COMPARISON OF WIDE BAND TYMPANOMETRY BETWEEN INDIVIDUALS WITH MENIERE'S DISEASE AND VESTIBULAR MIGRAINE

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CERTIFICATE

This is to certify that this dissertation entitled **"Comparison of Wide Band Tympanometry Between Individuals with Meniere's Disease and Vestibular Migraine"** is a bonafide work submitted as part of fulfilment of the degree of Master of Science **Audiology** of the student with Registration Number **P01II24S023027**. 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 **"Comparison of Wide Band Tympanometry Between Individuals with Meniere's Disease and Vestibular Migraine"** is the result of my own study under the guidance of Dr. Niraj Kumar Singh, Associate Professor of Audiology, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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List of Frequently Used Abbreviations

1. MD ear- affected (symptomatic) ear of Individuals in the Meniere’s disease group
2. Non-MD ear-unaffected (asymptomatic) ears of Individuals in the Meniere’s disease group.
3. MDVMHI Ears- same side ear of the Vestibular Migraine group with high IFAR as the affected (symptomatic) ear of the Meniere’s disease group.
4. NMDVMHI Ears- same side ear of the Vestibular Migraine group with high IFAR as the unaffected (asymptomatic) ear in the Meniere’s disease group.
5. MDVMNI Ears-same side ears of the Vestibular Migraine group with normal IFAR as the affected ears of the Meniere’s disease group
6. NMDVMNI Ears-same side ears of the Vestibular Migraine group with normal IFAR as the asymptomatic ears of the Meniere’s disease group
7. MDHC Ear- same side ear of the healthy control as the affected (symptomatic) ear of the individual with Meniere’s disease with whom he/she was age-and gender matched.
8. NMDHC Ear- same side ear of the healthy control as the unaffected (asymptomatic) ear of individuals with Meniere’s disease with whom he/she was age-and gender matched.
9. VMHIR Ear: Right ear of the Vestibular Migraine group with high IFAR.
10. VMNIR Ear: Right ear of the Vestibular Migraine group with normal IFAR.
11. VMHIL Ear: Left ear of the Vestibular Migraine group with high IFAR.
12. VMNIL Ear: Left ear of the Vestibular Migraine group with normal IFAR.

ABSTRACT

Meniere's disease (MD) and Vestibular Migraine (VM) are vestibular disorders with clinical overlapping features, intricating differential diagnosis. Endolymphatic hydrops (EH), the hallmark of MD, has also been reported in individuals with VM. EH not only affects the inner ear dynamics but is also known to alter middle ear mechanics. Wideband tympanometry (WBT) provides information about middle ear transfer function across wide range frequencies and can also reflect alteration associated with inner ear fluid dynamics. Therefore, the present study aimed to compare the findings of WBT among MD, VM and healthy controls to understand the difference in wideband absorbance among them. Ninety participants, which included 10 with MD, 20 with VM (10 each with high and normal inter-frequency amplitude ratio (IFAR) of vestibular evoked myogenic potential) and 60 age- and gender-matched healthy controls. Wideband absorbance was recorded from 226 to 8000 Hz at peak pressure. The results revealed no significant difference between the ears in the MD group and also, no significant difference between the MD group and healthy controls ($p>0.05$).VM groups exhibited alteration in the absorbance with significant difference between VM with high IFAR and VM with normal IFAR, and also between VM and healthy controls ($p<0.05$). There was no significant difference in resonance frequency among the groups ($p>0.05$). These findings suggest that WBT may capture subtle changes in middle ear mechanics associated with vestibular disorder with endolymphatic hydrops. Although results are sporadic in certain groups, distinct absorbance pattern were observed between VM with high IFAR vs VM with normal IFAR. Hence, WBT may provide complementary information for the assessment and differential diagnosis of vestibular disorders associated with endolymphatic hydrops; however, more studies with large sample size are needed for further validation of this preliminary finding.

Chapter I

Introduction

The human ear consists of three part ─ external ear, middle ear and inner ear. The middle ear serves as a biomechanical interface between air-filled external auditory canal and fluid filled inner ear. Middle ear has the most fundamental physiological role in impedance matching─ a process in which the middle ear transduces incoming acoustic energy to mechanical energy to overcome the substantial loss of energy that would otherwise occurred in its absence (AlMakadma et al., 2023a). The impedance transformation is achieved through combination of middle ear mechanisms such as area ratio, lever action and buckling effect which provides amplification of about 22.80 dB, 2.3 dB, 4 dB respectively (Ghosh & Funnell, 1995; Gottlieb et al., 2018; Siah & Funnell, 2002). In the absence this this mechanism 99.9% of the incident energy would be reflected at the air-fluid interface (Aibara et al., 2001; AlMakadma, 2023; Kurokawa & Goode, 1995; Merchant et al., 1997; Puria et al., 1997; Slama et al., 2010). However, even the healthy middle ear is not a perfect conductor of all audible frequencies; based on the impedance of the middle ear it provides differential gain to certain frequencies ─the transmission characteristics of middle ear are inherently frequency depended, governed by the mechanical components like stiffness, mass and resistance, which collectively specify middle ear impedance (AlMakadma et al., 2023b).

Traditional tympanometry, as routinely employed in audiological practice, has served as standard clinical tool for evaluating middle ear function for several decades. Traditional tympanometry commonly utilizes a single frequency probe tone, typically 226 Hz, to measure the acoustic admittance as a function of air pressure varied in a sealed ear canal. The resulting tympanogram provides clinically useful information regarding the tympanic membrane mobility, middle ear pressure and estimate about the stiffness or mass dominated pathology (Colletti, 1977; Iacovou et al., 2012, 2012; Lilly, 1984, 1984; Terkildsen & Thomsen, 1959).

Despite its widespread application, single frequency tympanometry is constrained by its limited usability across the range of audible frequencies. The use of single low frequency probe tone is sensitive to stiffness dominated component of middle ear which predominates at low frequencies. As a result, pathologies disproportionately affecting the mass or resistance components of middle ear, which manifest predominantly at high frequencies, may be missed in conventional tympanometry. Furthermore, the 226 Hz probe tone is considered inappropriate for use in paediatric population due to fundamentally different mechanical properties of the infant middle ear (AlMakadma, 2023; Iacovou et al., 2012, 2012; Lilly, 1984; Sanford et al., 2023). These limitations collectively underscore the need of middle ear assessment across a broad frequency range that can capture the full spectral profile of transmission function.

Wideband tympanometry (WBT) is an advanced diagnostic method that offers a comprehensive view of the middle ear function using stimuli with broad frequency spectra such as clicks and chirps. Unlike the traditional tympanometry, which depends on a single probe tone frequency, WBT performs simultaneous recordings across a wide range of probe frequencies (0.25 kHz to 8 kHz) to gather information about the absorbance characteristics and resonance frequency of the middle ear, and provides a wideband averaged tympanogram (Feeney et al., 2009; Keefe & Simmons, 2003; Shahnaz et al., 2009; Terzi et al., 2015; Voss & Allen, 199) without adding the burden of additional time requirement. WBT provides a comprehensive way to evaluate and differentially diagnose the middle ear pathologies which alters its frequency characteristics.

Some pathologies, such as otosclerosis and ossicular chain discontinuity, show WBT patterns that are typical to them. While otosclerosis is characterised by decreased low frequency absorbance up to 1000 Hz (Durante et al., 2022), the ossicular chain discontinuity shows increased low frequency absorbance with sharp peaks at 500 Hz and 800 Hz (Karuppannan & Barman, 2021). The other middle ear conditions also show changes in absorbance across a range of frequencies depending upon the changes in stiffness/ mass characteristics of the middle ear system (AlMakadma et al., 2023). However, changes in WBT are not necessarily associated with a middle ear pathology; The inner ear also contributes to the stiffness at the tympanic membrane (Carlborg & Farmer, 1983).

Changes in inner ear fluid volume pressure can induce vestibular and cochlear symptoms in some inner ear disease, and WBT was found helpful in pathologies which involve elevated intracranial pressure and inner ear pressure (Yücel et al., 2020). Therefore, it is plausible that inner ear conditions, especially those associated with altered motion mechanism of inner ear fluid and tissue, could affect WBT in some way. In fact, Wagholikar (2023) showed evidence for difference in WBT of children with congenital sensorineural hearing loss compared to the age-matched normal hearing peers. Therefore, it seems likely that individuals with inner ear pathologies, especially with pathologies affecting the endolymph volume, could have WBT findings different to those with normal hearing. While, there are several pathologies associated with altered motion dynamics in the inner ear, Meniere's disease and a sub-types of Vestibular Migraine that has concomitant endolymphatic hydrops are among the commonest to be associated with such alteration.

Although, WBT provides detailed information about changes in the dynamic of middle ear sound energy, it does not directly evaluate the vestibular system. Therefore, complementary vestibular function test like VEMP are necessary to understand the physiologic alternation associated with MD and VM. Consequently, combining WBT findings with VEMP test results may add more weightage in the diagnosis of disorders which overlap the symptoms and test findings like Meniere's disease and Vestibular

Migraine; hence, combining WBT with VEMP may provide a comprehensive understanding of the pathological changes impact on the middle ear system and may provide diagnostic biomarker.

Vestibular evoked myogenic potentials (VEMP) are short latency potentials generated through activation of vestibular receptors using sound or vibration. Two distinct clinical subtypes of VEMP are currently in use— the cervical VEMP (cVEMP) and ocular VEMP (oVEMP). The cVEMP is recorded from the skin surface over the tonically contracted ipsilateral sternocleidomastoid muscle and primarily reflects the functional integrity of the saccular macula and the sacculo-collic reflex pathway via the inferior vestibular nerve. The acoustic stimulus used to elicit cVEMP selectively stimulates the saccule due to its mass-loaded otolithic membrane, producing a biphasic inhibition of the sternocleidomastoid muscle's (SCM) moto neurons (Colebatch et al., 1994; Dlugaiczyk, 2020).

In contrast, the oVEMP is recorded from the contralateral inferior oblique extraocular muscle, it is generated primarily through utricular activation via the utriculo-ocular reflex pathway, with the superior vestibular nerve as the principal afferent limb. Air-conducted stimulus elicits an excitatory response, with utricular specificity confirmed by absent responses post-utricle ablation (Brantberg, 2009; Dlugaiczyk, 2020; Felipe & Kingma, 2013; Singh et al., 2023; Todd et al., 2007).

A key advancement in the clinical application of VEMPs has been the analysis of frequency tuning — the stimulus associated with the largest response amplitude among the tested stimulus frequencies, reflecting the biomechanical resonance properties of the otolithic membrane. In healthy ears, the largest response amplitude occurs at the stimulus frequencies of 500 Hz, consistent with the natural resonance frequency of the normal otolith organs (Fu et al., 2021)

Meniere's disease is a pathology of endolymphatic hydrops. It is characterized by a tetrad of symptoms that include episodic vertigo, tinnitus, fluctuating low-frequency sensorineural hearing loss, and aural fullness (Luryi et al., 2019). It can occur in isolation or with co-morbidities, such as migraine, benign paroxysmal positional vertigo and systemic autoimmune diseases (Gazquez et al., 2011; Kim et al., 2022; Kutlubaev et al., 2021), complicating the diagnosis in these cases. The presence of the above-mentioned symptom tetrad in an individual, when other pathologies with similar symptomatology are ruled out, forms the basis for a Meniere's disease diagnosis (Basura et al., 2020). At present, Meniere's disease has a two pronged clinical labelling—definite Meniere's disease and probable Meniere's disease (Lopez-Escamez et al., 2015).

Vestibular Migraine (VM) is a condition in which vestibular symptoms are causally related to migraine (Dieterich et al., 2016). Individuals with VM may complain of episodic spontaneous non-positional or positional vertigo, unsteadiness and/or balance problems in other forms (Dieterich et al., 2016). The duration of the above mentioned vestibular vestibular symptoms may vary within and across people from 5 minutes to 72 hours (Lempert et al., 2022). Vertigo and headache attacks can coincide or follow each other, but are not always temporally associated with each other (Cha & Baloh, 2007). It is estimated to affect about 2.7% of the general population (Lempert et al., 2022). The present diagnostic criteria mandate a symptom-based diagnosis, again, when all other conditions can not sufficiently justify the presence of all symptoms in a patient with headache and vertigo. Like Meniere's disease, VM also has a two-pronged diagnostic label—Vestibular Migraine and probable Vestibular Migraine (Lempert et al., 2022).

Despite differences in diagnostic criteria for both Meniere's disease and VM, they rely heavily on symptoms. The features of vertigo, nausea/vomiting, difficulty tolerating loud sounds and aura, the aspects typical of a Meniere's disease, also symbolize VM (Chen et al., 2022), thereby increasing the difficulty level of making the differential diagnosis between them. Several tests have been investigated for their efficacy in identifying these two enigmatic pathologies affecting the inner ear.

In ears affected by endolymphatic hydrops, however, the increased fluid pressure within the membranous labyrinth and consequent distension of the saccule alters the stiffness and mass characteristics of the otolithic membrane, resulting in a shift of the frequency tuning towards higher values, typically in the vicinity of 1000 Hz.

The frequency tuning can be assessed in a straight forward manner by obtaining VEMP in response to octave and mid-octave frequency tone-bursts from 250 Hz to 4000 Hz. Alternatively, it can be investigated using the ratio of VEMP amplitudes associated with a 1000Hz tone-burst to a 500Hz tone-burst, popularly called as inter-frequency amplitude ratio (IFAR). A value larger than the age-matched IFAR is a typical characteristic associated with the presence of endolymphatic hydrops (Drabkin et al., 2024; Singh et al., 2023). While endolymphatic hydrops is a typical pathophysiologic condition associated with Meniere’s disease, it has also been found associated with other vestibular pathologies, although to a much smaller extent than Meniere’s disease (Murofushi et al., 2017). Apart from Meniere’s disease, Vestibular Migraine is among the leading pathologies associated with endolymphatic hydrops (Gürkov et al., 2014). Gürkov et al. (2014) showed evidence of endolymphatic hydrops on MRI in nearly 27% of the patients with Vestibular Migraine, suggesting its high concomitance with Meniere’s disease. (Shahnaz et al., 2008, 2013).

1.1 Need for the study

All individuals with Meniere’s disease and over a quarter of those with VM have a characteristic endolymph hydrops. Endolymphatic hydrops, which is caused due to excessive buildup of endolymph in the inner ear, is hypothesised to transmit some of its effects towards the middle ear (Kimura & Hutta, 1997). Specifically, the increased inner ear fluid volume can apply pressure via the oval window and the ossicular chain to the tympanic membrane, leading to an increased stiffness at the tympanic membrane. Since stiffness is directly proportional to the resonance frequency (RF), a consequent increase in the resonance of the middle ear appears likely. WBT, which assesses the middle ear characteristics over a range of frequencies, can be used to measure this change in resonance. In fact, a few studies have been conducted to testify this hypothesis.

A recent study reported that the resonance frequency in the affected ear of individual with Meniere's disease was significantly lower than their unaffected ears and the ears of the individuals in the control group. Further, broadband tympanometry showed significantly lower absorbance in the frequency range of 2000 Hz-4000 Hz in the ears with Meniere's disease than the ears of healthy controls in this (Meng et al., 2022). In another study, WBT was obtained from symptomatic ears and asymptomatic ears of individuals with Meniere's disease (Tanno et al., 2020). The results revealed a significant difference in absorbance, which was observed mainly at low frequencies. In the asymptomatic ears and the symptomatic ears, the absorbance was lower than the ears of the control group. Specifically, the peak in the absorbance curve of the control group ears was at 1000 Hz, 1260 Hz, &1587 Hz, while the peak in the absorbance curve of the symptomatic ears and asymptomatic ears was between 2520 Hz and 3175 Hz. These alterations were more evident in symptomatic ears than the asymptomatic ears, especially at ambient pressure. While the above studies show sporadic evidence of Meniere's disease affecting the WBT outcomes, little is known whether this is an exclusive feature to Meniere's disease among the disorders affecting the inner ear.

As discussed above, endolymphatic hydrops is not an exclusive pathophysiology of Meniere's disease. Over a quarter of VM patients can also have endolymphatic hydrops, and should therefore also have similar WBT findings to Meniere's disease. However, there is a scarcity of studies on WBT in VM with or without endolymphatic hydrops. Therefore, there is also a need to compare the two sub-groups of VM, those with indicators for endolymphatic hydrops and those without it, on WBT.

1.2 Aim of the study

The present study aimed to evaluate the findings of WBT in individuals with Meniere’s disease and Vestibular Migraine with and without endolymphatic hydrops.

1.3 Objectives of the study

1. To compare the results of WBT between the affected (symptomatic) and unaffected (non-symptomatic) ears of individuals with Meniere’s disease.

2. To compare the results of WBT between the individuals with Meniere's disease and those of age- and gender-matched healthy controls.

3. To compare the results of WBT of individuals with Meniere’s disease against those with Vestibular Migraine exhibiting normal IFAR of VEMP.

4. To compare the results of WBT between individuals with Meniere’s disease and those with Vestibular Migraine having elevated IFAR of VEMP.

5. To compare the results of WBT of individuals with Vestibular Migraine having normal IFAR of VEMP against those of age- and gender-matched healthy controls.

6. To compare the results of WBT of individuals with Vestibular Migraine having elevated IFAR of VEMP against those of age- and gender-matched healthy controls.

7. To compare the results of WBT of individuals with Vestibular Migraine having elevated IFAR of VEMP against those with Vestibular Migraine having normal IFAR of VEMP.

1.4 Null Hypothesis

1. There is no significant difference in the results of WBT between the affected (symptomatic) and unaffected (non-symptomatic) ears of individuals with Meniere’s disease.
2. There is no significant difference in the results of WBT between the individuals with Meniere's disease and those of age- and gender-matched healthy controls.
3. There is no significant difference in the results of WBT of individuals with Meniere’s disease and those with Vestibular Migraine exhibiting normal IFAR of VEMP.
4. There is no significant difference in the results of WBT between individuals with Meniere’s disease and those with Vestibular Migraine having an elevated IFAR of VEMP.
5. There is no significant difference in the results of WBT of individuals with Vestibular Migraine having normal IFAR of VEMP and age- and gender-matched healthy controls.
6. There is no significant difference in the results of WBT between individuals with Vestibular Migrainehaving elevated IFAR of VEMP and the age- and gender-matched healthy controls.
7. There is no significant difference in the results of WBT between individuals with Vestibular Migraine having elevated IFAR of VEMP and those with Vestibular Migraine having normal IFAR of VEMP

Chapter II

Review of literature

The emergence of Wideband tympanometry (WBT) has contributed as a key biomarker in assessing middle ear dysfunction. WBT provides information on conventional single-frequency tympanograms as well as insights into parameters such as absorbance across frequencies, resonance frequency, and the wide-band averaged tympanograms (Feeney et al., 2009; Keefe & Simmons, 2003; Miehe et al., 2021; Shahnaz, Longridge, et al., 2009; Tanno et al., 2022a; Voss & Allen, 1994). WBT utilizes broadband click which allows assessing middle ear transfer function from 226 Hz to 8000 Hz, which was previously not possible with routine immittance measurements.

WBT helps with the assessment and differential diagnosis of middle ear pathologies that are characterised by frequency specific characteristics alteration (Shahnaz et al., 2008). Its application has expanded to include diagnosing and monitoring various conditions such as otosclerosis, ossicular chain discontinuity, tympanic membrane perforation, superior semicircular canal dehiscence syndrome and middle ear effusion (Feeney et al., 2003; Nakajima et al., 2013; Shahnaz, Bork, et al., 2009).

While the potential of WBT in vestibular disorders remains relatively underexplored, its application in conditions like Meniere's disease (MD) suggests its value in assessing the interactions between the middle ear and the inner ear in individuals with endolymphatic hydrops (EH). EH may arise from various etiological factors, including faulty endolymph absorption or excessive endolymph secretion due to dysfunction or obstruction of the endolymphatic sac or duct, immune-mediated inner ear disorder, genetic predisposition, viral infection affecting the inner ear, head trauma, inflammatory processes, and changes in inner ear fluid homeostasis (Zechner, 1976). Additionally, secondary hydrops may occur in association with chronic otitis media, temporal bone fracture, or post-surgical alteration of the inner ear (Ferster et al., 2017). This multifactorial mechanism highlights the pathophysiology underlying endolymphatic hydrops and highlights the potential role of WBT as a non-invasive tool for detecting subtle alternation in the middle ear transfer function which is due to changes in the inner ear fluid dynamics associated with hydrops.

1.1 WBT in individuals with Meniere's disease.

Meniere's disease is a pathology of endolymphatic hydrops. It is characterized by a tetrad of symptoms that include episodic vertigo, tinnitus, fluctuating low-frequency sensorineural hearing loss, and aural fullness (Luryi et al., 2019). It can occur in isolation or with co-morbidities, such as migraine, benign paroxysmal positional vertigo and systemic autoimmune diseases (Gazquez et al., 2011; Kim et al., 2022; Kutlubaev et al., 2021), complicating the diagnosis in these cases. The presence of the above-mentioned symptom tetrad in an individual, when other pathologies with similar symptomatology are ruled out, forms the basis for a Meniere's disease diagnosis (Basura et al., 2020). At present, Meniere's disease has a two pronged clinical labelling—definite Meniere's disease and probable Meniere's disease (Lopez-Escamez et al., 2015). A number of studies have examined to verify the proposed mechanism whereby endolymphatic hydrops elevates intra-cochlear pressure, leading to a reversal in pressure dynamics and consequently increasing the stiffness of the middle ear. Comparisons were done between the two ears of individuals with unilateral Meniere's disease and also between individuals with Meniere's disease and healthy controls across several studies. Table 1 summarizes the studies comparing the two ears of individuals with Meniere's disease whereas Table 2 adheres to the studies comparing individuals with Meniere's disease against healthy controls.

Table 1

Studies Comparing the WBT Findings Between the Ears in People with Unilateral Meniere's Disease.

Study	**Age range**	**Male/ Female**	**Measures**	**Findings**
Cakir Cetin et al. (2019)	30-65 years	14/16	Resonance frequency and Absorbance across frequencies.	No significant difference between the ears.
Demir et al. (2020)	24-56 years	13/8	Resonance frequency and absorbance	Significantly lower absorbance in MD ears at 250 Hz,500 Hz, 750 Hz and 1000 Hz, and significantly high resonance frequency than non-MD ears.
Miehe et al. (2022)	20-91 years	31/21	Absorbance across frequencies.	Reduced absorbance in the MD ears in the frequency range of 2000-4000 Hz at peak pressure.
Tanno et al. (2022)	20-80 years	4/18	Absorbance across frequencies.	Reduced absorbance in the MD ears in the frequency range of 226-794 Hz.

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Study	**Age range**	**Male/ Female**	**Measures**	**Findings**
Liu et al. (2021)	26-74 years	17/35	Absorbance across frequencies.	No significant difference in absorbance between the ears.
Leszczynski et al. (2023)	39-52 years	2/2	Absorbance across frequencies and resonance frequency.	Reduced absorbance and resonance frequency in the MD ears than the non-MD ears.

The above review shows inconclusive evidence on the findings of WBT between the ears in people with Meniere's disease. While some studies show significant difference in absorbance or resonant frequency (Demir et al., 2019a; Leszczyński et al., 2023; Miehe et al., 2022; Tanno et al., 2022b), otheres show no significant diffrence between MD ears and non-MD ears (Cakir Cetin et al., 2019; Liu et al., 2021), suggesting a need for continued exploration in this regards.

Table 2

Studies Comparing WBT Findings of People with Meniere's Disease against the Healthy Control Group.

Study	Age range	Male/ Female	Measures	Findings
Cetin et al. (2019)	MD- 31-69 years Controls- 30-65 years	MD- 14/16 Controls- 14/16	Resonance frequency and absorbance	No significant difference.
Miehe et al., (2022)	20-91 years	MD- 31/21 Control- 50/49	Absorbance	Reduced absorbance in frequency range of 2000-4000 Hz at peak pressure in MD group.
Tanno et al., (2022)	MD- 20-80 years Controls- 21-54 years	MD- 4/18 Control- 2/13	Absorbance	Reduced absorbance in frequency range of 1000-4000Hz in MD group.
Liu et al., (2021)	MD- 26-74 years Controls- 22-71 years	MD- 17/35 Controls- 13/17	Absorbance	Reduced absorbance at 1587 Hz, 2000 Hz, 2519 Hz, 3174 Hz, and 4000 Hz in MD group.

The above review shows inconclusive evidence on the findings of WBT for comparison between MD group and healthy controls. While some studies show significant difference in absorbance or resonant frequency between the groups (Liu et al., 2021; Miehe et al., 2021; Tanno et al., 2022b), othere show no significant diffrence between MD ears and control group ears (Cakir Cetin et al., 2019), suggesting a need for continued exploration in this regard.

1.2 WBT in individuals with Vestibular Migraine.

Vestibular Migraine (VM) is a condition in which vestibular symptoms are causally related to migraine (Dieterich et al., 2016). Individuals with VM may complain of episodic spontaneous non-positional or positional vertigo, unsteadiness and/or balance problems in other forms (Dieterich et al., 2016). The duration of the above mentioned vestibular symptoms may vary within and across people from 5 minutes to 72 hours (Lempert et al., 2022). It is estimated to affect about 2.7% of the general population (Lempert et al., 2022). Like Meniere’s disease, VM also has a two-pronged diagnostic label—Vestibular Migraine and probable Vestibular Migraine (Lempert et al., 2022). Few studies show the evidence for endolymphatic hydrops in 1-32% of the individuals with VM (Boegle et al., 2021; Eliezer et al., 2022; Kirsch et al., 2025; Oh et al., 2021). Similar to the hypothesized effect of EH on the WBT outcomes in Meniere’s disease, VM with/without EH could be believed to show differential outcomes on WBT. However, extensive search through various search engines failed to show any study in this regard, suggesting a need for an exploration.

Chapter III

Method

The present study aimed to compare the findings of WBT among individuals with Meniere's disease, Vestibular Migraine with and without endolymphatic hydrops, and age- and gender-matched healthy controls. Additionally, the present study also aimed to compare the findings of the findings of WBT between the affected (symptomatic) and unaffected (non-symptomatic) ears of individuals with Meniere’s disease; Finally, the study aimed to carry out the sub-group analysis by comparing the VM sub-groups with and without high IFAR.

3.1 Research design

To accomplish the aim of the study, a ‘standard multiple group comparison’ research design was used.

3.2 Participants

The present study incorporated four groups of adults in the age range of 15-50 years who were divided into four groups on the basis of certain pre-defined criteria.

3.2.1 Selection criteria for the group of Meniere’s disease

Group I consisted of 10 adults with unilateral definite Meniere's disease in the age range of 15 to 50 years (Mean age: 35.60, SD: 8.48). The diagnosis of Meniere’s disease was based on the criteria of the Barany Society (Lopez-Escamez et al., 2015) and American Academy of Otorhinolaryngology- Head and Neck Surgery (AAO-HNS, Basura et al., 2020) and all the participants were diagnosed by qualified audiologist. The inclusion and exclusion criteria are delineated below

3.2.1.1 Inclusion criteria for Meniere’s disease

- Otoscopy performed by an experienced otorhinolaryngologist showing clinically normal findings.
- Uncomfortable level of > 90 dBHL for speech.

- Speech recognition threshold (SRT) and speech identification score (SIS) showing appropriate correlation with the pure tone hearing threshold – SRT within ± 9 dBHL PTA and SIS > 80% in the ear with Meniere's disease and > 90% in the asymptomatic ears of individuals with Meniere's disease.
- Mild to moderately severe sensorineural hearing loss in the Meniere's disease affected ear; normal hearing in the unaffected ear.
- Normal middle ear functioning as ascertained by Type-A or Type- As tympanogram.
- Presence of acoustic reflex at 100 dB HL for a 1000 Hz reflex eliciting tone.

3.2.1.2 Exclusion criteria for Meniere's disease

- Retro-cochlear pathology or any neurological issues.
- Diagnosis of Probable Meniere's disease.
- Presence of other vestibular pathologies concomitant with Meniere's disease.

3.2.2. Vestibular Migraine with elevated IFAR of VEMP

Group II consisted of 10 individuals in the age range of 15 to 50 years (Mean age: 40.30, SD: 5.81) with a diagnosis of Vestibular Migraine with higher than the age-appropriate IFAR of VEMP. The diagnosis of Vestibular Migraine was ascertained using the ICHD-3 and the International Classification of Barany Society (A1.6.6 Vestibular Migraine - ICHD-3, n.d.; Lempert et al., 2022). The inclusion and exclusion criteria are delineated below:

3.2.2.1 Inclusion criteria for Vestibular Migraine with elevated IFAR of VEMP

- The diagnosis of Vestibular Migraine.
- The IFAR beyond the age-appropriate normative range of air-conduction cVEMP or oVEMP.

- Normal middle ear functioning as ascertained by Type-A or Type As tympanogram with the presence of acoustic reflex at 100 dBHL for a 1000 Hz reflex eliciting tone.

3.2.2.1 Exclusion criteria for Vestibular Migraine with elevated IFAR of VEMP

- Retro-cochlear pathology or any neurological issues, other than VM.
- Diagnosis of Probable Vestibular Migraine.
- Presence of other vestibular pathologies concomitant with Vestibular Migraine.

3.2.3 Selection criteria for Vestibular Migraine with normal IFAR of VEMP

Group III consisted of 10 individuals in the age range of 15 to 50 years (Mean age-38.60, SD-8.22) with a diagnosis of Vestibular Migraine with IFAR values of VEMP within the age-appropriate normal limits. The diagnosis of Vestibular Migraine was ascertained using the ICHD-3 and the International Classification of Barany Society (A1.6.6 Vestibular Migraine - ICHD-3, n.d.; Lempert et al., 2022) and by qualified audiologist. The inclusion and exclusion criteria are delineated below:

3.2.3.1 Inclusion criteria for Vestibular Migraine with normal IFAR of VEMP

- Diagnosis of Vestibular Migraine.
- The IFAR within the age-appropriate normative range of air conducted cVEMP or oVEMP.
- Normal middle ear functioning as ascertained by Type-A or Type- As tympanogram with the Presence of acoustic reflex at 100 dBHL for a 1000 Hz reflex eliciting tone.

3.2.3.2 Exclusion criteria for Vestibular Migraine with normal IFAR of VEMP

- Retro-cochlear pathology or any neurological issues, other than Vestibular Migraine.
- Diagnosis of Probable Vestibular Migraine.
- Other vestibular pathologies concomitant with Vestibular Migraine.

3.2.4 Healthy controls

Group IV consisted of 60 healthy individuals who will be age- and gender-matched to the participants of the three clinical groups in the ratio of 1:2. The normal auditory and balance function ensured through an audiological and balance test battery. The inclusion and exclusion criteria are delineated below:

3.2.4.1 Inclusion criteria for Healthy controls

- Otoscopy performed by an experienced otorhinolaryngologist showing clinically normal findings.
- Hearing sensitivity within normative range (≤ 20 dB HL) at octave frequencies from 250 Hz to 8000 Hz for air-conduction and from 250 Hz to 4000 Hz for bone conduction, as per the World Health Organisation criteria (WHO, 2021).
- SIS ≥ 90% for standard test material in the native language of the participants.
- SRT ≤ 20 dBHL.
- Normal middle ear functioning as identified by an A-Type or Type- As tympanogram with the presence of ipsilateral and contralateral acoustic reflexes at 100 dB HL for reflex eliciting tone of 1000 Hz.
- Loudness discomfort level > 90 dB HL for speech.
- No retro-cochlear lesion confirmed by conventional click-evoked auditory brainstem response elicited for two repetition rates (11.1/s & 90.1/s).

- No significant vestibular symptoms confirmed through the "SO STONED" questionnaire, which was developed by Wuyts et al. (2016), administered in the form of an interview.

3.2.4.2 Exclusion criteria for healthy controls

- Individuals with a known history of otological or neurological disorders.
- History of throbbing unilateral headache.
- Hypertension, diabetes or other systemic illness.
- History of significant noise exposure.

3.2 Ethical consideration

The study got ethical approval from the Institutional Review Board (SH/IRB/M.4/AUD.35/2025-26) (Appendix 8). The participants were informed about the study’s purpose and nature. All participants provided written informed consent before their enrolment in the study. Their participation in the study was on a non-payment basis.

3.3 Test environment and instrumentation

The experiment was conducted inside well-illuminated sound treated rooms with the ambient noise levels within the permissible limits (ANSI S 3.1, 1991). A calibrated Interacoustics Titan Suite IMP440/WBT440 version 3.3.1 wide band tympanometry device with an advanced research module was used for WBT measure. A calibrated two-channel Neurosoft Neuro Audio auditory evoked potential system (Version, 2010) was used for VEMP measures.

3.5 Procedure

3.5.1 Procedure for otoscopic examination

To inspect the ear, the clinician held the otoscope with the dominant hand and the ear with non-dominant hand. In order to visualize the tympanic membrane TM, the pinna was gently retracted in posterior and superior direction. EAC inspection included conditions such as impacted cerumen, otorrhea, erythema, canal edema etc., whereas, the tympanic membrane inspection included colour of the TM, abnormalities (bulging, perforation, etc.) and the of normal landmarks (cone of light, handle of malleus, pars flaccida, pars tensa etc.,).

3.5.2 Procedure for routine audiological evaluation

The pure-tone audiometric thresholds were obtained at octave frequencies from 250 Hz to 8000 Hz and 250 Hz to 4000 Hz for air-conduction and bone-conduction, respectively, using the modified Hughson and Westlake procedure (Carhart & Jerger, 1959). Speech audiometry included SRT, and SIS. These tests (SRT and SIS) were done using the standardized spondee word lists and phonetically balanced word lists, respectively, in the participant's native language. Loudness discomfort level for speech was obtained through the standard instructions as listed by the British Society of Audiology (2004).

3.5.3 Procedure for Immittance evaluation

Tympanometry was carried out with a probe-tone frequency of 226 Hz whose baseline intensity was 85 dB SPL. The air pressure in the external ear canal was varied from +200 daPa to -400 daPa. The same probe-tone frequency, along with the reflex eliciting signals of 1000 Hz at 100 dB HL, was used to examine the presence of acoustic reflex.

3.5.4 Procedure for Auditory brainstem response

Auditory brainstem response (ABR) was used to rule out retro-cochlear pathology. The skin at the electrode placement sites was cleaned with an abrasive gel, and 10-20 conduction paste was applied to enhance electrical conductivity. The reference electrode was placed on the test ear's mastoid, the active electrode on the upper forehead, and the ground electrode on the contralateral ear's mastoid. Click stimuli were delivered using rarefaction polarity. The stimulus delivery rates of 11.1/s and 90.1/s were used to present 1500 stimuli for each rate and response waveforms were band-pass filtered between 100 and 3000 Hz. The abnormality criteria on the basis of relative difference in latency between two peaks and amplitude ratio of wave V to I were used to classify the responses as indicative of retro-cochlear pathology (Musiek et al., 1984)**.**

3.5.5 Procedure for screening tests of posture and equilibrium.

Screening tools, such as Fukuda stepping test, Romberg test, past pointing test and Tandem gait test were performed to assess the posture and equilibrium of the participants. For Fukuda stepping test, the subjects stood on marked line on the floor, extended their arms and stepped in place with eyes closed for 50 steps while attempting to stay in their starting location. Subjects counted the steps, in order to assist their concentration. The examiner remained close by in silence in order to protect them from falling. The direction and degree of rotation were noted. Any deviation of 45^0 or more in any direction or 1 meter or more distance covered during the test were considered abnormal (Gargeshwari et al., 2017). For the Romberg test, subjects were instructed to stand quietly with feet together and arms crossed, for up to 30 seconds with eyes closed eyes, presence of any significant sway during eye-closed conditions or inability to maintain balance in the eye-closed condition for 30s were considered abnormal responses (Black et al., 1982; Johnson et al., 2005). For the past pointing test, subjects were asked to alternately touch the clinician target finger and the tip of their own nose with their index finger in eyes open conditions, presence of tremor and/or undershooting/overshooting of the target were considered abnormal responses (Barany et al., 1910). For the tandem gait test, the subjects were asked to stand straight with feet and walk forward in a straight line, placing the heel of the leading foot, so that it directly touches the toes of the back foot in eyes closed conditions, deviation to any side or loss of balance were considered abnormal responses (Giorgetti et al., 1998).

3.5.6 Procedure for Wide Band Tympanometry

All the Participants were seated comfortably and instructed to remain still and quiet for the entire test duration. An airtight seal was obtained in the ear canal with a suitable ear tip. Wideband absorbance (WBA)was obtained using the click stimuli of 100 dB peSPL delivered at a rate of 21.5 Hz. The ear canal pressure was swept from +200 to -400 daPa at a rate of 200 daPa/s. The response to 40 click stimulus were averaged to obtain the final WBT graph. The energy absorbance and other WBT parameter values at tympanometric peak pressure across frequencies were noted. The WBT measurement produced 122 frequency data points (1/24th octave bands) and all the 122 frequencies were analysed in the present study. The system was calibrated everyday using the calibration software given by the manufacturer, which was comparable to the source parameter calibration in four metal waveguide calibration units of 0.2, 0.5, 2 and 5 cc volumes. The cavity radius for cavities used in the study was 0.2 cm. The method suggested by Norgaard et al., (2017) was used to reduce the evanescent wave effects, and the use of small diameter cavities connected directly to the transducer without a plastic tip assured reliable transducer placement in the calibration cavities (direct coupling). By verifying that all participants had low absorbance at the lowest end of the frequency (10% or 0.1 absorbance).

3.5.7 Procedure for VEMP

The ocular VEMP responses were recorded from both ears of all healthy controls. For recording oVEMP, the participants were asked to sit in upright position and look upward at a target placed at an elevation of 30^0 (straight ahead) whenever the acoustic stimulus was presented. The response was obtained using the contralateral infra orbital (IO) electrode montage in which the active electrode was placed on the infraorbital ridge, just beneath the centre of the eye, with the reference electrode placed 2cm below the active electrode and a common ground electrode on the upper forehead. Before placing the recording electrodes, the skin at the electrode site were prepared using a commercially available abrasive gel to achieve absolute and inter-electrode impedance levels below 5kΩ and 2kΩ respectively, Silver chloride disc electrodes were placed on the cleaned areas with conduction gel and secured with adhesive tape. The stimulation sequences were separated by muscle rest periods. The responses were recorded from contralateral electrode with respect to the stimulation ear. Further, the participants were instructed to refrain from any movements of head, neck or jaw to avoid contamination of response from muscle artifacts. The response was elicited using tone-bursts of 500 Hz and 1000 Hz presented at 125 dB peSPL using 5.1 Hz repetition rate with rise and fall time of 2ms and plateau of 0ms. The responses were band pass filtered between 0.1 to 1000 Hz and averaged for 200 stimuli. A present response was considered when a negative peak (n1) was recorded with a latency of about 10 ms (8-12 ms) followed by a positive peak (p1) with a latency of about 15 ms (14-18 ms). In contrast, oVEMPs were considered absent when the biphasic peaks were not observed. In order to obtain the IFAR, the peak to peak amplitude of the response for 1000 Hz was divided by the peak to peak amplitude of the response for 500 Hz.

The ipsilateral (re: stimulus ear) cervical VEMP responses were obtained from both ears of healthy controls. To record cVEMP participants were instructed to sit in upright posture and turn the head in opposite to the direction to the ear of stimulus to an extent that the visual feedback monitor showed needle deflection in the acceptable range (30-70 microvolt). They were instructed to maintain the position for as long as the acoustic stimulus was being heard. The stimulation sequences were separated by rest periods of at least 1 minute. The responses were recorded by placing the active electrode on the sternocleidomastoid muscle at about 60% height and the reference electrode at the sternoclavicular junction. The common ground electrode was placed on the upper forehead. Before placing the recording electrodes, the electrical conductivity of the skin at the electrode site was improved using a commercially available abrasive gel to achieve absolute and inter-electrode impedance levels below 5kΩ and 2kΩ respectively. Silver chloride disc electrodes were placed on the cleaned areas with conduction gel and secured with micropore. The response was elicited using tone-bursts of 500 Hz and 1000 Hz presented at 125 dB peSPL with rise and fall time of 2ms and plateau of 0ms. The rate of stimulus presentation was fixed at 5.1 Hz. The responses were band-pass filtered between 10 to 1500 Hz and averaged for 200 stimuli. The response was deemed present when the first positive peak (P1) was recorded at a latency around 13 ms (12-16 ms) and followed by a negative peak (N1) at a latency of about 23 ms (20-27 ms). In order to obtain the IFAR, the rectified peak-to-peak amplitude of the response for the 1000 Hz tone burst was divided by the rectified peak-to-peak amplitude of the response for 500 Hz.

3.6 Statistical Analysis

All statistical analysis was accomplished using SPSS software version 20. The Shapiro-Wilk’s test of normality was utilized to decide on the use of parametric or non-parametric procedure to compare wideband tympanometry findings across subjects. The results of Shapiro- Wilk’s test showed non-normality in both the ears across majority of test frequencies (p <0.05), henceforth non-parametric tests were carried out.

Chapter IV

Results

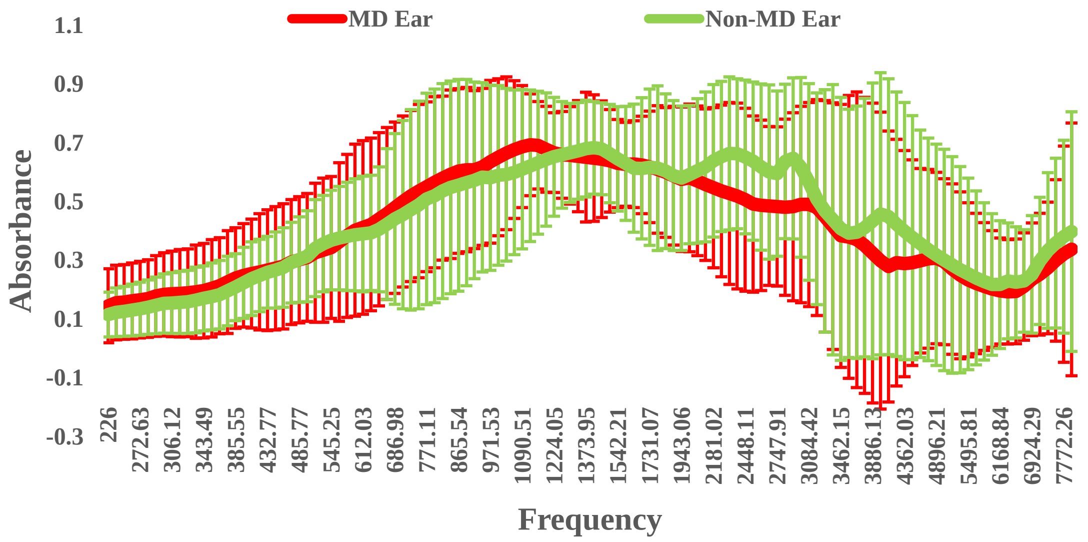
The present study aimed to compare the findings of WBT among three groups of participants ─ Meniere's disease, Vestibular Migraine and healthy controls. The study also aimed at sub-grouped comparison on the basis of affected and unaffected ear and also based on the IFAR value. To fulfil these objectives, WBT was performed on 90 participants─10 participants with Meniere's disease, 20 participants with Vestibular Migraine of which 10 had normal IFAR and the remaining 10 exhibited higher IFAR, and 60 age- and gender-matched healthy controls in the ratio of 1:2 (2 healthy controls per clinical participant).

4.1 The comparison of findings on WBT between the ears in individuals with Meniere's disease.

The datasets of absorbance did not meet the normal distribution criteria ($p<0.05$), therefore further statistical analyses were done using non-parametric tools. The wide band absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and inter quartile range (IQR). The median values ranged from 0.12 to 0.68 in the MD ear and 0.14 to 0.69 in non-MD ears in the Meniere's disease group. Further, the absorbance at each frequency was compared between the ears using the Wilcoxon signed rank test. There was no significant difference in absorbance between the ears at any frequency ($p>0.05$). The outcomes of the descriptive statistics and Wilcoxon Signed rank test are shown in Appendix 1. The absorbance values of both ears across frequencies are shown in Figure 1. The resonance frequency was also compared between the ears. There was no significant difference in the resonance frequency in the MD ear (median= 754.50, IQR= 270.25) and the non-MD ear (median= 754.50, IQR= 517) on the Wilcoxon Signed rank test [$Z= -1.37$, $p=0.16$]

Figure 1

Median and Interquartile Range of the Absorbance at Peak Pressure Across Frequencies in MD ear and Non-MD Ear.



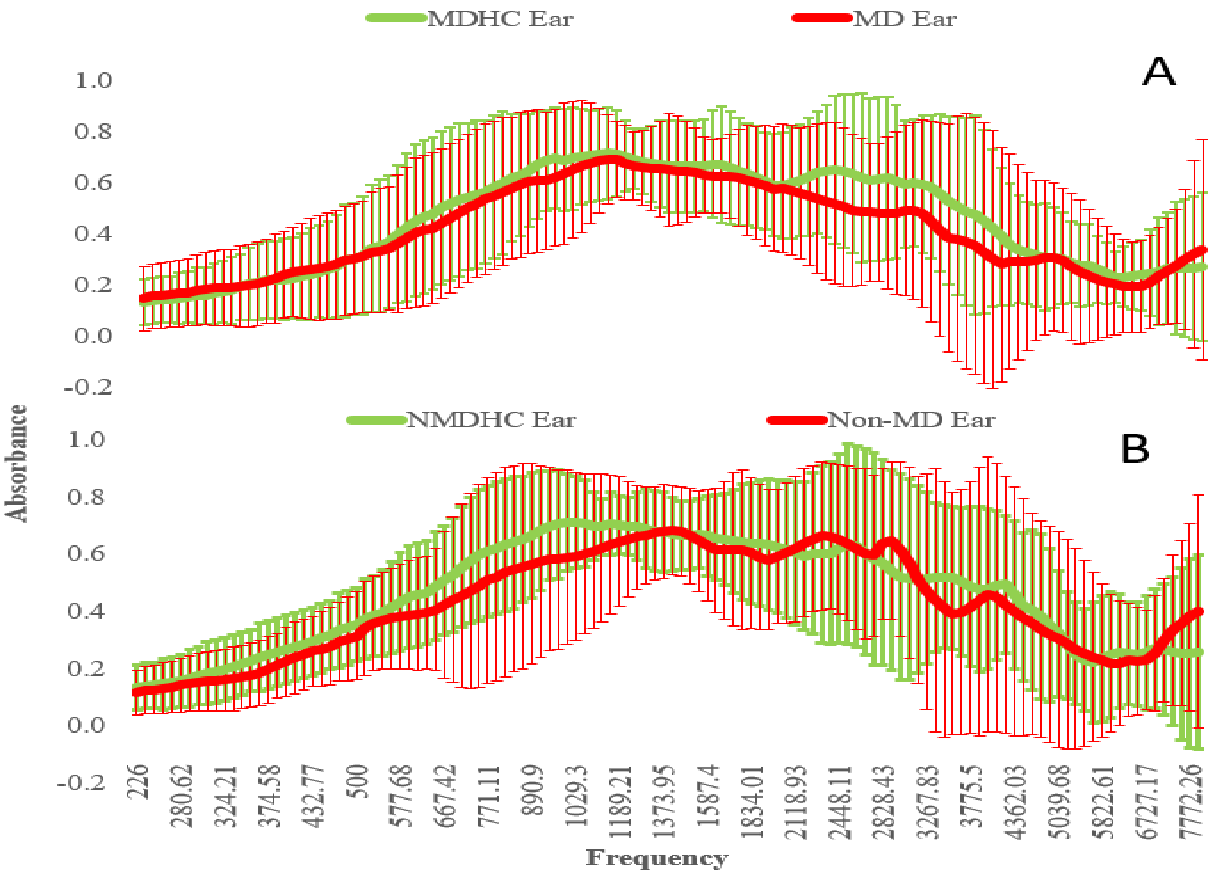
Note. IQR- Interquartile range; 'MD Ear': affected (symptomatic) ear of Individuals in the Meniere's disease group; 'Non-MD Ear': unaffected (asymptomatic) ears of Individuals in the Meniere's disease group. The whiskers represent the interquartile range, whereas the solid thick lines represent median.

4.2 The comparison of findings on WBT between the Meniere's disease group and the age- and gender-matched healthy controls.

The absorbance values in both the groups had non-normal distribution ($p<0.05$) necessitating the use of non-parametric statistical tools. The wide band absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.12 to 0.68 in MD ears and 0.14 to 0.69 in non-MD ears of the Meniere's disease group. In the healthy control group, the median values ranged from 0.13 to 0.71 in the non-MD matched ears and 0.13 to 0.72 in the MD matched ears. The absorbance at each frequency was compared between the groups using the Mann Whitney U test. There was no significant difference in absorbance between the groups at any frequency ($p>0.05$). The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 2. Absorbance values of both ears across frequencies are shown in Figure 2. Further, the resonance frequencies were 754.50 Hz (IQR=270.25), 898.0 Hz (IQR= 517.0), 799.0 Hz (IQR=243.75), 762.50 Hz (IQR=196.25) in MD ears, non-MD ears, MD matched ears and non-MD matched ears, respectively. They were compared between the groups using Mann Whitney U test. There was no significant difference in resonance frequency between MD ears and MD matched ears [$Z= 0.63$, $p= 0.52$] and also between the non-MD ears and non-MD matched ears [$Z=1.23$, $p=0.21$].

Figure 2

Median and Interquartile Range of the Absorbance at Peak Pressure Across Frequencies in the Meniere's Disease Group and the Age-and Gender-matched Healthy Control Group.



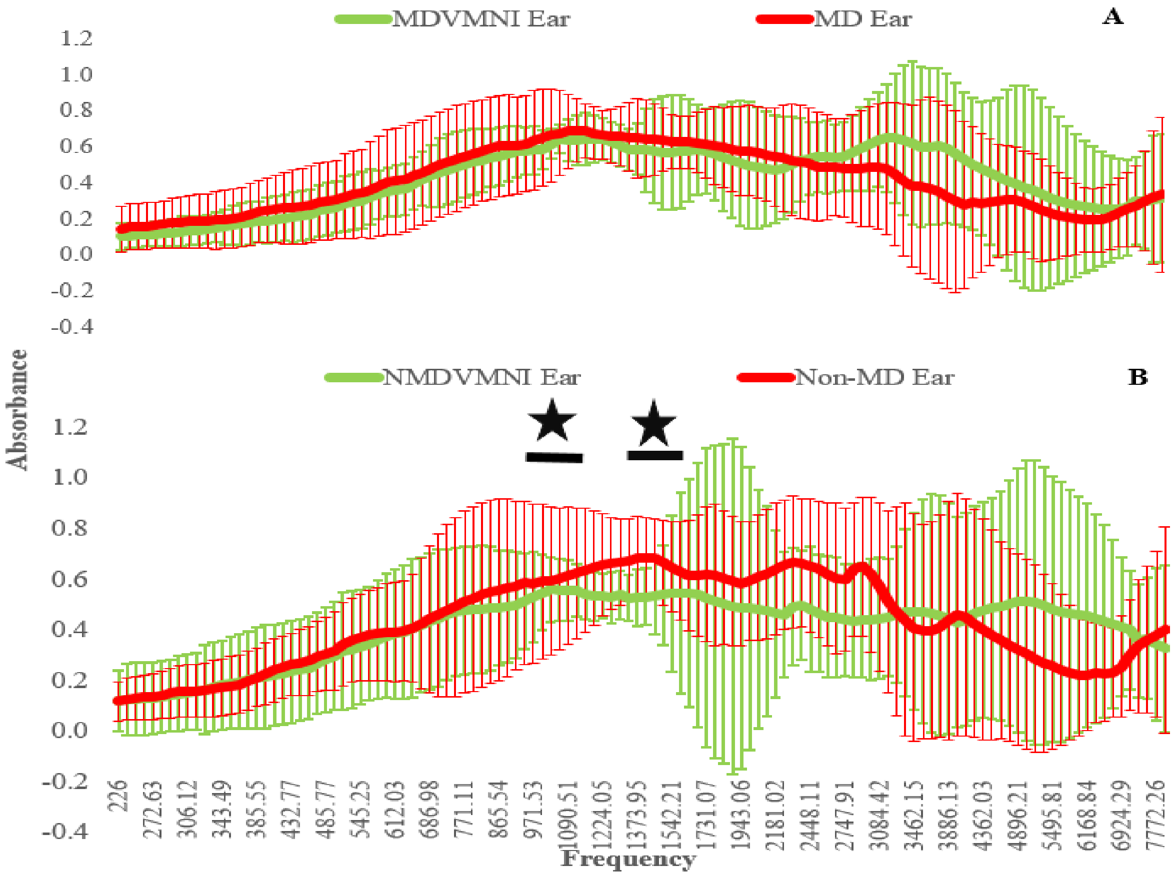
Note. (A) Absorbance across frequencies in MD ears of the Meniere's disease group and the matched ears of healthy control group; (B) Absorbance across frequencies in non-MD ears of the Meniere's disease group and the matched ears of the healthy control group; 'MD Ear': affected (symptomatic) ear of individuals in the Meniere's disease group; 'non-MD Ear': unaffected (asymptomatic) ears of individuals in the Meniere's disease group; 'MDHC Ear': same side ear of the healthy control as the affected (symptomatic) ear of the individual with Meniere's disease with whom he/she was age-and gender matched; 'NMDHC Ear': same side ear of the healthy control as the unaffected (asymptomatic) ear of individuals with Meniere's disease with whom he/she was age- and gender- matched; solid lines represent median; whiskers represent interquartile range.

4.3 The comparison of findings on WBT between the Meniere's disease group and the Vestibular Migraine group exhibiting normal IFAR of VEMP.

The absorbance values in both the groups had non-normal distribution ($p<0.05$) necessitating the use of non-parametric statistical tools. The wide band absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.12 to 0.68 in the MD ear and 0.14 to 0.69 in non-MD ears of the Meniere's disease group. The median values ranged from 0.12 to 0.56 in the non-MD matched ear (NMDVMNI ears) and 0.10 to 0.65 in the MD matched ears (MDVMNI ears) with Vestibular Migraine group exhibiting normal IFAR of VEMP. The absorbance value of each frequency was compared between the groups using the Mann Whitney U test. The NMDVMNI had significantly lower absorbance than the non- MD ear of Meniere's disease group in the frequency range of 1029.3 Hz to 1155.35 Hz and 1334.84 Hz to 1587.4 Hz ($p<0.05$). There was no significant difference between the groups for comparison between MD ears and MDVMNI. The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 3. The absorbance values of both ears across frequencies are shown in Figure 3. The resonance frequencies were 754.50 Hz (IQR=270.25), 898.0 Hz (IQR= 517.0), 834.50 (IQR=269.75), 746.0 (IQR=826.50) in MD ears, non-MD ears, MDVMNI, and NMDVMNI, respectively. There was no significant difference in resonance frequency between MD ears and MDVMNI ears [$Z=0.98$, p-0.32] and also between non-MD ears and NMDVMNI ears [$Z=0.83$, $p=0.40$].

Figure 3

Median and Interquartile Range of Absorbance at Peak Pressure Across Frequencies in Meniere's Disease Group and the Vestibular Migraine Group with Normal IFAR.



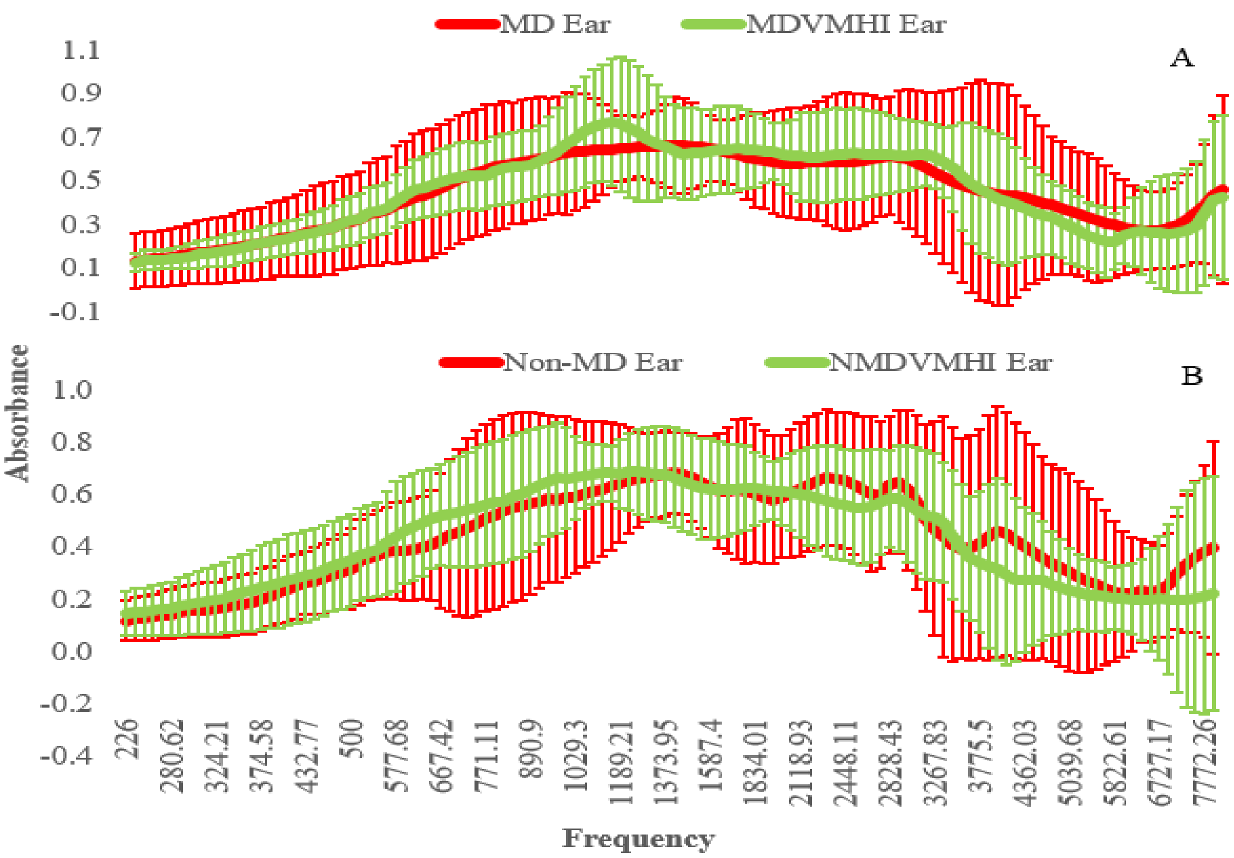
Note. (A) Absorbance across frequencies in MD ears of the Meniere's disease group and the matched ears of the Vestibular Migraine group with normal IFAR; (B) Absorbance across frequencies in non-MD ears of the Meniere's disease group and the matched ears of the Vestibular Migraine group with normal IFAR; 'MD Ear': affected (symptomatic) ear in the Meniere's disease group; 'non-MD Ear': unaffected (asymptomatic) ears of individuals in the Meniere's disease group; 'MDVMNI Ear': same side ears of the Vestibular Migraine group with normal IFAR as the affected ears of the Meniere's disease group; 'NMDVMNI Ear': same side ears of the Vestibular Migraine group with normal IFAR as the asymptomatic ears of the Meniere's disease group; solid lines represent median; whiskers represent interquartile range.

4.4 The comparison of findings on WBT between the Meniere's disease group and the Vestibular Migraine group with high IFAR of VEMP.

The absorbance values in both the groups had non-normal distribution necessitating the use of non-parametric statistical tools. The absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.12 to 0.68 in the MD ear and 0.14 to 0.69 in non-MD ears of the Meniere's disease group. The median values ranged from 0.14 to 0.69 in the NMDVMHI ears and from 0.13 to 0.77 in the MDVMHI ears. Further, the absorbance at each frequency was compared between the groups using the Mann Whitney U test. There was no significant difference in absorbance between the groups across the frequencies ($p>0.05$). The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 4. The absorbance values of both ears across frequencies are shown in Figure 4. The resonance frequency in MD, non-MD, MDVMHI and NMDVMHI ears were 754.50 Hz (IQR=270.25), 898.0 Hz (IQR= 517.0), 819.50 Hz (IQR= 290.0) and 778.50 Hz (IQR= 480.75) respectively. The resonance frequencies were compared between groups using Mann-Whitney U test. There was no significant difference in resonance frequency between MD ears and MDVMHI ears [$Z=1.13$, $p=0.25$] and also between non-MD ears and NMDVMHI ears [$Z=0.64$, p-0.52].

Figure 4

Median and Interquartile Range of the Absorbance at Peak Pressure Across Frequencies in the Meniere's Disease Group and the Vestibular Migraine Group with High IFAR.



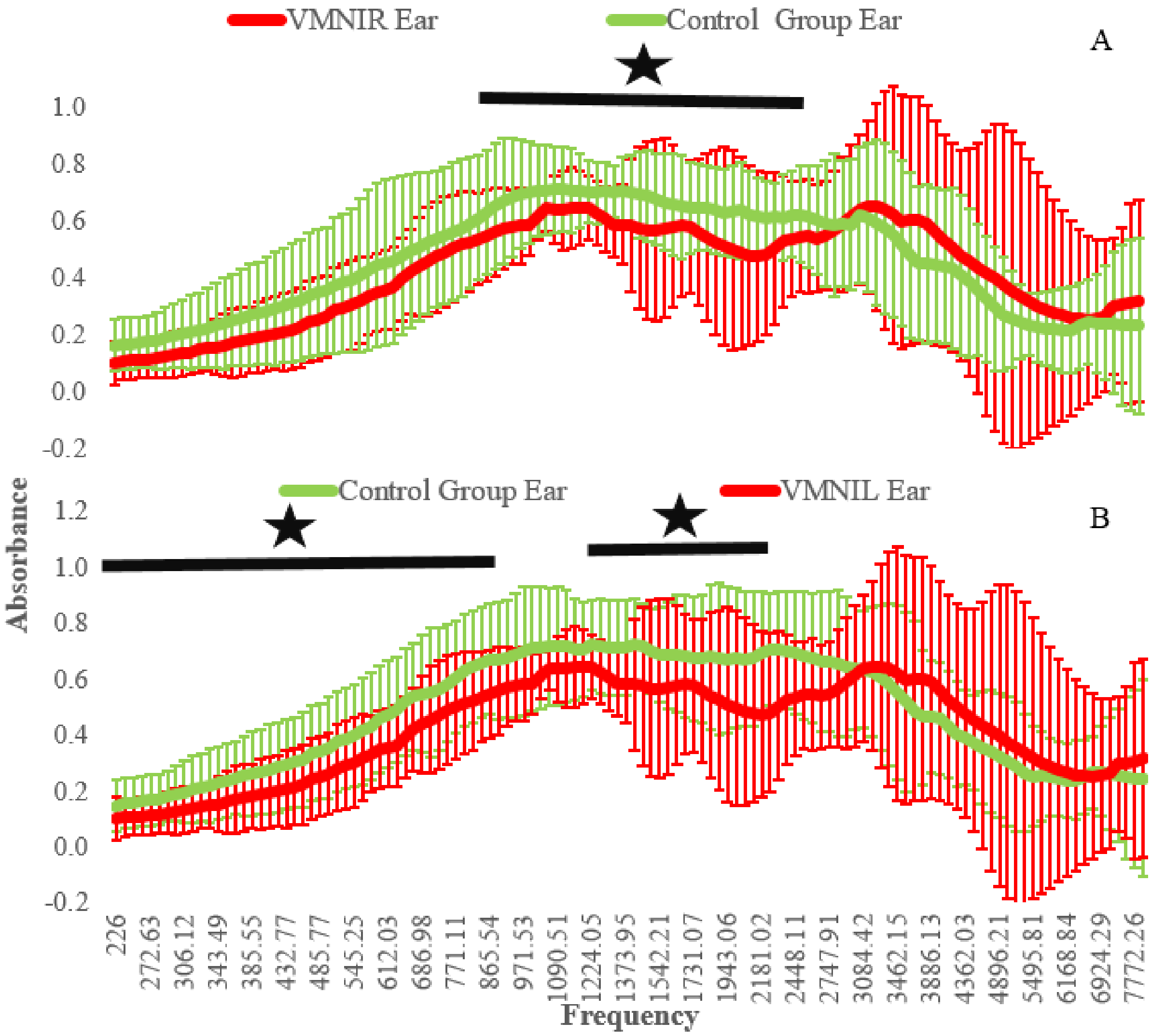
Note. (A) Absorbance across frequencies in MD ears of the Meniere's disease group and the matched ears of Vestibular Migraine group with high IFAR; (B) absorbance across frequencies in non-MD ears of the Meniere's disease group and the matched ears of the Vestibular Migraine group with high IFAR; 'MD Ear': affected (symptomatic) ear of individuals in the Meniere's disease group; 'non-MD Ear': unaffected (asymptomatic) ears of individuals in the Meniere's disease group; 'MDVMHI Ear': same side ear of the Vestibular Migraine group with high IFAR as the affected (symptomatic) ear of the Meniere's disease group; 'NMDVMHI Ear': same side ear of the Vestibular Migraine group with high IFAR as the unaffected (asymptomatic) ear in the Meniere's disease group; solid lines represent median; whiskers represent interquartile range.

4.5 The comparison of findings on WBT between the Vestibular Migraine group having normal IFAR of VEMP and the age- and gender-matched healthy control group.

The absorbance values in both groups had non-normal distribution necessitating the use of non-parametric statistical tools. The wide band absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.12 to 0.56 in right ear and 0.10 to 0.65 in left ear in individuals with Vestibular Migraine who had normal IFAR of VEMP. The median values ranged from 0.16 to 0.71 in right ear and 0.15 to 0.73 in left ear of the age- and gender-matched healthy controls. The absorbance of each frequency was compared between the groups using the Mann Whitney U test. The absorbance in individuals with VM having normal IFAR of VEMP was significantly lower compared to the healthy controls in the frequency range of 890.9-3084.2 Hz in right ear and frequency range of 226-971.53 Hz and from 1296.84-2593.68 Hz in left ear ($p<0.05$). The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 5. The absorbance values of both ears of both groups across frequencies are shown in Figure 5. The resonance frequencies in right ears and left ears of the Vestibular Migraine group with normal IFAR were 746.0 Hz (IQR=826.50) and 834.50Hz (IQR=269.75) respectively. In the healthy control group, the resonance frequency was 871.50 Hz (IQR=297.25) in right ear and 857.50 Hz (IQR=268.50) in left ear. The resonance frequency was compared between the groups and the comparisons revealed no significant difference between the groups' right ears [$Z=1.13$, $p=0.25$] and also left ears [$Z=0.64$, $p=0.52$].

Figure 5

Median and Interquartile Range of the Absorbance at Peak Pressure Across Frequencies in the Vestibular Migraine Group with Normal IFAR and the Age-and Gender-Matched Healthy Control Group.



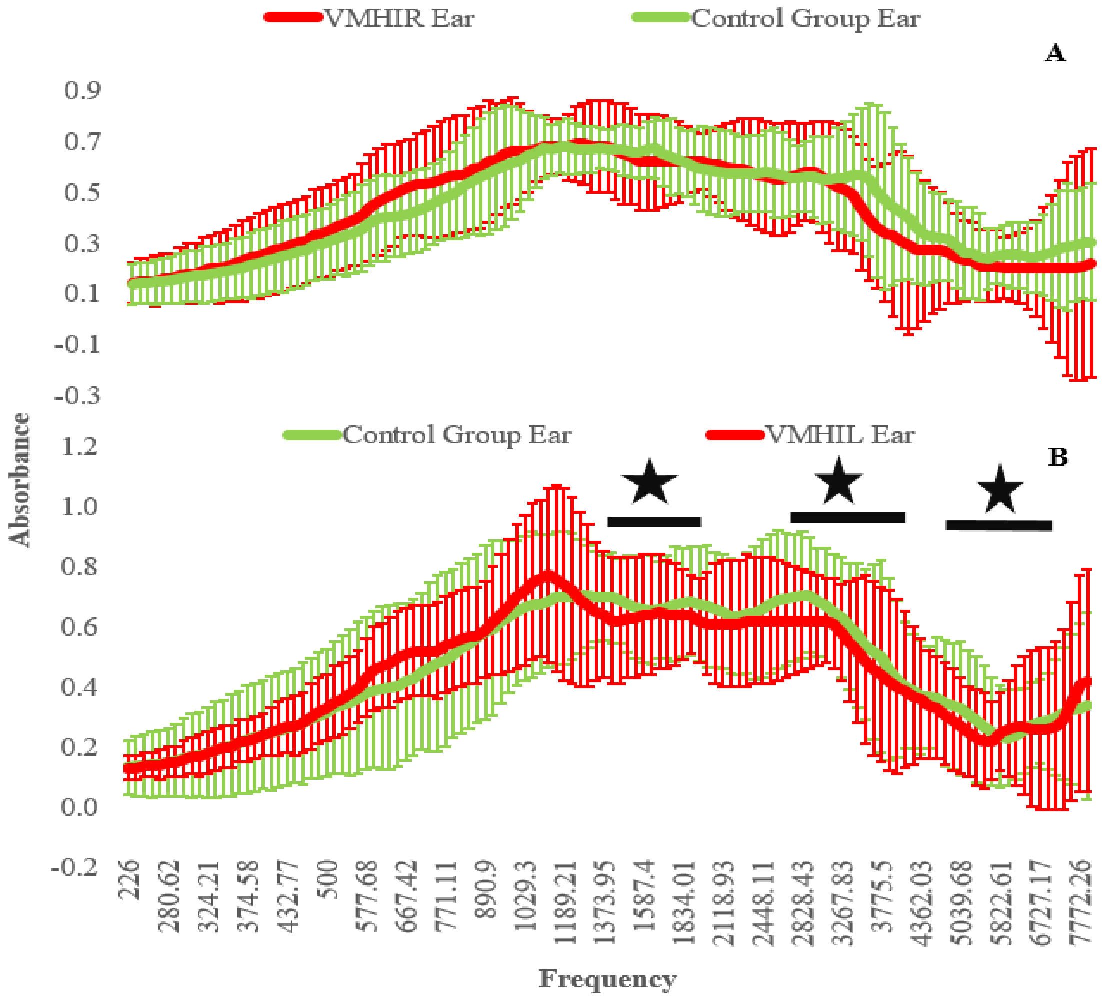
Note. (A) Absorbance across frequencies in right ear of both groups; (B) absorbance across frequencies in left ear of both groups; 'VMNIR Ear': right ear of individuals with Vesti r Migraine with normal IFAR; 'VMNIL Ear': left ear of individuals with Vestibular Migraine with normal IFAR; solid lines represent median; whiskers represent interquartile range.

4.6 The comparison of findings on WBT between the Vestibular Migraine group having high IFAR of VEMP and age- and gender-matched healthy control group.

The absorbance values in both the groups had non-normal distribution ($p<0.05$) necessitating the use of non-parametric statistical tools. The absorbance across all 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.14 to 0.69 in right ear and 0.13 to 0.77 in left ear in the Vestibular Migraine group with high IFAR of VEMP. The median values ranged from 0.14 to 0.68 in right ear and 0.13 to 0.70 in left ear in the age- and gender-matched healthy control group. Further, the absorbance of each frequency was compared between the groups using the Mann Whitney U test. The absorbance in individual with VM having higher IFAR of VEMP was significantly lower compared to the healthy controls in the frequency range of 917-1542.81 Hz, 2000-2828.43 Hz and 4621.41-6535.66 Hz in left ear ($p<0.05$). There was no significant difference in absorbance between the groups in right ear ($p>0.05$). The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 5. The absorbance values of both ears of both groups across frequencies are shown in Figure 6. The resonance frequency in right ear and left ear of the Vestibular Migraine group was 778.50 Hz (IQR=480.75) and 819.50 Hz (IQR=290.0) respectively. In healthy control group, the resonance frequency was 905 Hz (IQR=271.25) in right ear and 987.50 Hz (IQR=294.75) in left ear. The resonance frequency was compared between the groups using Mann-Whitney U test which revealed no significant group difference in right ears [$Z=0.1$, $p=0.88$] and also in left ears [$Z=0.22$, $p=0.82$].

Figure 6

Median and Interquartile Range of the Absorbance at Peak Pressure Across Frequencies in the Vestibular Migraine Group with High IFAR and the Age-and Gender- Matched Control Group.



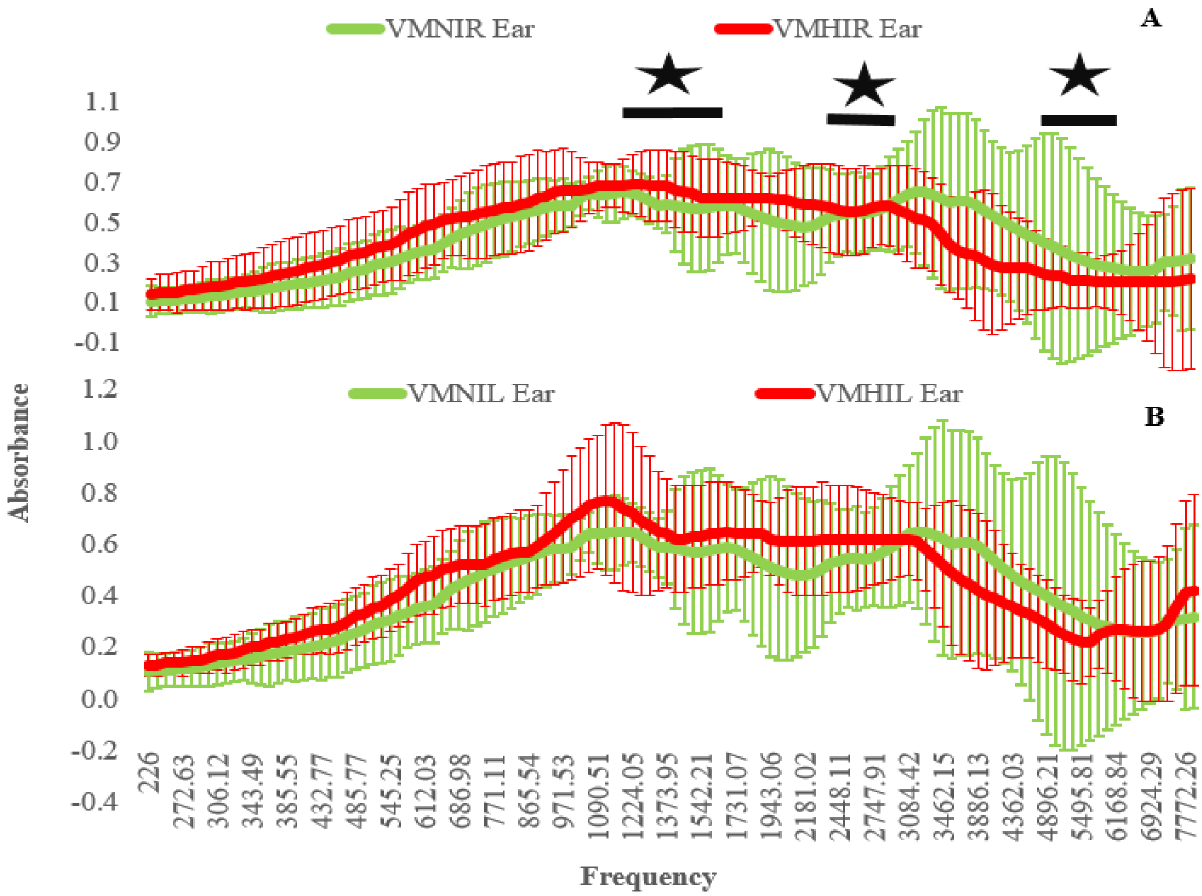
Note: (A) Absorbance across frequencies in right ears of the Vestibular Migraine group with high IFAR and the control group; (B) absorbance across frequencies in left ears of the Vestibular Migraine group with high IFAR and the control group; ‘VMHIR Ear’: right ear of the Vestibular Migraine group with high IFAR; ‘VMHIL Ear’: left ears of the Vestibular Migraine group with high IFAR; solid lines represent median; whiskers represent interquartile range.

4.7 The comparison of findings on WBT between the Vestibular Migraine group having high IFAR of VEMP and Vestibular Migraine group having normal IFAR of VEMP.

The absorbance values in both groups had non-normal distribution ($p<0.05$) necessitating the use of non-parametric statistical tools. The absorbance across 122 frequencies underwent descriptive statistical analyses to obtain median and IQR. The median values ranged from 0.14 to 0.69 in right ear and 0.13 to 0.77 in left ear in the Vestibular Migraine group having high IFAR of VEMP. The median values ranged from 0.12 to 0.56 in right ear and 0.10 to 0.65 in left ear in the Vestibular Migraine group having normal IFAR of VEMP. Further, the absorbance of each frequency was compared between the groups using the Mann Whitney U test. The absorbance in right ear of Vestibular Migraine group with normal IFAR of VEMP was significantly lower compared to right ear of the Vestibular Migraine group with high IFAR of VEMP in the frequency range of 943.87-1542.21 Hz and 2000-2828.43 Hz but it was significantly lower in the frequency range from 4621.41-6535.66 Hz ($p<0.05$). While there was a similar trend to right ear in the left ear, there was no significant difference in absorbance between the groups in the left ear ($p>0.05$). The outcomes of the descriptive statistics and Mann Whitney U test are shown in Appendix 7. The absorbance values of both ears of both groups across frequencies are shown in Figure 7. The resonance frequencies in right ear and left ear of the Vestibular Migraine group with high IFAR were 778.50 Hz (IQR=480.75) and 819.50 Hz (IQR=290.0), respectively. In the Vestibular Migraine group with normal IFAR, the resonance frequencies were 746.0 Hz (IQR=826.50) and 834.50Hz (IQR=269.75) in right and left ears, respectively. The resonance frequencies were compared between the two Vestibular Migraine groups using Mann-Whitney U test and the results showed no significant group difference in resonance frequency in right ears [$Z=0.15$, $p=0.88$] and also in left ears [$Z=0.22$, $p=0.82$].

Figure 7

Median and Interquartile Range of Absorbance at Peak Pressure Across Frequencies in Vestibular Migraine Group with High IFAR and Vestibular Migraine Group with Normal IFAR.



Note. (A) Absorbance across frequencies in right ears of the Vestibular Migraine group with high IFAR and Vestibular Migraine group with normal IFAR; (B) absorbance across frequencies in left ears of the Vestibular Migraine group with high IFAR and the Vestibular Migraine group with normal IFAR; 'VMHIR Ear': right ears of the Vestibular Migraine group with high IFAR; 'VMNIR Ear': right ears of the Vestibular Migraine group with normal IFAR; 'VMHIL Ear': left ears of the Vestibular Migraine group with high IFAR; 'VMNIL Ear': left ears of the Vestibular Migraine group with normal IFAR; solid lines represent median; whiskers represent interquartile range.

Chapter V

Discussion

The study aimed to compare the findings of Wide Band Tympanometry (WBT) among three groups of participants ─ Meniere’s disease (MD), Vestibular Migraine (VM) and healthy controls. The study also aimed at sub-grouped comparison on the basis of affected and unaffected ear and also based on the IFAR value. To fulfil these objectives, WBT was performed on 90 participants, of which 10 participants had MD, 10 participants each had VM with normal IFAR and VM with high IFAR, and 60 participants were included as age- and gender- matched healthy controls to the three clinical groups. The absorbance values were recorded at peak pressure condition across 122 frequencies in the range of 226-8000 Hz and these findings were compared within and between the groups.

5.1 WBT in individuals with unilateral Meniere’s disease.

Absorbance across frequencies was compared between MD and non-MD ears, as well as between the MD group and healthy controls, to investigate the potential influence of endolymphatic hydrops (EH) on acoustic immittance measures. Analyses conducted across all 122 frequency points revealed no statistically significant interaural differences within the MD group, and between the groups. These findings are consistent with those reported in the previous studies (Li et al., 2019; Liu et al., 2021); however, they diverge from several other studies (Cakir Cetin et al., 2019; Demir et al., 2019a; Miehe et al., 2021; Tanno et al., 2022b). Several plausible explanations may account for this discordance of the findings. These include possibility of high prevalence of EH in the asymptomatic ears of individuals with Meniere’s disease, middle ear muscle stiffness causing Meniere’s disease, and recordings being done in the asymptomatic phase of disease.

It is widely documented that EH occurs in 44% to 75% of the contralateral ears of people with unilateral MD, despite having no clinical signs of inner ear disease in these ears

(Huang & Young, 2015). Furthermore, the probability of bilateral EH significantly rises with increasing disease duration, with one estimate being 35% at 10 years and 47% after 20 years of disease persistence (Huppert et al., 2010). Such an explanation would, in theory, account for the lack of significant interaural differences seen in this study. However, it does not hold when comparing the MD and healthy groups. The absence of any significant difference in wideband absorbance between the MD group and healthy controls, suggests that the contralateral ear's EH could not have been the reason for interaural difference in WBT in the Meniere's disease group.

The physiology changes occurring in the middle ear muscles may further be thought to explain this phenomenon. There is evidence that high endolabyrinthine pressure due to MD may lead to increased muscle tone of the tensor tympani as well as the stapedius muscles (Bance et al., 2013). In the case of normal physiological functioning, contraction of the stapedius muscle causes lateral displacement of the stapes bone, which leads to change in the pressure of perilymph fluid. In the situation of pathological increase of muscle tone or spasm, the medial displacement of the stapes toward the oval window leads to increase of the pressure in the inner ear, loss of hair cells, and occurrence of vertigo, tinnitus, and aural fullness, the symptoms that are typical characteristics of MD. The role of stapedius and tensor tympani muscles in development of MD is supported by positive effect of sectioning of those muscles on vertigo, which was observed in 86.7% of cases (Loader et al., 2012). Thus, according to this model of pathology, contraction of the middle ear muscles should have reduced absorbance in MD patients. However, considering insignificant differences in WBA between MD patients and healthy individuals in this study, this cannot be considered a general explanation of our results.

A third and potentially more pertinent explanation relates to the clinical status of participants at the time of assessment. The individuals in the MD group were evaluated during a quiescent disease phase, characterized by the absence of active vertigo, tinnitus, and aural fullness with at least a gap of 1 week since the last attack. It is plausible that inner ear pressure had normalized by the time of testing, thereby eliminating the pressure-dependent acoustic signatures that may otherwise differentiate MD ears from healthy controls. This interpretation is consistent with the present findings and aligns with the broader understanding.

5.2 WBT in Vestibular Migraine.

Contrary to our hypothesis which suggested the possibility of EH in VM with IFAR, the absorbance values were significantly different between VM with normal IFAR and healthy controls. VM with normal IFAR had significantly lower absorbance than the healthy controls in the low to mid frequencies extending upto about 3000 Hz. This suggests that the energy traversing through to the middle ear was lower in the VM ears with normal IFAR than the control ears. The deviance from the hypothesis suggests that IFAR is possibly not a strong indicator of the presence of EH and might be governed by other factors unique to Meniere's disease, not merely the EH in them. While the diagnostic efficacy of IFAR in Meniere's disease is high, there is always a lingering question mark over EH being the lone pathophysiology correlate of symptoms in Meniere's disease (Gluth, 2020; Sperling et al., 1993) . Until a study prove a possible one-to- one relation of EH on MRI and high IFAR, the findings of the present study suggest that such a relationship does not exist. Therefore, it is possible that a number of individuals with VM with normal IFAR had EH which caused the reverse presence of fluid into the middle ear. The resultant stiffening of the tympanic membrane than caused higher reflectance and reduced absorbance. Since EH is known to affect stiffness, the resultant effects are observed in the low and mid frequencies as increase in stiffness is known to cause increased impedance in the low and mid frequency region (Demir et al., 2019b; Leszczyński et al., 2023; Liu et al., 2021; Tanno et al., 2022a).

The present study also incorporated a sub-grouped analysis on individuals with VM based on the theory guided assumption that a high IFAR is indicative of the presence of EH and a normal IFAR is suggestive of no EH in ears of people with VM. The VM group with normal IFAR were found to have lower absorbance than those with high IFAR, although statistical difference was observed only for comparison between the right ears of the group. These findings again suggest that IFAR may not accurately identify EH, especially in people with VM. Therefore, sub-grouping on the basis of IFAR may not provide a true reflection of the presence of EH and its effect on middle ear absorbance across the frequencies. Further studies are needed with more accurate identifiers of EH, such as high resolution of MRI, to confirm whether the presence of EH in VM likely affects the middle ear absorbance characteristics.

5.3 WBT in Meniere's disease compared to Vestibular Migraine.

The two pathologies with known possibility of EH were compared on WBT and the findings suggested no significant difference between the Meniere's disease group and the two sub-groups of the Vestibular Migraine (with normal IFAR and high IFAR). The only exemption to this was the comparison between the non-MD ears of the MD group and the matched ears of the VM group with normal IFAR. This comparison showed significantly lower absorbance in the non-MD ears than the matched ears of the VM with normal IFAR in the two short bands of frequencies from 1029 Hz to 1155 Hz and from 1334 Hz to 1587 Hz. One cannot reflect the possibility of this difference being a chance result given high variability in the data governed by small sample size. An alternative explanation could be again related to the asymptomatic stage in both groups which might have led to low EH at the time of WBT assessment, obscuring an otherwise possible reduced absorbance in the MD group or making the two groups show nearly similar absorbance through the middle ear.

5.4 Resonance frequency in Meniere's disease compared to Vestibular Migraine.

Finally, in the present study, resonance frequency was not significantly different across the groups, which suggests that EH induced changes in middle ear characteristics are not high enough to sufficiently offset resonance frequency for the difference to reach statistically significant proportion. Alternatively, it may also be an indicator that the effect of EH at the time of data acquisition was not high enough as the data were acquired during the quiescent stage of the pathologies. The findings pertaining to Meniere's disease are in consonance with few studies (Cakir Cetin et al., 2019; Liu et al., 2021); however, these findings are also in dissonance with several studies (Leszczyński et al., 2023; Miehe et al., 2021; Tanno et al., 2020) . The reasons for dissonance could be related to the difference in sample size and the stage of the pathology during which the data collection took place.

Chapter VI

Summary and Conclusion

WBT is a method for assessing middle ear function, providing comprehensive information about the middle ear characteristics. It also assesses middle ear function at different probe tone frequencies providing insights beyond the traditional tympanometry. WBT can provide the key measurement results like absorbance at peak and ambient pressure, resonance frequency, and wideband averaged tympanograms, making it valuable for diagnosing middle ear conditions like otosclerosis, middle ear effusions, ossicular chain discontinuity. In addition, it potentially provides information about inner ear conditions like Meniere's disease and third window disorders due to the possibility of altered fluid pressure from the inner ear into the middle ear.

Evidence from literature has shown that inner ear pathologies like Meniere's disease with a characteristic endolymphatic hydrops portray a typical absorbance reduction on WBT. However, not all studies have painted the same picture. Some studies have also shown normal-like absorbance values in the Meniere's ears, thereby supporting a need for continued exploration of absorbance-related outcomes in this pathology. Further, several studies have also shown evidence of endolymphatic hydrops in individuals with Vestibular Migraine. If indeed endolymphatic hydrops were to be the reason for reduced absorbance in individuals with Meniere's disease, Vestibular Migraine should yield similar outcomes. However, there is paucity of studies on WBT in Vestibular Migraine in general and the sub-group of Vestibular Migraine with endolymphatic hydrops in particular. Hence, the present study aimed to draw within and between groups comparison of WBT outcomes among Meniere's disease, Vestibular Migraine, and healthy controls.

The current study included 90 participants distributed across four groups: 10 individuals with unilateral Meniere's disease, 10 each with Vestibular Migraine with and without high IFAR of VEMP, and 60 healthy participants age- and gender-matched to the clinical groups in a 1:2 ratio. Wideband tympanometry was employed across 122 frequencies in the range of 226 Hz - 8000 Hz at peak pressure in response to a train of 100-dBpeSPL clicks. The absorbance values in both the groups had non-normal distribution ($p < 0.05$) necessitating the use of non-parametric statistical tools.

The comparison of absorbance and resonance frequency was made between the ears of individuals with Meniere’s disease, and the results showed no significant difference between them ($p > 0.05$). Further, there was also no significant difference between the Meniere’s disease group and the healthy controls ($p > 0.05$). While the hypothesis of endolymphatic hydrops in the asymptomatic ears and changes in middle ear muscles’ stiffness were pondered upon to explain these findings, the most befitting explanation seemed to be based on the time of data acquisition. The participants in the present study were assessed during a quiescent phase, during which normalization of endolabyrinthine pressure may have reduced mechanical sign detectable by WBT. Hence, this inference concluding that measurable effect of EH on middle ear mechanics may be variable based on episodes rather than sustained presentation.

Contrary to our hypothesis which suggested the possibility of EH in Vestibular Migraine with IFAR, the absorbance values were significantly different between Vestibular Migraine with normal IFAR and healthy controls. Vestibular Migraine with normal IFAR had significantly lower absorbance than the healthy controls in the low to mid frequencies extending upto about 3000 Hz. This suggests that the energy traversing through to the middle ear was lower in the Vestibular Migraine ears with normal IFAR than the control ears. The deviance from the hypothesis suggests that IFAR is possibly not a strong indicator of the presence of EH and might be governed by other factors unique to Meniere’s disease, not merely the EH in them.

The present study also incorporated a sub-grouped analysis on individuals with Vestibular Migraine based on the theory guided assumption that a high IFAR is indicative of the presence of EH and a normal IFAR is suggestive of no EH in ears of people with Vestibular Migraine. The Vestibular Migraine group with normal IFAR were found to have lower absorbance than those with high IFAR, although statistical difference was observed only for comparison between the right ears of the group. These findings again suggest that IFAR may not accurately identify EH, especially in people with Vestibular Migraine. Therefore, sub-grouping on the basis of IFAR may not provide a true reflection of the presence of EH.

Finally, in the present study, resonance frequency was not significantly different across the groups, which suggests that EH induced changes in middle ear characteristics are not high enough to sufficiently offset resonance frequency for the difference to reach statistically significant proportion. Alternatively, it may also be an indicator that the effect of EH at the time of data acquisition was not high enough as the data were acquired during the quiescent stage of the pathologies.

The present study provides preliminary evidence of changes in WBT associated with vestibular disorders characterized by endolymphatic hydrops. However, it also showed that the IFAR-based stratification of Vestibular Migraine group may not reliably differentiate Vestibular Migraine patients with endolymphatic hydrops from those without it.

Clinical Implications

- Based on the present study's findings, a question mark appears on the use of IFAR as a direct indicator for the presence of endolymphatic hydrops.
- The findings of this study showed that people with vestibular migraine may have possibility of reduced absorbance of the middle ear, suggesting that a middle ear analysis result should be carefully interpreted in them.

Limitation of the study and future direction

- The present study was bound a short time frame, thereby restricting the sample size; nonetheless a small sample size comes with inherent data variability. Therefore, future research could benefit from replicating the study, but with larger sample size.
- The sub-group stratification into Vestibular Migraine with endolymphatic hydrops and Vestibular Migraine without endolymphatic hydrops was on the assumption that IFAR is sensitive and specific in identifying concomitant endolymphatic hydrops. However, the end results suggest a need for efficacy studies on IFAR for endolymphatic hydrops identification.

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Appendices

Appendix-1

Median and Interquartile Range of Absorbance at Peak pressure in the Frequency Range of 226 Hz to 8000 Hz in both ears of the Meniere's Disease Group and the Outcome of Wilcoxon Signed Rank test for Inter-Ear Comparison.

Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
226	0.15	0.13	0.12	0.08	-0.56	0.58
250	0.16	0.13	0.12	0.08	-0.66	0.51
257.33	0.16	0.13	0.13	0.09	-0.76	0.45
264.87	0.16	0.13	0.13	0.09	-0.56	0.58
272.63	0.17	0.13	0.14	0.09	-0.56	0.58
280.62	0.17	0.13	0.14	0.09	-0.51	0.61
288.84	0.18	0.14	0.15	0.10	-0.46	0.65
297.3	0.18	0.14	0.15	0.10	-0.51	0.61
306.12	0.19	0.15	0.15	0.10	-0.46	0.65
314.98	0.19	0.15	0.16	0.11	-0.36	0.72
324.21	0.19	0.15	0.16	0.11	-0.36	0.72
333.71	0.19	0.16	0.16	0.11	-0.36	0.72
343.49	0.20	0.16	0.17	0.11	-0.36	0.72
353.55	0.20	0.17	0.18	0.11	-0.26	0.80
363.91	0.21	0.16	0.18	0.12	-0.10	0.92
374.58	0.23	0.18	0.20	0.12	-0.05	0.96
385.55	0.24	0.17	0.21	0.11	-0.05	0.96

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Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
408.48	0.25	0.19	0.24	0.13	-0.05	0.96
420.45	0.26	0.20	0.25	0.12	-0.05	0.96
432.77	0.27	0.21	0.26	0.12	-0.05	0.96
445.45	0.27	0.21	0.27	0.13	-0.15	0.88
458.5	0.28	0.21	0.28	0.14	-0.15	0.88
471.94	0.29	0.21	0.29	0.14	-0.26	0.80
485.77	0.30	0.21	0.30	0.15	-0.26	0.80
500	0.31	0.22	0.31	0.16	-0.26	0.80
514.65	0.33	0.24	0.34	0.17	-0.36	0.72
529.73	0.33	0.25	0.36	0.16	-0.36	0.72
545.25	0.34	0.24	0.37	0.17	-0.36	0.72
561.23	0.36	0.27	0.38	0.18	-0.31	0.76
577.68	0.38	0.28	0.38	0.18	-0.15	0.88
594.6	0.40	0.29	0.39	0.19	-0.26	0.80
612.03	0.41	0.30	0.39	0.20	-0.26	0.80
629.96	0.42	0.29	0.39	0.20	-0.46	0.65
648.42	0.44	0.30	0.41	0.21	-0.36	0.72
667.42	0.46	0.29	0.42	0.26	-0.36	0.72
686.98	0.48	0.29	0.44	0.29	-0.36	0.72
707.11	0.50	0.29	0.46	0.32	-0.36	0.72
727.83	0.52	0.29	0.47	0.34	-0.26	0.80
749.15	0.54	0.30	0.49	0.35	-0.15	0.88
771.11	0.55	0.29	0.51	0.36	-0.15	0.88
816.96	0.58	0.28	0.54	0.37	-0.26	0.80

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Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
840.9	0.59	0.29	0.55	0.36	-0.26	0.80
865.54	0.60	0.28	0.56	0.36	-0.15	0.88
890.9	0.61	0.28	0.56	0.35	-0.15	0.88
917	0.61	0.27	0.57	0.33	-0.05	0.96
943.87	0.62	0.27	0.58	0.32	-0.05	0.96
971.53	0.64	0.28	0.58	0.32	-0.05	0.96
1000	0.65	0.27	0.59	0.31	-0.36	0.72
1029.3	0.66	0.26	0.59	0.29	-0.36	0.72
1059.46	0.68	0.23	0.60	0.28	-0.36	0.72
1090.51	0.69	0.21	0.61	0.27	-0.46	0.65
1122.46	0.69	0.17	0.62	0.26	-0.26	0.80
1155.35	0.69	0.15	0.63	0.24	-0.15	0.88
1189.21	0.68	0.15	0.64	0.23	-0.26	0.80
1224.05	0.67	0.14	0.65	0.20	-0.05	0.96
1259.92	0.66	0.15	0.66	0.18	-0.15	0.88
1296.84	0.66	0.17	0.67	0.17	-0.36	0.72
1334.84	0.65	0.19	0.67	0.16	-0.42	0.68
1373.95	0.65	0.22	0.68	0.16	-0.36	0.72
1414.21	0.65	0.22	0.68	0.16	-0.15	0.88
1455.65	0.64	0.20	0.68	0.16	-0.05	0.96
1498.31	0.64	0.17	0.66	0.17	-0.05	0.96
1542.21	0.63	0.15	0.65	0.18	-0.15	0.88
1587.4	0.63	0.14	0.63	0.19	-0.47	0.64
1633.92	0.63	0.15	0.61	0.22	-0.53	0.59

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Table continued from the previous page

Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
1681.79	0.62	0.17	0.61	0.24	-0.47	0.64
1731.07	0.62	0.19	0.62	0.27	-0.36	0.72
1781.8	0.61	0.22	0.61	0.28	-0.26	0.80
1834.01	0.60	0.22	0.60	0.26	-0.15	0.88
1887.75	0.59	0.24	0.59	0.26	-0.36	0.72
1943.06	0.58	0.25	0.58	0.25	-0.05	0.96
2000	0.58	0.25	0.59	0.24	-0.05	0.96
2058.6	0.57	0.25	0.60	0.25	-0.05	0.96
2118.93	0.56	0.26	0.62	0.26	-0.05	0.96
2181.02	0.55	0.27	0.64	0.26	-0.05	0.96
2244.92	0.54	0.29	0.65	0.26	-0.76	0.45
2310.71	0.53	0.31	0.66	0.26	-0.87	0.39
2378.41	0.52	0.32	0.66	0.26	-0.87	0.39
2448.11	0.51	0.31	0.65	0.26	-0.87	0.39
2519.84	0.49	0.30	0.64	0.27	-0.87	0.39
2593.68	0.49	0.29	0.62	0.28	-0.76	0.45
2669.68	0.49	0.27	0.60	0.30	-0.66	0.51
2747.91	0.48	0.27	0.60	0.28	-0.46	0.65
2828.43	0.48	0.30	0.64	0.26	-0.31	0.76
2911.31	0.48	0.32	0.65	0.27	-0.05	0.96
2996.61	0.49	0.33	0.62	0.31	-0.15	0.88
3084.42	0.49	0.35	0.57	0.34	-0.15	0.88
3174.8	0.48	0.37	0.51	0.36	-0.18	0.86
3363.59	0.42	0.42	0.44	0.46	0.00	1.00

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Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
3462.15	0.38	0.45	0.41	0.45	0.00	1.00
3563.59	0.38	0.48	0.39	0.42	-0.31	0.76
3668.02	0.37	0.50	0.40	0.43	-0.18	0.86
3775.5	0.35	0.50	0.41	0.44	-0.06	0.95
3886.13	0.33	0.51	0.43	0.47	-0.06	0.95
4000	0.30	0.51	0.46	0.48	-0.26	0.80
4117.21	0.28	0.46	0.45	0.47	-0.15	0.88
4237.85	0.29	0.42	0.42	0.45	-0.65	0.52
4362.03	0.29	0.39	0.40	0.44	-1.13	0.26
4489.85	0.29	0.35	0.38	0.42	-1.17	0.24
4621.41	0.30	0.31	0.36	0.39	-1.07	0.29
4756.83	0.31	0.30	0.34	0.38	-0.77	0.44
4896.21	0.31	0.29	0.32	0.38	-1.07	0.29
5039.68	0.30	0.28	0.30	0.38	-0.92	0.36
5187.36	0.27	0.29	0.28	0.37	-1.07	0.29
5339.36	0.25	0.28	0.27	0.35	-1.17	0.24
5495.81	0.23	0.26	0.25	0.33	-1.43	0.15
5656.85	0.22	0.24	0.24	0.30	-1.48	0.14
5822.61	0.21	0.22	0.23	0.27	-1.58	0.11
5993.23	0.20	0.20	0.22	0.24	-1.48	0.14
6168.84	0.20	0.18	0.22	0.22	-1.42	0.16
6349.6	0.19	0.18	0.23	0.20	-1.25	0.21
6535.66	0.19	0.18	0.23	0.19	-1.24	0.21
6924.29	0.24	0.19	0.25	0.20	-1.27	0.20

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Frequency (in Hz)	MD Ears		Non-MD Ears		Wilcoxon Signed Rank test	
	Median	IQR	Median	IQR	Z-value	p-value
7127.19	0.25	0.21	0.30	0.22	-1.07	0.29
7336.03	0.27	0.22	0.33	0.26	-1.07	0.29
7550.99	0.30	0.28	0.36	0.29	-1.07	0.29
7772.26	0.32	0.37	0.38	0.33	-1.07	0.29
8000	0.34	0.43	0.40	0.41	-1.07	0.29

Note. IQR- Interquartile Range; ‘MD Ears’: affected (symptomatic) ear of individuals in the Meniere’s disease group; ‘Non-MD Ears’: unaffected (asymptomatic) ears of individuals in the Meniere’s disease group.

Appendix-2

Median and Interquartile Range of Absorbance at Peak Pressure in the Frequency Range of 226 Hz to 8000 Hz in Both Ears of Meniere's Disease Group and Age-and Gender-Matched Healthy Controls Group, and the Outcomes of Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
226	0.15	0.13	0.12	0.08	0.13	0.09	0.13	0.08	-0.48	0.63	-0.57	0.57
250	0.16	0.13	0.12	0.08	0.14	0.09	0.14	0.08	-0.44	0.66	-0.62	0.54
257.33	0.16	0.13	0.13	0.09	0.14	0.09	0.14	0.08	-0.44	0.66	-0.62	0.54
264.87	0.16	0.13	0.13	0.09	0.14	0.09	0.15	0.09	-0.44	0.66	-0.57	0.57
272.63	0.17	0.13	0.14	0.09	0.15	0.10	0.15	0.09	-0.44	0.66	-0.62	0.54
280.62	0.17	0.13	0.14	0.09	0.15	0.10	0.16	0.09	-0.40	0.69	-0.62	0.54
288.84	0.18	0.14	0.15	0.10	0.16	0.11	0.17	0.10	-0.44	0.66	-0.62	0.54
297.3	0.18	0.14	0.15	0.10	0.16	0.11	0.18	0.10	-0.46	0.64	-0.59	0.55
306.12	0.19	0.15	0.15	0.10	0.17	0.12	0.18	0.11	-0.53	0.60	-0.57	0.57
314.98	0.19	0.15	0.16	0.11	0.17	0.12	0.19	0.11	-0.57	0.57	-0.62	0.54
324.21	0.19	0.15	0.16	0.11	0.18	0.13	0.20	0.11	-0.53	0.60	-0.57	0.57
333.71	0.19	0.16	0.16	0.11	0.19	0.13	0.21	0.11	-0.70	0.48	-0.62	0.54

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
343.49	0.20	0.16	0.17	0.11	0.20	0.14	0.22	0.11	-0.81	0.42	-0.73	0.47
353.55	0.20	0.17	0.18	0.11	0.21	0.15	0.23	0.11	-0.79	0.43	-0.77	0.44
363.91	0.21	0.16	0.18	0.12	0.22	0.15	0.24	0.12	-0.73	0.47	-0.75	0.45
374.58	0.23	0.18	0.20	0.12	0.22	0.15	0.25	0.12	-0.75	0.46	-0.70	0.48
385.55	0.24	0.17	0.21	0.11	0.22	0.16	0.26	0.12	-0.64	0.52	-0.59	0.55
396.95	0.25	0.18	0.22	0.12	0.23	0.16	0.27	0.12	-0.62	0.54	-0.53	0.60
408.48	0.25	0.19	0.24	0.13	0.23	0.17	0.28	0.12	-0.68	0.50	-0.48	0.63
420.45	0.26	0.20	0.25	0.12	0.24	0.18	0.29	0.12	-0.66	0.51	-0.53	0.60
432.77	0.27	0.21	0.26	0.12	0.25	0.18	0.29	0.12	-0.62	0.54	-0.53	0.60
445.45	0.27	0.21	0.27	0.13	0.26	0.19	0.31	0.12	-0.70	0.48	-0.57	0.57
458.5	0.28	0.21	0.28	0.14	0.27	0.20	0.32	0.12	-0.68	0.50	-0.64	0.52
471.94	0.29	0.21	0.29	0.14	0.29	0.22	0.33	0.13	-0.81	0.42	-0.62	0.54
485.77	0.30	0.21	0.30	0.15	0.30	0.22	0.34	0.13	-0.75	0.46	-0.75	0.46
500	0.31	0.22	0.31	0.16	0.31	0.23	0.35	0.13	-0.70	0.48	-0.75	0.46
514.65	0.33	0.24	0.34	0.17	0.34	0.25	0.37	0.14	-0.55	0.58	-0.75	0.46
529.73	0.33	0.25	0.36	0.16	0.35	0.26	0.38	0.14	-0.57	0.57	-0.75	0.46

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
545.25	0.34	0.24	0.37	0.17	0.37	0.26	0.40	0.15	-0.55	0.58	-0.66	0.51
561.23	0.36	0.27	0.38	0.18	0.40	0.27	0.41	0.16	-0.53	0.60	-0.66	0.51
577.68	0.38	0.28	0.38	0.18	0.43	0.29	0.43	0.17	-0.55	0.58	-0.66	0.51
594.6	0.40	0.29	0.39	0.19	0.45	0.30	0.45	0.18	-0.64	0.52	-0.64	0.52
612.03	0.41	0.30	0.39	0.20	0.47	0.30	0.46	0.18	-0.57	0.57	-0.70	0.48
629.96	0.42	0.29	0.39	0.20	0.48	0.30	0.47	0.18	-0.53	0.60	-0.70	0.48
648.42	0.44	0.30	0.41	0.21	0.50	0.30	0.49	0.19	-0.57	0.57	-0.68	0.50
667.42	0.46	0.29	0.42	0.26	0.52	0.30	0.51	0.19	-0.57	0.57	-0.66	0.51
686.98	0.48	0.29	0.44	0.29	0.53	0.30	0.53	0.20	-0.70	0.48	-0.64	0.52
707.11	0.50	0.29	0.46	0.32	0.55	0.29	0.55	0.21	-0.68	0.50	-0.62	0.54
727.83	0.52	0.29	0.47	0.34	0.55	0.29	0.58	0.22	-0.75	0.46	-0.70	0.48
749.15	0.54	0.30	0.49	0.35	0.57	0.28	0.60	0.23	-0.86	0.39	-0.75	0.46
771.11	0.55	0.29	0.51	0.36	0.58	0.28	0.61	0.23	-0.84	0.40	-0.75	0.46
793.7	0.57	0.29	0.52	0.36	0.60	0.28	0.62	0.23	-0.95	0.34	-0.79	0.43
816.96	0.58	0.28	0.54	0.37	0.62	0.25	0.63	0.23	-0.88	0.38	-0.77	0.44
840.9	0.59	0.29	0.55	0.36	0.63	0.24	0.64	0.23	-0.88	0.38	-0.97	0.33

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
865.54	0.60	0.28	0.56	0.36	0.65	0.22	0.65	0.22	-0.97	0.33	-0.97	0.33
890.9	0.61	0.28	0.56	0.35	0.67	0.21	0.67	0.22	-0.97	0.33	-1.01	0.31
917	0.61	0.27	0.57	0.33	0.69	0.20	0.68	0.21	-0.88	0.38	-0.88	0.38
943.87	0.62	0.27	0.58	0.32	0.70	0.20	0.70	0.19	-0.90	0.37	-0.84	0.40
971.53	0.64	0.28	0.58	0.32	0.69	0.20	0.70	0.19	-0.88	0.38	-0.77	0.44
1000	0.65	0.27	0.59	0.31	0.70	0.20	0.71	0.17	-0.77	0.44	-0.88	0.38
1029.3	0.66	0.26	0.59	0.29	0.70	0.19	0.71	0.16	-0.84	0.40	-0.84	0.40
1059.46	0.68	0.23	0.60	0.28	0.71	0.18	0.71	0.15	-0.77	0.44	-0.92	0.36
1090.51	0.69	0.21	0.61	0.27	0.71	0.18	0.70	0.12	-0.86	0.39	-0.86	0.39
1122.46	0.69	0.17	0.62	0.26	0.72	0.18	0.70	0.10	-0.92	0.36	-0.75	0.46
1155.35	0.69	0.15	0.63	0.24	0.72	0.17	0.71	0.11	-0.84	0.40	-0.62	0.54
1189.21	0.68	0.15	0.64	0.23	0.70	0.14	0.70	0.10	-0.70	0.48	-0.68	0.50
1224.05	0.67	0.14	0.65	0.20	0.69	0.12	0.70	0.10	-0.66	0.51	-0.70	0.48
1259.92	0.66	0.15	0.66	0.18	0.68	0.13	0.70	0.12	-0.62	0.54	-0.79	0.43
1296.84	0.66	0.17	0.67	0.17	0.67	0.15	0.69	0.14	-0.40	0.69	-0.70	0.48
1334.84	0.65	0.19	0.67	0.16	0.67	0.17	0.68	0.14	-0.09	0.93	-0.66	0.51

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
1373.95	0.65	0.22	0.68	0.16	0.67	0.18	0.68	0.14	-0.13	0.90	-0.66	0.51
1414.21	0.65	0.22	0.68	0.16	0.67	0.18	0.67	0.13	-0.22	0.83	-0.33	0.74
1455.65	0.64	0.20	0.68	0.16	0.66	0.18	0.66	0.12	-0.13	0.90	-0.44	0.66
1498.31	0.64	0.17	0.66	0.17	0.67	0.18	0.67	0.12	-0.18	0.86	-0.35	0.73
1542.21	0.63	0.15	0.65	0.18	0.67	0.18	0.67	0.12	-0.04	0.97	-0.4	0.69
1587.4	0.63	0.14	0.63	0.19	0.67	0.21	0.66	0.14	-0.09	0.93	-0.4	0.69
1633.92	0.63	0.15	0.61	0.22	0.67	0.23	0.66	0.15	-0.13	0.9	-0.44	0.66
1681.79	0.62	0.17	0.61	0.24	0.66	0.22	0.65	0.16	-0.24	0.81	-0.48	0.63
1731.07	0.62	0.19	0.62	0.27	0.64	0.21	0.65	0.18	-0.22	0.83	-0.48	0.63
1781.8	0.61	0.22	0.61	0.28	0.63	0.2	0.64	0.2	-0.13	0.9	-0.55	0.58
1834.01	0.6	0.22	0.6	0.26	0.62	0.2	0.64	0.21	-0.13	0.9	-0.48	0.63
1887.75	0.59	0.24	0.59	0.26	0.61	0.19	0.64	0.22	-0.18	0.86	-0.31	0.76
1943.06	0.58	0.25	0.58	0.25	0.59	0.2	0.63	0.23	-0.2	0.84	-0.35	0.73
2000	0.58	0.25	0.59	0.24	0.59	0.21	0.63	0.23	-0.13	0.9	-0.33	0.74
2058.6	0.57	0.25	0.6	0.25	0.6	0.22	0.62	0.24	-0.04	0.97	-0.53	0.6
2118.93	0.56	0.26	0.62	0.26	0.61	0.22	0.6	0.25	0	1	-0.44	0.66

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
2181.02	0.55	0.27	0.64	0.26	0.62	0.23	0.59	0.26	-0.13	0.9	-0.66	0.51
2244.92	0.54	0.29	0.65	0.26	0.64	0.24	0.6	0.28	-0.22	0.83	-0.88	0.38
2310.71	0.53	0.31	0.66	0.26	0.65	0.26	0.6	0.31	-0.29	0.78	-1.08	0.28
2378.41	0.52	0.32	0.66	0.26	0.65	0.29	0.6	0.32	-0.04	0.97	-1.32	0.19
2448.11	0.51	0.31	0.65	0.26	0.65	0.3	0.62	0.33	-0.31	0.76	-1.54	0.12
2519.84	0.49	0.3	0.64	0.27	0.64	0.31	0.64	0.35	-0.33	0.74	-1.58	0.11
2593.68	0.49	0.29	0.62	0.28	0.62	0.33	0.63	0.35	-0.37	0.71	-1.63	0.1
2669.68	0.49	0.27	0.6	0.3	0.61	0.32	0.61	0.36	-0.44	0.66	-1.67	0.1
2747.91	0.48	0.27	0.6	0.28	0.62	0.32	0.58	0.37	-0.04	0.97	-1.54	0.12
2828.43	0.48	0.3	0.64	0.26	0.62	0.32	0.57	0.36	-0.04	0.97	-1.23	0.22
2911.31	0.48	0.32	0.65	0.27	0.61	0.3	0.54	0.35	-0.13	0.9	-1.25	0.21
2996.61	0.49	0.33	0.62	0.31	0.59	0.25	0.52	0.36	-0.04	0.97	-1.01	0.31
3084.42	0.49	0.35	0.57	0.34	0.6	0.25	0.51	0.35	-0.31	0.76	-1.14	0.25
3174.8	0.48	0.37	0.51	0.36	0.6	0.27	0.51	0.33	-0.37	0.71	-0.92	0.36
3267.83	0.45	0.39	0.47	0.41	0.59	0.28	0.52	0.3	-0.4	0.69	-0.97	0.33
3363.59	0.42	0.42	0.44	0.46	0.56	0.31	0.52	0.26	-0.66	0.51	-0.97	0.33

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
3462.15	0.38	0.45	0.41	0.45	0.53	0.33	0.52	0.25	-0.7	0.48	-0.97	0.33
3563.59	0.38	0.48	0.39	0.42	0.51	0.35	0.52	0.25	-0.59	0.55	-0.92	0.36
3668.02	0.37	0.5	0.4	0.43	0.49	0.37	0.5	0.26	-0.44	0.66	-0.88	0.38
3775.5	0.35	0.5	0.41	0.44	0.47	0.39	0.49	0.28	-0.31	0.76	-0.66	0.51
3886.13	0.33	0.51	0.43	0.47	0.45	0.36	0.48	0.29	0	1	-0.84	0.4
4000	0.3	0.51	0.46	0.48	0.42	0.31	0.48	0.28	-0.22	0.83	-0.84	0.4
4117.21	0.28	0.46	0.45	0.47	0.39	0.27	0.49	0.26	-0.31	0.76	-0.84	0.4
4237.85	0.29	0.42	0.42	0.45	0.36	0.24	0.49	0.24	-0.44	0.66	-0.57	0.57
4362.03	0.29	0.39	0.4	0.44	0.34	0.21	0.46	0.26	-0.57	0.57	-0.48	0.63
4489.85	0.29	0.35	0.38	0.42	0.33	0.2	0.42	0.26	-0.53	0.6	-0.24	0.81
4621.41	0.3	0.31	0.36	0.39	0.31	0.2	0.4	0.28	-0.48	0.63	0	1
4756.83	0.31	0.3	0.34	0.38	0.31	0.21	0.38	0.29	-0.4	0.69	-0.04	0.97
4896.21	0.31	0.29	0.32	0.38	0.31	0.2	0.35	0.27	-0.26	0.79	-0.22	0.83
5039.68	0.3	0.28	0.3	0.38	0.3	0.18	0.32	0.22	-0.13	0.9	-0.4	0.69
5187.36	0.27	0.29	0.28	0.37	0.29	0.16	0.28	0.19	-0.13	0.9	-0.07	0.95
5339.36	0.25	0.28	0.27	0.35	0.28	0.16	0.25	0.18	0	1	-0.04	0.97

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDHC Ears		NMDHC Ears		MD Ears Vs MDHC Ears		Non-MD Ears Vs NMDHC Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z-value	p-value
5495.81	0.23	0.26	0.25	0.33	0.28	0.16	0.23	0.18	-0.11	0.91	-0.07	0.95
5656.85	0.22	0.24	0.24	0.3	0.26	0.13	0.22	0.21	-0.26	0.79	0	1
5822.61	0.21	0.22	0.23	0.27	0.24	0.12	0.23	0.22	-0.15	0.88	-0.04	0.97
5993.23	0.2	0.2	0.22	0.24	0.23	0.1	0.25	0.22	-0.22	0.83	0	1
6168.84	0.2	0.18	0.22	0.22	0.23	0.12	0.26	0.2	-0.09	0.93	0	1
6349.6	0.19	0.18	0.23	0.2	0.23	0.13	0.25	0.18	-0.04	0.97	-0.11	0.91
6535.66	0.19	0.18	0.23	0.19	0.24	0.14	0.25	0.18	-0.13	0.9	-0.18	0.86
6727.17	0.21	0.18	0.23	0.17	0.25	0.17	0.26	0.2	-0.31	0.76	-0.24	0.81
6924.29	0.24	0.19	0.25	0.2	0.25	0.21	0.27	0.21	-0.31	0.76	-0.42	0.68
7127.19	0.25	0.21	0.3	0.22	0.26	0.22	0.27	0.23	-0.51	0.61	-0.35	0.73
7336.03	0.27	0.22	0.33	0.26	0.27	0.26	0.26	0.26	-0.84	0.4	-0.31	0.76
7550.99	0.3	0.28	0.36	0.29	0.26	0.27	0.25	0.3	-1.08	0.28	-0.22	0.83
7772.26	0.32	0.37	0.38	0.33	0.26	0.28	0.25	0.33	-1.25	0.21	-0.04	0.97
8000	0.34	0.43	0.4	0.41	0.27	0.29	0.26	0.34	-1.28	0.2	-0.18	0.86

Note. IQR- Interquartile Range; ‘MD Ears’: affected (symptomatic) ear of individuals in the Meniere’s disease group; ‘Non-MD Ears’: unaffected (asymptomatic) ears of individuals in the Meniere’s disease group; ‘MDHC Ears’: same side ear of the healthy control as the affected (symptomatic) ear of the individual with Meniere's disease with whom he/she was age-and gender matched; 'NMDHC Ears': same side ear of the healthy control as the unaffected (asymptomatic) ear of individuals with Meniere's disease with whom he/she was age-and gender matched.

Appendix 3

Median and Interquartile Range of Absorbance at Peak Pressure in the Frequency Range of 226 Hz to 8000 Hz in Both Ears of the Meniere's Disease Group and Vestibular Migraine Group with normal IFAR, and the Outcomes of Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
226	0.15	0.13	0.12	0.08	0.10	0.08	0.12	0.12	-0.79	0.43	-0.45	0.65
250	0.16	0.13	0.12	0.08	0.11	0.07	0.12	0.14	-0.72	0.47	-0.45	0.65
257.33	0.16	0.13	0.13	0.09	0.11	0.07	0.12	0.14	-0.45	0.65	-0.38	0.71
264.87	0.16	0.13	0.13	0.09	0.11	0.07	0.13	0.14	-0.53	0.60	-0.38	0.71
272.63	0.17	0.13	0.14	0.09	0.12	0.07	0.13	0.14	-0.53	0.60	-0.23	0.82
280.62	0.17	0.13	0.14	0.09	0.12	0.07	0.13	0.14	-0.53	0.60	0.00	1.00
288.84	0.18	0.14	0.15	0.10	0.12	0.08	0.14	0.14	-0.68	0.50	0.00	1.00
297.3	0.18	0.14	0.15	0.10	0.13	0.08	0.15	0.15	-0.64	0.52	-0.04	0.97
306.12	0.19	0.15	0.15	0.10	0.14	0.08	0.15	0.15	-0.38	0.71	-0.08	0.94
314.98	0.19	0.15	0.16	0.11	0.14	0.08	0.16	0.15	-0.30	0.76	-0.08	0.94
324.21	0.19	0.15	0.16	0.11	0.15	0.08	0.16	0.18	-0.19	0.85	-0.23	0.82
333.71	0.19	0.16	0.16	0.11	0.15	0.08	0.17	0.18	-0.15	0.88	-0.15	0.88

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
343.49	0.20	0.16	0.17	0.11	0.16	0.10	0.18	0.17	-0.72	0.47	-0.11	0.91
353.55	0.20	0.17	0.18	0.11	0.16	0.11	0.19	0.18	-0.76	0.45	0.00	1.00
363.91	0.21	0.16	0.18	0.12	0.17	0.12	0.19	0.19	-0.76	0.45	0.00	1.00
374.58	0.23	0.18	0.20	0.12	0.18	0.12	0.20	0.19	-0.83	0.41	0.00	1.00
385.55	0.24	0.17	0.21	0.11	0.19	0.12	0.21	0.20	-0.91	0.36	-0.04	0.97
396.95	0.25	0.18	0.22	0.12	0.19	0.13	0.21	0.20	-0.98	0.33	0.00	1.00
408.48	0.25	0.19	0.24	0.13	0.20	0.13	0.22	0.20	-1.06	0.29	0.00	1.00
420.45	0.26	0.20	0.25	0.12	0.20	0.13	0.23	0.20	-1.21	0.23	0.00	1.00
432.77	0.27	0.21	0.26	0.12	0.21	0.14	0.23	0.20	-1.25	0.21	-0.08	0.94
445.45	0.27	0.21	0.27	0.13	0.22	0.14	0.24	0.20	-1.29	0.20	-0.15	0.88
458.5	0.28	0.21	0.28	0.14	0.23	0.14	0.25	0.20	-1.29	0.20	-0.15	0.88
471.94	0.29	0.21	0.29	0.14	0.25	0.14	0.27	0.20	-1.36	0.17	-0.08	0.94
485.77	0.30	0.21	0.30	0.15	0.26	0.14	0.28	0.21	-1.36	0.17	-0.08	0.94
500	0.31	0.22	0.31	0.16	0.27	0.14	0.30	0.21	-1.29	0.20	-0.08	0.94
514.65	0.33	0.24	0.34	0.17	0.29	0.15	0.31	0.23	-1.21	0.23	-0.23	0.82
529.73	0.33	0.25	0.36	0.16	0.30	0.16	0.32	0.23	-1.21	0.23	-0.15	0.88

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
545.25	0.34	0.24	0.37	0.17	0.30	0.16	0.33	0.23	-1.21	0.23	-0.08	0.94
561.23	0.36	0.27	0.38	0.18	0.32	0.15	0.34	0.23	-1.21	0.23	0.00	1.00
577.68	0.38	0.28	0.38	0.18	0.34	0.14	0.36	0.23	-1.44	0.15	-0.08	0.94
594.6	0.40	0.29	0.39	0.19	0.35	0.14	0.37	0.25	-1.32	0.19	0.00	1.00
612.03	0.41	0.30	0.39	0.20	0.36	0.14	0.38	0.26	-1.21	0.23	-0.08	0.94
629.96	0.42	0.29	0.39	0.20	0.36	0.15	0.39	0.27	-1.10	0.27	-0.08	0.94
648.42	0.44	0.30	0.41	0.21	0.40	0.15	0.40	0.28	-1.02	0.31	-0.11	0.91
667.42	0.46	0.29	0.42	0.26	0.42	0.15	0.42	0.27	-0.83	0.41	-0.23	0.82
686.98	0.48	0.29	0.44	0.29	0.44	0.17	0.43	0.27	-0.76	0.45	-0.30	0.76
707.11	0.50	0.29	0.46	0.32	0.46	0.19	0.44	0.27	-0.76	0.45	-0.38	0.71
727.83	0.52	0.29	0.47	0.34	0.48	0.19	0.46	0.26	-0.64	0.52	-0.45	0.65
749.15	0.54	0.30	0.49	0.35	0.49	0.19	0.47	0.25	-0.42	0.68	-0.42	0.68
771.11	0.55	0.29	0.51	0.36	0.50	0.19	0.47	0.25	-0.45	0.65	-0.68	0.50
793.7	0.57	0.29	0.52	0.36	0.52	0.18	0.48	0.25	-0.45	0.65	-0.76	0.45
816.96	0.58	0.28	0.54	0.37	0.53	0.18	0.48	0.25	-0.45	0.65	-0.76	0.45
840.9	0.59	0.29	0.55	0.36	0.54	0.16	0.48	0.25	-0.38	0.71	-0.76	0.45

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
865.54	0.60	0.28	0.56	0.36	0.55	0.16	0.49	0.23	-0.38	0.71	-1.06	0.29
890.9	0.61	0.28	0.56	0.35	0.56	0.16	0.49	0.22	-0.38	0.71	-1.21	0.23
917	0.61	0.27	0.57	0.33	0.57	0.14	0.50	0.21	-0.38	0.71	-1.29	0.20
943.87	0.62	0.27	0.58	0.32	0.58	0.13	0.51	0.19	-0.11	0.91	-1.29	0.20
971.53	0.64	0.28	0.58	0.32	0.58	0.13	0.53	0.18	-0.23	0.82	-1.32	0.19
1000	0.65	0.27	0.59	0.31	0.59	0.11	0.54	0.15	-0.38	0.71	-1.66	0.10
1029.3	0.66	0.26	0.59	0.29	0.62	0.08	0.56	0.13	-0.23	0.82	-1.93	0.05
1059.46	0.68	0.23	0.60	0.28	0.64	0.08	0.56	0.12	-0.08	0.94	-2.04	0.04
1090.51	0.69	0.21	0.61	0.27	0.64	0.12	0.55	0.12	-0.15	0.88	-1.97	0.05
1122.46	0.69	0.17	0.62	0.26	0.64	0.14	0.55	0.11	-0.30	0.76	-1.97	0.05
1155.35	0.69	0.15	0.63	0.24	0.64	0.14	0.54	0.10	-0.04	0.97	-1.89	0.06
1189.21	0.68	0.15	0.64	0.23	0.65	0.13	0.53	0.09	-0.08	0.94	-1.82	0.07
1224.05	0.67	0.14	0.65	0.20	0.65	0.11	0.53	0.09	-0.15	0.88	-1.66	0.10
1259.92	0.66	0.15	0.66	0.18	0.63	0.11	0.53	0.10	-0.38	0.71	-1.89	0.06
1296.84	0.66	0.17	0.67	0.17	0.61	0.12	0.54	0.10	-0.76	0.45	-1.74	0.08
1334.84	0.65	0.19	0.67	0.16	0.59	0.11	0.52	0.09	-1.21	0.23	-1.89	0.06

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
1373.95	0.65	0.22	0.68	0.16	0.59	0.14	0.53	0.11	-1.44	0.15	-1.97	0.05
1414.21	0.65	0.22	0.68	0.16	0.58	0.23	0.53	0.11	-1.51	0.13	-1.82	0.07
1455.65	0.64	0.20	0.68	0.16	0.58	0.29	0.53	0.15	-1.66	0.10	-1.97	0.05
1498.31	0.64	0.17	0.66	0.17	0.57	0.31	0.54	0.20	-1.51	0.13	-2.04	0.04
1542.21	0.63	0.15	0.65	0.18	0.57	0.32	0.54	0.31	-1.36	0.17	-2.19	0.03
1587.4	0.63	0.14	0.63	0.19	0.58	0.31	0.54	0.40	-1.51	0.13	-1.97	0.05
1633.92	0.63	0.15	0.61	0.22	0.58	0.28	0.54	0.45	-1.29	0.20	-1.70	0.09
1681.79	0.62	0.17	0.61	0.24	0.59	0.25	0.54	0.52	-1.21	0.23	-1.44	0.15
1731.07	0.62	0.19	0.62	0.27	0.58	0.24	0.52	0.59	-1.06	0.29	-1.29	0.20
1781.8	0.61	0.22	0.61	0.28	0.56	0.26	0.51	0.62	-1.13	0.26	-1.29	0.20
1834.01	0.60	0.22	0.60	0.26	0.54	0.30	0.50	0.63	-1.06	0.29	-1.13	0.26
1887.75	0.59	0.24	0.59	0.26	0.53	0.32	0.49	0.67	-0.98	0.33	-1.29	0.20
1943.06	0.58	0.25	0.58	0.25	0.51	0.35	0.49	0.64	-0.91	0.36	-1.13	0.26
2000	0.58	0.25	0.59	0.24	0.50	0.35	0.48	0.56	-0.98	0.33	-0.98	0.33
2058.6	0.57	0.25	0.60	0.25	0.49	0.34	0.48	0.47	-1.06	0.29	-1.02	0.31
2118.93	0.56	0.26	0.62	0.26	0.48	0.32	0.47	0.42	-1.02	0.31	-1.10	0.27

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
2181.02	0.55	0.27	0.64	0.26	0.48	0.30	0.46	0.33	-0.91	0.36	-1.17	0.24
2244.92	0.54	0.29	0.65	0.26	0.48	0.28	0.46	0.25	-1.02	0.31	-1.10	0.27
2310.71	0.53	0.31	0.66	0.26	0.51	0.27	0.49	0.23	-0.68	0.50	-0.98	0.33
2378.41	0.52	0.32	0.66	0.26	0.53	0.23	0.50	0.22	-0.30	0.76	-0.76	0.45
2448.11	0.51	0.31	0.65	0.26	0.53	0.20	0.48	0.25	-0.23	0.82	-0.76	0.45
2519.84	0.49	0.30	0.64	0.27	0.55	0.19	0.46	0.23	-0.38	0.71	-0.83	0.41
2593.68	0.49	0.29	0.62	0.28	0.55	0.20	0.45	0.24	-0.38	0.71	-0.68	0.50
2669.68	0.49	0.27	0.60	0.30	0.54	0.19	0.44	0.24	-0.38	0.71	-0.61	0.55
2747.91	0.48	0.27	0.60	0.28	0.55	0.19	0.44	0.22	-0.57	0.57	-0.53	0.60
2828.43	0.48	0.30	0.64	0.26	0.57	0.21	0.43	0.22	-0.76	0.45	-0.53	0.60
2911.31	0.48	0.32	0.65	0.27	0.59	0.23	0.44	0.23	-0.95	0.34	-0.61	0.55
2996.61	0.49	0.33	0.62	0.31	0.61	0.25	0.44	0.24	-0.61	0.55	-0.45	0.65
3084.42	0.49	0.35	0.57	0.34	0.64	0.26	0.44	0.24	-0.23	0.82	-0.23	0.82
3174.8	0.48	0.37	0.51	0.36	0.65	0.30	0.45	0.23	-0.15	0.88	-0.08	0.94
3267.83	0.45	0.39	0.47	0.41	0.65	0.36	0.46	0.27	-0.45	0.65	-0.15	0.88
3363.59	0.42	0.42	0.44	0.46	0.64	0.42	0.47	0.33	-0.83	0.41	-0.30	0.76

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
3462.15	0.38	0.45	0.41	0.45	0.62	0.45	0.47	0.39	-0.83	0.41	-0.38	0.71
3563.59	0.38	0.48	0.39	0.42	0.60	0.44	0.47	0.44	-0.83	0.41	-0.15	0.88
3668.02	0.37	0.50	0.40	0.43	0.60	0.44	0.46	0.47	-0.83	0.41	-0.08	0.94
3775.5	0.35	0.50	0.41	0.44	0.60	0.43	0.45	0.48	-0.83	0.41	-0.30	0.76
3886.13	0.33	0.51	0.43	0.47	0.59	0.42	0.44	0.46	-0.83	0.41	-0.30	0.76
4000	0.30	0.51	0.46	0.48	0.56	0.39	0.43	0.41	-0.76	0.45	-0.76	0.45
4117.21	0.28	0.46	0.45	0.47	0.53	0.37	0.44	0.42	-0.53	0.60	-1.14	0.26
4237.85	0.29	0.42	0.42	0.45	0.50	0.37	0.46	0.42	-0.83	0.41	-1.29	0.20
4362.03	0.29	0.39	0.40	0.44	0.48	0.37	0.48	0.43	-1.06	0.29	-1.29	0.20
4489.85	0.29	0.35	0.38	0.42	0.46	0.40	0.48	0.44	-1.06	0.29	-1.36	0.17
4621.41	0.30	0.31	0.36	0.39	0.44	0.44	0.49	0.45	-0.98	0.33	-1.44	0.15
4756.83	0.31	0.30	0.34	0.38	0.42	0.50	0.50	0.49	-0.98	0.33	-1.44	0.15
4896.21	0.31	0.29	0.32	0.38	0.40	0.54	0.51	0.52	-0.91	0.36	-1.44	0.15
5039.68	0.24	0.28	0.30	0.38	0.38	0.56	0.51	0.55	-0.91	0.36	-1.51	0.13
5187.36	0.27	0.29	0.28	0.37	0.36	0.56	0.51	0.56	-1.06	0.29	-1.44	0.15
5339.36	0.25	0.28	0.27	0.35	0.34	0.54	0.49	0.55	-1.06	0.29	-1.44	0.15

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMNI Ears		NMDVMNI Ears		MD Ear Vs MDVMNI Ears		Non-MD Ears Vs NMDVMNI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
5495.81	0.23	0.26	0.25	0.33	0.32	0.50	0.48	0.52	-1.14	0.26	-1.55	0.12
5656.85	0.22	0.24	0.24	0.30	0.30	0.47	0.47	0.51	-1.14	0.26	-1.66	0.10
5822.61	0.21	0.22	0.23	0.27	0.29	0.43	0.46	0.49	-1.21	0.23	-1.66	0.10
5993.23	0.20	0.20	0.22	0.24	0.28	0.40	0.46	0.47	-1.21	0.23	-1.66	0.10
6168.84	0.20	0.18	0.22	0.22	0.27	0.37	0.45	0.44	-1.13	0.26	-1.66	0.10
6349.6	0.19	0.18	0.23	0.20	0.26	0.34	0.44	0.41	-1.10	0.27	-1.74	0.08
6535.66	0.19	0.18	0.23	0.19	0.26	0.32	0.43	0.38	-0.95	0.34	-1.66	0.10
6727.17	0.21	0.18	0.23	0.17	0.25	0.29	0.42	0.33	-0.83	0.41	-1.82	0.07
6924.29	0.24	0.19	0.25	0.20	0.26	0.28	0.41	0.27	-0.45	0.65	-1.82	0.07
7127.19	0.25	0.21	0.30	0.22	0.27	0.27	0.40	0.24	-0.23	0.82	-1.89	0.06
7336.03	0.27	0.22	0.33	0.26	0.30	0.24	0.36	0.22	-0.15	0.88	-1.36	0.17
7550.99	0.30	0.28	0.36	0.29	0.30	0.27	0.36	0.24	-0.45	0.65	-1.14	0.26
7772.26	0.32	0.37	0.38	0.33	0.31	0.35	0.34	0.30	-0.45	0.65	-0.83	0.41
8000	0.34	0.43	0.40	0.41	0.32	0.35	0.32	0.33	-0.61	0.55	-0.83	0.41

Note. IQR- Interquartile Range; ‘MD Ears’: affected (symptomatic) ear in the Meniere’s disease group; ‘Non-MD Ears’: unaffected (asymptomatic) ears of individuals in the Meniere’s disease group; ‘MDVMNI Ears’: same side ears of the Vestibular Migraine group with normal IFAR as the affected ears of the Meniere's disease group; 'NMDVMNI Ears': same side ears of the Vestibular Migraine group with normal IFAR as the asymptomatic ears of the Meniere's disease group.

Appendix 4

Median and Interquartile Range of Absorbance at Peak Pressure in the Frequency Range of 226 Hz to 8000 Hz in Both Ears of Meniere's Disease Group and Vestibular Migraine Group with Higher IFAR, and the Outcomes of the Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
226	0.15	0.13	0.12	0.08	0.13	0.04	0.14	0.08	-0.83	0.41	-0.45	0.65
250	0.16	0.13	0.12	0.08	0.13	0.04	0.15	0.09	-0.76	0.45	-0.45	0.65
257.33	0.16	0.13	0.13	0.09	0.14	0.04	0.15	0.09	-0.61	0.55	-0.53	0.60
264.87	0.16	0.13	0.13	0.09	0.14	0.04	0.15	0.10	-0.61	0.55	-0.68	0.50
272.63	0.17	0.13	0.14	0.09	0.14	0.05	0.16	0.10	-0.61	0.55	-0.76	0.45
280.62	0.17	0.13	0.14	0.09	0.15	0.05	0.16	0.10	-0.61	0.55	-0.76	0.45
288.84	0.18	0.14	0.15	0.10	0.15	0.05	0.17	0.11	-0.61	0.55	-0.76	0.45
297.3	0.18	0.14	0.15	0.10	0.16	0.06	0.18	0.12	-0.61	0.55	-0.87	0.38
306.12	0.19	0.15	0.15	0.10	0.17	0.06	0.18	0.12	-0.61	0.55	-0.91	0.36
314.98	0.19	0.15	0.16	0.11	0.17	0.07	0.19	0.13	-0.68	0.50	-0.87	0.38
324.21	0.19	0.15	0.16	0.11	0.18	0.07	0.20	0.13	-0.76	0.45	-0.91	0.36
333.71	0.19	0.16	0.16	0.11	0.19	0.07	0.20	0.14	-0.98	0.33	-0.98	0.33
343.49	0.20	0.16	0.17	0.11	0.20	0.07	0.21	0.14	-0.91	0.36	-0.91	0.36

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
353.55	0.20	0.17	0.18	0.11	0.20	0.07	0.22	0.15	-0.91	0.36	-0.91	0.36
363.91	0.21	0.16	0.18	0.12	0.22	0.07	0.23	0.16	-0.87	0.38	-0.91	0.36
374.58	0.23	0.18	0.20	0.12	0.22	0.07	0.24	0.16	-0.91	0.36	-0.91	0.36
385.55	0.24	0.17	0.21	0.11	0.23	0.07	0.25	0.17	-0.83	0.41	-0.91	0.36
396.95	0.25	0.18	0.22	0.12	0.24	0.07	0.26	0.17	-0.61	0.55	-0.83	0.41
408.48	0.25	0.19	0.24	0.13	0.25	0.08	0.27	0.17	-0.61	0.55	-0.68	0.50
420.45	0.26	0.20	0.25	0.12	0.26	0.09	0.28	0.17	-0.61	0.55	-0.61	0.55
432.77	0.27	0.21	0.26	0.12	0.27	0.09	0.29	0.17	-0.64	0.52	-0.68	0.50
445.45	0.27	0.21	0.27	0.13	0.27	0.10	0.30	0.17	-0.68	0.50	-0.68	0.50
458.5	0.28	0.21	0.28	0.14	0.28	0.10	0.31	0.17	-0.64	0.52	-0.68	0.50
471.94	0.29	0.21	0.29	0.14	0.30	0.11	0.33	0.18	-0.19	0.85	-0.68	0.50
485.77	0.30	0.21	0.30	0.15	0.32	0.11	0.34	0.18	-0.08	0.94	-0.61	0.55
500	0.31	0.22	0.31	0.16	0.33	0.11	0.35	0.18	-0.08	0.94	-0.61	0.55
514.65	0.33	0.24	0.34	0.17	0.35	0.12	0.37	0.18	-0.04	0.97	-0.42	0.68
529.73	0.33	0.25	0.36	0.16	0.36	0.12	0.38	0.18	-0.15	0.88	-0.30	0.76
545.25	0.34	0.24	0.37	0.17	0.38	0.12	0.39	0.18	-0.15	0.88	-0.30	0.76

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
561.23	0.36	0.27	0.38	0.18	0.40	0.12	0.41	0.20	-0.08	0.94	-0.23	0.82
577.68	0.38	0.28	0.38	0.18	0.43	0.13	0.44	0.21	-0.08	0.94	-0.19	0.85
594.6	0.40	0.29	0.39	0.19	0.46	0.14	0.46	0.21	0.00	1.00	-0.30	0.76
612.03	0.41	0.30	0.39	0.20	0.47	0.14	0.48	0.21	-0.04	0.97	-0.30	0.76
629.96	0.42	0.29	0.39	0.20	0.48	0.15	0.49	0.20	-0.08	0.94	-0.30	0.76
648.42	0.44	0.30	0.41	0.21	0.50	0.15	0.51	0.19	-0.15	0.88	-0.23	0.82
667.42	0.46	0.29	0.42	0.26	0.51	0.15	0.52	0.19	-0.23	0.82	-0.15	0.88
686.98	0.48	0.29	0.44	0.29	0.52	0.15	0.53	0.20	-0.30	0.76	0.00	1.00
707.11	0.50	0.29	0.46	0.32	0.52	0.15	0.53	0.21	-0.38	0.71	0.00	1.00
727.83	0.52	0.29	0.47	0.34	0.52	0.15	0.54	0.22	-0.45	0.65	0.00	1.00
749.15	0.54	0.30	0.49	0.35	0.52	0.16	0.55	0.23	-0.45	0.65	-0.11	0.91
771.11	0.55	0.29	0.51	0.36	0.54	0.16	0.56	0.23	-0.30	0.76	-0.15	0.88
793.7	0.57	0.29	0.52	0.36	0.55	0.16	0.57	0.23	-0.34	0.73	-0.30	0.76
816.96	0.58	0.28	0.54	0.37	0.56	0.16	0.57	0.23	-0.30	0.76	-0.30	0.76
840.9	0.59	0.29	0.55	0.36	0.57	0.16	0.59	0.24	-0.27	0.79	-0.30	0.76
865.54	0.60	0.28	0.56	0.36	0.57	0.16	0.60	0.24	-0.30	0.76	-0.30	0.76

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
890.9	0.61	0.28	0.56	0.35	0.59	0.16	0.62	0.24	-0.30	0.76	-0.23	0.82
917	0.61	0.27	0.57	0.33	0.62	0.18	0.63	0.22	-0.45	0.65	-0.45	0.65
943.87	0.62	0.27	0.58	0.32	0.64	0.20	0.65	0.21	-0.45	0.65	-0.34	0.73
971.53	0.64	0.28	0.58	0.32	0.67	0.22	0.66	0.21	-0.61	0.55	-0.23	0.82
1000	0.65	0.27	0.59	0.31	0.70	0.24	0.66	0.19	-0.61	0.55	-0.15	0.88
1029.3	0.66	0.26	0.59	0.29	0.72	0.25	0.66	0.16	-0.49	0.62	-0.04	0.97
1059.46	0.68	0.23	0.60	0.28	0.75	0.26	0.67	0.13	-0.68	0.50	-0.04	0.97
1090.51	0.69	0.21	0.61	0.27	0.76	0.26	0.68	0.12	-0.53	0.60	-0.30	0.76
1122.46	0.69	0.17	0.62	0.26	0.77	0.29	0.68	0.11	-0.76	0.45	-0.30	0.76
1155.35	0.69	0.15	0.63	0.24	0.76	0.31	0.68	0.11	-0.87	0.38	-0.11	0.91
1189.21	0.68	0.15	0.64	0.23	0.74	0.32	0.68	0.13	-0.83	0.41	-0.08	0.94
1224.05	0.67	0.14	0.65	0.20	0.72	0.31	0.69	0.15	-0.68	0.50	-0.15	0.88
1259.92	0.66	0.15	0.66	0.18	0.69	0.29	0.69	0.16	-0.53	0.60	-0.38	0.71
1296.84	0.66	0.17	0.67	0.17	0.67	0.27	0.68	0.18	-0.30	0.76	-0.38	0.71
1334.84	0.65	0.19	0.67	0.16	0.65	0.23	0.68	0.18	0.00	1.00	-0.23	0.82
1373.95	0.65	0.22	0.68	0.16	0.64	0.21	0.68	0.18	-0.08	0.94	-0.30	0.76

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
1414.21	0.65	0.22	0.68	0.16	0.62	0.21	0.66	0.19	0.00	1.00	-0.30	0.76
1455.65	0.64	0.20	0.68	0.16	0.62	0.21	0.65	0.20	-0.15	0.88	-0.23	0.82
1498.31	0.64	0.17	0.66	0.17	0.63	0.20	0.64	0.19	0.00	1.00	-0.15	0.88
1542.21	0.63	0.15	0.65	0.18	0.63	0.20	0.62	0.19	0.00	1.00	0.00	1.00
1587.4	0.63	0.14	0.63	0.19	0.64	0.20	0.62	0.19	-0.42	0.68	-0.15	0.88
1633.92	0.63	0.15	0.61	0.22	0.64	0.20	0.62	0.19	-0.83	0.41	-0.42	0.68
1681.79	0.62	0.17	0.61	0.24	0.65	0.19	0.62	0.18	-0.76	0.45	-0.91	0.36
1731.07	0.62	0.19	0.62	0.27	0.64	0.18	0.62	0.17	-0.76	0.45	-0.91	0.36
1781.8	0.61	0.22	0.61	0.28	0.64	0.17	0.62	0.16	-0.68	0.50	-0.98	0.33
1834.01	0.60	0.22	0.60	0.26	0.64	0.15	0.62	0.14	-0.76	0.45	-0.91	0.36
1887.75	0.59	0.24	0.59	0.26	0.64	0.13	0.62	0.12	-0.83	0.41	-1.06	0.29
1943.06	0.58	0.25	0.58	0.25	0.62	0.14	0.62	0.11	-0.83	0.41	-1.21	0.23
2000	0.58	0.25	0.59	0.24	0.61	0.17	0.61	0.13	-0.83	0.41	-1.29	0.20
2058.6	0.57	0.25	0.60	0.25	0.61	0.20	0.61	0.15	-0.53	0.60	-1.21	0.23
2118.93	0.56	0.26	0.62	0.26	0.61	0.21	0.60	0.17	-0.53	0.60	-1.06	0.29
2181.02	0.55	0.27	0.64	0.26	0.61	0.21	0.59	0.19	-0.42	0.68	-1.21	0.23

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
2244.92	0.54	0.29	0.65	0.26	0.61	0.21	0.59	0.20	-0.38	0.71	-1.59	0.11
2310.71	0.53	0.31	0.66	0.26	0.62	0.22	0.58	0.21	-0.30	0.76	-1.74	0.08
2378.41	0.52	0.32	0.66	0.26	0.62	0.21	0.57	0.22	-0.61	0.55	-1.66	0.10
2448.11	0.51	0.31	0.65	0.26	0.62	0.21	0.56	0.22	-0.61	0.55	-1.51	0.13
2519.84	0.49	0.30	0.64	0.27	0.62	0.21	0.55	0.22	-0.45	0.65	-1.51	0.13
2593.68	0.49	0.29	0.62	0.28	0.62	0.20	0.55	0.22	-0.61	0.55	-1.44	0.15
2669.68	0.49	0.27	0.60	0.30	0.62	0.19	0.56	0.22	-0.68	0.50	-1.29	0.20
2747.91	0.48	0.27	0.60	0.28	0.62	0.18	0.57	0.20	-0.45	0.65	-1.13	0.26
2828.43	0.48	0.30	0.64	0.26	0.62	0.17	0.58	0.19	-0.15	0.88	-1.02	0.31
2911.31	0.48	0.32	0.65	0.27	0.62	0.16	0.58	0.20	-0.30	0.76	-0.83	0.41
2996.61	0.49	0.33	0.62	0.31	0.62	0.15	0.56	0.22	-0.53	0.60	-0.83	0.41
3084.42	0.49	0.35	0.57	0.34	0.62	0.14	0.54	0.24	-0.68	0.50	-0.61	0.55
3174.8	0.48	0.37	0.51	0.36	0.61	0.15	0.52	0.25	-0.76	0.45	-0.68	0.50
3267.83	0.45	0.39	0.47	0.41	0.58	0.16	0.51	0.24	-0.91	0.36	-0.64	0.52
3363.59	0.42	0.42	0.44	0.46	0.55	0.20	0.49	0.23	-0.91	0.36	-0.45	0.65
3462.15	0.38	0.45	0.41	0.45	0.52	0.24	0.44	0.25	-0.91	0.36	-0.23	0.82

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
3563.59	0.38	0.48	0.39	0.42	0.49	0.28	0.39	0.24	-0.61	0.55	-0.23	0.82
3668.02	0.37	0.50	0.40	0.43	0.46	0.29	0.36	0.24	-0.30	0.76	0.00	1.00
3775.5	0.35	0.50	0.41	0.44	0.44	0.29	0.34	0.27	-0.23	0.82	-0.19	0.85
3886.13	0.33	0.51	0.43	0.47	0.42	0.30	0.33	0.32	-0.08	0.94	-0.53	0.60
4000	0.30	0.51	0.46	0.48	0.40	0.29	0.31	0.35	-0.23	0.82	-0.61	0.55
4117.21	0.28	0.46	0.45	0.47	0.39	0.26	0.29	0.35	0.00	1.00	-0.83	0.41
4237.85	0.29	0.42	0.42	0.45	0.37	0.23	0.27	0.31	-0.15	0.88	-0.91	0.36
4362.03	0.29	0.39	0.40	0.44	0.36	0.20	0.27	0.28	-0.30	0.76	-0.79	0.43
4489.85	0.29	0.35	0.38	0.42	0.34	0.18	0.27	0.25	-0.23	0.82	-0.68	0.50
4621.41	0.30	0.31	0.36	0.39	0.33	0.17	0.27	0.23	-0.15	0.88	-0.83	0.41
4756.83	0.31	0.30	0.34	0.38	0.31	0.17	0.26	0.20	0.00	1.00	-0.91	0.36
4896.21	0.31	0.29	0.32	0.38	0.29	0.17	0.24	0.18	-0.08	0.94	-0.98	0.33
5039.68	0.30	0.28	0.30	0.38	0.27	0.16	0.23	0.16	-0.15	0.88	-1.06	0.29
5187.36	0.27	0.29	0.28	0.37	0.25	0.15	0.23	0.15	-0.08	0.94	-1.06	0.29
5339.36	0.25	0.28	0.27	0.35	0.23	0.16	0.21	0.14	-0.08	0.94	-0.98	0.33
5495.81	0.23	0.26	0.25	0.33	0.22	0.16	0.21	0.14	-0.15	0.88	-0.91	0.36

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Frequency (in Hz)	MD Ears		Non-MD Ears		MDVMHI Ears		NMDVMHI Ears		MD Ear vs MDVMHI Ears		Non-MD Ears vs NMDVMHI Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
5656.85	0.22	0.24	0.24	0.30	0.22	0.13	0.21	0.14	-0.08	0.94	-0.49	0.62
5822.61	0.21	0.22	0.23	0.27	0.25	0.13	0.20	0.12	-0.15	0.88	-0.30	0.76
5993.23	0.20	0.20	0.22	0.24	0.26	0.16	0.20	0.13	-0.23	0.82	-0.08	0.94
6168.84	0.20	0.18	0.22	0.22	0.27	0.20	0.20	0.14	-0.11	0.91	-0.23	0.82
6349.6	0.19	0.18	0.23	0.20	0.27	0.23	0.20	0.16	-0.23	0.82	-0.11	0.91
6535.66	0.19	0.18	0.23	0.19	0.26	0.26	0.20	0.19	0.00	1.00	-0.08	0.94
6727.17	0.21	0.18	0.23	0.17	0.26	0.27	0.20	0.24	-0.23	0.82	-0.15	0.88
6924.29	0.24	0.19	0.25	0.20	0.26	0.27	0.20	0.29	0.00	1.00	-0.15	0.88
7127.19	0.25	0.21	0.30	0.22	0.27	0.28	0.20	0.35	-0.08	0.94	0.00	1.00
7336.03	0.27	0.22	0.33	0.26	0.29	0.30	0.20	0.42	-0.11	0.91	-0.08	0.94
7550.99	0.30	0.28	0.36	0.29	0.35	0.33	0.20	0.44	-0.23	0.82	-0.38	0.71
7772.26	0.32	0.37	0.38	0.33	0.41	0.36	0.21	0.45	-0.30	0.76	-0.45	0.65
8000	0.34	0.43	0.40	0.41	0.42	0.37	0.22	0.45	-0.30	0.76	-0.23	0.82

Note. IQR- Interquartile Range; ‘MD ear’: affected (symptomatic) ear of individuals in the Meniere’s disease group; ‘non-MD ear’: unaffected (asymptomatic) ears of individuals in the Meniere’s disease group; ‘MDVMHI ear’: same side ear of the Vestibular Migraine group with high

IFAR as the affected (symptomatic) ear of the Meniere’s disease group; ‘NMDVMHI ear’: same side ear of the Vestibular Migraine group with high IFAR as the unaffected (asymptomatic) ear in the Meniere’s disease group.

Appendix 5

Median and Interquartile Range of Absorbance at Peak Pressure in the Frequency Range of 226 Hz to 8000 Hz in Both Ears of Vestibular Migraine Group with Normal IFAR and Age-and Gender-Matched Healthy Control and the Outcomes of the Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
226	0.12	0.12	0.10	0.08	0.16	0.09	0.15	0.09	-1.54	0.12	-2.33	0.02
250	0.12	0.14	0.11	0.07	0.17	0.09	0.16	0.09	-1.45	0.15	-2.20	0.03
257.33	0.12	0.14	0.11	0.07	0.17	0.09	0.16	0.09	-1.41	0.16	-2.20	0.03
264.87	0.13	0.14	0.11	0.07	0.17	0.09	0.16	0.09	-1.36	0.17	-2.16	0.03
272.63	0.13	0.14	0.12	0.07	0.18	0.09	0.17	0.09	-1.36	0.17	-2.11	0.04
280.62	0.13	0.14	0.12	0.07	0.18	0.10	0.17	0.09	-1.36	0.17	-2.11	0.04
288.84	0.14	0.14	0.12	0.08	0.19	0.11	0.18	0.09	-1.39	0.17	-2.24	0.03
297.3	0.15	0.15	0.13	0.08	0.20	0.11	0.19	0.10	-1.34	0.18	-2.22	0.03
306.12	0.15	0.15	0.14	0.08	0.20	0.12	0.20	0.11	-1.32	0.19	-2.20	0.03
314.98	0.16	0.15	0.14	0.08	0.21	0.13	0.21	0.12	-1.32	0.19	-2.20	0.03
324.21	0.16	0.18	0.15	0.08	0.22	0.13	0.21	0.12	-1.32	0.19	-2.13	0.03
333.71	0.17	0.18	0.15	0.08	0.22	0.14	0.22	0.13	-1.32	0.19	-2.16	0.03
343.49	0.18	0.17	0.16	0.10	0.23	0.15	0.23	0.13	-1.34	0.18	-2.33	0.02

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
353.55	0.19	0.18	0.16	0.11	0.24	0.16	0.24	0.13	-1.41	0.16	-2.33	0.02
363.91	0.19	0.19	0.17	0.12	0.25	0.16	0.25	0.13	-1.43	0.15	-2.35	0.02
374.58	0.20	0.19	0.18	0.12	0.26	0.17	0.26	0.14	-1.45	0.15	-2.42	0.02
385.55	0.21	0.20	0.19	0.12	0.27	0.18	0.26	0.15	-1.41	0.16	-2.44	0.02
396.95	0.21	0.20	0.19	0.13	0.28	0.18	0.27	0.15	-1.45	0.15	-2.44	0.02
408.48	0.22	0.20	0.20	0.13	0.29	0.19	0.28	0.16	-1.41	0.16	-2.42	0.02
420.45	0.23	0.20	0.20	0.13	0.29	0.20	0.29	0.16	-1.28	0.20	-2.38	0.02
432.77	0.23	0.20	0.21	0.14	0.30	0.20	0.30	0.16	-1.28	0.20	-2.42	0.02
445.45	0.24	0.20	0.22	0.14	0.31	0.21	0.31	0.16	-1.28	0.20	-2.42	0.02
458.5	0.25	0.20	0.23	0.14	0.32	0.21	0.32	0.17	-1.32	0.19	-2.42	0.02
471.94	0.27	0.20	0.25	0.14	0.34	0.22	0.34	0.17	-1.28	0.20	-2.31	0.02
485.77	0.28	0.21	0.26	0.14	0.35	0.22	0.35	0.17	-1.28	0.20	-2.33	0.02
500	0.30	0.21	0.27	0.14	0.36	0.22	0.36	0.18	-1.19	0.24	-2.29	0.02
514.65	0.31	0.23	0.29	0.15	0.37	0.24	0.38	0.18	-1.23	0.22	-2.33	0.02
529.73	0.32	0.23	0.30	0.16	0.38	0.24	0.39	0.18	-1.19	0.24	-2.38	0.02
545.25	0.33	0.23	0.30	0.16	0.39	0.25	0.40	0.18	-1.12	0.26	-2.29	0.02

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
561.23	0.34	0.23	0.32	0.15	0.41	0.27	0.42	0.19	-1.14	0.25	-2.29	0.02
577.68	0.36	0.23	0.34	0.14	0.43	0.28	0.43	0.19	-1.08	0.28	-2.44	0.02
594.6	0.37	0.25	0.35	0.14	0.45	0.29	0.46	0.19	-1.01	0.31	-2.58	0.01
612.03	0.38	0.26	0.36	0.14	0.45	0.29	0.48	0.19	-1.01	0.31	-2.60	0.01
629.96	0.39	0.27	0.36	0.15	0.46	0.29	0.49	0.19	-1.10	0.27	-2.55	0.01
648.42	0.40	0.28	0.40	0.15	0.48	0.28	0.52	0.19	-0.97	0.33	-2.53	0.01
667.42	0.42	0.27	0.42	0.15	0.49	0.27	0.54	0.19	-1.06	0.29	-2.38	0.02
686.98	0.43	0.27	0.44	0.17	0.51	0.26	0.55	0.21	-1.06	0.29	-2.18	0.03
707.11	0.44	0.27	0.46	0.19	0.52	0.25	0.56	0.23	-1.19	0.24	-2.02	0.04
727.83	0.46	0.26	0.48	0.19	0.54	0.24	0.57	0.22	-1.19	0.24	-1.96	0.05
749.15	0.47	0.25	0.49	0.19	0.55	0.24	0.59	0.21	-1.36	0.17	-2.07	0.04
771.11	0.47	0.25	0.50	0.19	0.56	0.24	0.61	0.20	-1.41	0.16	-2.05	0.04
793.7	0.48	0.25	0.52	0.18	0.58	0.24	0.63	0.20	-1.45	0.15	-2.02	0.04
816.96	0.48	0.25	0.53	0.18	0.59	0.23	0.65	0.20	-1.54	0.12	-2.11	0.04
840.9	0.48	0.25	0.54	0.16	0.61	0.22	0.66	0.20	-1.70	0.09	-2.09	0.04
865.54	0.49	0.23	0.55	0.16	0.63	0.22	0.67	0.20	-1.80	0.07	-1.94	0.05

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
890.9	0.49	0.22	0.56	0.16	0.65	0.22	0.67	0.21	-2.02	0.04	-2.07	0.04
917	0.50	0.21	0.57	0.14	0.67	0.22	0.68	0.21	-2.22	0.03	-2.07	0.04
943.87	0.51	0.19	0.58	0.13	0.68	0.21	0.69	0.22	-2.42	0.02	-2.07	0.04
971.53	0.53	0.18	0.58	0.13	0.69	0.19	0.70	0.23	-2.49	0.01	-1.94	0.05
1000	0.54	0.15	0.59	0.11	0.70	0.18	0.71	0.22	-2.60	0.01	-1.78	0.08
1029.3	0.56	0.13	0.62	0.08	0.71	0.16	0.71	0.22	-2.82	0.01	-1.63	0.10
1059.46	0.56	0.12	0.64	0.08	0.71	0.16	0.72	0.21	-2.95	0.00	-1.65	0.10
1090.51	0.55	0.12	0.64	0.12	0.71	0.15	0.72	0.21	-2.99	0.00	-1.45	0.15
1122.46	0.55	0.11	0.64	0.14	0.71	0.15	0.72	0.20	-3.17	0.00	-1.19	0.24
1155.35	0.54	0.10	0.64	0.14	0.71	0.15	0.71	0.18	-2.90	0.00	-1.14	0.25
1189.21	0.53	0.09	0.65	0.13	0.70	0.13	0.71	0.17	-2.86	0.00	-1.36	0.17
1224.05	0.53	0.09	0.65	0.11	0.70	0.11	0.73	0.16	-2.86	0.00	-1.63	0.10
1259.92	0.53	0.10	0.63	0.11	0.70	0.11	0.72	0.17	-2.95	0.00	-1.76	0.08
1296.84	0.54	0.10	0.61	0.12	0.71	0.10	0.72	0.17	-3.08	0.00	-2.07	0.04
1334.84	0.52	0.09	0.59	0.11	0.70	0.09	0.72	0.17	-3.21	0.00	-2.35	0.02
1373.95	0.53	0.11	0.59	0.14	0.71	0.12	0.72	0.17	-3.28	0.00	-2.64	0.01

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
1414.21	0.53	0.11	0.58	0.23	0.70	0.13	0.73	0.16	-3.30	0.00	-2.47	0.01
1455.65	0.53	0.15	0.58	0.29	0.69	0.15	0.72	0.15	-3.26	0.00	-2.57	0.01
1498.31	0.54	0.20	0.57	0.31	0.69	0.16	0.70	0.15	-3.19	0.00	-2.68	0.01
1542.21	0.54	0.31	0.57	0.32	0.68	0.16	0.69	0.17	-3.08	0.00	-2.60	0.01
1587.4	0.54	0.40	0.58	0.31	0.67	0.17	0.69	0.19	-2.75	0.01	-2.42	0.02
1633.92	0.54	0.45	0.58	0.28	0.66	0.18	0.69	0.21	-2.58	0.01	-2.51	0.01
1681.79	0.54	0.52	0.59	0.25	0.65	0.18	0.69	0.22	-2.33	0.02	-2.27	0.02
1731.07	0.52	0.59	0.58	0.24	0.64	0.16	0.68	0.22	-2.20	0.03	-2.24	0.03
1781.8	0.51	0.62	0.56	0.26	0.65	0.15	0.68	0.23	-2.07	0.04	-2.18	0.03
1834.01	0.50	0.63	0.54	0.30	0.64	0.15	0.68	0.26	-1.89	0.06	-2.02	0.04
1887.75	0.49	0.67	0.53	0.32	0.64	0.15	0.67	0.27	-1.98	0.05	-1.85	0.07
1943.06	0.49	0.64	0.51	0.35	0.63	0.15	0.67	0.26	-1.94	0.05	-1.91	0.06
2000	0.48	0.56	0.50	0.35	0.64	0.16	0.68	0.25	-1.94	0.05	-1.94	0.05
2058.6	0.48	0.47	0.49	0.34	0.64	0.17	0.67	0.24	-2.29	0.02	-1.98	0.05
2118.93	0.47	0.42	0.48	0.32	0.62	0.15	0.68	0.24	-2.49	0.01	-1.83	0.07
2181.02	0.46	0.33	0.48	0.30	0.61	0.14	0.70	0.22	-2.82	0.01	-1.89	0.06

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
2244.92	0.48	0.25	0.48	0.28	0.61	0.13	0.71	0.20	-2.95	0.00	-2.07	0.04
2310.71	0.49	0.23	0.51	0.27	0.62	0.12	0.71	0.21	-3.17	0.00	-2.02	0.04
2378.41	0.50	0.22	0.53	0.23	0.61	0.15	0.70	0.21	-2.82	0.01	-2.07	0.04
2448.11	0.48	0.25	0.53	0.20	0.62	0.15	0.70	0.22	-2.69	0.01	-2.07	0.04
2519.84	0.46	0.23	0.55	0.19	0.62	0.17	0.69	0.23	-2.68	0.01	-2.07	0.04
2593.68	0.45	0.24	0.55	0.20	0.62	0.18	0.68	0.23	-2.38	0.02	-1.91	0.06
2669.68	0.44	0.24	0.54	0.19	0.60	0.19	0.67	0.25	-2.38	0.02	-1.74	0.08
2747.91	0.44	0.22	0.55	0.19	0.59	0.22	0.67	0.25	-2.38	0.02	-1.72	0.09
2828.43	0.43	0.22	0.57	0.21	0.59	0.25	0.66	0.26	-2.46	0.01	-1.54	0.12
2911.31	0.44	0.23	0.59	0.23	0.59	0.22	0.65	0.25	-2.57	0.01	-1.50	0.14
2996.61	0.44	0.24	0.61	0.25	0.59	0.23	0.64	0.22	-2.38	0.02	-1.23	0.22
3084.42	0.44	0.24	0.64	0.26	0.62	0.24	0.64	0.21	-2.05	0.04	-1.03	0.30
3174.8	0.45	0.23	0.65	0.30	0.61	0.26	0.63	0.23	-1.67	0.09	-0.75	0.45
3267.83	0.46	0.27	0.65	0.36	0.59	0.29	0.61	0.26	-1.36	0.17	-0.40	0.69
3363.59	0.47	0.33	0.64	0.42	0.57	0.30	0.58	0.29	-1.17	0.24	-0.09	0.93
3462.15	0.47	0.39	0.62	0.45	0.55	0.29	0.55	0.31	-0.92	0.36	-0.48	0.63

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
3563.59	0.47	0.44	0.60	0.44	0.52	0.29	0.52	0.32	-0.75	0.45	-0.81	0.42
3668.02	0.46	0.47	0.60	0.44	0.48	0.29	0.49	0.32	-0.53	0.60	-0.92	0.36
3775.5	0.45	0.48	0.60	0.43	0.45	0.27	0.47	0.24	-0.48	0.63	-1.01	0.31
3886.13	0.44	0.46	0.59	0.42	0.45	0.28	0.47	0.20	-0.44	0.66	-1.10	0.27
4000	0.43	0.41	0.56	0.39	0.45	0.27	0.46	0.20	-0.18	0.86	-0.95	0.34
4117.21	0.44	0.42	0.53	0.37	0.44	0.27	0.44	0.19	-0.31	0.76	-0.88	0.38
4237.85	0.46	0.42	0.50	0.37	0.43	0.28	0.41	0.19	-0.70	0.48	-0.79	0.43
4362.03	0.48	0.43	0.48	0.37	0.41	0.28	0.39	0.17	-0.86	0.39	-0.84	0.40
4489.85	0.48	0.44	0.46	0.40	0.38	0.26	0.37	0.17	-1.10	0.27	-0.84	0.40
4621.41	0.49	0.45	0.44	0.44	0.36	0.23	0.36	0.20	-1.23	0.22	-1.06	0.29
4756.83	0.50	0.49	0.42	0.50	0.33	0.22	0.34	0.22	-1.39	0.17	-1.06	0.29
4896.21	0.51	0.52	0.40	0.54	0.29	0.22	0.33	0.22	-1.41	0.16	-1.19	0.24
5039.68	0.51	0.55	0.38	0.56	0.27	0.20	0.31	0.23	-1.65	0.10	-1.28	0.20
5187.36	0.51	0.56	0.36	0.56	0.26	0.17	0.29	0.23	-1.69	0.09	-1.36	0.17
5339.36	0.49	0.55	0.34	0.54	0.25	0.13	0.27	0.21	-1.80	0.07	-1.36	0.17
5495.81	0.48	0.52	0.32	0.50	0.24	0.11	0.26	0.18	-1.76	0.08	-1.36	0.17

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Frequency (in Hz)	VMNIR Ears		VMNIL Ears		Left Control Ears		Right Control Ears		VMNIR Ears vs Control Ears		VMNIL Ears vs Control Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	p-value	Z- value	p-value
5656.85	0.47	0.51	0.30	0.47	0.23	0.12	0.26	0.16	-1.74	0.08	-1.36	0.17
5822.61	0.46	0.49	0.29	0.43	0.22	0.13	0.25	0.14	-1.72	0.09	-1.45	0.15
5993.23	0.46	0.47	0.28	0.40	0.22	0.14	0.25	0.13	-1.74	0.08	-1.50	0.14
6168.84	0.45	0.44	0.27	0.37	0.22	0.15	0.24	0.13	-1.83	0.07	-1.28	0.20
6349.6	0.44	0.41	0.26	0.34	0.22	0.15	0.24	0.14	-1.85	0.06	-1.28	0.20
6535.66	0.43	0.38	0.26	0.32	0.23	0.15	0.25	0.13	-1.80	0.07	-1.19	0.24
6727.17	0.42	0.33	0.25	0.29	0.25	0.15	0.27	0.13	-1.80	0.07	-1.01	0.31
6924.29	0.41	0.27	0.26	0.28	0.24	0.17	0.27	0.16	-1.85	0.07	-1.19	0.24
7127.19	0.40	0.24	0.27	0.27	0.24	0.20	0.27	0.20	-1.89	0.06	-1.19	0.24
7336.03	0.36	0.22	0.30	0.24	0.24	0.25	0.26	0.24	-1.67	0.09	-1.19	0.24
7550.99	0.36	0.24	0.30	0.27	0.23	0.28	0.25	0.29	-1.54	0.12	-1.61	0.11
7772.26	0.34	0.30	0.31	0.35	0.23	0.30	0.25	0.32	-1.65	0.10	-1.63	0.10
8000	0.32	0.33	0.32	0.35	0.23	0.31	0.25	0.35	-1.54	0.12	-1.54	0.12

Note. IQR- Interquartile Range; ‘VMNIR Ear’: right ear of individuals with Vestibular Migraine with normal IFAR; ‘VMNIL ear’: left ear of individuals with Vestibular Migraine with normal IFAR.

Appendix 6

Median and Interquartile Range of Absorbance at Peak Pressure in the Frequency Range of 226 Hz to 8000 Hz in Both Ears of VM with High IFAR Group and Age-and Gender-Matched Healthy Controls and the Outcomes of the Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
226	0.14	0.08	0.13	0.04	0.14	0.08	0.13	0.09	-1.14	0.26	-0.98	0.33
250	0.15	0.09	0.13	0.04	0.14	0.08	0.14	0.10	-0.98	0.33	-1.14	0.26
257.33	0.15	0.09	0.14	0.04	0.14	0.08	0.14	0.10	-0.91	0.36	-1.14	0.26
264.87	0.15	0.1	0.14	0.04	0.15	0.09	0.14	0.11	-0.91	0.36	-1.21	0.23
272.63	0.16	0.1	0.14	0.05	0.15	0.09	0.15	0.11	-0.91	0.36	-1.14	0.26
280.62	0.16	0.1	0.15	0.05	0.15	0.09	0.15	0.11	-0.76	0.45	-1.14	0.26
288.84	0.17	0.11	0.15	0.05	0.16	0.10	0.16	0.12	-0.76	0.45	-1.13	0.26
297.3	0.18	0.12	0.16	0.06	0.17	0.10	0.16	0.13	-0.76	0.45	-1.13	0.26
306.12	0.18	0.12	0.17	0.06	0.17	0.10	0.17	0.14	-0.91	0.36	-1.14	0.26
314.98	0.19	0.13	0.17	0.07	0.17	0.11	0.18	0.14	-0.91	0.36	-1.13	0.26
324.21	0.2	0.13	0.18	0.07	0.18	0.11	0.18	0.15	-1.06	0.29	-1.10	0.27
333.71	0.2	0.14	0.19	0.07	0.18	0.11	0.19	0.16	-1.06	0.29	-1.06	0.29

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
343.49	0.21	0.14	0.2	0.07	0.19	0.11	0.20	0.16	-0.95	0.34	-1.02	0.31
353.55	0.22	0.15	0.2	0.07	0.20	0.12	0.21	0.17	-1.06	0.29	-0.91	0.36
363.91	0.23	0.16	0.22	0.07	0.20	0.12	0.22	0.17	-1.06	0.29	-0.91	0.36
374.58	0.24	0.16	0.22	0.07	0.21	0.13	0.22	0.18	-0.91	0.36	-1.13	0.26
385.55	0.25	0.17	0.23	0.07	0.22	0.13	0.23	0.18	-0.91	0.36	-1.17	0.24
396.95	0.26	0.17	0.24	0.07	0.23	0.13	0.24	0.18	-0.95	0.41	-1.13	0.26
408.48	0.27	0.17	0.25	0.08	0.24	0.13	0.25	0.19	-0.79	0.43	-1.17	0.24
420.45	0.28	0.17	0.26	0.09	0.25	0.14	0.25	0.19	-0.76	0.45	-1.21	0.23
432.77	0.29	0.17	0.27	0.09	0.26	0.14	0.26	0.19	-0.79	0.43	-1.29	0.20
445.45	0.3	0.17	0.27	0.1	0.26	0.14	0.27	0.19	-0.76	0.45	-1.29	0.20
458.5	0.31	0.17	0.28	0.1	0.27	0.14	0.28	0.20	-0.72	0.47	-1.17	0.24
471.94	0.33	0.18	0.3	0.11	0.29	0.14	0.30	0.20	-0.64	0.52	-1.13	0.26
485.77	0.34	0.18	0.32	0.11	0.30	0.14	0.30	0.21	-0.68	0.50	-1.13	0.26
500	0.35	0.18	0.33	0.11	0.31	0.15	0.31	0.21	-0.68	0.50	-1.13	0.26
514.65	0.37	0.18	0.35	0.12	0.32	0.15	0.33	0.22	-0.61	0.55	-1.17	0.24

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
529.73	0.38	0.18	0.36	0.12	0.33	0.16	0.34	0.23	-0.45	0.65	-1.13	0.26
545.25	0.39	0.18	0.38	0.12	0.34	0.16	0.35	0.24	-0.45	0.65	-1.21	0.23
561.23	0.41	0.2	0.4	0.12	0.36	0.17	0.36	0.25	-0.34	0.73	-1.25	0.21
577.68	0.44	0.21	0.43	0.13	0.38	0.17	0.38	0.25	-0.38	0.71	-1.29	0.20
594.6	0.46	0.21	0.46	0.14	0.40	0.17	0.39	0.26	-0.42	0.68	-1.36	0.17
612.03	0.48	0.21	0.47	0.14	0.40	0.17	0.39	0.27	-0.30	0.76	-1.44	0.15
629.96	0.49	0.2	0.48	0.15	0.40	0.16	0.40	0.27	-0.30	0.76	-1.48	0.14
648.42	0.51	0.19	0.5	0.15	0.41	0.16	0.41	0.27	-0.38	0.71	-1.44	0.15
667.42	0.52	0.19	0.51	0.15	0.42	0.16	0.42	0.26	-0.42	0.68	-1.29	0.20
686.98	0.53	0.2	0.52	0.15	0.43	0.16	0.43	0.26	-0.57	0.57	-1.29	0.20
707.11	0.53	0.21	0.52	0.15	0.44	0.16	0.45	0.26	-0.57	0.57	-1.17	0.24
727.83	0.54	0.22	0.52	0.15	0.45	0.16	0.47	0.28	-0.83	0.41	-1.02	0.31
749.15	0.55	0.23	0.52	0.16	0.47	0.16	0.48	0.29	-0.91	0.36	-1.06	0.29
771.11	0.54	0.16	0.56	0.23	0.49	0.29	0.49	0.17	-1.06	0.29	-1.10	0.27
793.7	0.55	0.16	0.57	0.23	0.51	0.28	0.51	0.19	-1.14	0.26	-1.17	0.24

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
816.96	0.56	0.16	0.57	0.23	0.53	0.28	0.53	0.20	-1.06	0.29	-1.32	0.19
840.9	0.57	0.16	0.59	0.24	0.54	0.28	0.54	0.21	-1.13	0.26	-1.55	0.12
865.54	0.57	0.16	0.6	0.24	0.56	0.28	0.56	0.23	-1.21	0.23	-1.59	0.11
890.9	0.59	0.16	0.62	0.24	0.58	0.29	0.58	0.24	-1.14	0.26	-1.59	0.11
917	0.62	0.18	0.63	0.22	0.59	0.29	0.59	0.24	-1.17	0.24	-1.82	0.07
943.87	0.64	0.2	0.65	0.21	0.62	0.27	0.60	0.24	-1.21	0.23	-2.04	0.04
971.53	0.67	0.22	0.66	0.21	0.63	0.25	0.62	0.22	-1.21	0.23	-2.12	0.03
1000	0.7	0.24	0.66	0.19	0.65	0.24	0.63	0.20	-0.98	0.33	-2.38	0.02
1029.3	0.72	0.25	0.66	0.16	0.66	0.24	0.64	0.17	-1.13	0.26	-2.57	0.01
1059.46	0.75	0.26	0.67	0.13	0.67	0.24	0.66	0.14	-1.21	0.23	-2.65	0.01
1090.51	0.76	0.26	0.68	0.12	0.67	0.23	0.67	0.12	-1.06	0.29	-2.57	0.01
1122.46	0.77	0.29	0.68	0.11	0.68	0.22	0.67	0.10	-1.13	0.26	-2.19	0.03
1155.35	0.76	0.31	0.68	0.11	0.70	0.22	0.68	0.10	-1.13	0.26	-2.34	0.02
1189.21	0.74	0.32	0.68	0.13	0.70	0.22	0.68	0.11	-1.13	0.26	-2.42	0.02
1224.05	0.72	0.31	0.69	0.15	0.70	0.21	0.67	0.10	-0.98	0.33	-1.89	0.06

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
1259.92	0.69	0.29	0.69	0.16	0.70	0.19	0.67	0.09	-0.76	0.45	-2.12	0.03
1296.84	0.67	0.27	0.68	0.18	0.70	0.17	0.67	0.09	-0.76	0.45	-2.04	0.04
1334.84	0.65	0.23	0.68	0.18	0.70	0.15	0.67	0.08	-1.29	0.20	-2.04	0.04
1373.95	0.64	0.21	0.68	0.18	0.70	0.14	0.67	0.08	-1.63	0.10	-2.19	0.03
1414.21	0.62	0.21	0.66	0.19	0.70	0.15	0.67	0.09	-1.44	0.15	-2.27	0.02
1455.65	0.62	0.21	0.65	0.2	0.69	0.14	0.67	0.10	-1.29	0.20	-2.19	0.03
1498.31	0.63	0.2	0.64	0.19	0.68	0.16	0.66	0.10	-1.51	0.13	-2.34	0.02
1542.21	0.63	0.2	0.62	0.19	0.67	0.17	0.66	0.10	-1.59	0.11	-1.89	0.06
1587.4	0.64	0.2	0.62	0.19	0.66	0.18	0.67	0.11	-1.66	0.10	-1.74	0.08
1633.92	0.64	0.2	0.62	0.19	0.65	0.18	0.67	0.12	-1.51	0.13	-1.66	0.10
1681.79	0.65	0.19	0.62	0.18	0.66	0.16	0.65	0.13	-1.82	0.07	-1.82	0.07
1731.07	0.64	0.18	0.62	0.17	0.67	0.17	0.64	0.15	-1.82	0.07	-1.66	0.10
1781.8	0.64	0.17	0.62	0.16	0.67	0.19	0.63	0.13	-1.59	0.11	-1.66	0.10
1834.01	0.64	0.15	0.62	0.14	0.68	0.18	0.61	0.13	-1.51	0.13	-1.74	0.08
1887.75	0.64	0.13	0.62	0.12	0.68	0.18	0.60	0.15	-1.51	0.13	-1.66	0.10

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
1943.06	0.62	0.14	0.62	0.11	0.67	0.19	0.59	0.17	-1.44	0.15	-1.85	0.06
2000	0.61	0.17	0.61	0.13	0.67	0.20	0.58	0.17	-1.51	0.13	-1.89	0.06
2058.6	0.61	0.2	0.61	0.15	0.66	0.19	0.58	0.17	-1.66	0.10	-2.35	0.02
2118.93	0.61	0.21	0.6	0.17	0.65	0.19	0.57	0.17	-1.66	0.10	-2.42	0.02
2181.02	0.61	0.21	0.59	0.19	0.63	0.19	0.57	0.16	-1.59	0.11	-2.42	0.02
2244.92	0.61	0.21	0.59	0.2	0.63	0.19	0.57	0.15	-1.66	0.10	-2.53	0.01
2310.71	0.62	0.22	0.58	0.21	0.64	0.20	0.57	0.15	-1.66	0.10	-2.57	0.01
2378.41	0.62	0.21	0.57	0.22	0.65	0.22	0.58	0.15	-1.66	0.10	-2.12	0.03
2448.11	0.62	0.21	0.56	0.22	0.66	0.23	0.58	0.16	-1.51	0.13	-2.04	0.04
2519.84	0.62	0.21	0.55	0.22	0.67	0.23	0.58	0.18	-1.44	0.15	-2.12	0.03
2593.68	0.62	0.2	0.55	0.22	0.69	0.23	0.57	0.17	-1.36	0.17	-2.04	0.04
2669.68	0.62	0.19	0.56	0.22	0.69	0.22	0.56	0.15	-1.36	0.17	-2.04	0.04
2747.91	0.62	0.18	0.57	0.2	0.70	0.21	0.56	0.13	-1.36	0.17	-1.97	0.05
2828.43	0.62	0.17	0.58	0.19	0.70	0.21	0.56	0.14	-1.59	0.11	-1.89	0.06
2911.31	0.62	0.16	0.58	0.2	0.70	0.19	0.56	0.16	-1.25	0.21	-1.66	0.10

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
2996.61	0.62	0.15	0.56	0.22	0.68	0.18	0.55	0.17	-0.83	0.41	-1.36	0.17
3084.42	0.62	0.14	0.54	0.24	0.67	0.19	0.55	0.17	-0.83	0.41	-0.87	0.38
3174.8	0.61	0.15	0.52	0.25	0.65	0.19	0.56	0.20	-0.45	0.65	-0.45	0.65
3267.83	0.58	0.16	0.51	0.24	0.63	0.20	0.56	0.22	-0.08	0.94	-0.38	0.71
3363.59	0.55	0.2	0.49	0.23	0.60	0.21	0.57	0.24	-0.30	0.76	-0.23	0.82
3462.15	0.52	0.24	0.44	0.25	0.57	0.24	0.57	0.26	-0.27	0.79	-0.08	0.94
3563.59	0.49	0.28	0.39	0.24	0.54	0.25	0.55	0.30	-0.53	0.60	-0.38	0.71
3668.02	0.46	0.29	0.36	0.24	0.52	0.29	0.50	0.34	-0.91	0.36	-0.61	0.55
3775.5	0.44	0.29	0.34	0.27	0.50	0.32	0.47	0.35	-0.91	0.36	-0.68	0.50
3886.13	0.42	0.3	0.33	0.32	0.46	0.30	0.45	0.31	-0.91	0.36	-0.76	0.45
4000	0.4	0.29	0.31	0.35	0.43	0.26	0.42	0.27	-0.98	0.33	-1.29	0.20
4117.21	0.39	0.26	0.29	0.35	0.41	0.21	0.40	0.24	-0.91	0.36	-1.44	0.15
4237.85	0.37	0.23	0.27	0.31	0.39	0.19	0.36	0.22	-1.21	0.23	-1.59	0.11
4362.03	0.36	0.2	0.27	0.28	0.37	0.19	0.33	0.20	-1.25	0.21	-1.74	0.08
4489.85	0.34	0.18	0.27	0.25	0.37	0.17	0.32	0.18	-1.36	0.17	-1.74	0.08

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
4621.41	0.33	0.17	0.27	0.23	0.36	0.20	0.32	0.17	-1.44	0.15	-1.97	0.05
4756.83	0.31	0.17	0.26	0.2	0.35	0.21	0.31	0.16	-1.36	0.17	-1.97	0.05
4896.21	0.29	0.17	0.24	0.18	0.34	0.21	0.29	0.17	-1.44	0.15	-1.97	0.05
5039.68	0.27	0.16	0.23	0.16	0.33	0.22	0.26	0.18	-1.51	0.13	-2.12	0.03
5187.36	0.25	0.15	0.23	0.15	0.31	0.21	0.26	0.18	-1.66	0.10	-2.12	0.03
5339.36	0.23	0.16	0.21	0.14	0.29	0.21	0.25	0.17	-1.59	0.11	-1.97	0.05
5495.81	0.22	0.16	0.21	0.14	0.27	0.20	0.24	0.12	-1.44	0.15	-1.97	0.05
5656.85	0.22	0.13	0.21	0.14	0.25	0.18	0.25	0.11	-1.36	0.17	-1.97	0.05
5822.61	0.25	0.13	0.2	0.12	0.24	0.17	0.25	0.12	-1.21	0.23	-1.93	0.05
5993.23	0.26	0.16	0.2	0.13	0.23	0.16	0.25	0.13	-1.06	0.29	-1.97	0.05
6168.84	0.27	0.2	0.2	0.14	0.24	0.15	0.25	0.13	-0.83	0.41	-1.89	0.06
6349.6	0.27	0.23	0.2	0.16	0.25	0.14	0.24	0.14	-0.76	0.45	-2.04	0.04
6535.66	0.26	0.26	0.2	0.19	0.27	0.14	0.24	0.14	-0.61	0.55	-1.93	0.05
6727.17	0.26	0.27	0.2	0.24	0.28	0.14	0.25	0.16	-0.53	0.60	-1.85	0.06
6924.29	0.26	0.27	0.2	0.29	0.29	0.16	0.26	0.19	-0.53	0.60	-1.74	0.08

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Frequency (in Hz)	VMHIL Ears		VMHIR Ears		Left Control Ears		Right Control Ears		VMHIL Ears Vs Control Group Ears		VMHIR Ears Vs Control Group Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
7127.19	0.27	0.28	0.2	0.35	0.30	0.19	0.28	0.23	-0.68	0.50	-1.36	0.17
7336.03	0.29	0.3	0.2	0.42	0.31	0.22	0.29	0.25	-0.38	0.71	-1.29	0.20
7550.99	0.35	0.33	0.2	0.44	0.33	0.25	0.29	0.22	-0.08	0.94	-1.06	0.29
7772.26	0.41	0.36	0.21	0.45	0.33	0.28	0.30	0.22	-0.08	0.94	-0.87	0.38
8000	0.42	0.37	0.22	0.45	0.34	0.31	0.30	0.23	-0.08	0.94	-0.91	0.36

Note: IQR- Interquartile Range; ‘VMHIR Ears’: right ear of the Vestibular Migraine group with high IFAR; ‘VMHIL Ears’: left ears of the Vestibular Migraine with high IFAR.

Appendix 7

Median and Interquartile Range of Absorbance at Peak Pressure in The Frequency Range of 226 Hz to 8000 Hz in Both Ears of Vestibular Migraine Group with High IFAR and Vestibular Migraine Group with Normal IFAR and the Outcomes of the Mann-Whitney U test for Comparison Between the Groups.

Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
226	0.14	0.08	0.13	0.04	0.12	0.12	0.10	0.08	-1.14	0.26	-0.98	0.33
250	0.15	0.09	0.13	0.04	0.12	0.14	0.11	0.07	-0.98	0.33	-1.14	0.26
257.33	0.15	0.09	0.14	0.04	0.12	0.14	0.11	0.07	-0.91	0.36	-1.14	0.26
264.87	0.15	0.1	0.14	0.04	0.13	0.14	0.11	0.07	-0.91	0.36	-1.21	0.23
272.63	0.16	0.1	0.14	0.05	0.13	0.14	0.12	0.07	-0.91	0.36	-1.14	0.26
280.62	0.16	0.1	0.15	0.05	0.13	0.14	0.12	0.07	-0.76	0.45	-1.14	0.26
288.84	0.17	0.11	0.15	0.05	0.14	0.14	0.12	0.08	-0.76	0.45	-1.13	0.26
297.3	0.18	0.12	0.16	0.06	0.15	0.15	0.13	0.08	-0.76	0.45	-1.13	0.26
306.12	0.18	0.12	0.17	0.06	0.15	0.15	0.14	0.08	-0.91	0.36	-1.14	0.26
314.98	0.19	0.13	0.17	0.07	0.16	0.15	0.14	0.08	-0.91	0.36	-1.13	0.26
324.21	0.2	0.13	0.18	0.07	0.16	0.18	0.15	0.08	-1.06	0.29	-1.10	0.27
333.71	0.2	0.14	0.19	0.07	0.17	0.18	0.15	0.08	-1.06	0.29	-1.06	0.29

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
343.49	0.21	0.14	0.2	0.07	0.18	0.17	0.16	0.10	-0.95	0.34	-1.02	0.31
353.55	0.22	0.15	0.2	0.07	0.19	0.18	0.16	0.11	-1.06	0.29	-0.91	0.36
363.91	0.23	0.16	0.22	0.07	0.19	0.19	0.17	0.12	-1.06	0.29	-0.91	0.36
374.58	0.24	0.16	0.22	0.07	0.20	0.19	0.18	0.12	-0.91	0.36	-1.13	0.26
385.55	0.25	0.17	0.23	0.07	0.21	0.20	0.19	0.12	-0.91	0.36	-1.17	0.24
396.95	0.26	0.17	0.24	0.07	0.21	0.20	0.19	0.13	-0.83	0.41	-1.13	0.26
408.48	0.27	0.17	0.25	0.08	0.22	0.20	0.20	0.13	-0.79	0.43	-1.17	0.24
420.45	0.28	0.17	0.26	0.09	0.23	0.20	0.20	0.13	-0.76	0.45	-1.21	0.23
432.77	0.29	0.17	0.27	0.09	0.23	0.20	0.21	0.14	-0.79	0.43	-1.29	0.20
445.45	0.3	0.17	0.27	0.1	0.24	0.20	0.22	0.14	-0.76	0.45	-1.29	0.20
458.5	0.31	0.17	0.28	0.1	0.25	0.20	0.23	0.14	-0.72	0.47	-1.17	0.24
471.94	0.33	0.18	0.3	0.11	0.27	0.20	0.25	0.14	-0.64	0.52	-1.13	0.26
485.77	0.34	0.18	0.32	0.11	0.28	0.21	0.26	0.14	-0.68	0.50	-1.13	0.26
500	0.35	0.18	0.33	0.11	0.30	0.21	0.27	0.14	-0.68	0.50	-1.13	0.26
514.65	0.37	0.18	0.35	0.12	0.31	0.23	0.29	0.15	-0.61	0.55	-1.17	0.24

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
529.73	0.38	0.18	0.36	0.12	0.32	0.23	0.30	0.16	-0.45	0.65	-1.13	0.26
545.25	0.39	0.18	0.38	0.12	0.33	0.23	0.30	0.16	-0.45	0.65	-1.21	0.23
561.23	0.41	0.2	0.4	0.12	0.34	0.23	0.32	0.15	-0.34	0.73	-1.25	0.21
577.68	0.44	0.21	0.43	0.13	0.36	0.23	0.34	0.14	-0.38	0.71	-1.29	0.20
594.6	0.46	0.21	0.46	0.14	0.37	0.25	0.35	0.14	-0.42	0.68	-1.36	0.17
612.03	0.48	0.21	0.47	0.14	0.38	0.26	0.36	0.14	-0.30	0.76	-1.44	0.15
629.96	0.49	0.2	0.48	0.15	0.39	0.27	0.36	0.15	-0.30	0.76	-1.48	0.14
648.42	0.51	0.19	0.5	0.15	0.40	0.28	0.40	0.15	-0.38	0.71	-1.44	0.15
667.42	0.52	0.19	0.51	0.15	0.42	0.27	0.42	0.15	-0.42	0.68	-1.29	0.20
686.98	0.53	0.2	0.52	0.15	0.43	0.27	0.44	0.17	-0.57	0.57	-1.29	0.20
707.11	0.53	0.21	0.52	0.15	0.44	0.27	0.46	0.19	-0.57	0.57	-1.17	0.24
727.83	0.54	0.22	0.52	0.15	0.46	0.26	0.48	0.19	-0.83	0.41	-1.02	0.31
749.15	0.55	0.23	0.52	0.16	0.47	0.25	0.49	0.19	-0.91	0.36	-1.06	0.29
771.11	0.56	0.23	0.54	0.16	0.47	0.25	0.50	0.19	-1.10	0.27	-1.06	0.29
793.7	0.57	0.23	0.55	0.16	0.48	0.25	0.52	0.18	-1.17	0.24	-1.14	0.26

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
816.96	0.57	0.23	0.56	0.16	0.48	0.25	0.53	0.18	-1.32	0.19	-1.06	0.29
840.9	0.59	0.24	0.57	0.16	0.48	0.25	0.54	0.16	-1.55	0.12	-1.13	0.26
865.54	0.6	0.24	0.57	0.16	0.49	0.23	0.55	0.16	-1.59	0.11	-1.21	0.23
890.9	0.62	0.24	0.59	0.16	0.49	0.22	0.56	0.16	-1.59	0.11	-1.14	0.26
917	0.63	0.22	0.62	0.18	0.50	0.21	0.57	0.14	-1.82	0.07	-1.17	0.24
943.87	0.65	0.21	0.64	0.2	0.51	0.19	0.58	0.13	-2.04	0.04	-1.21	0.23
971.53	0.66	0.21	0.67	0.22	0.53	0.18	0.58	0.13	-2.12	0.03	-1.21	0.23
1000	0.66	0.19	0.7	0.24	0.54	0.15	0.59	0.11	-2.38	0.02	-0.98	0.33
1029.3	0.66	0.16	0.72	0.25	0.56	0.13	0.62	0.08	-2.57	0.01	-1.13	0.26
1059.46	0.67	0.13	0.75	0.26	0.56	0.12	0.64	0.08	-2.65	0.01	-1.21	0.23
1090.51	0.68	0.12	0.76	0.26	0.55	0.12	0.64	0.12	-2.57	0.01	-1.06	0.29
1122.46	0.68	0.11	0.77	0.29	0.55	0.11	0.64	0.14	-2.19	0.03	-1.13	0.26
1155.35	0.68	0.11	0.76	0.31	0.54	0.10	0.64	0.14	-2.34	0.02	-1.13	0.26
1189.21	0.68	0.13	0.74	0.32	0.53	0.09	0.65	0.13	-2.42	0.02	-1.13	0.26
1224.05	0.69	0.15	0.72	0.31	0.53	0.09	0.65	0.11	-1.89	0.06	-0.98	0.33

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
1259.92	0.69	0.16	0.69	0.29	0.53	0.10	0.63	0.11	-2.12	0.03	-0.76	0.45
1296.84	0.68	0.18	0.67	0.27	0.54	0.10	0.61	0.12	-2.04	0.04	-0.76	0.45
1334.84	0.68	0.18	0.65	0.23	0.52	0.09	0.59	0.11	-2.04	0.04	-1.29	0.20
1373.95	0.68	0.18	0.64	0.21	0.53	0.11	0.59	0.14	-2.19	0.03	-1.63	0.10
1414.21	0.66	0.19	0.62	0.21	0.53	0.11	0.58	0.23	-2.27	0.02	-1.44	0.15
1455.65	0.65	0.2	0.62	0.21	0.53	0.15	0.58	0.29	-2.19	0.03	-1.29	0.20
1498.31	0.64	0.19	0.63	0.2	0.54	0.20	0.57	0.31	-2.34	0.02	-1.51	0.13
1542.21	0.62	0.19	0.63	0.2	0.54	0.31	0.57	0.32	-1.89	0.06	-1.59	0.11
1587.4	0.62	0.19	0.64	0.2	0.54	0.40	0.58	0.31	-1.74	0.08	-1.66	0.10
1633.92	0.62	0.19	0.64	0.2	0.54	0.45	0.58	0.28	-1.66	0.10	-1.51	0.13
1681.79	0.62	0.18	0.65	0.19	0.54	0.52	0.59	0.25	-1.82	0.07	-1.82	0.07
1731.07	0.62	0.17	0.64	0.18	0.52	0.59	0.58	0.24	-1.66	0.10	-1.82	0.07
1781.8	0.62	0.16	0.64	0.17	0.51	0.62	0.56	0.26	-1.66	0.10	-1.59	0.11
1834.01	0.62	0.14	0.64	0.15	0.50	0.63	0.54	0.30	-1.74	0.08	-1.51	0.13
1887.75	0.62	0.12	0.64	0.13	0.49	0.67	0.53	0.32	-1.66	0.10	-1.51	0.13

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
1943.06	0.62	0.11	0.62	0.14	0.49	0.64	0.51	0.35	-1.85	0.06	-1.44	0.15
2000	0.61	0.13	0.61	0.17	0.48	0.56	0.50	0.35	-1.89	0.06	-1.51	0.13
2058.6	0.61	0.15	0.61	0.2	0.48	0.47	0.49	0.34	-2.35	0.02	-1.66	0.10
2118.93	0.6	0.17	0.61	0.21	0.47	0.42	0.48	0.32	-2.42	0.02	-1.66	0.10
2181.02	0.59	0.19	0.61	0.21	0.46	0.33	0.48	0.30	-2.42	0.02	-1.59	0.11
2244.92	0.59	0.2	0.61	0.21	0.46	0.25	0.48	0.28	-2.53	0.01	-1.66	0.10
2310.71	0.58	0.21	0.62	0.22	0.49	0.23	0.51	0.27	-2.57	0.01	-1.66	0.10
2378.41	0.57	0.22	0.62	0.21	0.50	0.22	0.53	0.23	-2.12	0.03	-1.66	0.10
2448.11	0.56	0.22	0.62	0.21	0.48	0.25	0.53	0.20	-2.04	0.04	-1.51	0.13
2519.84	0.55	0.22	0.62	0.21	0.46	0.23	0.55	0.19	-2.12	0.03	-1.44	0.15
2593.68	0.55	0.22	0.62	0.2	0.45	0.24	0.55	0.20	-2.04	0.04	-1.36	0.17
2669.68	0.56	0.22	0.62	0.19	0.44	0.24	0.54	0.19	-2.04	0.04	-1.36	0.17
2747.91	0.57	0.2	0.62	0.18	0.44	0.22	0.55	0.19	-1.97	0.05	-1.36	0.17
2828.43	0.58	0.19	0.62	0.17	0.43	0.22	0.57	0.21	-1.89	0.06	-1.59	0.11
2911.31	0.58	0.2	0.62	0.16	0.44	0.23	0.59	0.23	-1.66	0.10	-1.25	0.21

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
2996.61	0.56	0.22	0.62	0.15	0.44	0.24	0.61	0.25	-1.36	0.17	-0.83	0.41
3084.42	0.54	0.24	0.62	0.14	0.44	0.24	0.64	0.26	-0.87	0.38	-0.83	0.41
3174.8	0.52	0.25	0.61	0.15	0.45	0.23	0.65	0.30	-0.45	0.65	-0.45	0.65
3267.83	0.51	0.24	0.58	0.16	0.46	0.27	0.65	0.36	-0.38	0.71	-0.08	0.94
3363.59	0.49	0.23	0.55	0.2	0.47	0.33	0.64	0.42	-0.23	0.82	-0.30	0.76
3462.15	0.44	0.25	0.52	0.24	0.47	0.39	0.62	0.45	-0.08	0.94	-0.27	0.79
3563.59	0.39	0.24	0.49	0.28	0.47	0.44	0.60	0.44	-0.38	0.71	-0.53	0.60
3668.02	0.36	0.24	0.46	0.29	0.46	0.47	0.60	0.44	-0.61	0.55	-0.91	0.36
3775.5	0.34	0.27	0.44	0.29	0.45	0.48	0.60	0.43	-0.68	0.50	-0.91	0.36
3886.13	0.33	0.32	0.42	0.3	0.44	0.46	0.59	0.42	-0.76	0.45	-0.91	0.36
4000	0.31	0.35	0.4	0.29	0.43	0.41	0.56	0.39	-1.29	0.20	-0.98	0.33
4117.21	0.29	0.35	0.39	0.26	0.44	0.42	0.53	0.37	-1.44	0.15	-0.91	0.36
4237.85	0.27	0.31	0.37	0.23	0.46	0.42	0.50	0.37	-1.59	0.11	-1.21	0.23
4362.03	0.27	0.28	0.36	0.2	0.48	0.43	0.48	0.37	-1.74	0.08	-1.25	0.21
4489.85	0.27	0.25	0.34	0.18	0.48	0.44	0.46	0.40	-1.74	0.08	-1.36	0.17

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
4621.41	0.27	0.23	0.33	0.17	0.49	0.45	0.44	0.44	-1.97	0.05	-1.44	0.15
4756.83	0.26	0.2	0.31	0.17	0.50	0.49	0.42	0.50	-1.97	0.05	-1.36	0.17
4896.21	0.24	0.18	0.29	0.17	0.51	0.52	0.40	0.54	-1.97	0.05	-1.44	0.15
5039.68	0.23	0.16	0.27	0.16	0.51	0.55	0.38	0.56	-2.12	0.03	-1.51	0.13
5187.36	0.23	0.15	0.25	0.15	0.51	0.56	0.36	0.56	-2.12	0.03	-1.66	0.10
5339.36	0.21	0.14	0.23	0.16	0.49	0.55	0.34	0.54	-1.97	0.05	-1.59	0.11
5495.81	0.21	0.14	0.22	0.16	0.48	0.52	0.32	0.50	-1.97	0.05	-1.44	0.15
5656.85	0.21	0.14	0.22	0.13	0.47	0.51	0.30	0.47	-1.97	0.05	-1.36	0.17
5822.61	0.2	0.12	0.25	0.13	0.46	0.49	0.29	0.43	-1.93	0.05	-1.21	0.23
5993.23	0.2	0.13	0.26	0.16	0.46	0.47	0.28	0.40	-1.97	0.05	-1.06	0.29
6168.84	0.2	0.14	0.27	0.2	0.45	0.44	0.27	0.37	-1.89	0.06	-0.83	0.41
6349.6	0.2	0.16	0.27	0.23	0.44	0.41	0.26	0.34	-2.04	0.04	-0.76	0.45
6535.66	0.2	0.19	0.26	0.26	0.43	0.38	0.26	0.32	-1.93	0.05	-0.61	0.55
6727.17	0.2	0.24	0.26	0.27	0.42	0.33	0.25	0.29	-1.85	0.06	-0.53	0.60
6924.29	0.2	0.29	0.26	0.27	0.41	0.27	0.26	0.28	-1.74	0.08	-0.53	0.60

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Frequency (in Hz)	VMHIR Ears		VMHIL Ears		VMNIR Ears		VMNIL Ears		VMHIR Ears Vs VMNIR Ears		VMHIL Ears Vs VMNIL Ears	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Z- value	P-value	Z- value	P-value
7127.19	0.2	0.35	0.27	0.28	0.40	0.24	0.27	0.27	-1.36	0.17	-0.68	0.50
7336.03	0.2	0.42	0.29	0.3	0.36	0.22	0.30	0.24	-1.29	0.20	-0.38	0.71
7550.99	0.2	0.44	0.35	0.33	0.36	0.24	0.30	0.27	-1.06	0.29	-0.08	0.94
7772.26	0.21	0.45	0.41	0.36	0.34	0.30	0.31	0.35	-0.87	0.38	-0.08	0.94
8000	0.22	0.45	0.42	0.37	0.32	0.33	0.32	0.35	-0.91	0.36	-0.08	0.94

Note: IQR- Interquartile Range; ‘VMHIR Ears’: right ears of the Vestibular Migraine group with high IFAR; ‘VMNIR Ears’: right ears of the Vestibular Migraine group with normal IFAR; ‘VMHIL Ears’: left ears of the Vestibular Migraine group with high IFAR; ‘VMNIL Ears’: left ears of the Vestibular Migraine group with normal IFAR.

Appendix 8
Ethical consideration

All India Institute of Speech and Hearing
(An autonomous Institute under the
Ministry of Health and Family Welfare, Govt. of India)
Center of Excellence - Assessed & Accredited by NAAC with 'A' Grade
ISO 9001:2015 Implemented Institute
Manasagangothri, Mysuru-570006

ಅಖಿಲ ಭಾರತ ವಾಕ್ ಮತ್ತು ಶ್ರವಣ ಸಂಸ್ಥೆ
ಮಾನಸಗಂಗೋತ್ರಿ, ಮೈಸೂರು–570006
अखिल भारतीय वाक् श्रवण संस्थान
मानसगंगोत्री, मैसूरु - 570 006

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.35/2025-26 **Date: 06.01.2026**

Title of the Dissertation	: Comparison Of Wide Band Tympanometry Between Individuals With Meniere's Disease And Vestibular Migraine
Name of the Investigator	: Mr. Saroj Kumar Sutar
Guide	: Dr. Niraj Kumar Singh
Co-Guide (if any)	: Nil
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 vent of the proposal is not approved, a statement of reasons for the same must be indicated)	: **APPROVED**
Advice & suggestions (if any)	: NIL

Signature & Name of the Member Secretary-IRB
Dr. Animesh Barman
Professor of Audiology
All India Institute of Speech and Hearing, Mysore-570006

सदस्य सचिव / Member Secretary
संस्थान समीक्षा बोर्ड / Institutional Review Board
अखिल भारतीय वाक् श्रवण संस्थान
All India Institute of Speech and Hearing
मानसगंगोत्री / Manasagangothri
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