

Vestibular symptoms in paediatric patients with otitis media with effusion and/or Eustachian tube dysfunction

Portuguese Association of Otoneurology

Authors

Miguel Padrão

Serviço ORL, Centro Hospitalar do Baixo Vouga, Aveiro;
Centro Académico Clínico Egas Moniz

Diogo Dias

Serviço ORL, Centro Hospitalar do Baixo Vouga, Aveiro;
Centro Académico Clínico Egas Moniz

Isa Eloi

Serviço ORL, Centro Hospitalar do Baixo Vouga, Aveiro;
Centro Académico Clínico Egas Moniz

Sandra Augusto

Serviço ORL, Centro Hospitalar do Baixo Vouga, Aveiro;
Centro Académico Clínico Egas Moniz

Luísa Azevedo

Serviço ORL, Centro Hospitalar do Baixo Vouga, Aveiro;
Centro Académico Clínico Egas Moniz

Correspondence:

Miguel Padrão
miguelpadrao@campus.ul.pt

Article received on December 16, 2023.
Accepted for publication on March 29, 2024.

Abstract

Vestibular disorders are common in children, generating avoidance and anxiety behaviours with an impact on development.

Prompt diagnosis is crucial, but the low specificity of symptoms and poor patient co-operation make this difficult. Eustachian tube dysfunction (ET) and otitis media with effusion (OME) can cause vestibular disorders.

Here, we assess the prevalence of vestibular symptoms in children with OME and/or ET dysfunction. We used the Vanderbilt Pediatric Dizziness Handicap Inventory for Patient Caregivers questionnaire, translated and culturally adapted for Portugal, and carried out an otorhinolaryngological objective examination and audiometric evaluations.

None of the patients had acute vestibular symptoms. The differences in the questionnaire between the control and test groups were statistically significant ($p=0.002$), as well as between patients with and without a Type B Tympanogram ($p=0.014$) and with and without effusion ($p=0.003$). Carers of children with middle ear pathology should be approached with questionnaires that help assess the presence, severity and impact of vestibular symptoms

Keywords: Dizziness, Vestibular disorders, otitis media with effusion, eustachian tube dysfunction.

Introduction

Vestibular symptoms such as instability, vertigo, and dizziness can have different etiologies in children, including systemic cardiac, psychiatric, and metabolic conditions, as well as central nervous system and vestibular diseases. In this population, vestibular migraine, recurrent vertigo of childhood (RVC), and otitis media are the most commonly encountered etiologies^{1,2,3}. The pathophysiology of vestibular symptoms in otitis media, in particular, is not yet fully

understood⁴. The prevalence and incidence of vestibular dysfunction in children ranges between 1–10% and 1–15%^{5,6}, respectively. These figures vary depending on the study setting, referral criteria, age of the patients, and methods used for vestibular assessment⁷.

The available tests for vestibular assessment are less reliable in younger children, who might also have difficulties in describing their symptoms. Consequently, vestibular dysfunction is often considered an underdiagnosed condition in this population. The vestibular system plays a crucial role in the normal cognitive, psychological, and emotional development in children⁸. Therefore, vestibular disorders can lead to avoidance behavior and its adverse effects. Few instruments have been specifically adapted to assess the presence, severity, and impact of vestibular symptoms in the pediatric population. One of them is the Dizziness Handicap Inventory (DHI-PC), which was adapted by McCaslin et al. to be filled by pediatric caregivers⁹. In 2023, this instrument was translated and culturally adjusted to a European Portuguese by Nas cimento et al¹⁰. Auditory tube dysfunction with and without otitis media with effusion (OME) is a common childhood condition, affecting up to 90% of preschool children at least once in their life¹¹, and is a frequent cause of vestibular symptoms in this population. Both changes in endolymph composition, secondary to the presence of inflammatory mediators causing labyrinthitis¹², and pressure changes¹³ secondary to OME can result in vestibular symptoms. Recent studies have indicated that the prevalence of vestibular symptoms can reach 50% in children diagnosed with OME¹⁴. The objective of the present study was to evaluate the prevalence and impact of vestibular symptoms on children with middle ear pathology by comparing them with healthy children.

Materials and methods

The sample included 30 children between 5–12 years of age who were on the surgical waiting list for myringotomy and had a type

B/C tympanogram (TPG). These children were compared with 20 controls with an indication for adenoidectomy and tonsillectomy without middle ear pathology. The exclusion criteria were children with cognitive/syndromic deficits, cardiac pathology, orthopedic limitations, sensorineural deafness, history of traumatic brain injury, and those whose caregivers were unable to understand Portuguese. The groups were adjusted for age and comorbidities. The Vanderbilt Pediatric Dizziness Handicap Inventory for Patient Caregivers, translated and culturally adapted for the Portuguese population, was filled by the caregivers. The participants in the study underwent a comprehensive assessment, which included audiometry, tympanometry, and an objective otorhinolaryngologic examination.

This examination encompassed acoumetry, nystagmus investigation, audiometric tests, and assessment of the vestibulo-ocular reflex by the Head Impulse Test (HIT). Additionally, we assessed skew deviation, balance using the Romberg test, dysdiadochokinesia by repeated pronation and supination of the thigh, and gait. The questionnaire and the scoring scale used in the study are included in the annex section for reference.

Statistical analysis

The Python 3 programming language (Van Rossum et al, Amsterdam, Netherlands), with the matplotlib package 3.8.4 (Hunter et al), and the Orange version 3.32 (Demsar et al, Ljubljana, Slovenia) and Prism software v10 (GraphPad Software, Boston, Massachusetts USA) were used for statistical analysis.

The Mann-Whitney test was used to compare two groups, and $p < 0.05$ was considered statistically significant. The Kruskal-Wallis test was used for comparing more than two groups, with Dunn's multiple comparison post hoc test. Correlations were analyzed using the Spearman's correlation coefficient.

Results

None of the participants in this study exhibited acute vestibular signs during their assessment. The groups were randomly matched by age and sex. The test group included 30 participants with an average age of 6.2 ± 1.7 years, with 50% girls and 50% boys. The control group had 20 participants with an average age of 5.9 ± 1.2 years, with 55% girls and 45% boys. The test group had 20 (66%) participants with type B TPG and 10 (33%) with type C TPG. In the control group, all participants had type A TPG. OME was present in 73% of participants in the test group, and completely absent in the control group. Vestibular tests did not reveal significant findings in any of the groups in this study. Regarding acoumetry, in the test group, the Weber test showed lateralization to one of the ears in eight participants (27%) and no lateralization in 22 (73%), while the Rinne test was positive in five participants (17%) and negative in 25 (83%). In the control

group, the Weber test showed lateralization to one of the ears in two participants (10%) and no lateralization in 18 (90%), and the Rinne test was positive in two participants (10%) and negative in 18 (90%).

The average questionnaire score was 14.867 ± 3.256 in the test group, and 1.6 ± 1.245 in the control group ($W = 145.5$, $p = 0.00$). Although statistically significant, these results represent no daily activity limitation due to the vestibular disorder (between 0–16 points).

The results showed no correlation with age, with a Spearman's coefficient of 0.0018 ($S = 20787$, $p = 0.99$), which was higher in the subgroup of participants with type C TPG ($\rho = 0.31$, $S = 197.29$, $p = 0.33$) than in the subgroup with type B ($\rho = 0.08$, $S = 1,217.3$, $p = 0.72$), and was negative in the control group ($\rho = -0.36$, $S = 1,321.1$, $p = 0.13$), with no statistical significance. Our sample showed no statistically significant differences ($W = 168$, $p = 0.65$) when divided into two subgroups with

Table 1
Characteristics of the sample along with the vestibular and audiometric results

	Test group, N = 30		Control group, N = 20	
Age (y)	6,2 ±1,7		5,9 ±1,2	
Sex	Male	Female	Male	Female
	15/50%	15/50%	9/45%	11/55%
Type A TPG (N/%)	0/0%		20/100%	
Type B TPG (N/%)	20/66%		0/0%	
Type C TPG (N/%)	10/33%		0/0%	
OME (N/%)	22/73%		0/0%	
Nystagmus (N/%)	0/0%		0/0%	
HIT (N/%)	0/0%		0/0%	
Skew (N/%)	0/0%		0/0%	
Romberg (N/%)	0/0%		0/0%	
Dysdiadochokinesia (N/%)	0/0%		0/0%	
Gait disorders (N/%)	0/0%		0/0%	
Weber	With lateralization	Without lateralization	With lateralization	Without lateralization
Total N/%	8/27%	22/73%	2/10%	18/90%
Rinne	Positive	Negative	Positive	Negative
Total N/%	5/17%	25/83%	2/10%	18/90%

equal N and increasing age (5–6.5 and 6.5–12 years). The average result was 1.778 ± 1.38 in participants with type A TPG; 11.143 ± 8.093 in those with type C TPG; and 16.4 ± 3.895 in those with type B TPG ($p = 0.014$). Notably, the last group had average results compatible with mild daily limitation. In terms of the objective examination, a statistically significant difference ($p = 0.003$) was also found between participants with (17.0 ± 4.5) and without OME (3.2 ± 1.2).

Discussion

Middle ear pathology has a significant impact on the daily life of children not only due to obvious factors (absenteeism, fever, deafness, language development delay), but also because of its vestibular impact. Participants with OME and type B TPG had higher questionnaire scores in this study, reflecting greater morbidity. Although it is a frequent and common cause of vestibular dysfunction, OME has been scarcely studied¹⁵. However, the absence of acute vestibular signs doesn't conclusively exclude other causes of high questionnaire scores. The limitations of this study are the presence of non-specific symptoms and difficulties among the pediatric population in describing sensations of dizziness and imbalance; therefore, the hypothesis that the questionnaire could detect symptoms other than those arising from vestibular pathology remains open. Future studies on this topic should consider incorporating complementary paraclinical assessments. These may include neurophysiological assessment with cervical vestibular evoked myogenic potential (cVEMP), ocular vestibular evoked myogenic potential (oVEMP), or video HIT (vHIT), which may confirm our results¹⁶, and help to establish a prognosis for the underlying disease¹⁷.

Conclusions

Vestibular dysfunction should not be underestimated in the pediatric population, especially in children with OME or auditory tube dysfunction, as indicated by the higher scores observed in this study. Even in cases where the patients do not present with acute vestibular signs or severe complaints, the impact of this condition on their daily lives can still be significant. Future studies should investigate vestibular dysfunction using neurophysiological tests to confirm the subjective results of our study. It is crucial to actively question parents and caregivers about the vestibular symptoms in their children using instruments to assess their incidence and daily impact. Clinicians should maintain a high level of awareness regarding vestibular symptoms, conducting a targeted objective examination and using instruments and objective tests for ensuring an early diagnosis of vestibular dysfunction.

Conflict of interest

The authors declare that they have no conflict of interest regarding this article.

Data confidentiality

The authors declare that they followed their work protocols when publishing patient data.

People and animals' protection

The authors declare that the procedures followed are in accordance with the regulations established by the directors of the Committee for Clinical Research and Ethics and in accordance with the Declaration of Helsinki of the World Medical Association.

Table 2
DHI-PC scores

Score			
0-16	16-26	26-43	>43
No limitation	Mild limitation	Moderate limitation	Severe limitation

Privacy policy, informed consent and Ethics Committee Authorization

Os autores declaram que têm o consentimento por escrito para o uso de fotografias dos pacientes neste artigo.

Financing

This work did not receive any contribution, funding or scholarship.

Availability of scientific data

There are no publicly available datasets related to this work.

Bibliographic references

- Gioacchini FM, Alicandri-Ciufelli M, Kaleci S, Magliulo G, Re M. Prevalence and diagnosis of vestibular disorders in children: a review. *Int J Pediatr Otorhinolaryngol.* 2014 May;78(5):718-24. doi: 10.1016/j.ijporl.2014.02.009.
- Lee JD, Kim CH, Hong SM, Kim SH, Suh MW, Kim MB, et al. Prevalence of vestibular and balance disorders in children and adolescents according to age: a multi-center study. *Int J Pediatr Otorhinolaryngol.* 2017 Mar;94:36-39. doi: 10.1016/j.ijporl.2017.01.012
- Bower CM, Cotton RT. The Spectrum of vertigo in children. *Arch Otolaryngol Head Neck Surg.* 1995 Aug;121(8):911-5. doi: 10.1001/archotol.1995.01890080077015.
- Pazdro-Zastawny K, Zatoński T. The effect of middle ear effusion on the inner ear condition in children. *Adv Clin Exp Med.* 2020 Mar;29(3):325-330. doi: 10.17219/acem/112601.
- Riina N, Ilmari P, Kentala E. Vertigo and imbalance in children: a retrospective study in a Helsinki University Otorhinolaryngology Clinic. *Arch Otolaryngol Head Neck Surg.* 2005 Nov;131(11):996-1000. doi: 10.1001/archotol.131.11.996.
- Russell G, Ishaq Abu-Arafeh. Paroxysmal vertigo in children—an epidemiological study. *Int J Pediatr Otorhinolaryngol.* 1999 Oct 5;49 Suppl 1:S105-7. doi: 10.1016/s0165-5876(99)00143-3.
- Amorim AM, Ribeiro JC. Prevalence of Pediatric Vestibular Disorders. *Acta Med Port.* 2021 Aug 31;34(9):644-645. doi: 10.20344/amp.16788.
- Sousa EC, Siller AL, Tuma VC, Freitas Ganança C, Ganança MM, Caovilla HH. Relação entre dificuldades de leitura e escrita e sintomas e sinais de vestibulopatia periférica em crianças em idade escolar. *Acta Orl Técnicas em Otorrinolaringologia.* 2008;26(2):112-17
- McCaslin DL, Jacobson GP, Lambert W, English L, Kempf AJ. The development of the vanderbilt pediatric dizziness handicap inventory for patient caregivers (DHI-PC). *Int J Pediatr Otorhinolaryngol.* 2015 Oct;79(10):1662-6. doi: 10.1016/j.ijporl.2015.07.017.
- Nascimento J, Moreira I, Machado E, Monteiro C, Henriques MM, Araújo P. et al. Tradução e adaptação cultural para Portugal do questionário "Vanderbilt Pediatric Dizziness Handicap Inventory for Patient Caregivers" para avaliação de vertigem pediátrica. *Port J ORL [Internet].* 2023 Mar 16 [citado 2023 Sept 4];61(1):47-53. Disponível em: <https://journalsporl.com/index.php/porl/article/view/2007>
- Williamson I. Otitis media with effusion in children. *BMJ Clin Evid.* 2011 Jan 12;2011:0502.
- Goycoolea MV, Muchow D, Schachern P. Experimental studies on round window structure: function and permeability. *Laryngoscope.* 1988 Jun;98(6 Pt 2 Suppl 44):1-20. doi: 10.1288/00005537-198806001-00002.
- Carlborg BI, Konrádsson KS, Carlborg AH, Farmer JC Jr, Densert O. Pressure transfer between the perilymph and the cerebrospinal fluid compartments in cats. *Am J Otol.* 1992 Jan;13(1):41-8.
- Kolkaila EA, Emara AA, Gabr TA. Vestibular evaluation in children with otitis media with effusion. *J Laryngol Otol.* 2015 Apr;129(4):326-36. doi: 10.1017/S0022215115000535.
- Koyuncu M, Saka MM, Tanyeri Y, Seşen T, Unal R, Tekat A, et al. Effects of otitis media with effusion on the vestibular system in children. *Otolaryngol Head Neck Surg.* 1999 Jan;120(1):117-21. doi: 10.1016/S0194-5998(99)70381-5.
- Li S, Huang Y, Chen X, Wang W, Zhang Q, Zhang Q, et al. [Effect of otitis media with effusion on vestibular function in children: a pilot study]. *Lin Chuang Er Bi Yan Hou Tou Jing Wai Ke Za Zhi.* 2020 Mar;34(3):202-206. doi: 10.13201/j.issn.2096-7993.2020.03.004.
- Erkan Yıldız, Abdülkadir Bucak, Selçuk Kuzu. A new and simple test for diagnosis and prognosis in children with otitis media with effusion: cVEMP. *Acta Otolaryngol.* 2019 Nov;139(11):998-1003. doi: 10.1080/00016489.2019.1650199.

Attachment

Translated Portuguese version of the DHI-PC

Name:		Date:	
<p>VANDERBILT PEDIATRIC DIZZINESS HANDICAP INVENTORY (DHI) (Age 5 - 12)</p> <p>Instructions: The purpose of this questionnaire is to identify difficulties that your child may be experiencing because of his or her dizziness or unsteadiness. Please answer "yes", "no" or "sometimes" to each question. Answer each question as it pertains to your child's dizziness problem only.</p>			
	Yes (4)	Sometimes (2)	No (0)
1. Does your child's feel more tired because of this problem?			
2. Is your child's life affected by this problem?			
3. Does your child's problem make it difficult for him/her to play?			
4. Does your child feel frustrated because of this problem?			
5. Because of this problem, does your child feel embarrassed in front of others?			
6. Is it difficult for your child to concentrate because of this problem?			
7. Because of this problem, is your child anxious?			
8. Do other people seem anxious because of your child's problem?			
9. Does your child worry because of this problem?			
10. Does your child feel angry because of this problem?			
11. Does your child feel down because of this problem?			
12. Does your child feel sad because of this problem?			
13. Because of this problem, does your child feel different from other children?			
14. Does your child's problem significantly affect his/her participation in social or educational activities (for example, eating out, meeting with friends, going on field trips or to parties)?			
15. Is it difficult for your child to walk around the house in the dark because of this problem?			
16. Does your child have difficulty walking upstairs because of this problem?			
17. Does your child have difficulty walking for some time because of this problem?			
18. Does your child have difficulty riding a bike, scooter, or using rollerblades because of this problem?			
19. Does your child have difficulty reading or doing schoolwork because of this problem?			
20. Does your child's problem make it difficult for him/her to successfully do activities that others his/her age can do?			
21. Does your child have trouble concentrating at school because of this problem?			
Version 2	Total Score		