CEO Clinical and Experimental Otorhinolaryngology Vol. 18, No. 4: 326-338, November 2025 https://doi.org/10.21053/ceo.2025-00030
pISSN 1976-8710 eISSN 2005-0720

Original Article

Co-occurrence of Otologic Disorders and Benign Paroxysmal Positional Vertigo: A Systematic Review and Meta-Analysis

Mustafa Karabulut[1] · Sevgi Kutlu[2] · Wolfgang Viechtbauer[3] · Ali Melliti[1] · Cem Meço[4,5,6]
Alfarghal Mohamad[7] · Osman Nuri Özgirgin[8] · Anita Bhandari[9] · Herman Kingma[1,10] · Raymond van de Berg[1]

[1]*Department of Otorhinolaryngology and Head and Neck Surgery, School for Mental Health and Neuroscience, Maastricht University Medical Center, Maastricht, the Netherlands*
[2]*Department of Audiology, Faculty of Health Sciences, Ankara University, Ankara, Türkiye*
[3]*Department of Psychiatry and Neuropsychology, Maastricht University, Maastricht, the Netherlands*
[4]*Department of Otorhinolaryngology, Faculty of Medicine, Ankara University, Ankara, Türkiye*
[5]*Department of Otorhinolaryngology-Head and Neck Surgery, Salzburg Paracelsus Medical University, Salzburg, Austria*
[6]*Department of Otolaryngology, Head and Neck Surgery, Cornell University, Weill Cornell Medical College, New York, NY, USA*
[7]*Department of Ear Nose Throat, King Abdulaziz Medical City, Jeddah, Saudi Arabia*
[8]*Department of Otolaryngology-Head and Neck Surgery, Bayındır Hospital, Ankara, Türkiye*
[9]*NeuroEquilibrium Diagnostic Systems Pvt. Ltd., Jaipur, India*
[10]*Department of Otorhinolaryngology, Head and Neck Surgery, Aalborg University Hospital, Aalborg, Denmark*

Objectives. This systematic review was performed to investigate the co-occurrence of otologic disorders and benign paroxysmal positional vertigo (BPPV).

Methods. Searches were conducted in PubMed and Web of Science. The review included all original English-language studies—ranging from full-text clinical trials to case reports—enrolling participants aged ≥18 years. Articles were classified into two groups: group 1 comprised studies reporting otologic disorders in patients diagnosed with BPPV; group 2 comprised studies reporting instances of BPPV among patients with otologic disorders. The frequency of each condition was analyzed using descriptive statistics. Meta-analyses were performed using a random-effects model to estimate overall prevalence in both groups.

Results. The initial search yielded 3,407 records, of which 68 articles were included in the analysis. In group 1 (19 studies), 11.4% of patients with BPPV (932/8,157) had co-occurring otologic disorders. Sudden sensorineural hearing loss (present in 11.9% of patients in relevant included studies) and acute unilateral vestibulopathy/vestibular neuritis (5.0%) were most frequently reported. Meta-analysis produced pooled prevalence rates of 11.8% (95% CI, 3.1%–35.7%) for sudden sensorineural hearing loss and 6.5% (95% CI, 3.7%–11.2%) for acute unilateral vestibulopathy/vestibular neuritis. In group 2 (49 studies), 9.7% of patients with otologic disorders (1,106/11,457) experienced concurrent BPPV, with Menière's disease exhibiting the highest rate of concurrence (10.2%). Meta-analyses showed pooled prevalence rates of 10.4% (95% CI, 6.2%–16.8%) for acute unilateral vestibulopathy/vestibular neuritis and 9.1% (95% CI, 4%–19.1%) for Menière's disease.

Conclusion. The co-occurrence of otologic disorders and BPPV is prevalent. These findings underscore the need for mutual clinical screening and may inform understanding of the etiologies underlying BPPV.

Keywords. *Vertigo, Benign Paroxysmal Positional; Ear Diseases; Hearing Loss, Sudden; Vestibular Neuritis; Meniere Disease*

© 2025 by Korean Society of Otorhinolaryngology-Head and Neck Surgery.
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (https://creativecommons.org/licenses/by-nc/4.0) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

• Received February 1, 2025
Revised May 8, 2025
Accepted June 8, 2025

• Corresponding author: **Mustafa Karabulut**
Division of Balance Disorders, Department of Otorhinolaryngology and Head and Neck Surgery, School for Mental Health and Neuroscience, Maastricht University Medical Center, P. Debyelaan 25, 6229 HX Maastricht, the Netherlands
Tel: +31-43-387-6543, Email: mustafa.karabulut@mumc.nl

INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is a common vestibular disorder of the inner ear in adults, with a lifetime prevalence of 2.4% [1]. This condition most often arises between ages 50 and 70 and disproportionately affects women, with a female-to-male ratio of 2.4:1 [2]. Pathophysiologically, BPPV arises when otoconia detach from the utricular macula of the inner ear. These particles then migrate into the semicircular canals and either float freely (canalolithiasis) [3] or adhere to the cupula (cupulolithiasis) [4]. In rare cases, otoconia may become lodged within the canal, a condition known as canalith jam [5]. Such displacement causes cupular deflection, eliciting brief episodes of spinning vertigo in response to changes in head position [6,7]. BPPV is diagnosed based on the Bárány Society criteria, which combine a clinical history of positional vertigo and/or dizziness with characteristic findings on positional maneuvers, such as the Dix-Hallpike test for anterior/posterior canal involvement or the supine roll test for horizontal canal BPPV [8]. Approximately 50% to 70% of BPPV cases are idiopathic, with no identifiable etiology [9]. In a minority of patients, BPPV co-occurs with otologic disorders or arises in individuals with a history of such conditions [10]. This presents challenges due to overlapping symptoms, such as vertigo and dizziness [11]. Often, these symptoms are attributed to the primary disorder, causing BPPV to be overlooked. Alternatively, failure to thoroughly investigate underlying otologic pathology can result in misclassifying BPPV as idiopathic [11,12]. When co-occurring with an otologic disorder, BPPV most often involves the ipsilateral ear and may manifest concomitantly with or after the primary disorder. However, it remains uncertain whether this association is causal or coincidental. Indeed, most instances lack a definitive causal otologic disease [13]; thus, idiopathic BPPV remains the most common diagnosis [13]. Therefore, identifying potential underlying causes through structured history-taking is essential [14].

Although various otologic disorders—such as acute unilateral vestibulopathy/vestibular neuritis, Menière's disease, labyrinthitis, and other conditions—have been reported in association with BPPV, a detailed overview of the co-occurrence of otologic disorders and BPPV is currently lacking. Since these otologic disorders each have distinct pathophysiological mechanisms, the processes driving their co-occurrence with BPPV may differ from those underlying idiopathic cases [13]. Therefore, the aim of this study was to systematically investigate the co-occurrence of otologic disorders and BPPV.

HIGHLIGHTS

- Benign paroxysmal positional vertigo (BPPV) co-occurs with otologic disorders in 9.7%–11.4% of cases, exceeding the prevalence of BPPV in the general population (2.4%).
- Differences in diagnostic priorities and follow-up protocols may account for the variability in co-occurrence prevalence across studies.
- Overlapping symptoms frequently result in misdiagnosis or delayed identification of BPPV in patients with otologic disorders and vice versa. This underscores the necessity of structured history-taking and detailed vestibular assessments.

MATERIALS AND METHODS

Registration and protocol

The methods and results for this systematic review are reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [15]. The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (www.crd.york.ac.uk/prospero; registration no. CRD42024501512).

Data sources and screening

The final systematic search was conducted on November 7, 2024, in the PubMed and Web of Science (Core collection) databases. During a later review of the search strategy, additional keywords were identified as missing. Therefore, a secondary search was performed on December 25, 2024. The search queries were as follows: "Adult" and "Benign Paroxysmal Positional Vertigo" (Population), "Otologic disorders" (Outcome). No Comparison and Intervention were included. The term "Otologic disorders" encompassed a range of conditions such as "vestibular neuritis," "labyrinthitis," "sudden sensorineural hearing loss," "Menière's disease," "post-surgical complications," "benign recurrent vertigo," "autoimmune inner ear disease," and "congenital." Specific search queries were used (Supplementary Tables 1 and 2), and these queries were developed by two reviewers (MK and SK). No filters were applied.

Study selection

The relevant articles were selected using predetermined inclusion and exclusion criteria (as outlined below). All publications were first imported into EndNote X9 software. Subsequently, the "Find Duplicates" option was applied to remove publications appearing in multiple databases. Two reviewers (MK and SK) independently screened the articles by title and abstract (stage 1) and then conducted a full-text review of the articles (stage 2). After each stage, discrepancies between the reviewers regarding the inclusion and exclusion criteria were discussed in consensus meetings. Finally, the references of the articles included after stage 2 were also screened, and relevant articles were included to ensure that no pertinent articles were overlooked.

Inclusion and exclusion criteria

The inclusion and exclusion criteria can be found in Supplementary Table 3. The screening process was conducted sequentially, focusing first on study design, followed by population, and finally on outcomes. Regarding study design, all original studies written in English, ranging from full-text clinical trials to case reports, were included. Conference abstracts/reports, letters, animal studies, editorials, (systematic) reviews, and meta-analyses were excluded. Concerning the study population, only studies involving adult BPPV patients (≥18 years) were selected. Studies involving healthy subjects, model studies, animal studies, and temporal bone studies were excluded. Regarding outcomes, only studies that reported otologic disorders in conjunction with BPPV were considered. An otologic disorder was defined as a condition primarily originating from the inner ear, middle ear, ear canal or vestibulocochlear nerve disorder. Therefore, conditions with mixed origin (e.g. vestibular migraine), were excluded. Articles reporting light/heavy cupula or hypotheses of BPPV were excluded. Patients with functional vestibular disorders (e.g., persistent postural perceptual dizziness, mal de debarquement syndrome), cerebellar disorders, and central nervous system disorders (e.g., stroke, posterior circulation, multiple sclerosis) were excluded. Head trauma may cause detachment of the otoliths. However, head trauma in the absence of objective evidence of inner ear damage is not an otologic disease. Traumatic BPPV was therefore considered to be neither idiopathic nor secondary BPPV and excluded from the study.

Quality assessment

The Quality in Prognosis Studies (QUIPS) tool was applied to evaluate the risk of bias. The level of evidence was determined following the EBRO-platform (Evidence-Based Guideline Development) [16]. Level A1, A2, B, C, or D could be given, based on different items such as the number of participants and statistical power (Supplementary Table 4). The risk of bias and level of evidence were independently evaluated by both reviewers, who then discussed their findings during a consensus meeting. Each study's overall risk of bias score was assigned according to the checklist guidelines, categorized as "low risk of bias," "uncertain risk of bias," or "high risk of bias." Four types of biases were considered.

(1) Selection bias: "low risk of bias" in case diagnostic criteria of otologic disorders/BPPV were clearly reported, "uncertain risk of bias" in case diagnostic criteria were not clearly reported. (2) Attrition bias: "low risk of bias" in case the drop-out rate was below 20%, "uncertain risk of bias" in case the drop-out rate was not reported, and "high risk of bias" in case the drop-out rate was above 20%. (3) Detection bias: "low risk of bias" if co-occurring otologic disorders/BPPV were clearly reported, with all conditions quantitatively presented and no missing data. "Uncertain risk of bias" if co-occurring otologic disorders/BPPV were reported but not all were quantitatively presented, and no missing data was present. "High risk of bias" if co-occurring otologic disorders/BPPV were reported but not all were quantitatively presented, and missing data was present. (4) Publication bias: "low risk of bias" in case the statistical analysis was clearly reported, "uncertain risk of bias" in case the statistical analysis was not clearly reported, "high risk of bias" in case the statistical analysis was not appropriate for the design of the study [17].

Interrater reliability was assessed using Cohen's kappa. Kappa values were classified as follows: no agreement (values <0), slight (0.01–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and almost perfect agreement (0.81–1.00) [18]. Cohen's kappa was applied to evaluate the four types of bias: selection, attrition, detection, and publication bias.

Data extraction

Relevant data from the included articles were extracted by both reviewers (for more details, see Supplementary Tables 5 and 6). Otologic disorders included outer, middle and inner ear, as well as eight cranial nerve pathologies. In case the otologic disorder was not clearly reported, those were labelled as missing. The characteristics of the patients were extracted, including disease percentage (%), total number of patients in the study, the number of patients in the study reporting otologic disorders/BPPV, the number of idiopathic cases of BPPV, and non-otologic causes of BPPV. Two groups of articles were identified. Group 1: studies about BPPV patients in which co-occurring otologic disorders were reported; Group 2: studies about otologic disorders in which co-occurring BPPV was reported. The frequency of co-occurring otologic disorders and BPPV was analyzed in both groups.

Statistical analysis

Descriptive statistics (number and percentage) were used to show the frequency of each disorder. The percentage of each disorder was calculated by dividing the total number of patients reporting a specific disorder by the total number of patients included in the same study and multiplying the resulting proportion by 100. It was decided not to divide by the total number of patients included across all studies because patients did not have the opportuni-

ty to report a specific disorder in each study. Next, the study-specific proportions for each disease (e.g., Menière's disease, acute unilateral vestibulopathy/vestibular neuritis, labyrinthitis, etc.) were synthesized through meta-analyses, which were conducted to more accurately assess the heterogeneity across studies and estimate the overall prevalence. The meta-analyses were conducted for the two groups of studies separately (BPPV with co-occurring otologic disorders, and vice versa). Logit-transformed proportions and variances were calculated, and a random-effects model was used to estimate the pooled prevalences [19,20] along with corresponding 95% CI. A 95% prediction interval (PI) was also reported, which indicated a range of plausible true prevalence values for a new study from the same population [21]. Heterogeneity was assessed using Cochran's Q statistic, its degrees of freedom (df), and its corresponding *P*-value. Higgins' I^2 (%) was used to quantify the proportion of heterogeneity attributable to true between-study variability [22]. The outliers were identified using Baujat plots and excluded as deemed necessary. Funnel plots were generated to assess potential publication biases. The final results were visualized using forest and funnel plots. Finally, a one-sample proportion test was conducted to compare the observed proportions with the known prevalence reported in the general population. All statistical analyses were conducted using R version 4.2.2 [23] with the metafor package version 3.8.1 [24].

RESULTS

The initial search retrieved 3,345 articles. After removing 690 duplicates via EndNote (Clarivate Analytics), 2,655 records underwent title and abstract screening, and full-text review resulted in 61 included articles [10,25-84]. The secondary search yielded 62 articles; after removing 22 duplicates with EndNote, 40 remained for title and abstract screening. After full-text review, seven articles were found to meet the inclusion criteria [85-91]. In total, 68 articles were included in this study (Fig. 1).

Group 1: co-occurring otologic disorders in patients with BPPV—descriptive statistics

Nineteen studies [10,29,30,38,39,45,53,54,56,59,61,62,65,67,72,76,78,80,83] reported on otologic comorbidities among patients with BPPV. Across these studies, 11.4% of individuals with BPPV exhibited at least one co-occurring otologic disorder. Sudden sensorineural hearing loss was the most frequently observed condition (found in 11.9% of patients with BPPV in studies of this condition), followed by acute unilateral vestibulopathy/vestibular neuritis (5.0%), whereas labyrinthitis occurred in 2.8% of cases (Table 1). Furthermore, a variety of other otologic and non-otologic disorders were reported (Supplementary Tables 7 and 8, respectively).

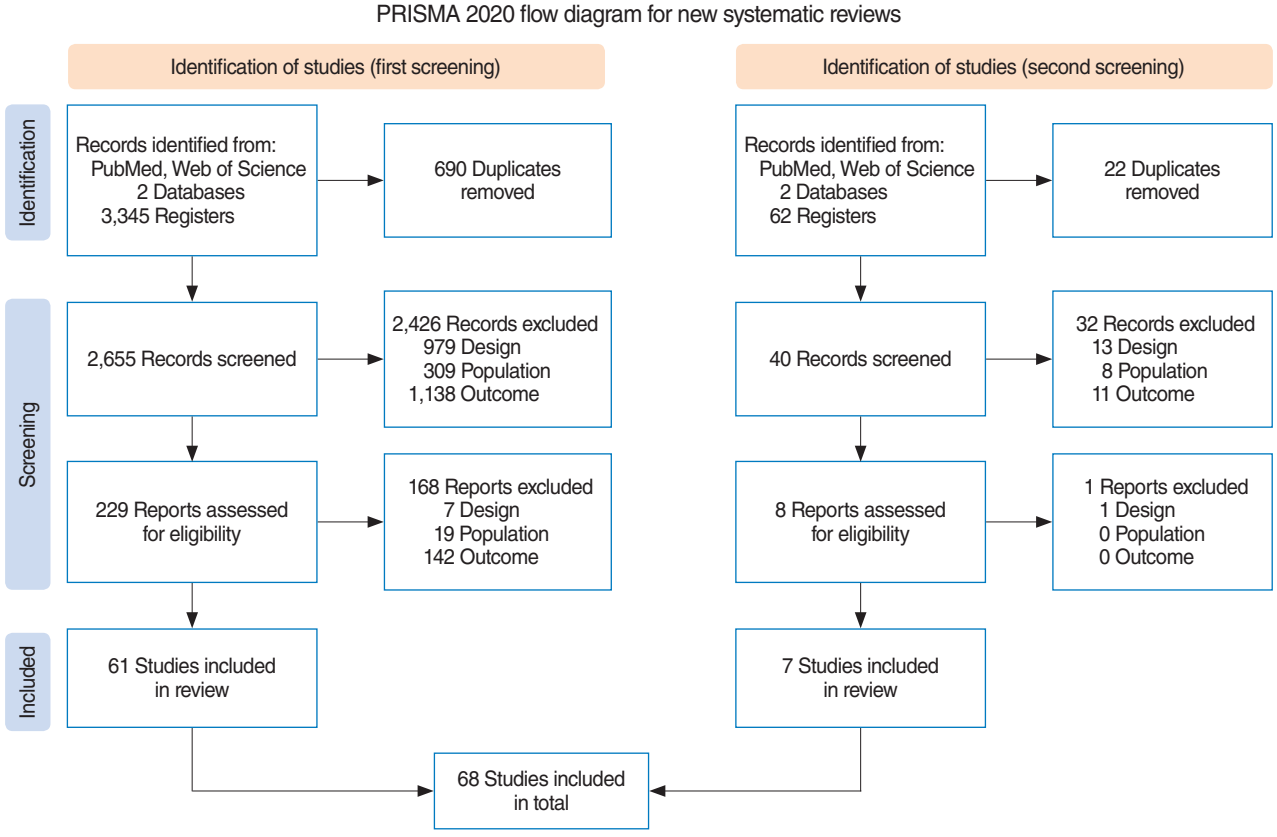


Fig. 1. Flowchart of study selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1. Prevalence of co-occurring otologic disorders among patients with BPPV (19 studies)

Variable	No. of reported studies	No. of patients with otologic disorders	Total no. of patients with BPPV	Percentage (%)
Post-surgical complications	2	25	532	4.7
Labyrinthitis	4	16	567	2.8
Acute unilateral vestibulopathy/vestibular neuritis	12	297	5,920	5.0
Menière's disease	13	318	6,927	4.6
Sudden sensorineural hearing loss	5	183	1,543	11.9
Others	7	93	4,198	2.2
Total	19	932	8,157	11.4
Idiopathic BPPV	18	3,890	5,310	73.3

BPPV, benign paroxysmal positional vertigo.

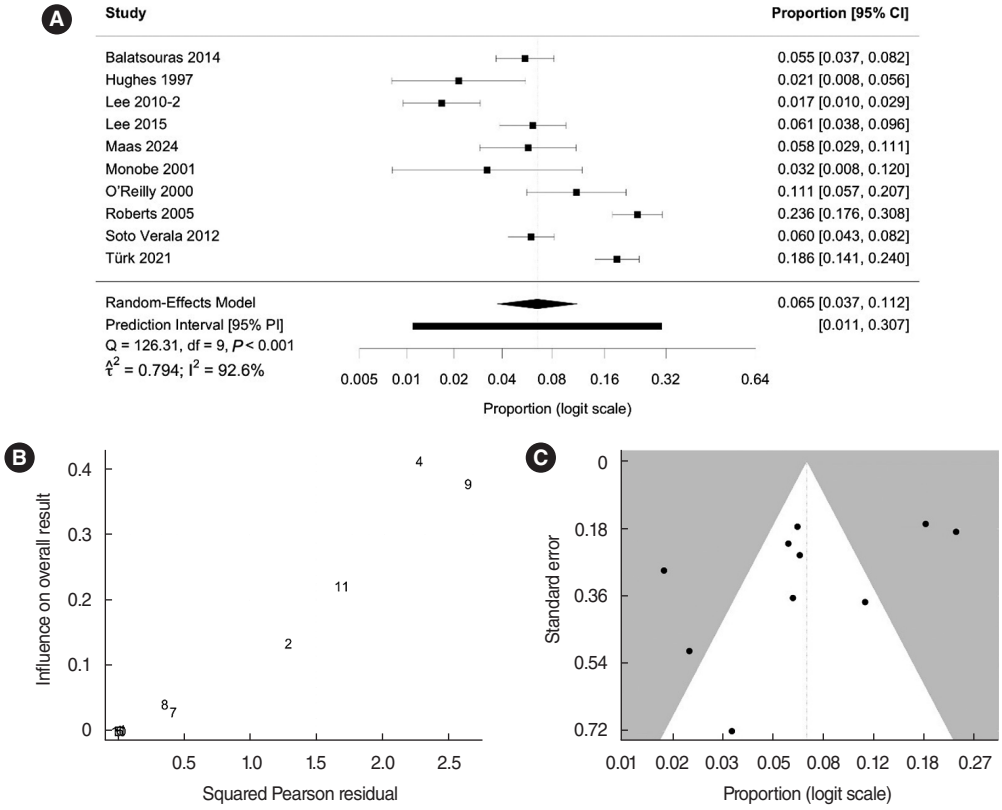


Fig. 2. (A) Forest plot of the meta-analysis for co-occurring acute unilateral vestibulopathy/vestibular neuritis in benign paroxysmal positional vertigo. (B) Baujat plot identifying Karlberg 2000 [10] and Waissbluth 2023 [80] as outliers. (C) Funnel plot illustrating asymmetry.

Meta-analyses for group 1

Acute unilateral vestibulopathy/vestibular neuritis

A meta-analysis of co-occurring acute unilateral vestibulopathy/vestibular neuritis in patients with BPPV initially included 12 studies; after excluding two outliers identified via Baujat plot (Karlberg 2000 [10] and Waissbluth 2023 [80]), 10 studies remained for the final analysis. The pooled prevalence was 6.5% (95% CI, 3.7%–11.2%). Heterogeneity remained high (Q=126.31, df=9, P<0.001; I^2=92.6%), with individual study proportions ranging from 1.7% to 23.6%. The 95% PI indicated that the true prevalence rate might lie between 1.1% and 30.7%. Funnel-plot asymmetry indicated possible publication bias, likely due to underreporting of smaller studies reporting higher prevalences (Fig. 2).

Menière's disease

Thirteen studies were initially included regarding the prevalence of co-occurring Menière's disease in patients with BPPV. However, two outliers (Karlberg 2000 [10] and Hughes 1997 [45]) were excluded based on Baujat plot results. The pooled prevalence of the 11 remaining studies was 5.3% (95% CI, 3.4%–8.2%). Heterogeneity remained high (Q=64.80, df=10, P<

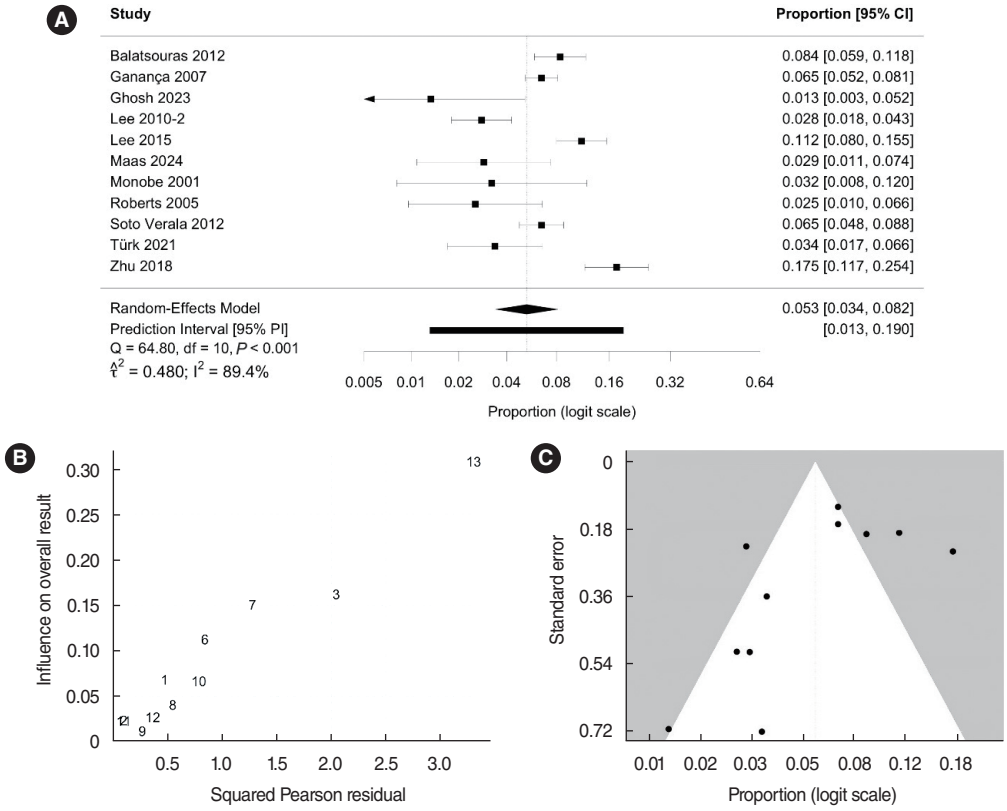


Fig. 3. (A) Forest plot of the meta-analysis for co-occurring Menière's disease in benign paroxysmal positional vertigo. (B) Baujat plot identifying Karlberg 2000 [10] and Hughes 1997 [45] as outliers. (C) Funnel plot illustrating asymmetry.

0.001; I^2=89.4%), with individual study estimates ranging from 1.3% to 17.5%. The 95% PI spanned 1.3%–19%, indicating that the true prevalence of co-occurrence could vary within this range. Funnel-plot asymmetry suggested potential publication bias (Fig. 3).

Sudden sensorineural hearing loss and labyrinthitis

The pooled prevalence of sudden sensorineural hearing loss was 11.8% (95% CI, 3.1%–35.7%; 95% PI, 0.4%–80.5%), and for labyrinthitis it was 2.9% (95% CI, 0.9%–8.4%; 95% PI, 0.3%–21.4%). Both analyses exhibited high heterogeneity (I^2=98.3% and I^2=75.9%, respectively) (Fig. 4). Because only five studies contributed data on sudden sensorineural hearing loss and four on labyrinthitis, outlier detection and publication bias assessments were not performed.

Group 2: co-occurring BPPV in patients with otologic disorders—descriptive statistics

A total of 49 studies [25-28,31-37,40-44,46-52,55,57,58,60,63,64,66,68-71,73-75,77,79,81,82,84-91] evaluated the prevalence of BPPV among patients with primary otologic diagnoses. Across these studies, 9.7% of patients with otologic disorders had co-occurring BPPV. Menière's disease demonstrated the highest co-occurrence rate at 10.2%, while post-surgical complications were least frequently associated (3.7%) (Table 2).

Meta-analyses for group 2

Acute unilateral vestibulopathy/vestibular neuritis

A meta-analysis was conducted regarding co-occurring BPPV in patients with acute unilateral vestibulopathy/vestibular neuritis. Initially, 11 studies were included. After excluding two case reports (Rambold 2004 [71] and Zapala 2006 [82]) and one outlier (Harada 1993 [43]), eight studies remained for the final meta-analysis. The pooled prevalence of BPPV in this population was 10.4% (95% CI, 6.2%–16.8%). Significant heterogeneity persisted (Q=64.57, df=7, P<0.001; I^2=87.2%), with prevalence estimates ranging from 3.2% to 21.3%. The 95% PI suggested that the true prevalence could range from 2.5% to 34.6% (Fig. 5).

Menière's disease

Ten studies were initially included regarding the assessment of co-occurring BPPV in patients with Menière's disease. However, two case reports (Baker 2020 [28] and Psillas 2011 [70]) and one outlier [Li 2010 [60]), identified via Baujat plot, were excluded, leaving seven studies for meta-analysis. The pooled prevalence was 9.1% (95% CI, 4%–19.1%). Despite these exclusions, heterogeneity remained high (Q=223.34, df=6, P< 0.001; I^2=97.1%), with study-specific estimates ranging from

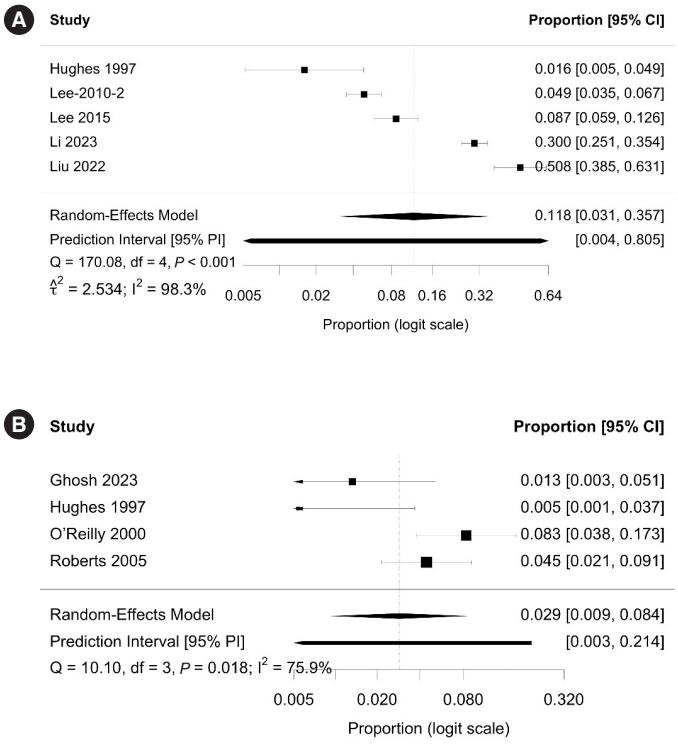


Fig. 4. Forest plots of the meta-analyses for co-occurring sudden sensorineural hearing loss (A) and labyrinthitis (B) in benign paroxysmal positional vertigo.

Table 2. Prevalence of co-occurring BPPV among patients with otologic disorders (49 studies)

Variable	No. of reported studies	No. of reported patients with BPPV	Total No. of patients with otologic disorders	Percentage (%)
Post-surgical complications	16	141	3,811	3.7
Labyrinthitis	4	87	1,609	5.4
Acute unilateral vestibulopathy/Vestibular neuritis	11	154	1,984	7.8
Menière's disease	10	273	2,678	10.2
Sudden sensorineural hearing loss	9	287	5,478	5.2
Others	10	164	1,757	9.3
Total	49	1,106	11,457	9.7

BPPV, benign paroxysmal positional vertigo.

2.4% to 32.4%. The 95% PI suggested that the true prevalence could lie between 0.9% and 52.2% (Fig. 6).

Sudden sensorineural hearing loss and post-surgical complications

Co-occurring BPPV was reported in seven studies of patients with sudden sensorineural hearing loss, with a pooled prevalence of 9% (95% CI, 5.6%–14.4%; 95% PI, 2.5%–28.4%). Among 11 studies examining post-surgical complications, the pooled prevalence of BPPV was 5.2% (95% CI, 3.3%–8.3%; 95% PI, 1.2%–19.3%). Both meta-analyses exhibited high heterogeneity (I^2=91.8% and I^2=80.2%, respectively) (Fig. 7). Baujat and funnel plots for these analyses are provided in Supplementary Figs. 1 and 2. Based on a one-sample proportion test, the observed prevalence of co-occurrence (9.7%–11.4%) was found to be significantly higher than the 2.4% prevalence in the general population (P<0.001).

Risk of bias and level of evidence

In the assessment of inter-rater agreement, Cohen kappa analysis yielded scores of 0.83 for selection bias, 0.78 for attrition bias, 0.82 for detection bias, and 0.76 for publication bias—indicating substantial to almost perfect agreement between the two raters across all domains. Regarding level of evidence, all interventional cross-sectional studies with control groups were classified as level B evidence due to the inclusion of these controls (n=14). Most studies (n=53) were graded as level C, primarily due to small sample sizes and non-comparative designs. Only one study—a randomized, double-blind trial with an adequate

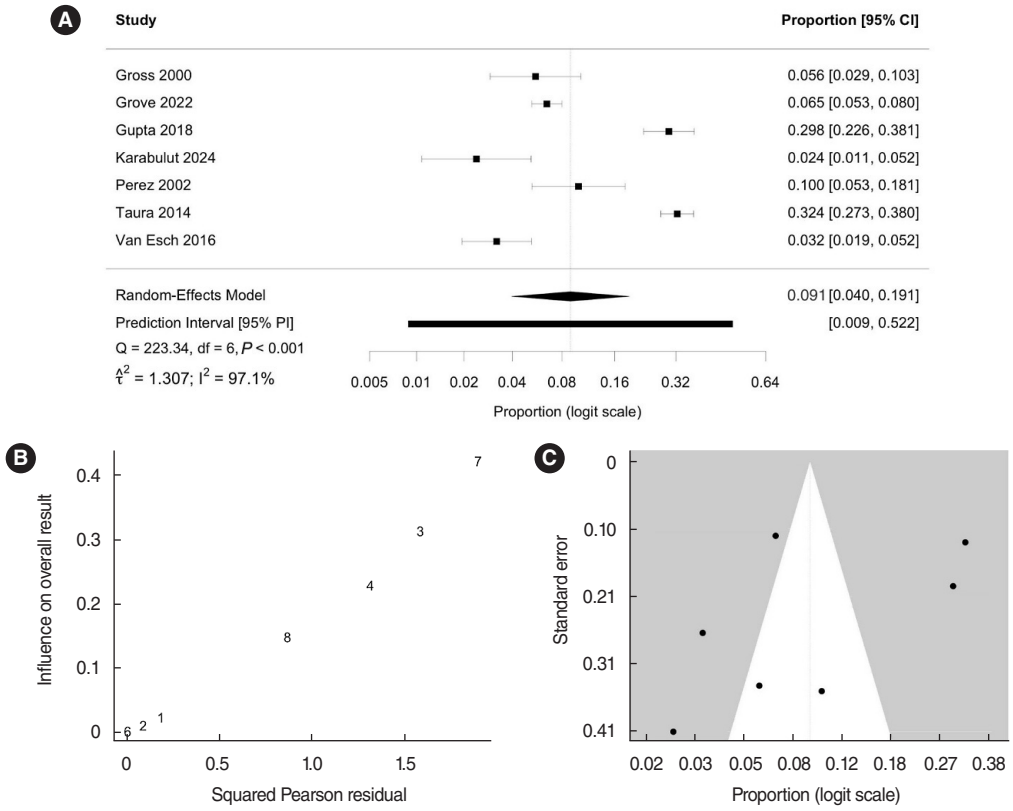


Fig. 5. (A) Forest plot of the meta-analysis for co-occurring benign paroxysmal positional vertigo in patients with acute unilateral vestibulopathy/vestibular neuritis. (B) Baujat plot identifying Harada 1993 [43] as an outlier. (C) Funnel plot illustrating asymmetry.

number of participants—achieved a level A2 rating (Supplementary Table 9).

DISCUSSION

This study investigated the co-occurrence of otologic disorders and BPPV. The findings revealed that 11.4% of patients with BPPV had co-occurring otologic disorders (group 1), whereas 9.7% of patients with otologic disorders had co-occurring BPPV (group 2). In group 1, sudden sensorineural hearing loss was the most prevalent condition, followed by acute unilateral vestibulopathy/vestibular neuritis. In group 2, Menière's disease and acute unilateral vestibulopathy/vestibular neuritis were the most common. However, both groups exhibited substantial heterogeneity, reflecting considerable variability in prevalence rates across the included studies.

Compared with the general population, BPPV appeared to co-occur more frequently in patients with certain otologic disorders. This finding underscores the importance of incorporating vestibular evaluation into the diagnostic workup. Early identification of coexisting BPPV may enable targeted vestibular management, improving treatment strategies and patient outcomes. The pooled prevalence rates for groups 1 and 2 differed. For instance, acute unilateral vestibulopathy/vestibular neuritis occurred in 6.5% of patients with BPPV, whereas BPPV was present in 10.4% of patients with acute unilateral vestibulopathy/vestibular neuritis. Several factors might account for these discrepancies.

First, diagnostic priorities may influence outcomes. Many clinicians focus on positional tests—such as the Dix–Hallpike or supine roll maneuvers—when positional vertigo is the primary concern. This emphasis often expedites the diagnosis of BPPV, since these tests are both quick and specific, potentially reducing the extent of history-taking and assessment [11]. This review demonstrated that the prevalence of secondary otologic disorders associated with BPPV, such as acute unilateral vestibulopathy/vestibular neuritis and Menière's disease, ranges from 3.5% to 12%. In clinical practice, however, most patients with vestibular symptoms receive a single diagnosis: multiple vestibular disorders are identified in only 3.7% [92] to 30.1% [93,94] of cases. These findings underscore the importance of explicitly screening for underlying otologic disorders when diagnosing BPPV [95], and vice versa. BPPV and other otologic conditions (e.g., vestibular hypofunction] may share overlapping symptoms, such as dizziness triggered by rapid head movements [94]. At a minimum, explicit screening should include structured history-taking, such as the four-step approach [14].

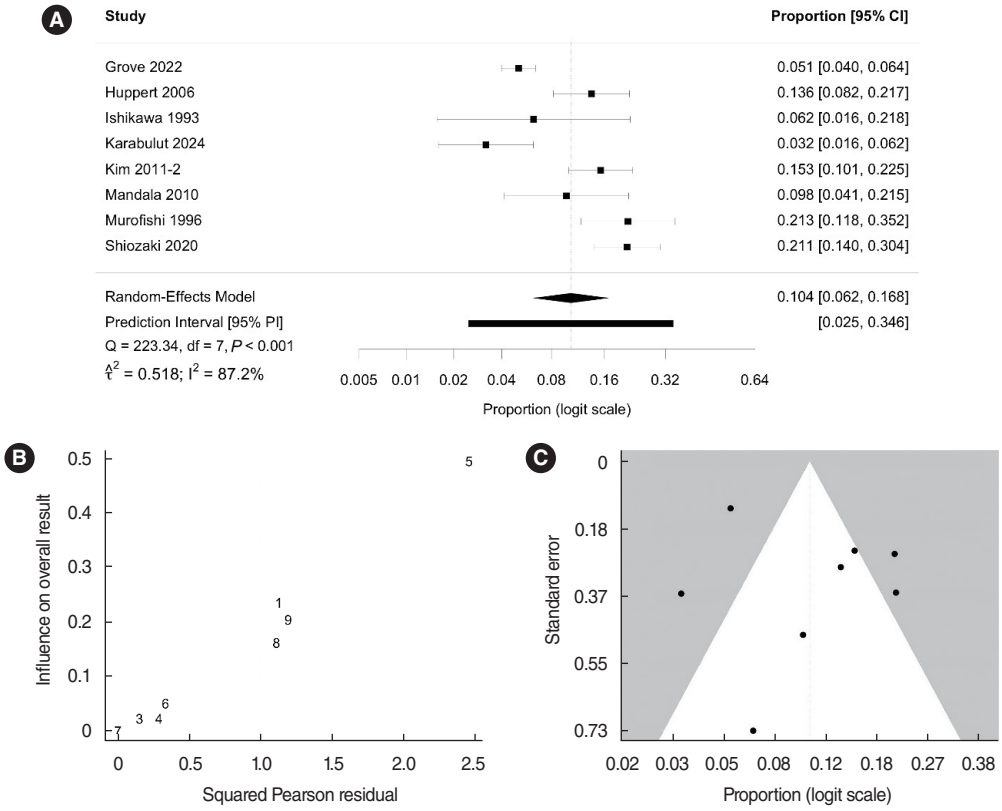


Fig. 6. (A) Forest plot of the meta-analysis for co-occurring benign paroxysmal positional vertigo in patients with Menière's disease. (B) Baujat plot identifying Li 2010 [60] as an outlier. (C) Funnel plot illustrating asymmetry.

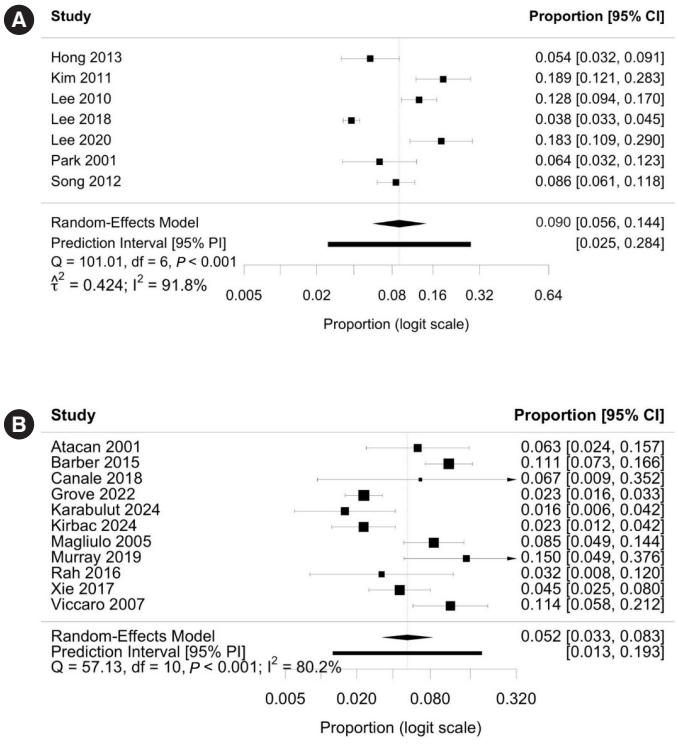


Fig. 7. Forest plots of the meta-analyses for co-occurring benign paroxysmal positional vertigo in patients with (A) sudden sensorineural hearing loss and (B) post-surgical complications.

Second, follow-up protocols varied across studies. BPPV often resolves rapidly following canalith repositioning maneuvers and may not warrant prolonged monitoring, whereas otologic disorders typically require extended follow-up [96]. This phenomenon may have increased the likelihood of detecting BPPV in these patients over time.

In this review, acute unilateral vestibulopathy/vestibular neuritis, Menière's disease, and sudden sensorineural hearing loss were reported more frequently, while other disorders were less commonly documented. This pattern suggests that these otologic conditions and BPPV may share underlying etiologies.

Acute unilateral vestibulopathy/vestibular neuritis and BPPV

The relationship between BPPV and acute unilateral vestibulopathy/vestibular neuritis remains unclear but may involve inflammation of the (primarily superior) vestibular nerve or ischemia of the anterior vestibular artery. Both the superior vestibular nerve and the anterior vestibular artery supply the utricle and the anterior and lateral semicircular canals. Consequently, inflammation or ischemia can damage these structures, potentially causing otoconia to detach from the utricle. Once detached, otoconia may migrate into the semicircular canals [97,98]. This phenomenon—BPPV following acute unilateral vestibulopathy/vestibular neuritis—is known as Lindsay-Hemenway syndrome [99].

Menière's disease and BPPV

Menière's disease is characterized by endolymphatic hydrops, with potential disruption of the inner ear fluid homeostasis [100]. This imbalance may damage the utricle and saccule, causing otoconia to detach from the utricle. These displaced otoconia can then migrate into the semicircular canals, resulting in secondary BPPV. Conversely, it has been hypothesized that BPPV might contribute to the development of Menière's disease. Detached otoconia could obstruct the endolymphatic duct, impairing endolymph drainage and leading to hydrops [101]. However, this hypothesis remains speculative and is not yet supported by robust clinical data.

Sudden sensorineural hearing loss and BPPV

Idiopathic sudden sensorineural hearing loss appears to be associated with BPPV. Although the precise mechanism remains unclear, nerve inflammation or vascular injury to the vestibular system—mechanisms similar to those implicated in acute unilateral vestibulopathy/vestibular neuritis—may cause otoconia to detach, resulting in BPPV [4,37,50].

In addition to a potential shared etiology, factors such as selection and publication biases may have influenced our findings. The studies included in this review may have selectively focused on certain otologic disorders, reflecting clinical practices that prioritize diagnosing and reporting those conditions [102]. Likewise, publication bias is possible, since studies demonstrating significant associations with specific disorders are more likely to appear in the literature. Indeed, funnel-plot asymmetries for several disorders suggest that smaller studies with higher prevalence rates may be underreported. Consequently, the prevalence estimates presented here may not fully represent the true distribution of otologic disorders in the BPPV population.

Even with detailed history-taking, identifying the etiology of BPPV or otologic disorders can be challenging, especially in cases of co-occurrence. For instance, this review included two BPPV cases reported following canal wall down surgery [26,34], making it difficult to establish whether BPPV resulted from cholesteatoma extension into the inner ear or from surgical manipulation (e.g., temporal bone drilling). Likewise, three cases of BPPV occurred after surgery to address superior canal dehiscence syndrome (SCDS) [31,73,81], and distinguishing whether BPPV reflects the underlying SCDS or is a complication of the procedure continues to pose a challenge. While BPPV may not necessarily develop from these disorders, overlapping symptoms (e.g., vertigo) can mimic BPPV and complicate its diagnosis. Therefore, in such cases, careful evaluation is essential to accurately identify any potential BPPV. Lastly, several additional otologic disorders—such as bilateral vestibulopathy and vestibular schwannoma—have been reported to co-occur with BPPV [10,45]. Although these co-occurrences appear uncommon, clinicians should remain mindful of them.

This systematic review has several limitations. First, some of the included studies lacked detailed clinical data, which may limit the generalizability of the findings and hinder accurate assessment of the relationship between otologic disorders and BPPV. Second, because most studies were observational, establishing causal relationships was challenging. Finally, high heterogeneity (I^2>90%) was observed across studies, likely reflecting clinical and methodological differences. Although PIs were provided to aid interpretation, the relatively small number of studies precluded further analyses to explore sources of heterogeneity.

To conclude, the co-occurrence of otologic disorders and BPPV is prevalent (9.7%–11.4%). The present findings underscore the need for explicit mutual screening of BPPV and otologic disorders. Moreover, they may help clarify the underlying etiologies of BPPV.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Mustafa Karabulut https://orcid.org/0000-0002-6149-3967
Sevgi Kutlu https://orcid.org/0000-0002-2175-5280

Wolfgang Viechtbauer https://orcid.org/0000-0003-3463-4063
Ali Melliti https://orcid.org/0009-0002-4786-3164
Cem Meço https://orcid.org/0000-0001-8372-8045
Alfarghal Mohamad https://orcid.org/0000-0003-1774-7728
Osman Nuri Özgirgin https://orcid.org/0000-0002-2520-1859
Anita Bhandari https://orcid.org/0000-0002-4134-8885
Herman Kingma https://orcid.org/0000-0001-9880-8224
Raymond van de Berg https://orcid.org/0000-0001-9734-8668

AUTHOR CONTRIBUTIONS

Conceptualization: MK, SK, RB. Methodology: MK, SK, AM (Ali Melliti), CM, AM (Alfarghal Mohamad), ONÖ, AB, HK. Formal analysis: MK, SK, WV, AM (Ali Melliti). Data curation: MK, SK, WV. Visualization: MK, WV. Project administration: RB. Writing–original draft: MK. Writing–review & editing: WV, AM (Ali Melliti), CM, AM (Alfarghal Mohamad), ONÖ, AB, HK, RB. All authors read and agreed to the published version of the manuscript.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found online at https://doi.org/10.21053/ceo.2025-00030.

REFERENCES

1. von Brevern M, Radtke A, Lezius F, Feldmann M, Ziese T, Lempert T, et al. Epidemiology of benign paroxysmal positional vertigo: a population based study. J Neurol Neurosurg Psychiatry. 2007 Jul; 78(7):710-5.
2. Kim HJ, Park J, Kim JS. Update on benign paroxysmal positional vertigo. J Neurol. 2021 May;268(5):1995-2000.
3. Hall SF, Ruby RR, McClure JA. The mechanics of benign paroxysmal vertigo. J Otolaryngol. 1979 Apr;8(2):151-8.
4. Schuknecht HF. Cupulolithiasis. Arch Otolaryngol. 1969 Dec;90(6): 765-78.
5. Castellucci A, Malara P, Ghidini A. Spontaneous downbeat nystagmus in posterior semicircular canal benign paroxysmal positional vertigo: a canalith jam? Neurol Sci. 2021 Jan;42(1):313-5.
6. Lee SH, Kim JS. Benign paroxysmal positional vertigo. J Clin Neurol. 2010 Jun;6(2):51-63.
7. Parnes LS, McClure JA. Free-floating endolymph particles: a new operative finding during posterior semicircular canal occlusion. Laryngoscope. 1992 Sep;102(9):988-92.
8. von Brevern M, Bertholon P, Brandt T, Fife T, Imai T, Nuti D, et al. Benign paroxysmal positional vertigo: diagnostic criteria. J Vestib Res. 2015;25(3-4):105-17.
9. Ozgirgin ON, Kingma H, Manzari L, Lacour M. Residual dizziness after BPPV management: exploring pathophysiology and treatment beyond canalith repositioning maneuvers. Front Neurol. 2024 May; 15:1382196.
10. Karlberg M, Hall K, Quickert N, Hinson J, Halmagyi GM. What inner ear diseases cause benign paroxysmal positional vertigo? Acta Otolaryngol. 2000 Mar;120(3):380-5.
11. Kerber KA, Newman-Toker DE. Misdiagnosing dizzy patients: common pitfalls in clinical practice. Neurol Clin. 2015 Aug;33(3): 565-75.
12. van Dam VS, Maas BD, Schermer TR, van Benthem PG, Bruintjes TD. Two symptoms strongly suggest benign paroxysmal positional vertigo in a dizzy patient. Front Neurol. 2021 Jan;11:625776.
13. Riga M, Bibas A, Xenellis J, Korres S. Inner ear disease and benign paroxysmal positional vertigo: a critical review of incidence, clinical characteristics, and management. Int J Otolaryngol. 2011;2011: 709469.
14. van de Berg R, Kingma H. History taking in non-acute vestibular symptoms: a 4-step approach. J Clin Med. 2021 Dec;10(24):5726.
15. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar;372:n71.
16. Burgers JS, van Everdingen JJ. Evidence-based guideline development in the Netherlands: the EBRO platform. Ned Tijdschr Geneeskd. 2004 Oct;148(42):2057-9.
17. Hayden JA, van der Windt DA, Cartwright JL, Cote P, Bombardier C. Assessing bias in studies of prognostic factors. Ann Intern Med. 2013 Feb;158(4):280-6.
18. Cohen J. A coefficient of agreement for nominal scales. Educ Psychol Meas. 1960 Apr;20(1):37-46.
19. Borenstein M, Hedges LV, Higgins JP, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods. 2010 Apr;1(2):97-111.
20. DerSimonian R, Laird N. Meta-analysis in clinical trials revisited. Contemp Clin Trials. 2015 Nov;45(Pt A):139-45.
21. IntHout J, Ioannidis JP, Rovers MM, Goeman JJ. Plea for routinely presenting prediction intervals in meta-analysis. BMJ Open. 2016 Jul;6(7):e010247.
22. Higgins JP. Commentary: heterogeneity in meta-analysis should be expected and appropriately quantified. Int J Epidemiol. 2008 Oct; 37(5):1158-60.
23. R Core Team. A language and environment for statistical computing. R Foundation for Statistical Computing; 2021.
24. Viechtbauer W. Conducting meta-analyses in R with the metafor package. J Stat Softw. 2010 Aug;36(3):1-48.
25. Ahmed S, Heidenreich KD, McHugh JB, Altschuler RA, Carender WJ, Telian SA. Refractory positional vertigo with apogeotropic horizontal nystagmus after labyrinthitis: surgical treatment and identification of dysmorphic ampullae. Otol Neurotol. 2015 Sep; 36(8):1417-20.
26. Aron M, Bance M. Insights into horizontal canal benign paroxysmal positional vertigo from a human case report. Laryngoscope. 2013 Dec;123(12):3197-200.
27. Atacan E, Sennaroglu L, Genc A, Kaya S. Benign paroxysmal positional vertigo after stapedectomy. Laryngoscope. 2001 Jul;111(7): 1257-9.
28. Baker BJ, May C. Meniere's disease and concurrent BPPV in an older adult: a case report. Phys Occup Ther Geriatr. 2020 Jan;38(1): 98-106.
29. Balatsouras DG, Ganelis P, Aspris A, Economou NC, Moukos A, Koukoutsis G. Benign paroxysmal positional vertigo associated with Meniere's disease: epidemiological, pathophysiologic, clinical, and therapeutic aspects. Ann Otol Rhinol Laryngol. 2012 Oct;121(10): 682-8.
30. Balatsouras DG, Koukoutsis G, Ganelis P, Economou NC, Moukos A, Aspris A, et al. Benign paroxysmal positional vertigo secondary to vestibular neuritis. Eur Arch Otorhinolaryngol. 2014 May;271(5): 919-24.
31. Barber SR, Cheng YS, Owoc M, Lin BM, Remenschneider AK, Kozin ED, et al. Benign paroxysmal positional vertigo commonly

occurs following repair of superior canal dehiscence. Laryngoscope. 2016 Sep;126(9):2092-7.
32. Canale A, Caranzano F, Lanotte M, Ducati A, Calamo F, Albera A, et al. Comparison of VEMPs, VHIT and caloric test outcomes after vestibular neurectomy in Menière's disease. Auris Nasus Larynx. 2018 Dec;45(6):1159-65.
33. Casani AP, Cerchiai N, Navari E. Paroxysmal positional vertigo despite complete vestibular impairment: the role of instrumental assessment. Acta Otorhinolaryngol Ital. 2018 Dec;38(6):563-8.
34. Castellucci A, Botti C, Bettini M, Fernandez IJ, Malara P, Martellucci S, et al. Case report: could Hennebert's sign be evoked despite global vestibular impairment on video head impulse test?: considerations upon pathomechanisms underlying pressure-induced nystagmus due to labyrinthine fistula. Front Neurol. 2021 Mar;12: 634782.
35. Comacchio F, Mion M, Armato E, Castellucci A. Sequential vestibular neuritis: report of four cases and literature review. J Audiol Otol. 2021 Apr;25(2):89-97.
36. Constant Ionescu E, Idriss S, Reynard P, Ltaief-Boudrigua A, Thai-Van H. Persistent positional vertigo in a patient with partial "autoplugged" superior semicircular canal dehiscence: a case study. J Int Adv Otol. 2022 Mar;18(2):188-91.
37. El-Saied S, Joshua BZ, Segal N, Kraus M, Kaplan DM. Sudden hearing loss with simultaneous posterior semicircular canal BPPV: possible etiology and clinical implications. Am J Otolaryngol. 2014 Mar-Apr;35(2):180-5.
38. Gananca CF, Caovilla HH, Gazzola JM, Gananca MM, Gananca FF. Epley's maneuver in benign paroxysmal positional vertigo associated with Meniere's disease. Braz J Otorhinolaryngol. 2007 Jul-Aug;73(4):506-12.
39. Ghosh A, Dorasala S. Epidemiology of benign paroxysomal positional vertigo (BPPV) and risk factors for secondary BPPV: a population-based study. Egypt J Otolaryngol. 2023 Jun;39(1):93.
40. Gross EM, Ress BD, Viirre ES, Nelson JR, Harris JP. Intractable benign paroxysmal positional vertigo in patients with Meniere's disease. Laryngoscope. 2000 Apr;110(4):655-9.
41. Grove CR, Souza WH, Gerend PL, Ryan CA, Schubert MC. Patients' experiences with management of benign paroxysmal positional vertigo: insights from the vestibular disorders association registry. Patient Relat Outcome Meas. 2022 Jul;13:157-68.
42. Gupta SK, Upadhyay A, Mundra RK. Role of electronystagmography in diagnosis of secondary BPPV in elderly patients with vertigo: a retrospective study. Indian J Otolaryngol Head Neck Surg. 2018 Sep;70(3):428-33.
43. Harada K, Oda M, Yamamoto M, Nomura T, Ohbayashi S, Kitsuda C. A clinical observation of benign paroxysmal positional vertigo (BPPV) after vestibular neuronitis (VN). Acta Otolaryngol Suppl. 1993;503:61-3.
44. Hong SM, Yeo SG. Clinical analysis of patients with idiopathic sudden sensorineural hearing loss and benign paroxysmal positional vertigo. Acta Otolaryngol. 2013 May;133(5):439-42.
45. Hughes CA, Proctor L. Benign paroxysmal positional vertigo. Laryngoscope. 1997 May;107(5):607-13.
46. Huppert D, Strupp M, Theil D, Glaser M, Brandt T. Low recurrence rate of vestibular neuritis: a long-term follow-up. Neurology. 2006 Nov;67(10):1870-1.
47. Ishikawa K, Edo M, Togawa K. Clinical observation of 32 cases of vestibular neuronitis. Acta Otolaryngol Suppl. 1993;503:13-5.
48. Karabulut M, Viechtbauer W, Van Laer L, Mohamad A, Van Rompaey V, Guinand N, et al. Chronic unilateral vestibular hypofunction: insights into etiologies, clinical subtypes, diagnostics and quality of life. J Clin Med. 2024 Sep;13(18):5381.
49. Karatayli-Ozgursoy S, Stamper GC, Lundy LB, Zapala DA. Bilateral multicanal benign paroxysmal positional vertigo coexisting with a vestibular schwannoma: case report. Ear Nose Throat J. 2011 Jan; 90(1):E10-5.
50. Karlberg M, Halmagyi GM, Buttner U, Yavor RA. Sudden unilateral hearing loss with simultaneous ipsilateral posterior semicircular canal benign paroxysmal positional vertigo: a variant of vestibulocochlear neurolabyrinthitis? Arch Otolaryngol Head Neck Surg. 2000 Aug;126(8):1024-9.
51. Kim YH, Kim KS, Kim KJ, Choi H, Choi JS, Hwang IK. Recurrence of vertigo in patients with vestibular neuritis. Acta Otolaryngol. 2011 Nov;131(11):1172-7.
52. Kim YH, Kim KS, Choi H, Choi JS, Han CD. Benign paroxysmal positional vertigo is not a prognostic factor in sudden sensorineural hearing loss. Otolaryngol Head Neck Surg. 2012 Feb;146(2):279-82.
53. Korres S, Balatsouras DG, Ferekidis E. Prognosis of patients with benign paroxysmal positional vertigo treated with repositioning manoeuvres. J Laryngol Otol. 2006 Jul;120(7):528-33.
54. Lee JB, Choi SJ. Canal paresis in benign paroxysmal positional vertigo secondary to sudden sensorineural hearing loss. Otol Neurotol. 2015 Dec;36(10):1708-13.
55. Lee JY, Lee YW, Chang SO, Kim MB. Vestibular function analysis of sudden sensorineural hearing loss with dizziness. J Vestib Res. 2020; 30(3):203-12.
56. Lee NH, Ban JH, Lee KC, Kim SM. Benign paroxysmal positional vertigo secondary to inner ear disease. Otolaryngol Head Neck Surg. 2010 Sep;143(3):413-7.
57. Lee NH, Ban JH. Is BPPV a prognostic factor in idiopathic sudden sensory hearing loss? Clin Exp Otorhinolaryngol. 2010 Dec;3(4): 199-202.
58. Lee SY, Kong IG, Oh DJ, Choi HG. Increased risk of benign paroxysmal positional vertigo in patients with a history of sudden sensory neural hearing loss: a longitudinal follow-up study using a national sample cohort. Otol Neurotol. 2019 Feb;40(2):e135-41.
59. Li GF, Liu M, Zhang YZ, Wang YT, Su L, Liu RR. Early treatment for benign paroxysmal positional vertigo secondary to sudden sensorineural hearing loss. Medicine (Baltimore). 2023 Oct;102(40): e35480.
60. Li P, Zeng XL, Li Y, Zhang GH, Huang XK. Clinical analysis of benign paroxysmal positional vertigo secondary to Meniere's disease. Sci Res Essays. 2010 Dec;5(23):3672-5.
61. Liu Y, Leng Y, Zhou R, Liu J, Wang H, Xia K, et al. Video head impulse test findings in patients with benign paroxysmal positional vertigo secondary to idiopathic sudden sensorineural hearing loss. Front Neurol. 2022 Jun;13:877777.
62. Maas BD, Hacarlioglugil E, van Leeuwen RB, Kamphuis S, Schermer TR, van Benthem PP, et al. Risk factors for recurrence of benign paroxysmal positional vertigo: a prospective study. Otol Neurotol. 2024 Sep;45(8):932-8.
63. Magliulo G, Gagliardi M, Cuiuli G, Celebrini A, Parrotto D, D'Amico R. Stapedotomy and post-operative benign paroxysmal positional vertigo. J Vestib Res. 2005 Jun;15(3):169-72.
64. Mandala M, Santoro GP, Awrey J, Nuti D. Vestibular neuritis: recurrence and incidence of secondary benign paroxysmal positional vertigo. Acta Otolaryngol. 2010 May;130(5):565-7.
65. Monobe H, Sugasawa K, Murofushi T. The outcome of the canalith repositioning procedure for benign paroxysmal positional vertigo: are there any characteristic features of treatment failure cases? Acta Otolaryngol Suppl. 2001;545:38-40.
66. Murofushi T, Halmagyi GM, Yavor RA, Colebatch JG. Absent vestibular evoked myogenic potentials in vestibular neurolabyrinthitis: an indicator of inferior vestibular nerve involvement? Arch Otolaryngol Head Neck Surg. 1996 Aug;122(8):845-8.
67. O'Reilly RC, Elford B, Slater R. Effectiveness of the particle repositioning maneuver in subtypes of benign paroxysmal positional

vertigo. Laryngoscope. 2000 Aug;110(8):1385-8.
68. Park HM, Jung SW, Rhee CK. Vestibular diagnosis as prognostic indicator in sudden hearing loss with vertigo. Acta Otolaryngol Suppl. 2001;545:80-3.
69. Perez N, Martin E, Zubieta JL, Romero MD, Garcia-Tapia R. Benign paroxysmal positional vertigo in patients with Meniere's disease treated with intratympanic gentamycin. Laryngoscope. 2002 Jun;112(6):1104-9.
70. Psillas G, Triaridis S, Markou K, Tsalighopoulos M, Vital V. Benign paroxysmal positional vertigo in the first acute attack of Meniere's disease. B-ENT. 2011;7(2):131-5.
71. Rambold H, Heide W, Helmchen C. Horizontal canal benign paroxysmal positioning vertigo with ipsilateral hearing loss. Eur J Neurol. 2004 Jan;11(1):31-5.
72. Roberts RA, Gans RE, Kastner AH, Listert JJ. Prevalence of vestibulopathy in benign paroxysmal positional vertigo patients with and without prior otologic history. Int J Audiol. 2005 Apr;44(4):191-6.
73. Roberts RA, Rivas A, Makowiec KF. Anterior canal benign paroxysmal positional vertigo following surgical management of superior canal dehiscence. Am J Otolaryngol. 2018 Nov-Dec;39(6):796-9.
74. Shiozaki T, Sakagami M, Ito T, Ota I, Wada Y, Kitahara T. What diagnosis should we make for long-lasting vertiginous sensation after acute peripheral vertigo? Acta Otolaryngol. 2020 Dec;140(12): 1001-6.
75. Song JJ, Yoo YT, An YH, Yoo JC, Kim JS, Koo JW. Comorbid benign paroxysmal positional vertigo in idiopathic sudden sensorineural hearing loss: an ominous sign for hearing recovery. Otol Neurotol. 2012 Feb;33(2):137-41.
76. Soto-Varela A, Rossi-Izquierdo M, Santos-Perez S. Benign paroxysmal positional vertigo simultaneously affecting several canals: a 46-patient series. Eur Arch Otorhinolaryngol. 2013 Mar;270(3): 817-22.
77. Taura A, Funabiki K, Ohgita H, Ogino E, Torii H, Matsunaga M, et al. One-third of vertiginous episodes during the follow-up period are caused by benign paroxysmal positional vertigo in patients with Meniere's disease. Acta Otolaryngol. 2014 Nov;134(11):1140-5.
78. Turk B, Akpinar M, Kaya KS, Korkut AY, Turgut S. Benign paroxysmal positional vertigo: comparison of idiopathic BPPV and BPPV secondary to vestibular neuritis. Ear Nose Throat J. 2021 Aug;100(7): 532-5.
79. van Esch BF, van Benthem PP, van der Zaag-Loonen HJ, Bruintjes TD. Two common second causes of dizziness in patients with Meniere's disease. Otol Neurotol. 2016 Dec;37(10):1620-4.
80. Waissbluth S, Becker J, Sepulveda V, Iribarren J, Garcia-Huidobro F. Benign paroxysmal positional vertigo secondary to acute unilateral peripheral vestibulopathy: evaluation of cardiovascular risk factors. J Int Adv Otol. 2023 Jan;19(1):28-32.
81. Xie Y, Sharon JD, Pross SE, Abt NB, Varma S, Della Santina CC, et al. Surgical complications from superior canal dehiscence syndrome repair: two decades of experience. Otolaryngol Head Neck Surg. 2017 Aug;157(2):273-80.
82. Zapala DA, Shapiro SA, Lundy LB, Leming DT. Simultaneous acute superior nerve neurolabyrinthitis and benign paroxysmal positional vertigo. J Am Acad Audiol. 2006 Jul-Aug;17(7):481-6.
83. Zhu M, Yu F, Zhou F, Wang H, Jiao Y, Wang M, et al. Benign paroxysmal positional vertigo associated with Meniere's disease. J Vestib Res. 2018;28(3-4):359-64.
84. Zubcic Z, Vceva A, Mendes T, Males J, Mihalj H, Vidic H, et al. Successful repositioning procedure for benign paroxysmal positional vertigo after stapedotomy. Acta Clin Croat. 2022 Nov;61(3):547-50.
85. Di Girolamo S, Fetoni AR, Di Nardo W, Paludetti G. An unusual complication of cochlear implant: benign paroxysmal positional vertigo. J Laryngol Otol. 1999 Oct;113(10):922-3.
86. Grayeli AB, Sterkers O, Toupet M. Audiovestibular function in patients with otosclerosis and balance disorders. Otol Neurotol. 2009 Dec;30(8):1085-91.
87. Kirbac A, Turan Dizdar H, Kaya E, Incesulu SA. New- and early-onset benign paroxysmal positional vertigo after otologic surgery. Eur Arch Otorhinolaryngol. 2025 Jan;282(1):175-81.
88. Murray D, Viani L, Garvan J, Murphy A, Vance R, Simoes-Franklin C, et al. Balance, gait and dizziness in adult cochlear implant users: a cross sectional study. Cochlear Implants Int. 2020 Jan;21(1):46-52.
89. Park SK, Kim SY, Han KH, Hong SK, Kim JS, Koo JW. Benign paroxysmal positional vertigo after surgical drilling of the temporal bone. Otol Neurotol. 2013 Oct;34(8):1448-55.
90. Rah YC, Park JH, Park JH, Choi BY, Koo JW. Dizziness and vestibular function before and after cochlear implantation. Eur Arch Otorhinolaryngol. 2016 Nov;273(11):3615-21.
91. Viccaro M, Mancini P, La Gamma R, De Seta E, Covelli E, Filipo R. Positional vertigo and cochlear implantation. Otol Neurotol. 2007 Sep;28(6):764-7.
92. Zhu RT, Van Rompaey V, Ward BK, Van de Berg R, Van de Heyning P, Sharon JD. The interrelations between different causes of dizziness: a conceptual framework for understanding vestibular disorders. Ann Otol Rhinol Laryngol. 2019 Sep;128(9):869-78.
93. Maarsingh OR, Dros J, Schellevis FG, van Weert HC, Bindels PJ, Horst HE. Dizziness reported by elderly patients in family practice: prevalence, incidence, and clinical characteristics. BMC Fam Pract. 2010 Jan;11:2.
94. van Leeuwen RB, Colijn C, van Wensen E, Bruintjes TD. The dizzy patient: consider a second diagnosis. Neurologist. 2017 May;22(3): 69-71.
95. Bhattacharyya N, Baugh RF, Orvidas L, Barrs D, Bronston LJ, Cass S, et al. Clinical practice guideline: benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg. 2008 Nov;139(5 Suppl 4): S47-81.
96. Lee JM, Lee HJ. Different clinical course of BPPV according to the medical conditions. Sci Rep. 2024 Jun;14(1):12941.
97. Fetter M, Dichgans J. Vestibular neuritis spares the inferior division of the vestibular nerve. Brain. 1996 Jun;119 (Pt 3):755-63.
98. Kao CL, Cheng YY, Leu HB, Chen TJ, Ma HI, Chen JW, et al. Increased risk of ischemic stroke in patients with benign paroxysmal positional vertigo: a 9-year follow-up nationwide population study in taiwan. Front Aging Neurosci. 2014 Jun;6:108.
99. Baloh RW, Honrubia V, Jacobson K. Benign positional vertigo: clinical and oculographic features in 240 cases. Neurology. 1987 Mar; 37(3):371-8.
100. Hornibrook J, Mudry A, Curthoys I, Smith CM. Ductus reuniens and its possible role in Meniere's disease. Otol Neurotol. 2021 Dec; 42(10):1585-93.
101. Yetiser S. Co-existence of benign paroxysmal positional vertigo and Meniere's syndrome. J Int Adv Otol. 2017 Apr;13(1):65-8.
102. Hegedus EJ, Moody J. Clinimetrics corner: the many faces of selection bias. J Man Manip Ther. 2010 Jun;18(2):69-73.