DD. Vitamin D metabolism, mechanism of action, and clinical applications. Chem Biol. 2014;21:319-29.
5. Castano L, Madariaga L, Grau G, García-Castaño A. 25(OH)Vitamin D deficiency and calcifediol treatment in pediatrics. Nutrients. 2022;14:1854.
6. Savastano S, Barrea L, Savanelli MC, Nappi F, Di Somma C, Orio F, et al. Low vitamin D status and obesity: Role of nutritionist. Rev Endocr Metab Disord. 2017;18:215-25.
7. Monsen AL, Refsum H, Markestad T, Ueland PM. Cobalamin status and its biochemical markers methylmalonic acid and homocysteine in different age groups from 4 days to 19 years. Clin Chem. 2003;49:2067-75.
8. Allen LH. How common is vitamin B-12 deficiency? Am J Clin Nutr. 2009;89:693-6.
9. Pinhas O, Doran N, Reichman B. Obese children and adolescents: A risk group for vitamin B12 concentration. Arch Pediatr Adolesc Med. 2006;160:933-6.
10. Narin F, Atabek ME, Karakukcu M, Narin N, Kurtoglu S, Gumus H, et al. The association of plasma homocysteine levels with serum leptin and apolipoprotein B levels in childhood obesity Ann Saudi Med. 2005;25:209-14.
11. Neyzi O, Bundak R, Gökçay G, Günöz H, Furman A, Darendeliler F, et al. reference values for weight, height, head circumference, and body mass index in Turkish children. J Clin Res Pediatr Endocrinol. 2015;7:280-93.
12. Halczuk K, Kaźmierczak-Barańska J, Karwowski BT, Karmańska A, Cieślak M. Vitamin B12 Multifaceted In Vivo Functions and In Vitro Applications. Nutrients. 2023;15:2734.
13. Green R. Vitamin B12 deficiency from the perspective of a practicing hematologist. Blood. 2017;129:2603-11.
14. Green R, Allen LH, Bjørke-Monsen AL, Brito A, Guéant JL, Miller JW, et al. Vitamin B12 deficiency. Nat Rev Dis Prim. 2017;3:1-20.
15. Stabler SP. Clinical practice. Vitamin B12 deficiency. N Engl J Med. 2013;368:149-60.
16. Demir N, Koc A, Üstyol L, Peker E, Abuhandan M. Clinical and neurological findings of severe vitamin B12 deficiency in infancy and importance of early diagnosis and treatment. J Paediatr Child Health. 2013;49:820-4.
17. Gunanti IR, Marks GC, Al-Mamun A, Long KZ. Low serum vitamin B-12 and folate concentrations and low thiamin and riboflavin intakes are inversely associated with greater adiposity in Mexican American children. J Nutrition. 2014;144:2027-33.
18. Pinhas-Hamiel O, Doron-Panush N, Reichman B, Nitzan-Kaluski D, Shalitin S, Geva- Lerner L. Obese children and adolescents a risk group for low vitamin B12 concentration. Arch Pediatr Adolesc Med. 2006;160:933-6.
19. MacFarlane AJ, Greene-Finestone LS, Shi Y. Vitamin B-12 and homocysteine status in a folate-replete population: results from the Canadian Health Measures Survey. Am J Clin Nutr. 2011;94:1079–87.
20. Fu Y, Zhu Z, Huang Z, He R, Zhang Y, Li Y, et al. Association between Vitamin B and Obesity in Middle-Aged and Older Chinese Adults. Nutrients. 2023;15:483.
21. Buyukinan M, Ozen S, Kokkun S, Saz EU. The relation of vitamin D deficiency with puberty and insulin resistance in obese children and adolescents. J Pediatr Endocrinol Metab. 2012;25:83-7.
22. Al-Musharaf S, Al-Othman A, Al-Daghri NM, Krishnaswamy S, Yusuf DS, Alkharfy KM, et al. Vitamin D deficiency and calcium intake in reference to increased body mass index in children and adolescents. Eur J Pediatr. 2012;171:1081-6.
23. Radhakishun N, van Vliet M, von Rosenstiel I, Weijer O, Diamant M, Beijnen J, et al. High prevalence of vitamin D insufficiency/deficiency in Dutch multi ethnic obese children. Eur J Pediatr. 2015;174:183-90.
24. Saggese G, Vierucci F, Boot AM, Czech-Kowalska J, Weber G, Camargo CA Jr, et al. Vitamin D in childhood and adolescence: an expert position statement. Eur J Pediatr. 2015;174:565-76.