Risk factors for dizziness in people aged over 50: cross-sectional and prospective data analysis

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RISK FACTORS for DIZZINESS in PEOPLE AGED OVER 50: CROSS-SECTIONAL and PROSPECTIVE DATA ANALYSIS

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Abstract

Dizziness is a common health concern for older adults affecting up to 30% of people aged 65 years and over. Dizziness can be debilitating and significantly diminish quality of life and lead to depression, falls and functional disability. With population ageing, the burden of dizziness on health care systems will increase significantly. It is important, therefore, to better understand factors that predispose older people to this condition.

The aims of this thesis were to identify key medical, physical and psychological factors associated with dizziness in two complementary cohorts: (1) 339 community-dwellers aged 75 years and older recruited through the electoral roll; (2) 313 people aged 50 years and older who experienced at least one significant dizziness episode in the past year. Participants completed questionnaires related to dizziness episodes, demographics, health and psychological well being. They also underwent assessments of sensorimotor function, vestibular function, dynamic balance, gait and cardiovascular health. Relationships between dizziness and these factors were then explored in both samples.

In the general sample, the prevalence of dizziness was 23%. Within this group, participants who reported dizziness in the past year were more likely to also report back pain, motion sickness and fear of falling, than those who did not report any dizziness. Amongst the dizziness sufferers (cohort 2), a multivariate logistic regression analysis revealed that higher physiological fall risk, unilateral vestibular hypofunction and increased anxiety were significantly and independently associated with increased dizziness frequency. 28% of dizziness sufferers reported moderate to severe handicap. Cardiovascular medication use, increased anxiety, a positive test of Benign Paroxysmal Positional Vertigo, and higher physiological fall

risk were identified as significant and independent predictors of higher dizziness handicap in multivariate logistic regression analysis. These findings indicate that dizziness is prevalent in older people, with many people with this condition experiencing significant handicap. Dizziness handicap was associated with both physical and psychological impairments. While it is difficult to establish causal relationships among all the associated factors, the significant associations uncovered provide insight into how dizziness affects older people, and information for possible strategies for treating this condition.

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Chapter 1

Introduction

1.1 Study Rationale and Aims

Dizziness is one the most common medical complaints experienced by older adults each year (1-4). With the ageing of the population dizziness, imbalance and falls will become more common. Dizziness can lead to significant limitations in daily functioning and is associated with poor self-rated health, number of chronic medical conditions, cognitive impairment, depression and polypharmacy (2, 5).

There is currently no uniform method of testing and diagnosing the elderly patient with dizziness. Due to this fact, many patients who present to medical clinics are admitted to hospital and/or undergo unnecessary and expensive medical testing (6, 7). In addition, many patients who present to a primary care facility with a complaint of dizziness leave without an accurate diagnosis. General practitioners often record the symptom of dizziness as a diagnosis rather than specifying the aetiology of the symptom (5).

Dizziness has been found to be a major risk factor for falls. Individuals who report dizziness are more than twice as likely to have a fall than their non-dizzy counterparts (8, 9). These falls can lead to injuries, high healthcare costs and death. With the ageing of the population, the burden of dizziness on society, health care systems, and individuals will increase significantly. The accurate diagnosis and treatment of people with dizziness is therefore of great importance to public health in Australia.

This thesis includes findings from two large studies of community dwelling middle-aged and older adults that incorporated a comprehensive battery of assessments. The primary aims were to assess the impact of dizziness on multiple domains of the participant's life and explore

relationships between dizziness and other medical, physiological and psychological factors. By doing so, it is proposed dizziness "profiles" may be developed based on physical, psychological and medical contributors to dizziness handicap and frequency. This in turn may inform optimal strategies for the management of dizziness in this population.

The major aims of the study are:

1. To determine the incidence of recent dizziness in a sample of community dwelling older people
2. To determine medical, physical, psychological and lifestyle factors associated with dizziness in a sample of community dwelling older people
3. To document the frequency of dizziness and degree of handicap in middle-aged and older adults who report significant dizziness in the past year.
4. To determine medical, physical, psychological and lifestyle factors associated with dizziness frequency and handicap in middle-aged and older adults who report significant dizziness in the past year.
5. To suggest a treatment model for the optimal management of dizziness for middle-aged and older adults with significant dizziness.

1.2 Thesis Outline

Chapter 1 provides the study overview and presents the aims of the thesis.

Chapter 2 presents a review of the literature to provide a background to the included studies. It describes the definition of dizziness and presents the estimates of the prevalence of this condition in older people. Chapter 2 also synthesises the available information on factors considered to be causes of dizziness including vestibular dysfunction, psychological disorders,

cardiovascular and sensorimotor impairment. This includes a description of the anatomy and physiology of the vestibular system to highlight the multiple vestibular causes of dizziness in the aged population. Finally Chapter 2 outlines the detrimental effects dizziness can have on quality of life and related factors in older people.

Chapter 3 presents cross-sectional findings from a sample of 334 community-dwelling people aged 75 years recruited from the electoral roll. It describes the methodology as well as the results pertaining to physiological, psychological and vestibular factors associated with recent dizziness in the cohort.

Chapter 4 presents findings of the 313 participants enrolled in the dizziness randomised controlled trial aged 50 years and older who experienced at least one significant dizziness episode in the past year. This chapter then presents results pertaining to physiological, psychological and vestibular factors associated with dizziness frequency and handicap in the cohort.

Chapter 5 presents the summary and general discussion of my study findings. The strengths, limitations and directions for future research are discussed and a treatment model for the optimal management of dizziness for middle-aged and older adults with significant dizziness is presented.

Chapter 2

Background: Dizziness in older people

The first part of this chapter introduces the concept of dizziness and its different sub-types. Then, relevant literature focused on the prevalence of dizziness in the aged population is presented. The chapter ends by providing a summary of the literature with respect to major risk factors associated with dizziness.

2.1 Definition and types of dizziness

Dizziness Definition

Dizziness has no exact definition. Rather it is a term used to describe a variety of different sensations. From vague lightheadedness to vigorous rotational vertigo, the term can have very different meanings depending on the cause of the symptom and the individual. It is commonly accepted that dizziness refers to altered sense of ones relationship to space (10).

Types of Dizziness

Traditionally, dizziness has been divided into four main subtypes which are defined thereafter; presyncope, disequilibrium, vertigo and psychogenic dizziness (11, 12).

Presyncope

This type of dizziness is commonly associated with disorders of the cardiovascular system and is described as a sense of lightheadedness. People with postural hypotension typically experience dizziness with rapid changes in posture including transferring from sitting to standing. The resultant reduction in blood pressure results in transient confusion, lightheadedness and/or syncope lasting from a few seconds to several minutes after changing postures (13).

Disequilibrium

Disequilibrium refers to a sensation of being 'off-balance'. Equilibrium is maintained by coordinated input from the visual, vestibular and somatosensory systems. Each system provides

the brain with different information about the position of the body in space. The visual system allows us to see where our head and body are relative to the world around us. Our proprioceptive system utilises special sensors sensitive to stretch or pressure in our muscles, tendons, and joints. The stretch of these sensors helps the brain to know how our feet and legs are positioned relative to the ground. The vestibular system in the inner ear comprises balance organs, which tell the brain about the movements and position of the head relative to gravity. Deterioration of one or more of these can cause dizziness and imbalance.

Degeneration or loss of function in any of the above systems can lead to disequilibrium. With ageing, the vestibular labyrinth shows reduction in the number of sensory epithelial cells and vestibular nerve fibres (14). Cardiovascular conditions including; atherosclerosis, hypertension and chronic hypotension may impact the vestibular pathways in the central nervous system (15). Eye conditions associated with ageing include; glaucoma, cataracts and macular degeneration, all of which can affect balance. Contributing factors to the degeneration of the visual system also include; age related decline in depth perception, contrast sensitivity and visual acuity. Finally, degeneration of the somatosensory system occurs as both peripheral motor and sensory nerve conduction velocities slow with advancing age. This contributes to changes in peripheral sensation as well as reaction time (16).

People who report disequilibrium have been shown to have poorer balance as well as a greater frequency of falls (17). In a study of 740 patients aged over 65 who presented to an otologic medical facility with dizziness, 79% were diagnosed as having 'disequilibrium of ageing' after review of the patients medical history, evaluation of available electronystagmography, audiometry and histopathology reports. In the remaining 21%, specific causes of dizziness were found including; unilateral and bilateral Meniere's Disease, acoustic neuroma, vestibular neuritis and cervical vertigo (15).

Vertigo

Vertigo is defined as the illusion of rotation perceived as either the individual or their environment spinning. This illusion of movement is caused by asymmetry of neural activity between the left and right vestibular nuclei which arises as a result of damage to one or more of the structures that make up the vestibular system. This mismatch between inputs from the visual, vestibular and somatosensory systems leads to the illusion of movement (18). Vertigo is often associated with loss of balance or unsteadiness. The incidence of many vestibular disorders including the most common – Benign Paroxysmal Positional Vertigo (BPPV) increases with age (19, 20). Vestibular vertigo has been found to account for 52% of new-onset dizziness in those aged 60 years or older (21).

Psychogenic Dizziness

Panic attacks, especially with hyperventilation, commonly cause a sense of dizziness which can be described as a disturbance of balance while standing or walking, with momentary illusions of motion (22). The symptoms often have specific triggers including places or specific situations.

Others

Drug toxicity has been found to account for up to 2-10% of dizziness episodes not related to one of the previously mentioned causes (23). Other less common causes of dizziness include; substance abuse, metabolic abnormalities, electrolyte disturbances, infections, anaemia, Parkinsons disease, and seizures (23).

2.2 Dizziness in the older population

Dizziness is a difficult diagnostic problem in the aged population as it has many potential aetiologies. The prevalence of dizziness in older adults has been found to be between 10 and 35% (1-3, 24). There is an increase in the odds of suffering from dizziness with

increasing age over 65 years (2). The prevalence in this age group has been found to be significantly higher in women than in men (25).

Many studies have assessed large cohorts of community dwelling older adults to create a profile of the older adult with dizziness (1-3, 12, 15, 25-31). Few, however, have used a comprehensive battery of assessments (32-34), to evaluate multiple body systems that contribute to orientation and balance. Studies vary in their reporting of the most frequent causes and consequences of dizziness in older adults. A systematic review of dizziness in the community and primary care settings found that in elderly dizzy populations, cardiovascular disease (57%), peripheral vestibular disease (14%) and psychiatric illness (10%) were the most common predisposing conditions for dizziness (35). With increasing age, the prevalence of dizziness is paralleled with many diseases (stroke, cardiovascular disease, diabetes, Parkinson's disease and other vascular and neurological conditions) that can induce this condition. In the elderly population, there is often more than one contributing cause of dizziness (28, 36). In a study of 417 patients aged between 65 and 95, 44% were found to have two or more dizziness subtypes (24).

In a meta analysis of 74 studies assessing fall risk factors in community dwelling older people, dizziness and vertigo were found to be a significant risk factor for falls (37). Along with increased risk of falls, dizziness in the elderly population was also associated with depression and anxiety as well as physical activity limitations (37). Elderly people with dizziness have lower scores than their non-dizzy counterparts on all eight of the 36-Item Short Form Health Survey parameters (38) – this includes measures of functional health, wellbeing and physical and mental health. This population has also been shown to have poorer health-rated quality of life (3, 4, 37, 39) and higher prevalence of symptoms like worry, fatigue and poor concentration (34).

Recent studies have examined the correlates of dizziness in community dwelling older adults. A study by Moraes et al in 2013 (26) investigated a cohort of 395 community-dwelling people. They found depressive symptoms, perceived fatigue, recurring falls and excessive drowsiness were independent predictors of dizziness. Kammerlind et al in 2013 (30) also studied a similar cohort of 305 people aged 75 to 90 years of age. This study divided the cohort into those with no or mild versus moderate to severe dizziness for analysis. They found those with substantial dizziness were less physically active, performed worse in physical assessments, reported more fear of falling, depression and anxiety, had worse quality of life, took more antihypertensive drugs and total number of drugs, suffered more falls and had higher incidence of stroke/TIA and heart disease. This study, however, did not include detailed assessment of vestibular function or gait and physical characteristics. They also studied an older cohort of adults.

The most common specific diagnosis found amongst those with dizziness in the aged population is Benign Paroxysmal Positional Vertigo (BPPV) (26%) (40). There are significant variations in reported prevalence of these causes between studies. This occurs as a result of the different populations investigated and the different criteria used in assigning diagnoses.

2.3 Major risk factors for dizziness

2.3.1 Vestibular dysfunction

Peripheral vestibular disease has been found to account for 14-39% of dizziness in older adults (24, 31, 32).

Vestibular system anatomy

The vestibular system is made up of three components: the peripheral sensory apparatus, a central processor, and a mechanism for motor output (figure 2.1) (41). The

peripheral sensory apparatus includes the vestibular end organs – the semi circular canals and otolith organs (figure 2.2).

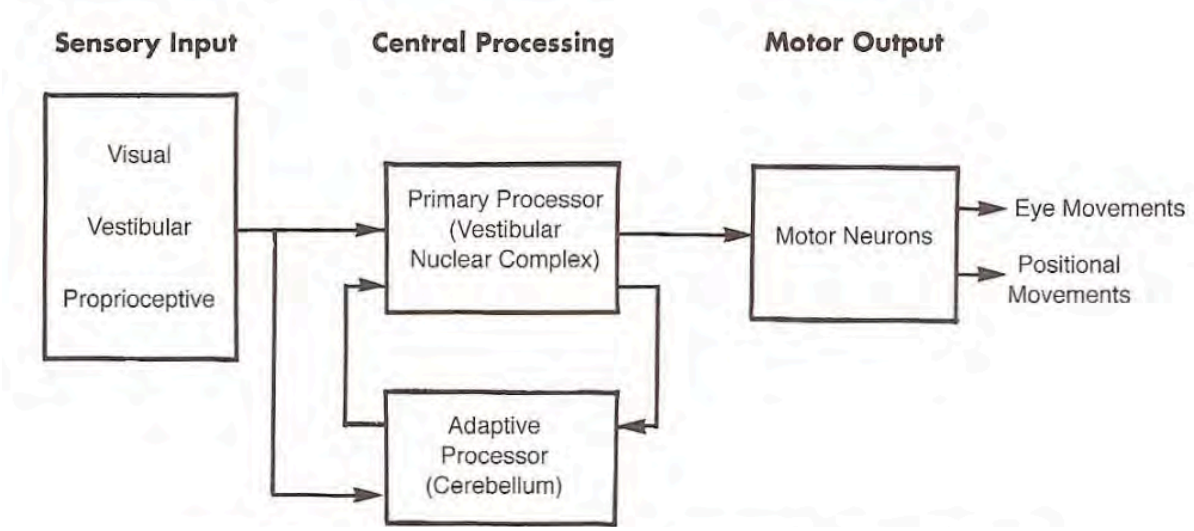

Figure 2.1 Block diagram illustrating the organisation of the vestibular system (Published in Herdman et al 2007 (49))

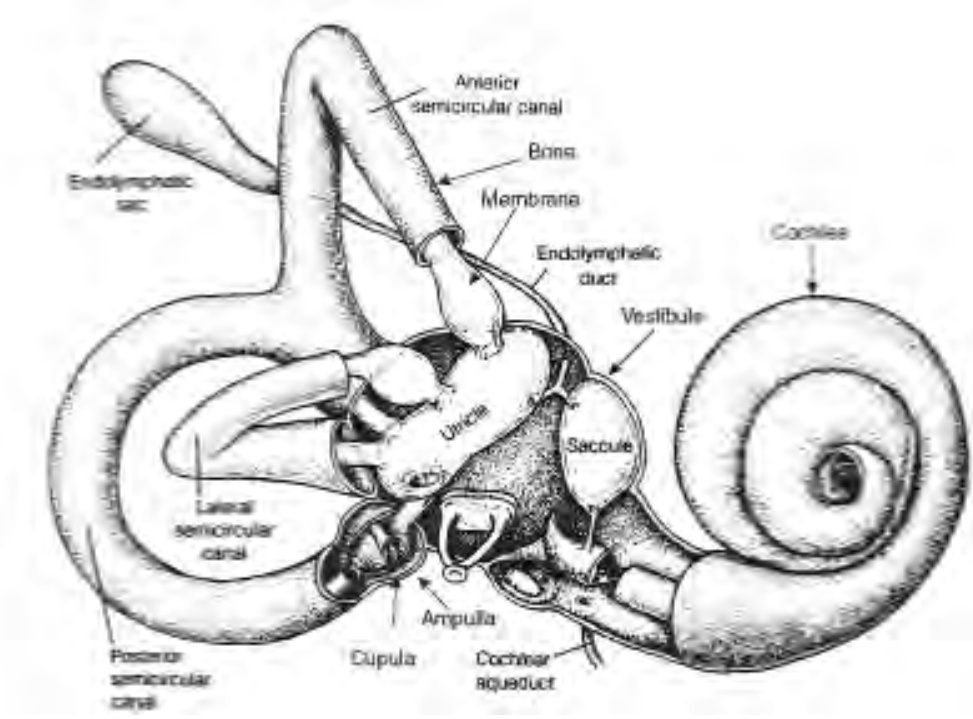

Figure 2.2 Vestibular labyrinth (Published in Herdman et al 2007 (49))

These structures send information about angular and linear head acceleration to the ipsilateral vestibular nuclear complex in the brain stem and cerebellum. Within these parts of the brain, second order neuronal pathways form the vestibulo-ocular reflex, vestibulospinal tracts and the vestibulo-cerebellar tracts and combines them with other sensory information from vision and proprioceptive sensors to determine head and body orientation (42, 43).

The vestibulo-ocular reflex

The vestibulo-ocular reflex (VOR) is responsible for maintaining a stable image on the retina by initiating compensatory eye movements during involuntary head rotations (44), i.e. the eyes move in the opposite direction to the head. A rotation of the head is detected by the semicircular canals, which triggers an inhibitory signal to the extra-ocular muscles on one side and an excitatory signal to these muscles on the other side. The result is a compensatory movement of the eyes. The otolith organs detect linear head acceleration and drive the translational VOR. There is integration of inputs from multiple brain areas including: vestibular afferents from organs on both sides, oculomotor areas of the brainstem, the cerebellum, and various higher level centres involved in vision and proprioception (45).

It has been suggested that in normal older people, a reduction in the VOR most likely occurs due to changes in the central nervous system motor pathways. Neuronal degeneration with aging in the; primary visual cortex, frontal and parietal visual motor centres, subcortical nuclei, brain stem nuclei and the cerebellum could explain reduction in visual-vestibular responses and resultant dizziness and imbalance (46).

The vestibulo-collic reflex

The vestibulo-collic reflex (VCR) is a set of automatic responses of the neck muscles to activation of the vestibular system. The purpose of this reflex is to stabilise the head during body movements. Vestibulocollic responses as measured by responses to high intensity clicks,

forehead taps and short duration galvanic stimulation decrease significantly in individuals aged over 60 years (47).

The vestibulo-spinal reflex

The purpose of the vestibulo-spinal reflex (VSR) is to stabilize the body. Changes in the orientation of the head are detected by the semicircular canals and otolith organs. This information is relayed to the vestibular nuclei via the vestibulocochlear nerve. The vestibular nuclei then relay motor commands through the vestibulospinal tract. The function of these motor commands is to alter muscle tone and change the position of the limbs and head with the goal of maintaining balance (47).

The cervico-collic reflex

This reflex also aims to stabilse the head during body movements. The trigger for the cervico-collic reflex is a stretch reflex caused by changes in neck position. The reflex causes neck muscle activation designed to oppose rotation of the head with respect to the body (48).

Vestibular disorders

Benign Paroxysmal Positional Vertigo

Benign Paroxysmal Positional Vertigo (BPPV) is considered to be the most common disorder of the peripheral vestibular system. This condition is characterised by brief episodes of vertigo – typically less than 30 seconds. The vertigo is triggered by changes in head position. In BPPV, calcium carbonate crystals called otoconia dislodge from the utricular macula and migrate to one of the semi-circular canals - most commonly, the posterior semicircular canal. When the head is reoriented relative to gravity, the gravity-dependent movement of the otoconia causes abnormal displacement of the endolymph within the affected canal. This in turn causes deflection of the cupula and results in nystagmus and vertigo (49). Each canal affected by the dislodged otoconia will generate its own signature pattern of nystagmus. Canalithiasis refers

to the free-floating otoconia within the semicircular canal. Cupulolithiasis refers to the variant of BPPV where the otoconia adhere to the cupula.

Blood supply to the inner ear is supplied by the vertebrobasilar system, primarily the anterior inferior cerebellar artery, which branches into the anterior vestibular artery. One hypothesis is that with increased age, decreased anterior vestibular artery blood supply causes BPPV (50). Its anatomical location within the inner ear makes the labyrinth particularly vulnerable to ischemia (51).

It is thought by age 70, 30% of elderly individuals have experienced BPPV at least once (18). BPPV accounts for 8-10% of individuals with moderate or severe dizziness/vertigo (18, 19). Another study has reported the lifetime prevalence of BPPV as 2.4% with the condition most commonly affecting the aged population (19). The number of women with BPPV has been found to be up to 1.5 times greater than that of men (52). Elderly people with BPPV have been found to report imbalance and dizziness as their primary presenting symptom as opposed to vertigo. As well as reporting imbalance, they also have significantly impaired static and dynamic balance (53).

Vestibular Neuritis

This condition affects the vestibulocochlear nerve (cranial nerve eight). The most common causes of vestibular neuritis are viral infections, such as influenza or the herpes viruses. In 2012, the incidence of vestibular neuritis was found to be an average of 10.3/100,000 in the 60-89 year old age group (54). This study used laboratory testing to confirm the diagnosis (54). The most common symptoms are nystagmus, prolonged rotational vertigo, often associated with nausea and vomiting. Infections that cause vestibular neuritis can resolve without treatment within days to a few weeks. The acute phase of vestibular neuritis with its intense vertigo usually resolves over a few days. Balance continues to improve over the

following weeks due to a combination of partial inner ear recovery and central nervous system compensation. If the inner ear is permanently damaged by the infection and the brain does not fully compensate for this damage, the individual can experience ongoing dizziness, fatigue and disequilibrium. Unilateral vestibular loss has been found to be as high as 30% in people aged over 65 (55). A significant relationship has been found between vestibular impairment and increased falls in the elderly. As well as experiencing more falls, these individuals also have poorer scores for subjective measures including balance confidence and anxiety (56).

Labyrinthitis

An inflammatory condition affecting the labyrinth, labyrinthitis is usually caused by viral and less commonly bacterial infections. The inflammation can also be caused by autoimmune disorders and head trauma. Symptoms include vertigo, nausea and imbalance. Other symptoms include tinnitus and hearing loss. Studies investigating incidence of labyrinthitis in elderly populations are lacking. One study found of 240 participants with BPPV, 15% had concurrent viral labyrinthitis (57).

Meniere's Disease

Meniere's disease is characterized by intermittent attacks of vertigo that last for minutes to hours, fluctuating hearing loss, aural fullness, and tinnitus. The condition accounts for 3% to 11% of diagnosed dizziness in neuro-otological clinics (14). It has been proposed that potential causes of the disease include viral infections and immune system related mechanisms (58). Meniere's disease can be difficult to diagnose as in the early stages of the condition as not all symptoms may be present. Meniere's disease typically affects people aged between 20 and 60 however individuals as old as 96 have been diagnosed and treated for the condition (59).

In order for the inner ear to function properly, the fluid within the labyrinth needs to retain a certain volume, pressure and chemical composition. Disruption to the properties of this

fluid including inadequate endolymph drainage causes a backlog of the fluid known as endolymphatic hydrops or Meniere's Disease (14). It is thought that Meniere's disease is caused by a combination of genetic and lifestyle factors. Despite the age of diagnosis, the symptoms of Meniere's disease can continue well into older age.

Vestibular Migraine

With a mean age of onset of 38 years for women and 42 years for men (60), vestibular migraine is not the most common vestibular disorder affecting the elderly population. Female-to-male prevalence of vestibular migraine is about 5:1 (60). There is an overlap in symptoms of both Meniere's disease and vestibular migraine. Vestibular migraine affects more than 1% of the general population and about 10% of patients in dizziness clinics (61).

Mal de debarquement

Mal de Debarquement, literally translates to "sickness of disembarkment". It refers to the phantom sense of self-motion which occurs after prolonged exposure to passive motion. The development syndrome typically follows extended boat travel, but can also occur following extended train, air and land travel (62). No study has yet investigated the incidence of this condition in the elderly or general populations. Symptoms usually include vague unsteadiness and disequilibrium or sensations of rocking and swaying, but not rotational vertigo. Mal de debarquement is distinguished from motion sickness because subjects are usually symptom free during periods of motion for example when driving or on a boat. It is commonly accepted that symptoms of mal de debarquement persist for at least one month as opposed to post-motion vertigo which lasts less than a month (63). Mal de debarquement most commonly affects those in their late 30's and 40's however age of onset in the literature ranges from 15 to 77 Women are more commonly affected by this condition than men (63).

Vertebrobasilar artery insufficiency

Another less common cause of vestibular dizziness in the aged population is vertebrobasilar artery insufficiency. The vertebral and basilar arteries carry blood to the inner ear, vestibulo-cochlear nerve and brainstem. Vertebrobasilar artery insufficiency occurs when blood flow through the vertebral and basilar arteries is restricted. Dizziness associated with vertebrobasilar artery insufficiency often occurs suddenly and can be accompanied by nausea, vomiting, headache and blurred vision. Posterior circulation ischaemia very rarely causes isolated vertigo attacks and when it does the attacks are brief and frequent (64).

2.3.2 Cardiovascular conditions associated with dizziness

Previous studies have found cardiovascular disease to be the most common major contributory cause of dizziness in older people (57-70%) (24, 31, 32). Most common conditions include; orthostatic hypotension and atrial fibrillation.

Orthostatic Hypotension

Orthostatic hypotension (OH) is a significant problem affecting the aged population. The features of OH include a sudden fall in systolic blood pressure of at least 20mmHg or diastolic blood pressure of at least 10mmHg (65). On standing, blood pools in the veins of the legs and trunk causing a transient decrease in venous return. This in turn reduces cardiac output and blood pressure. In response to this drop in blood pressure, baroreceptors in the aortic arch and carotid bodies activate autonomic reflexes to return BP to normal.

The main cause of OH in the elderly is decreased baroreceptor sensitivity (66). Other common causes include; the use of certain medications, hypovolemia and peripheral neuropathy. The symptoms of OH include; dizziness, lightheadedness, weakness and syncope (67). In a study of 521 community dwelling adults aged 75 and over, the frequency of OH was found to be 30.3% (68). In another study of 63 community dwelling middle and older aged

adults with non-specfic dizziness and a mean age 59, 44% had symptoms of dizziness upon tilt table testing (69).

Age-related changes to the cardiovascular system include changes to the heart and blood vessels within the body. Orthostatic dizziness is a common syndrome characterized by a feeling of lightheadedness when moving from lying to sitting or sitting to standing. Orthostatic dizziness is believed to be one of the most common causes of non-vestibular dizziness and is believed to arise from OH (70). In a study by Ratke et al in 2011, orthostatic dizziness accounted for 42% of all participants with dizziness and for 55% of non-vestibular dizziness diagnoses. This however was for adults aged 18-89 and a participant was considered dizzy if they answered yes to the question ''Did you ever experience moderate or severe dizziness or vertigo?'' It has been reported 47-51% of those with orthostatic dizziness were found to have OH (65, 71).

Atrial fibrillation

Atrial fibrillation is the most common cardiac arrhythmia. Atrial fibrillation increases in incidence with increasing age with about 70% of those with the condition aged between 65 and 85 (72). Dizziness is a common symptom associated with atrial fibrilation along with breathlessness and heart palpitations. Age-related changes in the left atrium cause irregular beating of the atria and ventricles. This irregular heart rhythm causes insufficient pumping of blood throughout the body including to the brain. This in turn causes dizziness.

2.3.3 Psychogenic Disorders

Clinically significant psychological problems including depression and anxiety occur in as much as 25-37% of elderly patients with dizziness (4, 73). This type of dizziness is typically characterised by lightheadedness or a floating sensation. These symptoms are frequently associated with anxiety, depression and panic disorder (74). A history of psychiatric disorders is

a strong predictor for the development of reactive psychiatric disorders following vestibular dysfunction (50).

It has been proposed that there are various mechanisms by which psychological factors can influence dizziness. The first is an individual's fear and avoidance of activities that have in the past caused dizziness leading to self-imposed activity restriction. This activity restriction deprives the individual of the stimulation necessary to promote central nervous system compensation for peripheral vestibular dysfunction (75).

Furman et al 2001 suggest that the term "psychiatric dizziness" should be reserved for those patients in whom the dizziness is "part of a recognized psychiatric syndrome" and "cannot be explained by vestibular dysfunction" (74). Furman et al in 1997 suggested that the following definition be used to define psychiatric dizziness: "the dizziness occurs exclusively in combination with other symptoms as part of a recognized psychiatric symptom cluster and this symptom cluster is not itself related to vestibular dysfunction." He also identifies the situation in which there is an overlap between psychiatric disorders and vestibular disorders. In these situations, it is suggested that individuals with panic disorder, depressive disorders, or somatoform disorders, are prone to developing psychogenic dizziness (76).

Dizzy patients who report higher levels of anxiety have been found to report greater handicap and recover less quickly (75). Anxiety-related somatic symptoms have been shown to better predict health status of individuals with dizziness than balance tests or vestibular symptomology measures in a study of 101 patients with vertigo (77). Hyperventilation is a common symptom of panic and anxiety syndromes. Studies have shown a relationship between hyperventilation and increased postural sway (82) as well as an interference with somatosensory information from the lower limbs. In patients with pre-existing unilateral vestibular hypofunction, dizziness developed or was enhanced by voluntary hyperventilation

(78). Patients with dizziness caused by hyperventilation have been shown to most commonly describe their symptom as 'lightheadedness' (74). Yardley et al in 1995 showed that in patients with dizziness caused by vestibular dysfunction, anxiety is correlated with an altered VOR and an increase in slow-phase velocity of nystagmus during rotation testing (79).

Recovery from balance disorders can be profoundly influenced by psychological, cognitive, emotional, and behavioral responses to dizziness. Anxiety and/or depressive disorders have been found to be present in 10-22% of individuals aged over 65 presenting to a primary care facility with dizziness (24, 80). As dizziness can be a frightening experience it can lead to panic and avoidance of situations in which dizziness may occur. Anxiety can exacerbate vestibular symptoms, and vestibular dysfunction may result in anxiety (81). Maarsingh et al in 2010 (5) found through a survey of 3,990 older Dutch adults who presented to their family doctor, that dizziness was associated with self-reported depression and anxiety. This study performed a comprehensive assessment of participant's anxiety and depression measures to explore the link between mental health disorders and dizziness in older adults. In this study however, the participants aged 65 years or older, were recruited after consulting their primary care physician for dizziness that had been present for at least 2 weeks. These participants therefore would likely have had significant dizziness in order to have sought medical attention. Self-reported depression and anxiety in this study were therefore associated with significant dizziness.

A study by Teixeira et al in 2016 demonstrated an association between physical exercise, depressive symptoms, dizziness and fall risk in middle-aged and older adults (82). Peluso et al in 2016 (83) also found an increased incidence of depression and anxiety in elderly subjects with dizziness. This study however included only 44 subjects, each with a diagnosed vestibular disorder.

Depressive symptoms have been shown to intensify in the presence of chronic dizziness in the elderly population (4). Individuals presenting to medical clinics with a chief complaint of dizziness have poorer scores on the Beck Depression Inventory than those presenting for other medical concerns (84). Hong et al in 2010 found 10.3% of patients recruited had clinically relevant depression and 66.7% of the patients had anxiety. In this study, patients were included if they were 65 years or over and had complained of dizziness when visiting one of four hospitals included in the study (80). These studies highlight the association between dizziness and anxiety/depression as an important health concern affecting the elderly population.

2.3.4 Sensorimotor Impairment

Sensorimotor function comprises; vision, proprioception, muscle strength in addition to vestibular sense. Age-related reduction in any sensorimotor system may contribute to a general sense of imbalance, and this sense of imbalance may be interpreted as dizziness by some older adults. Aside from vestibular function (already reviewed in a specific sub-section), vision and peripheral sensation are the two other senses which have been specifically investigated in relationship with dizziness.

Vision and dizziness

Lord et al found in a study of 95 residents of a hostel for the aged with a mean age of 83 that measures of vision including visual acuity and contrast sensitivity decreased significantly with increasing age (85). A longitudinal study of 577 men aged over 60 by Gittings and Fozard in 1986 reported that even in the absence of specific visual pathologies, participants exhibited an age-related decline in far visual acuity (86).

In a systematic review by Armstrong et al in 2016, five out of 13 studies found a strong association between poor vision and dizziness (87). In four of the five studies, poor vision and dizziness were self-reported rather than based on objective assessments. This may indicate that

dizziness is associated with the individual's perception of their vision rather than with the presence of a vision disorder.

Peripheral sensation

Another domain of sensorimotor function which has shown reduction in older age is peripheral sensation. In a study of 795 community dwelling patients 65 years of age and older recruited from the practices of family physicians, prevalence of peripheral neuropathy was 26% in participants aged 65-74 and increased to 36% in participants 75-84 and then to 54% in those aged 85 years and over (88). Individuals suffering from diabetes are likely to also present with reduced peripheral sensation or peripheral neuropathy in the lower limbs. Some have examined the relationship between self-reported dizziness and diabetes in older adults. Kammerlind et al in 2016 (30) found an association between dizziness and diabetes in their cohort of older adults aged 75 and older who were found to have significant dizziness. Stevens et al in 2008 (3) found that impaired balance was statistically significantly associated with diabetes in a similar cohort of older adults. This is likely explained by reduction in proprioceptive input from the extremities resulting from peripheral neuropathy secondary to diabetes. In contrast, Dros et al in 2012 found that older adults with dizziness were less likely to have a diagnosis of diabetes and suggested that individuals with diabetes consult their family doctors more and therefore have more attentive medical care than those without (27).

Only one study to date found an association between pain and dizziness. Menant et al 2013 (89) showed an association between back and neck pain in older adults with dizziness and suggested that this may be due to neck pain causing stiff posture and consequently less use of visual cues while walking. Alternatively, they suggested that the dizziness might be due to degradation of vestibulocervical and vestibulospinal reflexes. Neck induced balance disturbances can be caused by several different pathophysiological processes including; vertebrobasilar insufficiency and sensorimotor disturbances from upper cervical spine

structures. Altered connections between the cervical spine and the vestibular system cause a patient with neck pain to be less able to utilise information from the vestibular, somatosensory and visual systems causing "sensory mismatch", imbalance and dizziness (90).

2.4 Summary

In order to maintain balance, the brain uses input from each of the three sensory systems; vision, proprioception and vestibular. Age-related degeneration of these sensory systems and their central connections does not happen in a uniform way across different individuals. For this reason, the presentation of dizziness as a result of ageing is variable from person to person.

In addition, the presence of various physical, cardiovascular and neurological impairments increase in prevalence with increasing age. Many of these impairments not only lead to the development of dizziness but also impact the individual's ability to cope with dizziness. Studies vary in their reporting of the most common contributing cause of dizziness amongst elderly populations. This is largely due to different cohorts studied and different criteria used in assigning diagnoses. It is commonly accepted however that dizziness in the elderly is often a multifactorial problem requiring assessment and treatment of various body systems(3).

Chapter 3

Dizziness in community dwelling older people prevalence and related factors

This study presents the findings of 334 community-dwelling people aged 75 years recruited from the electoral roll. It describes physiological, psychological and vestibular factors associated with recent dizziness in the cohort.

The aims of this study are:

1. To determine the incidence of recent dizziness in a sample of community dwelling older people
2. To determine medical, physical, psychological and lifestyle factors associated with dizziness in a sample of community dwelling older people
3. To document the frequency and degree of handicap in middle-aged and older adults who report significant dizziness in the past year.

3.1 Methods

Characteristics of the sample

A subsample of participants from the Sydney Memory and Ageing Study - a large longitudinal study of cognitive function and ageing (1) was studied. The falls sub study was a cohort study with a one-year prospective falls follow-up. Three hundred and thirty four community-dwelling older people aged between 75 to 94 years (mean age, 83 ± 4 years) including 176 women (53%) volunteered to participate in the fall risk assessment arm of the 4th wave of the study.

Participants were recruited randomly through the electoral roll from two federal electoral areas of Eastern Sydney, Australia. Data were collected between 2011 and 2014. All participants could speak and write in English sufficiently to consent to participate and to complete psychometric tests, were independent in activities of daily living and were able to walk 400 m without assistance. Participants were excluded if they had a previous diagnosis of dementia or developmental disability, psychotic symptoms including a diagnosis of

schizophrenia or bipolar disorder, multiple sclerosis, motor neuron disease, were receiving treatment for cancer other than non-metastasized prostate and skin cancer or if they had medical or psychological conditions that may have prevented them from completing assessments. Participants were also excluded if they had a Mini-mental Statement Examination (MMSE) score of <24, or if they received a diagnosis of dementia after assessment. The study protocol was approved by the Human Research Ethics Committee at the University of New South Wales and informed consent was obtained from all participants.

General health questionnaires

Questionnaire about demographics and health

As part of the baseline assessment, participants completed a questionnaire in which they answered questions about their demographics and physical activity. Demographic data included age and gender. Total hours of physical activity per week was recorded using the validated Incidental and Planned Exercise Questionnaire (26).

Participants then answered questions about their health. They answered 'yes' or 'no' to a comprehensive list of medical conditions and symptoms including the presence of bodily pain and joint problems diagnosed by a medical doctor. Participants were asked if they had experienced an episode of significant dizziness in the past 12 months. Those who reported "yes" were classified as dizzy. The remainder was categorized as non- dizzy.

Participants who had dizziness over the past year, completed further questions on the number of episodes, the average length of the symptoms as well as the timing of the most recent episode. The participants were then asked if they experienced motion sickness and if they were able to read on a bus without feeling nausea, whether they had any eye related conditions or if they wore glasses and which type. A record of medication use including dosage was taken. Cognitive status was assessed using the mini mental state examination (MMSE) (49).

Dizziness Handicap Inventory

Participants who reported experiencing dizziness in the previous twelve months completed the Dizziness Handicap Inventory (DHI). This 25-item self-assessment questionnaire quantifies the functional, emotional and physical effects of dizziness (19). Scores of 0-30 represent mild, 31-60 moderate, and 61-100 severe symptoms (92) The DHI has been shown to have excellent test-retest reliability (20).

Euro Quality of life– 5-item questionnaire (EQ-5D), a measure of health status

The Euro Quality of Life – 5-item questionnaire (EQ-5D) is a generic measure of health status designed to describe and quantify health-related quality of life (23). The EQ-5D measures health status in terms of five dimensions; mobility, self-care, usual activities, pain/discomfort and anxiety/depression. The scores range analysed was the time trade-off derived EQ-5D Weights based on Australian Norms (91).

Cardiovascular Measures

Tilt-table test

Brachial blood pressure (BP) was measured using an electronic sphygmomanometer. After a 5-minute seated rest, three seated brachial BP measurements were made at 1-minute intervals, and the average of these measurements was calculated to provide a measure of resting BP. Supine and tilted BPs were then measured while participants lay on a tilt table. After 5 minutes of lying, three supine brachial BPs were measured at 1-minute intervals, and the last measure was used for the supine BP. The participant was then tilted to 70°, their brachial BP was measured immediately and at 1-minute intervals for up to 10 minutes (until BP stabilized). Orthostatic hypotension was defined as a reduction of 20 mmHg or more in systolic BP (SBP) or 10 mmHg or more in diastolic BP (DBP) within 3 minutes of tilting (12). Delayed OH was defined as a reduction of 20 mmHg or more in SBP or 10 mmHg or more in DBP after 3 minutes or more of tilt-table.

Physical function assessments

The Physiological Profile Assessment

Participants were assessed using the Physiological Profile Assessment (PPA) which is a validated tool used to assess fall risk in older people (3). It includes tests of vision, peripheral sensation, muscle strength, reaction time, and postural sway (foam, eyes open) (4). Composite physiological fall risk scores were calculated using a Web-based computer software program to assess the individual's performance in relation to a normative database compiled from large-scale studies (4). The PPA score has been found to predict community-dwelling older people at risk of experiencing multiple falls during one-year prospective follow-up, with up to 75% accuracy (3).

Vision was assessed using the Melbourne Edge Test of contrast sensitivity. In this test, a chart with 20 circular 25mm diameter patches containing edges with reducing contrast and variable orientation as the identifying feature is used. The edges are presented in the orientations: horizontal, vertical, 45 degrees left, and 45 degrees right. A key card containing the 4 possible edge angles is provided for participant instruction. The lowest contrast patch correctly identified is recorded as the participant's contrast sensitivity in decibel units (2).

Proprioception was measured using a seated lower limb-matching task. With eyes closed, participants align their great toe either side of a vertical protractor (60 x 60 x 1 cm). The average alignment error, measured in degrees from 5 trials was recorded (2).

Lower limb muscular strength was measured as the maximal isometric knee extension force. Testing was performed using a spring gauge attached to the participant's dominant leg. The force of the knee extensor muscles was measured with the participant sitting in a tall chair with a strap around the participant's dominant leg 10 cm above the ankle joint, and the hip and knee joint angles positioned at 90 degrees. The participant was asked to push against the strap

with maximal force for 2 to 3 seconds. The best result measured in kilograms taken from three trials was recorded (3).

Reaction time was assessed using a random delay light stimulus and depression of a switch by hand as the response. Reaction time was measured in milliseconds and the average of ten trials was recorded (4) after five practice trials.

Postural sway was measured using a sway meter that recorded displacements of the body at the level of the waist. The number of millimeter squares traversed by a pen attached to the swaymeter in 30 seconds was recorded (4). Testing was performed under four different conditions; on a firm surface (a linoleum covered floor) and on a piece of foam rubber (40 cm x 40 cm x 7.5 cm thick) with the participant standing in the center (2). The same test was repeated on both surfaces with the participant's eyes closed (4). The measurement of postural sway when standing on the foam with eyes open was entered in the PPA fall risk algorithm.

Touch sensation was measured with a pressure aesthesiometer containing 8 nylon filaments of equal length, but varying in diameter. The filaments were applied to the centre of the lateral malleolus and touch sensation measurements were expressed in milligrams of pressure (93).

Dynamic balance assessment

This assessment comprises two tests; Maximal Balance Range and Coordinated Stability. In these tests, participants stood with the sway meter placed around their waist and extending in the AP plane. In the Maximal Balance Range test, participants were asked to lean forward from the ankles without moving the feet or bending at the hips, as far as possible. Participants were then asked to lean back as far as possible. Maximal anterior-posterior distance moved was recorded on a sheet of paper fastened to the top of an adjustable height table using the sway

meter with the rod extending in the anterior plane. The participants could see the pen and had three attempts at the test, with the best attempt taken as the test result (5). In the Coordinated Stability test, participants were asked to adjust balance by bending or rotating the body without moving the feet, so that the pen on the end of the rod followed and remained within a convoluted track which was marked on a piece of paper attached to the top of an adjustable height table (5), placing them near or at the limits of their equilibrium (7).

Choice Stepping Reaction Time

The choice-stepping reaction time (CSRT) was measured in milliseconds using a computerised step pad, which was connected to a computer unit. The step pad consisted of 4 pressure sensitive panels that represented stepping direction (left and right forward panels, and left and right sides) as well as two central stance panels. On a screen, participants saw a graphical presentation of the arrows on the mat. The step direction was indicated by one arrow changing its colour. Participants were asked to step as quickly as possible onto the corresponding arrow of the pad and return to the center (9). The computer unit recorded timing of foot lift and landing at each panel. In this test, body weight and balance transfers are similar to the step responses required to avoid many falls (5). Total reaction time > 1.4s indicates impaired performance (6). The choice-stepping reaction time test has been shown to discriminate between older people fallers and non-fallers (6).

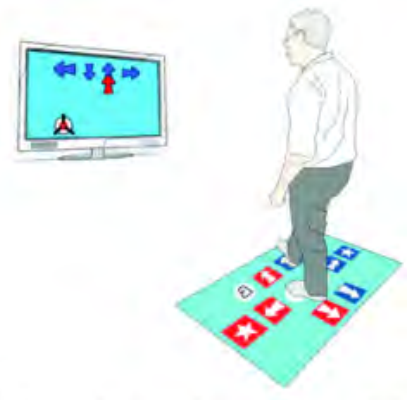

Figure 3.1 Choice-stepping reaction time test set-up

Gait Assessment

Participants walked at their self-selected usual walking speed along a 5.3 m long electronic GAITRite® mat placed in the center of a 7.5 m walkway. The GAITRite® mat is a portable walkway embedded with pressure sensors that detect footfalls as the participant walks the length of the mat. The variables measured were gait velocity (cm/s) and step length (cm). Three trials were recorded for each participant and the average was computed (29). High gait variability has been shown to be associated with increased risk of falling in community living older adults (11).

Timed up and go

The timed-up and go (TUG) test is a simple test used to assess a person's mobility. The time taken for the participant to rise from a chair, walk three meters, turn around, return to the chair, and sit down is measured (51). During the test, participants wore their regular footwear and used any mobility aids that they would normally use (28). They were required to perform the test as fast as possible.

Six-Meter Walk Test

Participants were asked to walk a distance of six meters at self-selected speed. The time taken was recorded. Three trials were allowed and the fastest time used in the analysis (4).

Vestibular tests

Neuro-otological assessment

Participants were seated comfortably and looked directly ahead towards an experienced examiner who conducted an occulomotor examination. This included assessments of smooth pursuit, saccades, vestibulo-ocular reflex (VOR), VOR suppression and the presence of nystagmus (spontaneous or gaze-evoked). Any abnormalities or the presence of nystagmus can be indicative of either peripheral or central vestibular disorders.

Dix Hallpike and Head-Roll Tests

The Dix-Hallpike manoeuvre was used to diagnose posterior canal Benign Paroxysmal Positional Vertigo (BPPV); a test in which participants wear infrared goggles to facilitate the observation of nystagmus. Participants were seated on a plinth and positioned so that their heads would be beyond the end of the plinth when supine. The head is turned 45 degrees toward the ear being tested (position A) – see Figure 3.2. The patient is quickly lowered into the supine position with the head extending about 30 degrees below the horizontal (position B). The patient's head is held in this position and the examiner observes the patient's eyes for nystagmus. To complete the maneuver, the patient is returned to the seated position (position A) and the eyes are observed for reversal nystagmus. During the head roll test, the subject lies supine with their neck flexed to 20 degrees. The head is rolled quickly 90 degrees to one side, the eyes are observed for nystagmus. The head is then rotated quickly to the other side and the eyes are again observed for nystagmus. A positive test (presence of nystagmus and/or symptoms of dizziness) for either manoeuvre indicates BPPV (22, 32).

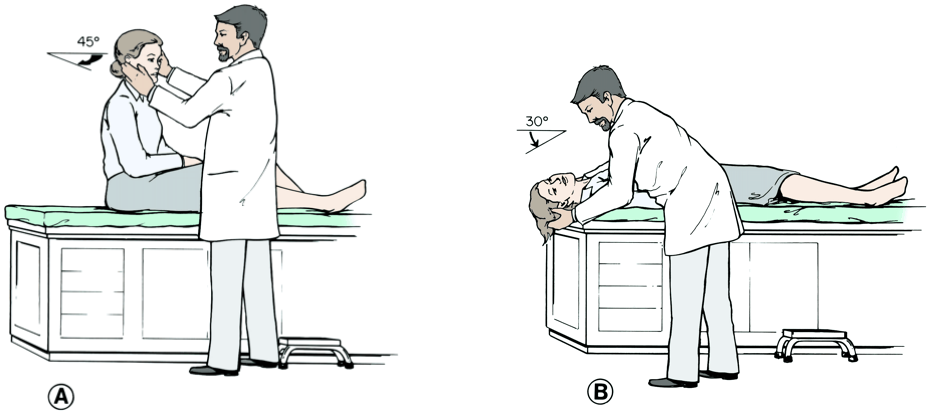

Figure 3.2. Dix–Hallpike manoeuvre (right ear) (from Lorne S. Parnes et al. Canadian Medical association Journal 2003;169: 681-693 (32)).

Head Impulse Test

For this test, the assessor stands in front of the participant and administers small, rapid and unpredictable horizontal head rotation perturbations. The participant is instructed to focus on the assessor's nose during this assessment and abnormal (positive) head impulse test responses are determined based on the presence of clear, reproducible, re-fixation saccades toward the target when the head is turned either direction (31). A positive head impulse test indicates impaired VOR and a peripheral vestibular disorder (45-47).

Head-shake Test

While wearing infrared goggles, the participant's head is tilted downward approximately 30 degrees and passively rotated in the horizontal plane 20-30 times at 1-2 Hz. Immediately after stopping, the participant's eyes were observed for any nystagmus. The nystagmus was captured on video with positive tests indicating vestibular asymmetry.

Psychological Assessments

Falls Efficacy Scale International

The Falls Efficacy Scale International (FES-I) is a self-report questionnaire, providing information on level of concern about falls for a range of activities of daily living. The scale contains 16 items scored on a four-point scale (1 = not at all concerned to 4 = very concerned). The FES-I has become a widely accepted tool for assessing concern about falling [13]. Previous studies indicate that the FES-I has excellent reliability and validity in measuring fear of falling (14). A score ≥ 22 indicates high levels of fear of falling (14).

Patient health questionnaire nine items

The Patient health questionnaire nine items (PHQ-9) is a self-administered questionnaire. It is a 9-item depression module from the full PRIME-MD Patient Health Questionnaire (PHQ). It is used for making criteria-based diagnoses of depressive and other

mental disorders commonly encountered in primary care. It consists of the 9 criteria upon which the diagnosis of Diagnostic and Statistical Manual of Mental Disorders DSM-IV depressive disorders is based (16). The PHQ has been shown to be reliable in detecting psychiatric disorders in the otorhinolaryngological setting for patients with a chief complaint of dizziness (15). A score > 9 indicates significant depressive symptoms (16).

Generalised anxiety disorder – 7 items

The Generalized Anxiety Disorder-7 items (GAD-7) scale is a valid tool for screening for anxiety and assessing its severity in clinical practice and research. A score > 7 indicates an anxiety disorder (17).

Neuroticism scale of the NEO – Five Factor Inventory

All participants completed the neuroticism scale of the NEO-Five Factor Inventory. The scale identifies individuals who are prone to psychological distress. It includes information about; anxiety, angry hostility, depression, self-consciousness, impulsiveness and vulnerability. A score ≥ 56 indicates a high level of neuroticism (18).

Falls data

Prospective data on falls were collected from the participants for twelve months using monthly falls diaries. If a diary was not returned within 2 weeks of the end of each month, participants were contacted by telephone. A fall was defined as an unexpected event in which a person comes to rest on the ground, floor, or other lower level (27). An unexplained fall was defined as a fall that occurred due to a blackout, dizziness, feeling faint, or when participants "found themselves suddenly on the ground." (94). The participants noted if any of the falls resulted in injury, broken bone/s, admission to hospital or an injury, which was currently affecting their mobility. Fallers were defined as those who experienced one or more falls during the twelve-month follow-up.

Statistical analysis

One dichotomous main outcome variable was used: "dizzy" – those who had experienced an episode of significant dizziness in the previous twelve months and "not dizzy" – those who had not.

There were missing data for some variables. For most cases the missing data were due to participants being physically unable to successfully complete the tests. In which cases the missing data were replaced with the mean score plus or minus two standard deviations; sway foam eyes open path - 2, sway foam eyes closed path - 12, maximal balance range - 1, coordinated stability - 6, touch at the metatarsophalangeal joint - 3, touch at lateral malleolus- 2, knee extension -1, proprioception-1. In few cases, data were missing due to equipment failure or participant failing to complete the test: sway floor eyes closed path- 1, sway foam eyes open path - 1, sway foam eyes closed path - 1, maximal balance range - 10, coordinated stability - 9, touch at the metatarsophalangeal joint - 13, touch at lateral malleolus – 11, knee extension -10, proprioception-5.

To allow for analyses of variables with skewed distributions, data with positively skewed distributions were square root or log10 transformed. The variables square root transformed were; Coordinated stability scores, proprioception, sway on floor eyes open, sway on floor eyes closed, sway on foam with eyes open. Timed up and go and the six meter walk times were $\log_{10}$ transformed.

Differences in baseline characteristics between the dizzy and non-dizzy participants were assessed using chi-square tests for cross tabulations for categorical variables and independent sample t-tests for continuous variables. The significance was set at $P < .05$ for all comparisons. The analysis plan also included multivariate models if several variables

considered to be predisposing factors for dizziness were identified in bivariate analyses. The analyses were performed using SPSS version 23 for Mac (SPSS Science Inc., Chicago, Ill., USA).

3.2 Results

Seventy out of a total of 334 participants (21%) indicated they had experience dizziness symptoms in the past year and were categorised as dizzy. Table 3.1 displays the demographic and medical data for the dizzy and non-dizzy groups. The age of the participants in the two groups did not differ significantly and no significant differences were found between the two groups for the presence of various medical conditions including; diabetes, hypertension, back pain, previous heart attack, stroke and transient ischaemic attacks (TIAs). There was a trend for more women than men to be classified as dizzy.

There was no difference in the proportions of dizzy and non-dizzy participants with respect to use of cardiovascular, psychotropic, benzodiazepine or antidepressant medications, or total number of medications used. The proportions of dizzy and non-dizzy participant with orthostatic hypotension and delayed orthostatic hypotension were also similar.

Table 3.2 presents the psychological assessment measures for the dizzy and non-dizzy groups. The two groups had similar scores in the EQ-5D, PHQ9, and GAD-7 assessments. The dizzy group however, were significantly more concerned about falling according to their FES-I scores, with a greater percentage with FES-I scores ≥ 22 indicating significant concern about falling, i.e. 34 (49%) in the dizzy group compared with 79 (30%) in the non-dizzy group.

Table 3.1 Comparison of demographic, medical and medication factors between the dizzy and non-dizzy participants. Data are presented as mean ± SD or n (%).

	Whole sample	Dizzy	Non-dizzy	Significance
	N=334	N=70	N=264	p-value
Age (years)	83 ± 4.1	84 ± 3.8	83 ± 4.2	.592
Gender (Women)	176 (53%)	48 (69%)	128 (48%)	.069
Orthostatic Hypotension	62 (18%)	14 (20%)	48 (18%)	.900
Delayed Orthostatic Hypotension	52 (16%)	12 (17%)	40 (15%)	.500
Body Mass Index (kg/m)	26 ±4.3	27 ±4.7	26 ±4.2	.767
Diabetes	37 (11%)	6 (9%)	31 (12%)	.310
Hypertension	194 (58%)	47 (67%)	147 (56%)	.692
Previous Heart Attack	48 (14%)	14 (20%)	34 (13%)	.355
Previous Stroke	13 (4%)	2 (3%)	11 (4%)	.740
Previous Transient Ischaemic Attack	26 (8%)	7 (10%)	19 (7%)	.773
Epilepsy	3 (0.9%)	1 (1.4%)	2 (0.8%)	.548
Neck pain	75 (22%)	23 (33%)	52 (20%)	.121
Back pain	128 (38%)	38 (54%)	90 (34%)	**.047**
Joint Problems	185 (55%)	52 (74%)	133 (50%)	**.019**
Cardiovascular medication	237 (71%)	56 (80%)	181 (69%)	.879
Antipsychotic medication	6 (2%)	3 (4%)	3 (1%)	.141
Antidepressants	38 (11%)	6 (9%)	32 (12%)	.473
Anti-anxiety medication	13 (4%)	5 (7%)	8 (3%)	.190

* Bold = $p<0.05$

Table 3.2 Cognitive and psychological characteristics comparison between dizzy and non-dizzy participants. Data are presented as mean ± SD or n (%).

	Whole sample N=334	Dizzy N=70	Non-dizzy N=264	p-value
Mini-Mental State Examination score	28.8 ±1.9	28.9 ±1.2	28.8 ±2	.611
Falls Efficacy Scale-International score ≥22	113 (34%)	34 (49%)	79 (30%)	**.028**
Euro Quality of life 5 –item, score	79 ±15.0	78 ±15.9	79 ±14.8	.508
Patient Health Questionnaire 9-item, score >9	15 (5%)	5 (7%)	10 (4%)	.352
Patient Health Questionnaire 9-item, score	2.5 ±3.2	2.8 ±3.0	2.4 ±3.2	.212
Generalised Anxiety Disorder 7-item, score>7	13 (4%)	3 (4%)	10 (4%)	1.00
Generalised Anxiety Disorder 7-item, score	1.7 ±3.0	2.1 ±3.2	1.5 ±3.0	.152

* Bold = $p<0.05$

Table 3.3 compares the physical, gait and balance characteristics between the dizzy and non-dizzy groups. The two groups did not differ significantly in balance performance including; maximal balance range, coordinated stability and postural sway measures. The measures of proprioception, lower limb strength, stepping, CSRT, TUG and the six-metre walk were also similar between the two groups. Significantly more dizzy participants experienced unexplained falls (11%) compared to the non-dizzy participants (4%) ($p = .034$). There was no significant difference found in any of the other prospective or past falls measures including number of falls.

Table 3.3 Physical and balance factors comparison between dizzy and non-dizzy participants. Data are presented as mean ± SD or n (%).

	Whole sample N=334	Dizzy N=70	Non-dizzy N=264	p-value
Physiological Profile Assessment score	0.5 ±1.0	0.50 ±0.88	0.50±1.00	.963
Maximal Balance Range (mm)	140 ±37	139 ±40	140 ±36	.876
Coordinated Stability score	13 ±12	13 ±12	13 ±12	.474
Choice Stepping Reaction Time (ms)	2208 ±143	1411 ±114	2503 ±153	.563
Timed Up and Go (s)	9.9 ±3.5	9.8 ±3.4	9.8 ±3.7	.851
6 Meter Walk Test (s)	9.7 ±3.2	9.7 ±2.4	9.7 ±3.4	.668
Fallers in the past year	111 (33%)	32 (46%)	79 (30%)	.102
Fallers - prospective (1+ fall)	132 (40%)	34 (49%)	98 (37%)	.430
Multiple fallers –prospective (2+ falls)	63 (19%)	15 (21%)	48 (18%)	1.00
Unexplained fallers	18 (5%)	8 (11%)	10 (4%)	**.043**
Sway floor eyes open path (mm)	89 ±43	91 ±43	88 ±42	.867
Sway floor eyes closed path (mm)	136 ±74	139 ±75	136 ±67	.992
Sway foam eyes open path (mm)	227 ±129	228 ±137	205 ±108	.904
sway foam eyes closed path (mm)	561 ±285	455 ±212	467 ±446	.449
Touch lateral malleolus (g)	3.8 ±1.6	3.7 ±1.6	3.8 ±1.6	.540
1st Metatarsophalangeal Joint touch (g)	4.3 ±1.9	4.2 ±1.96	4.3 ±1.92	.762
Knee extension strength (kg)	25.5 ±9.8	24.5 ±9.4	25.7 ±9.8	.341
Proprioception error (deg)	1.9 ±1.4	1.8 ±1.3	1.9 ±1.5	.438

* Bold = $p<0.05$

Table 3.4 Vestibular findings comparison between the dizzy and non-dizzy participants. Data are presented as n (%).

	Whole sample N=334	**Dizzy N=70**	**Non-dizzy N=264**	**Significance p-value**
Dix-Hallpike positive	21 (7%)	8 (11%)	13 (5%)	.114
Head-Impulse Test	21 (6%)	8 (11%)	13 (5%)	.116
Head-shaking nystagmus	16 (5%)	3 (4%)	13 (5%)	.436
Motion Sickness	98 (29%)	30 (42%)	68 (26%)	**.046**

* Bold = $p<0.05$

Participants with dizziness were more likely to suffer from motion sickness, however there was no association found between dizziness and positive head-impulse, head-shaking and Dix Hallpike tests.

The number and proportion of dizzy participants who had positive responses to each Dizziness Handicap Inventory (DHI) item are shown on Table 3.5. The most common activities that participants reported associating self-perceived handicapping effects of dizziness with included; looking up (27%), getting in/out of bed (20%), quick head movements (21%), turning in bed (24%) and bending over (30%). Six participants (9%) had DHI scores greater than 36 classifying their symptoms as moderate or severe.

Table 3.5 Dizziness Handicap Inventory (DHI) results. Percentage of dizzy participants (n=120) who reported "yes" or "sometimes" to DHI items

DHI Question	**Yes/Sometimes % (n)**
1. Looking up	27% (18)

2. Frustration	17% (11)
3. Restrict travel	8% (5)
4. Walking down aisle	3% (2)
5. Getting in/out bed	20% (13)
6. Restrict social activities	10% (7)
7. Difficulty Reading	4% (3)
8. Ambitious activities	11% (8)
9. Leaving home alone	1% (1)
10. Embarrassed	4% (3)
11. Quick movements	21% (14)
12. Avoid heights	20% (13)
13. Turning in bed	24% (16)
14. Strenuous housework	10% (7)
15. Intoxicated	4% (3)
16. Walking alone	7% (5)
17. Walking down sidewalk	14% (9)
18. Concentration	11% (8)
19. Walking in the dark	10% (7)
20. Home alone	0% (0)
21. Feel handicapped	1% (1)
22. Relational stress	6% (4)
23. Depressed	4% (3)
24. Job or responsibilities	4% (3)
25. Bending over	30% (20)

Multivariate model

There were three variables found to be associated with dizziness. Given that only back pain

would meet the criteria as a pre-disposing factor for dizziness, no multivariate analysis was undertaken

3.3 Discussion

Several studies have found that dizziness is a common complaint in older people, and associated with many comorbidities, and physical and psychological factors. In the present study, we found relatively few associated factors. Dizziness was significantly associated with self-reported back pain, fear of falling and motion sickness. There was also a trend towards more females reporting dizziness than males. Other common associations found in studies of dizziness in elderly populations including increased incidence of falls (52), prescription medication use (33) and presence of psychiatric disorders (44) were not found in this study.

Dizziness and Gender

More women reported significant dizziness in the previous twelve months (60%, n=42) compared to men (40%, n=28), (p = .097); an association less strong than previously found (40-43). A Dutch study of 3990 participants found significantly more women reported dizziness in the previous twelve months (40). This study used records from the participants' family medical practices and possibly reflects an increased likelihood of women compared to men to report and seek attention from their doctor for this symptom. In the present study, individuals report on their dizziness to researchers with a questionnaire and may not have attended their doctor as a result of the dizziness episodes. Therefore, symptom severity may have been less, and would likely be associated with fewer physical and psychological sequelae.

A German study of 1287 participants aged between 14-90 years (41) also found significantly more women than men reporting dizziness in the previous year. A common cause of dizziness amongst women pre-menopause is migrainous vertigo. Pre-menopausal women were not included in the current study, and this selection difference, could in part, account for

the divergent finding. Finally, Aggarwal et al found women were twice more likely than men to report dizziness in a study of 6158 participants (42). This study included individuals living in nursing homes and participants classified as dizzy had experienced dizziness episodes once or more per month. Thus, it may be gender differences in reported dizziness are more likely to be apparent if the condition is more severe and frequent.

Dizziness and back pain

Forty nine percent (n=38) of those with dizziness also reported back pain compared to 35% (n=90) of those without dizziness. This significant association could be due to stiffness and poor alignment of the spine in conditions associated with ageing. These age-related changes in posture in turn may interfere with the input and compensation of the vestibular and proprioceptive components of balance. Menant et al (34) suggested that neck pain leads to stiff posture and consequently less use of visual cues while walking. Altered posture can also arise from conditions which cause back pain. Alternatively, this finding may relate to an increased likelihood of a subset of the sample to be concerned about and report multiple conditions and symptoms.

Altered vestibular reflexes are also possible. The vestibulospinal reflex allows rapid correction of posture and stabilises the head and the body in response to rotation. The vestibulospinal reflex along with the vestibulo-ocular reflex and the vestibulo-collic reflex are partially responsible for maintaining balance and equilibrium. Along with vision and somatosensory input, any reduction in input of these reflexes is a potential cause of dizziness. Cold caloric vestibular stimulation has been shown to consistently activate paraspinal muscles (35). Back pain due to muscle or spinal alignment issues could compromise balance control by reducing the effectiveness of the vestibulospinal reflexes and by altering normal gait.

Dizziness and motion sickness

Participants with dizziness were more likely to experience motion sickness, with participants who experienced motion sickness 'often' twice as likely to be dizzy (n=8) than their non-dizzy counterparts (n=4). The most common condition in which motion sickness and dizziness co-exist is vestibular migraine and specifically in women more commonly than men. This cohort included participants of an older age range than those who typically suffer from vestibular migraine and there was no significant association between reported dizziness and reported migraines. Other factors may account for why these two symptoms are still linked in this older group. Vertigo is similar to motion sickness in that both may be due to vestibular stimulation that does not match the combination of visual, somatosensory and inner ear input to the brain, i.e. when there is conflict between expected and actual input from the vestibular system, motion sickness can occur. It is also possible that people with low affect are more aware of somatic sensations and report more somatic complaints. For example, if a sensation, such as dizziness is thought to be a sign of illness it is likely to be reported (36). It is possible that those individuals who reported motion sickness, dizziness (and also back pain) did so because they are more inclined to think of these as possible causes for concern.

Dizziness and Falls

Impaired balance and dizziness have been shown to be risk factors for falls in older people (43-45). In this study, dizziness was not associated with increased falls. Stevens et al (43) found a strong association between dizziness and having fallen in the previous two years. In that study, the participants were asked how often they had problems with dizziness when walking on a level surface. Possible responses were always, very often, often, sometimes, or never. The categorization of dizziness therefore more closely relates to an increased risk of falling. Participants in the present study could be classified as dizzy due to short episodes of dizziness when rolling in bed, for example; a trigger that would be less likely to result in a fall.

Graafmans et al found dizziness upon standing and falls to be statistically greater in those participants aged 70 and over. This finding however was accounted for by the fact that 45% of individuals with orthostatic hypotension, reported dizziness upon standing up compared to 23% of those without orthostatic hypotension (44). In the present study, there was no association between dizziness and orthostatic hypotension.

Perhaps the absence of an increase in falls in those with dizziness is due to the timing of dizziness episodes, which were up to twelve months prior to the assessment. Other studies that have shown a link between dizziness and falls have classified individuals as 'dizzy' if they had experienced a dizziness episode over a longer time frame, i.e. since the age of 60 years (89) and may reflect a more chronic condition.

Dizziness and Psychological diagnoses

Many studies have investigated the interaction of psychiatric and vestibular disorders (38,46-48), and there are varying hypotheses regarding the interrelationships of these disorders. The term psychogenic dizziness refers to the process by which the psychiatric disorder e.g., anxiety or depression is manifest as dizziness. In contrast, the somato-psychic hypothesis suggests that a primary neurotologic condition triggers a secondary anxiety disorder (41).

In this study, there was no increased prevalence of depression or anxiety amongst those with self-reported dizziness. Some studies have found strong associations between psychiatric disorders and dizziness using varying scales to classify dizziness. Substantial differences in dizziness severity and participant selection could account for the differences found across studies. Previous studies have either used a significantly younger cohort (46,47), or those in the dizziness groups experienced more frequent and recent episodes of dizziness (40, 41).

In the present study, 46% of participants with dizziness had FES-I scores greater than 22 (considered to be indicative of having a high concern about falling (13)) compared with 31% of non-dizzy participants. However, participants with dizziness and fear of falling did not have significantly greater anxiety and depression according to GAD-7 and PHQ-9 scores indicating increased fear of falling appears to be independent of anxiety and depression in older adults with dizziness.

Dizziness and prescription medication

Previous studies have shown a significant association between dizziness and number of prescription medications used in older people (39,40). Whilst using participants of a similar age range, these studies used information on the presence of dizziness from the participant's family doctor's database; a method that is likely to obtain different estimates of severity and prevalence. A study by Stevens et al, also found no statistically significant association between dizziness and use of prescription medication (43). The cohort used in this study was similar to that of the present study in that the participants were aged 65 and over, were community dwelling and reported on their own symptoms.

3.4 Conclusion

Consistent with previous studies, these data indicate dizziness is a common complaint in older people. However, in contrast to most previous research, relatively few co-morbidities, physical and psychological factors were found to be associated with the presence of dizziness. Significant relationships were evident between dizziness and back pain, fear of falling and motion sickness, but dizziness was not significantly related to vestibular, balance or gait impairments, orthostatic hypertension, prescription medication use or the presence of anxiety or depression. For the significant associations uncovered, it is difficult to determine cause-effect relationships, and multivariate modelling to determine independent risk factors for dizziness was not feasible. Significantly more dizzy participants experienced unexplained falls (10.3%)

compared to the non-dizzy group (3.7%). This finding is consistent with a previous study by Menant et al 2013 (89) who suggested that back pain might partly explain why dizzy older people are more prone to falling than their nondizzy peers. It is possible that adopting stiff posture while walking, could increase the risk of falling.

The relatively few associations may be due to the current cohort comprising a general sample of community dwelling older adults who had not sought attention from their doctor for their symptoms. Based on the few associations with adverse health outcomes, it appears many healthy older people who report dizziness are only minimally affected by this complaint. Dizziness, however, can be extremely debilitating for some people, so more targeted research into predisposing factors and consequences in those with severe dizziness is warranted. The following chapter will address these issues in a sample recruited based on the presence of recent and significant dizziness.

Chapter 4

Medical, physical and psychological factors associated with dizziness frequency and handicap in older people who report recent dizziness

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This study presents the findings of the 313 participants enrolled in the dizziness randomised controlled trial aged 50 years and older who experienced at least one significant dizziness episode in the past year. The aim of this study was to identify medical, physical, psychological and vestibular factors associated with dizziness handicap and dizziness episode frequency.

4.1 Methods

Participant recruitment, eligibility and ethical considerations

This study forms part of a larger single blind, parallel group randomised-controlled trial (RCT) investigating a novel approach to the diagnosis and management of dizziness in older people using a comprehensive assessment battery with tailored intervention. Participants were recruited through advertisements; flyers on noticeboards at community facilities, hospitals and universities; articles in newspapers and newsletters for older people; the Neuroscience Research Australia (NeuRA) website, newsletter and mailing list; and by mail box drops of private households and retirement villages in eastern Sydney.

All participants had a history of chronic or recurrent dizziness not currently being treated (a requirement for the RCT). To be eligible for the study, participants had to: (i) be aged 50 years and over; (ii) have experienced at least one significant episode of dizziness in the past 12 months; (iii) live independently in the community or retirement village and; (iv) be able to understand English. People were deemed ineligible to participate in the study if they; (i) had a degenerative neurological condition; (ii) were receiving treatment for their dizziness; (iii) had a cognitive impairment (a General Practitioner Assessment of Cognition (GPCOG) score of <5) and/or; (iv) were unable to walk 20 meters without difficulty (use of a walking aid permitted). For ethical reasons, any participants identified at assessment with conditions that required urgent treatment defined as suspected stroke, transient ischemic attack or other undiagnosed neurological or acute cardiovascular conditions, or severe depressive or anxiety symptoms (eg.

with expression of suicidal thoughts) were also excluded from the study and referred following consent for appropriate treatment.

The study protocol was approved by the Human Research Ethics Committee at the University of New South Wales and informed consent was obtained from all participants. The baseline assessment was conducted over a three-hour period at NeuRA. Assessments were done and data were collected between 2012 and 2015. The study flow-diagram is presented in Figure 1.

Questionnaires and Assessments

The questionnaires and assessments used in the present study are described in the previous chapter with one exception. The Iconographical Falls Efficacy Scale (IconFES) was used instead of the FES-I to assess concern about falling. IconFES uses pictures to describe a range of activities and situations. The questionnaire comprises 30 activities including the 16 original activities from the FES-I. The use of pictures along with verbal phrases allows the more detailed contextual elements of a situation to be conveyed to participants (95). The IconFES has been shown to have high internal consistency and excellent test–retest reliability over a 1-week time interval (95).

Dizziness Episodes and Falls Ascertainment

The occurrence of dizziness episodes and falls were collected prospectively in the control group of the RCT; this sub-group analysis was chosen to remove any confound of the effect of the intervention on these outcome measures. The dizziness episode and falls data were obtained using monthly diaries with follow-up telephone calls as required for 6 months following the baseline assessment. Any injuries, admissions to hospital and/or impact on mobility as a result of falls were also recorded.

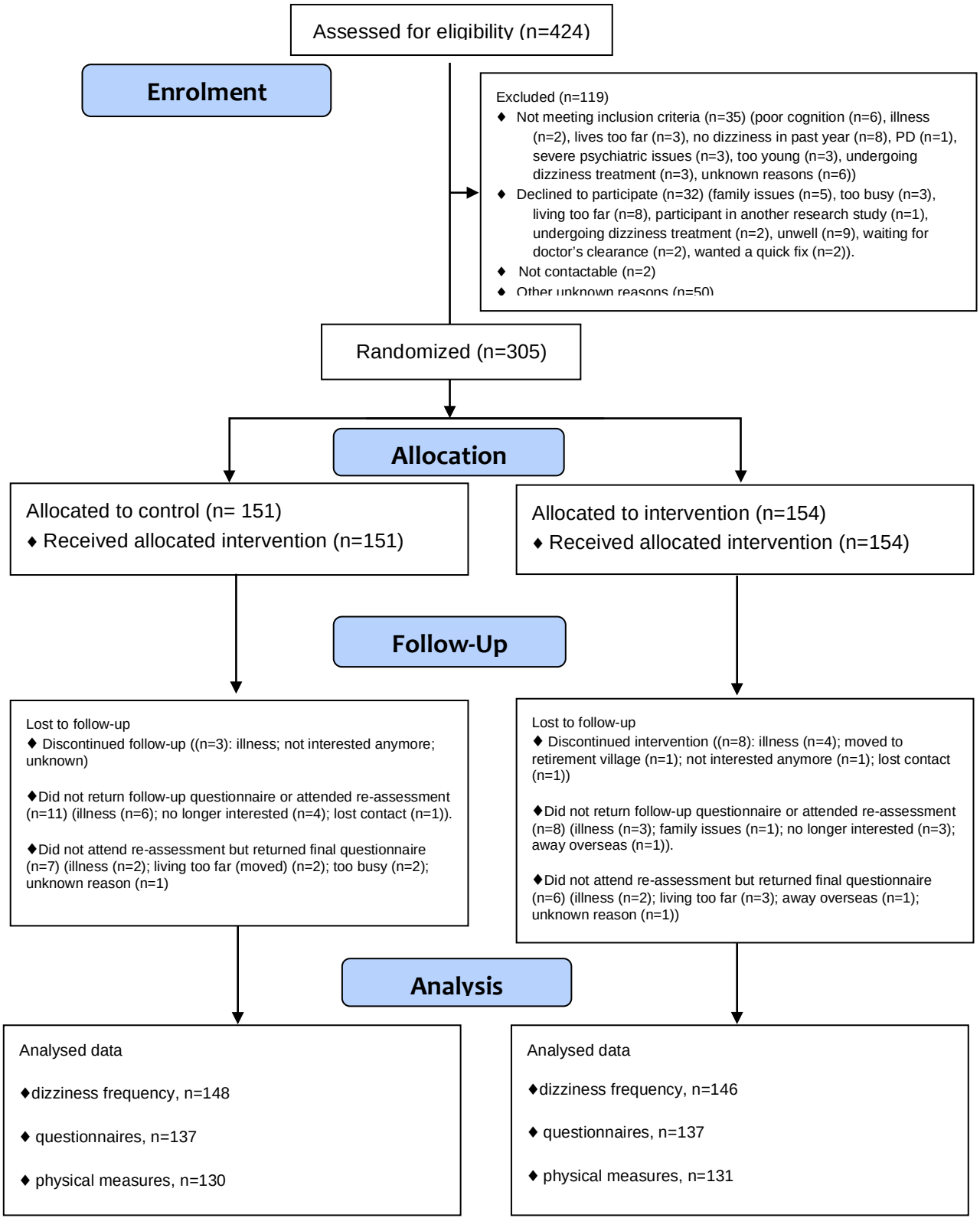

Figure 4.1 Study flow-diagram

Statistical Analysis

Continuously scored data were checked for normality of their distribution. Depending on the extent of skew, variables were either $\log_{10}$ transformed (four sway path variables and IconFes scores) or square root transformed (choice stepping reaction time, GAD-7, PHQ-9 and proprioception scores), before inclusion in parametric analyses.

The two primary dependent / outcome measures were dizziness episodes over the six month follow-up period and dizziness handicap measures at the six month retest. Participants who reported ≥36 occasions dizziness episodes (median split) were categorised as experiencing frequent dizziness and participants who reported <36 dizziness episodes were categorised as experiencing infrequent dizziness. Participants with dizziness handicap inventory (DHI) scores 0-30 at retest were categorised as having mild dizziness and those with DHI score >30 were categorised as having moderate to severe dizziness (92). Baseline characteristics between participants with high and low dizziness handicap, and frequent and infrequent dizziness were contrasted using chi-square tests for cross tabulations for categorical variables and t-tests for continuous variables.

Binary logistic regression analyses were then performed to identify independent risk factors for increased dizziness handicap and dizziness frequency. Variables were categorized into five domains: vestibular, cardiovascular, pain, psychological and sensorimotor/balance/gait. One variable from each domain that were considered to be risk factors for dizziness (as opposed to sequelae) and significantly discriminated between the groups in univariate analyses were selected for inclusion in multivariate models. This restriction was undertaken to allow for a minimum of 15 outcome cases (participants with high dizziness frequency / handicap) per variable entered as covariate. In addition, age was adjusted for in both models by including this variable as a covariate. All statistical analyses were performed using SPSS version for Mac (SPSS Science Inc., Chicago, Ill., USA).

4.2 Results

Part 1: Dizziness Handicap

Prevalence

Three hundred and five individuals aged between 50 and 91 (mean ± SD age, 67.8 ± 8.3 years) including 193 women (57%) comprised the study sample. Of these participants, 95 (31%) had DHI scores > 30 indicating moderate–severe dizziness handicap.

Demographic and medical factors

As presented in Table 4.1, participants with moderate to severe dizziness handicap were more likely to have had a stroke and to report neck pain and back pain. Participants with moderate to severe dizziness handicap were also taking more cardiovascular, psycholeptic, psychoanaleptic, nervous system, analgesic and total drugs than participants with mild dizziness handicap.

Cognitive and psychological factors

Table 4.2 indicates that participants with moderate to severe dizziness handicap performed worse across all measures of anxiety, depression, neuroticism, cognition and quality of life, with a greater number of participants with moderate to severe dizziness handicap having psychometric test scores indicating significant anxiety (GAD scores > 7) and depression (PHQ scores >9). Participants with moderate to severe dizziness handicap were also significantly more likely have greater concern about falling than participants with mild dizziness handicap.

T**able 4.1** Demographic and medical factors comparison based on Dizziness Handicap Inventory (DHI) score severity. Data are presented as mean ± SD or n (%).

	Whole sample	**DHI score 0-30**	**DHI score 31+**	**p-value**
	N=305	**N=210**	**N=95**	
Age (years)	67.8 ±8.3	67.2 ±7.8	69.1±9.1	.059
Gender (female)	193 (57%)	131 (62%)	62 (65%)	.629
Othostatic Hypotension	60 (20%)	39 (19%)	21 (22%)	.472
Delayed Orthostatic hypotension	29 (10%)	17 (8%)	12 (13%)	.211
Body Mass Index	26.3 ±5.3	26.0 ±5.0	27.0 ±5.8	.132
Diabetes	30 (10%)	16 (8%)	14(15%)	.053
Hypertension	115 (38%)	73 (35%)	42 (44%)	.115
Stroke	8 (3%)	1 (1%)	7 (7%)	**.000**
Heart attack	11 (4%)	7 (3%)	4 (4%)	.704
Transient Ischaemic Attack	20 (7%)	10 (5%)	10 (11%)	.060
Epilepsy	2 (1%)	1 (1%)	1 (1%)	.564
Neck pain	148 (49%)	92 (44%)	56 (59%)	**.014**
Back pain	167 (55%)	103 (49%)	64 (67%)	**.003**
Cardiovascular medication	162 (53%)	100 (48%)	62 (65%)	**.004**
Psycholeptic medication	41 (13%)	22 (11%)	19 (20%)	**.024**
Psychoanaleptic medication	36 (12%)	17 (8%)	19 (20%)	**.003**
Nervous system drugs	108 (35%)	61(29%)	47 (50%)	**.001**
Analgesics	52 (17%)	27 (13%)	25 (26%)	**.004**
Total number of medications	3.1 ±2.8	2.8 ±2.7	3.9 ±3.0	**.002**

Bold = $p<0.05$

Table 4.2 Cognitive, psychological and quality of life comparisons based on Dizziness Handicap Inventory (DHI) score severity. Data are presented as mean ± SD or n (%).

	Whole sample	**DHI score 0-30**	**DHI score 31+**	**p-value**
	N=305	**N=210**	**N=95**	
Reported Depression	35 (12%)	16(8%)	19 (20%)	.002
Reported Anxiety	27 (9%)	7 (3%)	20 (21%)	**.000**
Generalised Anxiety Disorder 7-item scale score >7	31 (10%)	15 (7%)	16 (17%)	**.009**
Patient Health Questionnaire 9-item score >9	34 (11%)	15 (7%)	19 (20%)	**.001**
Generalised Anxiety Disorder 7-item score	3.11 ±3.6	2.5 ±3.0	4.6 ±4.4	**.000**
Patient Health Questionnaire 9-item score	4.1 ±4.4	3.1 ±3.6	6.2 ±5.2	**.000**
Euro Quality of Life 5-item questionnaire (time trade-off score)	.65 ±.29	.67 ±.29	.58 ±.29	**.010**
General Practitioner Assessment of Cognition score	8.5 ±.8	8.6 ±.7	8.4 ±0.9	**.041**
Neuroticism score from the NEO-Five Factor Inventory	18.5 ±8.1	16.9 ±7.5	22.0 ±8.2	**.000**
Icon-Fall Efficacy Scale score	19.3±7.3	17.8±7.3	22.5±6.2	**.000**

Bold = $p<0.05$

Sensorimotor, balance, gait and fall-related factors

In terms of sensorimotor measures, participants with moderate to severe dizziness handicap had similar sensory measure scores but worse knee extension strength and simple reaction time compared with participants with mild dizziness handicap. Participants with moderate to severe dizziness handicap performed worse in all standing and leaning balance tests, and exhibited slower choice stepping reaction times, reduced gait speed and shorter step length. Finally, participants with moderate to severe dizziness handicap had increased composite PPA fall risk scores and were more likely to report multiple falls in the past year.

Table 4.3 Sensorimotor, balance, gait and fall-related factor comparisons based on Dizziness Handicap Inventory (DHI) score severity. Data are presented as mean ± SD or n (%).

	Whole sample N=305	**DHI score 0-30 N=210**	**DHI score 31+ N=95**	**p-value**
Contrast sensitivity (dB)	21.7 ±1.6	21.7 ±1.6	21.5 ±1.5	.296
Proprioception (deg)	1.7 ±1.5	1.6 ±1.3	1.9 ±1.8	.116
Lateral malleolus touch sensation (log_{10} mg pressure)	3.4 ±1.3	3.4 ±1.6	3.5 ±1.4	.636
Knee extension strength (kg)	30.0±12.9	31.1 ±13.1	27.6 ±12.2	**.028**
Simple reaction time (ms)	212 ± 30	209 ±27	224 ±35	**.001**
Sway Floor Eyes Open (mm)	118 ±84	104 ±60	152 ±114	**.000**
Sway Floor Eyes Closed (mm)	163±116	142 ±93	211±145	**.000**
Sway Foam Eyes Open (mm)	257 ±145	235 ±118	311 ±185	**.000**
Sway Foam Eyes Closed (mm)	408 ±196	386 ±178	470 ±230	**.006**
Coordinated Stability (error score)	6.0 ±8.6	4.5 ±6.5	9.5 ±11.4	**.000**
Choice Stepping Reaction Time	1069 ±189	1034±152	1148 ±236	**.000**

(ms)				
Gait velocity (cm/s)	119 ±23	123 ±20	111 ±26	**.000**
Step length (cm)	64.6 ±9.5	66.2 ±8.1	60.8 ±11.3	**.000**
Physiological Profile Assessment score	.83 ±.86	.65±.0.79	1.23±0.86	**.000**
Fallers in the past year	96 (32%)	58 (28%)	38 (40%)	**.031**
Multiple fallers	40 (13%)	20 (10%)	20 (21%)	**.006**
Total planned and incidental physical activity (hrs/week)	31.1 ±18.1	30.8 ±17.7	32.3 ±19.6	.547

Bold = p<0.05

Vestibular function

Compared with participants with mild dizziness handicap, participants with moderate to severe dizziness handicap were more like to have a positive Dix Hallpike test, but not more likely have a head-shaking nystagmus or report motion sickness.

Table 4.4 Vestibular Assessment: comparison based on Dizziness Handicap Inventory (DHI) score severity. Data are presented as mean ± SD or n (%).

	Whole sample	**DHI score 0-30**	**DHI score 31+**	**p-value**
	N=305	**N=210**	**N=95**	
Positive Dix Hallpike test	59 (19%)	32 (15%)	27 (28%)	**.007**
Presence of head-shaking nystagmus	42 (14%)	30 (15%)	12 (13%)	.792
Motion Sickness	114 (38%)	76 (37%)	38 (40%)	.580

Bold = p<0.05

Multivariate model predictors of moderate-severe dizziness handicap

The following variables were selected for possible inclusion in the multivariate forward selection logistic regression model (positive Dix Hallpike test - vestibular, cardiovascular medications - cardiovascular/medications, GAD-7 score - psychological, neck pain - pain, PPA composite score - sensorimotor/balance/gait). After controlling for age, the logistic model indicated that the following four measures may be significant and independent predictors of moderate-severe dizziness handicap: cardiovascular medication use (OR=2.52, 95% CI (1.27-4.97), p=0.008), GAD-7 score (OR=1.21, 95% CI (1.11-1.31), p=0.000), positive Dix Hallpike test (OR=3.58, 95% CI (1.69-7.56), p=0.001), and PPA (OR=3.28, 95% CI (2.06-5.21), p=0.000). The model was statistically significant (Cox & Snell R^2=0.203, χ^2=69.16, df=5, p<0.001) and it correctly classified 82% of participants with 32% sensitivity and 96% specificity. These findings indicate that the use of one or more of these tests tests could identify individuals at risk of developing moderate to severe dizziness.

Part 2: Dizziness Frequency

Demographic and medical factors

Table 4.5 displays the medical and demographic details of the 148 participants allocated to the control arm of the RCT based on the frequency of their dizziness episodes in the six-month follow-up period. The infrequent and frequent dizziness participants were of similar age and the two groups had similar proportions of men and women. Only one medical and medication factor differed between the groups: i.e. participants with frequent dizziness were significantly more likely to be taking psychoanaleptic medications than their infrequently dizzy counterparts.

Cognitive and psychological factors

Table 4.6 outlines the psychological characteristics of the participants. Participants with frequent dizziness had higher PHQ-9 scores and were more likely to have PHQ-9 scores of 10 or

more (indicative of depressive symptoms). Participants with frequent dizziness were also more likely to have higher GAD-7 scores and greater concern about falling than participants with less frequent dizziness.

Sensorimotor, balance, gait and fall-related factors

Table 4.7 shows the comparison between the two groups for sensorimotor, balance, and gait characteristics. The two groups differed significantly in just two measures: sway on foam with eyes open and PPA fall risk composite scores. The two groups did not differ with respect to either their history of either a single fall or multiple falls in the past year.

Table 4.5 Demographic and medical factors comparison based on frequency of dizziness episodes. Data are presented as mean ± SD or n (%).

	Whole follow-up sample N=148	**0-35 dizziness episodes N=76**	**36+ dizziness episodes N=72**	**p-value**
Age (years)	67.6 ±8.0	67.1 ±7.4	67.9±8.6	.519
Gender (female)	98 (66%)	48 (63%)	50 (69%)	.419
Orthostatic Hypotension	30(20%)	12 (16%)	18 (25%)	.164
Delayed Orthostatic Hypotension	16 (11%)	7(9%)	9 (13%)	.519
Body Mass Index	26.5 ±5.3	26.3 ±4.9	27.0 ±5.6	.372
Diabetes	13 (9%)	5 (7%)	8 (11%)	.330
Hypertension	55 (37%)	29 (38%)	26 (36%)	.797
Stroke	3 (2%)	3 (4%)	0 (0%)	.089
Heart Attack	7 (5%)	2 (3%)	5 (7%)	.217
Transient Ischaemic Attack	11 (7%)	6 (8%)	5 (7%)	.826

Neck pain	69 (47%)	34 (45%)	35 (49%)	.637
Back pain	81 (55%)	37 (49%)	44 (61%)	.129
Total number of medications	3.3 ±3.0	2.9 ±2.5	3.6 ±3.5	.216
Cardiovascular medication	81(55%)	44 (58%)	37 (51%)	.427
Psycholeptic medication	24 (16%)	16(21%)	8 (11%)	.101
Psychoanaleptic medication	20 (14%)	6 (8%)	14 (19%)	**.040**
Nervous system drugs	58 (39%)	27(36%)	31 (43%)	.348
Analgesics	30 (20%)	13 (17%)	17 (24%)	.325

Bold = $p<0.05$

Table 4.6 Cognitive, psychological and quality of life comparisons based on frequency of dizziness episodes. Data are presented as mean ± SD or n (%).

	Whole follow-up sample N=148	**0-35 dizziness episodes N=76**	**36+ dizziness episodes N=72**	**p-value**
Reported Depression	13 (9%)	5 (7%)	9 (22%)	**.006**
Reported Anxiety	14 (10%)	6 (8%)	8 (11%)	.504
Generalised Anxiety Disorder 7-item scale score >7	10 (7%)	2 (3%)	8 (11%)	**.040**
Generalised Anxiety Disorder 7-item scale score	2.8 ±3.3	2.04 ±3.0	3.4 ±3.4	**.003**
Patient Health Questionnaire 9-item score >9	17 (12%)	5 (7%)	12 (17%)	.054
Patient Health Questionnaire 9-item score	4.1 ±4.72	3.0 ±4.2	5.1 ±5.1	**.000**
Euro Quality of Life 5- item	.62 ±.30	.63 ±.30	.60 ±.31	.553

questionnaire score				
General Practitioner Assessment of Cognition score	8.6 ±.0.7	8.7 ±.6	8.5 ±.8	.189
Neuroticism scale from the NEO-Five Factor Inventory score	17.7 ±8.5	16.6 ±8.1	18.5 ±8.5	.166
Icon-Falls Efficacy Scale score	18.8 ± 7.1	18.3 ±8.3	19.2 ±5.7	.422
Dizziness Handicap Inventory score	23.6 ±16.7	18.8 ±14.8	28.4 ±17.5	**.000**

Bold = p<0.05

Table 4.7 Sensorimotor, balance, gait and fall-related factor comparisons based on frequency of dizziness episodes. Data are presented as mean ± SD or n (%).

	Whole follow-up sample N=148	**0-35 dizziness episodes N=76**	**36+ dizziness episodes N=72**	**p-value**
Contrast sensitivity (dB)	21.8 ±1.4	21.9 ±1.5	21.7 ±1.4	.614
Proprioception (deg)	1.6 ±1.3	1.6 ±1.3	1.6 ±1.3	.966
Lateral malleolus touch sensation (log_{10} mg)	3.4 ±1.6	3.5 ±1.5	3.3 ±1.5	.434
Knee extension (kg)	30.0 ±13.7	31.5 ±14.8	28.5 ±12.5	.185
Hand reaction time (ms)	215 ±30	213 ±32	215 ±28	.696
Sway Floor Eyes Open (mm)	123 ±91	108 ±54	142 ±117	.110
Sway Floor Eyes Closed (mm)	159 ±113	144 ±85	178 ±138	.170
Sway Foam Eyes Open (mm)	256 ±138	225 ±95	288 ±169	**.042**
Sway Foam Eyes Closed (mm)	419 ±207	421 ±182	410 ±231	.376

Coordinated Stability (score)	6.0 ±8.8	5.1 ± 7.0	6.8 ±10.3	.654
Choice Stepping Reaction time (ms)	1059 ±175	1051 ±195	1065 ±151	.472
Gait velocity (cm/s)	118 ±21	119 ±18	116 ±25	.487
Step length (cm)	64.2 ±8.5	64.5 ±7.3	63.8 ±9.8	.618
Physiological Profile Assessment score	.845 ±.815	.694 ±.718	.983 ±.887	**.030**
Fallers in the past year	42 (29%)	18 (26%)	24 (33%)	.380
Multiple fallers (2+ falls)	13 (9%)	5 (7%)	8 (11%)	.524

Bold = $p<0.05$

Vestibular function

Compared with participants with infrequent dizziness, participants with frequent dizziness were more likely to have head-shaking nystagmus, but not more likely have a positive Dix Hallpike test or report motion sickness (table 4.8).

Table 4.8 Vestibular Assessment: comparison based on frequency of dizziness episodes. Data are presented as n (%).

	Whole follow-up sample N=148	**0-35 dizziness episodes N=76**	**36+ dizziness episodes N=72**	**p-value**
Positive Dix Hallpike test	31 (21%)	13 (17%)	18 (25%)	.238
Head-shaking Nystagmus	24 (16%)	7 (10%)	17 (24%)	**.021**
Motion Sickness	52 (36%)	32 (42%)	20 (29%)	.088

Bold = $p<0.05$

Multivariate model predictors of frequent dizziness

In the final forward selection multivariate logistic regression model, three variables: GAD-7 score (OR=1.14, 95% CI (1.01-1.29), p=0.029), PPA score (OR=1.60, 95% CI (1.01-2.55), p=0.049) and positive head-shaking nystagmus (OR=2.97, 95% CI (1.11-7.97), p=0.030) were identified as independent predictors of increased dizziness frequency entered after controlling for age. The model was statistically significant (Cox & Snell R^2=0.104, χ^2=16.17, df=4, p=0.003) and correctly classified 67% of participants with 56% sensitivity and 78% specificity.

4.3 Discussion

Dizziness and cardiovascular function and prescription medication use

Many studies have found polypharmacy – the regular use of four plus prescription medications to be associated with dizziness in elderly populations (25-28). With the present studies we aimed to identify which specific categories of prescription medication were associated with dizziness in this population. Participants with high dizziness handicap were significantly more likely to use many categories of prescription medication including cardiovascular, psycholeptic, psychoanaleptic, analgesic and nervous system drugs. The

participants with frequent dizziness were more likely to take psychoanaleptic drugs than those with less frequent dizziness. These significant associations may be directly due to drug side effects and interactions, although it is also possible that the conditions for which some of the medications were prescribed may be contributing to dizziness. It has also been suggested that individuals with more chronic medical conditions have poor self-perception of their health and are therefore likely to report dizziness (25).

In this cohort, participants with moderate to severe dizziness took on average one additional medication than the less dizzy participants. They also took more nervous systems drugs. Both of these findings have been shown to contribute to fall risk (96). Cardiovascular medication use was an independent predictor of increased dizziness handicap; a finding in agreement with previous studies that have found use of nitrates (33) and antihypertensive therapy (2) to be associated with dizziness in older adults. Cardiovascular disease has been shown to cause dizziness, not just lightheadedness (97). There was no significant association between dizziness frequency or severity and the presence of common cardiovascular disorders including; orthostatic hypotension, heart disease and hypertension. The use of cardiovascular medication indicates the presence of cardiovascular disease or poor cardiovascular health. Perhaps the increased rates of cardiovascular medication use in participants with high dizziness frequency and severity explains that despite the absence of postural hypotension in this group, cardiovascular disease, poor cardiovascular health or perhaps the side-effects of some cardiovascular medications may cause significant dizziness.

In this study conducted in a large cohort of middle-aged and older community dwelling adults recruited due to the presence of significant dizziness, many factors were found to be associated with measures of dizziness severity. In multivariate analyses, higher GAD-7 scores, likely Benign Paroxysmal Positional Vertigo (BPPV) as indicated by a positive Dix Hallpike test, cardiovascular medication use and higher PPA scores were independent predictors of reporting

moderate to severe dizziness handicap while higher PPA and GAD-7 scores as well as a positive head-shaking test were independent predictors of suffering frequent dizziness.
More factors were significantly associated with high dizziness handicap compared to dizziness frequency in this study. This may be due to the nature of the questions in the DHI. With questions relating to specific functional tasks and activities of daily living, this questionnaire may have been more useful than simply recording frequency of dizziness episodes in identifying individuals who are adversely affected by dizziness across multiple domains.

Dizziness and Psychological factors

Both anxiety and depression (as assessed by many complementary measures) were associated with increased dizziness handicap and frequency – a relationship consistent with previous reports (26, 30). It has been reported that as many as 25-37% of elderly patients have a psychological diagnosis contributing to their dizziness (5, 36). Conversely, it has been suggested that dizziness causes an increase in depression and anxiety symptoms in older people (3, 4). Due to the cross-sectional nature of this study, it is not possible to determine causal relationships among depression, anxiety and dizziness severity. However, participants who identified themselves as dizzy are likely to also have been more mentally and emotionally affected by this disturbing condition.

The majority of factors associated with high dizziness frequency were related to depression and anxiety. These include higher PHQ-9 and GAD-7 scores as well as a history of depression and psychoanaleptic drug use. It may be that for participants with greater than 35 episodes of dizziness per year, psychogenic dizziness may be key diagnostic feature. And perhaps having constant dizziness contributes to the development of depression (5).

The relationship between dizziness and anxiety may also be partly explained by Chronic Subjective Dizziness: a condition in which individuals experience persistent dizziness and

motion sensitivity (98). In a recent functional MRI study, Indovina et al in 2015 (98) showed an overlap between vestibular and anxiety pathways in the brain. The authors suggest that ongoing activity and connectivity between the central vestibular system and neural structures related to anxiety results in chronic dizziness.

Dizziness and Sensorimotor Function, Balance and Gait

The only physiological correlates associated with increased dizziness frequency were increased sway on foam with eyes open and physiological falls risk scores. This tells us that frequent dizziness does not necessarily impact upon an individual physically. The symptoms although regular may be minor and short-lived. In contrast, high dizziness handicap was associated with poor performance in almost all measures of sensorimotor function, balance and gait. In the absence of any medical correlates that could possibly explain this relationship, this finding might be explained by age related degeneration of various body systems: including increased incidence of neurological and cardiovascular diseases as well as deterioration of the sensory organs in the peripheral vestibular system.

Dizziness and Vestibular Function

Of the many inner ear disorders that cause dizziness, BPPV is by far the most common (99). The Dix-Hallpike test is used to diagnose posterior canal BPPV (57), with the use of infrared goggles with video recording during the assessment, as used here, the most accurate method of BPPV diagnosis. In the current study, the overall prevalence of BPPV was similar to that found in previous studies of patients presenting with dizziness (18). Positive Hallpike test findings were significantly related to high dizziness handicap in that 28% (n = 27) of participants with a high dizziness handicap had a positive Hallpike test compared with 15% (n = 32) of participants with a low dizziness handicap (p=.048).

BPPV typically presents as multiple short episodes of dizziness. Participants with BPPV could have experienced multiple episodes over the twelve-month period. Due to the paroxysmal nature of the condition, the participant may be free from dizziness for hours to days at a time, causing them to record multiple isolated episodes of dizziness. Surprisingly, participants with more frequent dizziness were not more likely to have a positive Dix Hallpike test. In contrast to BPPV, individuals with chronic vestibular disorders such as vestibular neuritis, labyrinthitis or acoustic neuroma, typically experience a protracted episode of dizziness often with recurrent relapses of symptoms. The presence of unilateral vestibular hypofunction with many of these chronic conditions may explain the presence of head-shake nystagmus in participants with high dizziness frequency.

Multivariate Models

Common to both the high dizziness frequency and high dizziness handicap groups, were worse scores in the GAD-7 and higher physiological falls risk. This confirms the commonly reported relationship between dizziness and anxiety is present regardless of how dizziness is quantified. It also highlights that even in the absence of increased rates of falls amongst frequently dizzy participants, the risk of falls remains elevated across both groups. Cardiovascular medication use and presence of BPPV were independently associated with high dizziness handicap. Hypertension and high cholesterol can lead to vascular damage to the inner ear. It has been suggested that this may cause ischaemic changes to the vestibular labyrinth which in turn triggers detachment of otoconia leading to the development of BPPV.(19) Finally, positive head-shaking nystagmus was an independent predictor of dizziness frequency. The presence of head-shaking nystagmus indicates the presence of unilateral vestibular hypofunction. This sign is a common finding in general as well as dizzy populations, however the reason it was an independent predictor of dizziness frequency but not severity is not clear.

4.4 Conclusion

Amongst middle and older aged adults, dizziness is a common symptom that carries with it more sequelae than in younger populations. In this cohort, high dizziness frequency was associated with worse physiological fall risk, anxiety and depression, use of psychoanaleptic drug use as well as the presence of head-shaking nystagmus. In contrast to previous research, dizziness in this group was not significantly associated with comorbidities often identified in dizziness sufferers including; orthostatic hypotension and diabetes. There were also relatively few sensorimotor, balance and gait related associations with dizziness in this group. Amongst participants with high dizziness handicap, there were many more associated medical, psychological and physiological findings; including neck pain, back pain and increased use of most categories of medications. In comparison to the more frequently dizzy group, individuals with high dizziness handicap, also scored worse in most measures of sensorimotor function, balance and gait with the exception of contrast sensitivity, proprioception and lateral malleolus touch sensation. These participants also scored worse on all measures of mental health.

A broader range of correlates of dizziness were identified amongst those participants with high dizziness handicap than in those with high dizziness frequency. This indicates that the DHI is a more sensitive method than recording dizziness frequency for identifying middle and older aged adults at risk of developing complications as a result of dizziness. It is also possible that a subset of the cohort who were more frail and taking more medications, were more likely to report reduced quality of life, depression and anxiety as well as place more emphasis on dizziness when completing the Dizziness Handicap Inventory.

Chapter 5

General Discussion

In my attempt to understand the important factors associated with dizziness in older people, several physical, psychological, health and lifestyle factors were examined and discussed in the preceding chapters. This chapter discusses the study findings in relation to my original objectives as well as their implications for clinical practice, intervention and future research directions.

In patients 75 years and older, dizziness is the most common leading symptom that prompts a visit to the doctor and restricts activities of everyday life (100). There are many different causes of dizziness including those arising from psychological disorders, disturbances of the peripheral vestibular system, central nervous system and cardiovascular system. All of these systems deteriorate during ageing.

Many prevalence studies on dizziness in elderly populations are based on records from family practice. However, the correlates of dizziness in the population studied for this thesis are likely to be quite different from those of cohorts of patients who seek help from their doctor for dizziness. The main objective of this thesis was to characterise the demographic, medical, physical and psychological characteristics of middle-aged and older adults in the community with dizziness compared to those with less or no dizziness. The contrasting findings between the two studies likely relate to quite different cohorts resulting from different recruitment methods. The general sample of community-dwelling older adults included dizzy and non-dizzy participants whereas the dizziness study included middle-aged and older adults who had experienced a significant episode of dizziness in the past year. Participants from the general sample who stated they had dizziness in one questionnaire appear to have been less affected by dizziness than participants who enrolled in a dizziness study.

To my knowledge, this is the first study that has examined two complementary cohorts of community dwelling older adults using a comprehensive range of physical and psychological assessments. In the general sample, 23% of healthy older adults reported experiencing dizziness in the past year. This figure is consistent with previous studies that have estimated the one-year prevalence for significant dizziness to be between 20- 30% in persons older than 60 (29). Of the 305 participants in the dizziness study, 95 (31%) had DHI scores > 30 indicating moderate–severe dizziness handicap. This finding strengthens the argument that experiencing significant dizziness alone is not a cause of handicap in middle-aged and older adults.

The incidence of dizziness increases with advancing age. Interestingly, despite the significant age difference between the two cohorts; 83.0 ± 4.1 years in the general sample of older adults compared to 68.0 ± 8.2 years in the group of dizziness sufferers, symptom severity and impact on overall health was much greater in the younger cohort. This confirms the importance of evaluating not only the presence of dizziness but also the way in which the individuals perceive their dizziness handicap. Greater dizziness handicap was associated with more physical and psychological impairments.

In the general sample of older adults; back pain, motion sickness and fear of falling were the only factors significantly associated with dizziness. These are all subjective findings and are based on self-reporting of symptoms by the participant rather than diagnosis by a health care professional or objective assessment. Perhaps this can be explained by the theory of negative affectivity – a personality trait that refers to an individual's tendency to experience negative emotions. Individuals with negative affectivity differ in the way they perceive, and report body sensations. Participants with negative affectivity would be more likely to report abnormal physical sensations than those without (101).

In the dizziness study, the significant relationship between depression and anxiety and dizziness frequency and handicap can be interpreted in two ways; 1) Anxiety or depression is manifest as dizziness or 2) a primary neurotologic condition triggers a secondary anxiety disorder (41).

Physically the participants in the general sample with dizziness were similar to those without dizziness in measures of sensorimotor function, gait and falls. The only exception was that participants with dizziness were more likely to experience an unexplained fall. In the dizziness group, however, participants with high dizziness handicap and frequency differed greatly from the less dizzy participants in these measures. The more dizzy participants recorded slower gait speed, shorter step length and poorer balance including sway in varying conditions and maximal balance range. Worse physiological profile assessment (PPA) score was an independent predictor of both high DHI and more frequent dizziness episodes. This finding indicates the importance of efficient management of the older person with frequent and/or high dizziness handicap in preventing falls.

It appears that BPPV has a significant impact on the functional, emotional, and physical aspects of daily life as observed by DHI scores. This is perhaps due to the presentation of BPPV. Each episode starts without warning and is accompanied by intense rotational vertigo. It is also important to consider that even without finding an association between increased dizziness frequency and positive Dix Hallpike test, having a history of BPPV is also possibly responsible for increased dizziness frequency. To my knowledge, there is no physiological reason to explain why individuals with unilateral vestibular hypofunction as detected by the headshake test would be more likely to report increased dizziness frequency but not handicap. It is therefore possible the association found between dizziness frequency and head shaking nystagmus is a chance finding.

In contrast to previous studies, dizziness was not significantly associated with number of medications used in the general sample of older people. Multiple medication use, was however associated with high dizziness handicap in the dizziness sample. Multiple medication use in this population could be a marker of multiple comorbidities. It is difficult to determine if the multiple medications or the comorbidities that they are treating are responsible for the dizziness.

Within the general sample, significantly more dizzy participants experienced unexplained falls (10.3%) compared to the non-dizzy group (3.7%). It is difficult to determine the reason for this finding as no other physical or medical findings were significant and would be likely to mediate the relationship between dizziness and falls. However, the increased incidence of unexplained falls likely explains the increased fear of falling experienced by the dizziness sufferers in both cohorts.

The presence of dizziness may not be a major cause for concern for many middle-aged and older adults, that is, for some individuals dizziness has only minimal impact on their lives. This is reflected by the relative lack of dizziness correlates in general sample of community dwelling older adults who had experienced dizziness in the past year. In contrast, dizziness appears to drive health impairment, reduced quality of life and functional handicap in a significant sub-set of middle-aged and older people, as found by the many significant medical, physical and psychological correlates of dizziness handicap and frequency in the dizziness cohort.

The multivariate models performed in the dizziness cohort study indicate that there are a range of factors independently associated with dizziness in middle and older aged adults. The variables entered into the multivariate logistic regression models were chosen to give an indicator of the influence of five different domains on dizziness; vestibular, cardiovascular, pain,

psychological and sensorimotor/balance/gait on dizziness. The multivariate models uncovered factors independently associated with dizziness frequency (headshaking nystagmus, GAD-7 and PPA scores) and with dizziness handicap (positive Dix-Hallpike test, worse PPA and GAD-7 score and use of cardiovascular medications) which cross all five domains tested. This confirms the importance of screening dizziness sufferers for the presence of all of these impairments to correctly identify the individuals who require assessment and management of dizziness.

Strengths of both studies include the large sample sizes and the comprehensive battery of baseline assessments performed. The dizziness cohort study was superior to the general cohort study in that it included prospective collection of dizziness episodes. While several factors were identified as significant predictors of dizziness, comment is required on predictive accuracy of the multivariate logistic regression models. Both models had relatively low sensitivity: dizziness frequency (56%) and dizziness handicap (32%). This may be due in part to false negative findings during vestibular assessment. It is likely that a larger proportion of participants with high dizziness frequency and handicap would have had a positive Dix-Hallpike test if they were assessed during a dizziness episode. With a delay of days or weeks between recruitment and assessment, it is likely that many episodes of BPPV would have spontaneously resolved by the time the participant was assessed. Strategies for overcoming this limitation are addressed below.

Clinical Implications

This study has demonstrated that screening for presence of dizziness in a general sample of older adults is unlikely to be a useful or efficient public health initiative. However, assessing dizziness handicap and associated factors in people who seek medical attention may have utility. Assessments based on the findings of the dizziness cohort study could be used to create both quick and comprehensive assessment tools to evaluate dizziness for this group. For example, individuals seeking help for dizziness, moderate – severe dizziness handicap as

measured by the DHI should be used as an initial screen to identify those who require further assessment.

Patients who present to hospital emergency departments with dizziness typically present with acute symptoms and rapid assessment is required. In this setting, provided it is safe to do so and in the absence of any other neurological signs and symptoms, performing two simple tests (the Dix Hallpike and head-impulse tests) could help identify individuals with acute peripheral vestibular disorders. Additional tests conducted either in the ED or at a subsequent clinic visit could include assessments of anxiety, postural sway and medication use.

In a specialized dizziness - balance disorders clinic, comprehensive assessment of dizziness could include the above assessments and the full PPA (tests of vision, sensation, strength, reaction time and balance). However, because appointments are usually scheduled weeks or months in advance, patients are often asymptomatic at time of assessment. A "drop-in" clinic for individuals experiencing a dizziness episode would be beneficial for identifying the nature of a vestibular disorder and the appropriate therapy. In the case of BPPV it is important to correctly identify which one or more of the six semi-circular canals is affected. It is also necessary to determine whether the patient has ottoconia which are free-floating within the canal (Canalithiasis) or adhered to the cupula (Cupulolithiasis), in order to select the appropriate canalith repositioning manoeuver. Similarly, with other common vestibular disorders, being able to assess a patient soon after they become dizzy makes diagnosis more reliable. Abnormal eye signs and nystagmus typically become less obvious as the brain begins the process of compensation.

Based on the problems identified, appropriate treatment options including; balance exercises, cognitive behavioural therapy, medication management and vestibular rehabilitation

would be prescribed. These targeted interventions could disrupt the vicious cycle of dizziness and health-related issues experienced by older adults.

Future studies could implement the assessment and treatment models outlined above and then evaluate the effectiveness of these models. Future studies could also examine the causes of dizziness in the elderly by including occulomotor assessment done through remote extended monitoring in the patient's home. In this case, it would be easier to quantify the number of cases of BPPV and other paroxysmal vestibular conditions as well as the characteristics of their presentation. Vestibular migraine is thought to be second only to BPPV in frequency of vestibular causes of dizziness. There is currently very limited research on this disease. Investigation into dizziness in older adults with a history of migraine might provide some information on the evolving nature of this condition throughout an individual's life.

Conclusion

The two studies described in this thesis present contrasting findings. The first conducted in a cohort of randomly selected older people living in the community found the presence of dizziness was associated with only a few factors: back pain, motion sickness and fear of falling. In the second study conducted in a large cohort of middle-aged and older community dwelling adults recruited due to the presence of significant dizziness, many more factors were found to be associated with dizziness severity. In multivariate analyses, higher GAD-7 scores, likely BPPV as indicated by a positive Dix Hallpike test, cardiovascular medication use and higher PPA scores were independent predictors of reporting moderate to severe dizziness handicap while higher PPA and GAD-7 scores as well as a positive headshaking test were independent predictors of suffering frequent dizziness. These findings indicate that many people who seek attention for dizziness symptoms have significantly reduced quality of life and a range of underlying factors amenable to treatment. Further research is required to determine whether the risk factors identified for dizziness handicap and frequency could be used as a

clinical assessment to guide tailored intervention to alleviate dizziness and improve quality of life in older people with significant dizziness.

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Appendices: Structured Interviews

Memory and Ageing Study– Wave 4

Dizziness randomised-controlled trial

APPENDIX 1: STRUCTURED INTERVIEW

TREATING DIZZINESS

Section A: Demographics

Firstly, we would like to know some basic details about you.

1. What is your date of birth? ……/……/……

2. What is your gender? Male [ ] Female [ ]

3. What type of accommodation do you live in?

House	[ ]
Unit / flat	[ ]
Retirement village	[ ]
Other - please state: ……	[ ]

4. Who else lives in the home with you?

I live alone	[ ]
I live with my spouse only	[ ]
I live with my spouse and children	[ ]
I live with a child/children	[ ]
I live with relatives/friends	[ ]
Other - please state: ……	[ ]

5. How much of the time during the past 4 weeks…

	All of the Time	Most of the Time	A good bit of the time	Some of the Time	A Little of the Time	None of the Time
a) Have you felt calm and peaceful?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
b) Did you have a lot of energy?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
c) Have you felt downhearted and blue?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

6. Do you think the following would be useful in reducing your dizziness symptoms?
(You may mark more than one)

Improving muscular strength	[ ]
Reviewing the medications I am taking	[ ]
Improving balance	[ ]
Reducing anxiety and stress levels	[ ]
Visiting an ophthalmologist	[ ]
Reducing daily activities	[ ]

Attending physiotherapy sessions	[ ]
Getting up slowly and avoiding sudden changes in position	[ ]
Drinking plenty of liquid	[ ]
Eating healthy	[ ]

Section B: Health

Next, we would like to know about your health, including any conditions, symptoms or diseases you may have, or had in the past.

1. Do you currently suffer from any following conditions/diseases?

Hearing Impairment	Yes	[ ]	No	[ ]	
Parkinson's Disease	Yes	[ ]	No	[ ]	
Peripheral Vascular Disease	Yes	[ ]	No	[ ]	
Osteoporosis	Yes	[ ]	No	[ ]	
Arthritis /joint problems	Yes	[ ]	No	[ ]	
Multiple sclerosis	Yes	[ ]	No	[ ]	
Insomnia or sleep related disorders?	Yes	[ ]	No	[ ]	
Diabetes	Yes	[ ]	No	[ ]	Age diagnosed?.....
If Yes, how do you manage it? E.g. diet, tablets, insulin.....					
How would you describe your diabetic control? E.g. poor, fair, good?.....					
Kidney Disease	Yes	[ ]	No	[ ]	
Heart Disease (ischemic heart disease, angina, cardiac arrhythmia, atrial fibrillation)	Yes	[ ]	No	[ ]	If yes, please specify: ……
High Blood Pressure (including treated)	Yes	[ ]	No	[ ]	
High Cholesterol	Yes	[ ]	No	[ ]	
Incontinence - Urinary	Yes	[ ]	No	[ ]	
Epilepsy	Yes	[ ]	No	[ ]	
Chronic lung disease	Yes	[ ]	No	[ ]	Please specify……..
Thyroid disorder	Yes	[ ]	No	[ ]	
Please specify type: underactive [ ] overactive [ ] and treatment:……..					
Cancer	Yes	[ ]	No	[ ]	Year diagnosed……
Please specify type and treatment:…… Status:……..					
Depression (diagnosed)	Yes	[ ]	No	[ ]	
Anxiety disorder (diagnosed)	Yes	[ ]	No	[ ]	
Other mental health disorders	Yes	[ ]	No	[ ]	Please specify (bipolar disorder, schizophrenia..):……..
Pain - Neck	Yes	[ ]	No	[ ]	
Pain - Back	Yes	[ ]	No	[ ]	
Pain - Hip	Yes	[ ]	No	[ ]	
Pain - Knee / Leg	Yes	[ ]	No	[ ]	
Pain - Feet	Yes	[ ]	No	[ ]	
If you reported pain anywhere, would you rate it as:	Mild	[ ]	Moderate	[ ]	Severe [ ]
Does pain affect your mobility or function?	Yes	[ ]	No	[ ]	

Have you had any unplanned hospitalizations in the past year?	Yes	[ ]	No	[ ]	If yes, please specify: ……

2. Have you <u>ever</u> had any of the following conditions/ symptoms?

Stroke	Yes	[ ]	No	[ ]	
If yes, how many?..... Last one?..... Which side?.....					
TIA (Transient Ischemic Attack) or mini-stroke	Yes	[ ]	No	[ ]	
If yes, how many?..... Last one?..... Which side?.....					
Serious head injury/knocked out *and* been unconscious after it	Yes	[ ]	No	[ ]	
Heart Attack	Yes	[ ]	No	[ ]	
If yes, how many?.....					
Unexplained collapses	Yes	[ ]	No	[ ]	
If yes, when was the last one?.....					

3. How much alcohol do you consume on average?

None	[ ]
Trivial (<1 unit/day)	[ ]
Light (1-2 units/day)	[ ]
Moderate (3-6units/day)	[ ]
Heavy (7-9units/day)	[ ]
Very heavy (>9 units/day)	[ ]

4. How much do you smoke on average?

Non-smoker	[ ]
Ex-smoker	[ ]
Light smoker (<10/day)	[ ]
Moderate (10-19/day)	[ ]
Heavy (20+/day)	[ ]

5. What type of glasses do you normally wear?

	Inside	Outside
Single lens distance glasses	[ ]	[ ]
Bifocals	[ ]	[ ]
Multifocals	[ ]	[ ]
Contact lenses	[ ]	[ ]
Regular (non-prescription) sun glasses	[ ]	[ ]
NA – I don't wear glasses	[ ]	[ ]

6. Do / did you have any of the following eye-related problems / procedures?

	Left eye	Right eye	Both eyes	No
Cataracts	[ ]	[ ]	[ ]	[ ]
Cataract surgery	[ ]	[ ]	[ ]	[ ]
Glaucoma	[ ]	[ ]	[ ]	[ ]

Macular degeneration	[ ]	[ ]	[ ]	[ ]
Visual field loss			[ ]	[ ]

7. What aids do you usually use to help you move….?

	Inside the house	**Outside** the house
No aids used	[ ]	[ ]
Walking stick	[ ]	[ ]
Walking frame	[ ]	[ ]
Crutches	[ ]	[ ]

Section D: FALLS

Now we would like to ask some questions about falls.

1. How many falls did you have in the past 12 months?

0 – Please go to question 3	[ ]
1	[ ]
2	[ ]
3+	[ ]

2. Have you suffered any injuries from any falls in the past 12 months?

YES [ ] NO [ ]

a. Have you had any broken bones as a result of a fall? (Tick more than one if necessary)

NO [ ]

YES [ ] → Which part of your body? Wrist [ ]

Hip [ ]

Spine [ ]

Other [ ] Specify: .....

b. Were you taken to hospital as a result of one or more falls?

YES [ ] NO [ ]

c. As a result of a fall, did you suffer any injuries that affect your mobility now?

YES [ ] NO [ ]

3. Do you feel your balance is?

Poor	[ ]
Fair	[ ]
Good	[ ]
Very good	[ ]
Excellent	[ ]

Section E: MEDICATIONS (fill in according to list brought in by participant)

Medication	**Prescribed for**	**Dose**	**Frequency**	**Length of time taken**
(eg - brand name or drug/generic name)	(eg What is the medication used for)	(eg – 500mg)	(e.g. once daily)	(approximately)
1.				_____ Months
2.				_____ Months
3.				_____ Months
4.				_____ Months
5.				_____ Months
6.				_____ Months
7.				_____ Months
8.				_____ Months
9.				_____ Months
10.				_____ Months
11.				_____ Months
12.				_____ Months

If benzodiazepines: do you ever take more than than your prescribed dose? Yes [ ] No [ ]

If yes, why? .....

.....

Section F: GENERALIZED ANXIETY DISORDER 7-ITEM (GAD-7) SCALE

For each of the following questions, please circle the frequency the closest for you.

Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all sure	Several days	Over half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it's hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3
If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?		Not difficult at all		[ ]
		Somewhat difficult		[ ]
		Very difficult		[ ]
		Extremely difficult		[ ]

Section G: PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems?
Please circle the frequency the closest for you.

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. On the opposite – being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself in some way	0	1	2	3
10. If you checked off any problems, how difficult have these				

problems made it for you to do your work, take care of things at home, or get along with other people?	Not difficult at all Somewhat difficult Very difficult Extremely difficult	[ ] [ ] [ ] [ ]

Section H: EQ-5D SCALE

Under each heading, please tick the ONE box that best describes your health TODAY

MOBILITY	
I have no problems in walking about	[ ]
I have slight problems in walking about	[ ]
I have moderate problems in walking about	[ ]
I have severe problems in walking about	[ ]
I am unable to walk about	[ ]
SELF-CARE	
I have no problems washing or dressing myself	[ ]
I have slight problems washing or dressing myself	[ ]
I have moderate problems washing or dressing myself	[ ]
I have severe problems washing or dressing myself	[ ]
I am unable to wash or dress myself	[ ]
USUAL ACTIVITIES *(e.g. work, housework, family or leisure activities)*	
I have no problems doing my usual activities	[ ]
I have slight problems doing my usual activities	[ ]
I have moderate problems doing my usual activities	[ ]
I have severe problems doing my usual activities	[ ]
I am unable to do my usual activities	[ ]
PAIN / DISCOMFORT	
I have no pain or discomfort	[ ]
I have slight pain or discomfort	[ ]
I have moderate pain or discomfort	[ ]
I have severe pain or discomfort	[ ]
I have extreme pain or discomfort	[ ]
ANXIETY / DEPRESSION	
I am not anxious or depressed	[ ]
I am slightly anxious or depressed	[ ]
I am moderately anxious or depressed	[ ]
I am severely anxious or depressed	[ ]

I am extremely anxious or depressed	[ ]

Section H: EQ-5D SCALE (Continued)

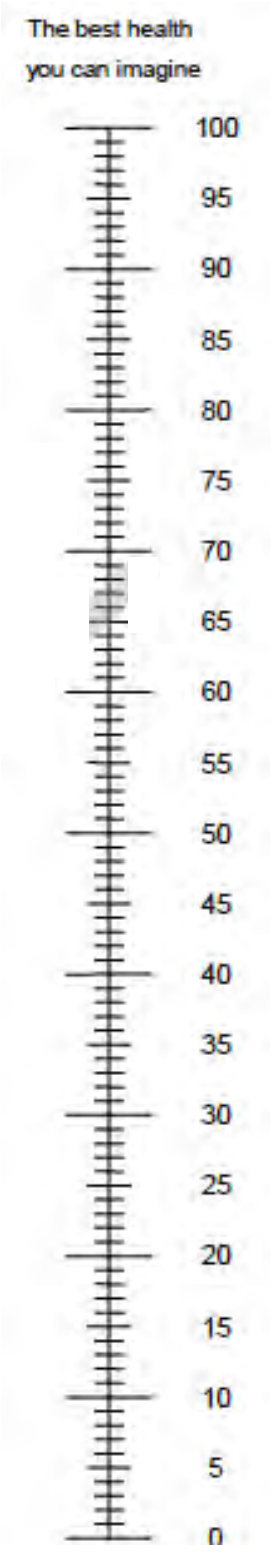
We would like to know how good or bad your health is TODAY.

This scale is numbered from 0 to 100.

100 means the best health you can imagine. 0 means the worst health you can imagine.

Mark an X on the scale to indicate how your health is TODAY.

Now, please write the number you marked on the scale in the box .....



Section I: AQoL-6D

Q1. How much help do you need with jobs around the house (e.g., preparing food, cleaning the house or gardening):	
I can do all these tasks very quickly and efficiently without any help	**[ ]**
I can do these tasks relatively easily without help	**[ ]**
I can do these tasks only very slowly without help	**[ ]**
I cannot do most of these tasks unless I have help	**[ ]**
I can do none of these tasks by myself	**[ ]**
Q2. Thinking about how easy or difficult it is for you to get around by yourself outside your house (e.g., shopping, visiting):	
getting around is enjoyable and easy	**[ ]**
I have no difficulty getting around outside my house	**[ ]**
A little difficulty	**[ ]**
Moderate difficulty	**[ ]**
A lot of difficulty	**[ ]**
I cannot get around unless there is someone there to help me	**[ ]**
Q3. Thinking about your mobility, including using any aids or equipment such as wheelchairs, frames, sticks:	
Im very mobile	**[ ]**
I have no difficulty with my mobility	**[ ]**
I have some difficulty with mobility (for example, going uphill)	**[ ]**
I have difficulty with mobility. I can go short distances only.	**[ ]**
I have a lot of difficulty with mobility. I need someone to help me	**[ ]**
I am bedridden	**[ ]**
Q4 . Thinking about washing yourself, toileting, dressing, eating or looking after your appearance:	
these tasks are very easy for me	**[ ]**
I have no real difficulty in carrying out these tasks	**[ ]**
I find some of these tasks difficult, but I manage to do them on my own	**[ ]**
many of these tasks are difficult, and I need help to do them	**[ ]**
I cannot do these tasks by myself at all	**[ ]**
Q5. Your close and intimate relationships (including any sexual relationships) make you:	
very happy	**[ ]**

generally happy	[ ]
neither happy nor unhappy	[ ]
generally unhappy	[ ]
very unhappy	[ ]
Q6. Thinking about your health and your relationship with your family:	
my role in the family is unaffected by my health	[ ]
there are some parts of my family role I cannot carry out	[ ]
there are many parts of my family role I cannot carry out	[ ]
I cannot carry out any part of my family role	[ ]
Q7. Thinking about your health and your role in your community (that is to say neighbourhood, sporting, work, church or cultural groups):	
my role in the community is unaffected by my health	[ ]
there are some parts of my community role I cannot carry out	[ ]
there are many parts of my community role I cannot carry out	[ ]
I cannot carry out any part of my community role	[ ]
Q8. How often did you feel in despair over the last seven days?	
never	[ ]
occasionally	[ ]
sometimes	[ ]
often	[ ]
All the time	[ ]
Q9. And still thinking about the last seven days, how often did you feel worried?	
Never	[ ]
occasionally	[ ]
somethimes	[ ]
often	[ ]
All the time	[ ]
Q10. How often do you feel sad?	
never	[ ]
rarely	[ ]

Some of the time	[ ]
usually	[ ]
All of the time	[ ]
Q11. When you think about whether you are calm and tranquil or agitated - I am	
always calm and tranquil	[ ]
usually calm and tranquil	[ ]
sometimes calm and tranquil, sometimes agitated	[ ]
usually agitated	[ ]
always agitated	[ ]
Q12. Thinking about how much energy you have to do the things you want to do - I am	
always full of energy	[ ]
usually full of energy	[ ]
occasionally energetic	[ ]
usually tired and lacking energy	[ ]
always tired and lacking energy	[ ]
Q13. How often do you feel in control of your life?	
always	[ ]
mostly	[ ]
sometimes	[ ]
Only occasionally	[ ]
never	[ ]
Q14. How much do you feel you can cope with life's problems?	
completely	[ ]
mostly	[ ]
partly	[ ]
Very little	[ ]
Not at all	[ ]
Q15.Thinking about how often you experience serious pain - I experience it:	
Very rarely	[ ]

Less than once a week	[ ]
Three to four times a week	[ ]
Most of the time	[ ]
Q16. How much pain or discomfort do you experience:	
None at all	[ ]
I have moderate pain	[ ]
I suffer from severe pain	[ ]
I suffer unbearable pain	[ ]
Q17. How often does pain interfere with your usual activities?	
never	[ ]
rarely	[ ]
sometimes	[ ]
often	[ ]
always	[ ]
Q18. Thinking about your vision (using your glasses or contact lenses if needed):	
I have excellent sight	[ ]
I see normally	[ ]
I have some difficulty focusing on things, or I do not see them sharply. E.g. small print, a newspaper or seeing objects in the distance.	[ ]
I have a lot of difficulty seeing things. My vision is blurred. I can see just enough to get by with.	[ ]
I only see general shapes. I need a guide to move around	[ ]
I am completely blind	[ ]
Q19. Thinking about your hearing (using your hearing aid if needed):	
I have excellent hearing	[ ]
I hear normally	[ ]
I have some difficulty hearing or I do not hear clearly. I have trouble hearing softly-spoken people or when there is background noise.	[ ]
Often I have difficulty hearing things clearly. Often I do not understand what is said. I usually do not take part in conversations because I cannot hear what is said.	[ ]
I hear very little indeed. I cannot fully understand loud voices speaking directly to me.	[ ]

I am completely deaf	[ ]
Q20. When you communicate with others, e.g. by talking, listening, writing or signing:	
I have no trouble speaking to them or understanding what they are saying	[ ]
I have some difficulty being understood by people who do not know me. I have no trouble understanding what others are saying to me.	[ ]
I am understood only by people who know me well. I have great trouble understanding what others are saying to me.	[ ]
I have a lot of difficulty seeing things. My vision is blurred. I can see just enough to get by with.	[ ]
I cannot adequately communicate with others	[ ]

Section J: Dizziness history

How would you describe your dizziness?					
1. Spinning sensation – if yes, is it	Yes	[ ]	No	[ ]	
• room spinning	Yes	[ ]	No	[ ]	
• head spinning	Yes	[ ]	No	[ ]	
• Both	Yes	[ ]	No	[ ]	
2.Faint / syncope	Yes	[ ]	No	[ ]	
3. Unsteadiness	Yes	[ ]	No	[ ]	
4. Something else	Yes	[ ]	No	[ ]	Please specify:
5. Date when dizziness first experienced: Circumstances((Duration, activity being performed, what did it feel like):					
6. Date when dizziness most recently experienced: Circumstances:					
7. Is it constant or does it comes and go? (circle)					
8. Ever investigated – if yes , was it by	Yes	[ ]	No	[ ]	
• A GP	Yes	[ ]	No	[ ]	Please specify:
• Some specialist(s)	Yes	[ ]	No	[ ]	Please specify:
9. Any associated symptoms	Yes	[ ]	No	[ ]	Please specify:
10. Hearing problems	Yes	[ ]	No	[ ]	Which ear:
11. Tinnitus	Yes	[ ]	No	[ ]	
12. Ear fullness	Yes	[ ]	No	[ ]	
13. Neck pain / problems (whiplash…)	Yes	[ ]	No	[ ]	Please specify:
13. Back pain / problems	Yes	[ ]	No	[ ]	Please specify:
14. Migraines / headaches	Yes	[ ]	No	[ ]	
15. Heart palpitations	Yes	[ ]	No	[ ]	
16. Heart missing a bit	Yes	[ ]	No	[ ]	
17. Family history of vertigo / dizziness	Yes	[ ]	No	[ ]	Please specify:
18. What do you do when your dizziness comes on (sit down, got to bed, medications, carry on…)?					

17. Do you suffer from motion sickness?	Yes	[ ]	No	[ ]	

Section K: VERTIGO SYMPTOM SCALE

For each of the following items, please circle the number between 1 and 5 to indicate how often (if at all) you experienced each symptom in the past year.

	Never (0) to Very often (more than once a week) (5)					
Things spinning/moving						
1. Less than two minutes	0	1	2	3	4	5
2. 2–20 minutes	0	1	2	3	4	5
3. 20 minutes to 1 hour	0	1	2	3	4	5
4. Several hours	0	1	2	3	4	5
5. More than 12 hours	0	1	2	3	4	5
Light-headedness/giddiness						
6. Less than 2 minutes	0	1	2	3	4	5
7. 2–20 minutes	0	1	2	3	4	5
8. 20 minutes to 1 hour	0	1	2	3	4	5
9. Several hours	0	1	2	3	4	5
10. More than 12 hours	0	1	2	3	4	5
Unsteadiness	0	1	2	3	4	5
11. Less than 2 minutes	0	1	2	3	4	5
12. 2–20 minutes	0	1	2	3	4	5
13. 20 minutes to 1 hour	0	1	2	3	4	5
14. Several hours	0	1	2	3	4	5
15. More than 12 hours	0	1	2	3	4	5

Section K: VERTIGO SYMPTOM SCALE (Continued)

For each of the following items, please circle the number between 1 and 5 to indicate how often (if at all) you experienced each symptom in the past year.

	Never (0) to Very often (more than once a week) (5)					
16. Falling over	0	1	2	3	4	5
17. Unable to stand, walk	0	1	2	3	4	5
18. Vomiting	0	1	2	3	4	5
19. Nausea, feeling sick	0	1	2	3	4	5
20. Heart/chest pain	0	1	2	3	4	5
21. Hot or cold spells	0	1	2	3	4	5
22. Tense/sore muscles	0	1	2	3	4	5
23. Trembling, shivering	0	1	2	3	4	5
24. Heart pounding	0	1	2	3	4	5
25. Arms/legs feel heavy	0	1	2	3	4	5
26. Visual disturbances	0	1	2	3	4	5
27. Headache	0	1	2	3	4	5
28. Breathing difficulties	0	1	2	3	4	5
29. Poor concentration	0	1	2	3	4	5
30. Tingling, pricking	0	1	2	3	4	5
31. Lower back pain	0	1	2	3	4	5
32. Pressure in the ears	0	1	2	3	4	5
33. Excessive sweating	0	1	2	3	4	5
34. Feeling faint	0	1	2	3	4	5

Section L: DIZZINESS HANDICAP INVENTORY

Instructions: *The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness or unsteadiness. Please answer "yes", "no" or "sometimes" to each question. Answer each question as it applies to your dizziness or unsteadiness only.*

Item	Question		Y	N	S
1.	Does looking up increase your problem?	P			
2.	Because of your problem, do you feel frustrated?	E			
3.	Because of your problem, do you restrict your travel for business or recreation?	F			
4.	Does walking down the aisle of a supermarket increase your problem?	P			
5.	Because of your problem, do you have difficulty getting into or out of bed?	F			
6.	Does your problem significantly restrict your participation in social activities such as going out to dinner, the movies, dancing or to parties?	F			
7.	Because of your problem, do you have difficulty reading?	F			
8.	Does performing more ambitious activities such as sports or dancing or household chores such as sweeping or putting dishes away increase your problem?	P			
9.	Because of your problem, are your afraid to leave your home without having someone accompany you?	E			
10.	Because of your problem, are you embarrassed in front of others?	E			
11.	Do quick movements of your head increase your problem?	P			
12.	Because of your problem, do you avoid heights?	F			
13.	Does turning over in bed increase your problem?	P			

14.	Because of your problem, is it difficult for you to do strenuous housework or yard work?	F			
15.	Because of your problem, are you afraid people may think you are intoxicated?	E			
16.	Because of your problem, is it difficult for you to walk by yourself?	F			
Item	Question		Y	N	S
17.	Does walking down a sidewalk increase your problem?	P			
18.	Because of your problem, is it difficult for you to concentrate?	E			
19.	Because of your problem, is it difficult for you to walk around the house in the dark?	F			
20.	Because of your problem, are you afraid to stay at home alone?	E			
21.	Because of your problem, do you feel handicapped?	E			
22.	Has your problem placed stress on your relationship with members of your family or friends?	E			
23.	Because of your problem, are you depressed?	E			
24.	Does your problem interfere with your job or household responsibilities?	F			
25.	Does bending over increase your problem?	P			
			X 4	X 0	X 2
	=				
	TOTAL				

Section M: NEO-FFI

This questionnaire contains 60 statements. Read each statement carefully. For each statement put a tick ✓ inside the square that has the response that best represents your opinion.

*If you need to change your answer, make an **X** through the incorrect response and then fill in the correct response.*

Statement		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I am not a worrier	N	4	3	2	1	0
2. I like to have a lot of people around me	E	0	1	2	3	4
3. I enjoy concentrating on a fantasy or daydream and exploring all its possibilities, letting it grow and develop	O	4	3	2	1	0
4. I try to be courteous to everyone I meet	A	0	1	2	3	4
5. I keep my belongings neat and clean	C	0	1	2	3	4
6. At times I have felt bitter and resentful	N	0	1	2	3	4
7. I laugh easily	E	0	1	2	3	4
8. I think it's interesting to learn and develop new hobbies	O	4	3	2	1	0
9. At times, I bully or flatter people into doing what I want them to	A	4	3	2	1	0
10. I'm pretty good about pacing myself so as to get things done on time	C	0	1	2	3	4
11. When I'm under a great deal of stress, sometimes I feel like I'm going to pieces	N	0	1	2	3	4
12. I prefer jobs that let me work alone without being bothered by other people	E	4	3	2	1	0
13. I am intrigued by the patterns I find in art and nature	O	0	1	2	3	4
14. Some people think I'm selfish and egotistical	A	4	3	2	1	0
15. I often come into situations without being fully prepared	C	4	3	2	1	0

16. I rarely feel lonely or blue	N	4	3	2	1	0
Statement		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17. I really enjoy talking to people	E	0	1	2	3	4
18. I believe letting students hear controversial speakers can only confuse and mislead them	O	4	3	2	1	0
19. If someone starts a fight, I'm ready to fight back	A	0	1	2	3	4
20. I try to perform all the tasks assigned to me conscientiously	C	0	1	2	3	4
21. I often feel tense and jittery	N	0	1	2	3	4
22. I like to be where the action is	E	0	1	2	3	4
23. Poetry has little or no effect on me	O	4	3	2	1	0
24. I'm better than most people, and I know it	A	4	3	2	1	0
25. I have a clear set of goals and work toward them in an orderly fashion	C	0	1	2	3	4
26. Sometimes I feel completely worthless	N	0	1	2	3	4
27. I shy away from crowds of people	E	4	3	2	1	0
28. I would have difficulty just letting my mind wander without control of guidance	O	0	1	2	3	4
29. When I've been insulted, I just try to forgive and forget	A	4	3	2	1	0
30. I waste a lot of time before settling down to work	C	4	3	2	1	0
31. I rarely feel fearful or anxious	N	4	3	2	1	0
32. I often feel as if I'm bursting with energy	E	0	1	2	3	4
33. I seldom notice the moods or feelings that different environments produce	O	0	1	2	3	4
34. I tend to assume the best about people	A	0	1	2	3	4

35. I work hard to accomplish my goals	C	0	1	2	3	4
Statement		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
36. I often get angry at the way people treat me	N	0	1	2	3	4
37. I am a cheerful, high-spirited person	E	0	1	2	3	4
38. I experience a wide range of emotions or feelings	O	4	3	2	1	0
39. Some people think of me as cold and calculating	A	4	3	2	1	0
40. When I make a commitment, I can always be counted on to follow through	C	0	1	2	3	4
41. Too often, when things go wrong, I get discouraged and feel like giving up	N	0	1	2	3	4
42. I don’t get much pleasure from chatting to people	E	4	3	2	1	0
43. Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement	O	0	1	2	3	4
44. I have no sympathy for beggars	A	4	3	2	1	0
45. Sometimes I'm not as dependable or reliable as I should be	C	4	3	2	1	0
46. I am seldom sad or depressed	N	4	3	2	1	0
47. My life is fast-paced	E	0	1	2	3	4
48. I have little interest in speculating on the nature of the universe or the human condition	O	4	3	2	1	0
49. I generally try to be thoughtful and considerate	A	0	1	2	3	4
50. I am a productive person who always gets the job done	C	0	1	2	3	4
51. I often feel helpless and want someone else to solve my problems	N	0	1	2	3	4
52. I am a very active person	E	0	1	2	3	4

53. I have a lot of intellectual curiosity	O	0	1	2	3	4
54. If I don't like people, I let them know it	A	4	3	2	1	0
Statement		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
55. I never seem to be able to get organised	C	4	3	2	1	0
56. At times I have been so ashamed I just wanted to hide	N	0	1	2	3	4
57. I would rather go my own way than be a leader of others	E	4	3	2	1	0
58. I often enjoy playing with theories or abstract ideas	O	0	1	2	3	4
59. If necessary, I am willing to manipulate people to get what I want	A	4	3	2	1	0
60. I strive for excellence in everything I do	C	0	1	2	3	4

Thank you for completing the questionnaire.

Uptake Questionnaire

Dizziness Study

Please tick the boxes you feel best answer the questions for you.

You may tick more than one box for each question if necessary.

1. What are your motivations for joining the dizziness study?

I have had an accident, a fall or injured myself due to dizziness episodes in the past and wish to prevent future incidents	[ ]
I have not had a dizziness related accident, fall or injury, but I am concern I could have one	[ ]
I have been advised by a health professional that joining the study might be a good idea	[ ]
I have lots of free time	[ ]
My family encouraged me to join	[ ]
I wanted to help the research on dizziness	[ ]
Other (Specify):	[ ]

2. Do you think the following would be useful in reducing your dizziness symptoms?

(You may mark more than one)

Improving muscular strength	[ ]
Reviewing the medications I am taking	[ ]
Improving balance	[ ]
Reducing anxiety and stress levels	[ ]
Visiting an ophthalmologist	[ ]
Reducing daily activities	[ ]
Attending physiotherapy sessions	[ ]
Getting up slowly and avoiding sudden changes in position	[ ]
Drinking plenty of liquid	[ ]
Eating healthy	[ ]

3. **Please indicate the extent to which you agree with each of the following statements. Put a tick (✓) inside the square that best represents your opinion. Remember that there are no right or wrong answers.**

Statement	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**
Participating in this study will help reduce my dizziness symptoms.				
Participating in this study will help reduce my likelihood of falling.				
Participating in this study will improve my overall health and wellbeing.				

MEMORY AND AGEING STUDY - WAVE 4

VESTIBULAR FUNCTION AND FALLS STUDY – QUESTIONNAIRE –PART 1

[NEUROSCIENCE RESEARCH AUSTRALIA and THE UNIVERSITY OF NEW SOUTH WALES]

Section A: Demographics

Firstly, we would like to know some basic details about you.

1. What is your date of birth? ……/……/……

2. What is your gender? Male [ ] Female [ ]

3. What type of accommodation do you live in?

House	[ ]
Unit / flat	[ ]
Retirement village	[ ]
Other - please state: ……	[ ]

4. Who else lives in the home with you?

I live alone	[ ]
I live with my spouse only	[ ]
I live with my spouse and children	[ ]
I live with a child/children	[ ]
I live with relatives/friends	[ ]
Other - please state: ……	[ ]

5. Do you use?

A computer at home	Yes	[ ]	No	[ ]
Emails	Yes	[ ]	No	[ ]
If yes, what is your email address? …… ……				
The internet	Yes	[ ]	No	[ ]

6. How much of the time during the past 4 weeks…

	All of the Time	Most of the Time	A good bit of the time	Some of the Time	A Little of the Time	None of the Time
a) Have you felt calm and peaceful?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
b) Did you have a lot of energy?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
c) Have you felt downhearted and blue?	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Section B: Health

Next, we would like to know about your health, including any conditions, symptoms or diseases you may have, or had in the past.

1. Do you currently suffer from any following conditions/diseases?

Hearing Impairment	Yes	[ ]	No	[ ]	
Parkinson's Disease	Yes	[ ]	No	[ ]	
Peripheral Vascular Disease	Yes	[ ]	No	[ ]	
Osteoporosis	Yes	[ ]	No	[ ]	
Angina	Yes	[ ]	No	[ ]	
Diabetes	Yes	[ ]	No	[ ]	Age diagnosed?.....
If Yes, how do you manage it? E.g. diet, tablets, insulin.....					
How would you describe your diabetic control? E.g. poor, fair, good?.....					
Kidney Disease	Yes	[ ]	No	[ ]	
Heart Disease	Yes	[ ]	No	[ ]	
High Blood Pressure (including treated)	Yes	[ ]	No	[ ]	
High Cholesterol	Yes	[ ]	No	[ ]	
Incontinence - Urinary	Yes	[ ]	No	[ ]	
Epilepsy	Yes	[ ]	No	[ ]	
Chronic lung disease	Yes	[ ]	No	[ ]	Please specify……...
Thyroid disorder	Yes	[ ]	No	[ ]	
Please specify type: underactive [ ] overactive [ ] and treatment:……..					
Cancer	Yes	[ ]	No	[ ]	Year diagnosed……
Please specify type and treatment:…… Status:……..					
Pain –Neck	Yes	[ ]	No	[ ]	
Pain – Back	Yes	[ ]	No	[ ]	
Pain - Hip	Yes	[ ]	No	[ ]	
Pain – Knee / Leg	Yes	[ ]	No	[ ]	
Pain - Feet	Yes	[ ]	No	[ ]	

2. Do you have pain, aching or stiffness in either one or both feet? YES [ ] NO [ ]

3. Have you <u>ever</u> had any of the following conditions/ symptoms?

Stroke	Yes	[ ]	No	[ ]	
If yes, how many?..... Last one?..... Which side?.....					
TIA (Transient Ischemic Attack) or mini-stroke	Yes	[ ]	No	[ ]	
If yes, how many?..... Last one?..... Which side?.....					

Serious head injury/knocked out *and* been unconscious after it	Yes	[ ]	No	[ ]	
Heart Attack	Yes	[ ]	No	[ ]	
If yes, how many?.....					
Knee replacement	Yes	[ ]	No	[ ]	
Hip replacement	Yes	[ ]	No	[ ]	

4. Since the age of 60, have you ever had any of the following symptoms?

Broken Wrist	Yes	[ ]		No	[ ]
Broken Hip / Pelvis	Yes	[ ]		No	[ ]
Other broken bone – Please specify:……	Yes	[ ]		No	[ ]
Unexplained collapses	Yes	[ ]		No	[ ]

5a. Since the age of 60, have you ever had vertigo / dizziness ?

YES [ ] NO [ ] (go to question 6)

5b. If yes, when did you last feel dizzy?

More than 10 years ago	[ ]
8-10 years ago	[ ]
1- 2 years ago	[ ]
2- 12 months ago	[ ]
2 -8 weeks ago	[ ]
Within the past 2 weeks	[ ]

5c. In the past year how often did you feel dizzy?

I didn't feel dizzy in the past year	[ ]
Once	[ ]
Twice	[ ]
3 to 5 times	[ ]
5 to 10 times	[ ]
Most of the time	[ ]
All the time	[ ]

5d How long on average do your dizziness symptoms last?

Less than 2 minutes	[ ]
2 - 20 minutes	[ ]
20 minutes to 1 hour	[ ]
Several hours	[ ]
More than 12 hours	[ ]

6. Do you suffer from motion sickness (i-e in a car, bus, boat…)?

Often [ ] Occasionally [ ] Never [ ]

7. Can you read on the bus without feeling nauseous?

YES [ ] NO [ ]

8. What type of glasses do you normally wear?

	Inside	Outside
Single lens distance glasses	[ ]	[ ]
Bifocals	[ ]	[ ]
Multifocals	[ ]	[ ]
Contact lenses	[ ]	[ ]
Regular (non-prescription) sun glasses	[ ]	[ ]
NA – I don't wear glasses	[ ]	[ ]

9. Do / did you have any of the following eye-related problems / procedures?

	Left eye	Right eye	Both eyes	No
Cataracts	[ ]	[ ]	[ ]	[ ]
Cataract surgery	[ ]	[ ]	[ ]	[ ]
Glaucoma	[ ]	[ ]	[ ]	[ ]
Macular degeneration	[ ]	[ ]	[ ]	[ ]
Visual field loss			[ ]	[ ]

10a. Has a doctor or other health professional told you that you have any joint problems, rheumatism or arthritis? YES [ ] NO [ ]

10b. If yes, what type of arthritis or joint problems do you have? And where?

Arthritis type / joint problems		Feet	Ankles	Knees	Hips	Back	Other
Osteoarthritis		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Rheumatoid arthritis		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Psoriatic arthritis		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Juvenile Rheumatoid		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Gout		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Neuropathic arthritis		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other – Please state……		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

11. How much bodily pain have you had during the <u>past 4 weeks</u>?

None	[ ]
Very mild	[ ]
Mild	[ ]
Moderate	[ ]
Severe	[ ]
Very severe	[ ]

12. What aids do you usually use to help you move…?

	<u>Inside</u> the house	**<u>Outside</u>** the house
No aids used	[ ]	[ ]
Walking stick	[ ]	[ ]
Walking frame	[ ]	[ ]
Crutches	[ ]	[ ]

Section D: FESI

For each of the following activities, please circle the opinion closest to your own to show how concerned you are that you might fall if you did this activity. In answering these questions, please think about how you usually do the activity. If you currently don't do the activity (e.g. if someone does your shopping for you), please answer to show whether you think you would be concerned about falling IF you did the activity.

	Not at all concerned	Somewhat concerned	Fairly concerned	Very concerned
1. Cleaning the house (e.g. sweep, vacuum or dust)	1	2	3	4
2. Getting dressed or undressed	1	2	3	4
3. Preparing simple meals	1	2	3	4
4. Taking a bath or shower	1	2	3	4
5. Going to the shop	1	2	3	4
6. Getting in or out of a chair	1	2	3	4
7. Going up or down stairs	1	2	3	4
8. Walking around in the neighbourhood	1	2	3	4
9. Reaching for something above your head or on the ground	1	2	3	4
10. Going to answer the telephone before it stops ringing	1	2	3	4
11. Walking on a slippery surface (e.g. wet or icy)	1	2	3	4
12. Visiting a friend or relative	1	2	3	4
13. Walking in a place with crowds	1	2	3	4
14. Walking on an uneven surface (e.g. rocky ground, poorly maintained pavement)	1	2	3	4
15. Walking up or down a slope	1	2	3	4
16. Going out to a social event (e.g. religious service, family gathering or club meeting)	1	2	3	4

Section E: GENERALIZED ANXIETY DISORDER 7-ITEM (GAD-7) SCALE

For each of the following questions, please circle the frequency the closest for you.

Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all	Several days	Over half the days	Nearly every day
8. Feeling nervous, anxious, or on edge	0	1	2	3
9. Not being able to stop or control worrying	0	1	2	3
10. Worrying too much about different things	0	1	2	3
11. Trouble relaxing	0	1	2	3
12. Being so restless that it's hard to sit still	0	1	2	3
13. Becoming easily annoyed or irritable	0	1	2	3
14. Feeling afraid as if something awful might happen	0	1	2	3
If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?		Not difficult at all		[ ]
		Somewhat difficult		[ ]
		Very difficult		[ ]
		Extremely difficult		[ ]

Section F: EQ-5D SCALE

Under each heading, please tick the ONE box that best describes your health TODAY

MOBILITY	
I have no problems in walking about	[ ]
I have slight problems in walking about	[ ]
I have moderate problems in walking about	[ ]
I have severe problems in walking about	[ ]
I am unable to walk about	[ ]
SELF-CARE	
I have no problems washing or dressing myself	[ ]
I have slight problems washing or dressing myself	[ ]
I have moderate problems washing or dressing myself	[ ]
I have severe problems washing or dressing myself	[ ]
I am unable to wash or dress myself	[ ]
USUAL ACTIVITIES *(e.g. work, housework, family or leisure activities)*	
I have no problems doing my usual activities	[ ]
I have slight problems doing my usual activities	[ ]
I have moderate problems doing my usual activities	[ ]
I have severe problems doing my usual activities	[ ]
I am unable to do my usual activities	[ ]
PAIN / DISCOMFORT	
I have no pain or discomfort	[ ]
I have slight pain or discomfort	[ ]
I have moderate pain or discomfort	[ ]
I have severe pain or discomfort	[ ]
I have extreme pain or discomfort	[ ]
ANXIETY / DEPRESSION	
I am not anxious or depressed	[ ]
I am slightly anxious or depressed	[ ]
I am moderately anxious or depressed	[ ]
I am severely anxious or depressed	[ ]

I am extremely anxious or depressed	[ ]

Section F: EQ-5D SCALE (Continued)

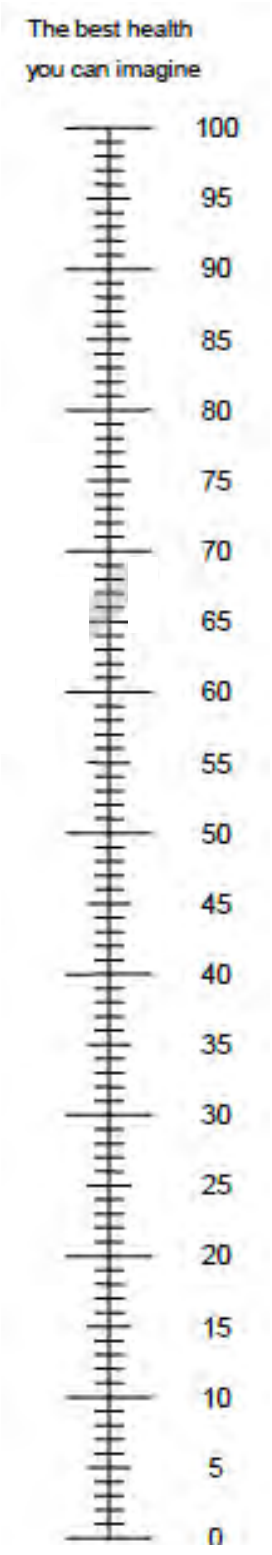
We would like to know how good or bad your health is TODAY.

This scale is numbered from 0 to 100.

100 means the best health you can imagine. 0 means the worst health you can imagine.

Mark an X on the scale to indicate how your health is TODAY.

Now, please write the number you marked on the scale in the box .....



Section G: Falls

Now we would like to ask some questions about falls.

1. How many falls did you have in the past year?

0 – Please go to question 3	[ ]
1	[ ]
2	[ ]
3+	[ ]

2. Have you suffered any injuries from any falls in the last year?

YES [ ] NO [ ]

a. Have you had any broken bones as a result of a fall? (Tick more than one if necessary)

NO [ ]

YES [ ] → Which part of your body? Wrist [ ]

Hip [ ]

Spine [ ]

Other [ ] Specify: .....

b. Were you taken to hospital as a result of one or more falls?

YES [ ] NO [ ]

c. As a result of a fall, did you suffer any injuries that affect your mobility now?

YES [ ] NO [ ]

3. Do you feel your balance is?

Poor	[ ]
Fair	[ ]
Good	[ ]
Very good	[ ]

Excellent	[ ]

4. Are you afraid of falling?

Not at all	[ ]
A little bit	[ ]
Moderately	[ ]
Quite a lot	[ ]
Extremely	[ ]

Section H: PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems?
Please circle the frequency the closest for you.

	Not at all	Several days	More than half the days	Nearly every day
11. Little interest or pleasure in doing things	0	1	2	3
12. Feeling down, depressed, or hopeless	0	1	2	3
13. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
14. Feeling tired or having little energy	0	1	2	3
15. Poor appetite or overeating	0	1	2	3
16. Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
17. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
18. Moving or speaking so slowly that other people could have noticed. On the opposite – being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
19. Thoughts that you would be better off dead, or of hurting yourself in some way	0	1	2	3
20. If you checked off any problems, how difficult have these				

problems made it for you to do your work, take care of things at home, or get along with other people?	Not difficult at all Somewhat difficult Very difficult Extremely difficult	[ ] [ ] [ ] [ ]

Thank you for your time

VESTIBULAR FUNCTION AND FALLS STUDY – QUESTIONNAIRE – PART 2

This should only be completed by participants who report dizziness episode(s) in the past 12 months.

Section A: Dizziness history

How would you describe your dizziness?					
1. Spinning sensation – if yes, is it	Yes	[ ]	No	[ ]	
• room spinning	Yes	[ ]	No	[ ]	
• head spinning	Yes	[ ]	No	[ ]	
2.Faint / syncope	Yes	[ ]	No	[ ]	
3. Unsteadiness	Yes	[ ]	No	[ ]	
4. Something else	Yes	[ ]	No	[ ]	Please specify:
5. Date when dizziness first experienced: Circumstances (Duration, activity being performed, what did it feel like):					
6. Date when dizziness most recently experienced: Circumstances:					
7. Is it constant or does it come and go? (circle)					
8. Ever investigated – if yes , was it by	Yes	[ ]	No	[ ]	
• A GP	Yes	[ ]	No	[ ]	Please specify:
• Some specialist(s)	Yes	[ ]	No	[ ]	Please specify:
9. Any associated symptoms	Yes	[ ]	No	[ ]	Please specify:
10. Hearing problems	Yes	[ ]	No	[ ]	Which ear:
11. Tinnitus	Yes	[ ]	No	[ ]	
12. Ear fullness	Yes	[ ]	No	[ ]	
13. Neck pain / problems (whiplash…)	Yes	[ ]	No	[ ]	Please specify:
13. Back pain / problems	Yes	[ ]	No	[ ]	Please specify:
14. Migraines / headaches	Yes	[ ]	No	[ ]	

15. Heart palpitations	Yes	[ ]	No	[ ]	
16. Heart missing a beat	Yes	[ ]	No	[ ]	
17. Family history of vertigo / dizziness	Yes	[ ]	No	[ ]	Please specify:
18. What do you do when your dizziness comes on (sit down, got to bed, medications, carry on…)?					
17. Do you suffer from motion sickness?	Yes	[ ]	No	[ ]	

Section B: VERTIGO SYMPTOM SCALE

For each of the following items, please circle the number between 1 and 5 to indicate how often (if at all) you experienced each symptom in the past year.

	Never (0) to Very often (more than once a week) (5)					
Things spinning/moving						
35. Less than two minutes	0	1	2	3	4	5
36. 2–20 minutes	0	1	2	3	4	5
37. 20 minutes to 1 hour	0	1	2	3	4	5
38. Several hours	0	1	2	3	4	5
39. More than 12 hours	0	1	2	3	4	5
Light-headedness/giddiness						
40. Less than 2 minutes	0	1	2	3	4	5
41. 2–20 minutes	0	1	2	3	4	5
42. 20 minutes to 1 hour	0	1	2	3	4	5
43. Several hours	0	1	2	3	4	5
44. More than 12 hours	0	1	2	3	4	5
Unsteadiness						
45. Less than 2 minutes	0	1	2	3	4	5
46. 2–20 minutes	0	1	2	3	4	5
47. 20 minutes to 1 hour	0	1	2	3	4	5
48. Several hours	0	1	2	3	4	5
49. More than 12 hours	0	1	2	3	4	5

Section B: VERTIGO SYMPTOM SCALE (Continued)

For each of the following items, please circle the number between 1 and 5 to indicate how often (if at all) you experienced each symptom in the past year.

	Never (0) to Very often (more than once a week) (5)					
50. Falling over	0	1	2	3	4	5
51. Unable to stand, walk	0	1	2	3	4	5
52. Vomiting	0	1	2	3	4	5
53. Nausea, feeling sick	0	1	2	3	4	5
54. Heart/chest pain	0	1	2	3	4	5
55. Hot or cold spells	0	1	2	3	4	5
56. Tense/sore muscles	0	1	2	3	4	5
57. Trembling, shivering	0	1	2	3	4	5
58. Heart pounding	0	1	2	3	4	5
59. Arms/legs feel heavy	0	1	2	3	4	5
60. Visual disturbances	0	1	2	3	4	5
61. Headache	0	1	2	3	4	5
62. Breathing difficulties	0	1	2	3	4	5
63. Poor concentration	0	1	2	3	4	5
64. Tingling, pricking	0	1	2	3	4	5
65. Lower back pain	0	1	2	3	4	5
66. Pressure in the ears	0	1	2	3	4	5
67. Excessive sweating	0	1	2	3	4	5
68. Feeling faint	0	1	2	3	4	5

Section C: DIZZINESS HANDICAP INVENTORY

Instructions: *The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness or unsteadiness. Please answer "yes", "no" or "sometimes" to each question. Answer each question as it applies to your dizziness or unsteadiness only.*

Item	Question		Y	N	S
26.	Does looking up increase your problem?	P			
27.	Because of your problem, do you feel frustrated?	E			
28.	Because of your problem, do you restrict your travel for business or recreation?	F			
29.	Does walking down the aisle of a supermarket increase your problem?	P			
30.	Because of your problem, do you have difficulty getting into or out of bed?	F			
31.	Does your problem significantly restrict your participation in social activities such as going out to dinner, the movies, dancing or to parties?	F			
32.	Because of your problem, do you have difficulty reading?	F			
33.	Does performing more ambitious activities such as sports or dancing or household chores such as sweeping or putting dishes away increase your problem?	P			
34.	Because of your problem, are your afraid to leave your home without having someone accompany you?	E			
35.	Because of your problem, are you embarrassed in front of others?	E			
36.	Do quick movements of your head increase your problem?	P			
37.	Because of your problem, do you avoid heights?	F			

38.	Does turning over in bed increase your problem?	P			
39.	Because of your problem, is it difficult for you to do strenuous housework or yard work?	F			
40.	Because of your problem, are you afraid people may think you are intoxicated?	E			
			Y	**N**	**S**
41.	Because of your problem, is it difficult for you to walk by yourself?	F			
42.	Does walking down a sidewalk increase your problem?	P			
43.	Because of your problem, is it difficult for you to concentrate?	E			
44.	Because of your problem, is it difficult for you to walk around the house in the dark?	F			
45.	Because of your problem, are you afraid to stay at home alone?	E			
46.	Because of your problem, do you feel handicapped?	E			
47.	Has your problem placed stress on your relationship with members of your family or friends?	E			
48.	Because of your problem, are you depressed?	E			
49.	Does your problem interfere with your job or household responsibilities?	F			
50.	Does bending over increase your problem?	P			
			X 4	X 0	X 2
	=				
	TOTAL				

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