



Research Article/Özgün Araştırma

Assessment of micronutrients in pediatric vertigo

Pediyatrik baş dönmesinde mikronutrisyon değerlerinin değerlendirilmesi

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Abstract

Aim: This study aimed to evaluate the clinical characteristics of patients admitted to the pediatric neurology outpatient clinic with the complaint of vertigo and to investigate the role of micronutrients in the etiology of vertigo

Materials and Methods: This study retrospectively evaluated the patients aged four to 18 years who were admitted to the pediatric neurology outpatient clinic with the complaint of vertigo to evaluate the clinical characteristics and the role of micronutrients in the etiology of vertigo. Patients, for whom the Z00.1 code, the routine child health examination code, was entered in the pediatric outpatient clinic in the same period when the patients presented with the complaint of vertigo were included as the healthy control group. Hemogram and hormone profiles [25(OH)D, FT4, TSH, vitamin B12, folic acid and ferritin] of the groups were compared.

Results: There was no statistically significant difference between the study group and healthy controls in terms of age and gender. Hematocrit ($p<0.001$), platelet ($p<0.001$), vitamin B12 ($p=0.015$), vitamin D ($p=0.043$) and TSH ($p=0.013$) levels were found to be significantly lower in the vertigo group compared to the control group.

Conclusion: The importance of micronutritional deficiencies cannot be denied in patients presenting with vertigo symptoms. Main point that makes our study valuable is that there are limited number of studies in the literature comparing laboratory parameters of pediatric patients with vertigo symptoms and healthy controls. There is a need for prospective studies, involving more cases and awareness on this issue.

Keywords: Children; Deficiency; Micronutrient; Vertigo; Vitamin.

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Introduction

Vertigo is the perception of rotational movement of the self or surrounding objects. Complaints such as dizziness, feeling sick, drunkenness, or feeling that the ground is slipping under feet can be defined as non-vertiginous dizziness.¹ There is limited information on pediatric vertigo in the literature. Its prevalence ranges from 8% to 15%.² The approach to vertigo in children is challenging due to the difficulty of obtaining a clear and reliable history. Pediatric vertigo was first described by Harrison in 1962.³ Diagnosis and necessary treatment management is clearly established after a detailed history is obtained and clinical examination and neurological evaluation are performed.⁴ There are many factors causing dizziness in children, such as trauma, infection, migraine, central nervous system disorders, benign paroxysmal vertigo (BPV), vestibular neuritis caused by viral infections, and psychosomatic disorders.⁵

Relevant studies in the literature have generally been conducted among adults.³ The number of studies on vertigo in the pediatric age group is limited. There are controversial data in the literature regarding the diagnostic criteria and management of vertigo in this age group.⁶ Micronutrients (vitamins and minerals) are essential components of the diet and required for normal cellular and molecular functions.⁷ Micronutrient deficiencies may occur in the presence of vitamin B12, folic acid, vitamin A, vitamin D, thiamine, zinc, selenium, and iron deficiencies. Micronutrient deficiencies are the underlying cause of diseases that affect the quality of life, as well as morbidity and mortality of populations, and threaten health globally.⁸

This study aimed to evaluate the clinical characteristics of patients admitted to the pediatric neurology outpatient clinic with the complaint of vertigo and to investigate the role of micronutrients in the etiology of vertigo.

Materials and Methods

This study evaluated the patients aged four to 18 years who were admitted to the pediatric neurology outpatient clinic of Adiyaman University Hospital with the complaint of

vertigo to evaluate the clinical characteristics and the role of micronutrients in the etiology of vertigo.

The attack frequency, duration of attacks and accompanying complaints (tinnitus, hearing loss, gait disturbance, migraine and attack history) were questioned in patients who presented with the complaint of vertigo. Hemogram, biochemical parameters (glucose, liver function tests, kidney function tests, and electrolytes), and hormone profile (25-hydroxy vitamin D [25(OH)D], vitamin B12, folic acid, ferritin, free T4, and thyroid-stimulating hormone [TSH]), and if requested, electroencephalography (EEG) and brain imaging findings were recorded from the patient files. Patients with missing data were excluded from the study. Participants were divided into three groups: preschool age (up to 6 years old), primary school age (7–12 years old) and adolescents (13–18 years old). Blood pressure was measured in all patients during the initial examination performed at the time of admission. When the file was scanned, the existing consultations [ear nose throat (ENT), pediatric cardiology and ophthalmology outpatient clinic] were evaluated.

Patients, for whom the Z00.1 code, the routine child health examination code, was entered in the pediatric outpatient clinic in the same period when the patients presented with the complaint of vertigo (Group 1), were included as the healthy control group (Group 2).

Hemogram and hormone profiles [25(OH)D, FT4, TSH, vitamin B12, folic acid and ferritin] of the groups were compared.

Serum vitamin B12 levels below 300 pg/mL were accepted as vitamin B12 deficiency.^{9,10} Hemoglobin and serum ferritin levels were utilized for the diagnosis of iron deficiency anemia. World Health Organization defined hemoglobin threshold values to classify anaemia according to the age of the child.¹¹ Serum 25(OH)D measurement reflects the vitamin D stores in the body. Vitamin D level should be 30–50 ng/mL to maximize calcium absorption and maintain normal ranges of parathyroid hormone (PTH). Accordingly,

values below 25(OH)D 30 ng/mL were considered as vitamin D deficiency.¹²

Type of the study

The study was planned as a descriptive retrospective study

The sample size of the study

The records of 94 patients were examined between 01.08.2017 and 01.08.2019.

Data collection tools

The patients aged four to 18 years who were admitted to the pediatric neurology outpatient clinic of Adiyaman University Hospital with the complaint of vertigo to evaluate the clinical characteristics and the role of micronutrients in the etiology of vertigo.

Data analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) Version 23.0 software and descriptive and comparative analyzes were performed. Independent Samples t-test was used for

normally distributed parameters and Mann-Whitney U test was used for the non-normally distributed parameters. Chi-square test was used to evaluate categorical variables. A *p* value of <0.05 was considered statistically significant.

Ethics committee approval

This study was approved by the local ethics committee (Approval no.: 2021/02-30). The principles of the Declaration of Helsinki conducted the research.

Results

The study included a total of 94 patients presenting with the complaint of vertigo. Of the cases, 62 (66%) were female and 32 (34%) were male. The mean age of the patients was 12.09 ± 3.90 (3–17) years. Nine (9.6%) cases were in the 4–6 age group, 34 (36.2%) in the 7–12 age group, and 51 (54.3%) in the 13–18 age group. A total of 118 cases, 65 (55.1%) female and 53 (44.9%) male were included in the control group. The mean age of the control group was 11.64 ± 3.40 (4–17) years (Table 1).

Table 1. Clinical characteristics of patients with vertigo complaints

Average age at time of application (years)	12.09±3.90 (3-17) years	
	n	(%)
Total number of patients	94	100
Male	62	66
Female	32	34
Age range (year)		
4-6	9	9.6
7-12	34	36.2
13-18	51	54.3
Vertigo Duration		
Instant/A few seconds	74	78.7
Less than a minute	10	11
A few minute	4	4.2
5-15 minutes	3	3.1
15-30 minutes	1	1
30-60 minutes	1	1
> 60 minutes	1	1
Vertigo Frequency		
Daily/Rare	77	82
A large number of daily	7	7.4
Several times a week	3	3.1
Once a week	3	3.1
Several times a month	4	4.4
Time period of vertigo		
0-1 month	39	41.5
2-6 months	31	33
7-12 months	7	7.4
13-24 months	9	9.6
>24 months	8	8.5

While an episode lasted a few seconds in majority of cases (n=74, 78.7%), it was observed to last 15–30 minutes in one (1%) case, 30–60 minutes in one (1%) case and >60 minutes in one (1%) case. The vertigo frequency was once a day in most of the cases (n=74, 82%) whereas it occurred once or several times a week in only three patients (3.1%). The duration of vertigo symptoms was found to last zero to one month in 39 cases (41.5%), two to six months in 31 (33%), and seven to 12 months in seven (7.4%). Symptoms accompanying vertigo were headache in 54 cases (57.4%), blackout/presyncope/syncope in 51 (54.3%), tinnitus in 10 (10.6%), nausea and vomiting in 21 (22.3%), photophobia or phonophobia in 12 (12.8%) (Table 1). A total of 51 cases underwent EEG and slowing of the background rhythm for age was observed only in one case.

In the etiology of vertigo, upper respiratory tract infection (URTI) was observed in five (5.3%) cases, psychogenic vertigo in five (5.3%), migraine in eight (8.4%) cases, BPV in 13 (14%), gastrointestinal bleeding in one (1%), cerebral pathologies in three (3.2%), and orthostatic hypotension in 12 (12.8%). The remaining 47 patients had iron deficiency anemia, vitamin D deficiency and vitamin B12 deficiency [iron deficiency anemia in 3 (3.2%), vitamin B12 deficiency in 4 (4.3%), vitamin D deficiency 11 (11.7%), vitamin D deficiency and iron-deficiency anemia in 11 (11.7%), and vitamin D and vitamin B12 deficiency in 14 (14.8%), vitamin B12 deficiency and iron-deficiency anemia in 4 (4.3%)]. The frequency and number of vertigo attacks of varying degrees regressed/decreased during pediatric neurology follow-up of these cases following the administration of vitamin B12, vitamin D and iron therapy (Table 2).

Table 2. Etiological profile of vertigo in children

Etiology	n	(%)	4-6 years	7-12 years	13-18 years
			n (%)	n (%)	n (%)
Orthostatic hypotension	12	12.8	0	7 (7.47)	5 (5.33)
Sinusitis/mastoiditis/labyrinthitis/otitis media	5	5.3	1 (1.06)	3 (3.18)	1 (1.06)
Benign paroxysmal vertigo	13	14	1 (1.08)	6 (6.46)	6 (6.46)
Migraine	8	8.4	0	3 (3.15)	5 (5.25)
Psychogenic Vertigo	5	5.3	0	2 (2.12)	3 (3.18)
Cerebral pathology (Intracranial mass, Central nervous system infections)	3	3.2	0	2 (2.13)	1 (1.07)
Gastrointestinal bleeding	1	1	0	1 (1)	0
Iron deficiency anemia	3	3.2	1 (1.07)	1 (1.07)	1 (1.07)
Vitamin D deficiency	11	11.7	3 (3.2)	4 (4.3)	3 (3.2)
Vitamin B12 deficiency	4	4.3	1 (1.1)	2 (2.1)	1 (1.1)
Vitamin D deficiency + iron deficiency anemia	11	11.7	3 (3.2)	3 (3.2)	4 (4.3)
Vitamin D deficiency + Vitamin B12 deficiency	14	14.8	4 (4.23)	4 (4.23)	6 (6.34)
Vitamin B12 deficiency + iron deficiency anemia	4	4.3	1 (1.1)	1 (1.1)	2 (2.1)

There was no statistically significant difference between the study group and healthy controls in terms of age and gender. Hematocrit ($p<0.001$), platelet ($p<0.001$), vitamin B12 ($p=0.015$), vitamin D ($p=0.043$) and TSH ($p=0.013$) levels were found to be significantly lower in the vertigo group compared to the control group (Table 3).

Discussion

Due to the small number of studies both in clinical practice and literature, this study aimed to highlight the clinical characteristics of patients presenting with vertigo and the

micronutrient deficiencies that take part in the etiology of pediatric vertigo.

Vitamin D is a hormone with an important function in maintaining calcium-phosphorus balance and bone health. The prevalence of vitamin D deficiency among the general population is reported to be 25–50%.¹³ It is particularly common in children and associated with many diseases. Symptoms such as rickets, fatigue, muscle pain, numbness in the extremities, and convulsions may be observed in the presence of vitamin D deficiency.¹⁴ In a study by Zhang et al. involving 268 cases, dizziness was reported in

29 cases with vitamin D deficiency and regression was observed in the complaints of 28 patients with vitamin D treatment.¹⁴ Symptoms of nutritional vitamin B12 deficiency include weakness, fatigue, dizziness, pale skin, pain, weight loss, diarrhea, constipation, and muscle weakness, as well as paresthesia in the extremities, gait ataxia, dizziness, loss of sensation, personality change, convulsion, orthostatic tachycardia and developmental retardation.¹⁵ Serin et al. detected dizziness in four of 38 patients with vitamin B12 deficiency.¹⁶ Similarly, Arican et al. reported dizziness in 9% of patients with various neurological symptoms associated with vitamin B12 deficiency.¹⁷ The authors

further reported borderline vitamin B12 deficiency in the majority of patients with dizziness and stated that clinicians should be aware of this issue.¹⁷ Iron deficiency anemia is a common health problem in the world. It is estimated that 30-50% of the world's population has iron-deficiency anemia.¹⁸ Nonspecific symptoms, including headache, paleness, palpitation, tinnitus, vertigo, tachycardia, syncope, and heart failure, may accompany iron deficiency anemia.¹⁹ In a study by Erdogan et al. involving 30 cases with vertigo, iron deficiency anemia was reported in two cases and vitamin B12 deficiency in two cases.²⁰

Table 3. Comparison of laboratory parameters of cases with vertigo symptoms and healthy controls

	Group 1 (Vertigo Group) n:94	Group 2 (Control Group) n:118	p
	Mean±SD (Min.-Max.)	Mean ±SD (Min.-Max.)	
Age (years)	12.09±3.90 (3-17)	11.64±3.40 (4-17)	0.2
WBC (/mm ³)	7.64±1.90 (4.07-13.55)	7.65±2.04 (4.33-13.39)	0.463
Hemoglobin (gr/dl)	13.35±1.72 (3.97-16.64)	13.52±1.28 (9.41-16.33)	0.267
Hct (%)	40.29±5.21 (11.11-57.10)	41.06±4.14 (29.76-48.85)	< 0.001
MCV (fL)	81.52±6.18 (58.97-93.05)	73.36±5.32 (55.11-96.97)	0.128
Platelet (10 ³ /μL)	262.30±66 (29.11-501.20)	310.46±139.35 (117.9-865)	< 0.001
Vitamin B12 (pg/ml)	198.61±83.83 (75-575)	235.99±103.12 (63-619)	0.015
Ferritin (ng/ml)	23.67±18.68 (1.80-113.7)	29.58±14.36 (3.5-81.7)	0.316
Folate (ng/ml)	9.09±3.52 (4.31-21.86)	8.72±4.56 (2.06-35.50)	0.316
Vitamin D (ng/ml)	18.03±8.20 (4.6-48.67)	23.05±17.76 (4.61-171)	0.043
FT4 (ng/dL)	0.94±0.47 (0.61-5.02)	0.88±0.18 (0.51-1.54)	0.264
TSH (mIU/L)	2.31±1.08 (0.54-5.49)	2.62±1.42 (0.16-7.74)	0.013

MCV: mean corpuscular volume; WBC: white blood cell

Yildirim et al. reported that only one of 132 patients with the complaint of dizziness had iron deficiency anemia.²¹ In a series of 183 cases, Korkmaz et al. found vitamin B12 deficiency in nine cases and iron deficiency anemia in three cases.²² The incidence of iron-deficiency anemia, vitamin B12 and vitamin D deficiency in the present study was found to be higher than in the literature. In the pediatric neurology outpatient clinic controls performed every three months after the administration of vitamin B12, vitamin D and iron treatment, the frequency and number of vertigo attacks were observed to decrease/regress in all patients.

The literature review has shown that there is a limited number of studies comparing the hemogram, vitamin B12 and folic acid levels of adult patients, who were admitted to the hospital with the complaint of vertigo, with those of healthy controls. In a study, vitamin

B12 and folic acid levels of patients admitted to the adult emergency department with the complaint of dizziness were compared with those of healthy controls and as a result of the study, vitamin B12 levels were found to be statistically significant ($p=0.000$) whereas there was no significance in terms of folic acid levels ($p=0.83$).²³ In another study comparing 160 adult patients suffering from vertigo and 120 healthy individuals, vitamin B12 level ($p<0.001$), hemoglobin ($p<0.01$), ferritin ($p=0.004$) and mean MCV values ($p=0.001$) were found to be statistically significant in the vertigo group while there was no significant difference in terms of folic acid levels.²⁴

Pediatric vertigo is a rare condition with an estimated incidence of <1%.²⁵ In a study, the prevalence of vertigo was reported to be higher in the 12–17 age group.²⁶ In the present study, the age group with the highest number of cases

with vertigo was the 13- to 17-year-old age group.

The differential diagnosis of pediatric vertigo is different from that seen in adults as many etiologies are specific to pediatric age and pathologies are quite different in children and adults.⁴ Compared to adults, response to the vertigo treatment is better and recovery is faster among children. Pediatricians, clinicians, otolaryngologists and neurologists often have difficulty in establishing the appropriate diagnosis in these cases. The inability of affected children to explain the characteristics of their symptoms may prevent diagnosis, particularly in very young children.²⁷

Vertigo is observed to be more common in female gender.²⁸ The female to male ratio was reported to be 1.57 by Swain et al., 1.17 by Batu et al., 1.94 by Erbek et al., and 1.81 by Korkmaz and Ekici.^{6,22,28,29} Compatible with the literature, female to male ratio was 1.93 in the present study.

Headache and nausea are the most common symptoms accompanying vertigo. In the literature, headache is reported in 35–60% of children presenting with vertigo.³⁰ In the study by Bhandari and Goswami, symptoms accompanying vertigo were reported to be headache (66.6%), nausea (42.2%), hearing loss (31.1%), tinnitus (13.3%) and loss of consciousness (10%).³¹ Swain et al. reported the accompanying symptoms as follows: nausea and vomiting (78.70%), headache (37.96%), hearing loss (13.88%), tinnitus (6.48%), aural fullness (6.48%), visual impairment (2.77%), altered state of consciousness (1.85%) and diaphoresis (3.70%).⁶ Erbek et al. stated that headache (66%), nausea-vomiting (26%), hearing loss-tinnitus (22%), visual impairment (20%), loss of consciousness (10%) and diaphoresis (4%) were the symptoms accompanying vertigo in their study.²⁸ Korkmaz and Ekici reported that headache (41%), syncope (27%) and nausea-vomiting (10%) were the most common findings accompanying vertigo.²² In the present study, the most common symptoms accompanying vertigo were headache (57.4%), blackout (41.5%) and nausea-vomiting

(22.3%). Bhandari and Goswami reported that vertigo symptoms lasted most commonly for zero to one month, two to six months and 13–24 months, respectively.³¹ Compatible with the literature, the duration of symptoms was observed to last for zero to one month most frequently (n=39, 41.5%), followed by two to six months (n=31, 33%) and seven to 12 months (n=7, 7.4%) in the present study. Swain et al. reported that the duration of vertigo lasted minutes in the majority of the cases (41.66%), whereas the attack lasted seconds (26.85%) and more than a day (6.48%) in others.⁶ In a study by Batu et al., the duration of vertigo was reported to last less than one minute in 36% of the cases and one to five minutes in 34% while Erbek et al. reported the duration of vertigo as seconds in 52%, minutes in 28%, hours in 14% and >24 hours in 6% of the cases.^{28,29} In the present study, the duration of vertigo was observed to last seconds in 78.7% of the cases.

The medical history of a patient with vertigo is the most important part of the evaluation. Parents should carefully observe these episodes as young children are unable to describe the symptoms. History and a detailed physical examination, including otological and neurological examination, may be utilized to establish diagnosis in most pediatric patients.³² Benign paroxysmal vertigo and migraine-associated vertigo are the most common causes of dizziness in childhood.³³ Migraine-associated vertigo is much more common in pediatric patients compared to the adult population. The prevalence of migraine-associated vertigo is reported to be 35% among pediatric patients with vertigo whereas only 6% of adults suffering from vertigo are diagnosed with migraine.³⁴ Orthostatic hypotension may cause vertigo in 3–9% of symptomatic children.³⁵ In the pediatric age group, BPV is a common cause of vertigo, with a prevalence of 2.6%.³⁶ In the study by Gruber et al., the most common etiology of vertigo was reported to be migraine (32%), acute labyrinthitis/neuritis (22%) and psychogenic dizziness (22%).⁴ Batu et al. reported the most common etiological causes as BPV (39%), psychogenic vertigo (21%), epileptic vertigo (15%) and migraine-associated vertigo

(11%).²⁹ In a study by Swain et al., the authors observed the most common etiologies of pediatric vertigo as vestibular migraine, BPV, and vestibular neuritis.⁶ In a study by Davitt et al. involving 2,726 cases, the most common etiology of vertigo among children aged two months to 19 years was vestibular migraine (23.8%) followed by BPV (13.7%), idiopathic/unspecified causes (11.7%), and labyrinthitis/vestibular neuritis (8.47%).³⁷ Korkmaz and Ekici reported that the most common causes that may accompany vertigo were BPV (23%), orthostatic hypotension (22%), migraine-associated vertigo (8%), psychogenic vertigo (7%) and vitamin B12 deficiency (5%), respectively.²² Karatoprak et al reported the most common diagnoses were migraine associated vertigo (21.7%) and orthostatic hypotension (20%) in children with dizziness.³⁸ In the present study, the most common reason accompanying vertigo symptoms was found to be nutritional reasons. Among other etiologies, BPV was the most common one, followed by orthostatic hypotension and migraine.

The literature review has shown that studies on vitamin B12, vitamin D and anemia in the etiology of pediatric/adult vertigo are limited. Unlike other studies, the rate of micronutrient deficiencies was high in the etiology of vertigo (iron-deficiency anemia, vitamin B12 and vitamin D deficiency) in the present study.

Limitations of the study

The limitations of our study were that it was conducted in a single center, the number of patients was limited, and retrospective study.

Conclusion

The importance of micronutritional deficiencies cannot be denied in patients presenting with vertigo symptoms. Main point that makes our study valuable is that there are limited number of studies in the literature comparing laboratory parameters of pediatric patients with vertigo symptoms and healthy controls. There is a need for prospective studies, involving more cases and awareness on this issue.

Ethics Committee Approval

Ethics committee approval was obtained with the decision of the Ethics Committee for Non-Interventional Procedures of Adiyaman University, numbered no.:2021/02-30. The principles of the Declaration of Helsinki conducted the research.

Informed Consent

The ethical committee consented to the study being conducted without patients' consent because of its retrospective nature.

Authors' Contributions

All authors gave approval to the final version of the manuscript to be submitted and all authors are in agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final version of the manuscript

Conflict Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and /or publication of this article.

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References

1. Joseph M, Furman L CM. Vertigo. In: Swainman KF, Ashwal S, Ferriero DM SN, ed. Swaiman's Pediatric Neurology Elsevier Saunders 2012:118-126.
2. Niemensivu R, Pyykkö I, Wiener-Vacher SR, Kentala E. Vertigo and balance problems in children - An epidemiologic study in Finland. *Int. J. Pediatr. Otorhinolaryngol.* 2006; 70(2):259-265 <https://doi.org/10.1016/j.ijporl.2005.06.015>
3. Harrison MS. Vertigo in childhood. *J. Laryngol. Otol.* 1962;76(8): 601-616 <https://doi.org/10.1017/s0022215100059776>
4. Gruber M, Cohen-Kerem R, Kaminer M, Shupak A. Vertigo in children and adolescents: Characteristics and outcome. *Scientific World Journal* 2012;1-6 <https://doi.org/10.1100/2012/109624>
5. Walls T, Teach SJ. Evaluation of dizziness and vertigo in children and adolescents. Uptodate. Published online 2020:1-29.
6. Swain S, Munjal S, Shajahan N. Vertigo in children: Our experiences at a tertiary care teaching hospital of eastern India. *J. Sci. Soc.* 2020;47(2): 74 https://doi.org/10.4103/jss.JSS_20_20
7. Bailey RL, West KP, Black RE. The epidemiology of global micronutrient deficiencies. *Ann. Nut. Metab.* 2015;66:22-33 <https://doi.org/10.1159/000371618>.

8. Tulchinsky TH. Micronutrient Deficiency Conditions: Global Health Issues. *Public Health Rev.* 2010;32:243-255 <https://doi.org/10.1186/s40985-017-0071-6>
9. Mahajan S, Aundhakar S. A study of the prevalence of serum vitamin B12 and folic acid deficiency in Western Maharashtra. *J. Fam. Med. Prim Care* 2015;4(1):64 <https://doi.org/10.4103/2249-4863.152255>.
10. Langan RC, Zawistoski KJ. Update on vitamin B12 deficiency. *Am Fam Physician* 2011;83(12):1425-30.
11. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. 2011.
12. Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. Evaluation, treatment, and prevention of vitamin D deficiency: An endocrine society clinical practice guideline. *J. Clin. Endocrinol. Metab.* 2011;96(7):1911-1930 <https://doi.org/10.1210/jc.2011-0385>.
13. Kennel KA, Drake MT, Hurley DL. Vitamin D deficiency in adults: When to test and how to treat. *Mayo Clin. Proc.* 2010;85(8):752-758 <https://doi.org/10.4065/mcp.2010.0138>.
14. Zhang X, Liu Z, Xia L, Gao J, Xu F, Chen H, et al. Clinical features of vitamin D deficiency in children: A retrospective analysis. *J Steroid Biochem. Mol. Biol.* 2020;196 <https://doi.org/10.1016/j.jsbmb.2019.105491>.
15. Georgieff MK, Ramel SE, Cusick SE. Nutritional influences on brain development. *Acta Paediatr Int. J. Paediatr* 2018;107(8):1310-1321 <https://doi.org/10.1111/apa.14287>.
16. Serin HM, Arslan EA. Neurological symptoms of vitamin b12 deficiency: Analysis of pediatric patients. *Acta Clin. Croat.* 2019;58(2):295-302 <https://doi.org/10.20471/acc.2019.58.02.13>.
17. Arıcan P, Bozkurt O, Cavusoglu D, Gencpınar P, Haspolat S, Duman O, et al. Various neurological symptoms with vitamin b12 deficiency and posttreatment evaluation. *J. Paediatr. Neurosci.* 2020;15(4):365-369 https://doi.org/10.4103/jpn.JPN_130_19.
18. Lee JH. Iron-deficiency anemia in children: From diagnosis to treatment. *J. Korean Med. Assoc.* 2016;59(9):678-682 <https://doi.org/10.5124/jkma.2016.59.9.678>.
19. Mattiello V, Schmutz M, Hengartner H, von der Weid N, Renella R. Diagnosis and management of iron deficiency in children with or without anemia: consensus recommendations of the SPOG Pediatric Hematology Working Group. *Eur J Pediatr* 2020;179(4):527-545 <https://doi.org/10.1007/s00431-020-03597-5>.
20. Erdoğan E, Güzel Nur B, Olgac Dundar N. Vertigo in childhood: Evaluation of clinical and laboratory findings. *Turkiye Klin. J. Med. Sci.* 2012;32(6):1601-1606 <https://doi.org/10.5336/medsci.2011-27059>
21. Yıldırım M, Doğan MT, Keçeli AM. Retrospective evaluation of patients consulted to the pediatric neurology department with dizziness/vertigo. *Ege Journal of Medicine* 2020;59(2):119-126 <https://doi.org/10.19161/etd.756284>
22. Korkmaz MF, Ekici A. Retrospective review of children with vertigo: a 3-year experience. *Eur. Res. J.* 2020;6(5):449-456. <https://doi.org/10.18621/eurj.630613>
23. Gülaçtı U, Lok U, Hatipoğlu S, et al. Assessment of vitamin B12 and folic acid deficiency in emergency department as a cause of acute presentation of dizziness. *Acta Medica Mediterranea* 2014;30:771.
24. Dugeroglu H, Kaya Y. Evaluation of Vitamin B12 Deficiency in Patients with Dizziness Complaints. *Firat University Health Science Medicine Journal* 2018;32(3):123-127.
25. Fried MP. The evaluation of dizziness in children. *Laryngoscope* 1980;90(9):1548-1560.
26. Li CM, Hoffman HJ, Ward BK, et al. Epidemiology of Dizziness and Balance Problems in Children in the United States: A Population-Based Study. *J Pediatr.* 2016;171:240-7.e1-3. <https://doi.org/10.1016/j.jpeds.2015.12.002>
27. Devaraja K. Vertigo in children; a narrative review of the various causes and their management. *Int. J. Pediatr. Otorhinolaryngol.* 2018;111:32-38 <https://doi.org/10.1016/j.ijporl.2018.05.028>
28. Erbek SH, Erbek SS, Yılmaz I, Topal O, Özgirgin N, Özlüoğlu LN, et al. Vertigo in childhood: A clinical experience. *Int. J. Pediatr. Otorhinolaryngol.* 2006;70(9):1547-1554 <https://doi.org/10.1016/j.ijporl.2006.04.001>
29. Batu ED, Anlar B, Topçu M, Turanlı G, Aysun S. Vertigo in childhood: A retrospective series of 100 children. *Eur. J. Paediatr. Neurol.* 2015;19(2):226-232 <https://doi.org/10.1016/j.ejpn.2014.12.009>
30. Humphriss RL, Hall AJ. Dizziness in 10 year old children: An epidemiological study. *Int. J. Pediatr. Otorhinolaryngol.* 2011;75(3):395-400. <https://doi.org/10.1016/j.ijporl.2010.12.015>
31. Bhandari A, Goswami A. Differential Diagnosis of Vertigo in Children. *Ann. Otol. Neurotol.* 2019;02(01):21-26.
32. Ralli G, Atturo F, de Filippis C. Idiopathic benign paroxysmal vertigo in children, a migraine precursor. *Int. J. Pediatr. Otorhinolaryngol.* 2009;73 Suppl 1:S16-S18. [https://doi.org/10.1016/S0165-5876\(09\)70004-7](https://doi.org/10.1016/S0165-5876(09)70004-7)
33. Balatsouras DG, Kaberos A, Assimakopoulos D, Katotomichelakis M, Economou NC, Korres SG. Etiology of vertigo in children. *Int. J. Pediatr. Otorhinolaryngol* 2007;71(3):487-494 <https://doi.org/10.1016/j.ijporl.2006.11.024>
34. Furman JM, Marcus DA, Balaban CD. Migrainous vertigo: Development of a pathogenetic model and structured diagnostic interview. *Curr. Opin. Neurol.* 2003;16(1):5-13 <https://doi.org/10.1097/01.wco.0000053582.70044.e2>
35. Gioacchini FM, Alicandri-Ciuffelli M, Kaleci S, Magliulo G, Re M. Prevalence and diagnosis of vestibular disorders in children: A review. *Int. J. Pediatr. Otorhinolaryngol.* 2014;78(5):718-724 <https://doi.org/10.1016/j.ijporl.2014.02.009>
36. Abu-Arafeh I, Russell G. Paroxysmal vertigo as a migraine equivalent in children: A population-based study. *Cephalalgia* 1995;15(1):22-25 <https://doi.org/10.1046/j.1468-2982.1995.1501022.x>
37. Davitt M, Delvecchio MT, Aronoff SC. The Differential Diagnosis of Vertigo in Children A Systematic Review of 2726 Cases. *Pediatr. Emerg. Care* 2017;36(8):368-371 <https://doi.org/10.1097/PEC.0000000000001281>
38. Karatoprak E, Sözen G, Yılmaz K. How often do neurological disorders lead to dizziness in childhood? *Turk Arch Pediatr* 2021;56(3): 249-53.