The Role of Occupational Therapy in the Recognition, Assessment, and Treatment of Presbyvestibulopathy

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Abstract
Sensory functions decline with age, and the likelihood of having multiple sensory impairments increases with age, potentially leading to decreased physical activity and performance, decreased social participation, poorer quality of life, and greater health care spending. Presbyvestibulopathy (PVP), a diagnosis established in 2019, is a vestibular dysfunction or loss related to the aging process characterized by mild bilateral vestibular deficits, chronic dizziness, unsteadiness, gait disturbance, and/or recurrent falls. Given the potential impact of vestibular dysfunction on occupational performance and participation in meaningful activities, occupational therapy’s (OT) role in PVP is evident; however, limited literature exists specific to OT and vestibular dysfunction. OT plays a distinct role in social participation, healthy aging, fall prevention and improving fall-related efficacy, environmental adaptation, and activity modification to improve occupational engagement and quality of life in older adults. Possible evidence-based interventions for age-related vestibular loss in the OT scope of practice could apply to older adults with PVP. This manuscript intends to use evidence relevant to OT to contribute to an understanding of PVP and the potential role of OT in recognizing, assessing, and treating clients with age-related vestibular loss.

Keywords
aging, falls, occupational performance, vestibular dysfunction, vestibular loss, vestibular rehabilitation therapy

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The authors declare that they have no competing financial, professional, or personal interest that might have influenced the performance or presentation of the work described in this manuscript.

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The United States and worldwide population are aging, increasing the risk of chronic diseases, disability, and raising health care costs (Centers for Disease Control and Prevention [CDC], 2022). It is estimated that 1 in 6 people will be 60 years of age or older by 2030 (World Health Organization [WHO], 2021). All peripheral sensory functions, including visual acuity, proprioception, hearing, and vestibular function decline with age, and the likelihood of having multiple sensory impairments increases with age (Correia et al., 2016; Gadkaree et al., 2016). Age-related sensory loss may contribute to cognitive decline, increased falls, decreased physical activity and performance, and decreased social participation, which can negatively impact occupational performance, participation in occupation, and quality of life (QoL) (Fischer et al., 2009; Gadkaree et al., 2016; Lin et al., 2013). Given the distinct role of occupational therapy (OT) in productive aging and QoL improvement, there is an increasing need for occupational therapists to recognize and address the impact of sensory loss on occupational performance in older adults.

As part of the Accreditation Council for Occupational Therapy Education (ACOTE) Standards, occupational therapists should be able to

plan and apply evidence-based occupational therapy interventions to address the physical, cognitive, functional cognitive, psychosocial, sensory, and other aspects of performance in a variety of contexts and environments to support engagement in everyday life activities that affect health, well-being, and quality of life. (ACOTE, 2018, p. 2)

OT’s role in age-related visual loss has been well established; however, the vestibular sensory system is not well understood or frequently addressed by novice clinicians. Vestibular, proprioceptive, and neuromuscular and movement-related functions are sensory functions that fall under the category of “body functions” in the Occupational Therapy Practice Framework (AOTA, 2020). Since these sensory functions can impact occupational performance, it is crucial that therapists understand how to assess and treat underlying sensory issues, including vestibular dysfunction. The American Occupational Therapy Association (AOTA) provides guidelines for entry-level and advanced occupational therapists specializing in vestibular rehabilitation therapy (VRT) (AOTA, 2017), yet there is no requirement for entry-level education to include coursework on VRT specifically (Cohen et al., 2011).

The vestibular system is complex, functioning as both a sensory and motor system (Zalewski, 2015). It consists of peripheral and central structures and is responsible for perceiving movement and sensing head position in space (Zalewski, 2015). The peripheral vestibular system, including three semicircular canals and two otolithic organs (saccule and utricle), senses the degree and direction of acceleration (Thompson & Amedee, 2009). Simply, cranial nerve VIII sends sensory input from peripheral structures to the vestibular nuclear complex, and the central nervous system processes and integrates visual, vestibular, and somatosensory input (Jones et al., 2009). The vestibular system responds by coordinating postural and oculomotor reflexes to maintain equilibrium and visual acuity during movement (Zalewski, 2015).

Dougherty et al. (2022) describe vestibular dysfunction as a disturbance of the body’s balance system because of an insult to the peripheral vestibular system, the central vestibular system, or both. There are multiple internationally accepted vestibular disorders, and diagnosis of specific vestibular disorders is often based on history and a comprehensive clinical examination of the vestibular, ocular motor, and cerebellar systems (Strupp et al., 2020). Specifically, presbyvestibulopathy (PVP) is a vestibular disorder pertaining to age-related peripheral vestibular loss, for which the Classification
Committee of the Barany Society established diagnostic criteria in 2019 (Agrawal et al., 2019). This manuscript aims to increase occupational therapists’ awareness of PVP, a disorder that can significantly impact occupational performance and productive aging in older adults.

**Prevalence and Classification of PVP**

A high prevalence of dizziness and balance issues occurs among older adults, and age-related vestibular loss has been increasingly recognized in the literature. Vestibular dysfunction often presents as symptoms of dizziness, imbalance, or vertigo (Agrawal et al., 2019; Dougherty et al., 2022); however, the etiology of dizziness can vary widely, including diagnoses related to otologic/vestibular, cardiovascular, neurologic, respiratory, metabolic, and psychiatric conditions (Newman-Toker et al., 2008). Regardless of etiology, Jönsson et al. (2004) found that 65% of people 70 years of age had vertigo, dizziness, or disequilibrium, with balance issues more common in women than in men. Similarly, in a study by Wassermann et al. (2021), of the 1,752 patients with chronic dizziness or vertigo, 46.7% were between 41 and 65 years of age, and 33.7% were > 65 years, with the older age groups more often getting diagnosed with multisensory deficit, bilateral vestibulopathy, central vertigo, or benign paroxysmal positional vertigo (BPPV). A cross-sectional study by Agrawal et al. (2009) found that 35.4% of adults 40 years of age and older in the United States had identified vestibular dysfunction on the modified Romberg Test, and this prevalence increased significantly with age.

PVP is defined as “a chronic vestibular syndrome characterized by unsteadiness, gait disturbance, and/or recurrent falls in the presence of mild bilateral vestibular deficits” (Agrawal et al., 2019, p. 161). To be diagnosed with PVP, the individual must be at least 60 years of age, and their vestibular dysfunction cannot be better accounted for by another disorder (Agrawal et al., 2019). To meet the criteria for chronic vestibular syndrome, the individual must have at least two of the following symptoms for 3 months or more: postural imbalance or unsteadiness, gait disturbance, chronic dizziness, or recurrent falls (Agrawal et al., 2019). Mild bilateral peripheral vestibular hypofunction is diagnosed by meeting certain criteria on video head impulse testing, rotary chart testing, or caloric testing (Agrawal et al., 2019). PVP, or symptoms of PVP, may also co-exist with other medical issues and diagnoses. In a cross-sectional study, Muller et al. (2022) found that out of 707 people 60 years of age and older with chronic dizziness, only 32 met the diagnostic criteria for PVP, and PVP was an isolated disorder in only one patient. Most patients did not meet diagnostic criteria because their chronic dizziness was better accounted for by other vestibular, neurological, cardiac, or psychiatric diseases (Muller et al., 2022).

A high prevalence of vestibular dysfunction, chronic dizziness, and multisensory impairments exists among older adults. However, PVP may be a less likely diagnosis in older adults with chronic vestibular dysfunction, considering the range of differential diagnoses related to vestibular dysfunction, other co-morbidities associated with aging, and the specific diagnostic criteria. Nevertheless, providers should consider PVP when assessing older adults with chronic vestibular dysfunction.

**Etiology and Associations with Other Age-related Sensory Dysfunction**

Age-related degeneration can occur in the peripheral and/or central vestibular structures that contribute to vestibular dysfunction. Age-related central vestibular dysfunction may be the result of neuronal loss in the vestibular nuclear complex or a decrease in cerebellar volume and/or Purkinje cell density (Arshad & Seemungal, 2016). Peripheral vestibular loss, thus PVP, is thought to be caused by age-related decline of the peripheral vestibular sensory organs, including semicircular canal and otolith function (Agrawal et al., 2012). This vestibular sensory organ decline may result from a reduction in volume and number of otoconia in the saccule and utricle, changes to the shape of otoconia, degeneration...
of the vestibular ganglion, and/or neuronal and hair cell degeneration and reduction, especially in the semicircular canals (Arshad & Seemungal, 2016; Walther & Westhofen, 2007).

PVP can be associated with other age-related sensory loss, such as presbyopia (age-related farsightedness) or presbycusis (age-related hearing loss) (Agrawal et al., 2019; Soto-Varela et al., 2020). A systematic review found a significant, positive association between hearing loss and postural control, including gait speed, standing balance, walking endurance, physical activity, and risk for falls (Agmon et al., 2017), some of which are characteristics of PVP. Further, more severe hearing loss was associated with a higher prevalence of falls and mobility deficits (Agmon et al., 2017). Zuniga et al. (2012) demonstrated a significant correlation between high-frequency hearing loss and saccular function in patients 70 years of age and older. The authors recommend screening individuals with presbycusis, particularly those with significant noise exposure history, for saccular dysfunction, which may contribute to fall risk in older adults (Zuniga et al., 2012). Last, Muller et al. (2022) found that in 32 people who met the diagnostic criteria for PVP, 96.9% had deficits in other sensorimotor functions, and over half had deficits in two or more systems, including somatosensory, visual, auditory, musculoskeletal, and cardiovascular disorders. Awareness of the etiology of age-related vestibular loss and the associations between sensorimotor loss and vestibular indicators may trigger therapists and providers to consider PVP in older adults with sensory and, more specifically, hearing loss.

Impact of PVP

PVP can significantly impact perceived QoL (Agrawal et al., 2017) and may lead to increased falls, further impacting activity engagement and performance. A cross-sectional study by Soto-Varela et al. (2020) found that patients with PVP perceived moderate to severe disability related to dizziness symptoms on the Dizziness Handicap Inventory (DHI), potentially impacting QoL. In this group of participants, factors including the female sex, obesity, falls, and mobility deficits on the Timed Up and Go (TUG) were most strongly related to perceived disability on the DHI (Soto-Varela et al., 2020). Similarly, a qualitative study by Harun et al. (2016) found that older adults with age-related vestibular loss perceived that their vestibular dysfunction contributed to a negative impact on body functions, activity participation, and independence. Participants reported that their vestibular issues manifested as other impairments, such as depression, fatigue, fear and anxiety, feelings of isolation, difficulty standing up and walking, reduced driving and social participation, and a loss of independence (Harun et al., 2016). Vestibular dysfunction in older adults can increase the risk of falls and fear of falling (Herssens et al., 2022; Lindell et al., 2019) and negatively impact mobility and walking speed (Anson et al., 2019; Lindell et al., 2019), activity participation (Schepens et al., 2012), and QoL (Agrawal et al., 2017), which may significantly impact occupational engagement and performance.

Age-related vestibular loss and dizziness are associated with increased health care costs and a significant economic burden. A study by Agrawal et al. (2017) estimated that the total economic burden of age-related vestibular loss costs $64,929 per individual, with a collective $227 billion societal burden. Kovacs et al. (2019) identified several factors contributing to increased health care costs related to vertigo, including inappropriate consultations, decreased productivity because of an inability to work, and an overuse of diagnostic imaging and emergency care visits. Dizziness is one of the most common reasons for emergency department visits in older adults, accounting for 3.3% of emergency department visits (Newman-Toker et al., 2008; Weiss & Jiang, 2021). Considering the financial, functional, occupational, and psychosocial implications of PVP, therapists can aid with the proper assessment for prevention of
diagnostic error (Corsino, 2022) and provide effective treatment for vestibular dysfunction to improve patient outcomes and QoL.

**Recognition and Assessment**

The evaluation, diagnosis, and treatment of vestibular dysfunction is complex and multifaceted. Diagnostic testing for vestibular disorders can be challenging as testing can be time-consuming and requires specialized equipment and trained professionals (Krishnan & Galaiya, 2022). Along with a wide range of etiologies for vestibular dysfunction and a variety of symptom descriptors, patients’ descriptions of the quality of their dizziness symptoms are often unclear and inconsistent (Newman-Toker et al., 2007), making an accurate diagnosis even more challenging. Further, there is no one quantifiable tool to measure vestibular dysfunction or diagnose disorders causing dizziness (Jung & Kim, 2015; Krishnan & Galaiya, 2022). Rather, diagnostic testing is based on an indirect assessment of the vestibulo-ocular reflex (VOR) and vestibular spinal reflexes (Krishnan & Galaiya, 2022). This suggests a need for specially trained providers and a multidisciplinary team to accurately diagnose and effectively manage vestibular dysfunction, including PVP.

Occupational therapists are not diagnosticians, but they may assist in recognizing PVP based on patient history and a physical examination. Entry-level occupational therapists have foundational knowledge in activity analysis, functional anatomy, vestibular system anatomy and physiology, neuroscience, and motor control (Cohen, 2006). Considering the patient’s history, characteristics, symptoms, occupational profile, and activity performance, an entry-level occupational therapist can help recognize vestibular loss related to aging. This enables them to understand the challenges patients with vestibular dysfunction may experience and to assess the impact of vestibular dysfunction on a patient’s occupational performance (Cohen, 2006). However, specific assessment and treatment of vestibular disorders requires therapists to have advanced training and knowledge of the structure and function of the vestibular system, the interactions between sensory systems, and vestibular diagnoses and interventions (AOTA, 2017). If the occupational therapists can recognize age-related vestibular loss impacting function/occupational performance, they can make recommendations for referrals to a neurotologist, neurologist, or otolaryngologist for further assessment and treatment.

Occupational therapists with advanced training in vestibular disorders and rehabilitation can administer multiple, simple bedside examinations to aid in the recognition and assessment of patients suspected to have PVP. Krishnan and Galaiya (2022) suggested that PVP should be considered in patients 60 years of age and older who are experiencing gradual-onset disequilibrium. Some researchers have recommended against using passive and active head shaking tests, un-instrumented head impulse tests (HIT), and video head impulse tests (vHIT) to screen patients for vestibular disorders (Cohen et al., 2018). However, some of these screening tools may be useful for patients who do not have access to vestibular physiologic testing because of funding issues, community barriers, geographical location, limited access to trained professionals or specialty clinics, or delayed or missed referrals.

Newer diagnostic approaches are available to help providers categorize patients with acute dizziness or vestibular dysfunction. Acute vestibular dysfunction may be categorized as an acute vestibular syndrome (AVS), a spontaneous episodic vestibular syndrome, or a triggered episodic vestibular syndrome (Edlow et al., 2018). Diagnostic testing for an acutely dizzy person is outside of the scope of this paper and should be separate from screening for PVP or other chronic, persistent dizziness and imbalance issues. PVP should be considered when the provider has ruled out other causes of vestibular dysfunction, such as vestibular neuritis, posterior circulation stroke, Meniere’s disease, BPPV, etc. Table 1 provides considerations for the occupational therapist to aid in the recognition and assessment of PVP.
If PVP is suspected, there are simple, quick, and clinically relevant screening tools and assessments that occupational therapists can administer to evaluate further fall risk, fall efficacy, ADL performance, balance and mobility issues, and vestibular dysfunction. Further, there are several appropriate, qualitative measures for clinicians to use with patients suspected of having PVP to aid in goal setting and evaluating therapy effectiveness. Targeted assessment will aid in identifying performance deficits to provide more targeted interventions related to occupational performance and engagement. Table 2 provides recommendations of screening tools and outcome measures occupational therapists can use to assess patients suspected of having PVP.

Table 2

<table>
<thead>
<tr>
<th>Screening tool</th>
<th>Outcome measure</th>
<th>Purpose</th>
</tr>
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<tbody>
<tr>
<td>CDC’s STEADI algorithm (CDC, 2019)</td>
<td>Dynamic Gait Index</td>
<td>Fall risk</td>
</tr>
<tr>
<td>Modified Romberg test</td>
<td>Balance and functional gait in older adults</td>
<td></td>
</tr>
<tr>
<td>Timed Up and Go</td>
<td>Balance and vestibular function</td>
<td></td>
</tr>
<tr>
<td>Head Impulse, Nystagmus, Test of Skew (HINTS) (Krishnan &amp; Galaiya, 2022)</td>
<td>Basic mobility, balance, and locomotion in older adults</td>
<td></td>
</tr>
<tr>
<td>Dix-Hallpike</td>
<td>Differentiate between AVS and vestibular hypofunction, and distinguish between central and peripheral AVS (Qiu et al., 2022).</td>
<td></td>
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<tr>
<td>Vestibular Disorders Activities of Daily Living Scale (VADL)</td>
<td>Perceived handicapping effects of dizziness on daily life</td>
<td></td>
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<tr>
<td>Activity-specific Balance Confidence Scale (ABC)</td>
<td>Perceived functional limitations in people with vestibular disorders</td>
<td></td>
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<tr>
<td>Short Falls Efficacy Scale – International (Short FES-I)</td>
<td>Perceived confidence in performing activities without losing balance</td>
<td></td>
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<tr>
<td>Vestibular Activities and Participation Measure (VAP)</td>
<td>Fear of falling while performing activities in older adults</td>
<td></td>
</tr>
<tr>
<td>Canadian Occupational Performance Measure (COPM)</td>
<td>Perceived activity limitations and participation restrictions in people with balance and vestibular disorders</td>
<td></td>
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<tr>
<td></td>
<td>Perceived occupational performance and identification of patient-driven goals</td>
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</tbody>
</table>
Treatment

Since the establishment of the PVP diagnostic criteria, no studies have evaluated treatment interventions for PVP specifically. However, some evidence-based treatment strategies have been identified for similar patient populations and diagnoses. A systematic review by Regauer et al. (2020) validated the use of vestibular rehabilitation in multiple variations for treating older adults with vertigo, dizziness, and/or balance disorders, regardless of etiology. VRT consists of four exercise components to promote gaze stabilization, habituation of symptoms, gait and balance, and endurance (Hall et al., 2021). The premise behind VRT is movement- or exercise-based activity to promote vestibular adaptation, substitution, or habituation (Hall et al., 2021). Vestibular adaptation consists of exercises, such as VOR x1 and VOR x2 exercises, that improve gaze and postural stability by promoting changes in the neuronal response to head movements to readjust the gait of the VOR or vestibular spinal reflex (Hall et al., 2021; Han et al., 2011). Vestibular substitution consists of VOR and vestibular spinal reflex exercises that improve gaze and postural and gait stability by using alternative strategies to substitute or compensate for impaired vestibular function (Hall et al., 2021). Examples of substitution exercises may include eye-head movements between targets for central reprogramming, remembered target exercises, or increasing the use of and dependence on visual or somatosensory input (Hall et al., 2021). Habituation consists of exercises or movements that expose the individual to specific stimuli that provoke symptoms of vertigo (Hall et al., 2021). Over time, repeated exposure to provocative stimuli can lead to central compensation and a reduction in symptoms (Han et al., 2011).

VRT has been supported as an efficacious treatment for bilateral vestibular hypofunction in the American Physical Therapy Association clinical practice guidelines (Hall et al., 2021). Bilateral vestibular hypofunction, or bilateral vestibulopathy, has similar diagnostic characteristics to PVP. Compared to bilateral vestibular hypofunction, persons with PVP will have a milder vestibular loss on vHIT, rotary chair, and caloric testing (Agrawal et al., 2019). Since vestibular rehabilitation can reduce dizziness symptoms and improve balance, postural stability, and function in people with bilateral vestibulopathy, VRT may have similar effects on persons with PVP. Regardless of the treatment protocol, vestibular rehabilitation, in general, can promote vestibular compensation and improve balance control, functional mobility, and patient-reported outcomes, including dizziness intensity, dizziness-related symptoms, depression, fear of falling, and independence in daily activities in older adults with chronic dizziness related to vestibular dysfunction (Aratani et al., 2020; Ricci et al., 2016). Occupational therapists with advanced training in vestibular rehabilitation should consider VRT as an intervention or preparatory activity for persons with PVP to improve symptoms, enable participation in daily activity, optimize functional performance, and improve QoL.

Despite the potentially important role OT can play in vestibular rehabilitation, few studies look specifically at OT’s involvement in the treatment of people with vestibular disorders, and only a few position papers have described the role of OT in vestibular rehabilitation (AOTA, 2017; Cohen, 2006). With OT’s holistic approach and skillful activity analysis, it can address the social/behavioral, contextual, cognitive, visual, and physical factors related to dizziness and imbalance that impact participation in occupation. According to AOTA (2017), OT can play a role in:
• Providing education about the condition and how vestibular dysfunction can impact occupational engagement
• Making recommendations or referring patients to specialists as needed, such as neurotology for further vestibular assessment/treatment, audiology for hearing loss, or a certified driver rehabilitation specialist
• Providing compensatory training, assistive devices, and adaptations for other related sensory losses impacting functional performance and participation
• Facilitating safe, functional mobility while engaging in meaningful occupations and visually challenging environments
• Training in fall prevention, as well as home and work safety modifications
• Improving static balance, dynamic balance, and fall-related efficacy
• Training in dual-task performance and task modification
• Providing health promotion education and habit and routine management

Several studies have validated the role of OT in persons with vestibular deficits and in productive aging. In addition to intervention focused on remediation through vestibular rehabilitation, OT can play a role in environmental modification, activity modification, and occupational adaptation for persons with vestibular deficits (AOTA, 2017). In people 50 years of age and older with symptoms of dizziness, Menant et al. (2018) compared usual care to a tailored, multifaceted intervention consisting of one or more of the following interventions: vestibular rehabilitation, internet-based cognitive-behavioral therapy, the Otago home-based exercises for balance and lower extremity strengthening, and/or medical management. Compared to usual care, the tailored, multifaceted intervention improved dizziness-related QoL on the DHI (Menant et al., 2018). Moreover, a review by Papageorgiou et al. (2016) validated the role of OT in promoting social participation and healthy aging and preventing social isolation through occupation in community-dwelling older adults. In addition, a meta-analysis by Schepens et al. (2012) highlighted the role of OT in addressing fall-related efficacy issues in older adults to promote activity participation. Considering the complex nature of vestibular dysfunction and the vast impact it can have on all aspects of daily life, a client-centered, multi-faceted intervention, including vestibular rehabilitation, may be a feasible OT-administered treatment option for persons with PVP.

Conclusion

This manuscript introduced readers to a relatively new diagnosis, PVP, that may contribute to mobility deficits, decreased participation, and lower QoL in older adults, potentially impacting occupational engagement. PVP should be considered in older adults with chronic dizziness or gradual onset disequilibrium, especially those with other age-related sensory impairments. Occupational therapists should use a holistic and client-centered approach to investigate the impact of vestibular dysfunctional on occupational performance. Novice and experienced clinicians have access to the tools necessary to provide evidence-based assessment and treatment for patients suspected of having PVP, and they should refer to specialists as appropriate. Recognizing, diagnosing, assessing, and treating persons with vestibular dysfunction, and more specifically PVP, is complex and multi-faceted, requiring a comprehensive approach and multidisciplinary team collaboration with OT.
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