

## Article

# Unraveling the etiology of pediatric vertigo and dizziness: a tertiary pediatric center experience

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**Objective:** The causes of vertigo and dizziness in children are diverse and require attention from various specialists. Numerous authors have reported that the commonest type of vertigo in children is migraine-associated vertigo (vestibular migraine and benign paroxysmal vertigo of childhood - BPV). We aimed to check whether this could be applied to our group of patients.

**Materials and methods:** A retrospective case series of 257 consecutive pediatric vertigo and dizziness patients referred to the tertiary pediatric ENT clinic from 2015 to 2020. Patients received a complete audiovestibular workup and were referred to pediatric neurologists and other specialists depending on the signs and symptoms.

**Results:** Of 257 children aged 1-17 years, almost one fifth of them, 49/257 (19.1 %) had a central type of vertigo, 20/257 of them (7.8%) had benign paroxysmal vertigo of childhood and 4/257 (1.6%) had a migrainous type of vertigo. Most of the children, 112/257 (43.6%), remained unclassified, without a final diagnosis.

**Conclusion:** Due to the numerous possible causes, a child presenting with dizziness and vertigo requires a multidisciplinary approach. In the majority of cases, vertigo spells are self-limiting. They stop spontaneously and sometimes remain clinically undiagnosed. The most prevalent reasons for pediatric vertigo may be temporary hemodynamic (vaso-vagal) and psychological imbalance.

**Keywords:** Dizziness; Vertigo; Migraine Disorders; Interdisciplinary Communication; Headache; Medulloblastoma; Lyme Neuroborreliosis; Somatoform Disorders; Child; Adolescent;

## 1. Introduction

Good balance is crucial for a child's normal development and psychophysical well-being. The symptoms of dizziness and vertigo are not as common in children as they are in the adult population. The prevalence of vertigo in children is said to be from 5 to 15% [1,2]. As has been proven by an American National Health Interview Survey, children with vertigo have significantly higher chances of attention deficit disorder, learning problems, developmental delay and intellectual disability. They also have higher odds of having difficulty with emotions, concentration or behavior and having a poor attention span [3]. As some experiments have shown, central vertigo is also critical in relation to numerical skills [4].

The causes of vertigo and dizziness in children are diverse and require attention from various specialists. As reported by numerous authors, the commonest type of vertigo in children is said to be migraine-related vertigo (vestibular migraine and benign paroxysmal vertigo of childhood- BPV) [2,5–14]. Vestibular migraine presents with vestibular symptoms, occasionally associated with migrainous headache [14,15].

In BPV, a two to six-year-old child has short vertigo spells (seconds to minutes), often accompanied by nystagmus and imbalance. It is frequently associated with a positive family history of migrainous headaches and the later development of typical migraine [16]. Other »central« causes of vertigo and dizziness in children include epileptic, infectious (including Borreliosis), neoplastic, vascular (e.g., malformation), postoperative vertigo, vertigo due to hydrocephalus, degenerative/hereditary vertigo and several others [5,17,18].

Vertigo and dizziness can present as epileptic aura, usually in patients with partial seizures, the temporal lobe being the most frequent ictal onset area in these patients [19].

Vertigo and dizziness in children can also be a consequence of psychological, post-traumatic, hemodynamic, autoimmune, hormonal, ophthalmologic, pharmacological and numerous other pathologies [3,15,17,18,20,21].

Lyme neuroborreliosis is a tick-borne infection of the nervous system caused by *Borrelia burgdorferi* spirochetes. Vertigo as a sign of Lyme borreliosis is more common in adults but can also appear in children [22]. It should not be forgotten in the differential diagnosis of pediatric vertigo.

Vestibular symptoms can arise because of lesions in the brainstem and the cerebellum, the medulloblastoma being one of the most common tumors of childhood. Head imaging is a necessary part of diagnostic workup when such a lesion is suspected [5].

Frequent vertigo episodes (up to 30 per day), lasting for seconds to minutes, are rare and can be caused by vestibular nerve vascular compression – a syndrome termed vestibular paroxysmia [5,6].

The most common cause of hemodynamically caused dizziness is orthostatic hypotension, which is said to be responsible for 3 to 9 % of symptomatic children [12] and can occur even in children without autonomic dysfunction [23].

The other common cause of vertigo and dizziness in children, as well as in adults, is psychological problems [5]. On the other hand, vertigo itself (of different origins) can lead to psychological distress - symptoms of depression and anxiety [24]. It is most prevalent among adolescent girls [9].

Peripheral vestibular causes of vertigo are very uncommon in children, with vestibular neuronitis occurring only in 1-5% of pediatric vertigo cases [25].

We aimed to investigate whether this is true for our cohort of patients. No similar studies have previously been done in Slovenia.

## 2. Materials and Methods

A retrospective study of 257 consecutive pediatric patients (aged 1 to 17 years) presenting with dizziness and vertigo at the tertiary pediatric ENT clinic (from January 2015 till November 2020).

The diagnostic workup started with detailed history taking. We were especially interested in problems concerning balance described by parents, who had sometimes even filmed a vertigo episode on a mobile phone. We also noted the child's own description of the symptoms, since they can be quite picturesque and narrative. We were also interested in possible oncological therapies, head trauma, headaches, family history of migraines, and previous intracranial operations. Patients were referred to the pediatric neurology clinic and, depending on the signs and symptoms, to ophthalmologic, infectious disease (serology results of *Borrelia Burgdorferi*), radiological (CT and MRI), psychological and cardiological consultations, as part of a multidisciplinary approach.

Each child presenting at our clinic received an otoneurological clinical examination, followed by audiovestibular testing tailored to their age and capacity to cooperate.

The otoneurological clinical examination consisted of otomicroscopy, detailed otorhinolaryngological examination and cranial nerve function and nystagmus assessment using video Frenzel goggles, Romberg's test, and tandem walking with eyes open and closed. The function of the semicircular canals was tested using low-frequency stimulus

(caloric and rotatory) testing and high-frequency testing (video head impulse test). The otolith organs were assessed by subjective visual vertical test (SVV) and cervical evoked myogenic potentials testing (cVEMP). When a peripheral vestibular disorder was excluded, they were referred to other subspecialists.

A pediatric neurologist performed the neurological examination, followed by EEG, laboratory (serology to *Borrelia Burgdorferi*) and sometimes head imaging (CT/ MRI).

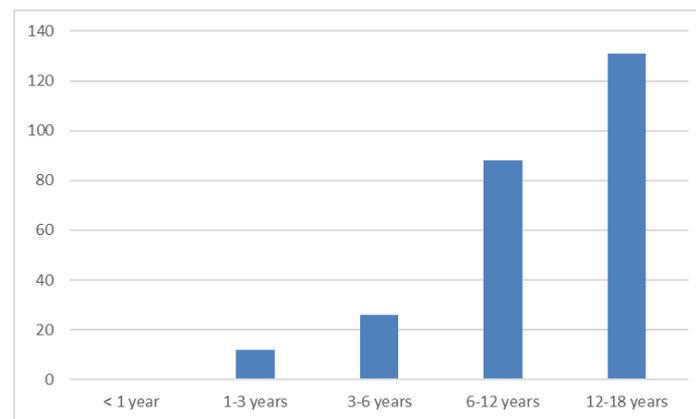
The children were given a multidisciplinary follow up until the symptoms subsided, as necessary.

Statistical analysis was done using SPSS V20.0 (IBM, Armonk, USA) and Microsoft Excel 2019 (Microsoft, Redmond, USA). Statistical significance was considered to be  $p < 0,005$ . Multiple specialists addressed the children and, due to that, some data were missing.

### 3. Results

A total of 109 (42.4%) male and 148 (57.6%) female pediatric vertigo and dizziness patients were referred to our tertiary ENT clinic in the 2015 to 2020 time period. The patients' ages were 1-17 years (mean 10.9, SD 4.3 years).

Figure 1 shows the frequency of pediatric vertigo and dizziness referrals to ENT clinic in relation to age.

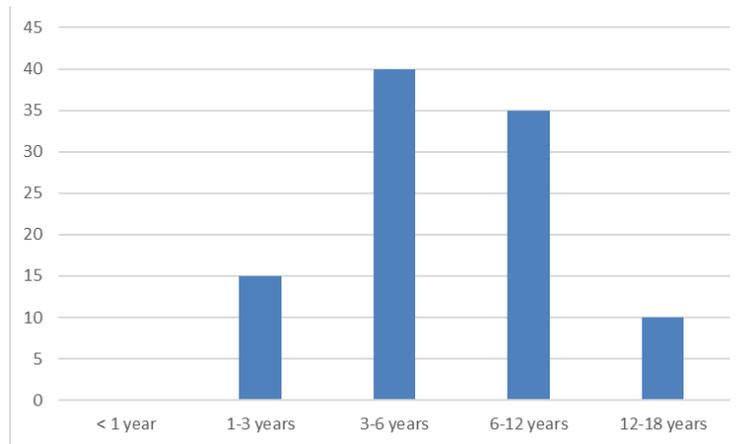


**Figure 1.** Frequency of vertigo and dizziness in children in relation to age.

In 83,9% of children there was no nystagmus visible with video Frenzel goggles; in 17%, the nystagmus had non-peripheral characteristics (not horizontal or not following Alexander's law). A pathological Romberg test was found pathological in 10% of the children, and the tandem walking test was pathological in 59 (33%).

Fifty-two percent (134/257) of patients were referred to a pediatric neurologist, wherein the neurological examination was flawless in 87%. In 50 children, an EEG was done. It was pathological in 9 (18%) of them.

In all, 165 children reported having headaches; 55 (33.3 %) of them had migrainous headaches and 10 (6.1%) reported having other types of headaches. Forty-nine (18.2%) had a positive family history of migrainous headaches, of which 5% of children with migrainous headaches and 40 % with a positive family history of migrainous headaches were diagnosed with childhood BPV. Figure 2 shows the prevalence of BPV among age groups.



**Figure 2.** Prevalence of BPV among different age groups. The diagnosis is most common in children aged 2 to 6.

Thirty-one patients with peripheral or central vertigo were excluded from the statistical analysis due to missing data on headaches, and 17 patients were classified as peripheral and 33 patients as central vertigo. The test of two proportions used was the chi-square test of homogeneity. Twelve patients (41.4%) with peripheral vertigo had headaches, compared to 5 patients (23.8%) with peripheral vertigo without headaches, a difference in proportions of 0.176,  $p = 0.196$ .

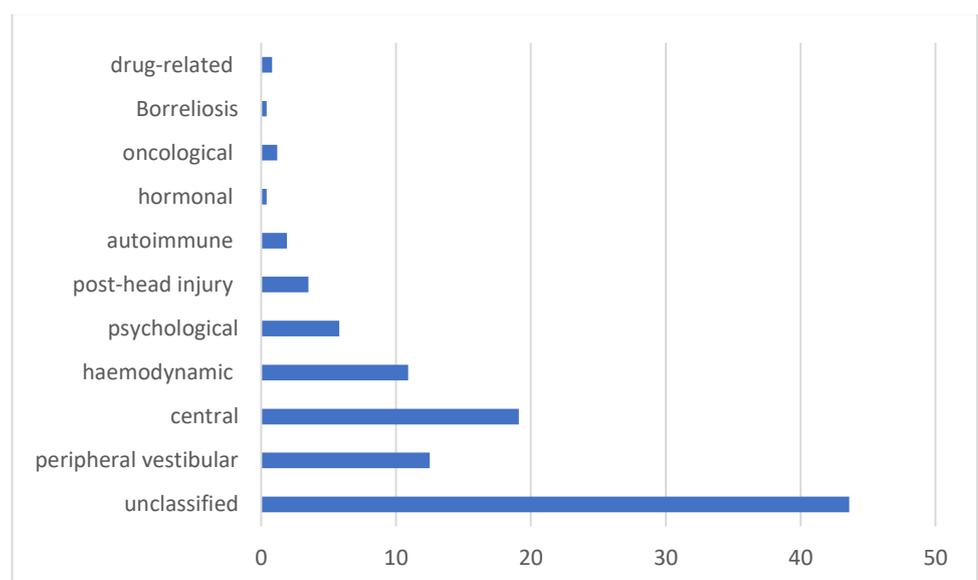
Nine (3.5%) had had previous intracranial operations, and 7 (2.8%) had positive serology to *Borrelia Burgdorferi*.

In terms of head imaging, 109 (42.9%) had an MRI of the head performed, of which only 18 (7.1%) of the children had some pathological finding (excluding cysts of the pineal gland). Forty-seven (18.5%) patients had a CT scan done, with only 2 (0.8%) of them being pathological.

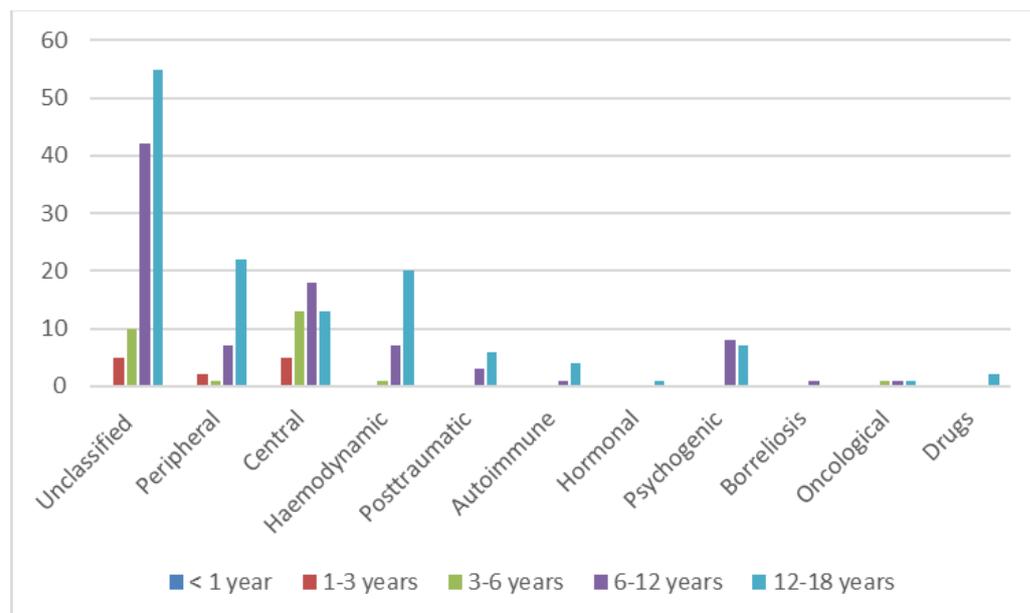
Eighty-four (33.1%) were referred to an ophthalmologist, 12/84 (14.3 %) being reported to have a deviation.

Seventeen (6.7%) had a head trauma preceding the onset of vertigo.

Figure 3 shows the final diagnosis of pediatric patients with symptoms of vertigo and dizziness, and Figure 4 the relation between the patient's age and the final diagnosis.

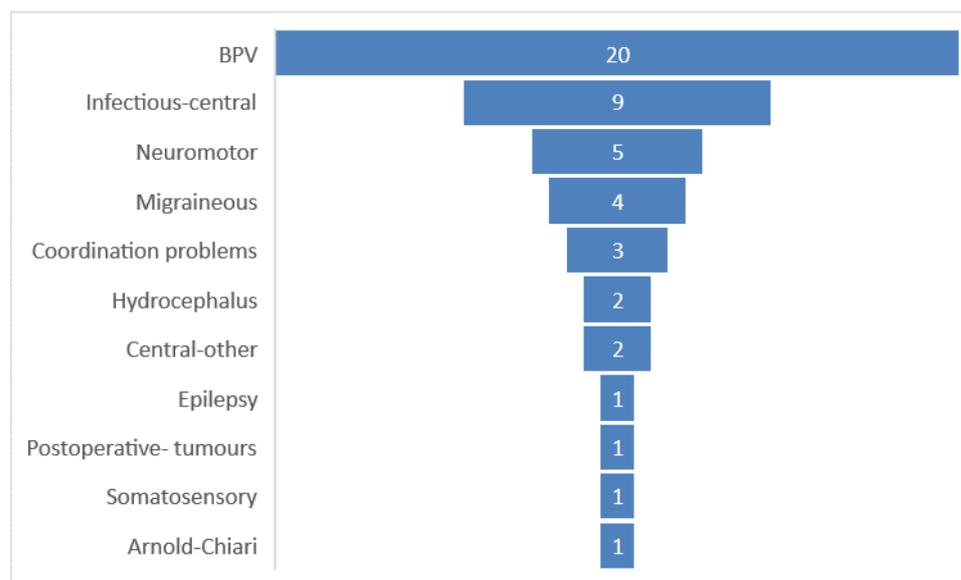


**Figure 3.** Final diagnosis of pediatric patients with the symptoms of vertigo and dizziness.



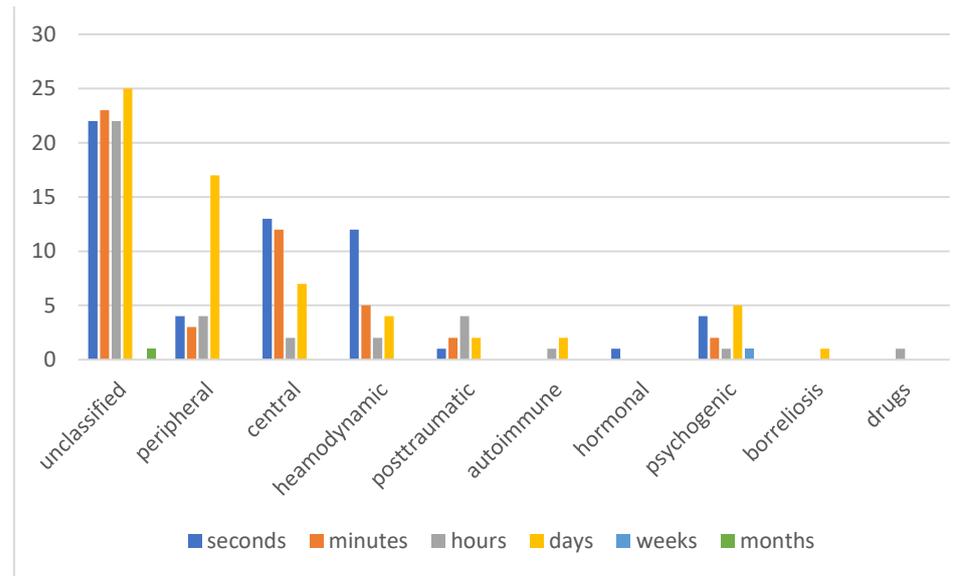
**Figure 4.** Relation between the patient's age and the final diagnosis

There were several different pathologies involved in a definite diagnosis of central loss, as can be seen from Figure 5.



**Figure 5.** Different central pathologies found in our patients in relation to age groups.

Figure 6 shows the relation between the duration of vertigo and dizziness symptoms and the final diagnosis.



**Figure 6.** Duration of vertigo and dizziness symptoms in relation to the final diagnosis.

#### 4. Discussion

We aimed to evaluate children with a diagnosis of dizziness and vertigo referred to our tertiary center. The causes of vertigo and dizziness in a child are numerous, and a child presenting with symptoms of dizziness and vertigo therefore requires a multidisciplinary approach. Neurologists, otorhinolaryngologists, ophthalmologists, radiologists, psychologists, psychiatrist and cardiologists are primarily involved in their clinical workup.

In our group of patients, the central pathology was found in 19% of patients, which is less than in other studies [18].

In relation to the central types of vertigo in our case series (Table 1), as in numerous other studies (2,6,11,13,14), we found BPV of childhood to be the most common type.

The prevalence of headaches in children and adolescents is up to 88% (24). In the literature, pediatric vertigo and dizziness patients present with headaches in 35 to 60% of cases (1). In our group of patients, 40% had occasional headaches, 33% of migrainous type. In children younger than 6, classical migraine is rare, but some migraine-related syndromes have been described (25), BPV being one. It is most prevalent in children aged 2 to 6. In our study, 55% of children with a final diagnosis of BPV were in that age group. Four children were diagnosed with classical migraine.

We found only 1 child with balance problems due to Arnold-Chiari malformation, which is much less than in other studies, in which it accounted for disequilibrium and vertigo in 10% of patients [17].

Motor, sensory and developmental problems as a cause of vertigo and dizziness were found in 9/257 patients, which is less than in other studies; with a similar pathology it was found in 10.6% of cases [17].

An imbalance of cerebrovascular fluid causes numerous problems. It is not surprising that the symptoms of dizziness also arise in children with hydrocephalus. We determined only 2/257 patients with disequilibrium symptoms due to that pathology.

In pediatric vertigo cases with an alteration of consciousness, an EEG should be done to rule out epileptic vertigo. In our rather large group of patients, we found only one child with vertigo due to epilepsy. In some other studies, an epileptic pathology was more frequent [7].

Head imaging in our pediatric vertigo and dizziness patients only revealed the relevant pathology in rare cases. We feel that head imaging, in view of the need for sedation in young children and the CT's ionizing radiation, should be directed towards selected

cases suspicious for posterior fossa and inner ear pathologies. We found only one child to have disequilibrium due to neoplastic disease (medulloblastoma).

In our case series, vertigo symptoms subsided spontaneously in most children (53%) during the clinical workup of various specialities and consequently remained undiagnosed. Otoneurological clinical assessment for a peripheral vestibular disorder was negative in all of them. They did not have any signs of neurological deficit during the neurological workup. Figure 4 shows the short duration of symptoms in the »unclassified« group of patients. The authors believe that those children probably had minor transient psychological or hemodynamic (orthostatic) problems. It is clear from Figure 3 that both of those appear primarily in the teenage group, the same as the »unclassified vertigo«. All the children with the symptoms of vasovagal -orthostatic dizziness were given instructions about alleviating the symptoms.

Interestingly, other authors have not reported having an undiagnosed (»idiopathic«) group of patients, not among the most frequent causes [17,26,27] of vertigo. In contrast to most other authors stating BPV to be the most prevalent cause of pediatric vertigo and dizziness symptoms, in our group of patients, the symptoms of vertigo and dizziness were more prevalent in older children (aged 6-12 and 12-18). On that basis, the most common final diagnosis was probably hemodynamic and psychological. In children older than 10, somatoform disorders are a common cause of vertigo [6].

A weakness of this study is that multiple specialists were included in the treatment, and some data are therefore missing. It would be desirable to make a prospective multicentric study to make the data more robust in the future.

Strengths of our study are the number of participants, which was large in comparison to other non-epidemiological studies [7,9,10,18,27,28], and the multidisciplinary approach that children treated in our institution receive.

## 5. Conclusions

Balance is crucial for a child's normal psychophysical development. Due to the numerous possible causes, a child presenting with dizziness and vertigo requires a multidisciplinary approach, in which referral to a neurologist is essential. Peripheral pathology is rare. In most cases, the pediatric vertigo is transient and self-limiting and, because of that, it sometimes remains undiagnosed, mainly in the teenage group of patients.

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**Informed Consent Statement:** Informed consent was obtained from patients and/or legal guardians of all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest. The sponsors had no role in the design, execution, interpretation, or writing of the study.

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