EVALUATION OF PERIPHERAL VESTIBULAR DISORDER AMONG ELDERLY PATIENTS AT THE TERTIARY HOSPITAL

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LIST OF SYMBOLS

N	Number of participant
X2	Chi square
Za	Confident interval
%	Percentage
P_0	Proportion of peripheral vestibular disorder without presbycusis
P_1	Proportion of peripheral vestibular disorder with presbycusis

LIST OF ABBREVIATIONS

PTA	Pure tone audiometry
ORL	Otorhinolaryngology
VHIT	Video head impulse test
BPPV	Benign paroxysmal positional vertigo
MVSS	Malay version vertigo symptoms scale
IPS	Institut Pengajian Siswazah
USM	Universiti Sains Malaysia

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PENILAIAN GANGGUAN DISFUNGSI VESTIBULAR DALAM KALANGAN PESAKIT BERUMUR DI HOSPITAL TERTIARI

ABSTRAK

Kajian ini bertujuan untuk menentukan prevalen disfungsi vestibular di kalangan warga tua Malaysia dan kaitannya dengan presbycusis, umur dan lain lain risiko. Kajian ini dijalankan di Klinik Otorinolaringologi (ORL), Hospital Universiti Sains Malaysia. Warga tua berumur 60 tahun dan keatas yang mendapatkan rawatan di klinik ORL samaada yang mempunyai presbycusis atau tidak dan memenuhi kriteria inklusif dan eksklusif di ambil untuk menyertai kajian ini. Seramai 135 sampel kajian diambil dan sumber maklumat dalam kajian ini termasuk borang soal selidik (Malay Version Vertigo Symptoms Scale), ujian talaan bunyi tulen (pure tone audiometry) dan ujian rakaman video vestibular (Video Head Impulse Test (vHIT). Hasil kajian menunjukkan prevalen bagi disfungsi vestibular dengan Presbycusis didalam kajian ini adalah sebanyak 46.7 peratus dari keseluruhan sampel. Umur pertengahan atau median dalam kajian ini adalah 68 tahun (60–86 tahun). Hasil kajian juga menunjukkan terdapat korelasi yang signifikan antara disfungsi vestibular dengan presbycusis dan simptom tinnitus dan juga simptom kepeningan (vertigo dizziness). Namun hasil kajian menunjukkan tiada korelasi yang signifikan antara presbycusis dan abnormal vHIT (p=.938). Bagi prevalen disfungsi vestibular tanpa presbyscusis, hasil kajian menunjukkan 53.3% dan tiada kolerasi yang signifikan dengan simptom tinnitus dan kepeningan. Kesimpulan dari kajian ini mendapati disfungsi vestibular berkait rapat dengan penuaan dan Presbycusis. Kajian yang lebih terperinci diperlukan untuk melihat keberkesanan ujian disfungsi vestibular kepada warga tua.

EVALUATION OF PERIPHERAL VESTIBULAR DISORDER AMONG ELDERLY PATIENTS AT THE TERTIARY HOSPITAL

ABSTRACT

This study aimed to determine the prevalence of vestibular dysfunction in the Malaysian elderly and its association with presbycusis, age and other associated risk factors. A cross-sectional study was undertaken in a tertiary otorhinolaryngology department and the community. Adults aged 60 years and above who attended ORL clinic at Hospital Universiti Sains Malaysia (HUSM) with or without presbycusis were invited to participate. A total number of 135 elderly were recruited in this study. The main outcome measures including Malay Version Vertigo Symptoms Scale, pure tone audiometry and vestibular assessment were obtained using a Video Head Impulse Test (vHIT). The prevalence of vestibular dysfunction with presbycusis in the study population of 135 elderly participants was 46.7 per cent. The median age was 68 years (range, 60–86 years). The findings showed that there was significant association between presbycusis and tinnitus and also between presbycusis and dizziness. However, the results showed that there was no significant association between presbycusis and vHIT (p = .938). The prevalence among non-prebycusis with vestibular dysfunction was 53.3 %, and the findings showed that there was no significant correlation between vestibular dysfunction without presbycusis with tinnitus and vertigo dizziness. In conclusion, vestibular dysfunction is significantly associated with ageing and presbycusis. Further research into the benefits of additional screening for vestibular dysfunction in elderly presbycusis patients is warranted.

CHAPTER 1

INTRODUCTION

1.0 Introduction

The first chapter will discuss the background of the study, problem statement, research objectives, research questions, the rationale and significance of the study

1.1 Background of the study

A population-based study found that 24% of people over the age of 72 reported having dizziness, making imbalance and dizziness prevalent problems for older people (Tinetti, Williams and Gill, 2000). Age-related imbalance and falls can result from a variety of disorders, including cardiovascular diseases, neurodegenerative diseases, vision loss, loss of proprioception, basal ganglia disease, reduced exercise activity, and vitamin deficiencies. In the elderly population, peripheral vertigo represented 39% of all instances of vertigo that were seen in neurotology clinics. Other diagnoses included BPPV, Ménière's disease, vestibular neuritis, vascular aetiology, and malignancies (Graafmans et al., 1996). Peripheral vestibular impairment is the primary or secondary cause of dizziness in most investigations on the condition in the elderly (Davis, 1994; Lawson et al., 1999; Neuhauser et al., 2001). There is a correlation between getting older and having more dizziness; in a Swedish study, dizziness was prevalent in 50% of people over the age of 85, compared to 36% of women and 29% of men who were dizzy at age 70 (Jonsson et al., 2004). The daily activities of older persons are often impacted by dizziness. In the same survey, vertigo or dizziness was reported as a hindrance by 8% of all 70 year-olds to performing daily activities, but a far larger 26% of the elderly agreed. Thus, it is very important to conduct a study to look for presence of

peripheral vestibular disease in an old age patient. This was the foundation and background for this study to be conducted.

Due to the link to falls and accidents, balance issues in older individuals are a significant public health problem. A major injury that is unrelated to the fall mechanism occurs in 10 to 15% of these falls, such as a broken bone or a serious head injury (WHO, 2007; WHO, 2021). According to estimates, over 95% of hip fractures in older persons originate from falling, and older patients who come with hip fractures as a result of falls were considerably more likely than age-matched controls to have aberrant results when the vestibuloocular reflex is tested (Scott, Wagar and Elliot, 2010). 30% of older individuals who live in the community experience a fall at least once annually, while 10% to 20% experience two or more falls (WHO, 2021). In Malaysia, study by Ashari et. al. (2021) found that 31.4% elderly participants experienced at least one fall in the 12 months prior, with 14.3% reporting two falls in that time frame.

In a retrospective research, individuals over 70 years old who complained of imbalance at a university neurotology clinic had considerably rotational vestibular testing reveals reduced mean vestibular function (Neuhauser et al., 2005). In comparison to 8 of the age-matched controls, 15 out of the 26 patients in that study reported having one or more falls the year prior. 40% of patients who presented to the emergency department (ED) with unexplained falls experienced vertigo, and 80% of patients exhibited symptoms of vestibular dysfunction.

Presbycusis is the age-related, progressive loss of hearing ability (NIH, 2023). It shares characteristics with other ageing processes in that it affects people at varying ages and rates. Cochlear hair cells typically deteriorate with age, starting at the basal end of the organ of Corti. As a result, hearing steadily declines and

eventually disappears, first for the highest audible frequencies (about 20,000 hertz) and then progressively for sounds with lower frequencies (Marin, Cerna and Barral, 2022). Age-related microvascular alterations in the inner ear have been linked to research that suggests they may mediate neurodegenerative changes. Presbycusis, the most typical type of hearing loss caused by age, is also possibly the most common neurological disease of ageing. Presbycusis and peripheral vestibular dysfunction are clearly connected, as evidenced by age-related spiral ligament degradation, atrophy expressed by lower fibrocytic density, and areas of acellularity in archival human temporal bones from older adults (Paplou, Schubert and Pyott, 2021).

1.2 Problem statement

Malaysia is one of many nations in the globe with an ageing population. According to current estimates, 7% of Malaysia's population, or 3.5 million people, are over 65 (DOSM, 2020). In 2030, there will be 5.8 million people in Malaysia who are 60 years of age or older, or nearly 15% of the country's population, according to the Department of Statistics Malaysia (DOSM). Presbycusis and vestibular dysfunction are two age-related disorders that are on the rise in this condition.

Vestibular dysfunction is known as a failure of the vestibular organs. Even when it is not symptomatic, vestibular dysfunction in the elderly contributes to falls. According to studies conducted in the United States, vestibular dysfunction affects up to 35.4 percent of persons aged 40 and above (Agrawal et al., 2009). Presbycusis is a complicated, underdiagnosed condition with a complex aetiology. It is the most common sensory impairment in the elderly, and it can have a negative impact on their quality of life and mental health (Miller. 2005). Bilateral high frequency

hearing loss is the outcome of the progressive loss of hair cells in the cochlea that characterises presbycusis (White, Helwany & Peterson, 2022). According to estimates, 1.57 billion individuals worldwide suffer from hearing loss as they age, which is the third most common source of years spent living with a disability. This statistic accounts for one in five people worldwide in the Global Burden of Disease Study 2019 (GBD, 2019). It was ranked first among sensory disorders. The study predicts that 2.45 billion people will have hearing loss by 2050, a 56.1% increase from the 2019 estimates.

Presbycusis, also known as age-related sensorineural hearing loss, is a complex condition that causes a gradual loss of auditory ability (Caspary et al., 2008). A considerably high number of these patients with presbycusis or age-related sensorineural hearing loss also experience dizziness and related vestibular symptoms. Study has shown that many people with presbycusis also experience tinnitus, which is the perception of a sound in one or both ears or in the head in the absence of an external sound source (Kang et al., 2021). Despite their differences, the vestibular and auditory systems function similarly. There is therefore a close relationship between their functions. When one is stimulated, the other also goes through changes (Abd Es Salam, 2018).

A correlation between the dysfunction of the cochlea and vestibular systems in the elderly has not been reported with strong supporting data. There is also a lack of knowledge regarding the medical causes of vestibular dysfunction.

The purpose of the current study was to estimate the prevalence of presbycusis and vestibular dysfunction in elderly Kelantanese. No previous studies have been reported on the prevalence of presbycusis in the elderly of the Kelantan population. The relationship between vestibular dysfunction and presbycusis was

also examined since anatomically connected components, such as the vestibulocochlear nerve, serve both vestibular and auditory functions.

1.3 Rationale and justification of the study

The suggested study satisfies the criteria for originality and significant knowledge contribution in a variety of ways:

1. Prediction of requirement for vestibular assessment in every presbycusis patient
2. Initiate early vestibular rehabilitation for patient with presbycusis to prevent complication

1.4 Research questions

1. What is the prevalence of peripheral vestibular disorder among elderly patients with presbycusis?
2. What is the prevalence of peripheral vestibular disorder among elderly with non presbycusis ?
3. Is there any association between the peripheral vestibular disorder and presbycusis?

1.5 Hypotheses

There is a significant association of presbycusis with peripheral vestibular dysfunction among elderly patient

1.6 Research objectives

1.6.1 General objective

To study peripheral vestibular disorder among elderly patients

1.6.2 Specific objectives

1. To determine the prevalence of peripheral vestibular disorder among elderly patient with presbycusis
2. To determine the prevalence of peripheral vestibular disorder among elderly with non presbycusis
3. To determine the association between presbycusis with peripheral vestibular disorder among elderly patient

1.7 Benefits of the study

This study will benefit the community by providing new information regarding prevalence of peripheral vestibular disorder in elderly patient. It is also important to determine the association peripheral vestibular disorder in elderly patient with presbycusis, therefore we can establish our local database.

CHAPTER 2

LITERATURE REVIEW

2.1 Vestibular dysfunction and Presbycusis

Vestibular dysfunction is an imbalance in the body's balance system brought on by damage to the vestibular system of the inner ear, the processing centres of the central nervous system, or both. A focused physical examination will frequently aid to distinguish between peripheral and central vestibular dysfunction because their symptoms may resemble one another. Typical symptoms include vertigo, nausea, vomiting, intolerance to head motion, uneven gait, and postural instability. Nystagmus is frequently also clinically evident (Newman-Toker et al., 2008). Benign paroxysmal positional vertigo (BPPV), the most prevalent kind of acute peripheral vestibular dysfunction (Palmeri & Kumar, 2022), typically manifests promptly and may represent up to one-third of vertigo presentations to dizziness clinics (Neuhauser, 2001). Each of these symptoms has a different prevalence, and no one sign is pathognomonic for vestibular dysfunction. The grouping of these symptoms into one set of signs and symptoms should increase clinical suspicion of vestibular impairment. The best way to distinguish between peripheral and central vestibular dysfunction is through a thorough history and physical examination (Choi & Kim, 2017; Seemungal, 2007).

Presbycusis is a term for bilateral hearing loss brought on by ageing. Presbycusis literally translates to "old hearing" or "older hearing (Miller, 2005). In the entire world, it is the most typical cause of hearing loss. It starts to show up around the age of 60 and worsens gradually, but there is evidence that certain stresses can quicken the process. Presbycusis affects various auditory system organs anatomically. Age-related alterations in hair cells, the stria vascularis, and afferent

spiral ganglion neurons are the main causes (Schuknecht & Gacek, 1993). The causes of presbycusis are multifaceted. Other contributing factors include aging-related deterioration leading to physiologic and anatomical changes, hormones, genetics, exposure to loud noises or ototoxic substances, a history of ear infections, the presence of specific systemic disorders, and exposure to loud noises or ototoxic substances (Wang & Puel, 2020; Frisina & Frisina, 2013). Regarding the primary impacted structures and functions, presbycusis can be further classified. Some claim that subdividing presbycusis has limited therapeutic value because there is frequently mixed pathology present and there is little change in approach or therapy (Wang & Puel, 2020; Lee, 2013). Presbycusis is currently classified into six groups: sensory, neural, strial, mechanical, mixed, and undetermined (Schuknecht & Gacek, 1993).

- Sensory presbycusis causes a distinctive high-frequency hearing loss by causing the loss of receptor hair cells at the basal portion of the cochlea (Wang & Puel, 2020)
- Striatal presbycusis was referred as stria vascularis cell degeneration. These cells are necessary to keep the endolymph's proper ion composition in order to produce the endocochlear potential for signal transmission (Salt, Melichar & Thalmann, 1987). Occasionally known as metabolic presbycusis.
- Neural presbycusis was characterized by the the loss of spiral ganglion neurons as well as cochlear nerve fibres.
- Cochlear conductive mechanical presbycusis: brought on by structural modifications to the cochlear duct Along with this, there is a certain audiogram pattern (Schuknecht & Gacek, 1993).
- Mixed presbycusis: pathologic alterations in more than one of the aforementioned structures.

- Indeterminate presbycusis was referred as incremental modifications to the aforementioned structures (Schuknecht & Gacek, 1993).

A complex condition called presbycusis causes a gradual decline in auditory function (Caspary et al, 2008). Many of these patients who have hearing loss due to ageing also have vertigo and other vestibular symptoms. Despite their differences, the vestibular and auditory systems function similarly. There is therefore a close relationship between their functions. When one is aroused, the other also goes through changes (Kurtarana et al., 2016).

Presbycusis is assumed to have a complex aetiology, while some of its causes are still unclear. There are both inherent causes (such as genetics) and extrinsic factors including exposure to noise, using drugs, smoking, and various co-morbidities (Gates & Mills, 2005). The main causes include changes in hair cells brought on by ageing, the stria vascularis, and afferent spiral ganglion neurons. Presbycusis is an instance of sensorineural hearing loss in which the inner ear or neurologic circuits that connect to the auditory brain are involved (Zahnert, 2011).

Worldwide, by the age of 75, practically all persons above the age of 90 are affected by presbycusis (Wattamwar et al., 2017). By 2025, the World Health Organization projects that more than 500 million adults 60 and older will have significant age-related hearing loss (Sprinzl & Riechelmann, 2010).

2.2 Prevalence of vestibular dysfunction and Presbycusis worldwide

Numerous population-based studies have estimated the prevalence of vestibular disorders. These studies can be divided into three groups: those that assessed vertigo, those that used balance tests to assess vestibular function, those that

took into account the prevalence of certain vestibular illnesses, and those that used dizziness as the primary symptom of vestibular dysfunction.

An accurate representation of the population was polled in Germany regarding vestibular vertigo, which was defined as positional vertigo (vertigo or dizziness brought on by changes in head position, such as lying down or turning in bed), rotational vertigo (illusion of self-motion or object motion), or recurrent vertigo with nausea and oscillopsia or imbalance. To validate the questionnaire, neurotologic interviews with 1003 subjects were conducted. The study found that among adults, vestibular vertigo has a lifetime prevalence of 7.4%, a 1-year prevalence of 4.9%, and a 1-year incidence of 1.4%. Elderly people were 3 times more likely to experience vestibular vertigo, while women were approximately 3 times more likely to experience it (Neuhauser, 2007; Neuhauser, 2005).

In the 216 study participants, vestibular dysfunction and presbyacusis were present in 30.1% of cases. This is based on research conducted in 2016 at Young Loo Lin University in Singapore by Tan et al. (2016). The aimed of the study was to ascertain the prevalence of vestibular dysfunction in Singaporean seniors and the relationship between presbycusis, ageing, and other risk factors.

Koo et al. (2015) investigated the prevalence of vertigo and vestibular dysfunction in the Korean population across the country to determine the contributing factors. The findings revealed that vertigo and vestibular dysfunction were respectively prevalent in Korea at 16.70% and 1.84%. Vestibular dysfunction was linked to ageing, a history of vertigo, and hearing loss. According to the Korean Ministry of Health and Welfare statistics annual report for 2000, hearing impairment was experienced by 7.2% of the population aged 65 in 2000 and was forecasted to reach 13.2% by 2020. The investigation of auditory function in the Korean

population supported the hypothesis that ageing is associated with high-frequency hearing loss (Kim et al., 2020). For the purpose of accurately diagnosing hearing impairment in senior patients, a threshold of 6 kHz should be used. Presbycusis patients should receive appropriate aural rehabilitation that entails active high-frequency management.

Vertigo and dizziness are prevalent symptoms in elderly adults with frequent falls, according to a study by Fetter et al (2000). The vestibular system is most likely malfunctioning when there is vertigo (illusion of movement). On the other hand, the perception of rotational movement points to a semicircular canal lesion, while the perception of linear movement points to an issue with the otolith organs (Fetter et al., 2000). According to a 2013 study by Iwasaki and Yamasoba, elderly people frequently experience imbalance and dizziness, which are creating public health concerns because they greatly increase their risk of falling. Despite the fact that there are many different factors that can induce vertigo in older persons, the most typical cause is peripheral vestibular impairment. The two most common forms of vestibular dysfunction in the elderly are Meniere's disease and benign paroxysmal positional vertigo. Aging causes a decline in every aspect related to maintaining postural stability. Age-related deterioration in peripheral vestibular function has been quantified using the vestibulo-ocular reflex with rotational testing and the vestibulo-collic reflex with testing of vestibular evoked myogenic potentials. There is evidence that the ageing process leads to a drop in vestibular function as well as a reduction in vestibular neurons and hair cells. Although the exact cause of age-related cellular loss in the vestibular endorgan is unknown, genetic susceptibility and the cumulative effects of oxidative stress are likely to both play significant roles. Due to the multifaceted nature of the causes of dizziness in older adults, each person's aetiology

should be taken into account when managing the disease. Both unilateral and bilateral vestibular impairment can be successfully treated with vestibular rehabilitation. Various prosthetic devices have also been created to help older people with their postural balance. Future research should concentrate on novel medical interventions such caloric restriction or mitochondrial antioxidants, which have been effective in lowering age-related hearing loss, even though there are currently no pharmacological treatments for addressing age-related vestibular dysfunction.

According to estimates, two-thirds of Americans aged 70 or older are thought to be affected by presbycusis, the most frequent cause of hearing loss globally (Tu & Friedman, 2018). Since each investigator uses a different set of criteria to define hearing loss, it is challenging to pinpoint the precise prevalence. Numerous attempts have been made to estimate the prevalence of hearing loss in large cohort groups, including participants from studies like the National Health and Nutrition Examination Survey (NHANES) and the Health Ageing and Body Composition (ABC) research (Yamasoba et al., 2013). The prevalence of hearing loss nearly doubles every subsequent decade from the ages of 12 to 79, according to data from NHANES, which includes a cross-section of non-institutionalized Americans (Lin, Niparko & Ferrucci, 2011). The Health ABC research participants with hearing loss were most likely to be white men, then white women, black men, and black women. (Helzner et al., 2005).

2.3 Elderly and Presbycusis

Presbyvertigo and presbycusis are two of the most prevalent disorders in the elderly and can have a devastating impact on their quality of life (Iwasaki & Yamasoba, 2015). The connection between presbyvertigo and presbycusis, however,

is not strongly supported by the literature. One study compared the quality of life, the frequency of comorbidities, and the variations in chronic medication in a sample of patients with presbycusis who had vertigo. The audiometry's pure tone average (PTA) was evaluated as well. The Dizziness Handicap Inventory Score (DHI) and the Hearing Handicap Inventory for the Elderly (HHIE) were also assessed. The incidence peaked between 71 and 80 years of age. In general practises where general physical examinations were undertaken, a prospective case-control study found that 18% of dizzy patients over 60 years old had a peripheral vestibular condition (Lawson et al., 1999). However, a prospective study conducted in a neurology clinic and involving extensive neuro-otological testing discovered that in 56% of patients over 50, peripheral vestibular dysfunction was the main cause of dizziness (Davis, 1994). Similarly, depending on the clinical examination conducted, cerebrovascular causes range from 0% to 70% (Lawson et al., 1999; Colledge et al., 1996) and psychiatric causes range from 0% to 40% in older patients with dizziness (Lawson et al., 1999; Davis, 1994; Sloane, Hartman and Mitchell, 1994). Many studies stated that 20% to 30% of elderly persons with dizziness had no precise diagnosis that may explain their symptoms (Lawson et al., 1999; Katsarkas, 1994; Belal and Gorig, 1986). Presbystasis is the name Belal and Glorig (1986) coined to refer to this kind of age-related issue that is not associated with a recognised disease (Colledge et al., 1996). However, other studies found that 18% to 85% of elderly adults with dizziness had several diagnoses (Lawson et al., 1999). The approach put forth by Tinetti, Williams, and Gill (2000) contends that dizziness in the elderly should be regarded as a complicated geriatric syndrome with a range of symptoms and causes, such as problems with the heart (cardiovascular), the brain (neurologic), the senses (sensory), the mind (psychological), and medications.

In primary care settings, vertigo and dizziness are common and incapacitating symptoms, although 40–80% of patients have no known cause (Bird, Beynon & Prevost, 1998; Kroenke & Price, 1993). 40% of those who have dizziness or vertigo find that it interferes with daily tasks, which can have major personal and societal consequences. An epidemiological examination is necessary due to the considerable impact of dizziness and vertigo (Neuhauser, Radtke & von Brevern, 2008). Rarely has a general population epidemiological survey of vertigo and vestibular dysfunction been conducted. It has been sta ted that the prevalence of dizziness over a year ranges from 6.1% to 27%(Mueller, 2014). The prevalence of vestibular dysfunction has also been reported with wide variability: 3.1–4.9% for 1 year prevalence (Neuhauser et al., 2008; Lai, Wang & Chuang, 2011) and 35.4% in a cross-sectional study from the USA.

From childhood until old age, BPPV is the most frequent cause of vertigo and wooziness, peaking at roughly 60 years (Baloh, Honrubia, Jacobson, 1987). Numerous studies have shown an increase in the prevalence of BPPV among the elderly (Neuhauser, 2007; von Breven et al., 2001). According to a recent epidemiologic study based on a sizable cross-sectional neurotologic survey, the prevalence of BPPV in individuals older than 60 years was observed to be about seven times greater than that in adults between 18 and 39 years old. But it was estimated that 1.6% of people had BPPV in a year and 2.4% of people had it in their lifetime (von Brevern et al., 2001). BPPV is commonly identified by the presence of episodic vertigo brought on by changes in head position and concurrent nystagmus observed during the positioning manoeuvre (Brandt and Steddin, 1993); physical therapy is an effective treatment for it (Eply, 1992). Johkura et al. (2008) found that almost 50% of elderly patients with chronic vertigo who visited an emergency

hospital had signs of horizontal canal BPPV, including extremely weak horizontal, direction-changing apogeotropic nystagmus. Daily postural exercises for BPPV helped some of these patients' problems. According to the findings, the reported prevalence of BPPV in elderly adults may be understated. It is believed that tiny particles stuck in the semicircular canals are the source of BPPV (Brandt and Steddin, 1993; Parnes and McClure, 1992). Otoconia that has been released from the utricula maculae makes up the majority of these particles. Numerous studies have shown that a significant amount of the utricular macula's otoconia deteriorate and fracture in the elderly (Igarashi et al., 1993; Johnsson and Hawkins, 1992). The higher occurrence of BPPV in older adults may be due to morphological changes in the otolith organs.

In neuro-otological clinics, 3% to 11% of diagnosed cases of dizziness are caused by Meniere's illness. In the general population, it is expected to have an annual incidence rate and point prevalence of 15/100,000 and 218/100,000, respectively (Wladislavosky-Waserman et al., 1980). Meniere's disease is typically thought to affect middle-aged adults (Ballester et al., 2002; Shojaku et al., 2005). But according to a significant case series research by Ballester et al. (2002), 15% of Meniere's disease patients are beyond the age of 65. In that study, 40% of instances involved reactivating long-standing Meniere's illness, whereas 60% involved developing the condition for the first time. The study also claimed that older adults experienced drop attacks more frequently than the general population. Drop attacks are brought on by abrupt otolithic malfunction. According to a multi-center study carried out in Japan found that more patients over 60 have developed Meniere's disease from scratch over the past 30 years (Shojaku et al., 2009).

Vestibular neuritis accounts for 3% to 10% of diagnoses in oto-neurological clinics (Neuhauser et al., 2001; Guilamy et al., 2004). There is a dearth of epidemiological information on vestibular neuritis. According to a Japanese epidemiological survey, the peak age distribution for vestibular neuritis was between 40 and 50 years old, and the prevalence of the condition was 3.5 per 100,000 people (Sekitani et al., 1993). Within a few weeks of the disease's inception, vestibular compensation eliminates the majority of the symptoms of vestibular neuritis, although 30% to 40% of patients still experience chronic, persistent dizziness (Godemann et al., 2005; Okinaka et al., 1993). Additionally, aging-related declines in vision, proprioceptive systems, and the intact side of the peripheral vestibular organs may result in a breakdown of vestibular compensation.

In a latest study done by Kang et al (2023) stated that sleep duration is associated with hearing loss, especially presbycusis. The prevalence of presbycusis in South Korean adults was 62.1%, of which 61.4% showed moderate to severe presbycusis. The incidence of moderate-to-severe, but not mild, presbycusis showed a significant positive correlation with sleep duration.

2.4 Assessment tools for vestibular dysfunction and Presbycusis

There are now new vestibular failure patterns that can be identified from the development of the video head impulse test (vHIT), which evaluates all three semicircular canals in both labyrinths.

2.4.1 Video Head Impulse Testing (vHIT)

The head impulse test (HIT) (Halmagyi & Curthoys, 1988) and its applications to measure vestibular function utilising the search coil, video recording, and image-processing techniques have led to the creation of a high-speed video-oculography system known as the video head impulse test (vHIT) (ICS Impulse device, Otometrics A/S, Taastrup, Denmark) (Weber et al., 2009; Macdougall et al., 2009).

The Barany society reported the video head impulse test (vHIT) in Paris in 2004. Ulmer and Chays subsequently explained the test in great detail the following year (Ulmer & Chays, 2005). A novel test called the video head impulse test (vHIT) may measure each semicircular canal's vestibulo-ocular reflex (VOR) gain and detect overt and covert saccades.

There have not been many studies looking into how ageing affects vHIT and vestibular autorotation testing (VAT). The VAT was developed in the early 1980s in an effort to provide a cost-effective solution to assess vestibular function over the broad range of head movement frequencies that occur during functional activities. During the VAT, the subject performs active horizontal or vertical head movements over an increasing frequency range from 0.5 to 5.9 Hz for 18 seconds while visually fixating a one square centimeter target placed six feet away (O Leary, 2002). Less than a dozen studies on these subjects have been published since 2009, with the majority appearing in the last few years. The majority of these articles have focused on the application of vHIT, particularly in pathologic populations and in the establishment of normative response ranges in healthy, young, and middle-aged people. The use of vHIT in the ageing population has only been covered in a few reports. The effectiveness of using vHIT in the elderly was examined by Agrawal and colleagues (Agrawal, Schubert and Migliaccio, 2014). According to the study, there are six older people's responses to the horizontal VOR increase that are

strongly positively correlated (aged 71 to 80) who live in their communities and were determined using video-oculography vHIT methods and sclera search coil techniques. These findings allowed Agrawal and colleagues to draw the logical and accurate conclusion that recognising corrective eye movements and recording VOR gain in older individuals can be accomplished utilising video-oculography during vHIT. In spite of the fact that video-oculography vHIT methods were not used in an investigation of the normal results of 50 healthy older adults, Davalos-Bichara and Agrawal (2014) argued for the use of vHIT in light of their findings that patients 80 years and older who underwent clinical head thrust testing accounts 64% of people have impaired horizontal semicircular canals (70 to 95 years of age). The latest study by Agrawal and colleagues in 2023 found that novel remote head impulse test (rHIT), rHIT may be better suited for detecting more severe vestibular deficiencies. As determined by the vHIT, 2 patients had normal bilateral VOR gains, 6 with unilateral vestibular hypofunction, and 2 with bilateral vestibular hypofunction. The correlation between the rHIT and vHIT gains was 0.73 ($p < .001$). The rHIT exhibited an absolute accuracy of 75.0%, sensitivity of 70.0%, and specificity of 80.0%. When ears had a vHIT VOR gain less than 0.40, the rHIT exhibited 100.0% accuracy. Conversely, 60.0% of deficient ears with vHIT VOR gains greater than 0.40 were incorrectly categorized by the rHIT. In a study conducted by Matino-Soler et al. (2014) using normative vHIT data from 10 distinct decades of life, 212 people aged 5 to 95 were used comprising of 110 women and 102 men. No matter the head impulse velocity, the study found consistent VOR gain beyond age 70. The researchers found that older age groups consistently experienced lower VOR gain than younger age groups, but only at higher head impulse velocities. However, for people older than 90, a significant decline in VOR gain was seen for all head impulse

velocities. Overall, Matino-Soler et al. (2014) found that as head impulse velocity and age increased, there was a significant drop in VOR gain, with a higher proportion of people over 70 years old experiencing refixation saccades. The effects of ageing on vHIT were also discussed by Li et al. (2014). 109 elderly vHIT patients between the ages of 26 and 92 were examined in the study. The connection between vHIT VOR increase and age was nonlinear, according to Li and colleagues. Between the ages of 26 and 79, the gain was found to be comparatively steady, but beyond that, a considerable fall was observed. In particular, Li and colleagues found that individuals over 80 had a roughly eight-fold lower chance of achieving a vHIT VOR increase higher than 0.80. A reduction in vHIT VOR gain was not associated with any major risk variables for cardiovascular disease, with the exception of age.

Uncertainty exists over the application of vHIT as a novel and perhaps efficient tool for detecting age-related VOR alterations in older individuals. However, these data continue to refute the notion that geriatric dizziness and a loss in vestibular physiologic evidence are causally related. The lack of a link between vHIT measurements and self-reported dizzy handicap is actually highlighted by recent research by McCaslin et al. (2014). The effects of ageing on VAT have only been the subject of a few research. In 14 healthy older people (aged 74 to 91), From 0.5 to 5 Hz of autorotation in the yaw plane, Hirvonen et al. (1997) evaluated VOR gain and phase. The study indicated that above 2 Hz, VOR gain and phase lead increased in comparison to 125 healthy working-age adults. Additionally, the study found that older adults lost a lot of data above 2 Hz, which was linked to physical restrictions (such stiff necks) or psychological restraints that hindered more frequent head shaking (which was thought to cause more dizziness due to serious retinal slip). A more recent study using autorotations between 1 and 3 Hz was conducted by Hsieh,

Lin, and Lee (2014) on 53 healthy adults between the ages of 25 and 75. The results of the study is contradictory with the data found by Hirnoven et al. (1997) which is mentioned a significant decline in mean eye velocity relative to head velocity beginning at age 55. Despite the limited number of study on VAT and ageing, it is not surprising that the two studies' conclusions diverge given that it is known that VAT has a high test variance and low test-retest reliability (Guyot and Psillas, 1997; Blatt et al., 2008).

CHAPTER 3

METHODOLOGY

3.1 Introduction

The approach for the current study, which attempts to determine the prevalence of peripheral vestibular dysfunction in people with presbycusis, is described in this chapter. A quantitative methodology is employed in this study. This chapter elaborates on the specifics of the research design, sampling, ethical conduct, pilot test, data gathering technique and procedure, and analysis. The chapter will then be summarised.

3.2 Study setting and study population

A cross-sectional study was performed in the Otorhinolaryngology (ENT) Department of a Malaysian tertiary teaching hospital at the Health Campus, Universiti Sains Malaysia. The study protocol was approved by the university ethics committee. Participants were elderly persons aged 60 years and above who could walk and had attended the Otorhinolaryngology (ORL) clinic between February and December 2020. Among the exclusion criteria of the participants for this study are the inability to stand or sit steadily on one's own, a history of neurological disorders or signs of neurological deficits, active, spinal or musculoskeletal disorders, uncontrolled cardiovascular and/or respiratory conditions, acute illness, mental disorders, uncorrected ocular disorders, intoxication, and use of medications with neuromuscular, ocular, vestibular, or ontological suppressive or toxic effects.

3.2.1 Sample size

Objective 1: To determine the prevalence of peripheral vestibular disorder in elderly patient with presbycusis

$$N = \left(\frac{Z\alpha}{\Delta}\right)^2 P(1-P)$$

Zα = 1.96

P = 40% (percentage or prevalence of vestibular dysfunction in presbycusis patient) (tan et al., 2016)

Δ = *precision = 7.5%*

n = **144**

Considering 10% drop-out rate= **158**

Objective 2: To determine the prevalence of peripheral vestibular disorder in elderly patient with non presbycusis.

$$N = \left(\frac{Z\alpha}{\Delta}\right)^2 P(1-P)$$

Zα = 1.96

P = 35% (percentage or prevalence of vestibular function among elderly patient) (gabor et al,2013)

Δ = *precision = 7.5%*

n = **182**

Considering 10% drop-out rate= **200**

Objective 3: To determine the association between peripheral vestibular disorder and elderly with presbycusis.

Confidence level = 95%

Power = 80%

m = 1

odd ratio 2.5

significant level is set at $p<0.05$

Based on two proportion formula in Power and Sample Size Program (PS):

$P_{1=}$ proportion of peripheral vascular disorder with presbycusis

$P_{0=}$ proportion of peripheral vascular disorder without presbycusis

n = **144**

Considering 10% drop-out rate = **158**

3.3 Sample recruitment

All individuals provided demographic information, general medical and ENT histories, and a history of falls. The major findings included the evaluation of vestibular function utilising the Video Head Impulse Test and pure tone audiometry (VHIT).

The Malay Version Vertigo Symptoms Scale (MVSS), a standard questionnaire, was used to achieve the aim of this study. The objective of this test was to differentiate between vestibular vertigo and non-vestibular dizziness by using both conventional and open-ended questions. To avoid using suggestive questions, firstly, the participant's own words were used to describe their experiences with dizziness or vertigo. This was done before conducting the interview for assessment. Participants were questioned regarding the forms, duration, causes, and past diagnoses of their dizziness. Interviews were conducted by the researcher. Demographic data, a medical history, a history of falls (falls that resulted in a hospital stay or limited mobility for at least three days), and a history of vertigo or tinnitus complaints in the ENT were also gathered as additional data. Upon patient consent, pure tone audiometry (PTA) was performed to measure the patient's hearing

threshold between 125 and 8000 Hz. Subjects then categorized into two groups: presbycusis or non-presbycusis. This audiometry test lasted about 45 minutes. All patients underwent VHIT.

3.3.1 Inclusion criteria

Patients aged above 60 years old

3.3.2 Exclusion criteria

1. History of ear surgery
2. Cholesteatoma
3. Underlying neurological disease stroke or parkinsion
4. Known diagnosis of noise induce hearing loss
5. Known history of receiving systemic ototoxic drugs
6. Any patients with history of otitis media, mastoiditis and temporal bone fracture.

3.3.3 Withdrawal criteria

The decision to take part in this study was made voluntarily. Subject is not required to participate in the study and is free to stop at any moment without incurring any costs or losing any advantages.