The Effects of Fear Avoidance on Disability Among Persons with Vestibular Disorders

by

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Purpose: The association between fear avoidance beliefs and disability among persons with vestibular disorders is unknown because there is no measure of fear avoidance in this population. The purpose of this study was to determine the psychometric properties of the Vestibular Activities Avoidance Instrument (VAAI) and to evaluate the effect of fear-avoidance beliefs on level of disability in persons with vestibular disorders at three months.

Methods: Subjects were recruited from a balance disorders clinic and physical therapy clinics and were between the ages of 18-100, English-speaking, and experiencing dizziness. Exploratory factor analysis of the 81-item VAAI was completed. The modified VAAI was assessed for internal consistency using Cronbach's alpha and for construct validity using Spearman's correlation coefficients and bootstrap resampling methods. The relationship between fear avoidance beliefs at baseline and disability at follow-up was determined using Spearman's correlation coefficients. Other baseline characteristics were accounted for by constructing general linear models and then including significant predictors and VAAI score at baseline in a final multivariate linear regression model with 3-month Vestibular Activities and Participation Measure (VAP) score as the dependent variable.

Results: The sample included 404 subjects (mean age=54 years). One factor was retained because it measure the construct of activity avoidance. After item reduction, the resulting scale included 9 items (VAAI-9) and demonstrated excellent internal consistency and convergent

validity with the Hospital Anxiety and Depression Scale (HADS), 12 Item Short-Form Health Survey, and the VAP at baseline. The VAAI-9 score at baseline was significantly related to all disability measures at 3 months. The multivariate linear regression model included the VAAI-9 score, the dizziness visual analogue scale, and the HADS Depression subscale score at baseline and predicted a significant proportion of the variance in VAP score at follow-up.

Conclusion: The VAAI-9 is a valid and reliable measure of fear avoidance beliefs in persons with vestibular disorders. Fear avoidance beliefs measured by the VAAI-9 at baseline were associated with activity and participation limitations at 3 months. The VAAI-9 may be a useful clinical tool to evaluate fear avoidance beliefs which is associated with disability in persons with vestibular disorders.

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Preface

I would like to acknowledge all the people who have made this research study possible and who have contributed to my journey culminating in this dissertation. I am grateful to have had the opportunity to work with each of my committee members who are all experts in their respective fields. My dissertation committee chair, Dr. Susan Whitney, has provided me with unwavering support, countless hours of her time, and invaluable knowledge and advice through her mentorship, for which I am eternally thankful. Dr. Patrick Sparto has mentored and supported me specifically in research methods, statistical analysis, and career development which has been crucial to the success of this research study and to my success as a doctoral student. I am grateful to Dr. Joseph Furman for sharing his clinical expertise, assistance with subject recruitment for this research study, and for his overall support throughout my early career as a clinician and research scientist. I appreciate the time and statistical support Dr. Gregory Marchetti has provided which enabled the successful completion of this research study. I am thankful to Dr. Jeffrey Staab who has shared his insight and knowledge related to the psychological aspects among persons with vestibular disorders which was vital for this research. I am grateful to Dr. Anthony Delitto who devoted his time and expertise to this research study and provided valuable support and advice throughout my time as a doctoral student.

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1.0 Introduction

Dizziness is a common problem in the general population estimated to effect between 10 and 30% of adults (1–3). Vestibular disorders cause dizziness and imbalance leading to decreased ability to complete activities of daily living and diminished quality of life (2–4). Dizziness caused by vestibular disorders is associated with seeking medical consultation, sick leave, interruption of regular activities, and avoiding leaving the house (2). As individuals age, dizziness increases in prevalence and can lead to postural instability and falls (3,5).

Diagnoses such as anxiety and depression are more common in persons who experience dizziness than in the general population (1,6–14). Up to 62% of individuals with vestibular disorders reported depression and 46% reported anxiety in their lifetime compared to 28% and 19% of adults in the general population (1). It has been suggested that persons with dizziness and imbalance who experience anxiety, depression, somatic symptoms, and poor coping strategies report higher symptoms, functional impairment, and have protracted recovery compared to those who do not have psychological comorbidity (6,15–22). Also, persons who have a vestibular insult and psychological comorbidity report greater handicap and impairment related to dizziness and do not improve to the same degree as those without psychological comorbidity with vestibular rehabilitation (6,23). Therefore, there is a need to develop specific treatment strategies for persons who demonstrate psychological morbidity as well as vestibular impairment.

Chronic dizziness shares similar qualities to chronic low back pain because feelings of dizziness can cause activity avoidance, which leads to increased risk for disability (2,24–26). Research on chronic low back pain has shown that fear-avoidance beliefs measured by self-report tools is a better predictor of disability levels than pain and clinical measures (24,26–28). However,

there are no such tools to measure fear avoidance and other psychological factors in persons with vestibular disorders. The measurement of fear-avoidance behaviors is now part of national clinical practice guidelines when treating patients with low back pain (29). Screening measures have been successful in stratifying patients into low to high risk groups for development of disability based on the presence of psychological and psychosocial factors (30,31). Successful measurement and classification of these factors have allowed for the development of cost-effective, targeted treatment approaches in physical therapy for persons with low back pain (32–35). Before specific treatment and classification strategies can be used in persons with vestibular disorders, a clinically useful, validated tool must be developed to identify fear avoidance in this population.

1.1 Problem Statement

Psychological factors such as anxiety, depression, and negative affect have been identified using patient-reported outcome measures in persons with vestibular disorders (36–38). However, many of the measurement tools used in these studies were not developed specifically for patients with vestibular disorders. Also, the measurement tools often only measure one psychological construct at a time (i.e. anxiety or depression or catastrophization). There is currently no comprehensive tool designed to specifically measure behavioral factors such as fear-avoidance beliefs among persons with vestibular disorders. As a result, behavioral factors are not routinely measured clinically in persons with vestibular and balance disorders. Because there is no comprehensive measurement tool, it is difficult to know how fear avoidance and other constructs affect levels of disability after a vestibular diagnosis in rehabilitation settings. It is also difficult for clinicians to design appropriate treatment programs without a way to quantify behavioral

factors that may negatively affect outcomes. There is a clinical need for the measurement of fear avoidance and other behavioral factors in persons with vestibular disorders and the effect these factors have on level of disability so that specific treatment strategies can be developed.

The Vestibular Activities Avoidance Instrument (VAAI) was recently developed by using items from reliable and valid outcome measures designed to measure fear avoidance, anxiety, somatization, depression, worry, and other psychological factors among persons with pain and adapted the items for use in persons with dizziness (39). After items were compiled using the Delphi technique, the VAAI consisted of 77 items (39). Preliminary reliability and validity analysis determined that the test-retest reliability was excellent (ICC = 0.97) and internal consistency was excellent (Cronbach's alpha = 0.98) (39). Four items were then adapted from the Start Back Screening Tool (SBST) because of its value in screening for psychological factors in persons with low back pain (30,31,40), and added to the VAAI making the scale a total of 81 items. Due to the length of the VAAI, its clinical usefulness was considered minimal because of time constraints and patient fatigue for answering questionnaires in the clinic.

1.2 Purpose

The purpose of this study is to further develop the VAAI into a clinically-useful tool by reducing the number of items and to evaluate the effect of fear-avoidance and other behavioral and psychological factors on level of disability in persons with vestibular and balance disorders (39).

1.3 Specific Aims and Hypotheses

1.3.1 Specific Aim 1

To further develop the VAAI into a valid and reliable measure of behavioral factors such as fear avoidance in persons with vestibular disorders.

1.3.1.1 Hypothesis 1a

The 81-item VAAI will be factorable, which will result in a shortened questionnaire with the relationships among the items explained by multiple factors and the shortened questionnaire will demonstrate similar psychometric properties as the 81-item VAAI.

1.3.1.2 Hypothesis 1b

The shortened version of the VAAI and the respective subscales will demonstrate adequate internal consistency reliability defined by a coefficient alpha value between 0.70 and 0.95.

1.3.1.3 Hypothesis 1c

The shortened version of the VAAI and respective subscales will demonstrate evidence of construct validity by having moderate to strong correlations ($\geq |0.30|$) with measures of disability, and psychological well-being.

1.3.2 Specific Aim 2

To identify behavioral factors such as fear avoidance beliefs and assess their association with level of activity and participation disability in persons with vestibular disorders at three months using the items included in the VAAI-9 abstracted from the original 81-item questionnaire.

1.3.2.1 Hypothesis 2

There will be a significant association between VAAI-9 score, and disability level measured by the Vestibular Activities and Participation measure at three months in persons with vestibular disorders.

2.0 Background

2.1 Prevalence of Vestibular Disorders in the General Population

In the United States, vestibular disorders are estimated to affect 18 million Americans each year (1). Vestibular disorders account for up to 4 million emergency department (ED) visits and 8% of primary care visits annually (41–44). In 2013-2015, there were an estimated 20.6 million visits to ambulatory care clinics for dizziness in the US (45). Kerber et al. found that the 1-year prevalence of dizziness or imbalance was 14.8% in 2008 representing 33.4 million people in the US (46). In Germany, the lifetime prevalence of vestibular vertigo (a sensation of rotation or illusion of motion) was 7.8%, the 1-year prevalence 5.2%, and the incidence was 1.5% in 2003 (47). The prevalence rates of vestibular vertigo are higher among older adults and in females (47). In 2011, the estimated number of visits for dizziness or vertigo to EDs in the US was 3.9 million, accounting for 3.7% of all ED visits nationally (48). The average cost for each ED visit due to dizziness was approximately $1000, which resulted in a total annual estimated cost of $3.9 billion for ED visits for dizziness/vertigo in the US in 2011 (48).

2.2 Consequences of Vestibular Disorders

Vestibular dysfunction causes dizziness and loss of postural control, leading to falls and subsequent injury (3,5,49,50). Persons with vestibular disorders are more likely to report dizziness and a history of a fall (3,50). Individuals with vestibular impairment are also more likely to

experience anxiety, panic, and depressive disorders than persons without vestibular impairment (1,8–14). Persons with vestibular vertigo, or "an illusion of rotation or other motion," have been found to limit activities due to difficulty remembering or confusion to a greater degree than those without vertigo (1).

Vestibular disorders affect the completion of activities of daily living and health-related quality of life (2,51). Neuhauser and colleagues found that the presence of vestibular vertigo was associated with interruption of daily activities and work activities, and avoiding leaving the house (2). They also found that both physical and mental health-related quality of life was lower among persons with vestibular vertigo when compared to persons in the general population without dizziness (2). Medical consultations and hospital visits are more frequent in persons with vestibular vertigo (2). Vestibular loss has been associated with a reduction in health utility compared to the general population after adjusting for demographic variables and comorbidities (51). Agrawal and colleagues found a lifetime loss of 1.3 quality-adjusted life years (QALYs) per individual for older adults with vestibular loss. In patients 60 years of age and older, the total lifetime economic burden was $64,929 and a total of $227 billion lifetime societal burden among older adults with vestibular loss (51).

2.3 Prevalence of Anxiety and Depression in the General Population

In the United States from 2013-2016, approximately 8% of individuals ages 20 years and older had depression in a given 2-week period measured by the National Health and Nutrition Examination Survey (52). Women were almost twice as likely to have depression (10.4%) compared to men (5.5%). Rates of depression differed by race and family income level, but not

by age group (52). In 2017, an estimated 17.3 million (7.1%) US adults had at least one major depressive episode (53). The lifetime prevalence of having one episode or recurrent episodes of major depressive disorder is 16.6% in US adults (54). Based on data from 2001-2003, the prevalence of any anxiety disorder among US adults ages 18 or older was approximately 19%. The prevalence of anxiety disorders was higher in females than males and lower in those aged 60 years and older (55). The lifetime prevalence of any anxiety disorder is 31.6% in US adults (54).

2.4 Prevalence of Anxiety and Depression among Persons with Vestibular Disorders

The prevalence of depression, anxiety, and/or panic disorder is greater among persons with vestibular disorders compared to the general population. In 2008, Bigelow et al. found 62% of individuals with vestibular vertigo in the US had experienced depression in their lifetime and 46% had a history of generalized anxiety disorder (1). This is compared to 28% and 19% of adults in the general US population, respectively. In adjusted analyses, those with vestibular vertigo had 3.4-fold greater odds of ever being depressed and 3.2-fold greater odds of having a history of anxiety compared with adults in the general population. They also found a higher prevalence of panic disorder in persons with vestibular vertigo (26%) than the general population (8%), with a 3.4-fold increased odds of experiencing panic disorder among those with vestibular vertigo (1). In Germany, several studies found that approximately 28-29% of persons experiencing dizziness also had a current anxiety disorder (6,56). Studies from various countries have found a greater percentage of subjects with dizziness reporting anxiety and depression symptoms and panic attacks when compared to subjects without dizziness (8–14). Individuals with Meniere's Disease, vestibular migraine, and vestibular paroxysmia have the highest prevalence of comorbid

psychological disorders (up to 65%) (6,14,57). However, from these cross-sectional data, it is difficult to determine the time-course of the development of the vestibular disorder and anxiety/depression.

2.5 The Relationship between Vestibular Disorders and Psychological Comorbidity

Some individuals develop secondary psychiatric diagnoses when they experience vestibular dysfunction. A study in South Korea found the incidence of high depression and/or anxiety levels measured by the Beck Depression Inventory and the Spielberger State-Trait Anxiety Inventory were 21.5% among individuals experiencing dizziness with no prior history of psychological disorder (57). Patients who experience chronic symptoms due to a vestibular disorder are more likely to have psychological morbidity than patients who recover, indicating that these symptoms may develop over the course of the vestibular disease (16,58,59). Furman and Jacob proposed a taxonomy for dizziness and anxiety emphasizing a bi-directional relationship between the two conditions: 1) psychiatric dizziness, or dizziness arising from a psychiatric diagnosis; 2) chance co-occurrence of psychiatric dizziness and an independent balance disorder; 3) psychiatric overlay occurring when patients with balance disorders have symptoms that are disproportionate to the diagnosis; or 4) an underlying neurological disturbance causes both dizziness and anxiety symptoms (60–62). Staab and Ruckenstein further emphasized this bi-directional relationship between dizziness and anxiety by finding three time-courses of illness in persons with dizziness who underwent a psychiatric evaluation. About a third of the sample had a primary anxiety disorder and no neurotologic illness, another third of the sample had a primary

neurotologic condition that triggered a secondary psychiatric disorder, and the remaining third had a neurotologic condition that caused an exacerbation of pre-exiting psychiatric symptoms (63).

2.5.1 Neuroanatomical Associations between Fear and Vestibular Disorders

Neural networks involving anxiety and fear have a direct link to the vestibular nuclei through the parabrachial nucleus (62). In animal models, investigators identified direct projections from the caudal medial vestibular nucleus and the inferior vestibular nucleus to brainstem regions that mediate autonomic functions, which may contribute to the effects of vestibular stimulation on cardiovascular and respiratory control (64–67). Porter and Balaban described a more extensive network to autonomic brainstem structures by identifying projections from the vestibular nucleus to the parabrachial nucleus and nucleus ambiguous (65,68). Fear and anxiety responses are generated from cortical, hypothalamic, and amygdaloid regions and are connected to the vestibular nuclei through the parabrachial nucleus, which may mediate fear-induced autonomic responses (62,69,70). Gorman et al. posit that panic may originate from an abnormally sensitive fear network involving the prefrontal cortex, insula, thalamus, amygdala, and projections to the brainstem (including the parabrachial nucleus) and hypothalamus (71). Others have summarized the neuroanatomical model and state that the somatic and visceral motor output pathways of the parabrachial nucleus network can explain the spectrum of fear and anxiety responses, including hormonal stress and autonomic responses as well as somatic motor responses such as avoidance behaviors (60,62,72). Other links from the fear/anxiety network include projections from the locus coeruleus and the dorsal raphe nucleus to the vestibular nuclei that likely play a role in vigilance and sensitivity and response to motion (60,72). Therefore, a threat such as postural instability or onset of acute dizziness could trigger the fear network, and through the shared neuroanatomical

pathways involving the parabrachial nucleus, generate autonomic, motor, and/or emotional responses (62).

Furman and Jacob describe how persons with vestibular disorders can develop abnormal sensory-motor processing by utilizing a sensory integration strategy that relies on visual and somatosensory information to replace inaccurate vestibular information and/or can develop space and motion sensitivity due to oversensitivity to vestibular stimulation (61). This sensitivity to motion can lead to space and motion discomfort, which can give rise to fears in certain environments or movements (61). Specifically, sensory conflict could elicit or contribute to fear responses in acrophobia, driving-related phobia, or panic disorders (73). Vestibular and other sensory inputs may cause the phenomena of space and motion discomfort (a condition often seen in patients with panic disorder and agoraphobia) that could elicit a fear/anxiety response through parabrachial network connections. Chronic subjective dizziness (now termed persistent postural-perceptual dizziness [PPPD]) is defined, in part, by hypersensitivity to motion and an exacerbation of symptoms in visually stimulating environments or tasks (74–76). Several neuroimaging studies in persons with PPPD have found that brain areas responsible for spatial orientation, multi-sensory integration, and threat assessment may not be as active in patients with PPPD when compared to healthy controls with sound-induced vestibular stimulation or simulated self-motion (76,77). In addition, there is evidence suggesting certain personality traits may influence functional connectivity in the vestibular-anxiogenic pathways (78–80).

Yardley describes how vestibular and anxiety symptoms can form a vicious cycle where dizziness is further aggravated by a panic response. In a study evaluating the heart rate and respiratory rate responses to head movement, persons with vestibular disorders who reported elevated levels of dizziness and somatic anxiety were more likely to have a greater increase in

respiration rate, which in turn could cause increased dizziness and or disorientation due to hyperventilation (12). Increases in panic responses can also lead to avoidance of movements and environments that may provoke dizziness, thus inhibiting the necessary vestibular compensation from taking place and restricting activity and participation (81,82).

The shared neural networks among fear, anxiety, and dizziness suggest that symptoms related to the onset of a vestibular disorder (dizziness, postural instability, space and motion discomfort) can lead to a fear response. This fear response can then elicit further dizziness and/or avoidance behaviors that can lead to further disability. There are specific vestibular disorders (PPPD) that are defined by hypersensitivity to motion and are often associated with psychological morbidity and can result in significant distress and functional impairment (74–76). Therefore, it is crucial for clinicians to identify fear responses to symptoms and avoidance behaviors provoked by vestibular disorders early on in patient care to prevent the development of chronic symptoms and further disability.

2.5.2 Consequences of Psychological Morbidity in Persons with Vestibular Disorders

Patients with vestibular disorders who have a history of a psychiatric conditions are at greater risk for emotional distress, psychological strain, and longer time to recovery (16–18,20). Persons with psychological morbidity report more vertigo-related handicap, more vertigo, autonomic arousal, depressive, anxiety, and somatic symptoms, and worse health-related quality of life than those without psychiatric morbidity (6,10,13,19,21,22). Wiltink et al. reported that individuals with dizziness and a comorbid anxiety disorder had a higher extent of healthcare utilization including use of medication and psychotherapy, a heightened perception of impairment, and reduced perceived health status (56). In a vestibular rehabilitation setting, persons with

negative affect improved on performance measures and in patient-reported outcome measures, but not to the same degree as persons with normal affect. The negative affect group had worse scores at initial and discharge assessments than the normal affect group in patient-reported outcome measures and required longer treatment duration (23). Similarly, older adults with self-reported anxiety and depression in vestibular rehabilitation settings tended to report lower balance confidence (83). In summary, a history of anxiety, depression, and the concurrent presence of self-reported anxiety and depressive symptoms can have a negative impact on quality of life and clinical outcomes among persons with vestibular disorders.

2.5.3 Treatment of Persons with Vestibular Disorders with Psychological Morbidity

Treatment for persons with vestibular disorders who also have psychological morbidity may require a multidisciplinary team of providers, including physicians, psychologists, audiologists, and physical therapists (84–86). Several studies have confirmed that selective serotonin reuptake inhibitors are effective for treating chronic subjective dizziness (now PPPD) or dizziness associated with psychiatric symptoms (74,87,88). Combined treatments including anti-depressive medications and vestibular rehabilitation, including behavioral interventions, show promise in treating persons with PPPD, although further research should be conducted (85,89). Including techniques such as cognitive behavioral therapies and mindfulness into vestibular rehabilitation programs has been effective in reducing disability and dizziness symptoms among patients with vestibular disorders and psychological morbidity (86,90–93). However, there is a need for rehabilitation programs developed for targeted treatment of specific vestibular and/or psychiatric symptoms (90). One of the major issues with developing targeted treatments for persons with dizziness and psychiatric symptoms and fear avoidance behaviors is that there is no

valid, reliable measurement tool for behavioral factors designed specifically for this population. Therefore, clinicians may not be made aware of psychological morbidity or the presence of behavioral factors leading to delay in the initiation of efficacious treatment modalities.

2.6 The Measurement of Fear Avoidance in Chronic Pain

2.6.1 The Fear Avoidance Model

The fear avoidance model (FAM) of exaggerated pain perception was first outlined by Lethem et al. and further adapted to a cognitive behavioral model of fear of movement/re-injury by Vlaeyen and colleagues, to describe the different emotional and behavioral responses to pain in patients with chronic low back pain (LBP) (Figure 1) (25,94,95). Lethem and colleagues describe patients who demonstrate a non-adaptive pain response and tend to avoid pain experiences and painful activities. This avoidance behavior can then lead to physical consequences such as loss of mobility, strength, and/or aerobic fitness, and psychological consequences including lack of exposure to pain experience resulting in failure to calibrate appropriately and exaggerated pain perception (95). According to some, avoidance behavior and/or rest may be effective in reducing pain and preventing further injury in the acute phase but avoidance behaviors that persist and occur in the anticipation of pain rather than in response to pain can lead to disability (94). Others argue that avoidance behaviors identified in the acute phase of injury could lead to more persistent disability (26,96,97). Vlaeyen et al. describe the FAM as pain-related fear which can lead to disability as follows: 1) a pain experience can lead to negative appraisals of pain such as catastrophic thinking, a precursor to fear; 2) fear characterized by avoidance behaviors which lead

to activity restriction; 3) avoidance behaviors begin to occur in anticipation of pain (hypervigilance) leading to the persistence of the avoidance behaviors; and 4) chronic avoidance leads to diminished cardiovascular and musculoskeletal functioning, as well as mood disturbances such as frustration and depression (Figure 1) (24,25,98). In contrast, if pain is perceived as non-threatening, individuals are likely to continue with their normal movement and daily routine, facilitating functional recovery (99).

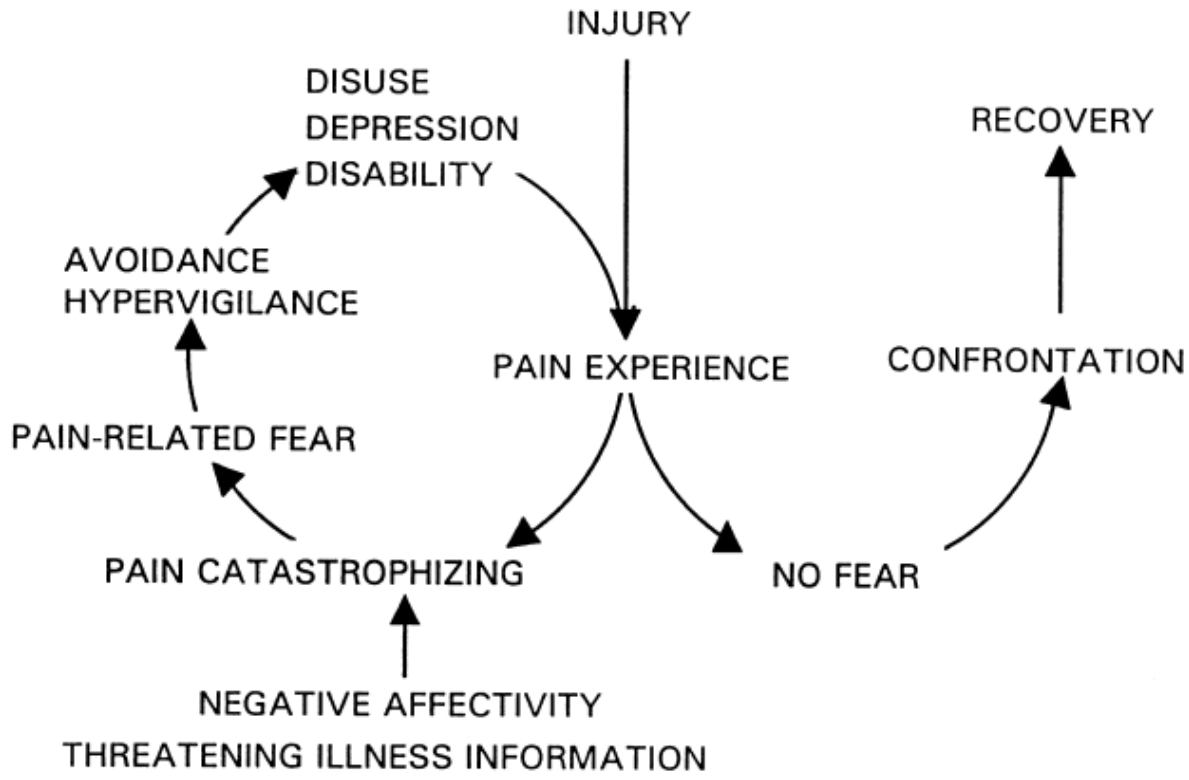

Figure 1 The Fear Avoidance Model (94)

Pain-related fear can lead to diminished physical performance, functional limitations, and poorer quality of life. In studies of patients with acute and chronic LBP, fear avoidance beliefs have been negatively associated with physical performance and self-reported measures of

disability (24,26,28,94,96,97,100–105). Several investigators have found that pain-related fear and fear of movement/re-injury were better predictors of self-reported disability than clinical findings and pain intensity (24,26,28). Similarly, pain-related fear and fear of movement are predictors of impaired physical performance on behavioral tests (28,94,100,102). In a systematic review of 21 prospective cohort studies, Wertli et al. found that elevated fear avoidance beliefs measured by the Fear Avoidance Beliefs Questionnaire (FABQ) and/or the Tampa Scale of Kinesiophobia (TSK) in patients with subacute LBP predicted reduced work-related outcomes (106). There were mixed results in patients with LBP for less than 2 weeks or for more than 3 months indicating that high fear avoidance beliefs were less associated with inferior outcomes in the very acute and chronic patient groups (106). Not only is fear of movement/re-injury predictive of current and future disability, but it is also associated with worse quality of life in persons with LBP (104).

The association between disability and fear avoidance beliefs has been identified in populations other than patients with LBP. George et al. found that elevated fear avoidance beliefs measured by the FABQ physical activity subscale were associated with lower self-reported function and higher pain ratings at baseline in patients seeking physical therapy care for cervical, lumbar, upper, or lower extremity pain (107). However, with physical therapy intervention, patients with elevated fear avoidance beliefs improved and achieved outcomes similar to patients with normal fear avoidance beliefs (107). In a sample of patients with knee osteoarthritis, fear avoidance, depression, and anxiety were all related to physical function measures (108).

Fear avoidance and anxiety are separate but related elements within the FAM (99). One component of anxiety, hypervigilance (which is included in the FAM), is described as consistently scanning one’s environment for potential threats and attention to threat-related stimuli

preferentially over neutral stimuli, and can develop from fear, motivating individuals to engage in defensive behaviors (99,109). Curtin et al. found that ruminative anxiety and levels of mindfulness were associated with all components of the FAM except pain severity in patients with chronic musculoskeletal pain (110). The TSK, which measures fear of movement/re-injury, is significantly correlated with depression, catastrophization, fear (social, agoraphobia, and bodily injury), and anxiety in patients with chronic LBP (94). Depression is a component of the FAM and thought to develop from chronic avoidance behaviors, withdrawal from daily activities, and social isolation leading to disuse and disability (25). Several studies have found a relationship between fear avoidance beliefs and self-reported depression in patients with LBP (26,94,96,103).

Recently, there have been several attempts to examine the relationship between the components of the FAM using structural equation modeling. In a mediation analysis, fear avoidance, catastrophizing, and depression significantly mediated the relationship between pain and disability (111). However, the mediating effect of catastrophizing was conditional on weekly physical activity. Catastrophizing was a significant mediator of the relationship between pain and fear, demonstrating validity to the proposed pathways within the FAM which indicate that catastrophic thinking can lead to avoidance behaviors (111). Another study found that both fear avoidance beliefs and avoidance behaviors were mediating variables explaining poor function in patients with LBP, but there was no mediating effect of depression (112). In summary, fear avoidance, anxiety, and depression are associated but the relationships among these variables are complex and have not yet been fully elucidated within the context of the FAM.

From the identification of fear avoidance beliefs and psychological factors as important components in the development of chronic pain, targeted treatment protocols have been developed to effectively treat these factors (33,34). Treatment programs typically include cognitive-

behavioral and/or psychologically-informed treatment techniques targeted to manage pain and psychological symptoms concurrently (33,34).

2.6.2 Fear Avoidance Measurement Tools Used in Persons with Low Back Pain

The Fear Avoidance Beliefs Questionnaire (FABQ) was initially developed to identify fear avoidance, which was hypothesized to be an important behavioral factor related to the development of disability in persons with LBP (26). The 16 items of the FABQ focus on the effect of physical activity and work on individuals' LBP and are based on the concepts of disease conviction and somatic focusing and several previously developed questionnaires (26,113–117). Exploratory factor analysis identified that the FABQ consists of 2 subscales: fear-avoidance beliefs about physical activity and fear avoidance beliefs about work (26). The item response categories range from strongly disagree (0) to strongly agree (6) for a possible physical activity subscale score of 0-24 and a work subscale score of 0-42. Items 1, 8, 13, and 14, and 16 are not included in the scoring because of low factor loadings or redundancy in the initial factor analysis (26). In a systematic review of health-related work outcome measures, Mateen and colleagues identify the FABQ as the most widely validated tool to evaluate pain-related fear and avoidance. However, the inclusion of a work subscale that is limited to physical aspects of work may not be applicable to all populations (26,118).

Sullivan et al. developed the Pain Catastrophizing Scale (PCS) to provide a valid index of catastrophizing in clinical and non-clinical populations. Catastrophizing is a construct included within the FAM with associations between pain and disability. The items of the PCS were developed from dimensions of catastrophization including: the tendency to increase attentional focus on pain-related thoughts, exaggerate the threat of pain stimuli, and adopt a helpless coping

strategy to painful situations (119–121). Some items were developed from the Coping Strategies Questionnaire (120). The PCS includes 13 items with a response scale ranging from 0 (not at all) to 4 (all of the time) (120). From a principal component analysis, 3 factors were extracted: rumination (4 items), magnification (3 items), and helplessness (6 items). These components of catastrophization are all potential cognitive responses to pain, whereas some of the other measurement tools measure behavioral responses to pain. The PCS has a significant weak association with depression (r = .26), trait anxiety (r = .32), negative affectivity (r = .32), and a strong association with fear of pain (r = .80) (120). In a confirmatory factor analysis including community-dwelling adults, patients with chronic pain, and patients with fibromyalgia, the three factor structure was confirmed, providing further evidence that the scale was identifying a catastrophization construct with three related dimensions (122,123).

The Tampa Scale of Kinesiophobia (TSK) was developed to identify patients with chronic pain who avoid painful activity because they fear further injury (124). The original version of the TSK was 17 items measured on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total score is calculated after reverse coding items 4, 8, 12, and 16 for a total score between 17 and 68 with higher scores indicating greater fear of movement/re-injury (94). A four-factor structure was first proposed including the following dimensions: harm, fear of re-injury, importance of exercise, and avoidance of activity (24). The TSK is moderately correlated with the FABQ physical activity and work scales (125). More recently, an 11-item version of the TSK has been proposed because 6 items were deemed psychometrically poor (126). The TSK-11 includes 2 factors with items relating to activity avoidance and somatic focus (127). The TSK-11 is now more widely used and demonstrates a strong association with the PCS (r = 0.60) (128,129).

The FABQ, PCS, and TSK all contain elements related to the FAM. The FABQ identifies fear of pain and avoidance related to physical activity and work, the TSK identifies fear of injury and pain, and the PCS is strongly correlated to fear of pain. The FABQ and TSK are similar because they both contain elements of somatic focus and activity avoidance beliefs and behaviors and address the construct of pain-related fear associated with physical activity and exercise within the FAM. The FABQ differs because it contains a subscale specific to work, whereas work is not mentioned in the other instruments. The PCS focuses more on thoughts, feelings, and coping strategies than either the FABQ or TSK and addresses the catastrophization component of the FAM, which is thought to be a precursor to pain-related fear and a cognitive response to pain (25,98,99). Therefore, the FABQ, PCS, and TSK measure separate, but related components within the FAM, with the FABQ and TSK measuring similar constructs.

2.7 The Measurement of Psychological Factors in Vestibular Disorders

The fear-avoidance model can be adapted to include dizziness because symptoms of dizziness share similar qualities to pain (Figure 2). Both pain and dizziness symptoms can develop from acute insult and may progress to chronic complaints. Dizziness and pain can cause activity avoidance, work leave, decreased ability to perform activities of daily living and decreased quality of life (2,106). Patient-reported outcome measures are used commonly in vestibular rehabilitation to measure balance confidence, quality of life, and perceived handicap (130–133). Attempts have been made to measure psychological factors such as anxiety, depression, and affect in persons with vestibular disorders using patient-reported outcome measures designed to measure psychological constructs in other patient populations (36,38). However, there is currently no instrument designed

specifically to provide a comprehensive measure of fear avoidance and other behavioral factors in persons with vestibular disorders.

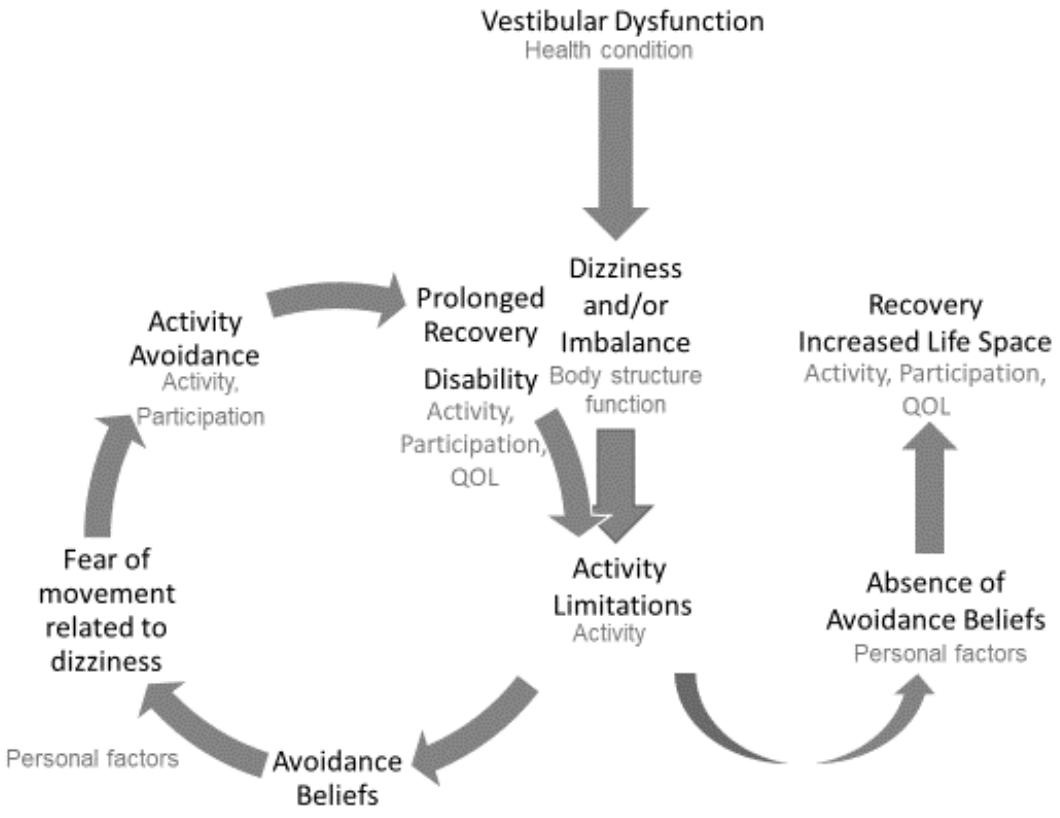

Figure 2 Theoretical framework of psychological factors and vestibular disorders in the context of the International Classification of Functioning, Disability and Health (ICF). Adapted from Vlaeyen J & Linton S, 2012. (134)

2.7.1 Tools used to Measure Psychological Factors in Persons with Vestibular Disorders

Pothier et al. have developed a Dizziness Catastrophizing Scale (DCS) by adapting the PCS to include the word "dizziness" in place of the word "pain" (38). The DCS has a moderate to strong correlation with the Dizziness Handicap Inventory (DHI), a measure of perceived

handicap due to dizziness, and a strong correlation with the Positive and Negative Affect Schedule (PANAS) negative affect score (130,135). The DCS demonstrates strong internal consistency, excellent test-retest reliability, and a single-factor solution with exploratory and confirmatory factor analysis. The DCS independently accounted for 47% of the variance in DHI score and when considered with the PANAS positive and negative subscales, explained 52% of the variance (38). Therefore, the DCS appears to be a valid and reliable measure of catastrophizing in persons with vestibular disorders and is associated with perceived disability. However, given the one factor solution and questions relating only to catastrophization, the DCS is limited to only measure one construct. Therefore, it may be helpful to clinicians to have a more comprehensive measure of fear avoidance. The measurement of behavioral responses to dizziness is important because clinicians need to know how the experience of dizziness symptoms are changing behaviors and because the interventions provided in physical therapy clinics are behavioral in nature. Because the DCS was developed from the PCS which only includes cognitive responses related to pain and not behavioral responses, the DCS may not measure these important behavioral responses to dizziness, such as activity avoidance (38,120).

There is some evidence that select items on the DHI are related to the concept of phobic avoidance and escape/avoidance coping processes and should be considered for inclusion on a measure of fear avoidance (15,37). The DHI is moderately correlated with an escape/avoidance coping process, which is evidence that some items may measure the construct of fear avoidance (15). Asmundson et al. found a 3-factor structure when conducting a factor analysis of the DHI, and identified one factor as “phobic avoidance” (37). The phobic avoidance factor of the DHI included items related to fear of certain activities such as being afraid to leave the home alone, avoiding heights, and fear of appearing intoxicated. This phobic avoidance factor was strongly

correlated with agoraphobic fear, anxiety, and depression (37). Ardic et al. found a 2-factor structure of the DHI with one factor being highly correlated with the original functional and physical subscales and the other factor associated with the original emotional subscale. The identified factor related to the emotional subscale contained similar items as the phobic avoidance factor identified by Asmundson and colleagues (136). Because the DHI is a valid and reliable measure of perceived disability with a long history of use in persons with vestibular disorders, the avoidance items from the DHI may be especially pertinent to this population.

The Vertigo Symptom Scale (VSS) was developed to assess the description of vertigo attacks and includes symptoms related to somatic anxiety, somatization, and hyperventilation (137). The VSS includes 36 items and some of the autonomic/anxiety symptom items are: heart pounding or fluttering, loss of concentration, tingling, prickling, or numbness in parts of the body, and pains in the heart or chest region. The autonomic/anxiety subscale of the VSS is associated with state and trait anxiety measured by the Spielberger's Trait Anxiety Inventory and the Hospital Anxiety and Depression Scale (137). In a multivariable regression model, the autonomic symptom items included in the VSS explained 17% of the variance in handicap scores. However, the somatic symptoms were not included in the regression model and it is therefore difficult to know exactly how the autonomic and anxiety symptom items contribute to disability. The Vertigo Symptom Scale – short form (VSS-SF) was developed and evaluated among patients with dizziness in Norway (138). The VSS-SF contains 15 items with 7 items relating to autonomic/anxiety symptoms. Although the items included in the VSS and the VSS-SF are related to anxiety, some of the symptoms reported could be due to other medical problems. For example, having shortness of breath or pains in the chest could be due to cardiorespiratory issues and may not be indicative of comorbid anxiety.

The Vestibular Rehabilitation Benefits Questionnaire (VRBQ) was developed to measure the quality of life benefit derived from vestibular rehabilitation among persons with dizziness (139). The VRBQ consists of 22 items, with 3 of these items relating to anxiety (140). The anxiety items are similar to those in the VSS, and include an assessment of feelings of tingling, prickling, or numbness in the body, feeling as though the heart is pounding, and having difficulty breathing (140). Again, these symptoms can be related to anxiety, but could also have been brought on by other medical conditions.

In summary, there are limited tools available to measure psychological factors and fear-avoidance behaviors in persons with vestibular disorders. While some tools exist to measure specific components of the FAM, such as the DCS, they do not measure the entire construct. Also, there are several tools that include some items relating to anxiety and emotional dysfunction (DHI, VSS, VSS-SF, and VRBQ), but are not designed to specifically measure fear avoidance.

2.7.2 The Vestibular Activities Avoidance Instrument

The Vestibular Activities Avoidance Instrument (VAAI) was developed with the goal to provide clinicians with a comprehensive patient-reported outcome measure that can identify fear avoidance and other psychological factors that may have an effect on outcomes among persons with vestibular disorders (39). The authors developed the VAAI by using reliable and valid outcome measures designed to measure fear avoidance, anxiety, somatization, depression, worry, and other psychological and behavioral factors among persons with pain and adapted the items for use in persons with dizziness. The patient-reported outcome measures used in the development of the VAAI were: the DHI, The Patients Health Questionnaire (PHQ-9 and PHQ-15), the Generalized Anxiety Disorder Assessment (GAD-7), the TSK, the FABQ, the Short Health

Anxiety Inventory (SHAI), and the Multidimensional Scale of Perceived Social Support (MSPSS) (26,124,130,141–145).

After items were compiled using the Delphi technique, the VAAI consisted of 77 items (39). Preliminary reliability and validity analysis determined that the test-retest reliability was excellent (ICC = 0.97) and internal consistency was excellent (Cronbach's alpha = 0.98) (39). The VAAI demonstrated convergent validity with mental (ρ = -0.58, $p < 0.01$) and physical (ρ = -0.63, $p < 0.01$) components of quality of life measured by the Short Form Health Survey (SF-12) (39). Several items were then adapted from the Start Back Screening Tool (SBST) because of its value in screening for psychological factors in persons with low back pain (30,31,40). After the 4 items relating to psychological factors from the SBST were adapted and added to the VAAI, the total number of items on the VAAI was 81. Due to the length of the VAAI, its clinical usefulness was considered minimal because of time constraints and patient fatigue for answering questionnaires in the clinic. Therefore, the primary aim of this study was to further develop the VAAI into a shorter, reliable, and valid tool for use in the clinic. The second aim of the study was to determine the effect of fear avoidance beliefs and other psychological factors on the level of disability among persons with vestibular disorders.

3.0 Factor Analysis of the Vestibular Activities Avoidance Instrument

3.1 Introduction

Patient-reported outcome measures are defined as tools that measure the subjective experience of the patient, independent of provider interpretation (132,146). They are commonly used in vestibular rehabilitation settings to measure symptom severity, perceived handicap due to dizziness, balance confidence, and activity and participation restrictions among persons with vestibular disorders (132,133,147). A systematic review in 2015 examining patient-reported outcome measures used in vestibular research identified 50 available instruments (132). The four most common instruments were the Dizziness Handicap Inventory (DHI), Activity-specific Balance Confidence (ABC) Scale, Vertigo Symptom Scale-short form (VSS-SF), and visual analogue scale (VAS) (132). When evaluated for reliability and validity they found that these 4 instruments had excellent test-retest reliability (132). Another recent systematic review of patient-reported outcomes used for patients with vestibular dysfunction found that the Vestibular Rehabilitation Benefits Questionnaire (VRBQ) demonstrated the most evidence for reliability and validity and recommended it for use when measuring outcome in vestibular rehabilitation (133).

Patients with vestibular disorders are known to have an increased prevalence of anxiety and depression when compared to the general population (1,8,10,11,13,14,148). Persons experiencing dizziness symptoms caused by vestibular disorders often avoid activities and are unable to perform activities of daily living and required work duties (2). There are few tools available that include questions to identify fear avoidance and other psychological factors in persons with vestibular disorders, but there are subsets of items measuring emotional, anxiety, and

catastrophization constructs included in the DHI, the VSS, the VRBQ, and the DCS. The DHI has an emotional subscale component thought to identify psychological factors (130). The developers of the VRBQ included 1 item to measure avoidance behavior with a total of 3 items to measure anxiety symptoms (140). The VSS includes an autonomic-anxiety subscale (10 items) thought to identify autonomic and anxiety symptoms (137). The Dizziness Catastrophizing Scale (DCS) was developed by adapting the Pain Catastrophizing Scale (PCS) for persons with dizziness and has demonstrated reliability and validity in persons with vestibular disorders (38). However, this measure has not yet been used extensively and only measures the construct of catastrophization, which is a cognition and not a behavior.

The Vestibular Activities Avoidance Instrument (VAAI) was initially developed at the University of Pittsburgh with the goal to identify avoidance beliefs and other behavioral and psychological factors such as anxiety, depression, worry, and somatization in persons with vestibular disorders (39). The VAAI was developed by including adapted questions from existing questionnaires (Section 2.1.4). The original questionnaire included 77 items with 4 additional items added from the Start Back Screening Tool (SBST). The current tool is now 81 items and provides a comprehensive measurement of various behavioral and psychological factors including fear avoidance beliefs. However, the length of the questionnaire was deemed too burdensome for clinical use. Therefore, the primary goal of this study was to perform exploratory factor analysis to identify the underlying constructs explaining the items and to reduce the number of items.

Exploratory factor analysis (EFA) is commonly used in biomedical research to explain the relationship between a set of items or indicators (149). The assumption of EFA is that there are a small number of underlying factors that can explain the inter-relationship among the variables (150). The steps for conducting EFA include: specifying the problem, generating the items,

assessing the adequacy of the correlation matrix, extracting the initial factors, rotating the factors, refining the solution (including item reduction), interpreting the findings, and reporting the results (151). The VAAI has already been developed and includes 81 items. This extensive questionnaire covers many behavioral and psychological constructs that may contribute to disability among persons with vestibular disorders. However, the underlying factors should be determined to evaluate the inter-relationship among the items and the number of items should be reduced so that the VAAI may be used and interpreted in clinical settings. In addition, the aim of this study was to evaluate the internal consistency reliability and construct validity of the shortened form of the VAAI. We hypothesized that the VAAI would be factorable, and that the shortened version of the VAAI would demonstrate adequate internal consistency and construct validity through significant relationships with measures of disability, health-related quality of life, and psychological well-being.

3.2 Methods

3.2.1 Participants

Participants were recruited from a tertiary care balance disorders center and outpatient vestibular rehabilitation physical therapy clinics in the Pittsburgh area: The University of Pittsburgh Medical Center (UPMC) Balance Disorders Clinic and UPMC Centers for Rehab Services clinics. Eligibility criteria included the following: ages 18 to 100 years, English-speaking, and cognitively able to answer questions. Potential subjects were told about the study by their healthcare provider. Those who agreed to hear more information about the study were

directed to a study investigator. The study investigator then obtained informed consent and directed the subject in answering the questionnaires either on a computer or on paper while in the clinic that day. This study was approved by the University of Pittsburgh Institutional Review Board (PRO13120388).

3.2.2 Outcome Measures

3.2.2.1 The Vestibular Activities Avoidance Instrument

The VAAI is an 81-item patient reported outcome measure that was originally developed at the University of Pittsburgh and modified for this study (Appendix A) (39). The VAAI includes questions from other measures of psychological factors, adapted for use in a population with unsteadiness and/or dizziness. All items except one are scored on a scale from 0-6 with 0 indicating "strongly disagree" and 6 indicating "strongly agree." The last item differs from the other items and is scored on a scale from 0-4. Therefore, the total possible score ranges from 0 to 484 with higher scores indicating higher levels of fear avoidance beliefs and other psychological symptoms. The goal of the present study was to develop this comprehensive instrument into a clinically useful tool by shortening the list of items using factor analysis and item reduction techniques.

3.2.2.2 The Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is a measure that is commonly used to identify anxiety and depression in physically ill patients (152,153). The HADS consists of 2 subscales, the anxiety subscale (HADS-A) and depression subscale (HADS-D). Each item is scored on a scale ranging from 0 to 3 with higher scores indicating greater levels of anxiety or depression symptoms with a total score for each subscale ranging from 0 to 21. A cut point of ≥

8 on each respective subscale has been accepted for identification of borderline anxiety or depressive disorders (152,153). The HADS was collected at baseline to determine if there was convergent validity with the modified VAAI.

3.2.2.3 The Vestibular Activities and Participation Measure

The Vestibular Activities and Participation Measure (VAP) was developed specifically to measure activity limitations and participation restrictions that may be present in persons with vestibular disorders (154). Items were developed using the International Classification of Functioning, Disability, and Health and the VAP has demonstrated excellent test-retest reliability (ICC=0.95) in this population. There is a total of 34 items with each item measured on a scale ranging from 0 indicating no difficulty with the activity to 4 indicating the individual is unable to do the activity. The items are then averaged for a total possible score ranging from 0 to 4 with a higher score indicating greater activity limitations and participation restrictions. Also, the VAP had a strong correlation with the World Health Organization Disability Assessment Scale II (WHODAS II) (ρ=0.70) and moderate to strong correlations with the DHI subscales and DHI total score (ρ=0.54-0.74) (154). The VAP was measured at baseline to determine if there was a relationship between VAAI score and activity limitations and participation restrictions.

3.2.2.4 The 12-Item Short Form Health Survey

The 12-Item Short Form Health Survey (SF-12) was designed to measure health related quality of life (155–159). The SF-12 has been used in persons with vestibular disorders and is associated with DHI scores among women with peripheral vestibular disorders (160). The SF-12 consists of a Physical Component Summary (PCS) score evaluating the effect of physical health on quality of life and a Mental Component Summary (MCS) score that evaluates the effect of

emotional health on quality of life. An algorithm is used to generate scores for the PCS and MCS for comparison for normative data. Higher scores indicate better physical or mental health than the mean according to normative data. The SF-12 PCS and MCS demonstrate high internal consistency ($\alpha > 0.8$), high to moderate test-retest reliability (ICC=0.6-0.78) and convergent validity with the EuroQoL (EQ-5D) in the general population (155). A modified version of the SF-12 was utilized in this study and was measured at baseline to determine if there was a relationship between the VAAI scores and the PCS and MCS scores.

3.2.3 Statistical Analysis

3.2.3.1 Sample Size

It is recommended that the minimum number of subjects required for exploratory factor analysis is 5 subjects per 1 item (161). Therefore, a sample size of 405 was considered adequate to perform exploratory factor analysis on the 81-item VAAI.

3.2.3.2 Exploratory Factor Analysis

Five items on the VAAI require reverse coding due to the direction the questions are asked. After this was completed, descriptive statistics were calculated for each item on the VAAI and the total score. The correlation matrix and covariance matrix were constructed. Strength of correlation cutoff values were determined as: 0-0.29 weak; 0.3-0.49 low; 0.50-0.69 moderate; 0.70-0.89 strong; and 0.90-1.00 very strong (151,162,163). Items that had strong or very strong relationships (>0.70) were examined to see if they were expressing the same concept. To determine if factor analysis was appropriate for the items, a correlation matrix was constructed among scale items. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test were conducted to determine

if there were a sufficient number of significantly correlated items (151,164). A non-significant result of Bartlett's test would indicate that factor analysis is not appropriate due to a lack of relationship between the items (165). Given a small KMO, factor analysis would not be recommended because this is a measure of the relationship between the magnitudes of the calculated correlation coefficients and the magnitudes of the partial correlation coefficients (151). If the items share some common factor, the KMO statistic should approach 1. According to Kaiser (1974), a KMO test result of > 0.90 is considered marvelous, 0.80-0.89 is considered meritorious, 0.70-0.79 is middling, and 0.60 or less is unacceptable (151,166). In addition to the overall KMO, an anti-image correlation matrix was constructed and the individual measures of sampling adequacy (MSA) for each item were evaluated. The MSA indicates how strongly the individual item is related to other items in the scale. Measures of Sampling Adequacy use the same cut-off values as KMO test results, and higher values indicate that the correlation matrix is factorable (166). Items with MSA values lower than 0.60 were evaluated for appropriateness and removed as this was evidence that there may not be an underlying factor structure that can summarize the items (151). After the removal of each appropriate item, the matrices were re-constructed, and the above tests were recalculated for the appropriate values.

After there was evidence of adequate sample size and adequate number of items demonstrating a relationship to one another to conduct EFA using the tests above, the EFA was conducted using Principal Component Analysis (PCA). The number of factors to retain was evaluated using several methods. First, the potential factors to retain were identified by factors with eigenvalues greater than 1. Then, the number of factors with eigenvalues greater than 1 were compared to the number of factors that explain greater than 5% of the variance (151). Next, a scree plot was generated, which is a graph of the number of factors plotted against their

eigenvalues. The slope of the line was visualized, and the point at which the line levels off (indicating factors with low eigenvalues) was selected as the number of factors to retain. The final method of determining the number of factors to retain was by conducting a parallel analysis. In this method, a random data set with the same number of observations and variables as the original data was generated. A correlation matrix was derived from the generated dataset and the eigenvalues were calculated (167). The parallel analysis was conducted using STATA 15.1. The factor solutions for each of the four methods described above were compared and the number of factors to retain was determined (151,168). The factor structure was rotated using an oblique rotation. Oblique rotation was chosen over orthogonal rotation because if the factors extracted are correlated, oblique rotation is recommended. The Direct Oblimin and Promax rotations were both conducted and the rotation with the clearest solution was utilized in the final EFA (169,170). All analyses other than the parallel analysis was completed using IBM SPSS Statistics 25.

3.2.3.3 Item Reduction and Reliability

To determine if the items included in each of the factors demonstrated internal consistency reliability, Cronbach's alpha was calculated (151). Given the large number of items, item reduction was completed by including items with the highest loadings on each factor and then evaluating internal consistency with Cronbach's alpha. This procedure was repeated multiple times by adding the next two highest loaded items at a time (151). The Cronbach's alpha was then plotted against the number of items for each iteration. The number of items was reduced by including only the items that substantially improved the alpha value and removing the items that did not significantly improve alpha. Then, the final factors were examined for internal consistency using Cronbach's alpha. The items within each factor were evaluated for common themes and then named accordingly. Cronbach's alpha values between 0.7 and 0.95 were considered as

evidence for internal consistency without redundancy among items (171). Items on the shortened scale were summed for a total score.

3.2.3.4 Validity

Construct validity of the VAAI was assessed through factor analysis (Section 3.2.3.2) and convergent validity. The items included in the shortened version of the VAAI were abstracted from the original 81-item questionnaire to test convergent validity. Convergent validity was determined by taking multiple random samples of the original sample and examining the correlation between the shortened VAAI total score, and the HADS, the SF-12, and the VAP using Spearman's correlation coefficients and the bootstrapping resampling method (172,173). Based on an a priori power analysis, a sample of 84 subjects was required to detect a correlation coefficient of 0.3 or greater with alpha level at 0.05 and power of 0.80. The bootstrapping method takes multiple random samples of a specific size from the existing sample of data where each data point is replaced after sampling. The resulting sampling distribution usually follows the normal distribution if the original sample is large. Computation of the bias corrected accelerated confidence intervals takes into account skew and bias in the observed distribution (174). Through this method, more accurate estimates of external validity for the shortened version of the VAAI can be obtained, although external validity should be reanalyzed in a separate sample in the future (175). For this analysis, 1000 samples were taken from the existing data for the correlation coefficients using the bootstrap resampling method.

Because the VAAI and HADS include theoretically related constructs (anxiety and depression), it was hypothesized that these two scales were significantly correlated. It was also hypothesized that greater activity and participation restrictions measured by the VAP and lower quality of life measured by the SF-12 would be associated with higher levels of fear avoidance

beliefs measured by the VAAI. A correlation coefficient of greater than 0.3 was considered adequate to determine convergent validity (176).

3.3 Results

3.3.1 Exploratory Factor Analysis

3.3.1.1 Item Characteristics

After a group discussion with the research team, item 81 of the VAAI was removed from the scale because it had a different response scale (adapted from the SBST) and had a different stem question than the other items in the scale. Next, items 20, 35, 47, 56, 70 were assessed to ensure that they were reverse-coded (Appendix A). After review of the questionnaire responses, one subject was removed from the analysis because they responded "strongly agree" to every item in the scale which suggests that the data did not accurately reflect an appropriate response. The mean, standard deviation and Shapiro-Wilk test of normality were calculated for each item and for the total scale (Table 1). All items and the total score of the VAAI did not follow a normal distribution. Next, the correlation matrix for all 80 items was visualized and items with correlations > 0.7 were noted. There were 12 pairs of items that had correlation coefficients > 0.7.

Table 1. Descriptive Statistics and Shapiro-Wilk Test of Normality for the Vestibular Activities Avoidance Instrument 80-Items (n=404)

N = 404		Shapiro-Wilk	
VAAI Item #	Mean (SD) [Range]	Statistic	*p*-value
1	5.2 (1.1)	0.68	<0.001
2	4.3 (1.6)	0.85	<0.001
3	2.9 (1.9)	0.91	<0.001
4	3.4 (1.8)	0.92	<0.001
5	3.1 (1.9)	0.92	<0.001
6	3.1 (1.9)	0.92	<0.001
7	3.9 (1.8)	0.88	<0.001
8	4.7 (1.6)	0.78	<0.001
9	2.6 (2)	0.90	<0.001
10	3.3 (2)	0.90	<0.001
11	2.9 (2)	0.91	<0.001
12	3.3 (2)	0.91	<0.001
13	3.8 (1.8)	0.88	<0.001
14	2.8 (1.8)	0.93	<0.001
15	3.2 (2.1)	0.89	<0.001
16	3.1 (1.9)	0.92	<0.001
17	2.8 (2)	0.90	<0.001
18	2.3 (2)	0.88	<0.001
19	3.1 (1.9)	0.91	<0.001
20	3.2 (1.6)	0.94	<0.001
21	2.2 (1.7)	0.90	<0.001
22	2.1 (1.8)	0.89	<0.001
23	2.7 (2)	0.90	<0.001
24	1.1 (1.5)	0.74	<0.001
25	1.5 (1.7)	0.81	<0.001
26	2.2 (1.9)	0.88	<0.001
27	2.7 (1.9)	0.92	<0.001
28	3.8 (1.9)	0.88	<0.001
29	2.8 (2.1)	0.89	<0.001
30	3.3 (2.2)	0.88	<0.001
31	3.3 (2.1)	0.87	<0.001
32	4.0 (1.7)	0.87	<0.001
33	1.1 (1.7)	0.67	<0.001
34	2.8 (2.1)	0.89	<0.001
35	2.9 (1.8)	0.93	<0.001
36	2.6 (2.1)	0.88	<0.001
37	2.9 (2.0)	0.90	<0.001
38	1.9 (1.9)	0.86	<0.001
39	2.8 (2.0)	0.89	<0.001

Table 1 (continued)

40	3.5 (1.9)	0.89	<0.001
41	2.3 (1.9)	0.90	<0.001
42	2.6 (2.0)	0.90	<0.001
43	3.4 (2.0)	0.90	<0.001
44	3.3 (2.0)	0.89	<0.001
45	1.7 (2.0)	0.78	<0.001
46	4.1 (1.7)	0.86	<0.001
47	2.3 (2.2)	0.85	<0.001
48	3.0 (1.9)	0.92	<0.001
49	2.0 (1.9)	0.87	<0.001
50	2.5 (2.2)	0.87	<0.001
51	3.1 (2.3)	0.86	<0.001
52	1.8 (1.9)	0.84	<0.001
53	2.6 (2.1)	0.89	<0.001
54	4.4 (1.7)	0.83	<0.001
55	1.8 (1.9)	0.84	<0.001
56	2.7 (1.7)	0.93	<0.001
57	2.4 (2.0)	0.88	<0.001
58	2.1 (2.0)	0.85	<0.001
59	3.5 (2.1)	0.88	<0.001
60	1.8 (1.8)	0.85	<0.001
61	3.1 (2.1)	0.89	<0.001
62	2.9 (2.1)	0.89	<0.001
63	2.3 (2.0)	0.88	<0.001
64	2.1 (1.9)	0.88	<0.001
65	1.8 (1.8)	0.85	<0.001
66	3.2 (2.2)	0.87	<0.001
67	2.0 (2.0)	0.84	<0.001
68	3.3 (1.9)	0.91	<0.001
69	2.5 (2.2)	0.87	<0.001
70	2.5 (1.9)	0.90	<0.001
71	1.9 (1.9)	0.86	<0.001
72	1.6 (1.9)	0.80	<0.001
73	0.9 (1.4)	0.64	<0.001
74	1.6 (1.6)	0.85	<0.001
75	3.4 (1.8)	0.91	<0.001
76	1.6 (1.7)	0.83	<0.001
77	1.9 (1.8)	0.87	<0.001
78	3.1 (2.0)	0.92	<0.001
79	1.8 (2.1)	0.80	<0.001
80	2.1 (1.9)	0.88	<0.001
Total Score (0-480)	217.9 (83.9) [31-433]	0.99	0.031

Abbreviations : VAAI, Vestibular Activities Avoidance Instrument

3.3.1.2 Tests of the Item Correlation Matrix

To determine that there were a sufficient number of significant correlations in the item correlation matrix, Bartlett's test of sphericity and the KMO test were completed. The result of Bartlett's test of sphericity was $X^2(3160) = 21099.24$, $p < 0.001$ and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA) was 0.95 indicating that there were a sufficient number of correlated items in the matrix to conduct the exploratory factor analysis (EFA). Then, the anti-image correlation matrix was constructed to evaluate the individual MSA values. All items had MSA statistics greater than .60, except for the following items: 20 (MSA = 0.31), 35 (MSA = 0.54), 47 (MSA = 0.48), 56 (MSA = 0.43), 70 (MSA = 0.56). Incidentally, these were the five reverse-coded items. Because the individual measures of sampling adequacy were less than 0.60 for these items, the correlation matrix was reassessed after removing one item at a time, starting with the item with the lowest MSA value (item 20). All five items were removed from the analysis to achieve individual MSA values > 0.60. Bartlett's test of sphericity and the KMO Measure of Sampling Adequacy were repeated for the 75 remaining items and similar results were found: $X^2(2775) = 20491.91$, $p < 0.001$; KMO = 0.96.

3.3.1.3 Principal Component Analysis (PCA)

The EFA was completed using a PCA. The number of factors to retain was determined using several methods. First, the number of factors with eigenvalues greater than 1 was noted to include 13 factors. Only two factors accounted for greater than 5% of the variance in the scale. Next, the scree plot was visualized to determine where the slope of the line started to level. The line of the scree plot appeared to level after three factors (Figure 3). Next, a parallel analysis was completed by generating 10 random datasets and averaging the eigenvalues obtained from the 10 correlation matrices. According to the parallel analysis, there were five factors that resulted in

greater eigenvalues in the PCA versus the parallel analysis indicating that five factors should be retained. Given the ambiguity between methods of determining the number of factors to retain, PCA and factor rotation was conducted for both two- and three-factor solutions based on the results from the scree plot and the percent of variance explained.

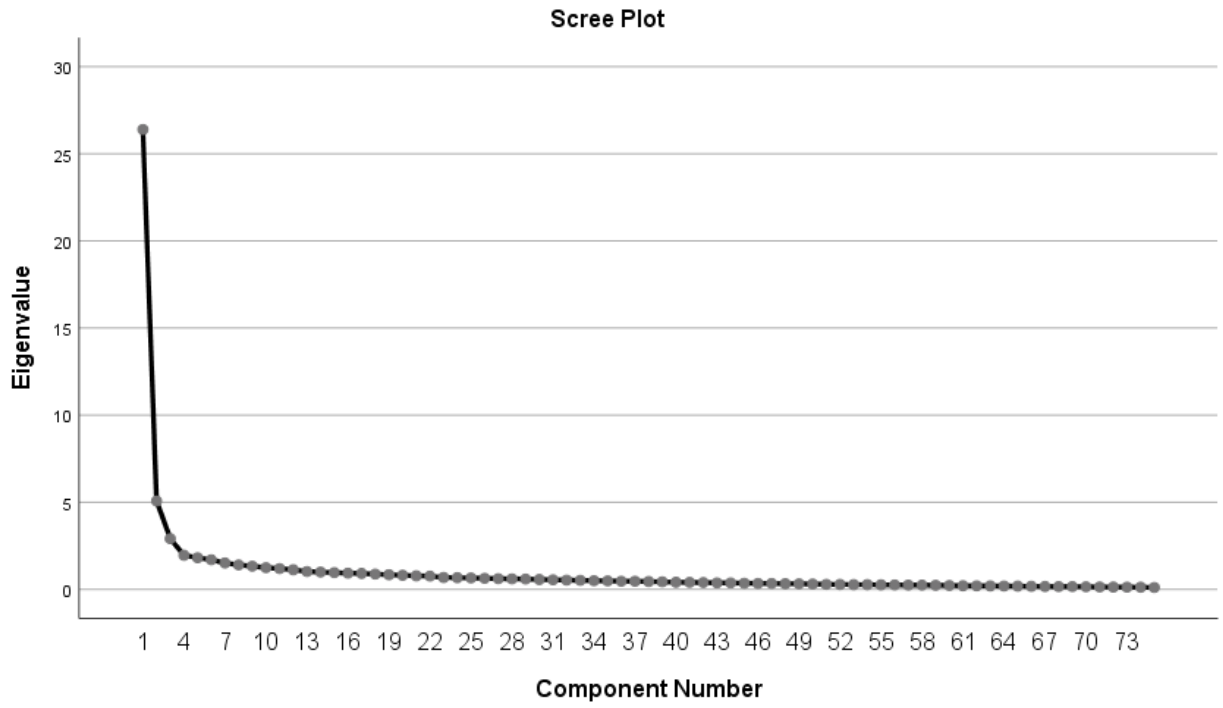

Figure 3. Scree Plot for Exploratory Factor Analysis of the VAAI 75 Items

3.3.1.4 Rotating the Factors

Two- and three-factor solutions were rotated using the oblique rotations, Direct Oblimin and Promax and compared. After comparing the two- and three-factor solutions, it was decided by the research team that a two-factor solution was more appropriate given that there were only 6 items included in the third factor using the Direct Oblimin rotation and because there were a large number of items that strongly loaded on multiple factors when using a three-factor solution. This indicates that a two-factor solution offers a result that was easier to interpret.

3.3.1.5 Refining the Factors

After reviewing the results of the two-factor solutions, there were 7 items (items 2, 32, 33, 51, 62, 73, 78) that did not have a factor loading > 0.4 on either factor using the Direct Oblimin rotation and 5 items (items 2, 32, 62, 73, 78) that did not have a factor loading > 0.4 using the Promax rotation. Interestingly, items 2 and 33, which were adapted from the FABQ, were previously found to have inconsistent factor loadings when the FABQ was developed (26). The research team agreed that the 7 items that did not load strongly on either factor using the Direct Oblimin rotation should be removed from the analysis. Also, the team agreed to remove 5 additional items (adapted from the FABQ and TSK-17) that were deemed to be psychometrically poor by previous studies of the original instruments and therefore not included in the scoring of the FABQ and the TSK-11 (26,126). The EFA was repeated using a two-factor solution and both Direct Oblimin and Promax rotations for the remaining 63 items.

Factor 1: Activity and Participation Avoidance

Factor 1 contained 40 items when using the Direct Oblimin rotation and 38 items using the Promax rotation. Overall, there was general agreement among the rotations regarding item inclusion in each factor and strength of factor loadings among the included items. Factor 1 included items that appeared to measure the construct of activity and participation avoidance (Table 2, Appendix B). Many of the items within Factor 1 of the VAAI were adapted from the DHI and FABQ.

Table 2. Two Factor Solution of 63-Item VAAI with Direct Oblimin Rotation – Factor 1

Direct Oblimin 2 Factor Solution – Factor 1					
	Item #	**Text**	**Adapted from**	**Factor 1 loading**	**Factor 2 loading**
1	66	It is difficult for me to do strenuous homework or yard work because of my dizziness.	DHI	0.811	-0.405
2	34	My participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties is significantly restricted because of my dizziness.	DHI	0.788	-0.507
3	44	My dizziness interferes with my job or household responsibilities.	DHI	0.778	-0.471
4	19	I cannot do physical activities, which might make my dizziness worse.	FABQ	0.769	-0.401
5	43	Performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase my dizziness.	DHI	0.763	
6	61	I can't do all the things normal people do because of my dizziness.	TSK	0.755	-0.482
7	15	I restrict my travel for business or recreation because of my dizziness.	DHI	0.725	-0.462
8	10	I am afraid that I might make myself dizzy or unsteady if I exercise.	TSK	0.719	-0.429
9	31	In general, I have not enjoyed all the things I used to enjoy.	SBST	0.713	-0.614
10	29	I feel handicapped because of my dizziness.	DHI	0.709	-0.592
11	7	Physical activity makes my dizziness worse.	FABQ	0.707	
12	12	It is difficult for me to concentrate because of my dizziness.	DHI	0.696	-0.587
13	18	I have had little interest or pleasure in doing things.	PHQ-9	0.686	-0.668
14	17	It is difficult for me to walk around the house in the dark because of my dizziness.	DHI	0.668	
15	58	It is difficult for me to go for a walk by myself because of my dizziness.	DHI	0.662	
16	27	My work makes my dizziness worse.	FABQ	0.661	-0.416
17	49	I should not do my regular work with my present dizziness.	FABQ	0.660	-0.474
18	45	I am afraid to leave my home without having someone go with me because of my dizziness.	DHI	0.658	-0.485
19	41	My work causes too much dizziness for me.	FABQ	0.655	-0.503

Table 2 (continued)

20	23	Walking down the aisle of a supermarket increases my dizziness.	DHI	0.644	
21	16	I should not do physical activities, which might make my dizziness worse.	FABQ	0.637	
22	3	When I walk down a sidewalk, my dizziness is worse.	DHI	0.637	
23	39	It is hard for me to read because of my dizziness.	DHI	0.608	
24	59	I avoid heights because of my dizziness.	DHI	0.591	
25	36	My dizziness places stress on my relationships with members of my family or friends.	DHI	0.589	-0.579
26	24	I am afraid to stay home alone because of my dizziness.	DHI	0.580	-0.467
27	46	Bending over increases my dizziness.	DHI	0.575	
28	50	I have been embarrassed in front of others because of my dizziness.	DHI	0.574	-0.437
29	54	Quick movements of my head increase my dizziness.	DHI	0.572	
30	8	I am frustrated because of my dizziness.	DHI	0.571	-0.481
31	69	I am afraid people may think I'm intoxicated because of my dizziness.	DHI	0.550	
32	26	I have difficulty getting into or out of bed because of my dizziness.	DHI	0.546	
33	28	I have been feeling tired or having little energy.	PHQ-15	0.546	-0.504
34	13	Looking up increases my dizziness.	DHI	0.536	
35	40	Being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my dizziness from worsening.	TSK	0.528	
36	30	I have had trouble falling or staying asleep or sleeping too much.	PHQ-9	0.504	-0.481
36	60	I often feel like I’m going to faint.	PHQ-15	0.500	-0.499
38	68	Dizziness lets me know when to stop exercising so that I don’t injure myself.	TSK	0.471	
39	1	My dizziness bothers me.	PHQ-15	0.452	
40	74	If I were to try to overcome my dizziness problem, my dizziness/unsteadiness would increase.	TSK	0.428	

Abbreviations: DHI, Dizziness Handicap Inventory; FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia; PHQ, Patient Health Questionnaire; SBST, Start Back Screening Tool

Factor 2: Anxiety and Worry

Factor 2 of the VAAI contained 23 items using the Direct Oblimin rotation and 25 items when using the Promax rotation. Again, there was general agreement between the rotations regarding items included in the factor and the strength of the factor loadings among items (Table 3, Appendix C). Factor 2 appeared to contain items measuring the construct of anxiety and worry. Many of the items were adapted from existing scales measuring anxiety including 5 of the 7 items included in the GAD-7 and 9 items from the SHAI.

Table 3. Two Factor Solution of 63-Item VAAI with Direct Oblimin Rotation – Factor 2

Direct Oblimin 2 Factor Solution – Factor 2					
	Item #	**Text**	**Adapted from**	**Factor 2 loading**	**Factor 1 loading**
1	11	Worrying thoughts have been going through my mind a lot of the time	SBST	-0.836	0.449
2	22	I am not able to stop or control worrying.	GAD-7	-0.823	0.439
3	80	I often have difficulty taking my mind off thoughts about my health.	SHAI	-0.815	0.416
4	52	I am afraid that I have a serious illness much of the time.	SHAI	-0.804	
5	55	I think of myself being ill much of the time.	SHAI	-0.800	0.502
6	42	I have been worrying too much about different things.	GAD-7	-0.793	
7	77	I try to resist thoughts of illness, but often cannot do it.	SHAI	-0.763	
8	6	I often feel nervous, anxious or on edge.	GAD-7	-0.758	0.408
9	71	I have been feeling afraid as if something awful might happen.	GAD-7	-0.752	0.416
10	25	I believe that I have a serious illness much of the time.	SHAI	-0.748	0.464
11	9	I am feeling down, depressed, or hopeless.	PHQ-9	-0.745	0.584
12	4	I worry about my health much of the time.	SHAI	-0.737	0.428
13	79	I have been feeling bad about myself or that I am a failure or have let my family or myself down.	PHQ-9	-0.664	0.487

Table 3 (continued)

14	14	My body is telling me I have something dangerously wrong.	TSK	-0.659	0.515
15	38	My family members and friends would say that I worry too much about my health.	SHAI	-0.637	
16	5	If I notice a body sensation that I cannot explain, I often find it difficult to think of other things.	SHAI	-0.624	
17	48	I have trouble relaxing.	GAD-7	-0.616	0.428
18	76	My illness has put my body at risk for the rest of my life.	TSK	-0.592	0.494
19	21	I feel that my dizziness is terrible and it's never going to get any better.	SBST	-0.564	0.492
20	64	I do not think that I will be back to my normal work within 3 months.	FABQ	-0.523	0.518
21	63	I have been feeling my heart pound or race.	PHQ-15	-0.497	
22	67	I have had shortness of breath.	PHQ-15	-0.494	
23	75	I notice dizziness more than most people my age.	SHAI	-0.429	0.415

Abbreviations: FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia; PHQ, Patient Health Questionnaire; SBST, Start Back Screening Tool; GAD, Generalized Anxiety Disorder; SHAI, Short Health Anxiety Inventory

3.3.1.6 Item Reduction

After consultation with the research team, it was decided that Factor 2 of the VAAI should be eliminated because it contained items measuring the construct of anxiety and these items were adapted from existing anxiety scales which are valid, reliable, and widely available (GAD-7, SHAI). In addition, Factor 1 appeared to measure avoidance of activities which was the construct of interest. The research team also decided to eliminate additional items from Factor 1 that loaded strongly on multiple factors (items: 8, 12, 18, 28, 30, 31, 36, and 60) and items with weak factor loadings defined as < 0.5 (items 1, 68, and 74). Both of these methods have been suggested by others (137,140,177).

After removal of Factor 2, items with strong loadings on multiple factors, and items without strong loadings (> 0.5) on any factors, there were 29 items remaining (Table 4). An EFA was

conducted using only the 29 items to evaluate if these items loaded on one factor only. The 29 remaining items did load on one factor only as indicated by the scree plot (Figure 4).

Table 4. Factor 1 of the VAAI – 29 Items

	Item #	Text	Adapted from	Factor 1 loading
1	66	It is difficult for me to do strenuous homework or yard work because of my dizziness.	DHI	0.809
2	34	My participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties is significantly restricted because of my dizziness.	DHI	0.795
3	44	My dizziness interferes with my job or household responsibilities.	DHI	0.786
4	19*	I cannot do physical activities, which might make my dizziness worse.	FABQ	0.771
5	61	I can't do all the things normal people do because of my dizziness.	TSK	0.763
6	43	Performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase my dizziness.	DHI	0.749
7	15	I restrict my travel for business or recreation because of my dizziness.	DHI	0.733
8	29	I feel handicapped because of my dizziness.	DHI	0.728
9	10	I am afraid that I might make myself dizzy or unsteady if I exercise.	TSK	0.719
10	7	Physical activity makes my dizziness worse.	FABQ	0.693
11	45	I am afraid to leave my home without having someone go with me because of my dizziness.	DHI	0.685
12	58	It is difficult for me to go for a walk by myself because of my dizziness.	DHI	0.682
13	49	I should not do my regular work with my present dizziness.	FABQ	0.678
14	41‡	My work causes too much dizziness for me.	FABQ	0.677
15	17	It is difficult for me to walk around the house in the dark because of my dizziness.	DHI	0.673
16	27‡	My work makes my dizziness worse.	FABQ	0.670
17	23	Walking down the aisle of a supermarket increases my dizziness.	DHI	0.644

Table 4 (continued)

18	16*	I should not do physical activities, which might make my dizziness worse.	FABQ	0.638
19	3	When I walk down a sidewalk, my dizziness is worse.	DHI	0.634
20	24	I am afraid to stay home alone because of my dizziness.	DHI	0.607
21	39	It is hard for me to read because of my dizziness.	DHI	0.600
22	50	I have been embarrassed in front of others because of my dizziness.	DHI	0.596
23	59	I avoid heights because of my dizziness.	DHI	0.590
24	69	I am afraid people may think I'm intoxicated because of my dizziness.	DHI	0.564
25	46	Bending over increases my dizziness.	DHI	0.551
26	54	Quick movements of my head increase my dizziness.	DHI	0.547
27	26	I have difficulty getting into or out of bed because of my dizziness.	DHI	0.546
28	40	Being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my dizziness from worsening.	TSK	0.529
29	13	Looking up increases my dizziness.	DHI	0.521

*, ǂ Items correlated > 0.7

Abbreviations: DHI, Dizziness Handicap Inventory; FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia

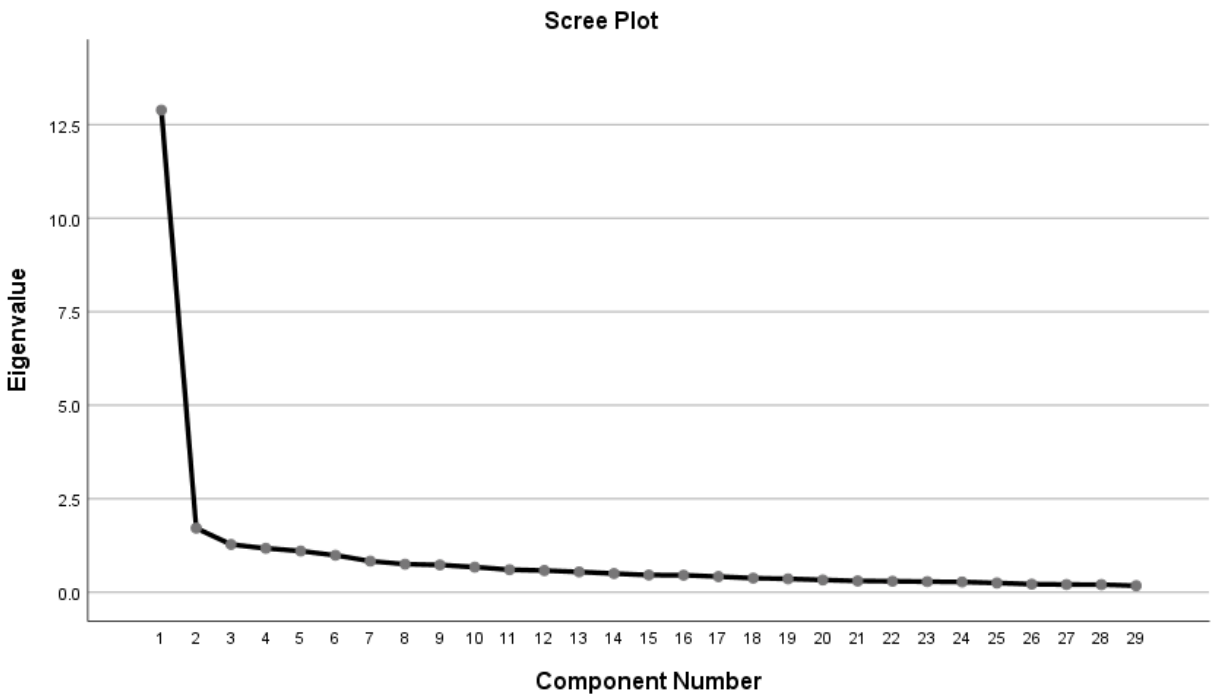

Figure 4. Scree Plot for Exploratory Factor Analysis of Remaining 29 Items in Factor 1

Of the remaining 29 items, there were 2 pairs of items (items 16 and 19; items 27 and 41) that were highly correlated (> 0.7) and had very similar wording. The research team eliminated item 16 because it had a lower factor loading than item 19. Items 41 and 27 had similar factor loadings. Therefore, the research team agreed to eliminate item 41 because item 27 was thought to be more concise and easier for readers to interpret. After the elimination of these 2 items there were 27 remaining items in the VAAI.

The research team then categorized the remaining 27 items into conceptual groups, including: Activities and Participation (12 items), Fear Avoidance (7 items), Work (3 items), and Specific Movement (5 items). Upon further review of the items included in the "Specific Movement" category, the research team decided that the 5 specific movement items should be eliminated for the following reasons: 1) the items in this category had the 5 lowest factor loadings

out of all 29 items; 2) the items measured difficulties with specific movements which do not capture the construct of activity avoidance; 3) four out of five of these items were adapted from the DHI which is frequently measured in clinics evaluating patients with vestibular and balance disorders; and 4) when internal consistency reliability was calculated, these 5 items lowered the overall alpha coefficient of the scale when they were included. After these 5 items were removed, the VAAI included 22 items measuring 3 concepts: Activities and Participation (12 items), Fear Avoidance (7 items), and Work (3 items) (Figure 5).

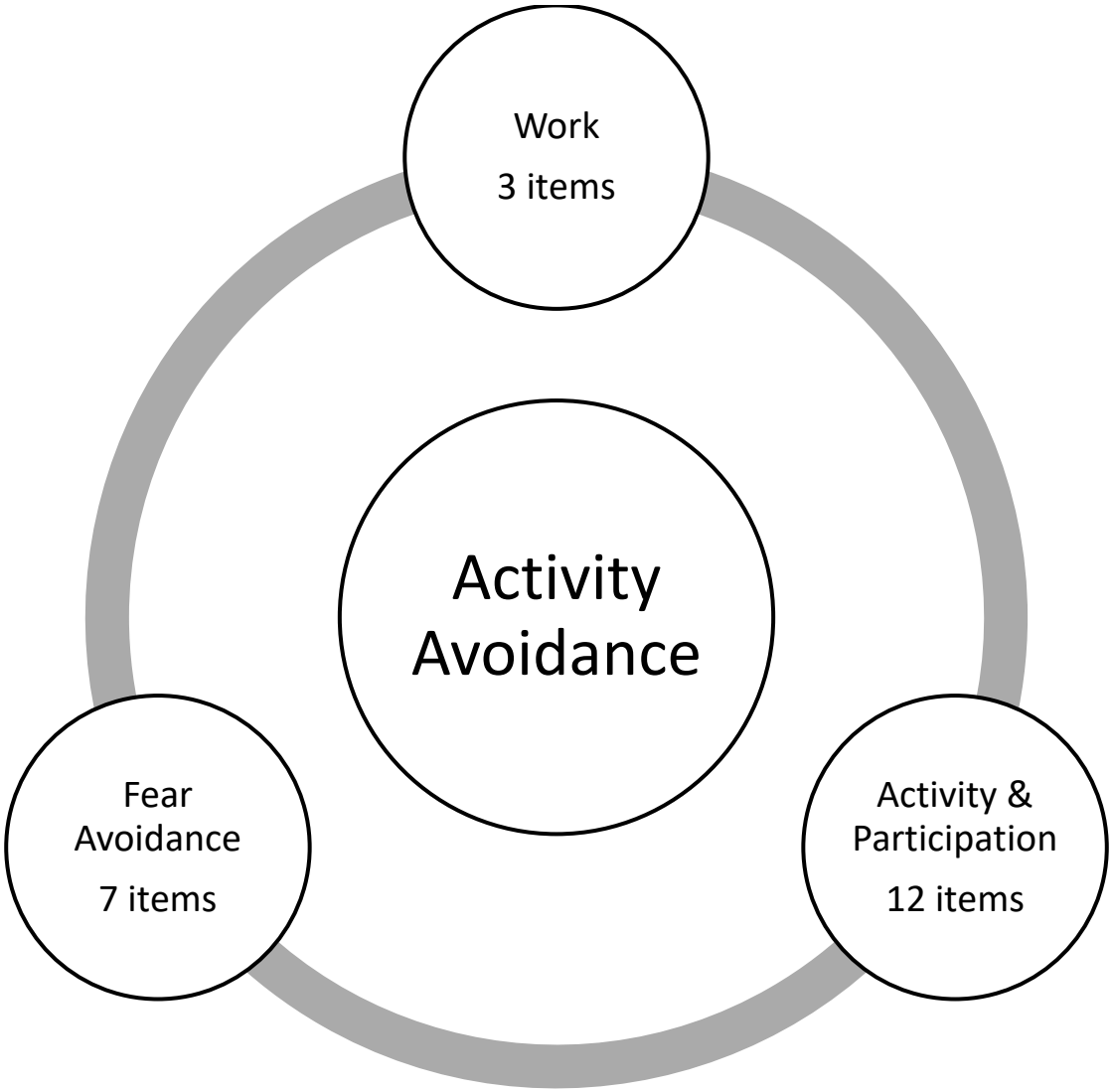

Figure 5. Conceptual Groupings of the 22-Item Vestibular Activities Avoidance Instrument

3.3.2 Reliability and Further Item Reduction

Internal consistency reliability was calculated for the remaining 22 items of the VAAI and Cronbach's alpha was 0.95, indicating that the scale was approaching the level of redundancy (171). Further item reduction was completed by taking the item with the highest factor loading from each conceptual grouping (activities and participation, fear avoidance, and work) and

calculating Cronbach's alpha. The process was repeated with the items with the second highest factor loadings, then third highest and so on until the Cronbach's alpha coefficient was not improved by a significant amount by the addition of more items. The Cronbach's alpha for the first 3 items (items 66, 44, and 19) was 0.84. When the next 3 items were added for a total of 6 items, Cronbach's alpha increased to 0.89. When the next 3 items were added for a total of 9 items, the alpha coefficient increased to 0.92. After this, 2 items were added at a time because there were only 3 items included in the work conceptual grouping. Therefore, after 9 items, one item from activities and participation and one item from fear avoidance were added at a time. This process was repeated until all 22 items were included and then plotted with the alpha coefficient on the y-axis and the number of items on the x-axis (Figure 6). The research team identified that 9 items demonstrated an excellent level of internal consistency (0.92) and the alpha coefficient did not improve to a large degree with the addition of more items (Cronbach's alpha increased by only 0.1 with the addition of 2 more items). Therefore, a shortened version of the VAAI including 9 items (VAAI-9) was agreed upon by the research group (Table 5).

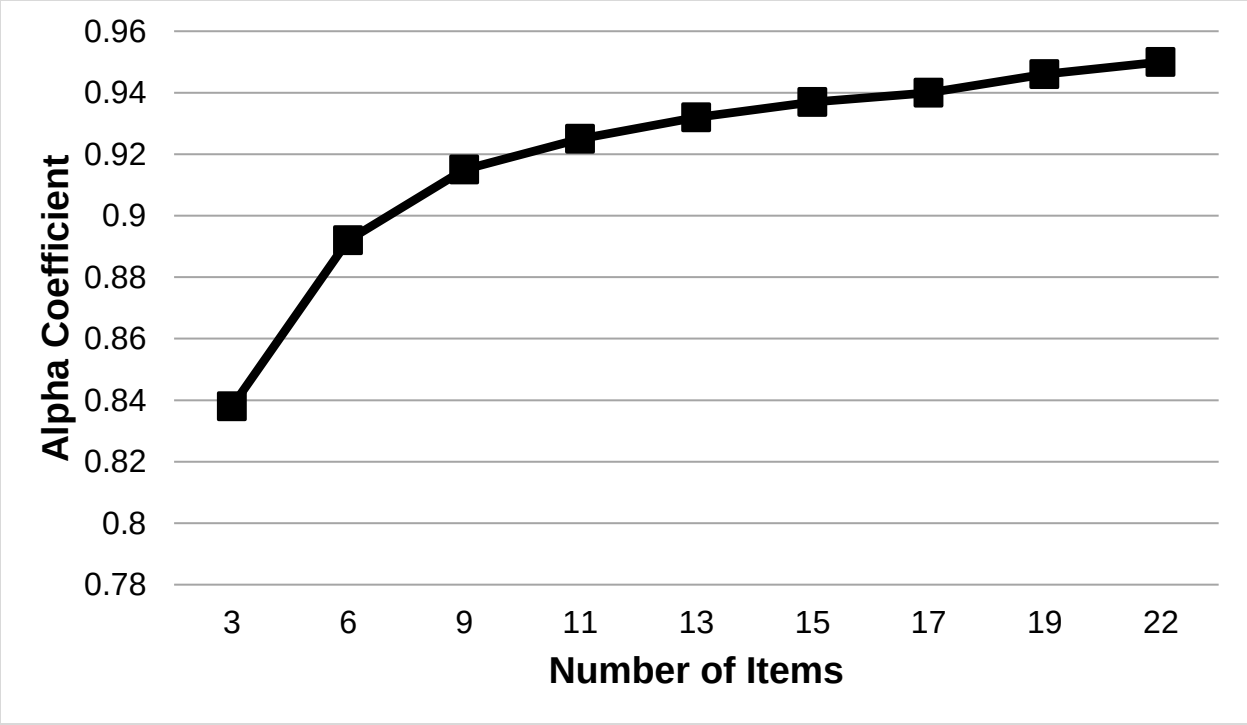

Figure 6. Cronbach's Alpha Values and Number of Vestibular Activities Avoidance Items

Table 5. Vestibular Activities Avoidance Instrument – 9 Items

Item	Text	Adapted from	Concept	Loading
66	It is difficult for me to do strenuous homework or yard work because of my dizziness.	DHI	Act/Part	0.809
34	My participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties is significantly restricted because of my dizziness.	DHI	Act/Part	0.795
44	My dizziness interferes with my job or household responsibilities.	DHI	Work	0.786
19	I cannot do physical activities, which might make my dizziness worse.	FABQ	Fear	0.771
61	I can't do all the things normal people do because of my dizziness.	TSK	Act/Part	0.763
10	I am afraid that I might make myself dizzy or unsteady if I exercise.	TSK	Fear	0.719
45	I am afraid to leave my home without having someone go with me because of my dizziness.	DHI	Fear	0.685
49	I should not do my regular work with my present dizziness.	FABQ	Work	0.678
27	My work makes my dizziness worse.	FABQ	Work	0.670

Abbreviations: DHI, Dizziness Handicap Inventory; FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia; Act/Part, Activities and Participation

3.3.3 Construct Validity

To determine convergent validity, the relationships between the items included in the Vestibular Activities Avoidance Instrument 9-Item (VAAI-9) abstracted from the original 81-item version of the questionnaire, VAP, SF-12, and HADS at baseline were assessed using Spearman's rho correlation coefficients. The bootstrap method was used to increase the precision of the 95% confidence interval (CI) estimates. The findings indicate that the VAAI-9 and VAP at baseline are strongly correlated ($\rho = 0.81$, $p < 0.001$), which is evidence of convergent validity with the VAP (Table 6). The VAAI-9 demonstrated a strong negative relationship to the SF-12 PCS ($\rho = -0.76$,

$p < 0.001$) and a moderate negative relationship to the SF-12 MCS ($\rho = -0.47$, $p < 0.001$) indicating greater fear avoidance is associated with poorer physical and mental health-related quality of life. The VAAI-9 and the HADS-A and HADS-D subscales were moderately correlated ($\rho = 0.47$; $\rho = .64$, $p < 0.001$), indicating that activity avoidance measured by the VAAI-9 is related to anxiety and depression symptoms.

Table 6. Convergent Validity of the VAAI-9

N = 404	**VAAI-9**		
	Spearman's ρ	***p***	**Bootstrap Bias Corrected 95% CI**
VAP	0.81	<0.001*	0.77, 0.84
SF-12 PCS	-0.76	<0.001*	-0.80, -0.71
SF-12 MCS	-0.47	<0.001*	-0.54, -0.38
HADS-A	0.47	<0.001*	0.38, 0.54
HADS-D	0.64	<0.001*	0.58, 0.69

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

3.4 Discussion

The aim of this study was to develop a valid and internally consistent tool that is feasible to use in the clinic to measure the construct of fear avoidance and related psychological and behavioral factors in persons with vestibular disorders. Through the process of EFA, item reduction, and internal consistency analysis, the 81-Item VAAI was organized into a short, seemingly reliable, 9-item instrument that can be used to measure fear avoidance in persons with vestibular disorders in clinical settings. Our hypothesis (1a) that the 81-Item VAAI included items that could be explained by multiple factors was accurately evidenced by the results of the EFA.

Hypothesis 1b stated that the shortened version of the VAAI would demonstrate at least adequate internal consistency reliability without redundancy. This is evidenced by the Cronbach's alpha value of 0.92 for the items included in the VAAI-9 indicating excellent internal consistency. Finally, we hypothesized that the shortened version of the VAAI would demonstrate construct validity through significant relationships with other measures of quality of life and psychological well-being. The VAAI-9 had a strong relationship with activity and participation restrictions (VAP) and moderate relationships with anxiety and depression symptoms (HADS).

3.4.1 The Vestibular Activities Avoidance Instrument

The VAAI was developed by Alshebber and colleagues and the original version of the questionnaire contained 77 items (39). The 77-Item VAAI demonstrated excellent internal consistency and test-retest reliability as well as construct validity with the SF-12 in their study (39). For the purposes of this study, 4 items from the SBST were added to the existing VAAI because of the prognostic value the SBST has demonstrated in predicting disability in persons with LBP and other musculoskeletal conditions (27,31,178). The SBST includes 9 items with 5 items related to psychosocial constructs (31). We adapted 4 of the 5 items included in the SBST psychosocial subscale because one of the items had already been included in the VAAI (adapted from the TSK). These items were thought to cover the constructs of bothersome symptoms, catastrophizing, anxiety, and depression (31). Prior to the initial EFA, we removed one of the items adapted from the SBST from the analysis due to the difference in time frame, stem question, and response scale. The item stated, "Overall, how bothersome has your dizziness been in the last 2 weeks?" and the responses ranged from "not at all" to "extremely." The response scale for the other 80 items ranged from "strongly disagree" to "strongly agree" and did not specify a 2-week

interval. Given these differences, it would be difficult to interpret the results of the one item because the response scale differed from all the other items in the VAAI which had the same response scale. A follow-up EFA was conducted which included item 81. Item 81 loaded on Factor 1 with a factor loading of 0.65. Given that the item with the lowest factor loading on the VAAI-9 was 0.67, it is unlikely that item 81 would have been included in the final shortened version of the questionnaire had it been included in the original EFA. The remaining 3 items that were adapted from the SBST were removed during the item reduction process because one item loaded strongly on multiple factors and two were included in Factor 2 (anxiety and worry). Although the VAAI-9 does not include any of the items adapted from the SBST, both measures include the construct of fear related to disability (31).

3.4.2 Exploratory Factor Analysis

When conducting the preliminary tests prior to the EFA, the five reverse coded items included in the 81-item VAAI were found to have low measures of sampling adequacy. Four of these items were adapted from the TSK-17 and one was adapted from the MSPSS. Other researchers have found that the four reverse coded items from the TSK-17 are psychometrically poor which is why they were removed when the TSK was adapted to 11 items (125,126). In general, when constructing a scale, it is recommended that negatively worded items (i.e. using the word "not") should be avoided (179). For example, an item that was adapted from the TSK for the VAAI was: "Just because something makes my dizziness worse does not mean it is dangerous." The inclusion of the word "not" makes it more difficult for the reader to interpret. If someone thinks something is *not* dangerous, the degree to which the person thinks something *is* dangerous may not be accurately measured by simply reverse-coding the item (179). Ideally, a scale should

include items worded in both positive and negative directions to avoid agreement bias. However, reversal in item polarity can confuse subjects leading to poor psychometric properties of some items (175). This is what was found in the five reverse coded items included in the VAAI.

The items in the VAAI were best described with a two-factor solution. This was suggested because the two factors extracted explained greater than 5% of the variance among the scale items. A three-factor solution was also considered because it was indicated by the results of the scree plot. However, it was dismissed by the research team because of the low number of items that loaded on the third factor (6 items) and because the items contained in the third factor had strong factor loadings on both Factors 1 and 3 indicating that a two-factor solution offered a cleaner and more interpretable result. The oblique rotation methods utilized were Direct Oblimin and Promax which provided similar results (169,170). While other oblique rotations are available, Direct Oblimin and Promax are the most commonly used (149,151). Given that the two factors were correlated, oblique rotation was indicated over orthogonal rotation (161).

The two-factor solution offered one factor that contained items related to activity avoidance and a second factor that included items related to health anxiety and worry. At the initiation of the project, it was unclear whether all anxiety-related items would load together in a separate factor or if they would be included in the fear avoidance construct. The results revealed that the second factor included all the items that were adapted from anxiety scales such as the GAD-7 and SHAI. The research team felt that these items should be removed from the VAAI because they were not included in the fear avoidance construct, but in a separate, anxiety construct evidenced by the results of the EFA. Also, the second factor included 5 out of the 7 items that were included on the GAD-7. Because the GAD-7 has already been widely used in many populations, including persons with vestibular disorders, and is a valid and reliable measure of generalized anxiety, the research

team felt that the GAD-7 should be utilized to measure anxiety in vestibular clinics rather than include some of these items in the VAAI (142,180).

The decision to eliminate items that loaded strongly on multiple factors is often debated in the literature. Some argue that items that load strongly on multiple factors should not be dropped because it may result in a scale with missing information (181). However, when items load strongly on multiple factors, it can be difficult to determine under which factor the item should be placed and may make interpretation of the resulting scale difficult (151,177). The VAAI items that loaded strongly on both factors were items measuring constructs of depression and somatization (adapted from the PHQ-9 and PHQ-15) and did not seem to fit well in either of the two factors. For this reason, the research team agreed to drop the items that loaded strongly on both factors.

3.4.3 Internal Consistency

The nine items that were selected to comprise the VAAI-9 have excellent internal consistency with a Cronbach's alpha coefficient of 0.92. For comparison, the alpha coefficient for the VAAI-81 item was 0.97, for the VAAI-77 item was 0.98, and for the VAAI-22 item was 0.95, indicating that there were likely redundant items contained in the longer versions of the VAAI (39). Through item reduction techniques using statistical analyses and expert opinion, the VAAI-9 was constructed, and the items included in the scale demonstrated excellent reliability without evidence of redundancy.

The VAAI-9 contains items measuring several concepts related to activity avoidance including activities and participation limitations (3 items), work limitations (3 items), and fear avoidance (3 items) (Figure 5). The items inquire about an individual's ability to participate in

activities related to work and job responsibilities, household chores, social events, physical activity, and exercise. In addition, the concept of fear avoidance is covered by the items that ask about fear of not being able to do things, fear of exercise, fear of going outside the home, and fear of making dizziness worse. Through this 9-item scale, a wide range of activities and fear related to activities may be identified.

Although there was no evidence of redundancy in this study with a Cronbach's alpha value less than 0.95, and there were no two items that were highly correlated (>0.7), future research should determine if there is redundancy in the scale given that there are 3 items relating to work, 3 items relating to activity and participation, and 3 relating to fear. There is a possibility that a shorter scale could be utilized if the psychometric properties are similar to the longer versions of the VAAI. Future reliability and validity studies in an external sample can determine if there is redundancy and/or if there are highly corelated items when using the modified 9-item version of the VAAI.

3.4.4 Construct Validity

The nine items that were selected to include in the VAAI-9 demonstrated a strong relationship with the VAP indicating that activity and participation limitations are related to fear and avoidance of activities, as hypothesized. This is not surprising given that some of the items contained within the VAAI-9 were adapted from the DHI and the VAP has demonstrated a strong relationship to the DHI in other studies (154,182). The VAP measures limitations in activities and participation based on the ICF model. These limitations may be due to the symptoms of dizziness and imbalance from a vestibular disorder or may be due, in part, to fear or anxiety that symptoms may be reproduced. The goal of developing the VAAI was to measure the construct of fear

avoidance that may be contributing to an individual's activity limitations in persons living with balance and vestibular disorders.

We hypothesized that the VAAI-9 would be significantly related to quality of life measured by the SF-12. The VAAI-9 demonstrated a strong negative relationship to the SF-12 PCS indicating that greater fear avoidance beliefs were strongly related to poorer physical health-related quality of life. A previous study found that the SF-12 PCS and the DHI, a measure of dizziness-related handicap, had a significant inverse relationship among persons with peripheral vestibular disorders (160). We found that the VAAI-9 had a moderate negative relationship with the SF-12 MCS indicating that greater fear avoidance beliefs were associated with poorer mental health-related quality of life. Previous studies have found significant negative relationships between the DHI, VAP, and various measures of physical and mental health-related quality of life among persons with dizziness (154,183,184). Our findings provide further evidence for convergent validity for the VAAI-9 as it is expected that the levels of fear avoidance beliefs are related to quality of life.

The VAAI-9 was significantly related to anxiety and depression symptoms evidenced by a moderate positive correlation with the HADS-A and HADS-D subscales. This was hypothesized because it is known that there is a relationship between psychiatric symptoms and vestibular disorders. First, there are shared neural networks that link anxiety, fear, and dizziness (62,69,70). Second, there is a higher prevalence of anxiety and depressive disorders among persons with dizziness when compared to the general population (1,6,56). Also, previous research studies have found relationships between dizziness handicap and psychiatric symptoms (18,22,137). The results of the present study indicating a moderate relationship between the VAAI-9 and HADS scores

align with the results of previous research and strengthens evidence for convergent validity (15,36,59).

3.4.5 Limitations

There are several limitations to the present study which should be noted. First, subjects were recruited for the study using a convenience sample. The individuals who chose not to complete the study may have differed from those who did complete the study, making generalizability of the study findings more challenging. The subjects were recruited from a tertiary care balance disorders clinic and from outpatient physical therapy clinics. It is not clear if the results would be similar in other settings. The sample from the tertiary care clinic probably would not capture milder cases or those who seek care from a primary care provider. However, the goal of developing the VAAI was to provide clinicians working in these settings (tertiary care vestibular disorder clinics and outpatient physical therapy clinics) with information regarding the presence of fear avoidance beliefs in persons with vestibular disorders.

There may be an effect of provider bias in this sample as some subjects were recruited from the tertiary care balance disorders clinic and others were recruited from PT clinics. There were statistically significant differences in some baseline patient-reported outcome measures, and this will be discussed further in section 4.3.

The final version of the VAAI was 9 items. This is very different from the original 81-item version and if the same study was repeated using the VAAI-9, the results may not be replicated because answering 81 items and answering 9 items is a different experience for subjects. The internal consistency and validity estimates were made using the nine items included in the VAAI-

9 abstracted from the original 81-item VAAI. Therefore, a follow-up study of the VAAI-9 in an external sample will be needed to determine the reliability and validity of the 9-item questionnaire.

3.4.6 Conclusions

In conclusion, the items included in the VAAI-9 demonstrate evidence for excellent internal consistency reliability and construct validity with measures of disability, quality of life, and psychological well-being. The VAAI-9 should be evaluated in a separate sample to confirm that it is a valid and reliable tool that can be used in clinics treating persons with balance and vestibular disorders. Also, to provide further evidence of reliability and validity, the VAAI-9 should be evaluated for test-retest reliability, discriminant, and predictive validity.

4.0 Identifying the Effect of Fear Avoidance on Disability Using the Vestibular Activities Avoidance Instrument

4.1 Introduction

Psychological factors are more prevalent in persons with vestibular disorders than in the general population (1,6,7,11,13,14,148). Patients with vestibular disorders who have a history of a psychiatric disorder are at greater risk for emotional distress, psychological strain, and for having a longer recovery time (16–18,20). Persons with vestibular disorders and psychiatric morbidity report more vertigo-related handicap, more vertigo and psychiatric symptoms, and worse health-related quality of life than those without psychiatric morbidity (6,10,13,19,21,22). In vestibular rehabilitation settings, persons with negative affect improved on performance measures and in patient-reported outcome measures, but not to the same degree as persons with normal affect and required longer treatment duration (23). This emphasizes the importance of identifying psychological factors early on in care in order to provide the best treatment for persons with vestibular disorders and psychiatric comorbidity.

In chronic pain literature, fear-avoidance beliefs and psychological factors measured by patient-reported outcome measures are predictors of increased risk for disability (27,106). The measurement of these factors has led to the development of risk stratification tools to classify patients into low- to high-risk groups based on the presence of psychological symptoms (30). Targeted treatment approaches in rehabilitation have been developed to treat persons with pain and psychological morbidity (33,34). However, there are few measurement tools that are specifically designed to measure fear avoidance in persons with vestibular disorders. Measures

such as the Dizziness Handicap Inventory (DHI), the Vestibular Symptom Scale (VSS), the Vestibular Rehabilitation Benefits Questionnaire (VRBQ), and the Dizziness Catastrophizing Scale (DCS) include items relating to emotional, anxiety, and catastrophization constructs, but were not designed to be comprehensive measures of fear avoidance and psychological factors among persons with dizziness (38,130,137,139). Therefore, it is difficult to develop targeted treatment programs for persons with vestibular disorders who exhibit various behavioral responses to dizziness and psychological symptoms.

The Vestibular Activities Avoidance Instrument (VAAI) has been developed to provide a comprehensive measure of fear avoidance among persons with vestibular disorders where there was previously no validated tool to measure these factors in persons with balance and vestibular disorders (39). The VAAI-9 has been evaluated for reliability and validity in persons with vestibular disorders and demonstrates internal consistency reliability and construct validity in this population. The scale only includes 9 items for convenient use in the clinic (Aim 1). With the measurement of fear avoidance beliefs in persons with vestibular disorders, optimal treatment approaches may be developed to provide the best care for persons exhibiting fear avoidance beliefs and vestibular disorders.

The purpose of this study was to determine the effect of fear avoidance on disability at 3 months using the items included in the modified version of the VAAI (VAAI-9). Based on available evidence regarding the effect of avoidance beliefs on the development of chronic pain, our hypothesis was that avoidance beliefs measured by the VAAI-9 were associated with level of disability at 3 months while accounting for other demographic and clinical characteristics.

4.2 Methods

4.2.1 Study Design and Participants

Subjects were recruited from the University of Pittsburgh Medical Center (UPMC) Balance Disorders Clinic and UPMC Centers for Rehab outpatient vestibular rehabilitation clinics. Eligibility criteria included: ages 18 to 100 years old, English-speaking, and cognitively able to answer the questions. Demographic and clinical characteristics including vestibular diagnosis, comorbid conditions, and number of medications were abstracted from the electronic medical record.

4.2.2 Outcome Measures

After subjects provided informed consent, they completed the 81-item VAAI, 12-Item Short Form Health Survey (SF-12), the Vestibular Activities and Participation Measure (VAP), the Hospital Anxiety and Depression Scale (HADS), the Patient Acceptable Symptom State (PASS), the Life Space Assessment (LSA), and several disability questions (Appendix E) on the computer or on paper while in the clinic that day (39,153–155,185–187). Then, the subjects were contacted in 3 months to answer the SF-12, the VAP, the PASS, the LSA, and Global Rating of Change (GROC), and the same disability questions (154,155,185–188). The follow-up questionnaires were completed by participants via email, over the phone, or by mail. Subjects were also asked about the severity of their dizziness symptoms using a visual analogue scale (VAS) for dizziness ranging from 0-10 at baseline and follow-up. Also, subjects were asked how they

would rate their current level of function from 0-100 with 100 indicating optimal function at both time points.

4.2.2.1 The Vestibular Activities Avoidance Instrument

The VAAI was an 81-item patient reported outcome measure which was developed at the University of Pittsburgh (39). The VAAI includes questions from other measures of fear avoidance beliefs and other psychological factors, adapted for use in a population with imbalance and/or dizziness. Through item reduction and factor analysis performed in the first aim of this study, the VAAI has been shortened to 9 items (VAAI-9) and these items which were abstracted from the original 81-item version of the questionnaire will be utilized in this part of the study. The total possible VAAI-9 score ranges from 0 – 54 with a higher score indicating more fear avoidance beliefs.

4.2.2.2 The 12-Item Short Form Health Survey

The 12-Item Short Form Health Survey (SF-12) was designed to measure health related quality of life and has been used in the general population and in patients with disease (155–159). The SF-12 score is associated with DHI scores among women with peripheral vestibular disorders (160). The SF-12 consists of a Physical Component Summary (PCS) score evaluating the effect of physical health on quality of life and a Mental Component Summary (MCS) score which evaluates the effect of emotional health on quality of life. An algorithm is used to generate scores for the PCS and MCS for comparison for normative data. Higher scores indicate better physical or mental health than the mean according to normative data. The SF-12 PCS and MCS demonstrate high internal consistency ($\alpha > 0.8$), high to moderate test-retest reliability (ICC=0.6-

0.78) and convergent validity with the EuroQoL (EQ-5D) in the general population (155). For this study, a modified version of the SF-12 was measured at baseline and at 3 months.

4.2.2.3 The Vestibular Activities and Participation Measure

The Vestibular Activities and Participation Measure (VAP) was developed to identify activity limitations and participation restrictions that may be present in persons with vestibular disorders (154). Items were developed using the International Classification of Functioning, Disability, and Health and the VAP has demonstrated excellent test-retest reliability (ICC=0.95) in this population. There is a total of 34 items with each item measured on a scale ranging from 0 indicating no difficulty with the activity to 4 indicating the individual is unable to do the activity. The items are then averaged for a total possible score ranging from 0 to 4 with a higher score indicating greater activity limitations and participation restrictions. The VAP has a strong correlation with the World Health Organization Disability Assessment Scale II (WHODAS II) (ρ=0.70) and moderate to strong correlations with the DHI subscales and total scores (ρ=0.54-0.74) (154). The VAP was measured at baseline and at 3 months to determine the amount of activity limitations and participation restrictions in this sample of individuals with vestibular disorders.

4.2.2.4 The Global Rating of Change

The Global Rating of Change (GROC) is a measure of perceived change for a health condition and is often used in rehabilitation settings to assess change in function from a patient perspective (188). This 15-point scale asks subjects how much their condition has changed from baseline. The GROC has been used to help determine responsiveness of outcome measures over time in patients with orthopedic and neurologic impairments (188–191). The GROC was used in

this study as an outcome measure at 3 months to identify subjects who perceived their condition as improved versus not improved (Appendix D). VAAI scores between subjects who perceived their condition as improved and those who perceived their condition as not improved will be compared. This will indicate whether those with higher score on VAAI is related to greater or lesser perceived change in function.

4.2.2.5 The Patient Acceptable Symptom State

The Patient Acceptable Symptom State (PASS) has been used in various patient populations, including those with arthritis pain (186). The PASS is a single question that states: "Taking into consideration your pain and functional impairment, do you consider your current state satisfactory." The patient answers "yes" or "no." For the purposes of this study, the question was adapted to include "dizziness and unsteadiness" instead of pain. This measure was collected at baseline and 3-month follow up as a measure of patient satisfaction and disability. The study investigators felt that a change from a "no" to a "yes" over 3 months would be an important indicator of disability and the patient's perception of the degree to which their symptoms have affected their life.

4.2.2.6 The Life Space Assessment

The Life Space Assessment (LSA) is a patient-reported outcome measure of mobility over a one month period and has been validated in community dwelling older adults and in persons with vestibular disorders (185,192). The LSA includes 5 questions about each level of life space (within the home, outside of the home, within the neighborhood, within the town, and outside of town) is achieved, how often the individual moves into the respective life space, and if any assistance is required. The total score ranges from 0-120 with higher scores indicating greater achieved life

space mobility. This measure was collected at baseline and 3-month follow up to determine the subject's level of mobility.

4.2.2.7 Disability Questions

Six disability questions were adapted from the Migraine Disability Assessment to determine the amount of disability subjects experienced over the prior 2 weeks as a result of their dizziness or unsteadiness (187). The questions include how many days dizziness and/or unsteadiness caused missed activities or limited activities at work, at home/with family, and in the community. These questions were collected at baseline and at the 3-month follow up to record disability related to dizziness and unsteadiness and to compare their perceived disability to VAAI score (Appendix E).

4.2.2.8 The Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) is used to identify anxiety and depression symptoms in clinical settings (152,153). The HADS consists of 2 subscales, the anxiety subscale (HADS-A) and depression subscale (HADS-D). Each item is scored on a scale ranging from 0 to 3 with higher scores indicating greater levels of anxiety or depression symptoms with a total score for each subscale ranging from 0 to 21. A cut point of ≥ 8 on each respective subscale has been accepted for identification of borderline anxiety or depressive disorders (152,153). The HADS was collected at baseline to determine if levels of baseline anxiety and depression symptoms influenced disability at follow-up.

4.2.3 Statistical Analysis

The demographics of the study sample were characterized using descriptive statistics (mean, standard deviation, frequency, percentage, range). Overall scores on the VAAI, the SF-12, the LSA, and the VAP were reported using means and standard deviations. The distributions of scores were visualized using histograms and boxplots. These were also used to assess for normality and outliers. The Shapiro-Wilk Test was used to determine normality of each overall score. The disability questions and GROC were assessed using median and range. Scores on each question were visualized using histograms. The PASS was assessed using frequency and percentages. Differences between baseline and follow-up outcome measure scores were analyzed using the Wilcoxon signed-rank test and the McNemar test for differences in PASS responses. Because there were many subjects that responded 0 to the disability questions at baseline and follow-up, the proportion of subjects who reported any days missed/limited for each disability question was calculated and compared at baseline and follow-up using McNemar tests.

Spearman's correlation coefficients were calculated to determine if the measures of disability at three months (SF-12, disability questions, PASS, GROC, and VAP) were associated with VAAI-9 scores at baseline. Correlations coefficients of 0.5 and greater were considered strong, 0.3 – 0.5 were considered moderate and less than 0.3 were considered weak (176).

To determine other potential covariate predictors of disability, the relationships between the VAP at 3 months and demographic variables such as age, symptom duration, and number of medications, were assessed using Spearman's correlation coefficients. Differences in VAP score at 3 months among male and female subjects, those with history of anxiety, history of depression, and history of panic disorder, and history of falls were compared using non-parametric Mann-Whitney U tests as the assumption of normality were not met. Then, general linear models were

constructed using each significant baseline demographic and outcome predictor and disability score (VAP score at 3 months). The assumption of normality was assessed by plotting the distribution of the residuals and visualizing the boxplots and normal probability plots. The assumption of homogeneity of variance was assessed using Levene's test (193). Effect size was calculated using partial eta squared and was interpreted as such: small effect size, $\eta^2 = .01$; moderate effect size, $\eta^2 = .06$; large effect size, $\eta^2 = .14$ (176).

A final multiple linear regression model was constructed using the significant predictors from the demographics and outcomes models and the VAP scores at 3 months as the dependent variable. The assumption of linearity was assessed by visualizing the partial scatter plots of the independent and dependent variables. The assumption of normality was evaluated by plotting the standardized residuals and assessing the skewness statistic with values greater than 1.5 indicating a non-normal distribution (194). The Durbin-Watson statistic was computed to evaluate independence of errors with values between 1 and 3 considered acceptable (195). Homogeneity of variance was assessed by plotting the studentized residuals and the independent variables and visualizing the scatter plots. To assess for potential multicollinearity, the variance inflation factor (VIF) and tolerance statistic was evaluated for the final model. Tolerance statistic values greater than 0.10 and VIF values less than 10 were considered evidence for no multicollinearity within the model (196). Effect size was evaluated using the R^2 value and was interpreted as follows: small effect size, $R^2 = .10$; medium effect size, $R^2 = .30$; large effect size, $R^2 = .50$ (176).

4.3 Results

4.3.1 Sample Characteristics

The mean age of the 404 subjects with dizziness was 54 years (SD = 17) with 32% of the sample being 65 years or older (Table 7). Most of the sample was female (64.6%) and reported either dizziness (93.8%), imbalance (80.4%) or both (75.5%). The duration of dizziness and imbalance symptoms were highly variable with a median duration of 8 and 9 months, respectively. Fifty-five percent of the sample reported having PT for dizziness or imbalance at their baseline visit. Also, 54% of the sample reported being employed at their baseline visit. The most frequent reasons for unemployment included being retired (62%), other reasons (19%), and due to dizziness (13%). Other reasons included being unemployed due to another health condition or disability.

Diagnoses were categorized using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes (Table 7). The BPPV category included diagnosis codes for right BPPV (H81.11), left BPPV (H81.12), and BPPV side unspecified (H81.10). The other peripheral vestibulopathy category included peripheral vestibulopathy of right ear (H81.91), left ear (H81.92), both ears (H81.93), and Meniere's Disease of right ear (H81.01) and of both ears (H81.03). The central vestibulopathy category included vestibular migraine (G43.109), central vertigo (H81.49), acoustic neuroma (D33.3), concussion (S06.0X0D), episodic ataxia (G11.8), post-concussion syndrome (F07.81), drop attack (R55), downbeat nystagmus (H55.09), subarachnoid hemorrhage (I60.9), and Chiari malformation (G93.5). The unspecified category included the general dizziness code (R42). The gait disorders category included abnormality of gait (R26.9), functional gait disorder (R26.89), gait instability (R26.81), and difficulty walking (R26.2). Most of the sample were diagnosed with unspecified dizziness (38%), followed by other

peripheral vestibulopathies (34%), central vestibulopathies (19%), BPPV (5%), and gait disorders (3%).

About a third of the sample reported previously experiencing a fall (37%) (Table 7). A previous fall was recorded by patient self-report on an intake form that was reviewed by a nurse at the appointment with the physician. The question asked the patient if they have had any falls. For subjects who were recruited from PT, a previous fall was determined by the physical therapist checking either a fall in the past month or in the past 6 months on the PT evaluation form. The most common comorbid conditions included hypertension (42%), depression (39%), arthritis (37%), migraine (35%), and gastro-esophageal reflux disease (35%).

Table 7. Baseline Characteristics for 404 Subjects

N = 404	**Mean (SD)**
Age (years)	54.0 (17.0)
	Median [Range]
Duration of dizziness (months) (n = 375)	8 [1-800]
Duration of imbalance (months) (n = 321)	9 [1-800]
Number of medications	6 [0-33]
	N (%)
Female	261 (64.6)
Recruited from PT	106 (26)
Age 65 years or older	129 (31.9)
Reported dizziness	379 (93.8)
Reported imbalance	325 (80.4)
Reported dizziness and imbalance	305 (75.5)
Previous PT for dizziness	220 (54.5)
Number of PT visits (n = 220)	
1-3 visits	67 (30.5)
4-6 visits	72 (32.7)
7-9 visits	28 (12.7)
10 or more visits	53 (24.1)
Employed	218 (54.0)
Reason for unemployment (n = 186)	
Due to dizziness	24 (12.9)
Retired	115 (61.8)
Looking after the home	7 (3.8)

Table 7 (continued)

Student	5 (2.7)
Other reason*	35 (18.8)
Primary Diagnosis	
BPPV	22 (5.4)
Peripheral vestibulopathy	136 (33.7)
Central vestibulopathy	79 (19.6)
Unspecified dizziness	155 (38.4)
Gait disorder	12 (3.0)
Reported a fall (n = 318)	118 (37.1)
Comorbid conditions (n = 397)	
Hypertension	168 (42.3)
Depression (n = 400)	155 (38.8)
Arthritis	148 (37.3)
Migraine (n = 400)	138 (34.5)
Gastro-esophageal reflux disease	137 (34.5)
Anxiety (n = 400)	117 (29.3)
Thyroid Disorder (n = 396)	83 (20.9)
Panic Disorder	72 (18.1)

**Other reason includes unemployed due to disability for another condition*
Note. BPPV included ICD-10 diagnosis codes: H81.11, H81.12, and H81.10; Peripheral vestibulopathy included ICD-10 diagnosis codes: H81.91, H81.92, H81.93, H81.01 and H81.03; Central vestibulopathy included ICD-10 diagnosis codes: G43.109, H81.49, D33.3, S06.0X0D, G11.8, F07.81, R55, H55.09, I60.9, and G93.5; Unspecified dizziness included the ICD-10 diagnosis code R42; Gait disorders included ICD-10 diagnosis codes: R26.9, R26.89, R26.81, and R26.2. Abbreviations: PT, physical therapy; BPPV, benign paroxysmal positional vertigo

4.3.2 Baseline Patient-reported Outcome Measures

At baseline, the VAAI-9 average score was 25 (SD = 14) (Table 8). The mean VAP score was 1.1 (SD = 0.8) indicating that on average subjects were reporting mild difficulty with activities and participation. Subjects reported a mean rating of 4/10 dizziness on the dizziness VAS with 0 indicating no dizziness and 10 indicating severe dizziness. The mean LSA score was 73.1 (SD = 29.3) suggesting limited life space mobility. The mean SF-12 PCS and MCS scores were 38.2 (SD = 10.5) and 45.5 (SD = 11.2), respectively. On average, the HADS anxiety subscale score was 7.2 (SD = 4.4) and depression subscale score was 5.5 (SD = 4.1). When asked about their

current level of function at baseline, subjects reported an average of 67% (SD = 23) function out of a scale ranging from 0 to 100 with a higher number meaning better functioning. The results from the disability questions indicated that most subjects were not missing activities due to dizziness (Median = 0 days missed at work, home, and in the community). However, they were limited to a small degree by dizziness when completing activities at home, and in the community but not limited for work activities overall (Median = 1 day of limited home, and community activities; Median = 0 days of limited work activities). According to the PASS, 34% of subjects responded "yes" indicating that they felt their current state was acceptable given their symptoms and functional impairments while the remaining 66% of subjects did not feel their current symptom state was acceptable at baseline.

Table 8. Baseline Patient-reported Outcome Measures

Outcome measure **n = 404**	**Mean (SD)**
VAAI-9 (0-54)	25.3 (14)
Dizziness VAS (0-10)	4 (2.7)
VAP (0-4)	1.1 (0.8)
LSA (0-120)	73.1 (29.3)
SF-12 PCS (0-100)	38.2 (10.5)
SF-12 MCS (0-100)	45.5 (11.2)
HADS-A (0-21)	7.2 (4.4)
HADS-D (0-21)	5.5 (4.1)
Functional rating (0-100) (n = 401)	66.9 (23.1)
	Median [Range]
Days of missed work activities (0-14)	0 [0-14]
Days of missed home activities (0-14)	0 [0-14]
Days of missed community activities (0-14)	0 [0-14]
Days of limited work activities (0-14)	0 [0-14]
Days of limited home activities (0-14)	1 [0-14]
Days of limited community activities (0-14)	1 [0-14]
	N (%)
PASS = Yes	138 (34.2)

Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; LSA, Life Space Assessment; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale; PASS=Yes, Patient Acceptable Symptom State was acceptable

4.3.3 Differences in Baseline Outcome Measures between Patient Sub-groups

The differences between baseline demographic variables and baseline outcome measures for subjects who completed the 3-month follow-up assessment (n = 286) and those who did not complete the assessment (n = 118) were analyzed using chi-square tests for categorical variables and with Mann-Whitney U tests for continuous variables (Table 9). There was a higher percentage of females among those who responded (68.7%) versus those who did not respond (56.4%, p = .019). Also, there was a lower percentage of employed subjects among those who responded (49.5%) to follow-up versus those who did not respond (65%, p = .005). There were no significant

differences in baseline patient-reported outcome measures between responders and non-responders.

Table 9. Differences in Baseline Demographic Characteristics and Outcome Measures among Responders and Non-Responders

Demographic characteristic	**Responders N = 286 Mean (SD)**	**Non-Responders N = 118 Mean (SD)**	***p***
Age	55.1 (17.3)	51.4 (16)	.052
Duration of Dizziness	35.4 (85.3)	48.8 (124.4)	.77
Duration of Imbalance	37.7 (89)	40 (109.8)	.30
Female, n (%)	195 (68.7)	66 (56.4)	.019*
Employed, n (%)	142 (49.5)	76 (65)	.005*
Patient-reported outcome	**Mean (SD)**	**Mean (SD)**	***p***
VAAI-9 (0-54)	25 (13.6)	25.9 (15.2)	.52
Dizziness VAS (0-10)	3.9 (2.7)	4.1 (2.7)	.36
Functional rating (0-100)	66.9 (23.1)	66.9 (23.1)	.98
HADS-A (0-21)	7.1 (4.4)	7.4 (4.4)	.46
HADS-D (0-21)	5.5 (4.1)	5.3 (4.1)	.55
VAP (0-4)	1.1 (0.8)	1.2 (0.9)	.37
SF-12 PCS (0-100)	38.4 (10.7)	37.5 (9.9)	.43
SF-12 MCS (0-100)	45.5 (11.1)	45.4 (11.6)	.98
LSA (0-120)	72.9 (28.8)	73.5 (30.5)	.80
PASS = Yes, n (%)	98 (34.1)	40 (34.2)	.99

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; PASS, Patient-Acceptable Symptom State*

The associations between baseline outcome measure scores and age were explored using Spearman's correlation coefficients. The results indicate that there were significant negative relationships between age, and VAAI-9 scores ($\rho = -0.15$, $p = 0.004$), HADS-A scores ($\rho = -0.34$, $p < 0.001$), and HADS-D scores ($\rho = -0.13$, $p = 0.007$). This means that higher scores on the VAAI-9, HADS-A, and HADS-D were associated with younger age. There were also significant

negative relationships between age and days with missed and limited work activities ($\rho = -0.22$, $p < 0.001$; $\rho = -0.23$, $p < 0.001$), and age and days with limited home ($\rho = -0.15$, $p = 0.003$) and community activities ($\rho = -0.11$, $p = 0.035$) due to dizziness. Younger age was associated with more days with missed and limited activities at work and more days with limited activities at home and in the community due to dizziness. The relationship with age and questions regarding work activities are likely due to older participants being retired and not having work duties. There was a significant positive relationship between age and the SF-12 MCS indicating that older subjects generally reported better mental health-related quality of life. There were no significant relationships between age and the dizziness VAS, VAP, LSA, functional rating, SF-12 PCS, or PASS.

Differences in outcome measure scores between persons who were not working due to dizziness (n = 24) and the rest of the sample were examined (Table 10). There were significant differences such that persons who were not working due to dizziness had more severe symptoms on the dizziness VAS, lower functional ratings, higher VAAI-9 scores, higher VAP scores, higher HADS-A and HADS-D scores, lower SF-12 MCS and PCS scores, and lower LSA scores. According to significant differences in the disability questions, persons who were not working due to dizziness missed more days of work activities, home activities, and community activities. There were no significant differences in days that were limited in work, home, and community activities between those who were not working due to dizziness and other individuals in the sample.

Table 10. Differences in Baseline Outcome Measures Among those not Working due to Dizziness

Outcome **N = 404**	**Unemployed due to dizziness** **n = 24**	**Working or Unemployed for other reason** **n = 380**	***p***
VAAI-9 (0-54)	41.4 (9.4)	24.2 (13.6)	<0.001*
Dizziness VAS (0-10)	6.6 (2.8)	3.8 (2.6)	<0.001*
VAP (0-4)	2 (0.7)	1.1 (0.8)	<0.001*
LSA (0-120)	54.9 (21.4)	74.2 (29.3)	0.001*
SF-12 PCS (0-100)	28.7 (10.1)	38.8 (10.2)	<0.001*
SF-12 MCS (0-100)	37.8 (12.2)	46.0 (11)	0.002*
HADS-A (0-21)	9.9 (5.5)	7.1 (4.3)	0.015*
HADS-D (0-21)	9 (5.4)	5.2 (3.9)	0.001*
Functional rating (0-100) (n = 401)	47.5 (24)	68.1 (22.5)	<0.001*
Days of missed work activities (0-14)	4.9 (3.6)	1.5 (3.6)	0.037*
Days of missed home activities (0-14)	3.2 (3.5)	1.5 (2.8)	0.003*
Days of missed community activities (0-14)	4.6 (4.7)	1.8 (3.2)	0.001*
Days of limited work activities (0-14)	2.3 (4.7)	2 (3.8)	0.41
Days of limited home activities (0-14)	4.1 (4.5)	2.7 (4)	0.13
Days of limited community activities (0-14)	3.2 (4.6)	2.1 (3.5)	0.37

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

The differences in outcome measure scores at baseline among persons who had a history of panic, depression, and anxiety disorders were investigated. History of psychiatric comorbidity was abstracted from the electronic medical record. Persons with a history of panic disorder (n = 72) had significantly higher VAAI-9 scores, higher VAP scores, lower functional ratings, higher dizziness ratings on the dizziness VAS, higher HADS-A and HADS-D scores, lower SF-12 MCS and PCS scores, and lower scores on the LSA compared to subjects who did not have a history of panic disorder (Table 11). Those with panic disorder reported missing significantly more activities at home and in the community than those without panic disorder. There were not significant

differences in days of missed and limited work activities, and days of limited activities in the home and community among those with and without panic disorder.

Table 11. Differences in Baseline Outcome Measures Among those with and without Panic Disorder

Outcome **N = 397**	**Panic** **n = 72**	**No Panic** **n = 325**	***p***
VAAI-9 (0-54)	31.2 (11.8)	23.9 (14.1)	<0.001*
Dizziness VAS (0-10)	4.7 (2.6)	3.8 (2.7)	0.007*
VAP (0-4)	1.4 (0.8)	1.1 (0.8)	0.005*
LSA (0-120)	64 (31.3)	75 (28.6)	0.006*
SF-12 PCS (0-100)	35.3 (10.1)	38.8 (10.5)	0.011*
SF-12 MCS (0-100)	40.8 (11)	46.6 (11)	<0.001*
HADS-A (0-21)	9.9 (3.8)	6.6 (4.3)	<0.001*
HADS-D (0-21)	7.4 (4.2)	5 (3.9)	<0.001*
Functional rating (0-100) (n = 394)	62.3 (22.8)	68.2 (23)	0.045*
Days of missed work activities (0-14)	1.6 (3.6)	1.7 (4)	0.27
Days of missed home activities (0-14)	2.1 (3)	1.5 (2.8)	0.014*
Days of missed community activities (0-14)	2.5 (3.7)	1.9 (3.3)	0.042*
Days of limited work activities (0-14)	2.2 (3.7)	1.8 (3.8)	0.11
Days of limited home activities (0-14)	3.5 (4.5)	2.7 (3.9)	0.12
Days of limited community activities (0-14)	2.4 (4)	2.1 (3.5)	0.79

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

Individuals with a history of anxiety disorder (n = 117) had significantly higher VAAI-9 scores, higher VAP scores, higher dizziness ratings on the dizziness VAS, higher HADS-A and HADS-D scores, lower SF-12 MCS and PCS scores, and lower LSA scores compared to persons without anxiety disorder (Table 12). Also, those with anxiety disorders reported more missed days of activities at home and in the community and more limited days at home. There were no significant differences in days of missed and limited work activities and days of limited community activities between subjects with and without anxiety disorder.

Table 12. Differences in Baseline Outcome Measures Among those with and without Anxiety Disorder

Outcome **N = 400**	**Anxiety** **n = 117**	**No Anxiety** **n = 283**	***p***
VAAI-9 (0-54)	29.4 (14)	23.5 (13.6)	<0.001*
Dizziness VAS (0-10)	4.4 (2.7)	3.8 (2.7)	0.020*
VAP (0-4)	1.3 (0.8)	1 (0.8)	<0.001*
LSA (0-120)	68.4 (29.7)	74.9 (28.9)	0.033*
SF-12 PCS (0-100)	36.1 (10.6)	39.0 (10.3)	0.008*
SF-12 MCS (0-100)	41.2 (11.6)	47.3 (10.6)	<0.001*
HADS-A (0-21)	9.2 (4.2)	6.4 (4.2)	<0.001*
HADS-D (0-21)	6.9 (4.4)	4.9 (3.8)	<0.001*
Functional rating (0-100) (n = 397)	64.6 (21.1)	68.1 (23.6)	0.077
Days of missed work activities (0-14)	2 (4.1)	1.5 (3.8)	0.094
Days of missed home activities (0-14)	2.2 (3.4)	1.3 (2.6)	0.003*
Days of missed community activities (0-14)	3 (4.2)	1.6 (2.8)	0.001*
Days of limited work activities (0-14)	2 (3.9)	1.9 (3.8)	0.74
Days of limited home activities (0-14)	3.9 (4.7)	2.3 (3.6)	0.002*
Days of limited community activities (0-14)	3.1 (4.6)	1.8 (3)	0.062

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

Subjects who had a history of depression had significantly higher scores on the VAAI-9, higher VAP scores, more severe dizziness ratings on the dizziness VAS, lower functional ratings, higher HADS-A and HADS-D scores, lower SF-12 MCS and PCS scores, and lower LSA scores compared to those without depression (Table 13). Persons with depression also reported more days of missed and limited activities at home and in the community compared to persons without depression. There were no significant differences in days of missed and limited work activities between those who did and did not have a history of depression.

Table 13. Differences in Baseline Outcome Measures Among those with and without Depression

Outcome **N = 400**	**Depression** **n = 155**	**No Depression** **n = 245**	***p***
VAAI-9 (0-54)	30.9 (12.1)	21.6 (13.9)	<0.001*
Dizziness VAS (0-10)	4.5 (2.6)	3.6 (2.7)	0.002*
VAP (0-4)	1.4 (0.8)	0.9 (0.8)	<0.001*
LSA (0-120)	65.2 (29.7)	77.9 (27.9)	<0.001*
SF-12 PCS (0-100)	34.5 (8.9)	40.5 (10.7)	<0.001*
SF-12 MCS (0-100)	40.3 (11)	48.8 (10.1)	<0.001*
HADS-A (0-21)	9.2 (4.1)	6 (4.1)	<0.001*
HADS-D (0-21)	7.5 (4)	4.1 (3.5)	<0.001*
Functional rating (0-100) (n = 397)	61.3 (21.1)	70.8 (23.4)	<0.001*
Days of missed work activities (0-14)	1.9 (4.1)	1.5 (3.8)	0.056
Days of missed home activities (0-14)	2.2 (3.3)	1.2 (2.5)	<0.001*
Days of missed community activities (0-14)	2.6 (3.7)	1.6 (3.1)	<0.001*
Days of limited work activities (0-14)	2.3 (4.1)	1.7 (3.6)	0.31
Days of limited home activities (0-14)	3.9 (4.6)	2.1 (3.5)	<0.001*
Days of limited community activities (0-14)	3 (4.3)	1.6 (3)	<0.001*

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

4.3.4 Assessment of Baseline Variables by Provider-Type

Because subjects were recruited from a tertiary care balance disorders clinic [n = 298 (74%)] and from physical therapy clinics [n = 106 (26%)], baseline demographic characteristics and baseline outcome measures were compared to assess for provider bias. There were no significant differences in subject age or gender between groups (Table 14). There were significant differences in duration of dizziness and duration of imbalance measured in months such that subjects who were recruited from the physician clinic tended to have experienced symptoms longer than subjects who were recruited from PT clinics.

Table 14. Comparison of Demographic Characteristics of Subjects by Provider Type

	MD N = 298 (74%)	**PT N = 106 (26%)**	***p***
Age, mean (SD)	54.7 (15.6)	54.0 (17.7)	0.32
Dizziness duration, mean (SD)	41.5 (92.2) Median = 9	32.6 (112.7) Median = 4	<0.001*
Imbalance duration, mean (SD)	39.7 (84.4) Median = 11	35.3 (116.2) Median = 4	0.001*
Female, n (%)	191 (64)	70 (67)	0.58

**p<0.05; Note. Age, dizziness duration, and imbalance duration were compared using Mann Whitney U tests. Sex was compared using Chi square test.*
Abbreviations: MD, subjects recruited from the UPMC Balance Disorders Clinic; PT, subjects recruited from the UPMC Centers for Rehab Services physical therapy clinics

There were significant differences in baseline outcome measures when comparing individuals who were recruited from the balance disorders clinic versus from PT clinics (Table 15). Subjects who were recruited from PT clinics had higher scores on VAAI-9 than subjects recruited from the physician office indicating greater fear avoidance beliefs ($Z = 2.67$, $p = 0.007$). Persons recruited from PT clinics reported being more limited in activities and participation when compared to subjects recruited from the physician clinic evidenced by VAP scores ($Z = 2.68$, $p = 0.007$). Subjects who were recruited from PT clinics had poorer physical health-related quality of life compared to subjects recruited from the physician clinic given the lower mean SF-12 PCS scores ($Z = -2.92$, $p = 0.003$). The subjects seen from the PT clinics reported more life space mobility limitations compared to subjects recruited from the physician clinic ($Z = -2.54$, $p = 0.011$). More subjects recruited from the physician reported that their state was satisfactory at baseline (38%) when compared to subjects recruited from PT clinics (23%) ($X^2(1) = 8.48$, $p = 0.004$). Although the differences in baseline outcome measure scores were statistically significant, the clinical significance is questionable. There were no differences in SF-12 MCS scores, HADS

subscale scores, dizziness VAS, or functional rating between subjects recruited from the physician office versus PT clinics.

Table 15. Comparision of Baseline Outcome Measures by Provider Type

	MD N = 298	**PT N = 106**	***p***
VAAI-9 (0-54)	24.2 (14)	28.4 (13.7)	0.007*
VAP (0-4)	1.1 (0.8)	1.3 (0.8)	0.007*
SF-12 PCS (0-100)	39.1 (10.8)	35.6 (9.2)	0.003*
SF-12 MCS (0-100)	45.6 (10.9)	45.1 (12.2)	0.95
HADS-A (0-21)	6.9 (4.2)	8 (4.9)	0.083
HADS-D (0-21)	5.3 (4.1)	6 (4.1)	0.086
LSA (0-120)	75 (29.4)	67.8 (28.3)	0.011*
VAS (0-10)	3.8 (2.8)	4.3 (2.5)	0.087
Function Rating (0-100)	67.9 (23.9)	64 (20.4)	0.054
PASS = Yes, n (%)	114 (38)	24 (23)	0.004*

**p<0.05; Note. PASS was compared using Chi square test; all other outcomes were compared using Mann Whitney U tests. Abbreviations: MD, subjects recruited from the UPMC Balance Disorders Clinic; PT, subjects recruited from Centers for Rehab Services physical therapy clinics; VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; LSA, Life Space Assessment; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale; PASS=Yes, Patient Acceptable Symptom State was acceptable*

4.3.5 Patient-reported Outcome Measures at Three Month Follow-up Compared to Baseline

Seventy-one percent of the sample completed the 3-month follow-up questionnaires (n = 286). The follow-up dizziness VAS was 2.8 on average (median = 2) which was significantly better than dizziness VAS at baseline (mean = 4; Z = -6.18, $p < 0.001$) (Table 16). The mean VAP score was 1.0 (median = 0.9) indicating that subjects continued to report mild impairment with

activities and participation and did not improve significantly from baseline (Z = -1.92, $p = 0.055$). The mean LSA score was 82 (median = 84) indicating that life space mobility was still considered limited at 3 months but had improved significantly since baseline (mean = 73.1, Z = 5.46, $p < 0.001$). The mean SF-12 PCS scores improved significantly over the study period from 38.2 to 42.9 (Z = 6.99, $p < 0.001$). However, there was no difference in SF-12 MCS scores between baseline and three months (Z = 1.15, $p = 0.25$). The mean functional rating was 78 (median = 85) which was significantly improved from baseline (mean = 67, Z = -7.64, $p < 0.001$). The median GROC at three months was 4 indicating that subjects felt moderately better overall. Sixty-two percent of the sample felt that their current symptom state was acceptable measured by the PASS at follow-up. This was a significant improvement from baseline where only thirty-four percent of the sample felt that their state was acceptable ($X^2 = 55.93$, $p < 0.001$).

Table 16. Patient-reported Outcome Measures at Baseline and Three Month Follow-up

Outcome measure **n = 286**	**Baseline** **Mean (SD)**	**3 Months** **Mean (SD)**	***p***
Dizziness VAS (0-10)	4 (2.7)	2.8 (2.9)	<0.001*
VAP (0-4)	1.1 (0.8)	1.0 (0.9)	0.055
LSA (0-120)	73.1 (29.3)	81.7 (28.5)	<0.001*
SF-12 PCS (0-100)	38.2 (10.5)	42.9 (11.0)	<0.001*
SF-12 MCS (0-100)	45.5 (11.2)	46.1 (12.1)	0.25
Functional rating (0-100)	66.9 (23.1)	78.2 (22.9)	<0.001*
	Median [Range]	**Median [Range]**	
GROC (-7-7)	--	4 [-6-7]	--
	N (%)	**N (%)**	
PASS = Yes	138 (34.2)	177 (61.5)	<0.001*

**p<0.05; Note: Differences in PASS were assessed using McNemar test; differences among all other outcome measures compared using Wilcoxon signed-rank tests.*
Abbreviations: VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; LSA, Life Space Assessment; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; GROC, Global Rating of Change; PASS = Yes, Patient Acceptable Symptom State was acceptable

Because there were a large number of subjects who reported 0 days missed/limited in activities for the disability questions at baseline and follow-up, the proportions of subjects reporting days of activities missed or limited for each disability question were compared at baseline and follow-up (Table 17). The results indicated that the proportions of subjects reporting any days missed and limited at work, home and in the community in the past 2 weeks were significantly less at follow-up compared to baseline. Overall, subjects at 3 months were reporting less disability that interfered with activities compared to baseline.

Table 17. Proportion of Subjects Reporting Disability at Baseline and 3 Months

N = 286	**Percent reporting disability Baseline**	**Percent reporting disability 3 Months**	***p***
Days of missed work activities	25.3	12.9	0.001*
Days of missed home activities	37.9	24.7	0.001*
Days of missed community activities	49.5	26.7	<0.001*
Days of limited work activities	32.7	22.9	0.007*
Days of limited home activities	52	33.7	<0.001*
Days of limited community activities	50.7	34	<0.001*

**p<0.05*

4.3.6 Association between VAAI-9 and Follow-up Measures of Disability

To examine the relationship between the VAAI-9 and measures of disability at three months, Spearman's correlation coefficients were analyzed (Table 18). There was a moderate positive relationship between VAAI-9 score at baseline and VAP score at 3-month follow up suggesting that greater avoidance beliefs at baseline were related to more activity and participation limitations at follow-up ($\rho = 0.54$, $p < 0.001$). There were also moderate negative correlations between the VAAI-9 at baseline and the patient function rating ($\rho = -0.45$, $p < 0.001$) and LSA

scores (ρ = -0.42, $p < 0.001$) at follow up. This indicates that persons with greater avoidance beliefs had lower functional ratings and less life space mobility at 3 months. The VAAI-9 at baseline was moderately correlated with dizziness VAS at follow up (ρ = 0.37, $p < 0.001$) indicating that greater fear avoidance beliefs at baseline were associated with greater severity of dizziness at follow up. The VAAI-9 measured at baseline had a significant negative correlation with the SF-12 PCS (ρ = -0.53, $p < 0.001$) and MCS scores (ρ = -0.44, $p < 0.001$) indicating a relationship between fear avoidance beliefs and health-related quality of life in three months. In general, the VAAI-9 at baseline was weak to moderately correlated with all disability questions at follow up indicating that greater fear avoidance beliefs at baseline was associated with more missed and limited days at work, home, and in the community. The VAAI-9 and the GROC had a weak negative association (ρ = -0.19, $p = 0.001$) indicating that greater fear avoidance beliefs at baseline was associated with less perceived change at follow up. Subjects who reported their state was not satisfactory on the PASS at follow up had significantly higher VAAI-9 scores at baseline (mean = 29.2) when compared to subjects who did report their state was satisfactory (mean = 22.3) at follow-up (Z = -4.10, $p < 0.001$).

Table 18. Association between VAAI-9 at Baseline and Follow-up Disability Measures (n = 286)

Follow-up Outcome	Spearman's ρ	*p*
VAP	0.54	<0.001*
Function	-0.45	<0.001*
Dizziness VAS	0.37	<0.001*
LSA	-0.42	<0.001*
SF-12 PCS	-0.53	<0.001*
SF-12 MCS	-0.44	<0.001*
GROC	-0.19	0.001*
Days of missed work activities (0-14)	0.30	<0.001*
Days of missed home activities (0-14)	0.36	<0.001*
Days of missed community activities (0-14)	0.31	<0.001*
Days of limited work activities (0-14)	0.30	<0.001*
Days of limited home activities (0-14)	0.39	<0.001*
Days of limited community activities (0-14)	0.33	<0.001*

**p<0.05; Abbreviations: VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; LSA, Life Space Assessment; SF-12, 12-Item Short Form Health Survey; PCS, Physical Component Summary Score; MCS, Mental Component Summary Score; GROC, Global Rating of Change*

4.3.7 Association between Demographic Characteristics and Follow-up VAP

To identify if there were other potential predictors of disability measured by VAP score at 3 months, the relationship between demographic characteristics at baseline and VAP score at follow up were assessed using Spearman's correlation coefficients (Table 19). There were weak relationships between the duration of dizziness and balance symptoms and VAP at follow-up indicating that a longer duration of symptoms at baseline was associated with more activity limitations and participation restrictions at three months. There was also a weak relationship between number of medications and VAP score at follow-up indicating that having more medications prescribed was associated with greater activity and participation limitations in three months ($\rho = 0.19$, $p = 0.001$).

Table 19. Spearman's Correlation Coefficients for Demographic Characteristics and Follow-up VAP Score

Baseline Demographics N = 286	**Spearman's ρ**	***p***
Age (years)	-0.10	0.081
Duration of dizziness (months) (n = 268)	0.30	<0.001*
Duration of imbalance (months) (n = 233)	0.27	<0.001*
Number of medications	0.19	0.001*

**p<0.05*

The relationships between follow-up VAP score and categorical demographic variables were assessed using Mann-Whitney U and Kruskal-Wallis tests (Table 20). Subjects under the age of 65 had significantly higher VAP scores (mean = 1.1) at 3 months than subjects who were 65 years and older (mean = 0.8) (Z = 2.60, p = 0.009). People who reported previously experiencing a fall had significantly higher VAP scores at 3 months (mean = 1.2) indicating greater limitations in activities and participation than subjects who had not experienced a previous fall at baseline (mean = 0.8) (Z = 3.56, $p < 0.001$). Those with a history of depression, panic disorder, and migraine tended to have higher VAP scores at follow-up when compared to subjects without these comorbidities. There were no significant differences in VAP score among genders, diagnostic groups, or subjects who did and did not have a history of anxiety disorder.

Table 20. Follow-up VAP Scores among Baseline Groups

Group **n = 286**	**N**	**Mean (SD)**	***p***
Male	89	0.9 (0.8)	0.56
Female	194	1.0 (0.9)	
Age ≥ 65	101	1.1 (0.9)	0.009*
Age < 65	185	0.8 (0.7)	
BPPV	17	0.6 (0.6)	0.16
Other peripheral vestibulopathy	97	1.1 (0.9)	
Central vestibulopathy	51	1.0 (0.9)	
Unspecified	111	1.0 (0.8)	
Gait disorder	10	0.9 (0.9)	
Previous fall	82	1.2 (0.9)	<0.001*
No previous fall	145	0.8 (0.8)	
Depression	108	1.2 (0.9)	<0.001*
No depression	175	0.9 (0.8)	
Anxiety	83	1.0 (0.9)	0.70
No anxiety	200	1.0 (0.8)	
Panic disorder	55	1.3 (0.9)	0.001*
No panic disorder	226	0.9 (0.8)	
Migraine	93	1.2 (0.9)	0.031*
No migraine	190	0.9 (0.8)	

**p<0.05; Note. All dichotomous variables analyzed using the Mann Whitney U test; differences among diagnostic categories assessed using the Kruskal-Wallis test; some data were missing from the electronic medical record for gender, fall history, comorbidities*
Abbreviations: PT, physical therapy; BPPV, benign paroxysmal positional vertigo

4.3.8 Association between Baseline Outcome Measures and Follow-up VAP

Additionally, the relationship between baseline outcome measures (the VAAI-9, the VAP, the dizziness VAS, the HADS-A, and the HADS-D) and follow-up VAP score were assessed using Spearman's correlation coefficients to identify if other outcomes should be included in a final prediction model. There were moderate positive correlations between the VAP at three-month follow-up and all baseline outcome measures (the VAAI-9, the VAP, the dizziness VAS, the HADS-A, and the HADS-D) (Table 21). The dizziness VAS was significantly related to VAP scores indicating that higher symptom report at baseline was associated with more activity and

participation restrictions at follow up ($\rho = 0.47$, $p < 0.001$). Both the HADS-A and HADS-D subscales were significantly associated with VAP score indicating that greater levels of anxiety and depression symptoms at baseline were associated with more activity and participation limitations at follow up.

Table 21. Spearman's Correlation Coeffecients for Baseline Outcome Measures and Follow-up VAP

Baseline Outcomes N = 286	**Spearman's ρ**	***p***
VAAI-9	0.54	<0.001*
VAP	0.51	<0.001*
Dizziness VAS	0.47	<0.001*
HADS-A	0.30	<0.001*
HADS-D	0.46	<0.001*

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAP, Vestibular Activities and Participation Measure; VAS, Visual Analogue Scale; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

4.3.9 General Linear Models

To assess the influence of demographic variables on disability at three months measured by the VAP, a general linear model was constructed using the significant demographic variables that were identified in the correlation analysis (Section 4.3.7). The dichotomous variables (age < 65, history of depression, panic, migraine, and falls) were entered as factors and duration of dizziness, imbalance, and number of medications were entered as covariates with VAP score at 3 months as the dependent variable. According to Levene's test, the homogeneity of variance assumption was satisfied [$F(26, 145) = 1.02$, $p = 0.443$] (193). The distribution of residuals was slightly skewed but given that the F test is robust to non-normal distributions, the normal probability plots were considered acceptable (194,197). The results indicated that the factors

history of falls and age < 65 have a statistically significant effect on VAP score at three months [F (1, 163) = 4.68, p = 0.032; F (1, 163) = 8.46, p = 0.004] (Table 22). The partial eta squared values indicated a small to medium effect for falls and age < 65 (partial η^2 = 0.028, 0.049) (176).

Table 22. General linear Model for Demographic Predictors of VAP Score at 3 Months

N = 172	**B**	**SE**	***p***	**Partial eta squared**
Intercept	0.92	0.29	0.002	--
Falls	-0.31	0.14	0.032*	0.028
Age < 65	0.45	0.15	0.004*	0.049
History of panic	-0.05	0.18	0.77	0.001
History of depression	-0.13	0.15	0.37	0.005
History of migraine	-0.08	0.15	0.57	0.002
Duration of dizziness	0.001	0.001	0.28	0.007
Duration of imbalance	-0.001	0.001	0.32	0.006
Number of medications	0.02	0.01	0.087	0.018

**p<0.05*

Next, a second general linear model was constructed to identify if the VAAI-9 as well as dizziness severity (dizziness VAS), baseline VAP, and anxiety and depression symptoms (HADS) predicted disability at 3 months measured by the VAP. The model included the baseline outcome measures: VAAI-9, dizziness VAS, HADS-A and HADS-D subscale, and VAP scores as covariates and the VAP score at three months as the dependent variable (Table 23). The distribution of residuals was slightly skewed but given that the F test is robust to the assumption of normality, the normal probability plots were considered acceptable (194,197). The results indicate that the VAAI-9 [F (1, 280) = 7.13, p = 0.008], dizziness VAS [F (1, 280) = 12.37, p = 0.001], and HADS-D scores [F (1, 280) = 8.08, p = 0.005], were significant predictors of VAP score at follow up. The partial eta squared values indicate small to medium effects sizes for HADS-D, VAAI-9, and dizziness VAS (partial η^2 = 0.023, 0.025, 0.042) (176).

Table 23. General Linear Model for Baseline Outcome Measure Predictors of VAP Score at 3 Months

N = 286	**B**	**SE**	***p***	**Partial eta squared**
Intercept	0.03	0.09	0.76	--
VAP	0.16	0.09	0.08	0.011
Dizziness VAS	0.06	0.02	0.001*	0.042
HADS-A	-0.003	0.01	0.77	<0.001
HADS-D	0.04	0.02	0.005*	0.023
VAAI-9	0.01	0.005	0.008*	0.025

**p<0.05; Abbreviations: VAS, Visual Analogue Scale; VAP, Vestibular Activities and Participation Measure; HADS-A, Hospital Anxiety and Depression Scale – Anxiety Subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale; VAAI-9, Vestibular Activities Avoidance Instrument 9-Item*

The significant predictors from both general linear models were included in a third general linear model. The dichotomous variables (falls and age < 65) were included as factors and dizziness VAS, HADS-D, and VAAI-9 were included as covariates with VAP score at follow up as the dependent variable (Table 24). According to Levene's test, the homogeneity of variance assumption was satisfied [F (3, 223) = 1.68, p = 0.173] (193). The distribution of residuals was slightly skewed but given that the F test is robust to non-normal distributions, the normal probability plots were considered acceptable (194,197). The result indicated that dizziness VAS [F (1, 221) = 12.74, $p < 0.001$], HADS-D [F (1, 221) = 9.02, p = 0.003], and VAAI-9 [F (1, 221) = 11.96, p = 0.001] were significant predictors of VAP score at 3 months. The partial eta squared values indicate a medium effect for dizziness VAS (partial $\eta^2 = 0.054$) and VAAI-9 (partial $\eta^2 = 0.051$) and a small to medium effect for HADS-D (partial $\eta^2 = 0.039$) (176).

Table 24. General Linear Model for Baseline Predictors of VAP Score at 3 Months

N = 227	B	SE	*p*	Partial eta squared
Intercept	0.09	0.13	0.498	0.002
Falls	-0.17	0.10	0.088	0.013
Age < 65	0.11	0.10	0.291	0.005
Dizziness VAS	0.07	0.02	<0.001*	0.054
HADS-D	0.04	0.02	0.003*	0.039
VAAI-9	0.02	0.005	0.001*	0.051

**p<0.05; Abbreviations: VAS, Visual Analogue Scale; VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

Because there was no significant change in VAP scores over 3 months, the general linear model was reanalyzed using baseline VAP scores as the dependent variable to identify if the results would be replicated (Table 25). Again, the dichotomous variables (falls and age < 65) were included as factors and dizziness VAS, HADS-D, and VAAI-9 were included as covariates with VAP score at baseline as the dependent variable (Table 25). According to Levene's test, the homogeneity of variance assumption was satisfied [$F(3, 314) = 1.46$, $p = 0.225$] (193). The distribution of residuals was slightly skewed but given that the F test is robust to non-normal distributions, the normal probability plots were considered acceptable (194,197). The results indicated that dizziness VAS [$F(1, 312) = 41.46$, $p < 0.001$], HADS-D [$F(1, 312) = 13.12$, $p < 0.001$], and VAAI-9 [$F(1, 312) = 162.24$, $p < 0.001$] were significant predictors of VAP score at baseline. These are the same three predictors that were significant in this model compared to the model with VAP score at 3 months as the dependent variable. The partial eta squared values indicate a large effect for dizziness VAS (partial $\eta^2 = 0.117$) and VAAI-9 (partial $\eta^2 = 0.342$) and a small to medium effect for HADS-D (partial $\eta^2 = 0.04$) (176).

Table 25. General Linear Model of Baseline Predictors of VAP at Baseline

N = 318	B	SE	*p*	Partial eta squared
Intercept	-0.11	0.07	0.15	0.007
Falls	-0.05	0.05	0.35	0.003
Age < 65	0.006	0.06	0.92	<0.001
Dizziness VAS	0.07	0.01	<0.001*	0.117
HADS-D	0.03	0.008	<0.001*	0.040
VAAI-9	0.03	0.003	<0.001*	0.342

**p<0.05; Abbreviations: VAS, Visual Analogue Scale; VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

4.3.10 Multivariate Linear Regression Model

Using the results of the final general linear model (Table 24), a multiple linear regression model was constructed using the enter method with the VAAI-9, dizziness VAS, and HADS-D as predictors and VAP score at three months as the dependent variable. Review of the partial scatter plots of the independent variables and the dependent variable indicate that the assumption of linearity was met. The standardized residuals were slightly skewed but considered reasonable given a skewness value of only 0.37 (skewness > 1.5 indicates non-normality) (194). The Durbin-Watson statistic was 1.41, indicating an acceptable independence of errors (195). Homogeneity of variance was considered acceptable after visualizing scatter plots of studentized residuals against values of the independent variables. The assumption of no multicollinearity was met given that the tolerance statistics were greater than 0.10 (.51 - .74) and variance inflation factors were less than 10 (1.35 – 1.97) (196).

The results of the multiple linear regression suggest that a significant proportion of the VAP score at 3 months was predicted by the VAAI-9 score, dizziness VAS, and HADS-D score [$F(3, 282) = 55.88$, $p < 0.001$]. For every 1-point increase in VAAI-9 score at baseline, the VAP

score in 3 months increased by approximately 0.02 points when controlling for dizziness VAS and HADS-D (Table 26). For every 1-point increase in dizziness VAS at baseline, the VAP score at 3 months increased by 0.08 points when controlling for VAAI-9 and HADS-D score. For every 1-point increase in HADS-D score at baseline, the VAP score at 3 months increased by 0.05 when controlling for VAAI-9 score and dizziness VAS. The R square value indicates that approximately 37.3% of the variation in VAP score at 3 months was predicted by VAAI-9 score, dizziness VAS, and HADS-D score. This suggests that subject score on the VAAI-9, the dizziness VAS rating, and the HADS-D score have a moderate effect on VAP score in three months (176).

Table 26. Multiple Linear Regression Model Predicting VAP Score at 3 Months

	Unstandardized Coefficients		**Standardized Coefficients**		**95% CI**	
	B	**SE**	**B**	***p***	**Lower Bound**	**Upper Bound**
Constant	0.004	0.09	-	0.97	-0.17	0.18
VAAI-9	0.02	0.004	0.28	<0.001*	0.01	0.03
Dizziness VAS	0.08	0.02	0.24	<0.001*	0.04	0.11
HADS-D	0.05	0.01	0.22	0.001	0.02	0.07

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

Again, because there was not a significant change in VAP score over the 3-month study period, the multivariate linear regression model was reanalyzed using the VAP score at baseline. The model was constructed using the enter method with the baseline VAAI-9, dizziness VAS, and HADS-D as predictors. Review of the partial scatter plots of the independent variables and the dependent variable indicate that the assumption of linearity was met. The standardized residuals were slightly skewed but considered reasonable given a skewness value of 0.93 (skewness > 1.5 indicates non-normality) (194). The Durbin-Watson statistic was 2.11 and indicated an acceptable independence of errors (195). Homogeneity of variance was considered acceptable after

visualizing scatter plots of studentized residuals against values of the independent variables. The assumption of no multicollinearity was met given that the tolerance statistics were greater than 0.10 (.51 - .73) and variance inflation factors were less than 10 (1.38 – 1.96) (196).

The results of the previous multiple linear regression model were replicated suggesting that a significant proportion of the VAP score at baseline was predicted by the VAAI-9 score, dizziness VAS, and HADS-D score [$F(3, 403) = 275.55$, $p < 0.001$]. For every 1-point increase in VAAI-9 score at baseline, the VAP score baseline increased by approximately 0.03 points when controlling for dizziness VAS and HADS-D (Table 27). For every 1-point increase in dizziness VAS at baseline, the VAP score at baseline increased by 0.07 points when controlling for VAAI-9 and HADS-D score. For every 1-point increase in HADS-D score at baseline, the VAP score at baseline increased by 0.03 when controlling for VAAI-9 score and dizziness VAS. The R square value indicates that approximately 67.4% of the variation in VAP score at baseline was predicted by VAAI-9 score, dizziness VAS, and HADS-D score. This suggests that subject score on the VAAI-9, the dizziness VAS rating, and the HADS-D score have a large effect on baseline VAP score (176).

Table 27. Multivariate Linear Regression Model Predicting Baseline VAP

N = 404	**Unstandardized Coefficients**		**Standardized Coefficients**		**95% CI**	
	B	**SE**	**B**	***p***	**Lower Bound**	**Upper Bound**
Constant	-0.12	0.05	-	0.018	-0.21	-0.02
VAAI-9	0.03	0.002	0.57	<0.001*	0.03	0.04
Dizziness VAS	0.07	0.01	0.23	<0.001*	0.05	0.09
HADS-D	0.03	0.007	0.15	<0.001*	0.02	0.04

**p<0.05; Abbreviations: VAAI-9, Vestibular Activities Avoidance Instrument 9-Item; VAS, Visual Analogue Scale; HADS-D, Hospital Anxiety and Depression Scale – Depression Subscale*

4.4 Discussion

The aim of this study was to identify the effect of fear avoidance beliefs on disability level at three months. We hypothesized that fear avoidance beliefs at baseline would be associated with disability at follow-up. The results indicated that there was a significant association between avoidance beliefs measured by VAAI-9 scores at baseline and disability measured by VAP scores at three months. The VAAI-9 scores at baseline were significantly associated with other measures of disability at three months including the dizziness VAS, functional rating, the days of activities missed and limited at home, work, and in the community, the LSA, the SF-12 PCS and MCS, and the GROC. The multivariate linear regression model indicated that when controlling for dizziness and depression symptom severity, VAAI-9 scores predict a significant proportion of the follow-up VAP score.

4.4.1 The Effects of Demographic and Clinical Variables on Outcomes

The effects of certain demographic and clinical variables such as age, psychological comorbidities, and type of vestibular diagnosis on patient-reported outcome measures were evaluated given findings from previous research. First, the relationship between age and patient-reported outcome measures was examined. In previous studies, there are mixed findings regarding the effects of age on outcomes (15,198–200). Piker and Jacobson found that older adults tend to experience symptoms differently than younger adults including having a greater tendency to fall (200). However, in another study, age did not have an effect on dizziness handicap or the presence of psychological comorbidities (15). Whitney and colleagues found that age did not have an effect on outcomes among those who underwent vestibular rehabilitation (198). When evaluating the

presence of psychiatric disorders in the general population, there is evidence that there is a low prevalence rate of anxiety disorders among those over 60 years of age (55). Our results were in agreement because we found that persons who were 65 years of age or older had lower levels of anxiety and depression symptoms, less fear avoidance beliefs, better mental health-related quality of life, and less activity and participation limitations when compared to those under 65 years. Some of these findings may be due to less work and household responsibilities (for example: caring for children) among those who are over the age of 65. While age less than 65 years was a significant predictor of VAP score at 3 months in the general linear model including demographic variables, it was not significant in the model including patient-reported outcome measure scores and was not included in the final multivariate linear regression model. Therefore, age was not a significant predictor of VAP score at 3 months when considering dizziness and depression symptom severity, and fear avoidance beliefs at baseline. However, the relationship between younger age and mental health and psychological well-being should be considered by clinicians when working with individuals who have vestibular disorders.

Differences in outcome measures among diagnostic groups (BPPV, peripheral vestibulopathy, central vestibulopathy, and gait disorders) were also assessed. This sample included a large percentage (38%) of patients with "unspecified dizziness" meaning that they were given the general dizziness ICD-10 diagnosis code (R42). There were fewer subjects diagnosed with BPPV than has been previously been found in other research studies (154,189). Persons with central vestibular disorders or mixed central and peripheral vestibular disorders are known to have a worse prognosis and worse performance on clinical outcomes (201–203). Furthermore, psychological comorbidities are more prevalent in certain vestibular diagnoses such as vestibular migraine and Meniere's Disease (6,14,204). There were no differences in VAP scores at 3 months

between diagnostic groups. However, there were differences in VAAI-9 score between diagnostic groups such that subjects with central vestibulopathy had the highest (worst) scores (mean = 29.4) and those with gait disorders had the lowest scores (mean = 22.1) (X^2 = 12.11, p = 0.017). Therefore, persons with central vestibular disorders appear to have more fear avoidance beliefs in this sample. Fear avoidance beliefs may play a role in determining prognosis and the patient's performance on clinical outcome measures for certain central vestibular diagnoses. The relationship between fear avoidance beliefs and vestibular diagnosis should be studied further in future research.

The presence of psychological comorbidities have negative effects on outcomes among persons with vestibular disorders (6,10,13,18,19,22,23,81,83,199). Therefore, we wanted to assess patient-reported outcome measure scores among those who did and did not have a history of panic disorder, depression, and anxiety disorder. As expected, those with psychological comorbidities had higher scores on the HADS and the VAAI-9 indicating more anxiety and depression symptoms and more fear avoidance beliefs compared to those without psychological comorbidities. We hypothesized that psychological comorbidities and level of anxiety and depression symptoms measured by the HADS would be associated with fear avoidance beliefs measured by the VAAI-9. Persons with anxiety, depression, and panic reported more limitations in activities and participation, more severe dizziness ratings, poorer health-related quality of life, and less reported mobility. This is in agreement with other studies that have found worse scores on outcome measures among persons who have psychological comorbidity and vestibular disorders (6,17,205). The presence of psychological disorders abstracted from the electronic medical record was not significant in the general linear model and was therefore not included in the multivariate linear regression model predicting VAP score at three months. The HADS-D score was a significant

predictor in the general linear models and therefore was included in the final model meaning that level of depression symptoms was accounted for and predicted VAP score at follow up. This may indicate that concurrent measurement of psychological strain using patient reported outcome measures versus abstracting a diagnosis from the medical record may be a better indicator of presence of psychological comorbidity.

The duration of symptoms was highly variable ranging from 1 month to over 60 years of dizziness and/or imbalance. The effect of duration of symptoms on patient-reported outcomes was evaluated and we found that longer duration of symptoms was associated with higher VAP score at follow-up indicating more activity and participation limitations. However, both duration of dizziness and imbalance were not significant in the general linear model predicting VAP score at three months. Duration of symptoms was not related to VAAI-9 score at baseline indicating that duration of symptoms did not influence the level of fear avoidance beliefs. Some studies have also found that duration of symptoms did not have an effect on outcomes over time (19), while others have found that symptom duration at baseline can predict the persistence of dizziness over time (206).

Patient-reported outcomes among subjects who reported that they were not working due to their dizziness (n = 24) were compared to the other subjects in the study. Those who were not working due to dizziness rated more severe dizziness symptoms, lower functional ratings, more fear avoidance beliefs, more anxiety and depression symptoms, more activity and participation limitations, poorer health-related quality of life, and more activities missed at work, at home, and in the community. It is difficult to determine if these individuals demonstrated poorer outcomes because they were not working or if they were not working because of a more severe disease state. For example, not being able to work due to dizziness likely contributes to lower functional ratings,

reporting more limitations in activities and participation, and perhaps elevated anxiety and/or depression symptoms. Conversely, the presence of elevated fear avoidance beliefs, anxiety, and depression may contribute to prolonged absence from work. Research in low back pain has demonstrated that fear avoidance beliefs can predict future work-related disability (26,96,207). Therefore, it is recommended that additional research evaluating VAAI-9 scores and work-related disability due to dizziness be conducted in the future.

At baseline, 55% of the sample had either undergone PT interventions in the past or were currently receiving PT interventions. The patient-reported outcome measures at baseline were compared between those who reported having PT and those who did not. Subjects who had prior PT had higher dizziness VAS ratings, VAP scores, VAAI-9 scores, and HADS-D scores compared to those who were not currently undergoing PT interventions. Those who had prior PT had lower functional ratings and SF-12 PCS scores. This indicates greater dizziness and depression symptoms, more fear avoidance beliefs, worse function, poorer physical health-related quality of life, and more limitations in activities and participation among those who had prior PT. Those who had prior PT but were still being seen either at a PT clinic or were referred to the physician clinic may represent cases that failed to improve despite PT intervention.

4.4.2 Differences in Outcome Measures over Time

Between the baseline visit and the three-month follow-up visit there were significant improvements in some outcome measures, including the dizziness VAS, LSA, SF-12 PCS scores, functional rating, disability questions, and PASS. These improvements were likely due to a combination of factors, including medical, pharmacological, and/or physical therapy interventions, or in some cases, improvements over time. There were no significant improvements in VAP scores

or SF-12 MCS scores between baseline and follow-up assessments. Previous work has found that the VAP was not responsive to change evidenced by a low area under the curve values during receiver operating characteristic curve analysis (189). Perhaps the lack of a specific intervention or the presence of chronic symptoms in the majority of subjects in the study explains the lack of change in VAP over time.

About half of the sample reported having current PT or having PT in the past at baseline. At follow-up, 74% of the sample reported having current PT or PT in the past. In total, 60 subjects underwent PT interventions during the study period which was determined by identifying those subjects who reported having PT at the follow-up assessment but did not report having PT at baseline. There were no significant differences in GROC, VAP, LSA, or dizziness VAS at follow-up among those who underwent PT during the study period and those who did not. Subjects who underwent PT during the study period did report higher functional ratings and better SF-12 MCS scores at follow up compared to those who did not received PT during the study. The prescription of new medications and other interventions were not collected as part of the study but may have influenced the improvements seen in some measures at follow-up.

4.4.3 Assessment of Provider Bias

Because subjects were recruited from PT clinics and others were recruited from a tertiary care balance disorders clinic, we wanted to evaluate for differences among groups by provider-type. Subjects who were recruited from the tertiary care balance disorders clinic experienced a longer duration of dizziness and imbalance symptoms at baseline compared to subjects recruited from PT clinics. This is not surprising given that patients are usually referred to the tertiary care balance disorders clinic from physicians or from physical therapists. Subjects recruited from the

balance disorders clinic scored significantly lower on the VAAI-9 and the VAP indicating fewer fear avoidance beliefs and less activity and participation restrictions. They had higher LSA scores and SF-12 PCS scores and a greater percentage of subjects reported their state was acceptable given their level of symptoms when compared to those recruited from PT clinics. While these differences reached statistical significance, the clinical significance is questionable given the small differences in mean scores (difference of 4 points on the VAAI-9, difference of 0.2 on the VAP).

4.4.4 The Association Between Fear Avoidance Beliefs and Disability

The VAAI-9 score at baseline was significantly associated with all three-month patient-reported outcome measures. Therefore, baseline levels of fear avoidance beliefs were related to dizziness severity, functional rating, activities missed and limited at work, at home, and in the community, level of mobility, perceived change over time, patient acceptable symptom state, health-related quality of life, and activity and participation limitations at three months. This is in agreement with studies in patients with chronic pain that indicate fear avoidance is associated with levels of disability, functional impairment, and symptom severity (26,28,94,105).

The aim of this analysis was to identify if the VAAI-9 score was associated with disability (VAP score) at three months while controlling for other potential demographic and clinical characteristics. In the demographic variable general linear model, the variables that had a significant effect on VAP score at 3 months were age less than 65 and history of falls indicating that persons under 65 years of age and those who had a history of falls tended to have more limitations in activities and participation. The results from the general linear model including the baseline outcome measure scores indicated that higher scores on the VAAI-9, HADS-D, and dizziness VAS at baseline were associated with higher VAP scores at 3 months. In the third

general linear model, which included the significant variables from the first two models, only VAAI-9 score, HADS-D score and dizziness VAS had a significant effect on VAP score at 3 months meaning that age and history of falls were no longer significant when controlling for these outcomes at baseline. The final multivariate linear regression model predicted a significant amount of the variance in VAP score at 3 months (37%) indicating that level of dizziness and depression symptoms and fear avoidance beliefs have a moderate effect on activities and participation at 3 months. When controlling for HADS-D and dizziness VAS, for every 1-point increase in VAAI-9 score, the VAP score at 3 months increased by 0.02.

Interestingly, when the general linear model and multivariate linear regression model were repeated using the baseline VAP scores as the dependent variable, the same baseline outcome measures were significant predictors. In fact, a large portion of the variance (67%) in baseline VAP score was predicted by baseline VAAI-9, dizziness VAS, and HADS-D scores. It is unfortunate that the subjects in this study did not improve to a significant degree in VAP score from baseline to follow-up assessment. The reasons for lack of improvement may include the fact that there was no specific intervention provided, or that many of the subjects included had chronic dizziness, or perhaps the sample had high levels of fear avoidance beliefs and depression symptoms. From the multivariate linear regression model, it appears that a large portion of the activity limitations measured by VAP score was predicted by fear avoidance beliefs, dizziness severity, and depression symptom severity. Therefore, if the sample had a high degree of fear avoidance beliefs and high symptom burden at baseline, it may explain the lack of change in VAP score over time. Future work should attempt to replicate these findings using other measures of disability.

In persons with dizziness, a cross-sectional study found that escape/avoidance type of coping measured by the Ways of Coping Questionnaire, anxiety, and depression were associated with dizziness handicap (15). Other studies found that fear of body sensations could predict chronic dizziness symptoms (20,208). A cross-sectional study using the Dizziness Catastrophizing Scale identified that the construct of catastrophization was associated with dizziness handicap and negative affect (38). Catastrophization is included in the fear avoidance model and is thought to be associated with the development of fear avoidance beliefs (24,120). A recent study by Herdman and colleagues used the Cognitive and Behavioral Responses Questionnaire to identify fear avoidance, embarrassment avoidance, and avoidance/resting behaviors and found that these constructs were associated with dizziness-related handicap (209). It has been a challenge to measure fear avoidance beliefs among persons with dizziness because there was no valid and reliable tool available. The development of the VAAI-9 has allowed us to measure the construct of fear avoidance and its relationship to measures of disability at three months among persons with vestibular disorders.

4.4.5 Limitations

There were several limitations to this study which should be mentioned. First, demographic and clinical data were collected from patient electronic medical records (EMR). Some of the information was missing and there is always the chance that data were entered incorrectly. However, the data from the EMR were abstracted by only one study investigator, eliminating inter-rater differences. The diagnostic categories utilized in the study were based on the ICD-10 code given by the physician or physical therapist. This has limitations because there are currently no ICD-10 codes for some vestibular diagnoses (for example, PPPD and mal de

debarquement syndrome). Furthermore, if the specific diagnosis was uncertain and/or complex, this could lead to the use of the general dizziness code (R42). It appeared that the unspecified dizziness code was likely over-utilized in this sample compared to other studies with similar populations (23,154,189,198,210).

The VAP scores at three months were skewed toward zero meaning many patients were not experiencing limitations in activities and participation. Therefore, the variable did not meet the assumptions for some of the statistical methods used in this study including the general linear models and the multivariable linear regression. To ensure accuracy, the results were checked using generalized linear models and by using bootstrap resampling methods for both the general linear models and for the multivariate linear regression model, which provide a more accurate estimate through the bias corrected accelerated 95% CIs. The results were the same using other methods for each of the models, providing evidence that our results were accurate.

While this study included many demographic and clinical characteristics, there are likely other personal, clinical, and environmental factors that were not measured but may play a role in the development of disability after a vestibular disorder. To measure disability at three months, we utilized the VAP, which measures important constructs of the biopsychosocial model (activities and participation limitations) (154). Therefore, other factors related to disability including the health condition and functional limitations may not have been measured comprehensively. Also, the VAP has not been found to be very responsive in other research studies and did not change significantly over a 3 month period in this study (189). The lack of change in the VAP may be a limitation in this outcome measure or may be an indicator that the patients in our study did not improve over the 3-month period. Many studies use the DHI to measure disability in persons with dizziness, but because the VAAI-9 includes items from the DHI, it would be inappropriate to use

in this study. Other disability measures could have been utilized, such as tools from the Patient-Reported Outcomes Measurement Information System (PROMIS) (211). Although these tools have not been validated in persons with vestibular disorders, they can provide a comprehensive measurement of disability from physical function to participation. Alternatively, the Vertigo Symptom Scale could have been used, although this is a measure of vertigo and anxiety/autonomic symptoms (137).

It should also be noted that the items included in the VAAI-9 were abstracted from the original 81-item questionnaire. The findings may be different if subjects were completing the 9-item scale versus the 81-item scale. Therefore, it is important that these findings be replicated in an external sample of individuals with vestibular disorders.

4.4.6 Conclusions

This study provides evidence that VAAI-9 score at baseline predicts level of disability measured by the VAP at three months. The baseline VAAI-9 scores were associated with other measures of disability at three months, including dizziness symptom severity, functional rating, disability questions, life space mobility, and GROC. Fear avoidance beliefs measured by the VAAI-9 predict a significant proportion of VAP score at follow-up while controlling for dizziness and depression symptom severity, suggesting that the VAAI-9 can potentially be used by clinicians to assist with the determination of patient prognosis and disability level after a vestibular disorder.

5.0 Clinical Relevance and Future Work

The first aim of this study was to develop a clinically useful and valid tool that measures fear avoidance beliefs among persons with vestibular disorders. The VAAI was shortened through EFA, item reduction, and internal consistency analyses to a 9-item questionnaire. The inclusion of 9 items should not be burdensome for patients to complete in a clinical setting. The VAAI-9 appears to measure constructs of fear avoidance related to physical activity and exercise, household and work responsibilities, and social activities. The present study provides evidence for internal consistency and construct validity of the VAAI-9 through significant relationships with other measures of disability, quality of life, and psychological well-being. However, additional research in clinical settings should be conducted using the 9-item version of the VAAI. Specifically, the VAAI-9 should be assessed for feasibility in vestibular rehabilitation and balance disorders clinics. Also, the VAAI-9 should be further studied for evidence of test-retest reliability and external validity.

The second aim of this study was to evaluate the relationship between fear avoidance beliefs at baseline and the level of disability at three-month follow-up. Fear avoidance beliefs measured by the VAAI-9 at baseline predicted VAP score at three months when controlling for severity of dizziness and depression symptoms. This is evidence that fear avoidance beliefs are important to measure and provide additional information above and beyond severity of symptoms and level of depression symptoms in persons with vestibular disorders. Additional research should be conducted in vestibular rehabilitation settings to identify the relationship between VAAI-9 score and outcomes before and after physical therapy interventions. The association between fear avoidance beliefs measured by the VAAI-9, other patient-reported outcome measures, and balance

performance measures used in clinical settings should be assessed. If fear avoidance beliefs measured at baseline are associated with poorer outcomes in vestibular rehabilitation settings, as they have been in orthopedic patient populations (32,107), the use of psychologically-informed physical therapy protocols may be developed and used among persons with vestibular disorders to enhance patient outcomes.

Appendix A The Vestibular Activities Avoidance Instrument – 81 Items

Due to your dizziness/unsteadiness, how much do you agree with each statement below.

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
1- My dizziness/unsteadiness bothers me.							
2- My dizziness/imbalance is caused by physical movement.							
3- When I walk down a sidewalk, my dizziness/unsteadiness is worse.							
4- I worry about my health much of the time.							
5- If I notice a body sensation that I cannot explain, I often find it difficult to think of other things.							
6- I often feel nervous, anxious or on edge.							
7- Physical activity makes my dizziness/ unsteadiness worse.							
8- I am frustrated because of my dizziness/unsteadiness.							
9- I am feeling down, depressed, or hopeless.							
10- I am afraid that I might make myself dizzy or unsteady if I exercise.							
11- Worrying thoughts have been going through my mind a lot of the time.							
12- It is difficult for me to concentrate because of my dizziness/unsteadiness.							
13- Looking up increases my dizziness/unsteadiness.							

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
14- My body is telling me I have something dangerously wrong.							
15- I restrict my travel for business or recreation because of my dizziness/unsteadiness.							
16- I should not do physical activities, which might make my dizziness/unsteadiness worse.							
17- It is difficult for me to walk around the house in the dark because of my dizziness/unsteadiness.							
18- I have had little interest or pleasure in doing things.							
19- I cannot do physical activities, which might make my dizziness/unsteadiness worse.							
20- If I were to exercise, my dizziness/unsteadiness would probably get better.							
21- I feel that my dizziness/unsteadiness is terrible and it's never going to get any better.							
22- I am not able to stop or control worrying.							
23- Walking down the aisle of a supermarket increases my dizziness/unsteadiness.							
24- I am afraid to stay home alone because of my dizziness/unsteadiness.							
25- I believe that I have a serious illness much of the time.							
26- I have difficulty getting into or out of bed because of my dizziness/unsteadiness.							
27- My work makes my dizziness/unsteadiness worse.							
28- I have been feeling tired or having little energy.							
29- I feel handicapped because of my dizziness/unsteadiness.							
30- I have had trouble falling or staying asleep or sleeping too much.							

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
31- In general I have not enjoyed all the things I used to enjoy.							
32- I am aware of bodily sensations much of the time.							
33- I have a claim for compensation for my dizziness/unsteadiness.							
34- My participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties is significantly restricted because of my dizziness/unsteadiness.							
35- Just because something makes my dizziness/unsteadiness worse does not mean it is dangerous.							
36- My dizziness/unsteadiness places stress on my relationships with members of my family or friends.							
37- I am afraid that I might make myself dizzy accidentally.							
38- My family members and friends would say that I worry too much about my health.							
39- It is hard for me to read because of my dizziness/unsteadiness.							
40- Being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my dizziness/unsteadiness from worsening.							
41- My work causes too much dizziness/unsteadiness for me.							
42- I have been worrying too much about different things.							
43- Performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase my dizziness/unsteadiness.							
44- My dizziness/unsteadiness interferes with my job or household responsibilities.							

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
45- I am afraid to leave my home without having someone go with me because of my dizziness/unsteadiness.							
46- Bending over increases my dizziness/unsteadiness.							
47- I get the emotional help and support I need from my family.							
48- I have trouble relaxing.							
49- I should not do my regular work with my present dizziness/unsteadiness.							
50- I have been embarrassed in front of others because of my dizziness/unsteadiness.							
51- I often have headaches.							
52- I am afraid that I have a serious illness much of the time.							
53- I cannot do my normal work with my present dizziness/unsteadiness.							
54- Quick movements of my head increase my dizziness/unsteadiness.							
55- I think of myself being ill much of the time.							
56- Even though something is causing me dizziness/unsteadiness, I don't think it's actually dangerous.							
57- I cannot do my normal work until my dizziness/unsteadiness is treated.							
58- It is difficult for me to go for a walk by myself because of my dizziness/unsteadiness.							
59- I avoid heights because of my dizziness/unsteadiness.							
60- I often feel like I'm going to faint.							

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
61- I can't do all the things normal people do because of my dizziness/unsteadiness.							
62- Turning over in bed increases my dizziness/unsteadiness.							
63- I have been feeling my heart pound or race.							
64- I do not think that I will be back to my normal work within 3 months.							
65- It's really not safe for a person with a condition like mine to be physically active.							
66- It is difficult for me to do strenuous homework or yard work because of my dizziness/unsteadiness.							
67- I have had shortness of breath.							
68- Dizziness/unsteadiness lets me know when to stop exercising so that I don't injure myself.							
69- I am afraid people may think I'm intoxicated because of my dizziness/unsteadiness.							
70- Although physical activities may increase my symptoms, I would be better off if I were physically active.							
71- I have been feeling afraid as if something awful might happen.							
72- I do not think that I will ever be able to go back to that work.							
73- My dizziness/unsteadiness was caused by my work.							
74- If I were to try to overcome my dizziness/balance problem, my dizziness/unsteadiness would increase.							
75- I notice dizziness more than most people my age.							
76- My illness has put my body at risk for the rest of my life.							

Item	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
77- I try to resist thoughts of illness, but often cannot do it.							
78- No one should exercise when he/she is dizzy.							
79- I have been feeling bad about myself or that I am a failure or have let my family or myself down.							
80- I often have difficulty taking my mind off thoughts about my health.							

81. Overall, how bothersome has your dizziness/unsteadiness been in the last 2 weeks?

Not at all	Slightly	Moderately	Very much	Extremely
□	□	□	□	□

Appendix B Two-Factor Solution Promax Rotation of the 63-Item VAAI – Factor 1

Promax 2 Factor Solution of 63 Item VAAI – Factor 1					
	Item #	**Text**	**Adapted from**	**Factor 1 loading**	**Factor 2 loading**
1	66	It is difficult for me to do strenuous homework or yard work because of my dizziness.	DHI	0.809	0.447
2	34	My participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties is significantly restricted because of my dizziness.	DHI	0.790	0.543
3	44	My dizziness interferes with my job or household responsibilities.	DHI	0.779	0.508
4	19	I cannot do physical activities, which might make my dizziness worse.	FABQ	0.768	0.440
5	43	Performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase my dizziness.	DHI	0.761	
6	61	I can’t do all the things normal people do because of my dizziness.	TSK	0.757	0.517
7	15	I restrict my travel for business or recreation because of my dizziness.	DHI	0.727	0.495
8	10	I am afraid that I might make myself dizzy or unsteady if I exercise.	TSK	0.720	0.464
9	31	In general, I have not enjoyed all the things I used to enjoy.	SBST	0.720	0.613
10	29	I feel handicapped because of my dizziness.	DHI	0.716	0.619
11	7	Physical activity makes my dizziness worse.	FABQ	0.703	
12	12	It is difficult for me to concentrate because of my dizziness.	DHI	0.702	0.613

13	18	I have had little interest or pleasure in doing things.	PHQ-9	0.696	0.690
14	17	It is difficult for me to walk around the house in the dark because of my dizziness.	DHI	0.669	0.412
15	49	I should not do my regular work with my present dizziness.	FABQ	0.663	0.502
16	27	My work makes my dizziness worse.	FABQ	0.663	0.446
17	58	It is difficult for me to go for a walk by myself because of my dizziness.	DHI	0.662	0.412
18	45	I am afraid to leave my home without having someone go with me because of my dizziness.	DHI	0.661	0.512
19	41	My work causes too much dizziness for me.	FABQ	0.660	0.530
20	23	Walking down the aisle of a supermarket increases my dizziness.	DHI	0.643	
21	3	When I walk down a sidewalk, my dizziness is worse.	DHI	0.635	
22	16	I should not do physical activities, which might make my dizziness worse.	FABQ	0.634	
23	39	It is hard for me to read because of my dizziness.	DHI	0.609	
24	59	I avoid heights because of my dizziness.	DHI	0.589	
25	24	I am afraid to stay home alone because of my dizziness.	DHI	0.585	0.490
26	50	I have been embarrassed in front of others because of my dizziness.	DHI	0.578	0.461
27	8	I am frustrated because of my dizziness.	DHI	0.576	0.502
28	46	Bending over increases my dizziness.	DHI	0.572	
29	54	Quick movements of my head increase my dizziness.	DHI	0.570	
30	28	I have been feeling tired or having little energy.	PHQ-15	0.552	0.523
31	69	I am afraid people may think I'm intoxicated because of my dizziness.	DHI	0.551	

32	26	I have difficulty getting into or out of bed because of my dizziness.	DHI	0.546	
34	13	Looking up increases my dizziness.	DHI	0.533	
35	40	Being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my dizziness from worsening.	TSK	0.528	
36	30	I have had trouble falling or staying asleep or sleeping too much.	PHQ-9	0.510	0.497
37	68	Dizziness lets me know when to stop exercising so that I don't injure myself.	TSK	0.473	
38	1	My dizziness bothers me.	PHQ-15	0.454	
39	74	If I were to try to overcome my dizziness problem, my dizziness/unsteadiness would increase.	TSK	0.433	

Abbreviations: DHI, Dizziness Handicap Inventory; FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia; PHQ, Patient Health Questionnaire; SBST, Start Back Screening Tool

Appendix C Two-Factor Solution Promax Rotation of the 63-Item VAAI – Factor 2

Promax 2 Factor Solution of 63-Item VAAI – Factor 2					
	Item #	**Text**	**Adapted from**	**Factor 2 loading**	**Factor 1 loading**
1	11	Worrying thoughts have been going through my mind a lot of the time	SBST	0.833	0.468
2	22	I am not able to stop or control worrying.	GAD-7	0.820	0.458
3	80	I often have difficulty taking my mind off thoughts about my health.	SHAI	0.811	0.435
4	55	I think of myself being ill much of the time.	SHAI	0.803	0.519
5	52	I am afraid that I have a serious illness much of the time.	SHAI	0.799	0.409
6	42	I have been worrying too much about different things.	GAD-7	0.784	
7	77	I try to resist thoughts of illness, but often cannot do it.	SHAI	0.757	
8	9	I am feeling down, depressed, or hopeless.	PHQ-9	0.756	0.598
9	6	I often feel nervous, anxious or on edge.	GAD-7	0.756	0.426
10	71	I have been feeling afraid as if something awful might happen.	GAD-7	0.751	0.433
11	25	I believe that I have a serious illness much of the time.	SHAI	0.750	0.480
12	4	I worry about my health much of the time.	SHAI	0.737	0.444
13	79	I have been feeling bad about myself or that I am a failure or have let my family or myself down.	PHQ-9	0.672	0.500
14	14	My body is telling me I have something dangerously wrong.	TSK	0.669	0.527

15	5	If I notice a body sensation that I cannot explain, I often find it difficult to think of other things.	SHAI	0.627	0.406
16	38	My family members and friends would say that I worry too much about my health.	SHAI	0.627	
17	48	I have trouble relaxing.	GAD-7	0.622	0.440
18	76	My illness has put my body at risk for the rest of my life.	TSK	0.603	0.504
19	36	My dizziness places stress on my relationships with members of my family or friends.	DHI	0.598	0.597
20	21	I feel that my dizziness is terrible and it's never going to get any better.	SBST	0.576	0.501
21	64	I do not think that I will be back to my normal work within 3 months.	FABQ	0.539	0.526
22	60	I often feel like I'm going to faint.	PHQ-15	0.515	0.507
23	63	I have been feeling my heart pound or race.	PHQ-15	0.501	
24	67	I have had shortness of breath.	PHQ-15	0.496	
25	75	I notice dizziness more than most people my age.	SHAI	0.441	0.422

Abbreviations: DHI, Dizziness Handicap Inventory; FABQ, Fear Avoidance Beliefs Questionnaire; TSK, Tampa Scale of Kinesiophobia; PHQ, Patient Health Questionnaire; SBST, Start Back Screening Tool; GAD, Generalized Anxiety Disorder; SHAI, Short Health Anxiety Inventory

Appendix D Global Rating of Change (188)

A very great deal better (7)	☐
A great deal better (6)	☐
A good deal better (5)	☐
Moderately better (4)	☐
Somewhat better (3)	☐
A little better (2)	☐
About the same, hardly any better at all (1)	☐
No change (0)	☐
About the same, hardly any worse at all (-1)	☐
A little worse (-2)	☐
Somewhat worse (-3)	☐
Moderately worse (-4)	☐
A good deal worse (-5)	☐
A great deal worse (-6)	☐
A very great deal worse (-7)	☐

Appendix E Disability Questions

Migraine Disability Assessment	Adapted Disability Questions
1. On how many days in the last 3 months did you miss work or school because of your headaches? *2. How many days in the last 3 months was your productivity at work or school reduced by half of more because of your headaches (do not include days you counted in question 1 where you missed work or school)?* *3. On how many days in the last 3 months did you not do household work because of your headaches?* *4. How many days in the last 3 months was your productivity in household work reduced by half or more because of your headaches (do not include days you counted in question 3 where you did not do household work)?* *5. On how many days in the last 3 months did you miss family, social, or leisure activities because of your headaches?* *A. On how many days in the last 3 months did you have any headache (if a headache lasted more than one day, count each day)?* *B. On a scale of 0 to 10, on average how painful were these headaches (0 = no pain at all, and 10 = pain is as bad as it can be)?*	*1. On how many days in the last 2 weeks did you miss scheduled work activities completely because of your dizziness?* *2. On how many days in the last 2 weeks did you miss scheduled activities at home/with family completely because of your dizziness?* *3. On how many days in the last 2 weeks did you miss scheduled social or community events completely because of your dizziness?* *4. On how many days in the last 2 weeks did you participate in scheduled work activities, but were limited because of your dizziness?* *5. On how many days in the last 2 weeks did you participate in scheduled activities at home/with family, but were limited because of your dizziness?* *6. On how many days in the last 2 weeks did you participate in scheduled social or community events, but were limited because of your dizziness?*

Adapted from Stewart, W. F., et al. 1999

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