SIGNS, SYMPTOMS AND AUDIO-VESTIBULAR TEST RESULTS IN PATIENTS WITH MÉNIÈRE'S DISEASE: A REGISTER BASED STUDY

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CERTIFICATE

This is to certify that this dissertation, entitled **"Signs, Symptoms and Audio-Vestibular Test Results in Patients with Ménière's Disease: A Register Based Study"** is a Bonafide work submitted in part fulfilment for the degree of Master of Science (Audiology) of the student registration number P01124S023022. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Signs, Symptoms and Audio-Vestibular Test Results in Patients with Ménière's Disease: A Register Based Study"** is the result of my own study under the guidance of Dr. Sujeet Kumar Sinha, Associate Professor in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other university for award of any other diploma or degree.

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Dedicated to Maa, Papa and my teachers.

"Onward and upward."

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Aim and Objectives:

The present study aimed to report the signs, symptoms, and audio-vestibular findings in individuals diagnosed with Ménière's disease who visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders at the All India Institute of Speech and Hearing, Mysore. The objectives of the study were to document the hearing- and vestibular-related symptoms, and to report the findings of Pure Tone Audiometry, Immittance, Otoacoustic Emissions, Auditory Brainstem Response, Cervical Vestibular Evoked Myogenic Potentials (cVEMP), Ocular Vestibular Evoked Myogenic Potentials (oVEMP), Video Head Impulse Test (vHIT), and Subjective Visual Vertical (SVV).

Method:

A retrospective case analysis using a register-based approach was conducted by reviewing the medical records of patients with Ménière's disease from July 2024 to August 2025. A total of 63 subjects aged between 22 to 80 years were included in the research. Demographic data, as well as symptoms relating to hearing and vertigo, any related complaints, and test results obtained for auditory-vestibular tests were documented in the records. Test results that were analyzed included Pure Tone Audiometry, Immittance and Reflexometry, Otoacoustic Emissions, Auditory Brainstem Response, cVEMP, oVEMP, vHIT, and SVV. Descriptive statistics such as mean and standard deviation were used for analysis of selected audiological and vestibular parameters.

Results and Discussion:

Based on the results of this study, Ménière's disease was found to be prevalent among middle-aged individuals, and it was noted that there were more male patients than female patients. Unilateral disease was more common compared to bilateral disease. The most frequent auditory complaints included tinnitus, decreased sensitivity, and ear pressure. The most common

vestibular symptoms included vertigo, imbalance, and lightheadedness. Nausea, vomiting, sweating, headache, and positional dizziness were some of the most common associated symptoms. Vestibular migraine was the most common comorbid condition.

Pure Tone Audiometry findings revealed hearing loss ranging from normal hearing to profound hearing loss, with moderate to moderately severe sensorineural hearing loss being the most common. Most participants demonstrated type A tympanograms with predominantly normal acoustic reflexes. Otoacoustic emissions were absent in the majority of Ménière's disease ears. Auditory Brainstem Responses were present in most participants, with no indication of retrocochlear pathology. Vestibular test findings revealed abnormalities in cVEMP and oVEMP responses, including absent responses, abnormal asymmetry ratios, and altered frequency tuning patterns. vHIT findings demonstrated reduced vestibulo-ocular reflex gain predominantly in the vertical semicircular canals, while SVV findings were found to be within normal limits. The results indicate considerable variability in the clinical and audio-vestibular presentation of Ménière's disease.

Conclusion:

The present study highlights the heterogeneous nature of Ménière's disease with respect to its clinical presentation and audio-vestibular findings. The findings emphasize the importance of comprehensive audio-vestibular assessment for accurate diagnosis and differential diagnosis of Ménière's disease, especially in individuals with atypical symptoms and overlapping vestibular conditions. The study also contributes to the limited Indian literature on the clinical and audio-vestibular profile of Ménière's disease.

Keywords:

Ménière's disease, vertigo, tinnitus, hearing loss, vestibular symptoms, cVEMP, oVEMP, vHIT, Subjective Visual Vertical, audio vestibular findings.

Chapter-1

Introduction

Ménière's disease is a chronic inner ear disorder characterized by a tetrad of recurrent, spontaneous, episodic vertigo, tinnitus, fluctuating sensorineural hearing loss, and aural fullness (Lopez-Escamez et al., 2015). Vertigo is spontaneous and lasts between 20-120 minutes (Goebel, 2016). Although the etiology of Ménière's disease is still unknown, it is most often associated with increased endolymph resulting in aural symptoms that are episodic in nature. Ménière's disease is characterized by a diverse array of signs and symptoms, with several core features consistently reported across the literature.

Fluctuating sensorineural hearing loss is another core symptom, typically affecting low- to mid-frequencies, which can progress to a flat loss with disease progression (Neff et al., 2012). Tinnitus is usually a low-pitched, roaring, or machine-like sound and is a frequent auditory symptom of Ménière's disease (Espinosa Sanchez et al., 2016). Aural fullness is also often reported (Lopez-Escamez et al., 2015). Vertigo episodes can be accompanied by nausea and vomiting, and some patients may experience drop attacks, known as Tumarkin crisis (Ihler et al.,2022). Additional vestibular symptoms may include gait disturbance and unsteadiness (Ihler et al., 2022).

The diagnosis of Ménière's disease becomes challenging as the signs and symptoms mimic various other disorders such as autoimmune inner ear disorders, Cogan's syndrome, Endolymphatic sac tumor, Neuroborreliosis, Otosyphilis, Vestibular migraine, and Susac syndrome (Lopez-Escamez et al., 2015). Thus, it is essential to differentiate Ménière's disease from other disorders using the key clues from audio-vestibular test results, along with their comprehensive medical history.

While vestibular migraine is a distinct disorder, a comorbidity between Ménière's disease and migraine is widely reported, affecting 40-50% of Ménière's disease patients

(Lopez-Escamez et al., 2024; Radtke et al., 2011). Some Ménière's disease patients may report a history of headaches, photophobia, and phonophobia, symptoms typically associated with migraine (Neff et al., 2012). Some studies also report the presence of nystagmus in vestibular migraine, which can be spontaneous or positional (Noh et al., 2021; Hannigan et al., 2022).

Initially, hearing loss typically affects low- to mid-frequency sounds (Lorente-Piera et al., 2025; Hannigan et al., 2022). This can include frequencies below 2000 Hz (Basura et al.,2020), specifically 250–1000 Hz (Lorente-Piera et al., 2025), and even 200–600 Hz in early stages (Maihoub et al., 2022). Hearing loss can range from mild to moderate at initial stages, potentially progressing to profound levels in advanced stages (Lorente-Piera et al., 2025; Basura et al., 2020). Lorente-Piera et al. (2025) reported that the most common pattern of hearing loss is fluctuating, followed by sudden onset and progressive onset (Lorente-Piera et al., 2025). Low-frequency air-bone gaps are frequently seen in patients with Ménière's disease (Ihler et al., 2022).

Patients with Ménière's disease exhibit significant speech impairment and often lack a correlation between pure-tone thresholds and speech recognition performance. These speech deficits are mostly observed in the lower-frequency range, even when PTA is relatively preserved in those frequencies (Lorente-Piera et al., 2025). Pdes et al. (2023) found that higher stimulus presentation levels improved speech recognition in 75% of the individuals with Ménière's disease. Thus, the optimal speech presentation levels enhance recognition, improving the quality of life among such populations.

Tympanometry is usually normal in Ménière's disease. Wideband tympanometry may reveal subtle middle ear-inner ear interactions and might provide information on the changes in the middle ear that occur subsequent to the fluid changes within the inner ear (Meng et al., 2022). Studies reveal 'A' type tympanogram with the presence of acoustic reflexes indicating normal middle ear function (Kitajima et al., 2011; Selvakumar et al., 2012). Normal middle ear

reflex thresholds have also been reported in individuals with Ménière's Disease (Selvakumar et al., 2012). Reduced middle-ear resonant frequency and reduced absorbance are common features of Ménière's disease and may serve as potential biomarkers for the condition (Meng et al., 2022).

Oto-Acoustic Emissions (OAEs) are usually absent in the Ménière's affected ear when compared to the unaffected ear. The mean amplitude of the emission is also reported to be significantly lower in Ménière's disease than in normal hearing ears (de Kliene et al., 2002). Absence of distortion product OAEs is a characteristic feature of Ménière's disease (Corvaro et al., 2022). Studies show that DPOAEs are usually absent in patients with Ménière's disease (Selvakumar et al., 2012; Cianforne et al., 2000). It has also been observed that the incidence of DPOAEs is frequency-dependent, with higher frequencies more often showing DPOAEs than lower frequencies (Huffelen et al., 1998).

Cervical Vestibular Evoked Myogenic Potentials (cVEMPs) and Ocular Vestibular Evoked Myogenic Potentials (oVEMPs) are abnormal in most patients with Ménière's disease. The abnormalities have been reported in terms of absence of VEMPs (Unsal et al., 2019; Hannigan et al., 2022), reduction in amplitude (Saravanan & Sinha, 2013), prolongation of latencies (Ferreira et al., 2023; Unsal et. al.,2019) and differences in interaural amplitude or a change in frequency tuning of cVEMPs (Angeli et al., 2019; Rauch et al., 2004). However, the abnormalities in VEMPs vary between studies. Some authors have also reported increased cVEMP amplitude in patients with Ménière's disease (Unsal et al., 2019; Lamounier, 2017). Latencies of cVEMP peaks are not statistically prolonged from healthy sides (Saravanan & Sinha, 2013).

Most of the studies have reported abnormally low VOR gain values in Ménière's disease. Abnormalities have been found to present more frequently in the posterior canals, followed by the horizontal canal (Molnár et al., 2023). Some other studies have also reported

VOR gain in vHIT within normal limits (Hannigan et al., 2022; Unsal et al., 2019). However, significant higher asymmetry ratios are obtained in individuals affected by Ménière's disease (Unsal et al., 2019; Molnár et al., 2023). A few studies also reported the presence of covert saccades in ears affected by Ménière's disease (Unsal et al., 2019).

The subjective visual vertical (SVV) test often reveals abnormalities in patients with Ménière's disease, with increased deviation towards the symptomatic ear (Behzad et al., 2024; Kingma, 2006). Although Ferreira et al. (2023) reported that deviation can also occur towards the asymptomatic ear along with the symptomatic ear (Ferreira et al.,2023). However, SVV alone is not sufficiently sensitive to diagnose Ménière's disease (Behzad et al., 2024).

Need for the Study

Many studies have been conducted on Ménière's disease to determine its etiology, audio-vestibular test findings, and other factors related to the disease. Despite this, there is a dearth of literature on providing a complete profile of Ménière's disease, including details of signs, symptoms, and audio-vestibular test results, in the clinical population, especially in India.

The classic triad of symptoms (vertigo, tinnitus, and hearing loss) is present in only 40% of patients at the initial stage of the disease (Belinchon et al., 2012). A significant number of patients may report vertigo but do not initially experience aural symptoms such as aural fullness, tinnitus, or hearing loss (Hannigan et al., 2022). On the other hand, many patients with Ménière's disease may experience aural symptoms such as aural fullness without vertigo (Ihler et al., 2022). Hannigan et al. (2022) also reported that the audiogram of a patient with Ménière's disease can be of several types, including flat, rising, and peaked patterns (low- and high-frequency), and can occur without hearing loss. It is also not uncommon to find normal VEMP findings in patients with Ménière's disease (Lamounier, 2017), as well as increased cVEMP amplitude (Unsal et al., 2019). Controversial vHIT findings are also seen in patients with

Ménière's disease. For example, some authors report that the posterior canals, followed by the superior and lateral canals, show the greatest reduction in VOR gain, whereas other studies report that the lateral canal is most affected (Blödow et al., 2014).

Diagnosis of Ménière's disease is done through detailed history and examination (Selvakumar et al., 2012), and there is no 'gold standard' test for the diagnosis of Ménière's disease. Often, atypical presentations in these cases lower the sensitivity of clinicians' diagnoses worldwide. The diagnosis of Ménière's disease is not only complicated by the differences in its clinical presentation, but also the co-occurrence with other disorders such as vestibular migraine, which have overlapping symptoms and often co-occur with Ménière's disease (Neff et al., 2012). vestibular migraine may also have aural symptoms, which are usually not required for the diagnosis of vestibular migraine, and on the other hand, Ménière's disease may present with symptoms that are usually typical of vestibular migraine, such as headache, photophobia and phonophobia (Blödow et al., 2014).

To summarize, patients with Ménière's disease have variable signs and symptoms. There is a lack of comprehensive data comparing the audio vestibular findings with their symptoms. Also, there is a clear need for a register-based study to address the gap between theory and clinical practice in the assessment of patient outcomes across various patterns of Ménière's disease. To date, understanding the link between symptoms and audio-vestibular test results is unclear. All of these disparities, typical presentations, comorbidities, and overlapping symptoms of Ménière's disease need to be identified, and for that, a compilation of data from a register-based study can be very helpful.

Aim of the Study

The aim of the present study was to report the signs, symptoms, and audio-vestibular findings of Ménière's disease.

Objectives of the Study

1. To report the signs and symptoms related to hearing and vestibular issues in patients with Ménière's disease.
2. To report the findings of Pure Tone Thresholds, Otoacoustic emissions, Tympanometry, Acoustic reflexes and Auditory Brainstem Responses.
3. To report the Cervical vestibular myogenic evoked potential (cVEMP) and Occular vestibular myogenic evoked potential (oVEMP) test findings in patients with Ménière's disease.
4. To report Vestibular Head Impulse Test (vHIT) findings in patients with Ménière's disease.
5. To report Subjective Visual Vertical (SVV) findings in patients with Ménière's disease

Chapter 2

REVIEW OF LITERATURE

The prevalence of Menière's disease (MD) varies significantly across different studies, reflecting uncertainties in diagnostic criteria and geographical differences. It is reported to be between 3.5 to 513 per 100,000 by studies worldwide (Basura et al., 2020). Selvakumar (2012) reported a prevalence of 15.6% for Ménière's disease among patients attending an audio-vestibular tertiary care clinic. It also suggests that cases are likely to be missed in routine Indian outpatient clinics unless a structured proforma using established diagnostic criteria (such as the AAO 1995 criteria) is employed (Selvakumar et al., 2012)

Ménière's disease, although characterized by the tetrad of symptoms, is a very heterogeneous disorder that presents with varied signs, symptoms, progression, and clinical test findings (Basura et al., 2020). Many patients present with atypical symptomatology rather than Ménière's classical signs and symptoms, which often leads to a delay in diagnosis of months or even years (Vassiliou et al., 2011; Lorente-Piera et al., 2025).

2.1 Signs and Symptoms of Ménière's Disease

Ihler et al. (2022) investigated patient characteristics and symptoms in a prospective study of patients with Ménière's disease. They focused on sociodemographic factors, clinical features, and audiometric findings. The study included 96 patients, of whom 31 had definite Ménière's disease (dMD), 36 had probable Ménière's disease (pMD), and 29 showed typical clinical features (MC) but did not fulfil the full diagnostic criteria. Sociodemographic factors such as gender, age, and education were balanced across all groups. Almost half of the patients were diagnosed before age 50, and common comorbidities included high blood pressure, allergic rhinitis (27%), and asthma (14%). Significant differences in aural fullness, tinnitus, and fluctuating hearing helped differentiate the dMD and pMD groups from the MC category.

52% of MC patients experienced aural symptoms without vertigo, whereas 14% had vertigo with no cochlear symptoms. 100% of dMD patients had vertigo for 20 minutes to 12 hours compared to only 24% in the MC group. Other symptoms, such as nausea (77%), gait disturbance (73%), and emesis (71%), were common across all patients.

Tokumasu et al. (1996) investigated the initial symptom profile and long-term progression of vertigo and cochlear manifestations in individuals with Ménière's disease. This study included 151 patients. The detailed long-term follow-up data were available for 28 individuals. There were 106 (70.1%) individuals in their 30s, 40s and 50s, and 28 (18.5%) individuals were aged 60 years or above. Cochlear symptoms such as hearing loss, tinnitus, and aural fullness preceded vertigo in 61% of cases. 21% of the individuals initially presented with isolated vertigo followed by cochlear symptoms, and only 18% exhibited both simultaneously at onset. The findings also demonstrated variable vertigo recurrence, with some patients experiencing early, clustered attacks and others showing prolonged remission periods.

Zhang et al. (2016) analyzed the specific characteristics of cochlear symptoms and functions in patients with MD. Clinical records, audiometric data, tinnitus analysis, and caloric testing for 115 patients diagnosed with definite unilateral Menière's disease based on the 1995 AAOHNS criteria were reviewed. The mean age was 47.9 years, and the male-to-female ratio was 1.17:1 (62 men and 53 women). In 50.43% of cases, the disorder began with only cochlear symptoms (tinnitus, hearing loss, or both) without vertigo. 15.65% of patients presented with only vertigo at onset. For 64.4% of patients, the tinnitus frequency matched the poorest hearing threshold on their audiogram. The average hearing threshold was 45.24 dB HL, and a majority of patients (55.65%) were already in Stage 3 at the time of diagnosis.

Gürkov et al. (2019) conducted a prospective study on Ménière's disease to clinically characterize the symptoms of the disease using MRI-confirmed endolymphatic hydrops. They included 249 patients who were assessed through 3T gadolinium-enhanced MRI, structured

clinical interviews, and audiometry. Results showed that 81.1% of patients reported rotatory sensations and 21% to 27% of patients had vertigo attacks lasting less than 20 minutes. One third (34%) of patients reported no auditory symptoms during the vertigo attacks. Patients with simultaneous cochleovestibular onset had a higher frequency of drop attacks (29.4% vs 13.5% in the general cohort). Along with the classic triad, attacks were associated with nausea (89.7%), vomiting (76.4%), profuse sweating (56.8%), and transient loss of consciousness (7.2%). The study found no significant association between Ménière's disease and migraine (prevalence 7.2%) or autoimmune disorders. Also, A positive family history for Ménière's disease was present in only 4.3% of cases.

2.2 Audiological Test Findings:

2.2.a. Pure Tone Audiometry

Stahle et al. (1991) studied the course of Ménière's disease in 161 patients over at least 9 years (with some followed for 20+ years). Progressive worsening of hearing was observed over time. After 20 or more years, all patients had at least 30 dB hearing loss, and 82% had losses greater than 50 dB. Hearing thresholds got poor in both low and high frequencies, but stabilized around 50 dB after 5 to 10 years. Speech discrimination also worsened, with an average of 53% after 13 to 16 years. 47% of patients developed bilateral symptoms after 20 years, showing that the chance of bilateral involvement increases as the disease progresses. Some patients (21.3%) had normal hearing at the initial stage. Audiogram patterns also changed over time, with initially a variety of configurations observed, including peak (28%) and rising (20%) patterns, but these decreased over time. Flat audiogram became the most common pattern, increasing from 21% at baseline to 74% after 15 years

Corvaro et al. (2022) performed an audiological evaluation on participants (aged 19-75 years), out of which 32 patients had Ménière's disease, and 28 individuals were age- and sex-matched controls with cochlear hearing loss of other etiologies. Audiological tests were

performed on these groups. The degree of hearing loss in both the Ménière's disease and control groups ranged from mild to profound. Mild (22.7%) and moderate (26.4%) losses were found to be the most common in the Ménière's group, and mild (15.1%) and moderate (30.2%) losses in the control group. Severe hearing loss was equally present in both groups (7.5%). Although profound loss was slightly higher in controls (5.7% vs 3.8%). Hearing loss at isolated frequencies without a defined degree was observed in a large proportion of both groups (39.6% in Ménière's, 41.5% in controls). Flat audiograms were most common in both groups (30.2% in Ménière's; 41.5% in controls). Rising configurations were more frequently observed in the Ménière's disease group (30.2%).On the other hand, sloping patterns were more common in the control group (39.6%). Reversed U-shaped curves were equally seen in both groups (9.4%), and anacusis was slightly higher in the Ménière's group (3.8%).

Paparella et al. (1982) compared pure tone audiograms of 300 patients with Ménière's disease and 400 patients without Ménière's disease to inspect the presence of a high-frequency peak audiogram configuration. The results revealed that 42% of patients with Ménière's disease show a peak audiogram (significantly higher than in other groups: 6% in non-Ménière's cochlear hearing loss and 7% in normal hearing individuals).

Lee et al. (2014) examined low-frequency air–bone gaps (LFABG) in Ménière's disease. A total of 337 patients with definite Ménière's disease were studied, and LFABG was observed in about 13.9% of patients. They also reported that when this air–bone gap resolved, hearing thresholds improved, and a significant reduction in vertigo episodes (from about 2.9 attacks to 0.5) was observed. This suggests that LFABG occurs during active or worsening phases of the disease. According to the study, LFABG reflects a temporary worsening of inner ear fluid pressure. They also suggested that LFABG may not predict long-term outcomes, but it can be a useful clinical indicator of disease activity.

Selvakumar et al., (2012) determine the frequency and clinical profile of patients with Ménière's disease using AAO (1995) criteriain an Indian tertiary care hospital. Patients aged 5 to 75 years presenting with symptoms such as hearing loss, vertigo, tinnitus, and aural fullness were evaluated over a 12-month period. A comprehensive audio-vestibular test battery was done. PTA findings showed bilateral hearing loss in 41% of patients, while 23% had left ear involvement and 17% had right ear involvement. 19% of patients had normal hearing at the time of testing. They also reported that the most common audiogram configuration was the flat type.

Mateijsen et al. (2001), in a prospective clinical cohort study involving 111 patients with Ménière's disease, re-evaluated the characteristics of hearing loss. Pure-tone and speech audiometry revealed reduced hearing sensitivity in the Ménière's disease ears. Low-frequency or combined low- and high-frequency hearing loss patterns were found to be significantly more common. However, the study found no association between the degree or configuration of hearing loss and the duration of the disease which indicates that audiometric patterns cannot be used to track the progression of the disease. Also, a strong correlation was observed between pure-tone thresholds and speech audiometry results, with speech discrimination scores correlating with the degree of hearing loss with no disproportionate deterioration. The findings further suggested that audiogram shape does not independently influence speech discrimination beyond the effect of overall hearing loss.

2.2.b. Tympanometry and Reflexometry

Selvakumar et al. (2012) conducted a prospective case series at an Indian tertiary care hospital to determine the frequency and clinical profile of patients with Ménière's disease using AAO (1995) criteria. Patients aged 5–75 years presenting with symptoms like hearing loss, vertigo, tinnitus, and aural fullness were evaluated over a 12-month period. A comprehensive audio-vestibular test battery was performed. In impedance audiometry, 66 patients with

Ménière's disease had type A tympanograms, and 4 had type C tympanograms. 85% patients had normal reflexes, and 15% had absent reflex.

Leszczyński et al. (2023) investigated changes in wideband acoustic absorbance and resonance frequency in relation to the degree of endolymphatic hydrops, as confirmed by MRI in 4 patients with definite Ménière's disease. All the patients showed normal classical tympanograms. The study showed clear differences between symptomatic and asymptomatic ears, especially in wideband absorbance patterns. A characteristic low-frequency notch was observed in affected ears due to altered inner ear mechanics. In some cases, similar but less pronounced changes were also seen in the contralateral ear. Differences in absorbance were observed across hydropic grades, but these changes were not consistently greater in more advanced stages. Resonance frequency findings were variable and lacked a consistent pattern across patients.

Kitajima et al. (2011) investigated the relationship between Eustachian tube function and hearing ability in patients with Ménière's disease. The study revealed that 25% of patients had Eustachian tube dysfunction, while 92% had normal tympanometry. According to the stage, the prevalence of Eustachian tube dysfunction increased with severity: 0% in stage 1, 40% in stage 2, 38% in stage 3, and 50% in stage 4.

Demir et al. (2020) determined the diagnostic significance of evaluated wideband tympanometry (WBT) findings in patients with unilateral Ménière's disease. A total of 21 patients were studied, and the affected ears were compared with the contralateral normal ears. WBT parameters analyzed were the resonance frequency (RF) and frequency-specific absorbance values across 0.25–8 kHz. The results revealed that RF was significantly lower in the affected ears ($p < 0.001$). Absorbance values were significantly reduced at low frequencies (0.25–1 kHz; $p < 0.05$), but showed no significant differences at higher frequencies.

2.2.c. Otoacoustic Emissions

Harris and Probst (1992) evaluated transient evoked otoacoustic emissions (TEOAEs) in 31 patients with unilateral Ménière's disease using click and 1-kHz tone-burst stimuli. Responses were found to be present in 29/31 non-affected ears and 26/31 affected ears with click stimuli, and in 30/31 non-affected ears and 28/31 affected ears with 1 kHz tone bursts. The presence of TEOAEs in affected ears was strongly influenced by audiometric configuration. Responses were observed only when at least one frequency between 0.75 and 2 kHz had a threshold better than 30 dB HL. The study also revealed that the contralateral ears with normal hearing showed reduced emission levels (by ~5 dB) and fewer spectral peaks compared to the normative data. Overall, the findings suggest that TEOAEs in Ménière's disease exhibit atypical characteristics that reflect the altered cochlear function even in ears with relatively preserved hearing

Corvaro et al. (2022) conducted a study to evaluate transient evoked otoacoustic emissions (TEOAE) and distortion product otoacoustic emissions (DPOAE) in patients with Ménière's disease. They included 60 participants (19–75 years), comprising 32 patients with Ménière's disease and 28 age- and sex-matched controls with cochlear hearing loss of other etiologies. A mismatch was found between OAE and pure-tone results, with OAEs indicating cochlear dysfunction even in the contralateral ears with normal hearing thresholds. In the affected ears with hearing loss, TEOAEs were present, whereas DPOAEs were absent, unlike in the control group, where both TEOAEs and DPOAEs were typically absent in cochlear loss.

Kleine et al. (2002) investigated whether otoacoustic emissions (OAEs) exhibit abnormal characteristics in patients with Ménière's disease. Click-evoked and distortion product OAEs were measured in 100 patients. The results showed a lower incidence of OAEs in the affected ears (56%) than in the contralateral ears (85%). The mean emission amplitude was also reduced in affected ears (2.6 dB) and in contralateral ears (5.3 dB) compared with

normal-hearing ears. Ears with present OAEs showed better hearing thresholds, with an average 24 dB difference compared to ears without OAEs. However, the correlation between hearing loss and emission amplitude was weak.

Cianfrone et al. (2000) evaluated distortion product otoacoustic emissions (DPOAEs) in 70 patients with Ménière's disease (and the changes in the emissions after glycerol administration in 58 patients). Despite average hearing thresholds exceeding 40 dB HL, more than 60% of affected ears showed present DPOAEs, indicating preserved outer hair cell function.

Fetterman (2001) examined the role of distortion product otoacoustic emissions (DPOAEs) and cochlear microphonics (CMs) in understanding cochlear involvement in Ménière's disease with endolymphatic hydrops. Clinical and audiological data were collected from patients who presented with vestibulo-auditory symptoms. The results revealed a greater frequency of DPOAEs with larger amplitudes at lower frequencies. In some cases (18%), emissions were present even when hearing thresholds were ≥50 dB HL.

2.2.d. Auditory Brainstem Response

Yamada et al. (1975) evaluated the use of auditory brainstem response (ABR) to differentiate between types of hearing loss, including conductive hearing loss, in 7 patients with Ménière's disease. The latency–intensity (L–I) curves of wave V across stimulus levels (10–85 dB HL) were found. In conductive hearing loss, L–I curves showed a rightward parallel shift, with ABR thresholds within 15 dB of pure-tone thresholds in 83% of cases. On the other hand, in individuals with Ménière's disease, the latencies were within normal limits at high intensities (e.g., 85 dB HL) but were prolonged at low intensities. This pattern differs from the parallel shift seen in conductive loss and is considered characteristic of Ménière's pathology. Also, it was found that ABR-estimated thresholds in Ménière's disease were typically lower

than those obtained with standard pure-tone audiometry (4 kHz), unlike in conductive hearing loss, where both measures correlate well.

Kacker and Deka (1986) conducted a study involving 72 patients presenting with vertigo, hearing loss, and tinnitus of various etiologies; 41.66% were diagnosed with Ménière's disease and underwent auditory brainstem evoked response (ABR) testing. Within the Ménière's group (30 patients: 21 males, 9 females), 20 had unilateral involvement, and 10 had bilateral involvement. Hearing loss ranged from moderate to severe. The unilateral cases showed 7 moderate, 6 moderately severe, and 7 severe-to-total losses, while the bilateral cases included 2 mild, 6 moderate, and 2 severe hearing losses. ABR findings demonstrated normal interpeak latencies (I–V IPL) in most patients (17 unilateral and all 10 bilateral), which effectively helped rule out retrocochlear pathology, such as an acoustic neuroma. Wave I latency was earlier in affected ears, even at lower stimulus intensities (40–45 dB SL), sometimes comparable to responses at 60 dB SL in normal ears, suggesting recruitment. In a few cases (3 unilateral), no response could be obtained due to severe hearing loss. These differences were found to be statistically significant, suggesting that ABR is useful in assessing cochlear and neural function and in differentiating Ménière's disease from retrocochlear lesions.

2.3 Vestibular Test Findings:

2.3.a. Video Head Impulse Test:

Limviriyakul et al. (2020) compared the effectiveness of caloric testing and the video head impulse test (vHIT) in assessing vestibular function in Ménière's disease. 51 patients diagnosed with definite Ménière's disease (AAO–HNS, 1995) underwent audiological evaluation, caloric testing, and vHIT. Abnormal vHIT was defined as VOR gain <0.8 (lateral SCC) and <0.7 (vertical SCCs). Patients were divided into active (n = 40) and inactive (n = 11) groups based on symptom status. Results showed caloric weakness in 76.5% of patients, and

abnormal vHIT gain in 47.1%. No significant correlation was found between caloric and vHIT results ($r = 0.207$). However, disease duration showed a significant relationship ($p < 0.002$). The most common abnormal vHIT finding in patients with caloric weakness involved the anterior semicircular canal.

Hannigan et al. (2021) conducted a retrospective analysis of 644 patients and evaluated the relationship between video head impulse testing (vHIT) and caloric testing across different vestibular disorders. Results were concordant in 570 patients, where 500 showed normal findings, and 54 showed concordant asymmetries. Sixteen patients showed bilateral vestibular hypofunction. 36 patients showed dissociation between tests, characterized by normal vHIT gains (~0.93–0.98) but abnormal caloric responses (canal paresis >30%, mean 48%). Among these, the majority were diagnosed with Ménière's disease (n = 27), along with a few cases of vestibular schwannoma, vestibular neuritis, and vestibular migraine. No patient with abnormal vHIT had normal caloric results. The findings highlight that caloric testing complements vHIT, particularly in detecting endolymphatic hydrops, and that normal vHIT with abnormal caloric responses (dissociation) is strongly associated with Ménière's disease, making it a useful diagnostic indicator.

Unsal et al. (2019) evaluated vestibular function in 33 patients with Ménière's disease (16 bilateral and 17 unilateral cases) and 39 healthy controls. The results showed reduced VOR gain in vHIT in 44.9% of affected ears, indicating vestibular dysfunction. In addition to reduced gain values, increased asymmetry ratios were observed in ears affected by Ménière's disease compared to controls. Molnár et al. (2023) compared the video head impulse test (vHIT) and caloric testing in 56 controls, a few patients with vestibular neuritis, and 26 patients with Ménière's disease. The authors reported abnormal gain asymmetry (GA) in 65.3% of patients with Ménière's disease. Only one patient, though, showed an actual gain reduction. This suggested that asymmetry is a more sensitive indicator than just gain. Horizontal semicircular

canal hypofunction was indicated by significantly greater GA values than in controls, while hyperfunction may also occur infrequently. No correlation was found between vHIT and caloric test results. Compared with caloric testing, vHIT often showed greater specificity but poorer sensitivity.

Rubin et al. (2018) compared the video head impulse test (vHIT) and caloric reflex test findings in patients with advanced unilateral Ménière's disease. 37 patients with a mean hearing loss of 59 ± 18 dB HL were examined in this study. The results revealed that all patients demonstrated normal vHIT findings, without any abnormal gain or corrective saccades. On the other hand, Caloric testing revealed abnormalities in most cases, with a mean deficit of 45%. Only three patients showed normal caloric responses. These findings indicate a dissociation between the two tests, suggesting that vHIT may remain normal even in advanced stages of Ménière's disease.

2.3.b. Vestibular Evoked Myogenic Potentials

Shabana et al. (2026) conducted a cross-sectional, analytical study of 28 individuals with vertigo using the following diagnostic techniques for Ménière's disease: oVEMP, caloric test, and video head impulse test (vHIT). All participants underwent detailed audiological and vestibular assessments, and the results showed that oVEMP had the highest sensitivity (67.9%), with abnormalities present in 68% of patients (most commonly delayed latency and increased interaural amplitude difference). Caloric tests showed abnormalities in 53.6% cases, mostly unilateral weakness, and exhibited the highest specificity (76.6%). vHIT showed the lowest sensitivity (7.1%), where none of the subjects showed abnormal gain, despite its moderate specificity (71.2%). Correlations were observed between pure-tone thresholds and vestibular test parameters.

Singh et al. (2015) evaluated the frequency amplitude ratio (FAR) of cervical vestibular evoked myogenic potentials (cVEMP) and found the most effective frequency pair for

diagnosing Ménière's disease. In this prospective study, 22 patients with unilateral definite Ménière's disease were compared with 22 healthy controls. The results showed that the FAR combinations (750/500, 1000/500, 1500/500, and tuned frequency/500) were significantly higher in Ménière's disease ears than in controls ($p < 0.05$). The 750/500 frequency pair demonstrated the highest diagnostic accuracy, with 95.45% sensitivity and 79.55% specificity at a cut-off value of ≥1.12.

Saravanan and Sinha (2013) reported that cVEMP abnormalities are frequently observed, with an incidence ranging from 39% to 58%, and that approximately 50–69% show abnormal amplitude or asymmetry. The most common abnormalities observed are decreased or absent amplitudes (51% of cases), increased interaural asymmetry (as high as 69%), and high thresholds in affected ears. Increased latency results are not consistent; however, increased latency has been observed in 35% of affected ears and 25% of unaffected ears. Frequency tuning curve for cVEMP is abnormal; there is a change in the tuning curve from 500Hz (normal) to approximately 1000 Hz in Ménière's ears. cVEMP thresholds are significantly elevated, particularly in affected ears and in patients with drop attacks. Additionally, cVEMP parameters, especially the interaural amplitude difference ratio and threshold, correlated with disease stage and may help differentiate between acute and stable phases.

Angeli and Goncalves (2019) conducted a case-control retrospective study to determine whether cVEMP findings can reflect disease stage in Ménière's disease. They compared 47 unilateral MD patients with 30 non-MD vertigo controls. The ratio of the cVEMP amplitudes at frequencies of 1000/500 Hz was determined to be significantly greater among Ménière's ears (mean ratio = 1.14 ± 0.25) than among non-Ménière's ears (mean ratio = 0.96 ± 0.20; $p = 0.001$). Among MD patients, those with the active stage had greater ratios (1.22 ± 0.25) than patients with stable disease (1.00 ± 0.18; $p = 0.0035$). The diagnostic ability was shown to be moderately reliable, with the area under the curve (AUC) of 0.716, sensitivity of 83%, and

specificity of 53% (cut-off point 0.94) for the differentiation of MD from non-MD dizziness. To differentiate the MD active phase from the MD stable phase, the AUC, sensitivity, and specificity were 0.746, 68%, and 81%, respectively (the cut-off point was 1.048). The increase in the ratio was due to a reduction in the 500 Hz amplitude.

2.3.c. Subjective Visual Vertical

Kumagami et al. (2009) conducted a study involving 22 patients with unilateral Ménière's disease. They assessed the SVV responses before, during, and after acute attacks. The aim of the study was to examine the presence and frequency of otolith dysfunction during acute attacks of Ménière's disease using the Subjective Visual Vertical (SVV) test. Results showed that 14 patients (63.6%) exhibited abnormal SVV tilts during attacks. The tilt was directed toward the affected ear in 13 of 14 cases (92.9%). These abnormalities were found to be temporary and resolved within a few weeks in 12 of 14 patients (85.7%).

Ferreira et al. (2023) evaluated otolith function by comparing Subjective Visual Vertical (SVV), cervical Vestibular Evoked Myogenic Potential (cVEMP), and ocular Vestibular Evoked Myogenic Potential (oVEMP) findings in patients during the inter-crisis period of unilateral definite Ménière's disease. This study comprised an experimental group of 22 patients with unilateral Ménière's disease and a control group of 14 healthy individuals. All the participants underwent SVV testing (bucket method), cVEMP, and oVEMP assessments. Statistical analysis showed no significant differences between SVV, cVEMP, and oVEMP results, and there was good concordance among the tests.

Castro-Urquizo et al. (2021) evaluated and interpreted subjective visual vertical (SVV) using the bucket test in patients with benign paroxysmal positional vertigo (BPPV) and Ménière's disease. This cross-sectional study included 78 participants: 51 with BPPV and 27 with Ménière's disease (22 inactive and 5 with an active crisis). SVV was determined using the bucket test (normal value: 0 °- 3 °). In BPPV patients, average SVV was reported to be

2.62° before the Epley manoeuvre and 1.7° after the manoeuvre, where 57% of them were found to have abnormalities ($p<0.001$). In Ménière's disease, the average SVV was 2.74° in non-crisis cases and 5.06 ° in active crisis cases ($p=0.002$).

To summarize, individuals with Ménière's disease present with a range of signs and symptoms. Also, there is significant variation in audiological and vestibular findings among individuals with Ménière's disease. Variation in audiological/vestibular findings may be due to the stages of Ménière's disease. The review also indicates that less research has been done in the area of Ménière's disease in India. Hence, the study is required to fill the knowledge gap.

Chapter-3

Method

A register-based study was used to identify the signs and symptoms presented by patients with Ménière's disease, along with audiological and vestibular test results. A retrospective case analysis was conducted by reviewing the case files of individuals who visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders at the All India Institute of Speech and Hearing, Mysore, presenting with complaints of tinnitus/vertigo from July 2024 to August 2025.

In the register-based analysis, the following details were obtained from the case files:

- The demographic details of the client (age, gender, socioeconomic status)
- The complaints of the individuals (Information like aural fullness, tinnitus, difficulty in hearing, vertigo, imbalance, giddiness, headache, nausea, associated problems)
- Results of pure-tone audiometry (type and degree of hearing loss)
- Immittance (Type of Tympanogram)
- Acoustic reflexometry (presence or absence of acoustic reflexes for ipsilateral and contralateral reflexes)
- OAE evaluation results
- Auditory Brainstem Response Test results (presence/absence of ABR, Cochlear Pathology vs Retrocochlear pathology)
- Cervical Vestibular Evoked Myogenic Potential (cVEMP) results (Latencies, Amplitude, Frequency tuning and Asymmetry Ratio)
- Ocular Vestibular Evoked Myogenic Potential (oVEMP)(Latencies, Amplitude, Frequency tuning and Asymmetry Ratio)
- Video Head Impulse Test (vHIT)(VOR gain and presence/absence of refixation saccades)

- Subjective Visual Vertical (Abnormal/normal)

Table 1 presents the parameters to be analyzed in this register-based study.

Table 1

Parameters Analyzed from this Register-Based Study

Test Batteries	Tests	Parameters To Be Analyzed
Comprehensive Audio-Vestibular Case History	-	Audio-Vestibular Symptoms, Any other associated symptoms
Auditory related	Pure Tone Audiometry	Type and Degree of Hearing loss
	Tympanometry	Type of Tympanogram
	Reflexometry	Presence or absence of ipsilateral & contralateral acoustic reflexes
	Oto-Acoustic Emissions	Presence or Absence of OAEs
	Auditory Brainstem Responses	Presence/absence of ABR, Cochlear Pathology vs Retrocochlear pathology
Vestibular Related	Cervical Vestibular Evoked Myogenic Potential	P13 & N23 Latencies, P13-N23 peak-to-peak amplitude, frequency tuning asymmetry ratio
	Ocular Vestibular Evoked Myogenic Potential	N10 & P15 Latencies, N10-P15 peak-to-peak amplitude, frequency tuning asymmetry ratio
Vestibular Related	Video Head Impulse Test	VOR Gain, presence or absence of Refixation saccades
	Subjective Visual Vertical	Normal or abnormal SVV

- **Statistical Analysis:**

Descriptive statistics, including the mean and standard deviation, was done for Pure tone thresholds, Vestibular Evoked Myogenic Potentials, and Video Head Impulse Test.

Chapter-4

Results

The present study was conducted to document the various audio-vestibular findings in individuals diagnosed with Ménière's disease who visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders at the All India Institute of Speech and Hearing, Mysore, from July 2024 to August 2025. A total of 593 clients visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders with the primary complaint of giddiness during that time. Out of these 593 patients, 87 clients were diagnosed with Ménière's disease with and/or without a comorbid vestibular condition such as vestibular migraine or labyrinthitis. Of the 87 clients, data could be collected for 63. The age range of these participants was between 22 and 80 years.

Out of the 63 participants, 57 were diagnosed with unilateral Ménière's disease, while 6 had bilateral involvement. Among those with unilateral Ménière's disease, 52 participants (37 males and 15 females) had only Ménière's disease, whereas 8 participants presented with an additional comorbid condition. Of the 6 participants with bilateral Ménière's disease, 4 (3 males and 1 female) had only Ménière's disease, while 2 females had associated comorbid conditions; no males in the bilateral group had comorbidities. Overall, 11 out of 63 participants had comorbid conditions along with Ménière's disease. Among these, vestibular migraine was the most common comorbidity (10 participants), followed by labyrinthitis in one participant.

The various data collected from the case files are Audiological and Vestibular symptoms, Puretone Audiometry, Immittance test results, Otoacoustic Emissions, Auditory Brainstem Responses, Video Head Impulse Test, Cervical and Occular Vestibular Evoked Myogenic Potentials, and Subjective Visual Vertical test results.

4.1. Signs and Symptoms related to hearing and vestibular issues in patients with Ménière's disease.

4.1.1. Age Ranges of the Individuals

Out of the total 63 participants, 40 participants were males and 23 participants were female subjects. The categorization of the individuals was done by dividing the subjects falling in the five age groups namely 21 to 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years and more than 60 years into male and female. The gender distribution for Ménière's disease is given in Figure 4.1.

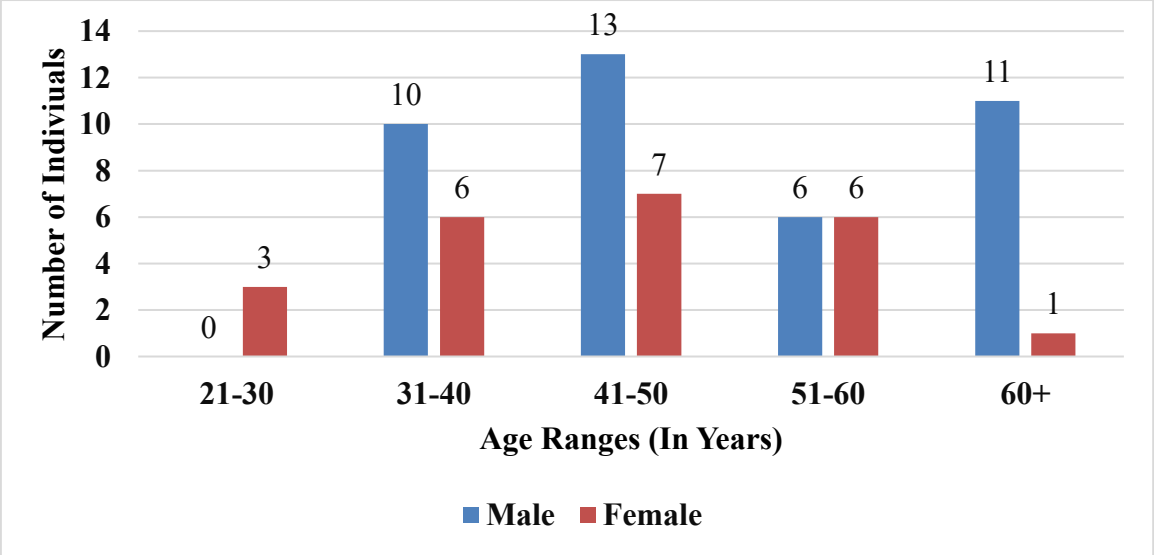

Figure 4.1 *Figure Showing the Distribution of the Age Ranges*

4.1.2. Ear Related Symptoms

Ear related symptoms, namely, reduced hearing sensitivity, tinnitus, sensation of ear blocking, itching of the ear, ear discharge and ear pain were documented.

Out of the 40 male participants, 27 reported reduced hearing, 39 individuals reported presence of tinnitus, 11 presented with ear blocking, 6 with itching in the ear and only 1 individual reported ear pain. None of the male individuals reported any ear discharge. Out of the 23 female participants, 19 reported reduced hearing, 21 individuals reported presence of tinnitus, 11 presented with ear blocking, 3 with itching in the ear and 2 reported ear pain. None

of the female individuals reported any ear discharge. The same has been shown in the Figure 4.2.

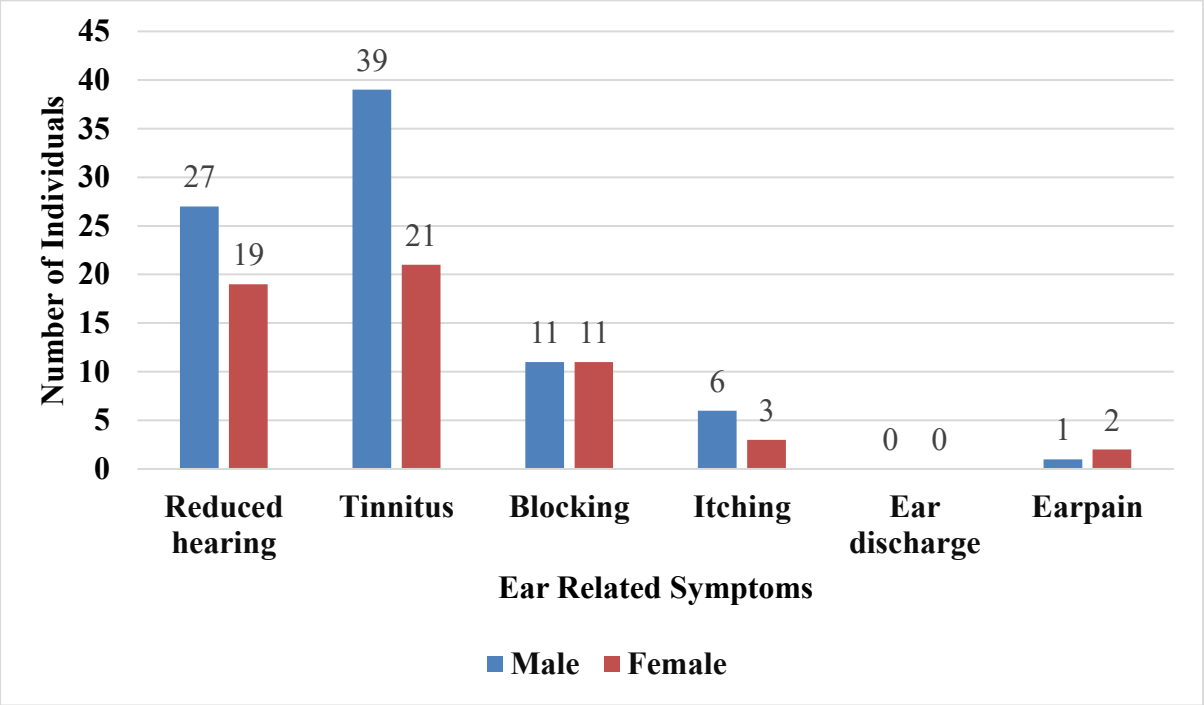

Figure 4.2 *Figure Showing the Distribution of the Audiological Symptoms*

4.1.3. Vestibular Symptoms

Vestibular symptoms such as spinning, blackouts, uncertainty, unconsciousness, falling, swaying or imbalance, floating, lightheadedness, and blurred vision were documented.

Out of 40 male individuals diagnosed with Ménière's disease, 37 individuals reported the presence of spinning, and 2 individuals reported uncertainty. 1 individual experienced unconsciousness, and 4 individuals had at least one episode of fall without loss of consciousness. 19 males reported having symptoms of swaying or imbalance. Floating sensation was experienced by 3 individuals, lightheadedness by 11, and blurring of vision by 5 male individuals. None of the male individuals had any blackout episodes. Out of 23 females, 22 reported spinning as a symptom. At least one episode of blackout, unconsciousness, and the feeling of floating was present in 2 females. One participant experienced uncertainty, and one reported at least one episode of falling. Swaying or imbalance was noted by 5 individuals.

Additionally, 9 females reported lightheadedness, and 8 experienced blurred vision. This is shown in Figure 4.3.

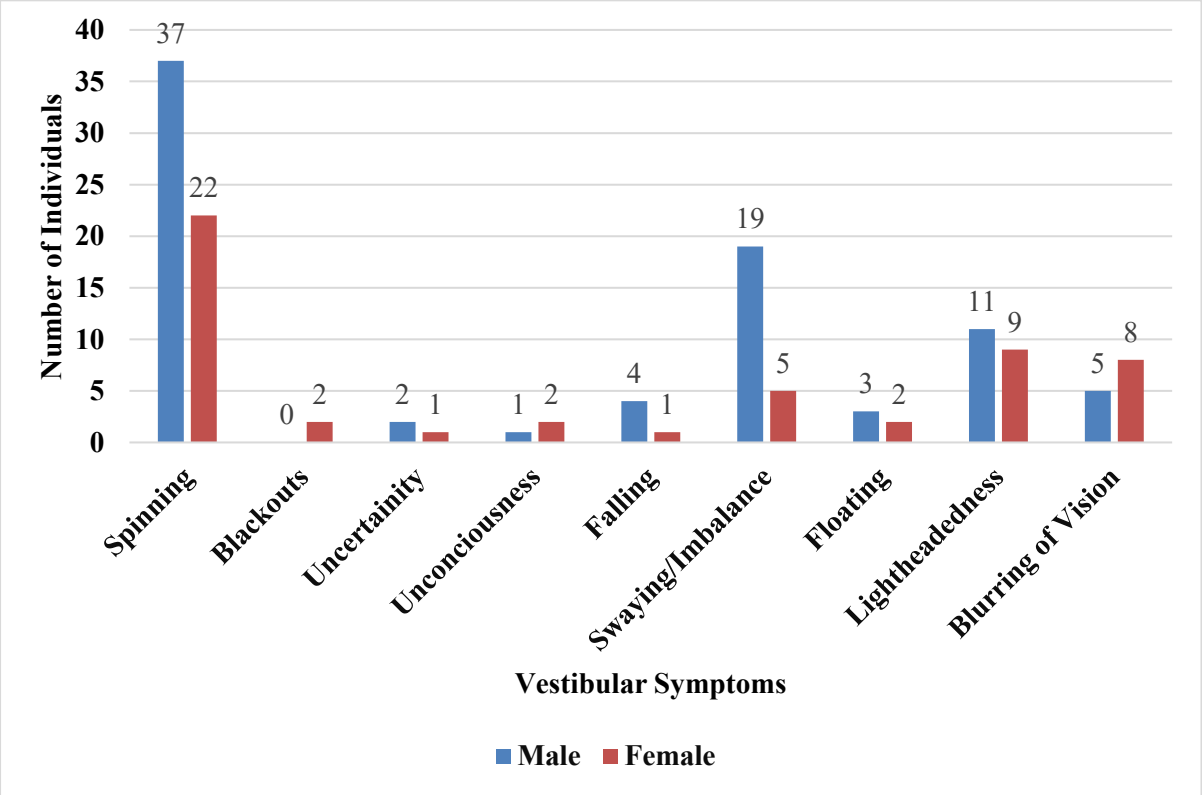

Figure 4.3 *Figure Showing the Distribution of the Vestibular Symptoms*

The spinning sensation was reported to last for less than 15 minutes in 7 male and 7 female individuals, 15-30 minutes in 7 males, 30 minutes to 1 hour in one male and one female individual. Spinning sensation was experienced for more than an hour in 22 males and 14 females.

4.1.4. Other Associated Symptoms

Apart from Audiological and vestibular symptoms reported by the individuals, other associated symptoms, such as vomiting, sweating, nausea, increased heart rate, motion sickness, lack of sleep or presence of stress, giddiness caused due to change in head position, sitting down or standing up, walking or climbing the stairs were documented. The presence of hypertension, diabetes, or headache was also noted.

Of the 40 male participants, 31 reported vomiting, 20 sweating, and 14 nausea associated with other vestibular symptoms, such as a spinning sensation. 3 male individuals reported an increase in heart rate during the episode of vertigo. One individual reported having motion sickness. 7 male participants reported either a lack of sleep or excessive stress. 13 male participants sometimes experienced giddiness with a change in head position; 4 experienced vertigo while standing up or sitting down; and 2 experienced it while walking or climbing up/down stairs. 15 individuals reported to have hypertension, 12 individuals had diabetes and 14 individuals reported to have notable severity or frequency of headaches. This is shown in Figure 4.4.

Out of the 23 female participants, 19 reported vomiting, 8 reported sweating and 9 had nausea associated with other vestibular symptoms like spinning sensation. 3 female individuals reported an increase in heart rate during the episode of vertigo. 4 female individuals reported having motion sickness. 3 female participants reported having either a lack of sleep or excessive stress. 7 female individuals experienced giddiness with a change in head position, and 1 individual experienced it while walking or climbing stairs. 2 individuals reported hypertension, 4 individuals had diabetes, and 10 individuals reported severe or frequent headaches. This is shown in Figure 4.4.

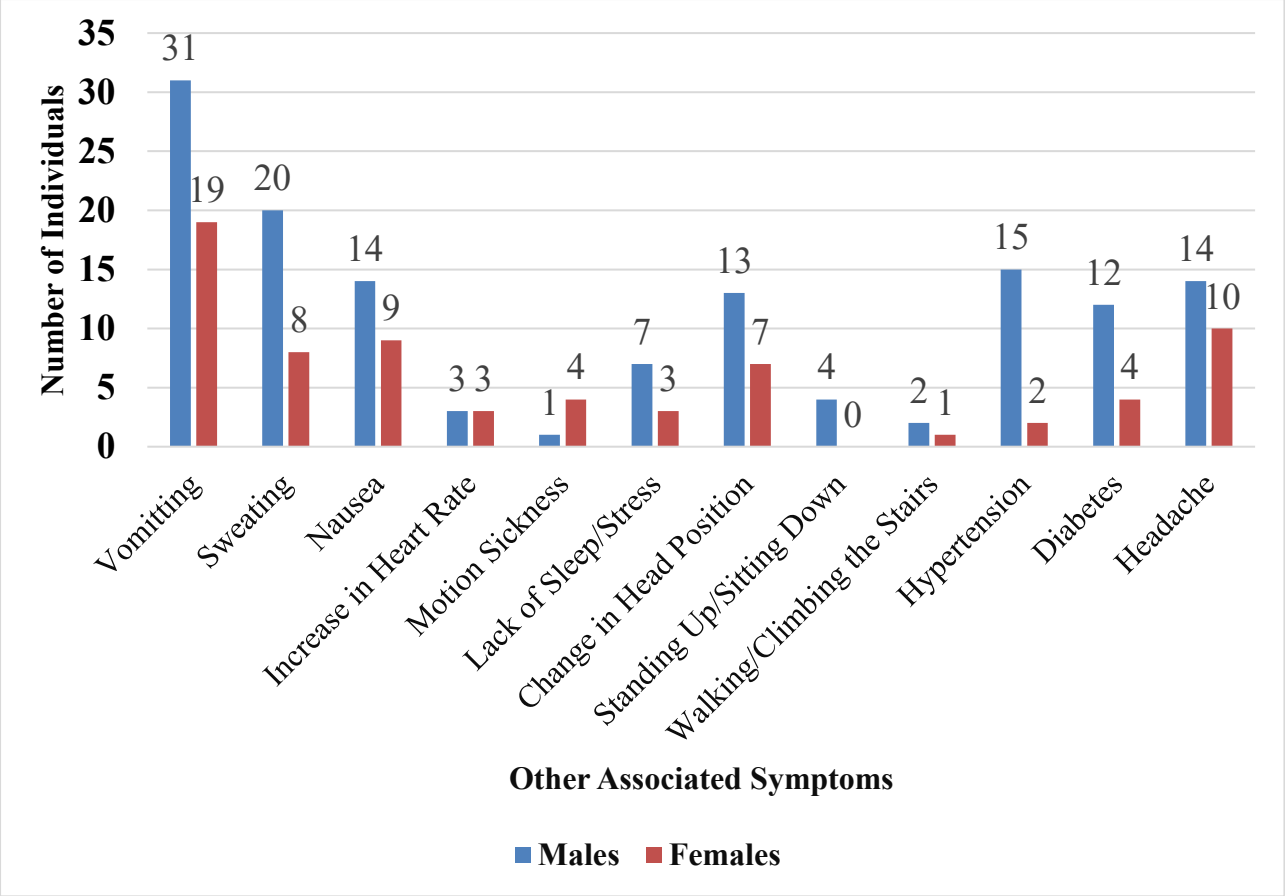

Figure4.4 *Figure Showing the Distribution of the Other Associated Symptoms*

4.2. Audiological Test Findings

4.2.1. Pure Tone Audiometry

Pure tone audiometry was carried out for all 126 ears (80 males' ears and 46 females' ears), where air conduction thresholds for 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz were found. Bone conduction thresholds were measured at 250 Hz, 500 Hz, 100 Hz, 2000 Hz, and 4000 Hz. The 4-frequency pure tone average (PTA) was found (i.e., average of the air conduction thresholds for 5000 Hz, 1000 Hz, 2000 Hz, and 4000 Hz)

Degree of hearing loss. Out of 69 ears with Ménière's disease (57 unilateral MD ears and 12 bilateral MD ears), 6 participants were found to have normal hearing. 5 participants exhibited minimal hearing loss. Mild hearing loss was observed in 13 ears, and moderate hearing loss in 19 ears. Additionally, 20 ears had moderately severe hearing loss, and 5 ears demonstrated severe hearing loss. Only one participant had profound hearing loss. No cases of

profound hearing loss were identified among the males. The same has been shown in Figure 4.5.

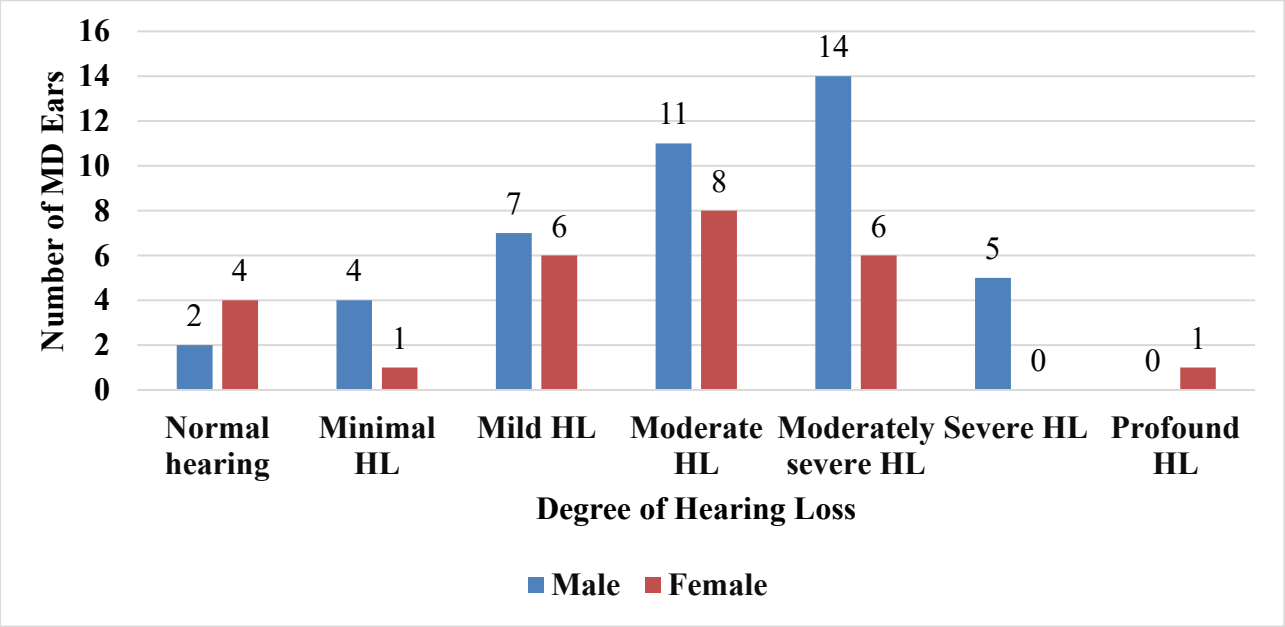

Figure 4.5 *Figure Showing the Distribution of Hearing Loss in Ménière's Disease-Affected Ears*

Out of 57 ears with no Ménière's disease, 22 participants were found to have normal hearing. 18 participants exhibited minimal hearing loss. Mild hearing loss was observed in 13 ears, and moderate hearing loss in 4 ears. No cases of moderately severe, severe and profound hearing loss were identified in ears with no Ménière's disease. This is shown in Figure 4.6.

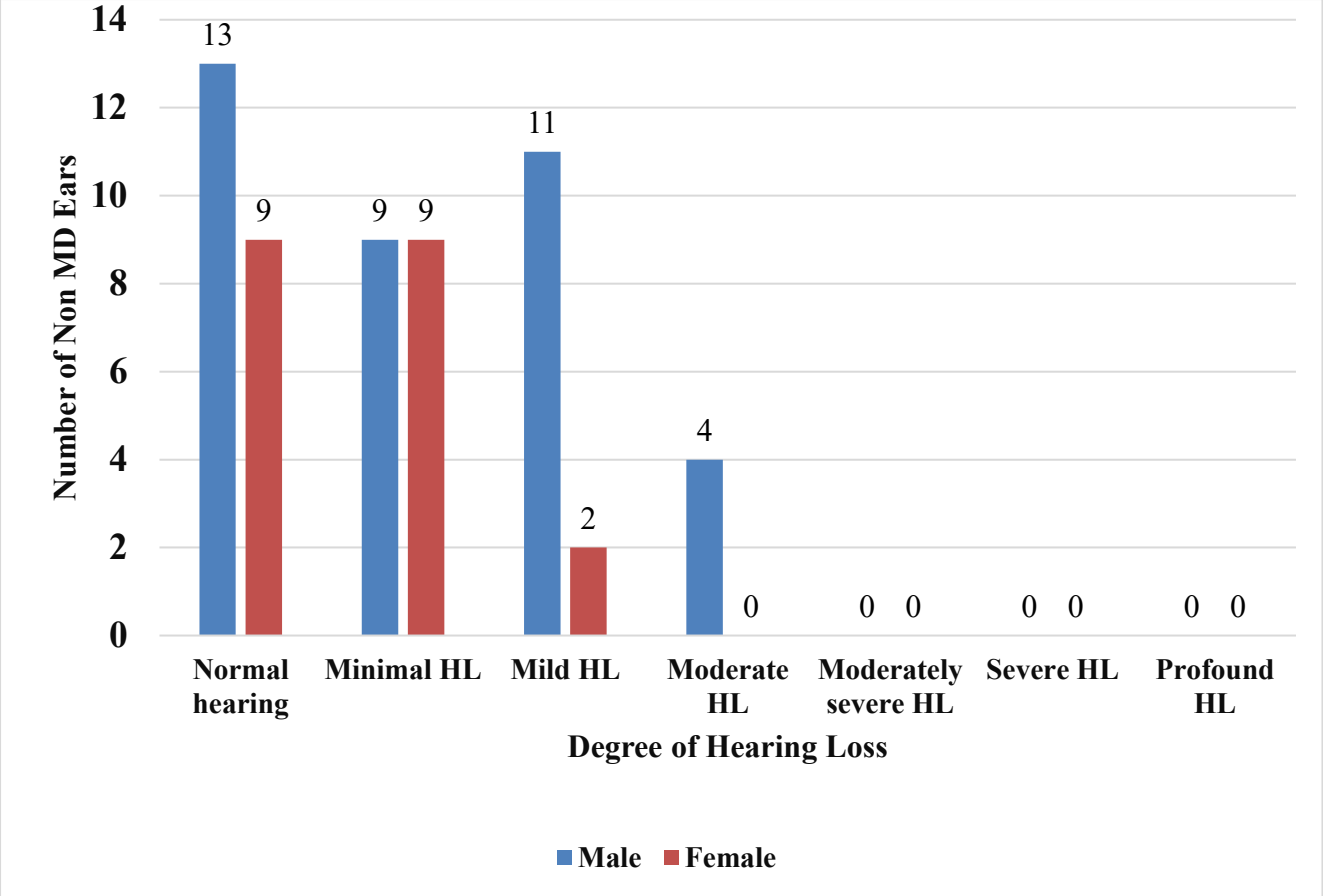

Figure 4.6 *Figure Showing the Distribution of Hearing Loss in Non-Ménière's Disease Ears*

The mean pure tone thresholds and its standard deviation for Ménière's disease ears for each frequency is depicted in the Figure 4.7.

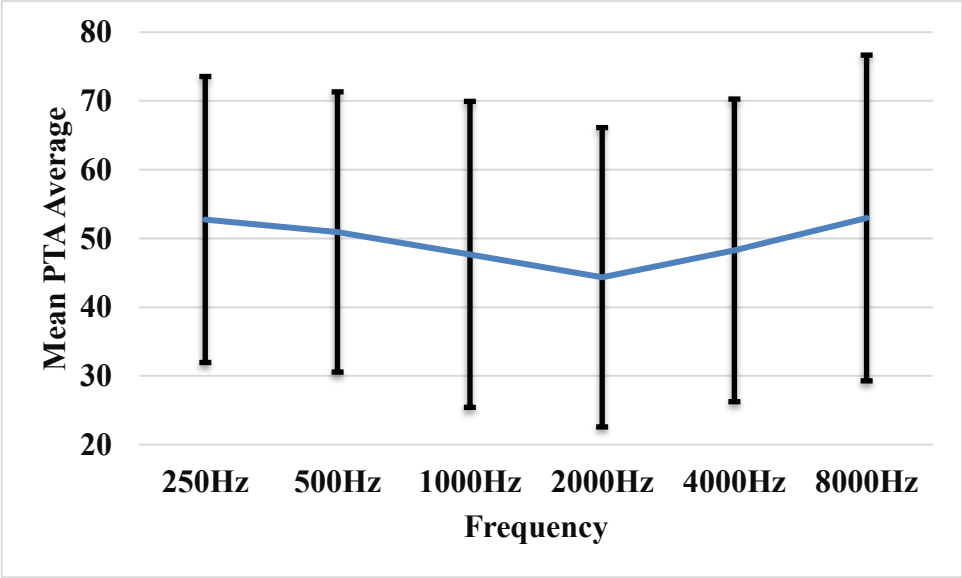

Figure 4.7 *Figure Showing the Mean PTA Thresholds for Ménière's Disease Affected Ears*

4.2.2. Tympanometry and Reflexometry

A. Tympanogram Type. From the data reviewed, it was noted that out of 69 ears with Ménière's disease:

- 36 ears had an A-type tympanogram,
- 19 ears had an As-type tympanogram,
- 11 ears had an Ad-type tympanogram,
- 3 ears had a C-type tympanogram, and
- None of the ears had B-type tympanogram

It was also noted that out of 57 ears without Ménière's disease:

- 35 ears had an A-type tympanogram,
- 15 ears had an A-type tympanogram,
- 6 ears had an Ad-type tympanogram,
- One ear had a C-type tympanogram, and
- None of the ears had B-type tympanogram

B. Acoustic Reflexes. Out of 69 ears with Ménière's disease, Ipsilateral acoustic reflexes were carried out for 58 ears and contralateral reflexes were found for 55 ears.

- 28 ears were found to have ipsilateral acoustic reflexes present. 30 ears with MD had absent ipsilateral acoustic reflexes. Out of the 30 absent ipsilateral acoustic reflexes, 1 ear had normal hearing, 1 ear had minimal hearing loss, 5 ears had mild hearing loss, 6 ears had moderate hearing loss, 12 ears had moderately severe hearing loss, 4 ears had severe hearing loss, and 1 ear had profound hearing loss.
- 33 ears were found to have contralateral acoustic reflexes present. 22 ears with MD had absent contralateral acoustic reflexes. Among the ears with absent responses, none showed normal hearing, minimal or profound hearing loss. Mild hearing loss and

moderate hearing loss were observed in 4 ears each, moderately severe hearing loss was seen in 11 ears, and severe hearing loss in 3 ears.

The same is shown in Figure 4.8.

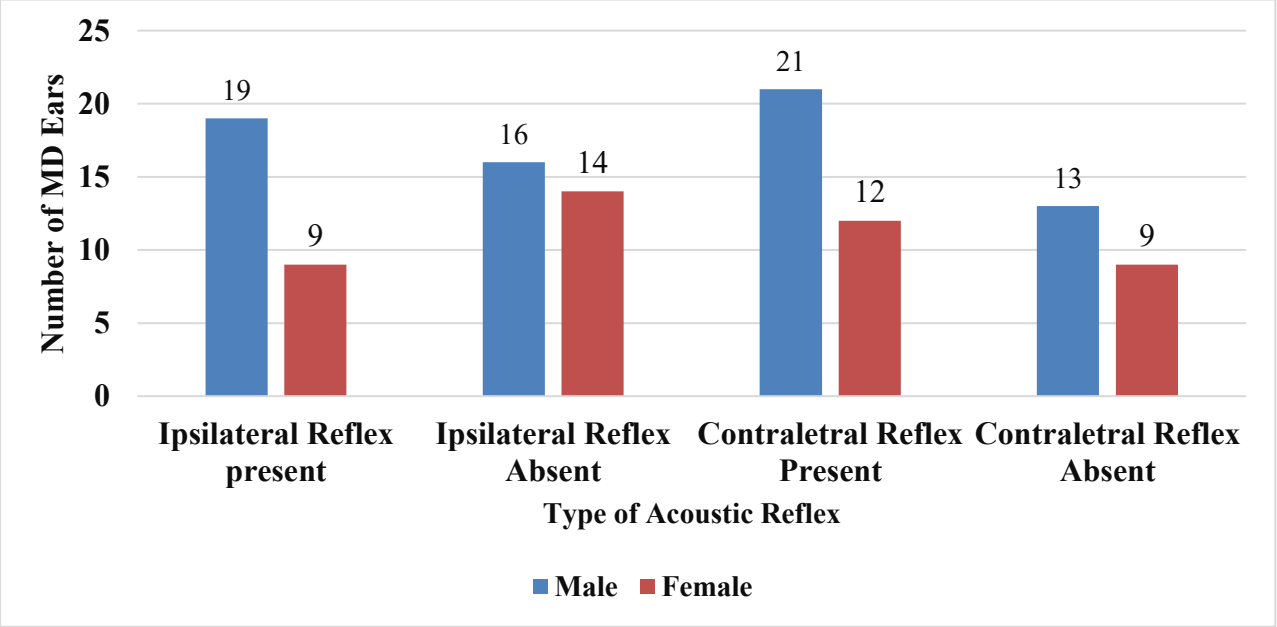

Figure 4.8 *Figure Showing the Presence or Absence of Acoustic Reflexes in Ménière's Disease-Affected Ears*

Out of 57 unaffected ears, Ipsilateral acoustic reflexes were carried out for 51 ears and contralateral reflexes were done for 50 ears.

- 32 ears were found to have ipsilateral acoustic reflexes present. 19 unaffected ears had absent ipsilateral acoustic reflexes.
- 22 ears were found to have contralateral acoustic reflexes present. 28 unaffected ears had absent contralateral acoustic reflexes.

4.2.3. Otoacoustic Emissions

TEOAEs were detected in 126 ears. Among the 58 MD ears examined, it was present in 8 participants and absent in 50. Among the 51 non-MD ears, it was present in 18 participants and absent in 33. Out of the 50 MD ears where the TEOAEs were found to be absent, 4 had

normal hearing, 3 had minimal hearing loss, 8 had mild hearing loss, 14 had moderate, 15 had moderately severe hearing loss, 5 were found to have severe, and one had profound hearing loss.

4.2.4. Auditory Brainstem Response

Auditory Brainstem Responses were found for 62 out of 69 ears with Ménière's disease, and were found to be present in 59 ears and absent in 3 ears with Ménière's disease. For the non-Ménière's disease ears, ABR was recorded in 52 out of 57 ears and was found to be present in all of them. Lesion testing was also performed on all 126 ears to differentiate between cochlear and retrocochlear pathology, and none of the participants was found to have retrocochlear pathology.

4.3. Vestibular Evoked Myogenic Potentials (VEMP)

4.3.1. Cervical Evoked Myogenic Potentials (cVEMP)

- cVEMP testing was carried out in 66 out of 69 ears with Ménière's disease at 500 Hz and in 65 out of 69 ears at 1000 Hz. Responses were present in 47 ears (71.21%) at 500 Hz and 48 ears (73.85%) at 1000 Hz. Absent responses were obtained in 19 ears (28.79%) and 17 ears (26.15%), respectively. The maximum, minimum, mean and standard deviation of the latencies and amplitude of the same are given in Tables 4.1 and 4.2, respectively. A shift in frequency tuning was observed in 8 ears (16.66%).
- cVEMP testing was carried out in 55 ears out of 57 ears without Ménière's disease at 500 and 1000 Hz. Responses were present in 47 ears (85.45%) at 500 Hz and 50 ears (90.91%) at 1000 Hz. Absent responses were obtained in 8 ears (14.55%) and 5 ears (9.09%), respectively. The maximum, minimum, mean and standard deviation of the latencies and amplitude of the same are given in Tables 4.3 and 4.4, respectively. A shift in frequency tuning was observed in 4 ears (8%).
- Asymmetry ratio was found to be abnormal (>30%) in 10 ears (14.49%) out of 69 ears.

Table 4.1

Table Showing the Latency and Rectified Amplitude of cVEMP for 500 Hz for Ménière's Disease Affected Ears

N=47	Minimum	Maximum	Mean	Std. Deviation
P13 Latency	11.60	11.60	17.70	13.87
N23 Latency	0.90	17.30	23.30	20.80
Rectified Amplitude	0.20	0.20	1.90	0.87

Table 4.2

Table Showing the Latency and Rectified Amplitude of cVEMP for 1000 Hz for Ménière's Disease Affected Ears

N=48	Minimum	Maximum	Mean	Std. Deviation
P13 Latency	11.50	17.70	13.51	1.49
N23 Latency	16.10	25.70	20.69	2.06
Rectified Amplitude	0.20	3.90	1.07	0.67

Table 4.3

Table Showing the Latency and Rectified Amplitude of cVEMP for 500 Hz for Non- Ménière's Disease Ears

N=47	Minimum	Maximum	Mean	Std. Deviation
P13 Latency	11.00	16.40	13.59	1.30
N23 Latency	16.80	25.80	21.04	2.13
Rectified Amplitude	0.30	3.40	1.15	0.71

Table 4.4

Table Showing the Latency and Rectified Amplitude of cVEMP for 1000 Hz for Non- Ménière's Disease Ears

N=50	Minimum	Maximum	Mean	Std. Deviation
P13 Latency	11.40	22.10	13.52	1.79
N23 Latency	15.70	25.10	20.85	1.77
Rectified Amplitude	0.20	3.10	1.12	0.65

4.3.2. Occular Evoked Myogenic Potentials (oVEMP)

- oVEMP testing was carried out in 65 ears out of 69 ears with Ménière's disease at 500 Hz and 1000 Hz. Responses were present in 41 ears (63.08%) at 500 Hz and 40 ears (61.54%) at 1000 Hz. Absent responses were obtained in 24 ears (36.92%) and 25 ears (38.46%), respectively. The maximum, minimum, mean and standard deviation of the latencies and amplitude of the same are given in Tables 4.5 and 4.6, respectively. A shift in frequency tuning was observed in 22 ears (55%).
- oVEMP testing was carried out in 54 ears out of 57 ears without Ménière's disease at 500 Hz and in 55 ears out of 57 at 1000 Hz. Responses were present in 40 ears (74.07%) at 500 Hz and 43 ears (78.18%) at 1000 Hz. Absent responses were obtained in 3 ears (5.56%) and 2 ears (3.64%), respectively. The maximum, minimum, mean and standard deviation of the latencies and amplitude for the same are given in Tables 4.7 and 4.8, respectively. A shift in frequency tuning was observed in 4 ears (9.30%).
- Asymmetry ratio was found to be abnormal (>30%) in 17 ears (24.63%) out of 69 ears.

Table 4.5

Table Showing the Latency and Rectified Amplitude of oVEMP for 500 Hz for Ménière's Disease Affected Ears

N=41	Minimum	Maximum	Mean	Std. Deviation
N10 Latency	8.90	15.00	11.13	1.22
P15 Latency	13.10	19.60	15.99	1.62
Amplitude	0.20	4.90	1.16	1.10

Table 4.6

Table Showing the Latency and Rectified Amplitude of oVEMP for 1000 Hz for Ménière's Disease Affected Ears

N=40	Minimum	Maximum	Mean	Std. Deviation
N10 Latency	8.70	13.00	10.51	1.01
P15 Latency	12.50	20.20	15.50	1.69
Amplitude	0.30	4.90	1.28	1.23

Table 4.7

Table Showing the Latency and Rectified Amplitude of oVEMP for 500 Hz for Non- Ménière's Disease Ears

N=40	Minimum	Maximum	Mean	Std. Deviation
N10 Latency	9.00	13.30	10.89	1.07
P15 Latency	13.40	19.70	15.97	1.52
Amplitude	0.30	4.50	1.74	1.21

Table 4.8

Table Showing the Latency and Rectified Amplitude of oVEMP for 1000 Hz for Non- Ménière's Disease Ears

N=43	Minimum	Maximum	Mean	Std. Deviation
N10 Latency	9.00	12.50	10.52	0.99
P15 Latency	10.20	20.00	15.41	1.73
Amplitude	0.30	6.40	1.59	1.40

4.4. Video Head Impulse Test (vHIT)

- vHIT was carried out for 52 out of 69 MD Ears. It was found that refixation saccades were present for 10 lateral canals (19.23%) and 3 posterior canals (5.77%). Gain was found to be less than 0.8 in 4 ears (7.69%) for the lateral canal and less than 0.7 in 7 ears (13.46%) and 14 ears (26.92%) for the anterior and posterior canals, respectively.
- vHIT was carried out for 44 out of 57 non-MD ears, and it was found that refixation saccades were present for 6 (13.64%) lateral canals. Gain was found to be less than 0.8 in 2 ears (4.54%) for lateral canal and less than 0.7 in 7 (15.91%) and 21 (47.72%) ears for anterior and posterior, respectively.

The mean, maximum and minimum VOR gain for all three canals is given in Tables 4.9 and 4.10 for Ménière's disease and non-Ménière's disease ears, respectively.

Table 4.9

Table Showing the VOR Gain for Ménière's Disease-Affected Ears

N=52	Minimum	Maximum	Mean	Std. Deviation
Lateral Canal Gain	0.44	1.30	0.94	0.13
Anterior Canal Gain	0.44	1.16	0.85	0.15
Posterior Canal Gain	0.19	1.04	0.71	0.18

Table 4.10

Table Showing the VOR Gain for Non- Ménière's Disease Ears

N=44	Minimum	Maximum	Mean	Std. Deviation
Lateral Canal Gain	0.73	1.30	0.96	0.09
Anterior Canal Gain	0.40	1.16	0.87	0.15
Posterior Canal Gain	0.19	1.02	0.71	0.17

4.5. Subjective Visual Vertical (SVV)

The subjective visual Vertical test was carried out for 23 of 63 individuals and was found to be normal in all. The same is shown in Figure 4.9.

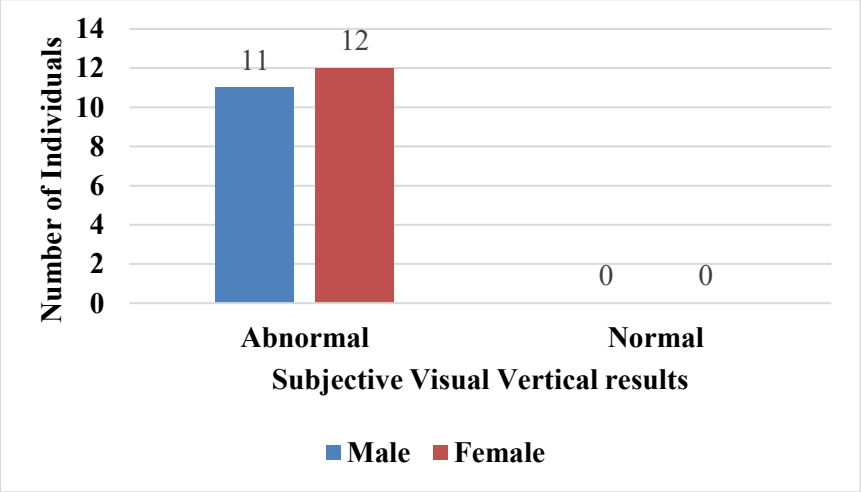

Figure 4.9 *Figure Showing the Subjective Visual Vertical Results Among All the Individuals Tested*

The present study included 63 patients with Ménière's disease, out of which 57 had unilateral involvement, and 6 had bilateral involvement. The condition was seen more commonly in males and was most frequently observed during middle age. Among the ear-related symptoms, tinnitus and reduced hearing sensitivity were the most commonly reported complaints. Spinning vertigo was the predominant vestibular symptom and was often associated with vomiting, sweating, and headache. Pure-tone audiometry findings in affected ears ranged from normal hearing to profound hearing loss and moderate -to-severe

sensorineural hearing loss was observed most frequently. Elevated thresholds were commonly seen in both low and high frequencies. Immittance evaluation mostly revealed type A tympanograms. Acoustic reflexes were absent in some individuals, even in cases with relatively mild hearing loss. Otoacoustic emissions were absent in most Ménière's disease ears. Auditory brainstem responses were present in almost all participants and showed no retrocochlear pathology. Both cVEMP and oVEMP showed absent responses and abnormal asymmetry ratios in some participants. Frequency tuning shifts were observed more often in oVEMP than cVEMP findings. vHIT results showed reduced vestibulo-ocular reflex gains mainly in the vertical semicircular canals, especially the posterior canal, along with occasional corrective saccades. However, the average gain values were similar between Ménière's disease and non-affected ears. Subjective Visual Vertical testing was found to be normal in all tested individuals.

Chapter-5

Discussion

This study examined signs, symptoms, and audio-vestibular findings in individuals diagnosed with Ménière's disease who visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders at the All-India Institute of Speech and Hearing, Mysore, between July 2024 and August 2025. The findings demonstrated considerable variability in clinical presentation and audio-vestibular test outcomes among participants. The observations from the present study are discussed in relation to the previous literature.

5.1 Signs and Symptoms in Ménière's Disease

5.1.1 Age, Gender, and Laterality

In the present study, the majority of individuals diagnosed with Ménière's disease were in the 41–50-year age group, followed by 31–40, 51–60, and 60+. Male individuals were more commonly affected than females.

These findings suggest that Ménière's disease is predominantly observed during middle and late adulthood. Similar findings have been reported in previous studies. Tokumasu et al. (1996) reported that the majority of individuals with Ménière's disease were in their third, fourth, and fifth decades of life. Ihler et al. (2022) noted that nearly half of patients received their diagnosis before age 50. Similarly, Zhang et al. (2016) also reported a mean age of approximately 47.9 years in individuals with definite unilateral Ménière's disease.

Regarding gender distribution, males were more frequently affected than females in the present study. Zhang et al. (2016) reported similar findings, noting a slight male predominance. However, previous literature remains inconsistent, with some studies reporting equal gender distribution while others demonstrate a greater proportion of affected females. One possible explanation for the present finding may be sociocultural differences in healthcare

utilisation, in which men in India may be more likely to seek medical attention than women (Selvakumar et al., 2012).

The present study additionally revealed that unilateral Ménière's disease was considerably more common than bilateral involvement. Similar findings have been reported in the literature, showing that Ménière's disease commonly begins in one ear. Sharma (2017) reported unilateral hearing loss in nearly 70–85% of patients, while Stahle et al. (1991) observed that bilateral involvement tends to increase with longer disease duration. Syed and Aldren (2012) also reported that Ménière's disease usually begins unilaterally and later progresses to involve the second ear after several years.

Vestibular migraine was found to be the most common comorbid condition associated with Ménière's disease in the present study. This finding supports previous literature and demonstrates the considerable overlap between the two disorders. Radtke et al. (2011) reported that vestibular migraine frequently coexists with Ménière's disease. Since both conditions share symptoms such as vertigo, nausea, headache, and auditory complaints, differential diagnosis may become particularly difficult.

Several mechanisms have been proposed to explain the association between migraine and Ménière's disease. It has been reported that the vestibular and trigeminal systems are connected via neurovascular pathways (Olesen et al., 2009; Goadsby et al., 2009). Dysregulated trigeminal nerve activity during migraine may therefore affect cochleo-vestibular functioning. Lee et al. (2000) additionally suggested that migraine-associated vasospasm may produce ischemic injury within the cochlea. Baloh (1997) further proposed that ion channel dysfunction and altered extracellular potassium levels may contribute to both migraine and endolymphatic hydrops, thereby increasing the susceptibility of patients with migraine to develop Ménière's disease.

5.1.2 Ear-Related Symptoms

Among the ear-related symptoms documented in the present study, tinnitus was the most commonly reported, followed by reduced hearing sensitivity and a sensation of ear blockage. A smaller number of participants reported itching in the ear and ear pain, while none reported ear discharge.

These findings are in accordance with previous literature. Lopez-Escamez et al. (2015) described tinnitus as one of the major symptoms of Ménière's disease, often occurring with fluctuating hearing loss and aural fullness. Similar observations were reported by Zhang et al. (2016) and Tokumasu et al. (1996). These authors noted that cochlear symptoms such as hearing loss and tinnitus are often among the earliest manifestations of Ménière's disease. Tinnitus in Ménière's disease is primarily associated with endolymphatic hydrops involving excessive accumulation of endolymph within the inner ear (Espinosa-Sanchez & Lopez-Escamez, 2016). Gluth (2020) explained that increased endolymphatic pressure can cause swelling of the membranous labyrinth, potentially disrupting the interaction between hair cells and the tectorial membrane and leading to hearing loss.

Additional explanations for tinnitus have also been proposed in previous studies. Hallpike and Cairns (1938) suggested that degenerative changes affecting Corti's organ may contribute to tinnitus generation. Schuknecht (1963) proposed that rupture of the membranous labyrinth may result in mixing of endolymph and perilymph, which leads to altered potassium concentrations that interfere with neural transmission and sensory function. Zenner et al. (1999) explained that transient endolymphatic leakage may elevate potassium levels around cochlear hair cells, leading to abnormal transmitter release, hearing loss, and tinnitus.

Nadol and Thornton (1987) described histopathological findings, such as increased endolymphatic volume, ruptures of the membranous labyrinth, fusion of cilia, and disorganisation of outer hair cells, as causes of hearing loss. These structural abnormalities may

interfere with cochlear transduction and contribute to sensorineural hearing loss. Paparella et al. (1982) suggested that hydrops may mechanically alter cochlear traveling waves, which affects both low- and high-frequency hearing sensitivity. Tonndorf (1968) proposed that extensive saccular hydrops may distort or immobilise travelling waves within the cochlea, thereby contributing to cochlear dysfunction. Schuknecht (1981) additionally reported that long-standing Ménière's disease is associated with loss of cochlear hair cells and spiral ganglion cells, particularly within the apical turn of the cochlea, which may explain the low-frequency hearing loss commonly observed during the early stages of the disease.

The present study additionally demonstrated a high prevalence of aural fullness among affected individuals. Paparella and Djalilian (2002) similarly reported that aural fullness is experienced by a large proportion of patients and may even precede definite vertiginous episodes.

The high prevalence of aural fullness in the present study may also be associated with endolymphatic hydrops. Levo et al. (2014) suggested that hydrops-associated distention within vestibular structures may activate trigeminal sensory pathways, thereby contributing to the sensation of ear fullness.

Merchant et al. (2005) reported that endolymphatic hydrops may represent a histopathological marker of the disorder and may not directly produce all symptoms of Ménière's disease. They identified cases in which hydrops was present without classic symptoms, and others in which classic symptoms occurred without histological evidence of hydrops. These findings suggest that disturbances in inner ear homeostasis and additional pathological mechanisms may contribute to symptom generation.

None of the participants in the present study reported ear discharge, which is expected because Ménière's disease primarily affects the inner ear and is not generally associated with middle ear pathology.

5.1.3 Vestibular Symptoms

The most commonly reported vestibular symptom in the present study was spinning sensation (vertigo), followed by swaying or imbalance, lightheadedness, and blurring of vision. A few participants reported floating sensations, falls, blackouts, uncertainty, and unconsciousness.

The spinning sensation experienced by most participants is consistent with the classical clinical presentation of Ménière's disease. Lopez-Escamez et al. (2015) described episodic vertigo as a hallmark symptom of the disorder. Gürkov et al. (2018) reported rotatory vertigo in more than 80% of patients with MRI-confirmed endolymphatic hydrops. Likewise, Ihler et al. (2022) found that all patients with definite Ménière's disease experienced vertigo episodes lasting between 20 minutes and 12 hours.

Several explanations have been proposed for the occurrence of vertigo in Ménière's disease. De Costa et al. (2002) suggested that during vertigo attack, the affected labyrinth becomes incapable of maintaining its normal basal discharge rate, while the contralateral labyrinth continues to discharge normally. This asymmetry in vestibular input reaching the central nervous system is interpreted as rotational movement, thereby producing vertigo. Schuknecht (1963) proposed that rupture of the membranous labyrinth results in mixing of endolymph and perilymph, leading to biochemical alterations that disturb vestibular sensory function. Costa et al. (2002) further reported that severe saccular hydrops may extend into the semicircular canals and mechanically alter the function of the crista ampullaris, thereby producing sudden vertigo.

Many individuals in the present study additionally reported swaying and imbalance. These findings are similar to the observations reported by Ihler et al. (2022), who described gait disturbances and imbalance in a considerable proportion of patients. Several participants additionally reported falls, giddiness, and imbalance. Kentala et al. (2001) similarly described drop attacks in individuals with Ménière's disease and associated them with gait disturbances,

tinnitus, anxiety, and visually induced vertigo. The authors also observed that vertigo episodes could be triggered by head movement, physical strain, pressure changes, and rapid visual motion.

The presence of falls and imbalance in the present study may indicate advanced vestibular or otolithic involvement. Baloh et al. (1990) suggested that Tumarkin attacks occur due to sudden utriculosaccular dysfunction caused by abrupt pressure changes within the inner ear affecting otolithic organs. Schuknecht (1963) further proposed that the sudden collapse or rupture of distended membranous structures in the utricle or saccule may cause abrupt disturbances of the otolithic organs, leading to sudden falls.

Lightheadedness and blurring of vision were also reported by several participants. A few individuals additionally reported blackouts or unconsciousness. Gürkov et al. (2018) reported a higher prevalence of Tumarkin attacks among patients with simultaneous cochleo-vestibular onset of symptoms. Positional giddiness reported by some participants may also be associated with extensive saccular hydrops. Tonndorf (1968) and Paparella et al. (1991) suggested that severe hydrops extending into the semicircular canals may mechanically alter the function of the crista ampullaris, thereby producing positional vertigo.

5.1.4 Other Associated Symptoms

Several associated symptoms were reported in the present study. Vomiting was the most commonly reported symptom, followed by sweating, headache, nausea, positional giddiness, hypertension, and diabetes.

The high prevalence of vomiting and nausea observed in the present study has also been reported in previous literature. Gürkov et al. (2018) reported nausea in approximately 89.7% of patients and vomiting in 76.4% of patients during vertigo attacks. Ihler et al. (2022) similarly reported nausea and emesis in a large proportion of patients. De Costa et al. (2002) noted that

asymmetric vestibular input during attacks may produce strong autonomic and vestibular responses, thereby contributing to nausea and vomiting.

Sweating and increased heart rate observed in some participants may reflect activation of the autonomic nervous system during severe vertigo attacks. Gürkov et al. (2018) similarly reported profuse sweating in more than half of their patients. Many participants additionally reported headache, and vestibular migraine was identified as the most common comorbid condition. Neff et al. (2012) reported that individuals with Ménière's disease may experience migraine-associated symptoms such as headaches, photophobia, and phonophobia.

Several mechanisms have been proposed that explain the overlap between migraine and Ménière's disease. Several authors have suggested that neurotransmitters released during migraine attacks may modulate vestibular functioning (Cutrer & Baloh, 1992; Baloh, 1997; Dieterich & Brandt, 1999). Repeated vascular changes affecting the vestibular labyrinth may eventually contribute to irreversible cochlear and vestibular dysfunction. These mechanisms may explain the frequent coexistence of migraine-related symptoms among individuals with Ménière's disease (Brandt, 1999).

Some participants in the present study experienced giddiness while changing head position, standing up, sitting down, or walking. Such findings may indicate vestibular instability or the coexistence of additional vestibular disorders. The coexistence of vestibular migraine and labyrinthitis in certain participants may also have contributed to these positional symptoms. Stress and sleep-related factors reported by some participants may additionally influence symptom severity. Horner and Cazals (2005) suggested that neuroendocrinological pathways involved in stress regulation may affect inner ear functioning and contribute to symptom exacerbation in Ménière's disease. Hypertension and diabetes were observed in several participants in the present study. Ihler et al. (2022) also reported hypertension as a common comorbid condition among individuals with Ménière's disease.

5.2 Audiological Test Findings

5.2.1 Pure Tone Audiometry

The pure-tone audiometry findings in the present study revealed hearing loss ranging from normal to profound in ears affected by Ménière's disease. The majority of affected ears demonstrated moderate to moderately severe hearing loss. Elevated hearing thresholds were observed at both low and high frequencies, while thresholds were relatively better around 2000 Hz.

The findings of the present study are consistent with previous literature demonstrating that sensorineural hearing loss is one of the characteristic features of Ménière's disease. Neff et al. (2012) and Basura et al. (2020) reported that hearing loss in Ménière's disease usually begins at low frequencies and progressively worsens with increasing disease duration. However, Paparella et al. (1982) reported that peaked or inverted-V audiograms are commonly associated with Ménière's disease. Meyerhoff et al. (1981) additionally reported varied audiometric configurations, including flat, peaked, downward-sloping, and rising patterns.

Several pathophysiological mechanisms have been proposed to explain these audiometric findings. Paparella et al. (1982) suggested that low-frequency hearing loss may result from distortion of the compliant cochlear region due to endolymphatic hydrops, whereas high-frequency hearing loss may arise from disturbances affecting the basal cochlear region. Tonndorf (1968) further proposed that hydrops may mechanically alter cochlear travelling waves, thereby producing cochlear dysfunction. Extensive saccular hydrops may additionally distort or immobilise travelling waves within the basal turn of the cochlea. Schuknecht (1981) reported that temporal bones from individuals with long-standing Ménière's disease demonstrate loss of cochlear hair cells and spiral ganglion cells, particularly within the apical turn of the cochlea.

Nadol and Thornton (1987) additionally observed ultrastructural abnormalities, including fusion of cilia and disorganisation of cuticular structures within outer hair cells. Zenner et al. (1999) proposed that transient endolymphatic leakage may lead to potassium intoxication, affecting cochlear hair cells and contributing to acute hearing loss during Ménière attacks. Repeated or prolonged episodes may eventually produce irreversible cochlear damage and chronic sensorineural hearing loss.

5.2.2 Immittance and Reflexometry

Immittance findings in the present study predominantly revealed type A tympanograms in both Ménière's disease-affected and non-affected ears. A small number of ears demonstrated As, Ad, and C-type tympanograms, while none demonstrated B-type tympanograms.

These findings are consistent with previous literature. Selvakumar et al. (2012) and Kitajima et al. (2011) reported that most individuals with Ménière's disease have normal tympanometric findings. The present study additionally revealed normal acoustic reflexes in the majority of participants. Similar findings were reported by Muchnik et al. (1989), who observed low-frequency air-bone gaps despite normal middle ear function and present acoustic reflexes in patients with classical Ménière's disease. Selvakumar et al. (2012) further reported that although most patients demonstrate normal acoustic reflexes, absent reflexes may occasionally occur.

5.2.3 Otoacoustic Emissions

The present study revealed that transient evoked otoacoustic emissions (TEOAEs) were absent in the majority of ears affected by Ménière's disease. However, a small number of affected ears demonstrated present OAEs. Some ears also showed absent OAEs despite normal hearing thresholds.

The reduced presence of OAEs observed in affected ears is consistent with the findings of Kleine et al. (2002), who reported lower OAE incidence and reduced amplitudes in ears

affected by Ménière's disease compared to unaffected ears. Harris and Probst (1992) proposed that altered otoacoustic emissions in Ménière's disease may result from increased inner ear pressure caused by endolymphatic accumulation resulting in outer hair cell damage. Zenner et al. (1999) suggested that potassium intoxication associated with transient endolymphatic leakage may alter outer hair cell motility and cochlear amplifier function. Nadol and Thornton (1987) additionally reported ultrastructural abnormalities affecting outer hair cells in temporal bone studies of Ménière's disease.

5.2.4 Auditory Brainstem Response

Auditory Brainstem Responses (ABR) in the present study were present in the majority of ears affected by Ménière's disease, while no evidence of retrocochlear pathology was identified in any participant.

The presence of ABR responses in most affected ears is consistent with the findings of Kacker and Deka (1986). They reported normal interpeak latencies in the majority of individuals with Ménière's disease. Their findings suggested that ABR is useful in differentiating cochlear pathology from retrocochlear lesions. A few ears in the present study demonstrated absent ABR responses. This may be related to severe degrees of hearing loss in those ears. Kacker and Deka (1986) similarly reported absent responses in some individuals with severe hearing loss.

5.3 Vestibular Test Findings

5.3.1 Cervical Vestibular Evoked Myogenic Potentials (cVEMP)

The present study revealed abnormalities in cervical Vestibular Evoked Myogenic Potential (cVEMP) findings among ears affected by Ménière's disease. A greater percentage of absent responses, abnormal asymmetry ratios, and shifts in frequency tuning were observed in ears affected by Ménière's disease when compared to non-Ménière's disease ears.

Murofushi et al. (2008) observed abnormal cVEMPs in 39% of patients with Ménière's disease. De Waele et al. (1999) additionally reported absent cVEMPs in more than half of affected individuals. Hong et al. (2008) further demonstrated abnormal cVEMPs and significantly greater asymmetry in amplitude ratios between ears. Young et al. (2002) suggested that increased cVEMP amplitudes may indicate saccular hydrops and help differentiate the early and late stages of the disease. Manzari et al. (2010) further reported that dynamic saccular function decreases during Ménière attacks, resulting in reduced cVEMP responses.

The altered frequency tuning observed in the present study is consistent with previous studies, which reported that ears affected by Ménière's disease often show a higher amplitude of cVEMP at 1000 Hz rather than the normal 500 Hz pattern (Rauch et al., 2004; Timmer et al., 2006). Salviz et al. (2015) reported that changes in the frequency tuning of cVEMP in individuals with MD had a sensitivity of 75% and a specificity of 75% for diagnosing MD. Several mechanisms have been proposed to explain these tuning abnormalities. Todd et al. (2000) proposed a mass-and-stiffness theory to explain the mechanism of frequency tuning in individuals with MD. Salviz et al. (2015) proposed that the endolymphatic hydrops causes the distention of the saccular membrane. As there is a distention of the saccule, the stiffness characteristics of the saccule change. Due to the change in stiffness, the saccule's response changes accordingly. In MD, due to changes in stiffness characteristics, the amplitude of cVEMP is higher at 1000 Hz than at 500 Hz with a tone-burst stimulus (Salviz et al., 2015; Angeli & Goncalves, 2019). Apart from distension of the saccular membrane, other factors, such as a reduction in otolith mass or loss of saccular hair cells, could also account for the change in frequency tuning of the cVEMP in MD (Taylor et al., 2012; Salviz et al., 2015).

Kuo et al. (2005) reported that rupture or distortion of saccular hydrops during Ménière attacks may reduce or eliminate cVEMP responses. Following rupture, collapse or distortion

of the saccule may interfere with normal vestibular signal transmission. Taylor et al. (2012) additionally demonstrated that abnormalities in air-conducted cVEMPs were more common than abnormalities elicited by bone-conducted stimulation, suggesting predominant saccular involvement in Ménière's disease.

5.3.2 Ocular Vestibular Evoked Myogenic Potentials (oVEMP)

Ocular Vestibular Evoked Myogenic Potential (oVEMP) findings were abnormal in ears affected by Ménière's disease. Absent responses, abnormal asymmetry ratios, and frequency tuning shifts were observed in affected ears when compared to non-Ménière's disease ears. Also, the abnormality of oVEMP was more compared to the cVEMP in Ménière's disease.

Similar findings were reported by Winters et al. (2011), who observed reduced response rates and decreased amplitudes in individuals with Ménière's disease. Winters et al. (2012) and Sandhu et al. (2012) also demonstrated altered frequency tuning in affected ears, with best responses shifting toward higher frequencies such as 1000 Hz. Manzari et al. (2010) reported that dynamic utricular function in hydropic ears may become enhanced during Ménière attacks, as evidenced by augmented oVEMPs. Kuo et al. (2005) suggested that closure of the utriculo-endolymphatic valve following saccular rupture may increase pressure within the utricle, thereby influencing oVEMP responses. Taylor et al. (2012) further reported a predominance of abnormalities in air-conducted oVEMPs among individuals with Ménière's disease, supporting the presence of significant otolithic dysfunction. The reasons for the reduced amplitude of oVEMPs in MD are similar to those for cVEMPs. The utricular haircell loss and the damage to the utricular membrane will lead to reduced amplitude and reduced oVEMP responses in MD.

Salviz et al. (2015) recorded cVEMP and oVEMP responses to both 500 Hz and 1000 Hz tone-burst stimuli in individuals with MD. Salviz et al. (2015) reported that the overall

abnormality, including the response rate of oVEMP and change in frequency tuning of oVEMP, is higher for oVEMP than for cVEMP in individuals with Ménière's disease. Sandhu et al. (2012) also reported that a change in frequency tuning was more commonly observed for oVEMP than cVEMP in MD. Merchant et al. (2005) reported that endolymphatic hydrops increases the stiffness of the otolith organs, particularly the saccule. However, the change in frequency tuning of oVEMP is more commonly observed than that of cVEMP in individuals with Ménière's disease (Merchant et al., 2005).

oVEMP has also been reported to be more affected than cVEMP in individuals with severe to profound sensorineural hearing loss without endolymphatic hydrops (Bansal et al., 2013). Similarly, Apeksha and Devananda (2022) also reported more oVEMP than cVEMP abnormality in individuals with sensorineural hearing loss. According to Tribukait et al. (2004), findings from the subjective visual horizontal test indicated that, in individuals with severe to profound sensorineural hearing loss, hearing ability showed a stronger association with utricular function than with saccular function. The authors also suggested that the cochlea has a closer anatomical and functional relationship with the utricle compared to other inner ear sensory receptors. Consequently, abnormalities in oVEMP may occur more commonly than cVEMP abnormalities in patients with Ménière's disease.

5.3.3 Video Head Impulse Test (vHIT)

The vHIT findings in the present study revealed reduced vestibulo-ocular reflex (VOR) gain predominantly in the vertical canals, especially the posterior semicircular canal. Corrective saccades were observed in fewer participants, particularly in the lateral and posterior canals. Mean VOR gain values for Ménière's disease and non-Ménière's disease ears were found to be similar.

Similar findings were reported by Unsal et al. (2019), who identified pathological vHIT gain values in nearly 45% of affected ears in Ménière's disease. Blödow et al. (2014)

additionally reported significantly lower vHIT gain values on the affected side than on the unaffected side. The authors proposed that vestibular abnormalities may become less pronounced during symptom-free periods, which may explain the variability in vHIT findings across studies. Costa et al. (2002) explained that vestibular asymmetry may vary depending on the stage of the attack and the extent of labyrinthine dysfunction.

However, there are equivocal findings regarding the canal involvement in individuals with Ménière's disease. Zulueta-Santos et al. (2014) reported that the VOR gain is reduced in all six semicircular canals in individuals with Ménière's disease; however, the posterior canal is more affected (40%), followed by the superior semicircular canal (22.8%) and the lateral semicircular canal (14.2%). Sobhy et al. (2019), however, reported that the lateral semicircular canal was more affected (20%), followed by the superior semicircular canal (7.5%) and then the posterior canal (5%). The differences in results across studies could be due to differences in the populations studied or to methodological differences in classifying normal and abnormal VOR results.

5.3.4 Subjective Visual Vertical (SVV)

The Subjective Visual Vertical (SVV) findings in the present study were normal in all individuals tested.

This observation differs from several previous studies that reported abnormal SVV tilts in individuals with Ménière's disease. Kumagami et al. (2009) observed abnormal SVV deviations during acute attacks in approximately 63.6% of patients. Most tilts were directed toward the affected ear. Castro-Urquizo et al. (2021) similarly reported greater SVV deviations during active Ménière attacks. Kumagami et al. (2009) explained that SVV abnormalities are generally observed during acute attacks and tend to recover afterwards due to central compensation and restoration of vestibular end-organ function. Ferreira et al. (2023) similarly reported that significant SVV abnormalities are not generally observed during the inter-crisis

period in individuals with unilateral Ménière's disease. The absence of abnormal SVV findings in the present study may therefore reflect recovery mechanisms during interictal periods.

Chapter-6
Summary and Conclusion

The present study aimed to report signs, symptoms, and audio-vestibular findings in patients with Ménière's disease. A register-based retrospective study design was carried out, where a review of case files of patients diagnosed with Ménière's disease, with or without a comorbid condition, who visited the Centre of Excellence for Persons with Tinnitus and Vestibular Disorders, All India Institute of Speech and Hearing, Mysore, between July 2024 and August 2025 was conducted. The following findings were obtained from the study:

- Unilateral Ménière's disease was found to be more common than bilateral Ménière's disease.
- The number of males affected by Ménière's disease was more than the number of females.
- The majority of the patients diagnosed with Ménière's disease fell under the age range of 41-50 years
- Vestibular migraine was found to be the most common comorbid condition associated with Ménière's disease.
- The most reported ear-related symptom was found to be tinnitus, followed by reduced hearing, blocking sensation, itching and ear pain.
- Spinning was the most common vestibular symptom reported, followed by swaying or imbalance, lightheadedness, and blurring of vision.
- Spinning sensation was experienced for more than an hour in most males and females.
- Vomiting was reported by most patients diagnosed with Ménière's Disease, followed by sweating, headache, nausea, giddiness upon change in head position, diabetes and hypertension.

- Pure tone audiometry findings revealed varying degrees of sensorineural hearing loss ranging from normal to profound. Most patients had a moderate-to-severe degree of hearing loss.
- Overall, the PTA thresholds were found to be elevated at low and high frequencies, with the lowest threshold at 2000 Hz.
- Immittance findings predominantly revealed type A tympanograms in the majority of the patients, followed by As and Ad types.
- Ipsilateral acoustic reflexes were found to be absent in a few cases, even with a normal, minimal or mild degree of hearing loss and contralateral acoustic reflexes were found to be absent in a few cases with mild hearing loss.
- Otoacoustic emission findings revealed emissions in most of the Ménière's disease-affected ears.
- Some patients demonstrated absent OAEs despite normal hearing thresholds.
- Auditory Brainstem Responses were mostly present in all Ménière's disease affected patients, and no retrocochlear pathology was found in any of them.
- cVEMP and oVEMP findings in ears with Ménière's disease revealed a higher percentage of absent responses and greater shifts in frequency tuning. An abnormal asymmetry ratio was observed in a few cases with Ménière's disease.
- Shift in frequency tuning was observed in more cases for oVEMP than cVEMP findings.
- VOR gain was found to be most affected for the vertical canals, with the posterior canal being affected the most in cases with Ménière's disease.
- VOR gain was found to be similar for Ménière's disease and non-Ménière's disease affected ears.

- Corrective saccades were observed in lateral and posterior canals in a few patients with Ménière's disease during vHIT testing.
- Subjective Visual Vertical findings are normal in patients with Ménière's disease.

Conclusions

Ménière's disease is a highly heterogeneous disorder with wide variations in clinical presentation and audio-vestibular test findings. The present study reported a comprehensive profile of Ménière's disease, including the signs and symptoms reported by patients, along with their audiological and vestibular test findings. This study is consistent with some previous studies. The varied signs and symptoms may indicate different phases of Ménière's disease. The results of the study will help the clinician understand the various signs and symptoms and the audio vestibular test findings in Ménière's disease.

Clinical Implications

- The present study provides a comprehensive report of the signs, symptoms and audio-vestibular test findings that are usually carried out for the assessment of Ménière's disease helping in increasing the diagnostic accuracy.
- As there is a dearth of literature profiling the signs, symptoms and test findings in Ménière's disease in an Indian population, this study contributes to the existing Indian literature
- A comprehensive profile of Ménière's disease through this study would help differentially diagnose it from other diseases such as vestibular migraine that has many overlapping symptoms.
- Identification of characteristic audio-vestibular findings may help in early diagnosis of the disease and aid in planning appropriate management and rehabilitation strategies for the affected individuals

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APPENDIX

Demographic Details and the Provisional Diagnosis of the Patients

Serial No.	Client No.	Age (In Years)	Gender	Income Slab	Provisional Diagnosis
1	457390	42	Male	II	Left ear: Ménière's disease
2	475523	63	Male	I	Left ear: Ménière's disease
3	500836	57	Male	III	Left ear: Ménière's disease
4	541176	61	Male	I	Right ear: Ménière's disease
5	561189	66	Male	I	Left ear: Ménière's disease
6	576684	50	Male	II	Left ear: Ménière's disease
7	577231	66	Male	I	Left ear: Ménière's disease
8	587439	67	Male	I	Left ear: Ménière's disease
9	589348	53	Male	I	Left ear: Ménière's disease with vestibular migraine
10	594886	69	Male	I	Left ear: Ménière's disease
11	600120	56	Male	I	Right ear: Ménière's disease
12	600707	77	Male	I	Left ear: Ménière's disease
13	600734	50	Male	I	Left ear: Ménière's disease
14	601022	36	Male	I	Left ear: Ménière's disease
15	601825	37	Male	III	Right ear: Ménière's disease with vestibular migraine
16	603931	34	Male	II	Left ear: Ménière's disease
17	605826	44	Male	I	Right ear: Ménière's disease
18	606020	54	Male	I	Left ear: Ménière's disease
19	606196	40	Male	I	Left ear: Ménière's disease
20	606231	44	Male	I	Right ear: Ménière's disease
21	609030	47	Male	I	Left ear: Ménière's disease

22	609181	39	Male	I	Right ear: Ménière’s disease
23	610199	39	Male	III	Right ear: Ménière’s disease
24	610872	42	Male	I	Right ear: Ménière’s disease
25	613923	70	Male	II	Left ear: Ménière’s disease
26	617232	71	Male	I	Right ear: Ménière’s disease
27	617621	37	Male	I	Left ear: Ménière’s disease
28	619262	48	Male	I	Right ear: Ménière’s disease
29	619521	45	Male	III	Left ear: Ménière’s disease with vestibular migraine
30	619681	45	Male	I	Right ear: Ménière’s disease
31	620171	52	Male	I	Left ear: Ménière’s disease
32	620482	50	Male	I	Right ear: Ménière’s disease
33	621590	47	Male	I	Right ear: Ménière’s disease
34	623325	62	Male	II	Right ear: Ménière’s disease
35	623354	36	Male	I	Left ear: Ménière’s disease
36	623380	53	Male	I	Right ear: Ménière’s disease
37	624171	68	Male	I	Right ear: Ménière’s disease
38	445342	35	Female	I	Right ear: Ménière’s disease
39	549823	49	Female	I	Right ear: Ménière’s disease with vestibular migraine
40	569340	41	Female	I	Left ear: Ménière’s disease with vestibular migraine
41	574857	52	Female	I	Left ear: Ménière’s disease
42	583457	28	Female	I	Right ear: Ménière’s disease with vestibular migraine
43	587876	48	Female	I	Ménière’s disease in the right ear
44	595960	31	Female	I	Left ear: Ménière’s disease with vestibular migraine
45	602313	54	Female	I	Ménière’s disease in the right ear
46	605782	22	Female	I	Left ear: Ménière’s disease secondary to vestibular labyrinthitis
47	606217	51	Female	I	Left ear: Ménière’s disease

48	606997	35	Female	I	Right ear: Ménière’s disease
49	609549	47	Female	I	Ménière’s disease in the left ear
50	610050	41	Female	I	Ménière’s disease in the right ear
51	610694	40	Female	I	Ménière’s disease in the right ear
52	612185	80	Female	I	Ménière’s disease in the left ear
53	613227	25	Female	I	Ménière’s disease in the left ear with vestibular migraine
54	614717	48	Female	I	Ménière’s disease in the left ear
55	614883	42	Female	I	Ménière’s disease in the left ear
56	615794	35	Female	III	Ménière’s disease in the left ear
57	616012	52	Female	I	Ménière’s disease in the left ear
58	361057	48	Male	I	Bilateral Ménière’s disease
59	461384	38	Male	I	Bilateral Ménière’s disease
60	616265	40	Male	I	Bilateral Ménière’s disease
61	602860	52	Female	I	Bilateral Ménière’s disease with vestibular migraine
62	608268	60	Female	I	Bilateral Ménière’s disease with vestibular migraine
63	617012	36	Female	I	Bilateral Ménière’s disease

Note: Income Slab I: Monthly income up to 22,5000 Rupees, Income Slab II: Monthly income between 22,500 and 30,000 Rupees, Income Slab III: Monthly income equal to or more than 30,000 Rupees.

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INSTITUTE REVIEW BOARD (IRB) APPROVAL FOR BIO-BEHAVIOURAL RESEARCH PROPOSAL INVOLVING HUMAN SUBJECTS AT AIISH

AIISH Institute Review Board (IRB)

Ref: SH/IRB/M.4/AUD.02/2025-26

Date: 06.01.2026

Title of the Dissertation	: Signs, Symptoms and Audio-Vestibular Test Results in Patients with Ménière's Disease: A Register-Based Study
Name of the Student	: Ms. Preksha Agarwal
Guide	: Dr. Sujeet Kumar Sinha
Proposed Duration of the Project	: 08 months
Source of funding	: Non-funded Master's dissertation
Estimated budget	: Nil
Reference Number of the Project	: Nil
Date on which the IRB meeting was held	: 02.01.2026
A clear statement of the decision reached IRB meeting (In the event of the proposal is not approved, a statement of reasons for the same must be indicated)	: **APPROVED**
Advice & suggestions (if any)	: NIL

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