

# Childhood vertigo: A retrospective series of 791 cases

<sup>1,2</sup>Zülal Özdemir Uslu, <sup>3,4</sup>Didem Ardıçlı, <sup>3,4</sup>Deniz Yılmaz

<sup>1</sup>Ankara Keçiören Training and Research Hospital, Department of Pediatrics, Ankara, Turkey; <sup>2</sup>University of Health Sciences, Dr. Sami Ulus Children's Health and Diseases Training and Research Hospital, Department of Pediatric Endocrinology, Ankara, Turkey; <sup>3</sup>Ankara Keçiören Training and Research Hospital, Department of Pediatric Neurology, Ankara, Turkey; <sup>4</sup>Ankara City Hospital, Department of Pediatric Neurology, Ankara, Turkey

## Abstract

**Background:** Vertigo is one of the most common complaints leading to admissions in pediatric neurology clinics. Diagnosis of vertigo in children is often challenging due to limited communication capacity in defining symptoms, the unreliability of neurovestibular investigations in children and the variability of etiologies. The aim of this study is to evaluate clinical and etiological profile of vertigo in childhood and to assess the diagnostic yield of neuroimaging and electroencephalography (EEG). **Methods:** All patients under the age of 18 years presented with vertigo to the pediatric neurology outpatient clinic of Ankara Keçiören Research and Training Hospital were included in the study. Demographic data, accompanying symptoms, family history, physical and neurological examination findings, neuroimaging, and EEG results were retrospectively analyzed. The etiological spectrum was also evaluated according to age groups. **Results:** A total of 791 patients (female/male=2.1) with a mean age of 13.1 years were included in the study. The most common etiologies were vestibular migraine (27.3%) and psychogenic vertigo (14.9%) in the entire cohort; whereas benign paroxysmal vertigo of childhood was the top diagnosis in children ≤12 years (25%). The most common accompanying symptom was headache (36.7%) which was most frequently associated with vertigo attacks in migrainous patients. In most cases there was no correlation between neuroimaging findings and vertigo. Additionally, the contribution of EEG to the diagnosis was found to be limited.

**Conclusion:** Most of the childhood vertigo cases can be diagnosed accurately by a detailed medical history, physical and neurological examination. A multidisciplinary approach is essential for evaluating childhood vertigo and all the signs and symptoms accompanying vertigo should be considered while planning further investigations including neuroimaging and EEG.

**Keywords:** Vertigo, childhood, vestibular migraine, EEG, neuroimaging

## INTRODUCTION

Dizziness is one of the common causes of pediatric visits and is traditionally classified into four categories including vertigo.<sup>1</sup> The prevalence of vertigo in children has been reported as 5.3%, with an increasing frequency in adolescence.<sup>2</sup> Vertigo is defined as the illusion of environmental motion, often described as a feeling of “spinning” or “moving”. Most of present literature assessing vertigo consists of adults since vertigo or even dizziness is relatively infrequent in childhood. The diagnosis of vertigo in children is often challenging due to limited communication capacity to define symptoms, the unreliability of neurovestibular investigations in younger children, and variability of etiologies.<sup>3-5</sup>

The etiological spectrum of vertigo in children is wide and known to differ from that in adults. Benign paroxysmal positional vertigo (BPPV) and Ménière's disease (MD), the two most common etiologies of vertigo in adults, are rarely observed in children, while benign paroxysmal vertigo of childhood (BPVC), which according to the Committee of Vestibular Disorders of the Bárány Society and the International Headache Society should be named as recurrent vertigo of childhood (RVC), is unique to the pediatric population. Furthermore, etiologies may vary according to the age group and the clinic where the study is conducted.<sup>6-8</sup>

A detailed medical history is the most important diagnostic tool in evaluating vertigo. Age at

Address correspondence to: Zülal ÖZDEMİR USLU, University of Health Sciences, Dr. Sami Ulus Children's Health and Diseases Training and Research Hospital, Department of Pediatric Endocrinology 06080, Altındağ, Ankara, Turkey. Tel: (90)-505 802 36 88, E-mail: zulal.ozdemir@live.com

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admission, frequency and duration of vertigo episodes, accompanying symptoms, its relation to the position, presence of visual, hearing, motor and speech problems, family history of migraine and epilepsy should be questioned. A careful and focused physical examination of ocular-motor and vestibular functions allows accurate diagnosis in most patients without further investigations.

The aim of this study is to evaluate clinical and etiological profile of vertigo in childhood and assess the diagnostic yield of neuroimaging and EEG.

## METHODS

Clinical data from patients aged <18 years who presented with vertigo to the pediatric neurology outpatient clinic of Ankara Keçiören Training and Research Hospital between January 2014 and December 2018 were retrospectively reviewed. The following variables were collected from hospital records: age at admission, gender, associated symptoms, history of head trauma, comorbidities, family history, physical and neurological examination findings, specialists' consultations, if performed neuroimaging and electroencephalography (EEG) findings. The final etiologic diagnosis of patients relied on established criteria or guidelines and was classified into the following categories: neurologic (BPVC, vestibular migraine (VM), epileptic vertigo (EV), multiple sclerosis, neurofibromatosis type 1, tumors), cardiovascular (orthostatic hypotension (OH), hypertension, ventricular extrasystole and prolonged QT interval), otologic (otitis media, BPPV, upper airway infections), ocular disorders (astigmatism and amblyopia), trauma, psychogenic and others. Patients who could not be classified into a diagnostic category were defined as unknown etiology.

The etiological spectrum was also evaluated according to age groups; Group 1 (G1): patients ≤12 years and group 2 (G2): patients >12 years. The diagnoses of VM and BPVC were made according to the diagnostic criteria of International Classification of Headache Disorders-3 (ICHD-3).<sup>9</sup> Ear-nose-throat specialists confirmed the diagnosis of BPPV by performing the Dix-Hallpike maneuver. Orthostatic hypotension is defined as a decrease in systolic blood pressure of 20 mm Hg or a decrease in diastolic blood pressure of 10 mm Hg within three minutes of standing when compared with blood pressure from the sitting or supine position. Blackout defined as temporary loss of vision while syncope as temporary loss of consciousness. Patients with

a known psychiatric disorder or vertigo attacks under stressful conditions who have normal physical and audiological examination and further investigations were included in the group of psychogenic vertigo (PV). Approval was obtained from the Ethics Committee of Ankara Keçiören Training and Research Hospital.

## Statistics

Descriptive statistics are presented as percentage, median, mean and standard deviation. Kruskal-Wallis H test was performed to compare diagnostic groups. Chi-square and Fisher's exact tests were conducted to analyze the relationship between two qualitative variables. SPSS for Windows version 11.5 was used and  $p < 0.05$  was accepted as statistically significant.

## RESULTS

A total of 791 children were included. Demographic features and clinical characteristics of the patients are presented in Table 1. There were 260 patients (33%) in G1 and 531 patients (67%) in G2. Female/male ratio was higher in G2 (2.61 vs 1.05,  $p < 0.01$ ).

The most frequent etiologies within the entire cohort were VM (27.3%) and PV (14.9%); followed by OH (10.4%) and BPVC (8.2%). Etiology was undetermined in 14.6% ( $n=116$ ) of the patients (Figure 1a). The leading cause of vertigo was BPVC (25%) in G1 while VM (30.7%) in G2 similar to the entire cohort (Figure 1b). VM and PV were more prevalent in patients >12 years and none of the patients in G2 was diagnosed with BPVC (Table 2,  $p < 0.01$ ).

A female predominance was observed in all etiologic categories, with the highest prevalence in the VM group ( $p=0.02$ ), except for BPVC and otitis media, where the sex distribution was similar (Table 2). The most common symptoms accompanying vertigo were headache (36.4%), blackout (9.6%), and nausea/vomiting (9.4%), respectively. Headache was more frequent in the VM group, blackout and syncope were more frequent in the OH group, convulsions and staring episodes were more common in the EV groups ( $p < 0.01$ ).

A family history of migraine was present in 165 (20.8%) patients and more frequent in the VM group (49%) and the BPVC group (44%), compared to the other groups (Table 2,  $p < 0.01$ ). A family history of epilepsy was positive in 54 children (6.8%), without statistical significance in terms of etiologies.

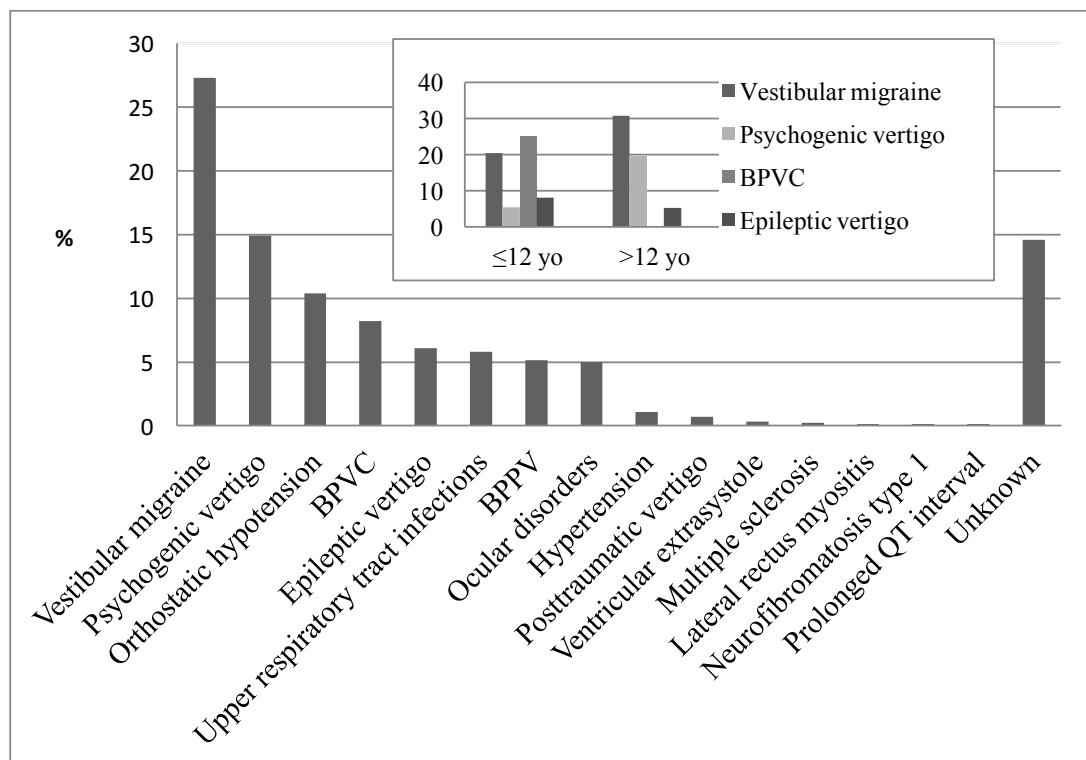
**Table 1: Demographic features and clinical characteristics of the patients**

Variables	n (%)
<b>Total number of patients</b>	791
<b>Sex, n (%)</b>	
Male	253 (32%)
Female	538 (68%)
<b>Age at admission, mean <math>\pm</math> SD (range), years</b>	13.1 $\pm$ 3.4 (1.5-17.9)
$\leq$ 12years	260 (33%)
$>$ 12 years	531 (67%)
<b>Accompanying symptoms at presentation</b>	
Headache	288 (36.4%)
Blackout	76 (9.6%)
Nausea/vomiting	74 (9.4%)
Syncope	40 (5.1%)
Tinnitus	21 (2.7%)
Photophobia	9 (1.1%)
Staring	4 (0.5%)
Convulsions	4 (0.5%)
None	275 (34.7%)

SD: standard deviation

Abnormal neurological examination findings were found in 19 (2.4%) patients: tremor (n=6), abnormal tandem gait (n=6), positive Romberg test (n=2), nystagmus (n=2), unilateral external gaze restriction (n=1), facial asymmetry (n=1),

and hyperactive deep tendon reflexes (n=1). A 14-year-old girl had multiple café-au-lait spots, axillary freckling and dermal neurofibromas on physical examination and she was diagnosed with neurofibromatosis type 1 (NF-1).



**Figure 1a** Distribution of the various etiologies for vertigo, **1b** Common diagnostic groups according to age

**Table 2: Comparison of the most common etiologies in terms of sex, age, and family history of migraine**

Variables		VM	PV	OH	BPVC	EV	p value
<b>Sex, n (%)</b>	Female	167 (77.3)	77 (65.3)	62 (66.7)	33 (50.8)	36 (73.5)	<b>0.02</b>
	Male	49 (22.7)	41 (34.7)	31 (33.3)	32 (49.2)	13 (26.5)	
<b>G1 (n)</b>	≤12 years	53 (24.5)	14 (11.9)	23 (24.7)	65 (100)	21 (42.9)	<b>&lt;0.01</b>
<b>G2 (n)</b>	>12 years	163 (75.5)	104 (88.1)	70 (75.3)	0 (0)	28 (57.1)	
<b>Migraine FH, n (%)</b>	Positive	105 (49)	10 (8.5)	13 (14)	29 (44)	8 (16.3)	<b>&lt;0.01</b>
	Negative	111 (51)	108 (91.5)	80 (86)	38 (56)	41 (83.7)	

VM: Vestibular Migraine, PV: Psychogenic Vertigo, OH: Orthostatic Hypotension, BPVC: Benign Paroxysmal Vertigo of Childhood, EV: Epileptic Vertigo, SD: Standard Deviation, FH: Family History

Among 228 patients (28.8%) who underwent a cardiac evaluation, pathologic findings were as follows: OH (n=82), hypertension (n=9), ventricular extrasystoles (n=3), and prolonged QT interval (n=1).

Children whose symptoms provoked by head movements or suggested peripheral vertigo were referred to ear-nose-throat (ENT) specialists. Those who had already been diagnosed with other causes of vertigo did not seek consultation. ENT specialists evaluated 226 patients (28.5%) and 41 patients (5.2%) were diagnosed with BPPV. Infections were present in 46 children (5.8%); 28 (3.6%) acute otitis media and 18 (2.2%) sinusitis.

Children expressing visual symptoms such as blurred vision, far/nearsightedness were referred to ophthalmologist. Children who had already undergone ophthalmologic examination in the last six months and those who had already been diagnosed with the other causes of vertigo did not seek consultation. Abnormal ophthalmologic examination associated with vertigo was determined in 40/232 patients (5%); astigmatism (n=39) and amblyopia (n=1).

Of the 118 patients diagnosed with PV (14.9%), 11 had a prior psychiatric disorder (generalized anxiety disorder=6, mood disorders=3, obsessive compulsive disorder=1 and panic attack=1). Psychosocial stressors were present in 107 patients and these included change of school, peer bullying, academic problems, parental divorce and economic difficulties. Two children with generalized anxiety disorder and three with mood disorders were receiving sertraline, one with obsessive compulsive disorder was receiving aripiprazole.

EEG testing was performed in 495 (62.5%) patients with convulsion or staring episodes, previous history of suspicious seizures or a family history of epilepsy because vertigo could be confused with myoclonic seizures due to overlapping symptoms. Out of these patients, 47

(9.5%) showed epileptiform discharges. Among the 49 patients (6.2%) diagnosed with EV, 47 had abnormal EEG findings along with additional clinical information and two had normal EEG but a history of seizures. There was no statistically significant difference between EEG abnormality and age groups (p=0.293).

Neuroimaging was performed in 588 (74%) patients; brain magnetic resonance imaging (MRI) in 576 (97.9%) and head computed tomography (CT) in 12 (2.1%). All CT scans were normal while abnormal and mostly incidental MRI findings were detected in 83 patients (14%) including sinusitis/mastoiditis/adenoid vegetation (n=41), arachnoid cysts (n=23), cerebellar ectopia (n=11); while periventricular leukomalacia, Chiari type 1 malformation, lateral rectus myositis and posttraumatic encephalomalacia (n=1 each). Multiple focal areas of T2 hyperintensity involving the pons, cerebellum, periventricular white matter, and corpus callosum were detected in the patient with clinically diagnosed with NF1. MRI revealed left lateral rectus myositis in a 15-year-old patient presenting with vertigo. Two adolescent girls with characteristic multiple T2 hyperintense demyelinating lesions on brain MRI met the diagnostic criteria of multiple sclerosis (MS). Vertigo attacks were accompanied by nausea/vomiting in one of them with a family history of MS, while the other one presented with isolated vertigo. Both exhibited abnormal neurological examination findings, including vertical nystagmus, abnormal tandem gait, and positive Romberg test. No statistical significance was found between abnormal MRI findings and age groups (p=0.449).

Six patients with a history of head trauma were diagnosed with post-traumatic vertigo. All but one (with an abnormal tandem gait) had normal neurological examination. None of them exhibited any neurological symptoms or abnormal neuroimaging findings.



## DISCUSSION

The main finding in this pediatric vertigo series was that although the top two diagnoses were VM (27.3%) and PV (14.8%) in the entire cohort, BPVC (25%) was the most common etiology in children  $\leq 12$  years. Childhood vertigo has a wide etiological spectrum. The most common etiologies have been reported with varying frequencies in different studies, probably due to diverse inclusion/exclusion criteria, study designs, age distributions and clinics where the study is conducted.<sup>7,10-13</sup> A recent systematic review involving 22 studies (including 2,726 subjects) on the etiology of vertigo in children has shown that VM (23.8%) and BPVC (13.7%) were the prevailing diagnoses.<sup>2</sup> Another study from a pediatric neurology clinic in Turkey indicated that BPVC (39%), PV (21%) and EV (15%) were the top three diagnoses.<sup>14</sup> The diagnosis of BPVC is based on the presence of at least five attacks accompanied by at least one of nystagmus, ataxia, vomiting, pallor according to ICHD-3, which starts suddenly and regresses spontaneously within seconds.<sup>9</sup> RVC defined by Bárány Society has recently replaced the term BPVC and is defined as recurrent spells of vertigo without evidence of vestibular migraine of childhood.<sup>8,15</sup> However, both BPVC and RVC are used interchangeably in the current literature. Since our study is retrospective and covers the period prior to the change in terminology from BPVC to RVC, we adhere to the definition of BPVC. Regardless of the nomenclature, it remains one of the most common etiological causes in childhood vertigo. The frequency of BPVC (8.2%) in our study was lower than most of the previous reports<sup>11,14,16,17</sup>, although it stood out as the most common etiology among children  $\leq 12$  years (25%). Gruber *et al.* also reported the frequency of BPVC as 8% similar to the current report.<sup>5</sup> In another study, involving 616 pediatric patients presenting to the emergency department with vertigo or dizziness, the frequency of BPVC was also reported as 6.3%.<sup>18</sup> The higher mean age of our patients (with two-thirds being older than 12 years) and the diagnostic challenges in younger children may have contributed to the relatively low rate of BPVC in this study. This trend aligns with the notion that etiology of vertigo in children varies depending on the age at presentation.

Females outnumbered males (F:M=2.1) in this study, consistent to previous reports.<sup>19-21</sup> The female predominance was most pronounced in the VM and PV groups, whereas the sex distribution was equal in the BPVC and otitis media groups, as anticipated.

Headache was the most common symptom accompanying vertigo attacks, followed by blackout and nausea. Although headache was correlated with migraine attacks in 84% of the cases ( $p < 0.01$ ), it also manifested in other etiologies, as previously described.<sup>12,14,22</sup> Staring episodes and convulsions were significantly associated with EV compared to other groups ( $p < 0.01$ ). Therefore, an EEG might prove useful in the differential diagnosis, particularly when staring episodes or altered consciousness are present.

Orthostatic hypotension emerged as the third most common etiology (10.4%) in our study and vertigo attacks were frequently accompanied by blackout and syncope. Although OH rarely occurs in isolated vertigo, other cardiovascular conditions such as hypertension, cardiac arrhythmias should be considered in children with vertigo, as they can result in severe complications or life-threatening events.<sup>18</sup> Assessment of vital signs, including supine/standing blood-pressure measurements along with electrocardiography (ECG) should be included in the evaluation before performing further investigations.

A family history of migraine was significantly higher in BPVC and VM ( $p = 0.012$ ), consistent with previous reports.<sup>14,23</sup> In a meta-analysis including 86 pediatric patients with BPVC, 36% had a family history of migraine.<sup>24</sup> Marcelli *et al.* reported that none of the BPPV patients had migraine in their family, whereas all of the BPVC patients had such a family history. However, the exact pathomechanism is not yet precisely known.<sup>25</sup>

In the literature, ocular disorders account up to 10% of vertigo cases, and symptoms often completely resolve with optical correction with eyeglasses or orthoptic therapy.<sup>26-28</sup> In our study, ophthalmological disorders associated with vertigo were found in 5% of cases. Even if the underlying etiology of vertigo is different, the symptoms can be exacerbated in the presence of astigmatism or refractive errors. Therefore an ophthalmological examination should also be part of the diagnostic approach in children with vertigo.<sup>26</sup>

EEG testing was performed in 62.5% of our patients with a diagnostic yield of 9.5%, as epileptiform discharges were detected in 47 patients. The frequency of EV has been reported between 2.5-15% in previous studies.<sup>14,16,20</sup> Variations in these findings may stem from the rate of EEG utilization and potential selection bias across different clinical departments.

Benign paroxysmal positional vertigo, one of the most common causes of vertigo in adults, occurs less frequently in the pediatric age group. A positive positioning examination (Dix-Hallpike maneuver) is useful to confirm the diagnosis.<sup>29</sup> In our study, BPPV accounted for 5% of the cases. The prevalence of BPPV in childhood varies between 1-12% in different studies.<sup>14,20,30</sup>

The prevalence of PV in the literature exhibits substantial variation: 2.5- 28%.<sup>5,14,31,32</sup> In our population, PV emerged as the second most frequent diagnosis, with almost one-fifth of patients having a prior psychiatric disorder and half of them undergoing psychiatric treatment. They were not diagnosed with drug-induced vertigo because they had already experienced vertigo before initiating psychiatric treatment. Langhagen *et al.* demonstrated the coexistence of migrainous and psychogenic vertigo in 19% of patients, particularly noticeable in girls over 12 years of age.<sup>31</sup> The diagnosis of PV should be considered after excluding other potential causes. PV can be determined by identified through a comprehensive history-taking process and psychological evaluation.

Considering the risks of ionizing radiation in the pediatric population and the higher sensitivity of brain MRI in detecting posterior fossa and inner ear abnormalities, MRI appears to be the preferred neuroimaging technique. The neuroimaging rate in our study (74%) was relatively high compared to the previous reports, which ranged between 20.8-70%.<sup>14,18</sup> This higher rate in our study was attributed to parental requests and concern of overlooking a serious underlying condition. A significant portion of the abnormalities detected on MRI were incidental, and less than 1% contributed to the patient's diagnosis. Only two patients diagnosed with MS displayed findings requiring early treatment, both of whom exhibited abnormal neurological examination findings. In another instance, a patient had a clinical diagnosis of NF-1 with typical phenotypic features on physical examination and brain MRI unveiled T2 signal hyperintensity in multiple regions. Idiopathic lateral rectus myositis is a rare condition that may induce dizziness and diplopia.<sup>33</sup> Our patient did not exhibit signs of orbital infection, and symptoms resolved spontaneously. Our experience underscores the limited diagnostic yield of CT in the vertigo evaluation. Conversely, MRI assumes a more significant role in suitably selected cases. It remains crucial to conduct a comprehensive examination before performing further investigations to accurately determining

the underlying etiology.

Among 791 patients 42% (n=333) classified into neurologic vertigo group as reported by Karatoprak *et al.*<sup>21</sup> In comparing the causes of pediatric vertigo, the neurologic/non-neurologic vertigo ratio was found to be 0.72 in the entire cohort; 1.14 in G1; 0.57 in G2.

Although we evaluated the patient according to an investigation algorithm based on our cohort and the literature (Figure 2), the etiology of vertigo could not be determined in 14.6% of our patients, which was reported between 9-19% in various studies.<sup>10,12,18,19</sup> Mentioned diagnostic challenges in the pediatric cases, retrospective design and follow-up dropouts may contribute to the lack of etiology in these cases.

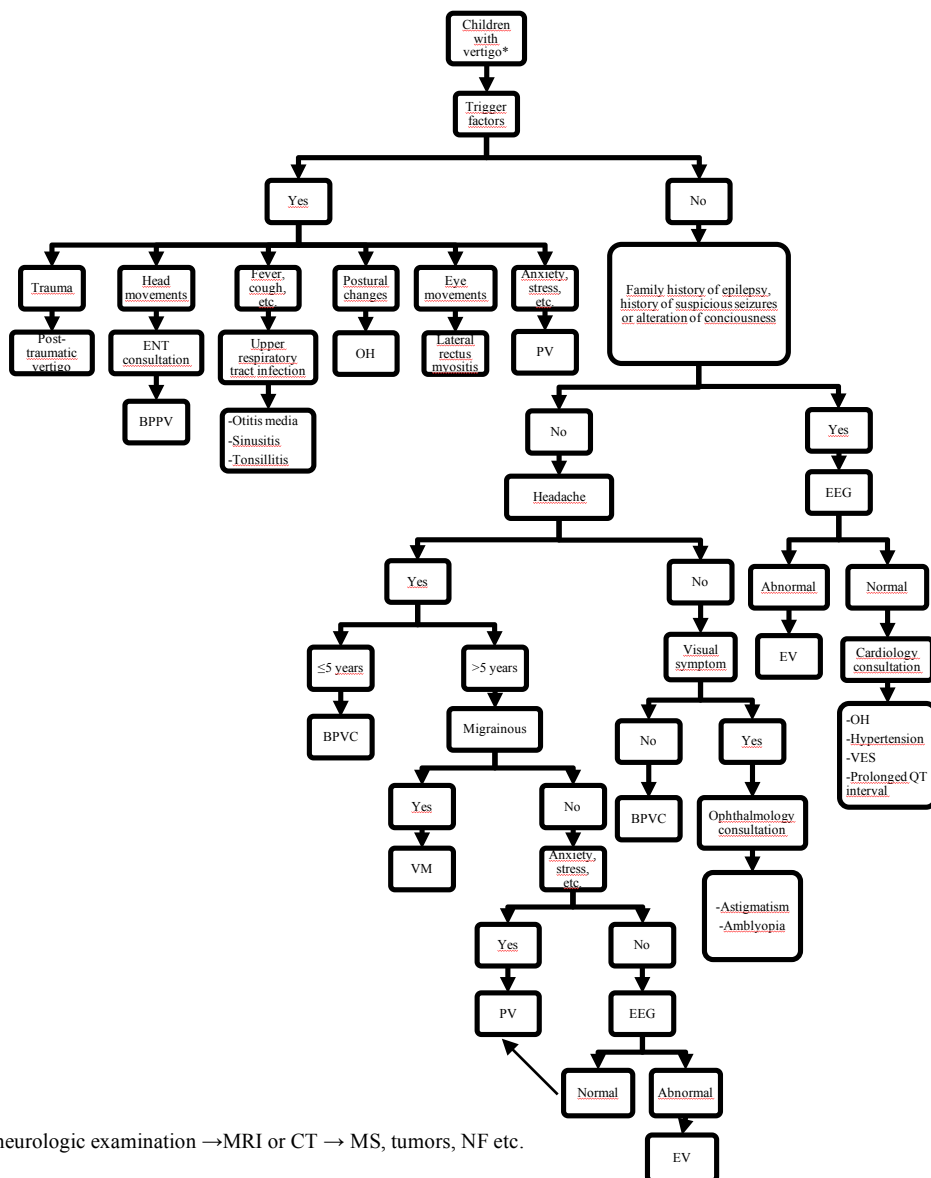
Our study possesses several strengths, including a large sample size and ample number of neuroimaging and EEG assessments, contributing to a meaningful diagnostic yield in vertigo evaluation. Since our study reflects the data of a pediatric neurology clinic, the higher rate of EV and lower proportion of otological causes because of lacking audiological tests which is a limitation of the study can be attributed to a potential referral and selection bias.

In summary, our dataset represents one of the largest pediatric vertigo series in the literature and revealing that VM and PV are the most frequent etiologies of pediatric vertigo, with BPVC prevailing among the younger age group. Based on our findings, EEG or MRI should be performed in only selected cases, particularly in the presence of accompanying symptoms, abnormal physical or neurological examination findings and distinctive history details. While a substantial portion of cases prove to be benign and treatable, accurately diagnosing the condition is pivotal for appropriate management and prognosis prediction.

## DISCLOSURE

Financial support: None

Conflict of interest: None



\*Abnormal neurologic examination →MRI or CT → MS, tumors, NF etc.

Figure 2. Diagnostic algorithm for pediatric vertigo

BPPV: Benign paroxysmal positional vertigo; BPVC: Benign paroxysmal vertigo of childhood; EEG: electroencephalography; ENT: Ear-Nose-Throat; EV: Epileptic vertigo; OH: Orthostatic Hypotension; PV: psychogenic vertigo; VES: ventricular extrasystole; VM: Vestibular migraine

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