THE DEVELOPMENT AND VALIDATION OF THE VESTIBULAR ACTIVITIES AND PARTICIPATION (VAP) MEASURE FOR PEOPLE WITH VESTIBULAR DISORDERS BASED ON THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH (ICF)

by

Alia A. Alghwiri

BSc, Physical Therapy, University of Jordan, 2005

MS, Neuromuscular Physical Therapy, University of Pittsburgh, 2008

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This dissertation was presented

by

Alia A. Alghwiri

It was defended on

January 5, 2011

and approved by

Carol E. Baker, PhD
Associate Professor, School of Education, University of Pittsburgh

Joseph M. Furman, MD, PhD
Professor, Department of Otolaryngology, University of Pittsburgh

Gregory F. Marchetti, PhD, PT
Associate Professor, Department of Physical Therapy, Duquesne University
Assistant professor, Department of Otolaryngology, University of Pittsburgh

Joan C. Rogers, PhD, OTR/L, FAOTA
Professor, Department of Occupational Therapy Chair, University of Pittsburgh

Patrick J. Sparto, PhD, PT
Associate Professor, Department of Physical Therapy, University of Pittsburgh

Committee Chair
Susan L. Whitney, PhD, PT, NCS, ATC, FAPTA, Associate Professor, Department of Physical Therapy

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Alia A. Alghwiri, PhD

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Background: Activities and participation domains are affected in people with vestibular disorders; however, specialized outcome measures for evaluating activities and participation according to the International Classification of Functioning, Disability and Health (ICF) do not exist.

Purpose: To develop and validate the Vestibular Activities and Participation (VAP) measure for people with vestibular disorders according to the ICF.

Methods: A list of activities and participation candidate items were generated and included in a survey. The survey was then sent to a panel of vestibular experts and agreement was obtained on the items to include in the VAP using the Delphi technique. The psychometric properties of the VAP were established including test-retest reliability; minimum detectable change at 95% confidence level (MDC_{95}), concurrent validity with the World Health Organization Disability Assessment Schedule II (WHODAS II); convergent validity with the Dizziness Handicap Inventory (DHI), and discriminant validity. The test-retest reliability of the VAP total score was estimated using the Intra Class Correlation Coefficient (ICC), model (3,1) and the 95% confidence interval (CI). Agreement per-item was estimated using Cohen's kappa statistics. Concurrent and convergent validity were examined using the Spearman correlation coefficient (*rho*). Discriminant validity was established using a generalized linear model (GLM).

Results: Fifty five activities and participation items were generated in which 32 of them had 70% or greater agreement for inclusion in the VAP. The test-retest reliability of the VAP total score was excellent (ICC=.95), (CI=.91-.97). Un-weighted kappa (.41-.80) and weighted kappa (.58-.94) were good to excellent. The VAP had strong correlation (*rho*=.7, $p<.05$) with the WHODAS II and moderate to strong correlations (*rho*=.54-.74) with the DHI subscale and total scores. The MDC_{95} was .58. After adjustment for age, gender and self-reported imbalance were independent predictors of the transformed VAP total score.

Conclusion: The VAP measure was developed to examine the disabling effect of vestibular disorders on people's activities and participation based on the ICF. The VAP demonstrated excellent reliability and was validated with external instruments.

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PREFACE

I would like to acknowledge the members of my committee for their assistance and encouragement throughout my doctoral program. I would like to express my deepest appreciation to my committee chair, Susan Whitney, PhD, PT, NCS, ATC, FAPTA, for her continuous guidance and support. I would also like thank my mentor Patrick Sparto, PhD, PT, for his continuous assistance and insights.

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1.0 INTRODUCTION

Vestibular deficits manifest as a wide range of signs and symptoms including dizziness, vertigo, and imbalance. Dizziness and vertigo are well recognized problems that rank among the most common complaints reported in medicine globally and in the United States.[1-3] In the United States, over 69 million Americans over the age of 40 reported vestibular dysfunction from 2001 to 2004.[1] In Europe, dizziness and vertigo are also frequent complaints in emergency settings.[2]

Vestibular disorders result in debilitating consequences, physical and psychological, that impair individuals' activities of daily living (ADL) and health related quality of life (QOL).[4] Unsteadiness, imbalance, and falls are all physical sequelae of vestibular disorders that contribute to individuals' disability.[1] Psychological disturbances including panic disorders, agoraphobia, anxiety, and major depression were also reported in approximately 50% of individuals with vestibular disorders.[5-8]

As a result of the disabling consequences of vestibular disorders, people with vestibular disorders avoid a wide range of activities, environments and situations for fear of provoking symptoms.[4,8,9] Such avoidance affects the individual's ability to promote adaptation, since controlled exposure is necessary for adaptation, and contributes to greater disability.[8] Therefore, many basic and essential activities may become unsafe and difficult to perform such as negotiating stairs, climbing ladders, driving, and shopping because of fear and avoidance behaviors.[8,9] Gradually, persons with vestibular disorders may become limited in essential daily living activities and restricted in participating in the community.

Activities and participation make up the second component of the functioning and disability part of the International Classification of Functioning, Disability and Health (ICF).[10] Activities are defined as “the execution of a task or action by an individual” and participation is defined as “involvement in a life situation”.[10] The negative aspects of activities and participation are called activity limitations and participation restrictions, which denote the difficulty individuals face in executing activities or problems in involvement in life situations, respectively.[10] The ICF framework has not distinguished between activities and participation in the current version of the classification system; therefore, activities and participation have shared domains.[10] Many instruments have been developed to measure the extent of activity limitations and/or participation restrictions based on the ICF in different populations.[11-16] However, there is no outcome measure that assesses the extent of activity limitations and/or participation restrictions in individuals with vestibular disorders.

Several self-report instruments have been developed to address the self-perceived health status in people with vestibular disorders.[17-20] Nevertheless, these vestibular instruments were not designed to capture the impact of vestibular disorders on creating activity limitations and participation restrictions in individuals with vestibular disorders as described in the ICF. Therefore, a specialized instrument that quantifies activity limitations and participation restrictions in people with vestibular disorders is needed to provide clinicians and researchers with an enhanced understanding of patients’ problems and needs.

1.1 STATEMENT OF PROBLEM

There is clear evidence of the debilitating effects of vestibular disorders on patients' activities and participation; however, a specialized outcome measure that examines activity limitations and participation restrictions in individuals with vestibular disorders does not exist.

1.2 THE PURPOSE

The purpose of this study was to develop and validate a new outcome self-report measure that examines the activities and participation according to the ICF in people with vestibular disorders.

1.2.1 Specific aims

1) To identify and retrieve activities and participation items from eight self-report instruments used in vestibular rehabilitation. The identification process was conducted by linking the content of the instruments to the ICF. The identified activities and participation items were used in the development process of the new measure.
2) To develop a new outcome measure, named the Vestibular Activities and Participation (VAP) to examine activity limitations and participation restrictions in people with vestibular disorders. The development process was achieved using the Delphi technique.

3) To examine the reliability (test-retest) and validity (concurrent, convergent, and discrminant) of the VAP in people with vestibular disorders. Concurrent validity of the VAP was established by examining the association between the VAP total score and the World Health Organization Disability Assessment Schedule II (WHODAS II). Convergent validity of the VAP was established by examining the association between the VAP total score and the Dizziness Handicap Inventory (DHI) total and dimensions scores.

2.0 BACKGROUND

2.1 EPIDEMIOLOGY OF VESTIBULAR DISORDERS

Incidence and prevalence of vestibular disorders are important information for clinicians working with patients with vestibular disorders for many reasons. This information provides clinicians with an estimate of the distribution of vestibular disorders and the frequency of vestibular symptoms in the population. Additionally, the epidemiology reveals the disease burden caused by vestibular disorders which enhances the understanding of the consequences of vestibular disorders. Moreover, information on the frequency and determinants of vestibular disorders contributes to a better understanding of the underlying causes of the disease and helps to improving patient care.[21] Nevertheless, the epidemiology of vestibular disorders and their signs and symptoms is still an underdeveloped field.[21]

Of the available data, dizziness and vertigo rank among the most common complaints reported in medicine in the United States and around the world.[1-3,21] Approximately 20% to 35% of individuals in the general population report dizziness episodes to a physician or via a national health survey.[2,22] In the United States, about 7.5 million patients with dizziness were examined in ambulatory care settings between 1999 and 2000.[2,3,23] From 2001 to 2004, over 69 million Americans over the age of 40 reported vestibular dysfunction.[1] Neuhauser et al. conducted a large population survey in Germany and determined that the life-time prevalence of vestibular vertigo in adults aged 18-79 years was 7.8%, the 1-year prevalence was 5.2%, and the incidence was 1.5%.[22]

2.2 CONSEQUENCES OF VESTIBULAR DISORDERS

Vestibular disorders can lead to physical as well as psychological consequences such as postural control deficits and anxiety-depression symptoms, respectively. About 80% of individuals with vestibular vertigo in a population survey had an interruption of daily activities, sick leave, or medical consultation.[22] Many individuals with vestibular disorders limit their activities and restrict their participation within the community to avoid provoking symptoms and potential embarrassments of unexpected episodes of dizziness or disequilibrium.[7,9] Such avoidance of activities and participation may create additional problems and contribute to greater disability.

2.2.1 Physical consequences

The vestibular system plays an important sensory role with the visual and somatosensory systems in the maintenance of postural control. Postural control is achieved by continual positioning of the body's center of gravity (COG) over the base of support (BOS) during both static and dynamic situations.[24] Postural instability and disequilibrium can manifest as a result of the vestibular dysfunction. Vestibular dysfunction is considered as one of the intrinsic factors that increase the risk of falling.[25] In a study of 546 patients presenting with no known cause of falls to an Accident and Emergency Department in the United Kingdom, 80% of these patients had symptoms of vestibular impairment.[25] Persons 40 years of age and older with symptoms of vestibular dysfunction had a 12 fold increase in the risk of falling.[1] Falls can result in serious consequences to persons' health and quality of life (QOL), especially in older adults. Dizziness, vertigo, and imbalance have disabling effects on people with vestibular disorders; they interrupt their normal life by impairing their performance of daily living activities and their participation with the community.[4]

2.2.2 Psychological consequences

Psychological disturbances are associated with vestibular disorders. Many studies have shown that approximately 50% of individuals with dizziness report some psychological disturbance.[5-7,26] Panic disorders, agoraphobia, anxiety, and major depression were among the most common psychiatric diagnoses in people with vestibular disorders.[4] It is suggested that psychological or social distress are the underlying causes for psychiatric morbidity in patients with vestibular disorders.[4,27] In a controlled study, a significant amount of anxiety and depression was found in patients experiencing vertigo, especially females.[27] Additionally, persons with vestibular disorders exhibit a range of cognitive deficits in spatial and non-spatial functions, attentional processes, and memory tasks.[28]

2.2.3 The interaction between physical and psychological consequences of vestibular disorders

Cognitive deficits associated with vestibular disorders have been shown to affect postural stability and cause balance disturbances.[4,8,28] Specifically, attentional deficits in vestibular patients can worsen the postural sway in situations of increased attentional demands.[28] Additionally, many studies have suggested that panic disorders and agoraphobia are associated with balance impairment and vestibular dysfunction.[29,30] Therefore, psychological deficits can retard recovery from balance disorders if not addressed during rehabilitation.[4,8]

2.3 THE EFFECT OF VESTIBULAR DISORDERS ON ACTIVITIES AND PARTICIPATION

Vestibular disorders have a significant negative impact on patients' activities and participation due to the disabling effect of the disorders' physical and emotional consequences.[4] Many studies have shown the disabling effect of dizziness, vertigo, and imbalance on patients' ability to perform daily living activities.[4,9,27,31,32] In people who have a history of dizziness, the fear of becoming dizzy was strongly correlated with their perception of disability.[27] Similarly, people with vertigo have reported significant role limitations and social restrictions due to recurrent vertigo episodes.[4,31] In particular, unpredictable vertigo was found to be the symptom most strongly associated with greater disability in which many day-to-day activities become difficult or dangerous.[9] Moreover, people with Menière's disease reported that the physical and emotional problems caused by the disease affect their ability to carry out normal activities and effective participation.[9,31] Persons with vestibular schwanoma also have reported impaired quality of life (QOL) and less active coping behaviors compared to healthy controls.[32] Furthermore, in a survey examining the independence of performing activities of daily living (ADL), half of the patients with a variety of vestibular disorders reported a reduction in their independence after developing a vestibular disorder.[31]

Driving is one of the important limited activities in people with vestibular disorders. After developing a vestibular disorder, patients have reported a reduction in their driving skills including driving at night and driving in the rain.[33,34] Conditions of reduced visibility were found to affect patients' ability to navigate environments, especially on highways and high-traffic roads.[34] Possible explanations regarding the reduction of driving skills in people with vestibular disorders include the pathological changes in the vestibulo-ocular reflex (VOR), the vestibulo-spinal reflex (VSR), or the cognitive impairments associated with vestibular disorders such as reduced attentional skills.[34] Rapid head turns during mirror checks while driving may elicit vertigo and/or blurred vision.[34] Situations of increased attentional demands such as driving on crowded roads, trying to make left turns, or parking increase the complexity of the driving task for patients with vestibular disorders.[34]

Shopping is another basic and essential activity that becomes difficult to perform in people with vestibular disorders. Shopping malls and grocery stores are described as challenging environments by patients with vestibular disorders due to their conflicting visual or surface oriented references.[35,36] Certain environments increase spatial disorientation and may provide inadequate or misleading balance information for individuals with vestibular disorders.[29] Space and motion discomfort that is associated with people with vestibular disorders was reported to interfere with social, occupational, or academic functioning.[35,36]

Occupational functioning is highly affected by vestibular disorders sequelae. Occupational difficulties were reported in 66% of those who experience vertigo and 26% of employed people with vestibular disorders quit working because of their vertigo symptom.[37] Many factors play a role in the occupational problems for patients with vestibular disorders including the nature of the job and the frequency and severity of symptoms. Depending on the demands of the job, number of hours, and activities required, patients with vestibular disorders may have to modify their jobs or stop working. Occupations that require high mental demands for sustained periods might be difficult for persons with vestibular disorders who have some attentional deficits.[38]

There is compelling evidence that the overall activities and participation domains appear to be significantly impaired in people with vestibular disorders.[4] Cognitive defects, space and motion discomfort, disequilibrium and falls are all vestibular disorders' sequelae that limit individuals' activities and restrict their community participation.[4] Agoraphobia, panic disorders, and restricted social interactions represent some forms of activity limitations and participation restrictions in people with vestibular disorders.[4]

2.4 MEASUREMENT OF FUNCTIONAL LIMITATIONS AND DISABILITY IN PEOPLE WITH VESTIBULAR DISORDERS

Assessment of functioning and disability is one of the main areas that should be considered during the evaluation process of patients with vestibular disorders. In order to identify the level of patients' functioning and disability, a battery of valid and reliable tests should be used. Therefore, several vestibular self-report instruments have been developed in an attempt to quantify the disabling effect of vestibular disorders on a person's daily life. Eight instruments that are used to assess functional limitations and disability in people with vestibular disorders were reviewed including the Dizziness Handicap Inventory (DHI)[19], the Vertigo Handicap Questionnaire (VHQ)[20], the Activity-specific Balance Confidence (ABC) Scale[39], the UCLA Dizziness Questionnaire[18], the Activity of Daily Living Questionnaire (ADLQ)[40], the Vestibular Disorders Activities of Daily Living Scale (VADL)[17], the Prototype Questionnaire (PQ)[41], and the Vestibular Rehabilitation Benefit Questionnaire (VRBQ).[42]

2.4.1 The Dizziness Handicap Inventory (DHI)

The DHI is a 25-item questionnaire that quantifies the impact of dizziness on daily life by evaluating the self-perceived handicap in patients with vestibular disorders.[19] The DHI items were developed from interviews of patients with dizziness.[19] Content analysis categorized the DHI items into 3 domains: functional, emotional, and physical aspects of dizziness and disequilibrium.[19] The response scale used in the DHI is "yes/sometimes/no" scored as "4/2/0" respectively. The DHI was found to have good internal consistency for the total score (α=.89) and satisfactory internal consistence for the subscales (α=.72-.85).[19] The test-retest reliability of the DHI was high (r=.97).[19] Additionally, the DHI was found to be responsive to change as an outcome measure in vestibular rehabilitation.[43] There is evidence for discriminant validity based on the good relationships between the DHI scores and the number of episodes of dizziness.[44] The total DHI score and eight dimensions of the Medical Outcomes Study short form 36 (SF-36) were found to be correlated (spearman r=.53-.72, P =.001) demonstrating the convergent validity of the DHI.[44]

2.4.2 The Vertigo Handicap Questionnaire (VHQ)

The VHQ is a 22-item questionnaire that measures the disabling consequences of vertigo on activities of daily living (ADL), social life, and leisure.[20,41,45] The VHQ was derived from in-depth interviews of 84 persons with vestibular disorders.[20] Factor analysis identified 4 dimensions of handicap that accounted for 63% of the variance. The VHQ items are scored using a 5-point scale from 0 (no handicap) to 4 (maximum handicap).[20] The VHQ was found to have high internal consistency for the total score (α=.93) and satisfactory internal consistency for the dimensions' scores (α=.75-.82).[20] The VHQ scores were found responsive in 14 patients who improved after 6 months.[20] The discriminant validity was examined in patients with episodic vertigo and patients who experienced only single vertigo episode. Patients with episodic vertigo had worse scores (p<.03) than patients with a single vertigo episode.[20]

2.4.3 The Activities-specific Balance Confidence (ABC) Scale

The ABC scale was developed to provide a description of activity difficulty and fear of falling in an older population by expanding the Falls Efficacy scale (FES).[39,46] The ABC has 16 items developed through combined efforts of clinicians and older adults.[39] The items include activities with various levels of difficulty that range from walking around the house to walking on icy sidewalks.[39] The scale of the ABC is from 0% (indicating no confidence) to 100% (indicating complete confidence) in performing the task without any difficulty.[39] The ABC was found to be internally consistent (α=.96), had good test-retest reliability, and the total score was stable over a 2-week interval (r=.92, p<.001).[39] A strong correlation was found between the ABC and the FES (r=.84, p<.001)[39] and the DHI (r=-.64, p<.0005)[47] demonstrating convergent validity. Patients who reported a fall in the previous year had lower ABC scores than patients who did not report a fall.[39] Similarly, the ABC score was able to distinguish between patients with and without reduced mobility .[39] In another study an ABC score of less than 67% was found to indicate high risk for falling in older people.[48]

2.4.4 The UCLA Dizziness Questionnaire (UCLA-DQ)

The UCLA-DQ is a 5-item scale that assesses the frequency and severity of dizziness as well as the impact of dizziness on daily activities and QOL.[18] A 5-point Likert verbal scale is used for the UCLA-DQ items.[18] A significant relationship was found between frequency of dizziness represented by the first item, severity of dizziness represented by the second item, and the other 3 items of the questionnaire (*p*<.01).[18,45] Internal consistency, test-retest reliability, responsive, and convergent validity have not been tested.[45]

2.4.5 The Activity of Daily Living Questionnaire (ADLQ)

The ADLQ is a 7-item questionnaire that was developed by Black et al. to be used as an outcome measure in a study that primarily assessed the effect of individualized vestibular rehabilitation on symptoms as well as daily activities of patients with peripheral vestibular disorders.[40] The ADLQ scores indicated improvement in patients' status after individualized vestibular rehabilitation for patients with peripheral vestibular disorders.[40] The reliability and validity of the ADLQ were not examined.

2.4.6 The Vestibular Disorders Activities of Daily Living Scale (VADL)

The VADL scale was developed to assess self-perceived disablement in individuals with vestibular impairment.[17] The VADL scale has 28 items that are grouped into 3 subscales: functional (basic self-maintenance tasks), ambulatory (mobility skills), and instrumental (higher-level or more socially complex tasks).[17] Patients can rate their self-perceived disablement level on a scale that ranges from 1 (independent) to 10 (too difficult, no longer performed).[17] The VADL scale had high internal consistency for the total score ($\alpha \geq .97$); functional subscale score ($\alpha = .92$); ambulation subscale score ($\alpha = .96$); and instrumental subscale score ($\alpha = .91$).[17] Likewise, the VADL had high test-retest reliability over 2 hours for the total score using the concordance correlation coefficient (rc=1); functional subscale score (rc = .87); ambulation subscale score (rc = .95); and instrumental subscale score (rc = .97).[17] In addition, the VADL demonstrated good face validity as determined by a group of experts.[17] The VADL scores were able to significantly discriminate between patients and controls ($p<.0001$).[49] However, the VADL did not distinguish patients with benign paroxysmal positional vertigo (BPPV) from patients with vestibulopathy.[49] Convergent validity was also demonstrated by the moderate correlation between the VADL total score and the DHI total score (Spearman's $\rho=.66$, $p<.001$).[49] Responsiveness of the VADL was not evaluated.

2.4.7 The Prototype Questionnaire (PQ)

The PQ was developed in an attempt to measure the effect of dizziness on QOL from a patient-oriented view.[41] The process of developing the items included collecting data through interviews of 18 individuals with vestibular disorders, who were receiving vestibular rehabilitation, then analyzing the data. The data analysis of patients' interviews revealed 64 themes influencing quality of life (QOL). Afterward, 35 items were selected as potential questionnaire items.[41] The 35 potential items were then refined and validated for the development of the VRBQ.[42]

2.4.8 The Vestibular Rehabilitation Benefit Questionnaire (VRBQ)

The VRBQ was developed as a refined version of the PQ. It is comprised of 22 items that have been categorized into 3 dimensions: dizziness and anxiety (6 items), motion-provoked dizziness (5 items), and QOL (11 items).[42] Each group of items has its own response scale; however, all scales consist of 7-point verbal scales.[42] The internal consistency of the VRBQ was good for the total score (α=.73) and good to excellent for the dimension scores (α=.74-.92).[42] The test-retest reliability over 24 hours revealed strong intra-class correlations for the total VRBQ score (ICC=.92) and the dimension scores (ICC=.94-.99).[42] Responsiveness was investigated over 12 weeks of a vestibular rehabilitation program and found to have moderate effect size (.35 - .67) for the VRBQ, small to moderate effect for the DHI and VSS, and small effect for the MOS-36.[42] The convergent and discriminant validity of the VRBQ was measured by comparing it to the DHI, the Vertigo Symptom Scale (VSS), and the SF-36.[42] The VRBQ total score was moderately correlated to the DHI total score (r=.44) and the VSS total score (r=.45), whereas the VRBQ total score was weakly correlated to the SF-36- mental and physical subscales (r=-.27 and r=-.33 respectively).[42]

2.5 VESTIBULAR REHABILITATION

Many studies have shown the effectiveness of vestibular rehabilitation in reducing functional disability and improving patients' activities and participation.[40,50,51] Vestibular rehabilitation was found to be an effective approach in improving the functioning parameters for individuals with vestibular hypofunction by improving the performance of daily living activities and reducing the level of disability.[40,51,52] Therefore, vestibular rehabilitation is recommended for most individuals with vestibular disorders.[51] However, the effectiveness of the treatment varies among the subdivisions of vestibular disorders.[51] Patients with benign paroxysmal positional vertigo (BPPV) may benefit the most from repositioning maneuvers provided by a physical therapist.[51] This is followed by patients with peripheral vestibular disorders who were found to have good functional recovery in both subjective and objective measures of QOL and balance respectively.[40,52] Individuals with central vestibular disorders can have considerable functional improvement but rarely complete recovery.[51,53]

Rehabilitation works on the relationship between impairment and functional performance (activities and participation) in individuals within their environment. Vestibular rehabilitation reduces dizziness and balance problems in individuals with vestibular disorders to improve their activities and participation.[4,54] Individualized therapy is usually provided to persons with vestibular disorders according of their level of impairment to improve their activities and participation through a number of therapeutic exercises such as exercises that improve the vestibulo-ocular reflex (VOR) gain and postural control.[51] These exercises alleviate or habituate some of the symptoms associated with dizziness, improve balance and postural control that might be affected, and enhance patients' ability to engage within the environment by better understanding of their capabilities. All these therapeutic benefits can improve patients' performance in daily activities and social participation.

Since individuals with vestibular disorders seek help when they feel that their activities and participation are reduced and their abilities to perform their essential activities are impaired, a clear definition and explanation of activities and participation is needed. The activities and participation are well discussed in the ICF as a component in the functioning and disability part and have their categories and qualifiers. Since the ICF is the best available framework that describes the activities and participation, a summary of the ICF and activities and participation component is provided in the following section.

2.6 THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH (ICF)

The ICF was developed in 2001 by the World Health Organization (WHO) to serve as a universal and standard language and framework for the description of health and health-related states.[10] The need for the ICF arose from the lack of an international framework that has a universal description of levels of functioning and disability and permits comparison of health data across countries. The ICF is considered a complementary classification to another international classification in the WHO family called the International Classification of Disease and Related Health Problems (ICD).[10] The ICD-10 (tenth version) provides an etiological framework by diagnosis of disease, disorder, and other health conditions.

The ICF has certain properties that make this classification unique. The ICF is universal as it captures the full range of human functioning, human health and health-related states and classifies them in health and health-related domains.[10] In addition, the ICF is for all people, not only for people with a disability. The International Classification of Impairments, Disabilities and Handicaps (ICIDH) has been criticized for adopting a medical-biological view of disability which maintained the stigmatization of people with disabilities.[55,56] The ICF adopts a bio-psycho-social model of functioning, disability, and health in which disability is viewed as a complex interaction among its components.[56] The bio-psycho-social model of disability provides a modern way to investigate and discuss disability from both medical and social perspectives.[55,56] The other important property of the ICF is the heavy emphasis on the role of environmental factors in human functioning and disability and the bidirectional interaction among its components.[10]

The ICF consists of two parts, which are further subdivided into two components each. The first part deals with functioning and disability and has two components: body functions and structures, and activities and participation. The second part involves contextual factors that include two components: environmental factors and personal factors. All components interact and have a complex relationships with the health condition to give us a description of an individual's functioning in a specific domain.[10] All the above concepts are represented by the ICF model of functioning and disability (Figure 1). The ICF model of functioning and disability adopts a bio-psycho-social approach that considers the relationship among functioning and disability components to be integrative (not merely medical or social) and interactive in nature. Therefore, the ICF model of functioning and disability does not follow a hierarchical model or one-to-one relationship (Figure 1).

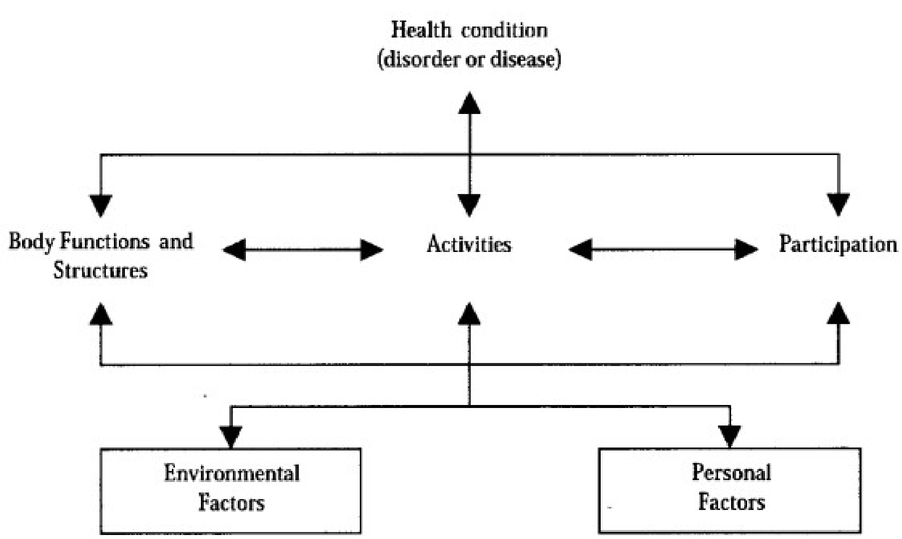

Figure 1: The ICF Model of Functioning and Disability

One of the main aims of the ICF is to provide a systematic coding scheme for health data. The ICF uses an alphanumeric system to describe its components in which the letters b, s, d, and e are used to denote body functions, body structures, activities and participation, and environmental factors. These letters are followed by a numeric code that describes the first, second, third or fourth levels. These codes have no inherent meaning without the *qualifiers* that denote a magnitude of the level of health or the severity of the problem. All the classified components in the ICF are quantified using the same generic scale.[10]

Before the development of the ICF as a unified language and framework, investigators faced many challenges in selecting the most appropriate outcome measures for their studies and readers have had many difficulties in interpreting and comparing the results of different studies using different outcome measures.[57] However, a common conceptual understanding of the constructs examined by outcome measures is now emerging with the development of the ICF. Therefore, using the ICF as a reference framework to describe and compare health constructs in measurement tools is promising.

From a clinical perspective, the ICF has many clinical benefits and uses. Recent evidence supports that diagnosis alone is not appropriate to describe the level of functioning of individuals or the amount of services that they need, because individuals with the same diagnoses do not have the same functional level, and they may need different treatment approaches.[58] The ICF describes the functional status of individuals which is a better indicator for the amount and type of health care needs as well as the predicted outcomes.[10,58] The ICF also provides a unified language for documentation of the functional status of individuals after assessment or follow up.[10,58] Moreover, the ICF emphasizes environmental modifications as key factors in the intervention process, which opens more avenues and creates greater potential for improving an individual's functional level.[10,58] The ICF provides a unified language between health care providers which is considered an important development in the field of health care and research.[58]

The operationalization of the ICF in clinical settings was recognized by the development of the ICF checklist, the disease-specific Core Sets, and the WHODAS II.[55,58] The ICF checklist provides clinicians and consumers with a very useful and easy-to-use assessment overview of all ICF components.[10] The ICF Core Sets project was designed to define what ICF categories are important to measure in many acute and chronic health conditions through consensus methods.[59,60] Brief and comprehensive Core Sets were developed to help practitioners select the most important items to measure from the ICF in burdensome acute and chronic health conditions.[59,60] The brief ICF Core Set includes the minimal standard for reporting of functioning and health, therefore it includes as few categories as possible but still sufficient to describe the typical spectrum of problems in patients' functioning and health. The comprehensive ICF Core Set serves as a multidisciplinary assessment guide to comprehensively describes the typical spectrum of problems in patients functioning and health.[60] The WHODAS II is a generic activities and participation instrument that was developed by the WHO to examine the functional level of individuals irrespective of pathology.[16]

One of the controversial issues in the ICF is the distinction between activities and participation.[55,58] The ICF framework has not distinguished between activities and participation and left them in one component with mixed domains. However, some researchers suggested that activities and participation are distinguishable and tried to provide criteria for separating them but they recognized the difficulty of such a distinction in the current version of the ICF.[61-63] Additionally, some researchers found that there is a lack of clarity between activities and participation *definitions* and a big overlap between their *dimensions* in the current version of the ICF, therefore, blending both categories together was found to be the best way to measure them.[56,62]

2.7 MEASURING ACTIVITIES AND PARTICIPATION

The ICF is not an assessment tool; it provides clinicians with a comprehensive conceptual framework of functioning and disability that helps clinicians identify "what to measure". "How to measure" remains open to clinical judgment. Therefore, many tools have been developed that are disease specific based on the ICF framework especially in the activities and participation component since measuring activities and participation is a challenging task.

There are many reasons to measure activities and participation. The concepts of activities and participation become important constructs in health care and rehabilitation as they play a significant role in understanding the interaction between the individual with a health condition and the environmental factors.[15,64] Additionally, individuals with health conditions are usually concerned with how they function within their context more than the actual impairment.[65] Rehabilitation works mainly on addressing the problems in activities and participation reported by individuals with health conditions. Therefore, understanding the interactive relationship among impairments, activity limitations, participation restrictions, and environmental factors is highly important to be able to design specific and tailored intervention plans for individuals with health conditions.

Many generic as well as disease-specific instruments were developed to examine activities and/or participation based on the ICF[11-16] or on its previous version, the ICIDH.[66-68] The WHODAS II is one of these instruments that was developed by the WHO and represents a standardized instrument in the area of activities and participation.[16]

2.7.1 The World Health Organization Disability Assessment Schedule II (WHODAS II)

The WHODAS II was developed to examine activity limitations and participation restrictions experienced by individuals irrespective of medical diagnosis. The WHODAS II provides a standardized way to measure activities and participation according to the ICF.[16] The WHODAS II has 3 versions: 36-item, 12-item, and 12+24-item versions. It is also available in 3 different forms: interviewer-administered, self-administered, and proxy-administered.[16] The psychometric properties (reliability and validity) of the WHODAS II have been assessed internationally on 4 different groups: general population; people with physical problems; people with mental and emotional problems; and people with problems related to alcohol and drug use.[16] The intraclass correlation coefficient (ICC) values for the test-retest reliability results of the WHODAS II within 7 days were as follows: at item level (ICC=.69-.89), at domain level (ICC=.93-.96), and at overall level (ICC=.98).[16] The internal consistency of the WHODAS II ranged from “acceptable” to ‘very good”.[16] The face validity was examined by asking experts if the WHODAS II content measures disability as defined by the ICF and 64% of experts agreed. Many health status and functioning instruments were administered simultaneously with the WHODAS II to assess concurrent validity. These instruments included the London Handicap Scale (LHS); the Medical Outcomes Study’s 36-Item Health Survey (SF-36); SF-12; the Functional Independence Measure

(FIM); the WHO Quality of Life (WHOQOL-100); and the WHO Quality of Life Brief Scale (WHOQOL-BREF). Most correlation coefficients ranged between .45 and .65.[16]

2.8 THE DELPHI TECHNIQUE

The Delphi method is an interactive method for eliciting consensus opinions from a panel of experts.[69] The use of this method started in defense research conducted by the Rand Corporation in the US in the 1950s.[70] Gradually, the method became an established technique used in mainstream research. Many researchers have used the technique to try to achieve consensus opinions among experts for a wide variety of purposes. In the educational field, many studies have been conducted to reach a consensus about the educational courses to be taught.[71-73] Matthews et al. (1975) consulted 18 community-based professionals for planning educational courses for dieticians.[72] Spivey (1971) also used the Delphi technique for determining curriculum content.[73] Lawrence et al. (1983) used a total of 1,685 experts who covered all the medical schools in the US to estab

lish the content of a surgical curriculum.[71] In the medical field, Card and Fielding (1986) used 30 radiographers as the expert panel to survey the problems experienced by therapy radiographers when dealing with cancer sufferers.[74] In vestibular rehabilitation, Maarsingh et al. (2009) used a group of 24 national and international experts on dizziness to reach a consensus regarding including dizziness diagnostic tests in a diagnostic protocol for dizzy elderly patients in primary care.[75]

The Delphi method should be implemented in a way to have four features: anonymity, iteration, controlled feedback, and statistical group response. Anonymity can be achieved by using a formal questionnaire to obtain opinions. The iteration process occurs in two or more rounds in which a facilitator provides carefully controlled feedback between rounds about the experts' judgments and the reasons they provided. Finally, the process is stopped by a pre-defined stop criterion and the full group response is expressed using summary measures.[69,75] The Delphi method is a structured, formal way to reach consensus that has many advantages over other ways of reaching consensus such as informal meetings or group discussion. In the latter techniques, members can be inhibited from expressing their opinions because of other dominant individuals. Therefore, the Delphi method tries to achieve consensus of expert opinion without the bias that can occur in other techniques. Additionally, the Delphi method encourages honest opinion that is free from peer group pressure.[69,70]

2.9 THE STUDIES

Three studies were conducted in order to develop and validate the VAP measure. The first study explored the content covered by eight self-report instruments used in vestibular rehabilitation by linking their items to the ICF. In the second study, we used a list of candidate activities and participation items to obtain experts' agreement on the items to include in the VAP measure using the Delphi technique. The list of candidate items included the activities and participation items retrieved from the eight self-report instruments in the first study as well as other activities and participation items added by two experts in vestibular rehabilitation from the ICF classification. After that, the results of the Delphi technique were discussed by the research group and the items to include in the VAP measure were determined. Additionally, the stem question and the response scale to use with the VAP measure were generated. The third study was conducted in order to examine the reliability (test-retest) and validity (concurrent and convergent) of the VAP in people with vestibular disorders. Concurrent validity of the VAP was established by examining the association between the VAP total score and the WHODAS II, whereas convergent validity was established by examining the association between the VAP total score and the DHI dimensions and total scores. The three studies are discussed in detail in the following chapters.

3.0 CONTENT COMPARISON OF SELF-REPORT MEASURES USED IN VESTIBULAR REHABILITATION BASED ON THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH (ICF)

3.1 INTRODUCTION

Vestibular deficits have been shown to manifest as a wide range of signs and symptoms including dizziness, vertigo, and imbalance.[4] Vestibular disorders can result in debilitating physical as well as psychological consequences that impair an individual's activities of daily living (ADL) and health related quality of life (HRQOL).[4]

Examining functional limitations and disability in people with vestibular disorders is of interest to clinicians, researchers, and patients in order to describe limitations as well as direct and monitor the effect of interventions. Therefore, several self-report measures have been developed in an attempt to quantify the potentially limiting effect of vestibular disorders on an individual's functional skills and ADL.[17-20] However, the currently used vestibular questionnaires differ in their purpose and content.[41] Some questionnaires focus on the impact of a specific vestibular symptom on an individual's HRQOL such as the Dizziness Handicap Inventory (DHI)[19] and the UCLA Dizziness Questionnaire (UCLA-DQ)[18] that examine the impact of dizziness on people's daily life. Most recently, the prototype questionnaire (PQ)[41] and its refined version, the Vestibular Rehabilitation Benefit Questionnaire (VRBQ)[42] were developed in an attempt to measure the effect of dizziness on QOL from a patient-oriented view. Likewise, the Vertigo Handicap Questionnaire (VHQ) is a symptom-specific questionnaire that measures the disabling consequences associated with vestibular vertigo.[20] Other vestibular questionnaires are geared more towards ADL assessment such as the Activities-specific Balance Confidence (ABC) scale,[39] the Vestibular Disorders Activities of Daily Living (VADL) scale,[17] and the Activity of Daily Living Questionnaire (ADLQ).[40]

In order to select the appropriate measure that identifies the patient's specific problems, functional limitations, and disability, psychometric properties (reliability, stability, validity and responsiveness) are usually examined and compared among questionnaires. However, being able to examine and compare the content covered by each questionnaire is an aspect of validity that would provide information allowing clinicians and researchers to judge the appropriateness of the questionnaires to answer specific clinical questions. Therefore, this study focused on the content comparison aspect of the questionnaires used to measure functional limitations for persons with vestibular disorders. In order to achieve this comparison, a reference framework and established linking rules were needed to identify and compare the concepts that are contained in the questionnaires.

The development of the International Classification of Functioning, Disability and Health (ICF) in 2001 offers a universal and standard language and theoretical framework for the description of health and health-related states that can be used for the content comparison process.[10] The ICF adopts a bio-psycho-social model in which functioning and disability are viewed as a result of a complex interaction among its components: body functions, body structures, activities and participation, environmental factors, and personal factors.[10]

One of the main aims of the ICF is to provide a systematic coding scheme for health data.[10] Therefore, the ICF provides a comprehensive list of categories that can be linked to the meaningful concepts of the questionnaires' items. Rules to link health-status measures to the ICF were proposed by Cieza et al. in 2002[76] and were updated in 2005.[77] The content comparison process and the linking rules have been used in several research papers to link health-related questionnaires to the ICF in order to compare the content of HRQOL, work productivity, and low back pain questionnaires using the ICF as a standardized framework.[57,78,79] However, the content of the questionnaires used in vestibular rehabilitation have not been compared.

The purpose of our study was to describe and compare the content covered by 8 clinical self report measures that are used in vestibular rehabilitation based on the linkage of their content to the ICF.

3.2 METHODS

3.2.1 Instruments

Since the aim of our study was to focus on clinical self report measures that are used in vestibular rehabilitation, we decided to include the three currently used questionnaires in vestibular rehabilitation: the DHI,[19] the VHQ,[20] and the ABC.[39] We also included the ADLQ[40] and the VADL[17] because of their focus on the affected ADL that are frequently reported by individuals with vestibular disorders to their clinicians. Additionally, we examined the UCLA-DQ,[18] the PQ[41] and its refined version the VRBQ[42] because of their focus on examining the QOL that is affected in people with vestibular disorders which is another important area to attempt to quantify in the field of vestibular rehabilitation. A total of 164 items were reviewed from the selected instruments. A brief description of the available information of the selected instruments is presented below including the aim, number of items/dimensions, items generation, the response scale, internal consistency, test-retest reliability, responsiveness, convergent validity, and discriminant validity. Additionally, Table 1 provides a summary of the psychometric properties of the 6 measures: DHI, VHQ, ABC, UCLA-DQ, VADL, and VRBQ. There was no available information about the psychometric properties of the ADLQ and the PQ presented in Table 1.

The DHI is a 25-item questionnaire that quantifies the impact of dizziness on daily life by evaluating the self-perceived handicap in patients with vestibular disorders.[19] The DHI items were developed from interviews of patients with dizziness.[19] Content analysis categorized the DHI items into 3 domains: functional, emotional, and physical aspects of dizziness and disequilibrium.[19] The response scale used in the DHI is "yes/sometimes/no" scored as "4/2/0" respectively. The DHI was found to have good internal consistency for the total score (α=.89) and satisfactory internal consistency for the subscales (α=.72-.85).[19] The test-retest reliability of the DHI was high (r=.97).[19] Additionally, the DHI was found to be responsive to change as an outcome measure in vestibular rehabilitation.[43] There is evidence for discriminant validity based on the good relationships between the DHI scores and the number of episodes of dizziness.[44] The total DHI score and eight dimensions of the Medical Outcomes Study short form 36 (SF-36) were found to be correlated (spearman r=.53-.72, p=.001) demonstrating the convergent validity of the DHI.[44]

The VHQ is a 22-item questionnaire that measures the disabling consequences of vertigo on ADL, social life, and leisure.[20,41,45] The VHQ was derived from in-depth interviews of 84 persons with vestibular disorders.[20] Factor analysis identified 4 dimensions of handicap that accounted for 63% of the variance. The VHQ items are scored using a 5-point scale from 0 (no handicap) to 4 (maximum handicap).[20] The VHQ was found to have high internal consistency for the total score (α=.93) and satisfactory internal consistency for the dimension scores (α=.75-.82).[20] The VHQ scores were found to be responsive in 14 patients who improved after 6 months.[20] Discriminant validity was examined in patients with episodic vertigo and patients who experienced only a single vertigo episode. Patients with episodic vertigo had worse scores (p<.03) than patients with a single vertigo episode.[20]

The ABC scale was developed to provide a description of activity difficulty and fear of falling in an older population by expanding the Falls Efficacy scale (FES).[39,46] The ABC has 16 items developed through combined efforts of clinicians and older adults.[39] The items include activities with various levels of difficulty that range from walking around the house to walking on icy sidewalks.[39] The scale of the ABC is from 0% (indicating no confidence) to 100% (indicating complete confidence) in performing the task without any difficulty.[39] The ABC was found to be internally consistent (α=.96), had good test-retest reliability, and the total score was stable over a 2-week interval (r=.92, p<.001).[39] A strong correlation was found between the ABC and the FES (r=.84, p<.001)[39] and the DHI (r=-.64, p<.0005)[47] demonstrating convergent validity. Patients who reported a fall in the previous year had lower ABC scores than patients who did not report a fall.[39] Similarly, the ABC score was able to distinguish between patients with reduced mobility.[39] In another study an ABC score of less than 67% was found to indicate high risk for falling in older people.[48]

The UCLA-DQ is a 5-item scale that assesses the frequency and severity of dizziness as well as the impact of dizziness on daily activities and QOL.[18] A 5-point Likert verbal scale is used for the UCLA-DQ items.[18] A significant relationship was found between frequency of dizziness represented by the first item, severity of dizziness represented by the second item, and the other 3 items of the questionnaire ($p<.01$).[18,45] Internal consistency, test-retest reliability, responsive, and convergent validity have not been tested.[45]

The ADLQ is a 7-item questionnaire that was developed by Black et al. to be used as an outcome measure in a study that primarily assessed the effect of individualized vestibular rehabilitation on symptoms as well as daily activities of patients with peripheral vestibular disorders.[40] The ADLQ scores indicated improvement in patients' status after individualized vestibular rehabilitation for patients with peripheral vestibular disorders.[40] The reliability and validity of the ADLQ were not examined.

The VADL scale was developed to assess self-perceived disablement in individuals with vestibular impairment.[17] The VADL scale has 28 items that are grouped into 3 subscales: functional (basic self-maintenance tasks), ambulatory (mobility skills), and instrumental (higher-level or more socially complex tasks).[17] Patients can rate their self-perceived disablement level on a scale that ranges from 1 (independent) to 10 (too difficult, no longer performed).[17] The VADL scale had high internal consistency for the total score ($\alpha \geq .97$); functional subscale score ($\alpha = .92$); ambulation subscale score ($\alpha = .96$); and instrumental subscale score ($\alpha = .91$).[17] Likewise, the VADL had high test-retest reliability over 2 hours for the total score using the concordance correlation coefficient ($rc=1$); functional subscale score ($rc = .87$); ambulation subscale score ($rc = .95$); and instrumental subscale score ($rc = .97$).[17] In addition, the VADL demonstrated good face validity as determined by a group of experts.[17] The VADL scores were able to significantly discriminate between patients and controls ($p<.0001$).[49] However, the VADL did not distinguish patients with benign paroxysmal positional vertigo (BPPV) from patients with vestibulopathy.[49] Convergent validity was also demonstrated by the moderate correlation between the VADL total score and the DHI total score (Spearman's $\rho=.66$, $p<.001$).[49] Responsiveness of the VADL was not evaluated.

The PQ was developed in an attempt to measure the effect of dizziness on QOL from a patient-oriented view.[41] The process of developing the items included collecting data through interviews of 18 individuals with vestibular disorders, who were receiving vestibular rehabilitation, then analyzing the data. The data analysis of patients' interviews revealed 64 themes influencing QOL. Afterward, 35 items were selected as potential questionnaire items.[41]

The VRBQ was developed as a refined version of the PQ. It is comprised of 22 items that have been categorized into 3 dimensions: dizziness and anxiety (6 items), motion-provoked dizziness (5 items), and QOL (11 items).[42] Each dimension has its own response scale; however, all scales consist of 7-point verbal scales.[42] The internal consistency of the VRBQ was good for the total score ($\alpha=.73$) and good to excellent for the dimension scores ($\alpha=.74$-$.92$).[42] The test-retest reliability over 24 hours revealed strong intra-class correlations for the total VRBQ score (ICC=.92) and the dimension scores (ICC=.94-.99).[42] Responsiveness was investigated over 12 weeks of a vestibular rehabilitation program and found to have a moderate effect size (.35 - .67) for the VRBQ, a small to moderate effect for the DHI and VSS, and a small effect for the SF-36.[42] The convergent and discriminant validity of the VRBQ was measured by comparing it to the DHI, the Vertigo Symptom Scale (VSS), and the SF-36.[42] The VRBQ total score was moderately correlated to the DHI total score ($r=.44$) and the VSS total score ($r=.45$), whereas the

VRBQ total score was weakly correlated to the SF-36- mental and physical subscales (r=-.27 and r=-.33 respectively).[42]

The ICF consists of 2 parts, which are further subdivided into 2 components each.[10] The first part deals with functioning and disability and has 2 components including body functions and structures plus activities and participation. The second part involves contextual factors that include environmental and personal factors. The coding system of the ICF follows a pattern in which all categories start with a letter (b, s, d, or e) denoting one of the ICF components: body functions (b), body structures (s), activities and participation (d), and environmental factors (e) followed by a numeric code that starts with the chapter number or first ICF level (one digit) followed by the second ICF level (2 digits) and sometimes followed by the third and fourth ICF levels (one digit each).[10] The following category in the second chapter of body functions provides an example of the levels of the coding system of the ICF:

b2: Sensory functions and pain (first level)

b240: Sensations associated with hearing and vestibular function (second level)

b2401: Dizziness (third level)

3.2.2 Procedures

The linking process was conducted in two stages by two trained health professionals on the basis of the ICF book[10] and established linking rules.[77]

3.2.2.1 Identification of meaningful concepts

In the first stage, each rater identified the meaningful concepts in each questionnaire item independently including examples and response options. More than one meaningful concept may be identified from each item. For instance, item number 8 in the VRBQ *'lying down &/or turning over in bed makes me feel dizzy'* has 3 meaningful concepts; lying down (d410), turning over in bed (d410), and dizziness (b240). After determining the meaningful concepts for each item, the meaningful concepts were compared between the 2 raters and a consensus among the meaningful concepts was discussed and one list of meaningful concepts was used in the second stage of the linking process.

3.2.2.2 Linking of meaningful concepts

In the second stage, each meaningful concept was linked to an ICF category by identifying the most appropriate component, chapter number (first level), and second level of the category that most precisely described the meaning of the concept. At this point, the ICF codes for each rater were presented for inter-observer rating agreement calculation. The ICF categories between both raters were then compared and a consensus among the ICF codes was discussed. In cases of disagreement between the two raters, a third expert in the ICF coding and the linking rules was consulted and made the final decision. A list of disagreed upon concepts was provided to the third rater with the ICF codes selected by the first and second raters. The third rater selected one of the health professional's ICF codes and provided the rationale behind her choice.

3.2.3 Analysis

3.2.3.1 Measuring the inter-observer rating agreement

The inter-rater agreement between the health professionals regarding the component, first, and second ICF levels was computed using Cohen's kappa statistics. Cohen's kappa is a measure of agreement between 2 raters corrected for chance and ranges from 0 to 1, in which 0 indicates no agreement and 1 indicates perfect agreement.[80,81] A kappa of ≥.75 indicates excellent agreement, .4-.74 indicates good agreement, and <.4 indicates poor agreement.

Categories at the component, first and second ICF level were converted to consecutive ordinal codes to allow for evaluation of agreement where no ICF association could be identified. The number of total ordinal categories was five at the component level, 11 at the first ICF level and 19 at the second ICF level.

There was no attempt to make inferences from the agreement beyond the 2 experts' studied. Therefore, the precision of the agreement estimates (kappa 95% confidence intervals) were not reported. We used SPSS 16.0 (Chicago Il) and Microsoft Excel 2008 for Mac version 12.1.0 (Microsoft Corp., Redmond, WA) for the statistical analysis of Cohen's kappa.

3.2.3.2 The overall representation of each measure

The representation of each examined measure was clarified by calculating the percentages of concepts that are related to each ICF component (body functions, activities and participation, and environmental factors) as well as the concepts that did not map to the ICF to the total number of concepts identified. Clarifying the representation of each measure was the goal of our study.

Knowledge of the ICF concepts included in commonly used vestibular measures may provide clinicians with an overview of what components are included in each measure.

3.3 RESULTS

Disagreement between the first and second raters occurred in 5 concepts: 1 from the DHI, 1 from the ABC, and 3 from the PQ. The 5 concepts along with the first and second health professionals' chosen ICF codes were presented and reviewed by the third rater. The third rater agreed with the first rater's chosen ICF code in 1 concept and with the second rater's chosen ICF codes in the other 4 concepts. The recommended codes by the third rater were then considered in the agreed on list.

A total of 312 meaningful concepts from the 164 items of the 8 vestibular questionnaires were identified and linked to the ICF. The meaningful concepts identified were linked to 51 different ICF categories; 19 categories related to "body functions", 30 categories to "activities and participation", and 2 categories to "environmental factors". No concepts belonging to the "body structures" categories were linked. Table 2 shows the number of items, meaningful concepts, concepts not linked to the ICF and the concepts referred to the ICF components in the questionnaires used in vestibular rehabilitation. Forty two out of 312 concepts (13%) could not be linked to any of the ICF components (Table 3).

The kappa coefficients between the 2 raters at the component, first, and second ICF levels indicated excellent inter-observer agreement across the component, first and second levels of the ICF. The kappa coefficients were .83 at the component level, 0.87 at the chapter or first ICF level and .96 at the second ICF level. Higher agreement was seen at the first (.87) and second (.96) ICF levels over the component level (.83) due to the high frequency of test concepts where no codes could be identified.

The 51 ICF categories were mainly related to the body functions as well as the activities and participation components of the ICF. Tables 4 and 5 represent the content comparison of the vestibular instruments using the ICF categories as a reference. The numbers in Tables 4 and 5 indicate how often each ICF category was addressed in the examined vestibular instruments.

3.3.1 Representation of body functions

"Sensations associated with hearing and vestibular function" and "emotional functions" were covered by most examined questionnaires (see Table 4). Dizziness, vertigo, spinning, and unsteadiness were the sensations associated with hearing and vestibular function covered mainly by the VRBQ (20 concepts), the PQ (16 concepts), and the VHQ (13 concepts). "Emotional functions" were covered mainly within the VHQ (8 concepts), the DHI (7 concepts), and the PQ (4 concepts). Feeling frustrated, afraid, embarrassed, depressed, anxious, worried, and happy were all linked to "emotional functions" since there is no separate category for different feelings in the ICF.

3.3.2 Representation of activities and participation

All 8 instruments include concepts that refer to the “mobility” chapter from the ICF with different emphasis (see Table 5). “Walking” and “changing basic body position” categories from the “mobility” chapter are included most frequently by 6 out of 8 instruments (75%). All measures except the VRBQ include specific categories of the “domestic life” chapter including mainly “doing housework” (63%) and “acquisition of goods and services (shopping)” (50%). All instruments except the ABC and the VRBQ include the “remunerative employment” category (75%) from the “major life areas” chapter. A considerable number of concepts in all instruments except the ABC and the ADLQ refer to the “recreation and leisure” category (75%) from the “community, social and civic life” chapter. Concepts that refer to the “self-care” chapter are covered mainly by the VADL (5 concepts), PQ (4 concepts), and the VRBQ (4 concepts). Categories from the first 2 chapters “learning and applying knowledge” and “general tasks and demands” plus the “interpersonal interactions and relationships” chapter are mainly covered by the DHI and VHQ. No concepts referring to the third chapter “communication” were found in any of the examined instruments.

3.3.3 Representation of environmental factors

The PQ is the only measure that addresses some environmental factors. “Having difficulty with flashing lights” and “avoiding noisy places” were the 2 concepts in the PQ that referred to the environmental factors. “Having difficulty with flashing lights” was linked to e240 (light) and “avoiding noisy places” was linked to e250 (sound).

3.3.4 Representation of concepts that did not map to the ICF

Forty two concepts from 5 questionnaires (UCLA-DQ, VADL, DHI, VRBQ, and PQ) could not be linked to any of the ICF components. The UCLA-DQ had only 1 concept that did not map to the ICF and it is about overall QOL. The VADL had 2 concepts that did not map to the ICF within one item "Moving *in* or *out* of the bathtub or shower". The DHI had 4 concepts that did not map to the ICF: 2 of them related to head movements; 1 about ambitious activities; and 1 about avoiding heights. The VRBQ had 11 concepts that did not map to the ICF: 3 of them related to head movements; 3 about avoiding certain activities, positions or situations within one item; 2 about feeling stable in the dark or when eyes are closed within one item; 1 about going out alone; 1 about holding on to something for support; and 1 about QOL. The PQ had 24 concepts that did not map to the ICF (see Table 3). Table 3 represents all the concepts that did not map to any of the ICF categories and the assigned codes that were given to them according to the rules recommended by Cieza et al, 2005.

3.3.5 Overall summary of components representation in the vestibular measures

The VADL, ADLQ, ABC, DHI, and UCLA mainly focus on examining the activities and participation component of the ICF (see Figure 2). The focus of the VRBQ, VHQ, and PQ is more on the body functions component of the ICF (see Figure 2).

3.4 DISCUSSION

Using the ICF as a theoretical framework was found to be useful for comparing the content of health-status questionnaires as well as exploring the focus of the measures currently in use in vestibular rehabilitation. Based on the linkages, the 8 vestibular questionnaires were found comparable, with their focus on body functions and activities and participation components of the ICF.

Clinicians and researchers need to take multiple factors into consideration when selecting the appropriate instrument to use.[57] Clinicians and researchers need to determine the construct to be examined and the population of interest. By determining the construct and the population of interest, a number of instruments may be useful to the clinician. By understanding the content covered by the different measures, clinicians can make an informed choice of the most appropriate instrument.

The comparison of examined instruments based on the ICF revealed that body functions and activities and participation are the main components covered by the 8 instruments currently in use in vestibular rehabilitation. All examined measures have mixed concepts of two or more ICF components with different percentages within each instrument.

In the body functions component, "sensations associated with hearing and vestibular function" and "emotional functions" categories are frequently addressed by most of the examined instruments (75% each). These 2 categories refer to 2 important features in people with vestibular disorders: the sensation of dizziness, vertigo, or imbalance that this population experiences and the emotional problems that may be attributed to this sensation such as feeling frustrated, afraid, depressed, worried or anxious.

In the activities and participation area, all of the component's chapters are covered by the examined questionnaires with the exception of the communication chapter. Vestibular disorders usually do not affect communication skills. Whereas some activities and participation chapters are addressed heavily by most of the examined measures including chapters related to mobility, domestic life, and community, social and civic life.

The distinction between activities and participation concepts is one of the main controversial issues in the ICF.[61,82] The ICF classified the activities and participation as one component but gave each one of them different definitions and qualifiers which has increased the ambiguity among ICF users. Although the ICF provided 4 ways to distinguish between activities and participation in the book, these rules are general and difficult to administer. Moreover, blending the activities and participation concepts was recommended by several studies.[63,83-86] Therefore, categorizing the activities and participation concepts identified from the examined instruments into separate "activities" and "participation" codes was outside of the scope of this study.

Environmental factors are infrequently addressed by the 8 examined instruments. Only 2 categories related to "light" and "sound" are included in the PQ even though environmental factors have a potential effect on individuals with vestibular disorders.[38]

The linkage also revealed that none of the examined instruments is specialized in one component of the ICF. Therefore, specialized instruments that quantify a single component and answer a specific question are needed. A specialized activities and participation instrument that quantifies the activity limitations and participation restrictions in people with vestibular disorders is needed because of the great effect of vestibular disorders on individuals' activities and participation.[4] A specialized instrument that quantifies the environmental factors that are problematic for people with vestibular disorders might also be helpful.

The linking process conducted in this study was very helpful in discovering the focus of each questionnaire. Five of the examined questionnaires (VADL, ADLQ, ABC, DHI, and UCLA) provide clinicians and researchers with information that is more related to the level of activity limitations and participation restrictions with different emphases (see Figure 2). The remainder of the examined instruments (VRBQ, VHQ, and PQ) provides clinicians and researchers with information that is more related to the functional impairment (see Figure 2). Having an insight into the content covered by the questionnaires would help clinicians not only decide the appropriate measure to use but also correctly interpret the results and consequently design the intervention to address the person's limitations. The results in Figure 2 could help clinicians to reduce redundant measures that provide the same information, improving efficiency for both the clinician and the patient.

Excellent agreement was displayed by the health professionals at the component, first and second ICF levels according to the kappa statistics. Factors affecting the psychometric properties of the ICF classifications in relation to existing quality of life measures for persons with vestibular disorders should be further studied.

Most of the meaningful concepts contained in the questionnaires' items that could not be linked to any of the ICF categories were related to moving the head to look up or down as well as questions about agoraphobia (a fear of leaving the home) (see Table 3). Moving the head is a normal activity that individuals perform while looking to the sky, looking down to find something on the ground or looking over the shoulder in driving to see traffic. These head movements often cause dizziness in people with vestibular disorders; consequently, they stabilize their head in fear of triggering dizziness. The unlinked concepts above are important concepts that are not addressed in the ICF and might be added to a future revision of the ICF such as "moving the head in different directions".

3.4.1 Study limitations

Our method of selecting vestibular measures was not based on a systematic search, instead we selected the most widely used measures in vestibular rehabilitation. Therefore, our review may not include all pertinent measures. Thus, the study results are limited to the examined vestibular instruments.

3.5 CONCLUSION

The eight vestibular outcome measures studied consisted primarily of body functions plus activities and participation items. Two experts demonstrated excellent agreement related to rating the 8 vestibular outcome questionnaires. Clinicians reviewing the questionnaires may have a better idea of the focus of each instrument.

Table 1: Summary of the psychometric properties (reliability and validity) of six of the examined questionnaires

Psychometrics	DHI	VHQ	ABC	UCLA-DQ	VADL	VRBQ
Internal consistency (α)	Total score=.89 Dimensions=.72-.85	Total score =.93 Dimensions =.75-.82	.96	Not evaluated	Total score =.97 Dimensions=.91-.96	Total score=.73 Dimensions=.74-.92
Test-retest reliability	r=.97 (total score) r=.92-.97 (dimensions)	No significant change	r=.92	Not evaluated	rc=1 (total score) rc=.87-.97 (dimensions)	ICC =.92 (total score) ICC=.94-.99 (dimensions)
Responsiveness	Scores not presented	Scores not presented	Not evaluated	Not evaluated	Not evaluated	Effect size=.35-.67
Convergent validity	ρ=.53-.72 (DHI vs. Sf-36)	Not evaluated	r=-.64 (ABC vs. DHI) r=.84 (ABC vs. FES)	Not evaluated	ρ =.66, p<.001 (VADL vs. DHI)	r=.44 (VRBQ vs. DHI) r=.45 (VRBQ vs. VSS)
Discriminant validity	According to the number of dizziness episodes	Worse VHQ scores when the vertigo episode is recurrent instead of single	Fallers from non-fallers in the previous year and patients with reduced mobility from patients without reduced mobility	Significant relationship between frequency and severity of dizziness on the others 3 items	Significant difference between patients and controls	r=-.27- -.33 (VRBQ vs. SF-36

α: Cronbach's α coefficient, r: Pearson correlation coefficient, rc: concordance correlations coefficient, ICC: Intraclass correlation coefficient, ρ: Spearman correlation coefficient.
DHI: Dizziness Handicap Inventory; VHQ: Vertigo Handicap Questionnaire; ABC: Activities-specific Balance Confidence Scale; UCLA-DQ: UCLA Dizziness Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

Table 2: The number of items, meaningful concepts identified, concepts not linked to the ICF, and the concepts referred to the ICF components in the questionnaires used in vestibular rehabilitation

	DHI	VHQ	ABC	UCLA-DQ	ADLQ	VADL	PQ	VRBQ
Total number of items	25	26	16	5	7	28	35	22
Total number of ICF concepts identified	42	50	23	18	9	41	79	50
Concepts not linked to the ICF	4	1	0	1	0	2	24	10
Body functions concepts	9	26	3	7	1	1	34	30
Activities and participation concepts	29	23	20	10	8	38	19	10
Environmental factors concepts	0	0	0	0	0	0	2	0

DHI: Dizziness Handicap Inventory; VHQ: Vertigo Handicap Questionnaire; ABC: Activities-specific Balance Confidence Scale; UCLA-DQ: UCLA Dizziness Questionnaire; ADLQ: Activities of Daily Living Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; PQ: Prototype questionnaire; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

Table 3: All the concepts that did not map to the ICF are included below. The words in italics represent the concepts that did not map to the ICF

Measures	Items	Assigned codes
DHI	Does *looking up* increase your problem?	nd-ph
	Does *performing more ambitious activities* like sports, dancing, household chores such as sweeping or putting dishes away increase your problem?	nd-gh
	Do *quick movements of your head* increase your problem?	nd-ph
	Because of your problem do you *avoid heights*?	nc
UCLA	What impact does my condition have on the overall *quality of life*? Examples: participation in social activities, sharing intimate relationships, making plans for the future, obtaining or maintaining work, & participate in leisure activities.	nd-qol
VADL	*Moving in or out of the bathtub or shower.*	nd-ph nd-ph
PQ	I am so anxious about the dizziness that I feel one or more of: heart pounding or fluttering, hot or cold sweats, tingling or numbness difficulty breathing, *faintness.*	hc
	Looking up at the sky makes me feel dizzy.	nd-ph
	Moving my head from side to side makes me feel dizzy.	nd-ph
	I have difficulty in one (or more) of these situations: open spaces (like crossing a wide road), *patterned floors (e.g. tiled shopping centre)*, flashing lights or screens (e.g. cinema) supermarket aisle.	nc nc
	I restrict my *head and body movement.*	nd-ph
	I have to find *special ways of doing things.*	nd
	I prefer to have someone with me when I go out.	nd
	I have *difficulty doing things* in my home or garden.	nd

	I think there may be something seriously wrong with me.	nd
	I need to *hold on to something for support*.	nc
	I have restricted my participation in physical activities.	nd-ph
	I need to be careful and/or *take things slowly.*	nd
	I am worried about hurting myself (falling over, *bumping into things*, crossing the road, driving).	nc
	I prefer to stay in or near home.	nc
	The dizziness is *affecting my independence.*	pf
	I prefer not to go to noisy and/or *crowded places.*	nc
	The dizziness is affecting my *quality of life.*	nd-qol
	I avoid some *activities, positions or situations.*	nd-gh nd nd
	I prefer not to be alone.	nd
	My balance feels worse in the dark or when my eyes are closed.	nd-ph nd-ph
RBQ	*Looking up at the sky* makes me feel dizzy.	nd-ph
	Moving my head slowly from side to side makes me feel dizzy.	nd-ph
	Moving my head quickly from side to side makes me feel dizzy.	nd-ph
	Compared to before the dizziness, *I feel comfortable going out alone.*	pf
	Compared to before the dizziness, *I need to hold on to something for support.*	nc
	Compared to before the dizziness, *I think my quality of life is good.*	nd-qol
	Compared to before the dizziness, I avoid some *activities, positions*	nd-gh

	or situations.	nd nd
	Compared to before the dizziness, *I feel stable in the dark or when my eyes are closed.*	nd-ph nd-ph

nc: not covered; nd: not definable; nd-gh: not definable-general health; nd-ph: not definable-physical health; nd-qol: not definable-quality of life; hc: health condition; pf: personal factors.
DHI: Dizziness Handicap Inventory; UCLA-DQ: UCLA Dizziness Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; PQ: Prototype Questionnaire; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

Table 4: Frequencies showing how often body functions categories are addressed in the measures linked to the ICF

ICF category		DHI	VHQ	ABC	UCLA-DQ	ADLQ	VADL	PQ	VRBQ
b117	Intellectual functions		2						
b126	Temperament and personality functions		1	1				1	1
b140	Attention functions	1						1	
b144	Memory functions							1	1
b152	Emotional functions	7	8		1			4	1
b160	Thought functions							1	1
b164	Higher-level cognitive functions		1		1				
b215	Functions of structures adjoining the eye							1	
b230	Hearing functions				1				
b235	Vestibular function			1				2	
b240	Sensations associated with hearing and vestibular function	1	13	1	4			16	20
b270	Sensory functions							1	
b280	Sensation of pain							1	
b410	Heart functions							1	1
b440	Respiration functions							1	2
b455	Exercise tolerance functions					1		1	
b640	Sexual functions						1		
b760	Control of voluntary movement functions		1						
b840	Sensation relate to the skin							2	3

DHI: Dizziness Handicap Inventory; VHQ: Vertigo Handicap Questionnaire; ABC: Activities-specific Balance Confidence Scale; UCLA-DQ: UCLA Dizziness Questionnaire; ADLQ: Activities of Daily Living Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; PQ: Prototype questionnaire; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

Table 5: Frequencies showing how often activities and participation categories are addressed in the measures linked to the ICF

	ICF category	DHI	VHQ	ABC	UCLA-DQ	ADLQ	VADL	PQ	VRBQ
d163	Thinking		1						1
d166	Reading	1							
d230	Carrying out daily routine		2						
d240	Handling stress	1							
d410	Changing basic body position	4	2	3			3	3	3
d430	Lifting and carrying objects						1		
d440	Fine hand use			1					
d445	Hand and arm use			3			2		
d450	Walking	4	1	8		1	6	6	
d455	Moving around		1	2			2		
d460	Moving around in different locations		1						
d465	Moving around using equipment			2			2		
d470	Using transportation	1				1	1		
d475	Driving				1	1	1		
d5	Self-care				1				1
d510	Washing oneself						1		1
d520	Caring for body parts								1
d540	Dressing						4		1
d620	Acquisition of goods and services	1	1		1	2			
d630	Preparing meals						1		
d640	Doing housework	5	1	1		1	7		
d650	Caring for household objects	1	2			1			
d660	Assisting others				1		1		
d750	Informal social relationships	1	1						
d760	Family relationships	1	2						
d770	Intimate relationship				1				
820	School education						1		
	Acquiring, keeping				1				

845	and termination a job								
850	Remunerative employment	1	1		2	1	2		
920	Recreation and leisure	8	7		2		3		2

DHI: Dizziness Handicap Inventory; VHQ: Vertigo Handicap Questionnaire; ABC: Activities-specific Balance Confidence Scale; UCLA-DQ: UCLA Dizziness Questionnaire; ADLQ: Activities of Daily Living Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; PQ: Prototype questionnaire; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

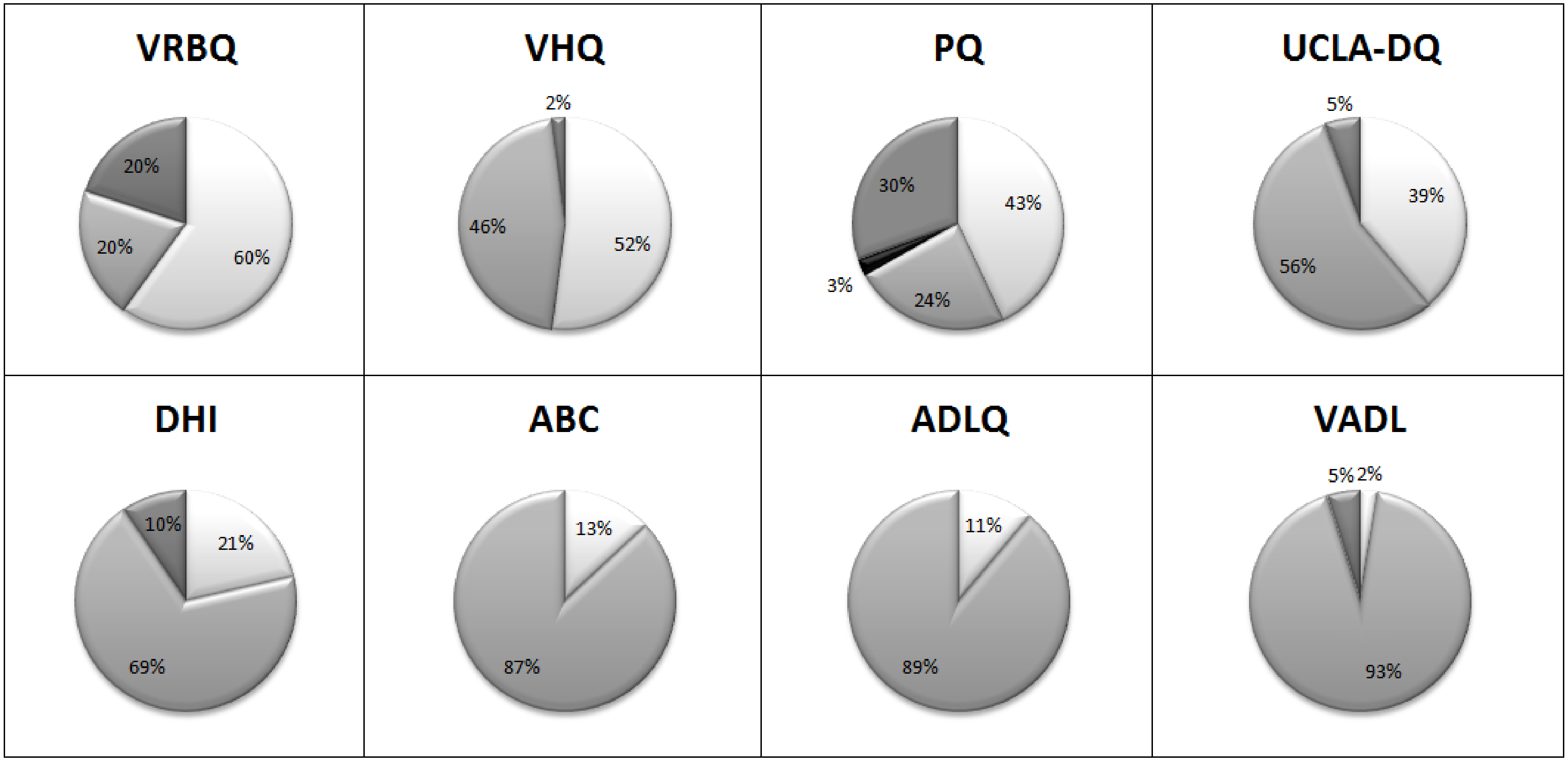

Figure 2: The percentages of concepts related to the body functions, activities and participation, and environmental factors components of the ICF as well as the percentages of concepts that did not map to the ICF in each of the examined instruments

☐ (White) Percentage = Number of body function concepts/Total number of concepts identified.
■ (Light gray) Percentage = Number of activities and participation concepts/Total number of concepts identified.
■ (Black) Percentage = Number of environmental factors concepts/Total number of concepts identified.
■ (Dark gray) Percentage = Number of concepts did not map to the ICF/Total number of concepts identified.

DHI: Dizziness Handicap Inventory; VHQ: Vertigo Handicap Questionnaire; ABC: Activities-specific Balance Confidence Scale; UCLA-DQ: UCLA Dizziness Questionnaire; ADLQ: Activities of Daily Living Questionnaire; VADL: Vestibular Disorders Activities of Daily Living Scale; PQ: Prototype questionnaire; VRBQ: Vestibular Rehabilitation Benefit Questionnaire.

4.0 THE DEVELOPMENY OF THE VESTIBULAR ACTIVITIES AND PARTICIPATION (VAP) MEASURE USING THE DELPHI TECHNIQUE

4.1 INTRODUCTION

Vestibular disorders have a significant negative impact on patients' activities and participation due to the disabling effect of the disorders' physical and emotional consequences.[4] Many studies have shown the disabling effect of dizziness, vertigo, and imbalance on patients' ability to perform daily living activities.[4,9,27,31,32] In people who have a history of dizziness, the fear of becoming dizzy was strongly correlated with their perception of disability.[27] Similarly, people with vertigo have reported significant role limitations and social restrictions due to recurrent vertigo episodes.[4,31] In particular, unpredictable vertigo was found to be the symptom most strongly associated with greater disability in which many day-to-day activities become difficult or dangerous.[9] Moreover, people with Menière's disease reported that the physical and emotional problems caused by the disease affect their ability to carry out normal activities and effective participation.[9,31] Persons with vestibular schwanoma also have reported impaired quality of life (QOL) and less active coping behaviors compared to healthy controls.[32] Furthermore, in a survey examining the independence of performing activities of daily living (ADL), half of the patients with a variety of vestibular disorders reported a reduction in their independence after developing a vestibular disorder.[31]

Driving, shopping, and occupational functioning have been reported to be limited in people with vestibular disorders.[33-37] After developing a vestibular disorder, patients have reported a reduction in their driving skills, particularly driving at night and driving in the rain.[33,34] Similarly, shopping malls and grocery stores are described as challenging environments by patients with vestibular disorders due to their conflicting visual or surface oriented references.[35,36] Certain environments increase spatial disorientation and may provide inadequate or misleading balance information for individuals with vestibular disorders.[29] Likewise, occupational difficulties were reported in 66% of patients who experience vertigo and 26% of employed people with vestibular disorders quit working because of their vertigo symptom.[37]

Vestibular rehabilitation has been found to be an effective approach in reducing functional disability and improving activities and participation for individuals with vestibular disorders.[40,50-52] Therefore, measuring the level of activities and participation is important because objectifying difficulties with activities and participation could provide clinicians and researchers with an improved understanding of patients' problems and needs. The World Health Organization (WHO) defines *activities* as "the execution of a task or action by an individual", and *participation* as "involvement in a life situation" in the International Classification of Functioning, Disability and Health (ICF).[10]

The ICF was developed in 2001 by the WHO to serve as a universal and standard language and framework for the description of health and health-related states.[10] The ICF is not an assessment tool; it provides clinicians with a comprehensive conceptual framework of functioning and disabilities as well as contextual factors that help health professionals identify "what to measure". "How to measure" remains open to clinical judgment. Therefore, many generic and disease-specific tools[11-16] have been developed based on the ICF framework, especially in the activities and participation component, since measuring activities and participation is a challenging task. At present, there is no established activities and participation outcome measure for individuals with vestibular disorders.

There are many reasons to measure activities and participation. Activities and participation become important concepts in health care and rehabilitation as they play a significant role in understanding the interaction between the individual with a health condition and environmental factors.[15,64] Additionally, individuals with health conditions are usually concerned with how they function within their environment more than they are with the actual impairment.[65] Therefore, an understanding of the interactive relationship among impairments, activity limitations, participation restrictions, and environmental factors[87] could lead to specific and tailored intervention plans for individuals with health conditions.

Vestibular disorders affect activities and participation of individuals who may improve with vestibular rehabilitation. Examining activity limitations and participation restrictions can help clinicians design a targeted intervention plan as well as follow the progress of patients with vestibular disorders. However, specialized outcome measures addressing activity limitations and participation restrictions according to the ICF do not exist for individuals with vestibular disorders. The purpose of this study was to develop an outcome measure that examines the activities and participation of people with vestibular disorders according to the ICF.

4.2 METHODS

The development of the VAP measure was accomplished in 3 phases: (1) generation of a list of activities and participation candidate items, (2) determination of experts' agreement on the items to include in the new measure using the Delphi technique, and (3) finalizing the development of the VAP.

4.2.1 Establishment of a list of activities and participation

The list of candidate items was selected based on 2 independent processes (Figure 3). The first process involved retrieving activities and participation items from 8 current valid and reliable instruments[17-20,39-42] used in people with vestibular disorders by linking their items to the best fitting ICF categories. The linking of vestibular instrument items to the ICF was done independently by 2 trained health professionals on the basis of the ICF classification and linking rules.[77] The second process included reviewing the entire pool of activities and participation categories in the ICF book by 2 experts in vestibular rehabilitation and selecting items not included in the other instruments that might be affected when a person sustains a vestibular disorder.

4.2.2 Determination of experts' agreement

The list of activities and participation candidate items generated in Phase 1 was included in an internet-based survey to obtain experts' agreement using the Delphi technique. The Delphi technique is a structured, formal way to reach consensus that has many advantages over other ways of reaching consensus such as informal meetings or group discussion.[88] The Delphi method encourages an honest opinion that is free from peer group pressure and achieves consensus of experts' opinions without the bias that can occur in other techniques.[69,70] The Delphi procedure including the internet-based survey was approved by the Institutional Review Board of the University of Pittsburgh.

4.2.2.1 Experts

Two of the research group (S.W. and J. F.) selected 23 experts on vestibular disorders to participate in the Delphi procedure. They represented physical therapy, otolaryngology, audiology, neurology, psychiatry, and occupational therapy. Selection of experts was based on level of expertise or years of experience in the field of vestibular dysfunction. An invitation letter was sent via e-mail to each expert individually to mainitain anonymity. The invitation letter included brief information about the Delphi method and background information about the measurement development project and its rationale. Experts who showed a willingness to participate in the study were sent a web link to the survey in a subsequent individual e-mail.

4.2.2.2 The Delphi process

An internet-based survey of 55 activities and participation items was used with the panel of experts to achieve consensus on which items to include in a new measure that evaluates the progress in treatment for people with vestibular disorders between the ages of 18-85 years. A 4-point verbal response scale was used with the survey to determine the experts' opinion whether to include or exclude items from the new tool (Table 6). Seventy percent agreement or more[75] on including items in the new measure was set as the predetermined criterion for inclusion. Two rounds were conducted and participants were given 4 weeks in each round to complete the survey.

In the first Delphi round, each participant received a link to the survey that included the list of activities and participation candidate items along with the question and the response scale. Table 6 provides an example of a portion of the survey. At the end of the survey, participants were given the opportunity to suggest additional items from ICF activities and participation categories and to provide their justification for adding them.

In the second round, each participant was emailed a spreadsheet showing the percent agreement of the panel and his/her own response for each candidate item. Participants were asked to consider revising their responses in the light of the responses of other panel members and to indicate the new response if they decided to change it. The default answer was "no change" for the items that participants did not change.

4.2.2.3 Data analysis

Analysis of experts' agreement from the first and second rounds was conducted and the percentage agreement per item was calculated. For each item, the scores were divided into 2 categories: "inclusion" and "exclusion". The total scores of the first 2 responses: "This item should definitely not be included in the measure" and "This item does not need to be included for the measure to be useful" represented "exclusion". The total scores of the last 2 responses: "Although not essential, this item would contribute to the measure" and "It is essential that this item be included in the measure" represented "inclusion". The items that had 70% agreement or more[75] on including items in the new measure were considered for inclusion in the VAP measure. There is no universal agreed percentage of the level of consensus to use with the Delphi technique; it is usually up to authors' judgment. We chose "70%" as the agreement criteria for inclusion in order to obtain a rigorous estimation of the items that most experts agree to have in the new measure.

4.2.3 Finalizing the development of the VAP measure

In this phase, the results of the Delphi technique were discussed by the research group and the items to include in the VAP measure were determined. Additionally, the research group generated the stem question as well as the response scale to use with the VAP measure.

4.3 RESULTS

4.3.1 Establishment of a list of activities and participation candidate items

Fifty five activities and participation candidate items were obtained from the linkage of the vestibular instruments to the ICF (39 items) and reviewing the ICF classification (16 items) processes (Table 7). The linkage of vestibular instruments, that was conducted independently by 2 of the research group (A.A. and S.W.), to the second level of ICF categories yielded 30 activities and participation categories. In linking instruments' items to the second level of ICF categories, a number of different concepts were linked to a broader category, for example: "walking short distances" (d4500), "walking long distances" (d4501), "walking on different surfaces" (d4502), and "walking around obstacles" (d4503) were all linked to the broader category "walking" (d450). For the purpose of using these categories in the candidate list of the new measure, specific ICF categories at either the second or third ICF level were used which increased the number of retrieved categories to 39. Sixteen additional items were selected by 2 experts in vestibular rehabilitation (S.W. and P.S.) from the activities and participation component of the ICF. The representation of the candidate list items was 24 items (44%) related to mobility; 8 items (15%) related to domestic life; 6 items (11%) related to community, social and civic life; 5 items (9%) related to major life areas; 5 items (9%) related to self-care; 3 items (5%) related to general tasks and demands; 3 items (5%) related to interpersonal interactions and relationship; 1 item (2%) related to learning and applying knowledge; and no items related to communication domain.

4.3.2 Determination of experts' agreement

Seventeen experts agreed to participate in the Delphi study: 7 physical therapists (41%), 6 otolaryngologists (35%), 1 audiologist (6%), 1 neurologist (6%), 1 psychiatrist (6%), and 1 occupational therapist (6%). The experts' average years of experience in the field of vestibular dysfunction was 20 (minimum 11, maximum 32). Twelve experts were from the United States (70%), 3 from the United Kingdom (18%), 1 from Australia (6%), and 1 from South America (6%). All participants completed the first round survey (Figure 3). No additional items were provided by the panel of experts in the first round. Sixteen of 17 participants completed and returned the second round survey (Figure 3). The responses of the 17th expert who did not respond to the second round were considered the same as the first round responses (i.e. no change).

During the first round, 32 items had 70% or greater agreement to include in the new measure (Table 7). The representation of the items was 18 items (56%) related to mobility; 4 items (13%) related to major life areas; 3 items (9%) related to domestic life; 3 items (9%) related to community, social and civic life; 2 items (6%) related to general tasks and demands; 1 item (3%) related to learning and applying knowledge; 1 item (3%) related to interpersonal interactions and relationship; and no items related to the self-care domain.

During the second round of the Delphi technique, the same 32 items had 70% or greater agreement; however, the percentage agreement increased (Table 7). The number of items that had 100% agreement increased from 10 items in the first round to 12 items in the second round. Similarly, 5 items had 94% agreement in the first round whereas 9 items had 94% agreement in the second round. Consequently, the number of items that had 88% and 82% agreement decreased from 7 items each in the first round to 6 items and 1 item in the second round respectively. One item had 76% agreement in the second round. Finally, the same 3 items had 70% in the first and second rounds.

4.3.3 Finalizing the development of the VAP measure

The 32 items with 70% or more agreement after 2 rounds of the Delphi were included in the VAP measure. However, 2 of these items: “lying down” and “transferring oneself while lying” were combined into 1 item “Lying down (get into or out of bed) or turning over in bed” because the research group felt that they provided complimentary information. In addition, the research group decided to add 3 items that had less than 70% agreement to include in the VAP measure because of the important information they might add: “washing whole body” (65%), “taking care of animals” (59%), and “assisting others with self care and/or in movement” (41%). Therefore, the VAP measure contains 34 items. Subsequently, the following stem question was generated to use with the VAP measure: *“due to your dizziness/imbalance, how much difficulty did you have recently in”*. After that, the following directions were added to the beginning of the measure: “*This questionnaire evaluates the effect of dizziness and/or balance problems on your ability to perform activity and participation tasks. Please rate your difficulty without the assistance of other persons on each task. If your performance varies due to intermittent dizziness or balance problems please select the greatest level of difficulty. If you never do a particular task, please check the box in column NA (not applicable)*”. Finally, the response scale of the VAP measure was set as a 5-point scale indicating the level of difficulty: none=0, mild=1, moderate=2, severe=3, unable to do=4, and not applicable (NA). The total score of the VAP can be obtained by calculating the average of the item scale values after excluding the “not applicable” items. Table 8 presents the VAP measure.

4.4 DISCUSSION

The VAP was developed as a new self-report measure of activity limitations and participation restrictions for people with vestibular disorders that corresponds to the ICF, a standardized framework that has gained worldwide acceptance. Having an instrument that maps directly to the ICF provides clinicians and researchers with a content-clear instrument that can be easily used for specific purposes and clearly compared to other instruments. Additionally, the scores of such an instrument can be appropriately interpreted to reflect patients' status. Therefore, the VAP measure is different than the available vestibular instruments because all its items are related to the activities and participation component of the ICF. Existing vestibular instruments include items from the body functions as well as the activities and participation components of the ICF.

The Delphi technique was used to achieve consensus among experts to include activities and participation items for the development of the VAP. Using the Delphi process to obtain a list of agreed on "activities and participation" items among experts in the field of vestibular dysfunction ensured content validity of the VAP measure.[89-92] Content validity infers that an instrument is representative of the concept that one is attempting to measure and free from the influence of irrelevant factors.[91,92] Among the 55 candidate items that were sent to the panel of experts through the Delphi process, 39 items were retrieved from current instruments that were previously validated in individuals with vestibular disorders.[17-20,39-42] Having items in the VAP measure from other established vestibular instruments adds to the validity of the VAP measure. Thirty two candidate items had 70% or greater agreement for inclusion in the VAP measure after the first round and the second round of the Delphi technique, indicating the stability of responses. Such stability of responses is considered as a reliable indicator of consensus.[93]

Mobility items were predominant in both the original list of candidate items (24 out of 55) and the selected items by the panel of experts after 2 rounds of the Delphi (18 out of 32). Mobility items are important to be examined in people with vestibular disorders since they are affected directly and indirectly by vestibular hypofunction.[4] Vestibular disorders may affect patients' postural stability and contribute to their disequilibrium due to the important role of vestibular input in maintaining postural control.[94] In addition, positional changes and moving the head or body during mobility tasks usually elicit dizziness and/or vertigo in individuals with vestibular disorders.[26] Consequently, many patients limit their movements to avoid provoking symptoms of dizziness and/or vertigo.[7,9] Therefore, examining items related to mobility in individuals with vestibular disorders can provide clinicians with crucial information about the activity limitations that patients may experience due to vestibular disorders.

The ICF major life areas domain had the next highest number of selected items (4 out of 32) after 2 rounds of the Delphi. Four items out of 5 major life areas items in the original list had more than 70% agreement to include in the new measure. Two of the selected items were added by the vestibular experts through the review process of the ICF classification: "vocational training" and "higher education". The other 2 selected items, "school education" and "maintaining a job", exist in present vestibular instruments. Occupational difficulties have been reported by individuals with vestibular disorders and some quit their jobs after sustaining a vestibular insult.[37] Many factors play a role in the occupational problems for people with vestibular disorders including the nature of the job and the frequency and severity of symptoms.

Depending on the demands of the job, number of hours, and activities required, people with vestibular disorders may have to modify their jobs or stop working. Occupations that require high mental demands for sustained periods might be difficult for persons with vestibular disorders who have some attentional deficits.[95]

No items related to communication were in the original list of activities and participation candidate items since vestibular disorders usually do not affect communication skills. Five self care items were in the original list (see Table 7). However, none of the self-care items reached the 70% agreement criteria for inclusion in the new measure after 2 rounds of the Delphi. The potential reasons why none of the self-care items reached the 70% agreement criteria could be the characteristics of the experts selected for the Delphi technique and the lack of patients' input. Physical therapists, otolaryngologists, audiologist, neurologist, and psychiatrist may have been less concerned with self-care problems than the occupational therapist. Nevertheless, "washing whole body" which reached 65% agreement was added because individuals with vestibular disorders frequently report losing balance during bathing activities. The research group also added two items from the domestic life domain: "taking care of animals" and "assisting others with self care and/or in movement" because they felt that these items could be challenging for people with vestibular disorders.

4.4.1 Study limitations

There are 2 main limitations in this study. First, the development of the VAP measure in this study was based on the available activities and participation categories in the current version of the ICF. However, there were some items in the current vestibular instruments that could not be linked to the ICF because they were not included or covered by the ICF classification. An example is moving the head in different directions which is considered an important activity that is highly affected in people with vestibular disorders. Such items could not be added to the list of candidate items that was sent to the Delphi panel of experts. Therefore, the VAP may miss some activities that are affected in people with vestibular disorders because of their absence from the current version of the ICF. The second limitation is the lack of patients' input on the development process of the VAP measure. Self-care items would have had greater agreement if patients with vestibular disorders were consulted during the development of the measure.

4.5 CONCLUSION

The development of the VAP provides a tool that can be used for assessment, intervention planning, and outcome evaluation in people with vestibular disorders. The VAP measure examines the disabling effect of vestibular disorders on people's activities and participation based on a standardized framework (the ICF). Future work will establish the psychometric properties of the VAP in people with vestibular disorders.

Table 6: A sample of the survey that was used in the first round of the Delphi procedure[α]

Select the statement that best expresses your opinion regarding the inclusion of the activity or participation items in a measure that will be used to evaluate progress in treatment for people with vestibular disorders between the ages of 18-85 years:				
Item	This item should definitely not be included in the measure	This item does not need to be included for the measure to be useful	Although not essential, this item would contribute to the measure	It is essential that this item be included in the measure
Focusing attention	☐	☐	☐	☐
Understanding a single task	☐	☐	☐	☐
Carrying out daily routine.	☐	☐	☐	☐
Handling stress & other psychological demands	☐	☐	☐	☐
Lying down	☐	☐	☐	☐
Squatting	☐	☐	☐	☐
Kneeling.	☐	☐	☐	☐
Sitting (from lying)	☐	☐	☐	☐
Standing (from sitting)	☐	☐	☐	☐
Bending over	☐	☐	☐	☐

[α]A total of 55 items were included in both Delphi rounds. The 10 items above are only a sample of the items.

Table 7: The results of round 1 and 2 of the Delphi technique. The percentages represent the number of the Delphi panel experts who marked either "Although not essential, this item would contribute to the measure", or "It is essential that this item be included

Area	Items	Source[a]	First round	Second round
Learning and applying knowledge	Focusing attention (concentrate, remember)	Linking process	94%	94%
General tasks and demands	Understanding a single task	Expert review	29%	18%
	Carrying out daily routine (managing and completing daily routine)	Linking process	100%	100%
	Handling stress & other psychological demands (e.g. driving a vehicle during heavy traffic or taking care of many children)	Linking process	88%	88%
Mobility	Lying down (get into or out of bed)	Linking process	100%	100%
	Squatting	Expert review	41%	32%
	Kneeling	Expert review	24%	12%
	Sitting (from lying)	Linking process	88%	94%
	Standing (from sitting)	Linking process	100%	100%
	Bending over or Picking up objects from the ground	Linking process	100%	100%
	Maintaining a standing position (staying in a standing position for some time)	Expert review	65%	59%
	Transferring oneself while sitting (e.g. moving from a chair to a bed)	Expert review	59%	47%
	Transferring oneself while lying (turning over in bed)	Linking process	88%	88%
	Lifting and carrying objects (e.g. carrying a child)	Linking process	71%	71%
	Reaching (overhead and down)	Linking process	100%	100%
	Walking short distances (e.g. around the house, outside to nearby car)	Linking process	94%	100%
	Walking long distances	Linking process	82%	88%
	Walking on different surfaces (icy sidewalks, uneven surfaces)	Linking process	100%	100%
	Walking around obstacles (e.g. in crowds, across parking lot)	Linking process	100%	100%
	Climbing (up & down stairs)	Linking process	100%	100 %

	Running	Expert review	71%	71%
	Jumping	Expert review	24%	18%
	Swimming	Linking process	29%	24%
	Moving around within the home (e.g. moving between rooms or from floor to floor)	Linking process	88%	100%
	Moving around within buildings other than home	Expert review	82%	94%
	Moving around using equipment (e.g. walker, wheelchair)	Linking process	82%	76%
	Using transportation (traveling using private or public transportation)	Linking process	94%	94%
	Driving (e.g. automobile, motorcycle)	Linking process	94%	94%
Self-care	Washing body parts (e.g. face, hair)	Linking process	47%	41%
	Washing whole body (bathing in a bathtub or shower)	Linking process	65%	65%
	Caring for teeth	Linking process	29%	18%
	Dressing (putting on clothes, taking off clothes)	Linking process	47%	41%
	Putting on footwear or taking off footwear	Linking process	65%	59%
Domestic life	Shopping	Linking process	100%	100%
	Gathering daily necessities (e.g. harvesting vegetables and fruits, getting water and fuel)	Expert review	65%	59%
	Preparing meals (planning, organizing, cooking and serving meals for oneself and others)	Linking process	82%	82%
	Doing housework: washing & drying clothes & garments, cleaning cooking area & utensils, cleaning living area, & disposing of garbage	Linking process	94%	94%
	Maintaining dwelling & furnishings (e.g. painting, repairing furniture, using required tools for repair work)	Expert review	59%	59%
	Taking care of plants, indoors and outdoors (gardening)	Linking process	41%	29%
	Taking care of animals (e.g. feeding, cleaning & exercising pets)	Expert review	59%	59%
	Assisting others with self care and/or in movement	Linking process	41%	41%
Interpersonal interactions and relationships	Informal relationships with friends (creating, maintaining friendship relationships)	Linking process	59%	41%
	Family relationships	Linking process	71%	71%
	Intimate relationships (sexual relationships)	Linking process	59%	59%
Major life areas	School education (engaging in all school related responsibilities & privileges)	Linking process	82%	88%

	Vocational training (engaging in all activities at a vocational program)	Expert review	88%	94%
	Higher education (engaging in all the activities of advanced educational programs)	Expert review	82%	88%
	Maintaining a job (e.g. remunerative employment, non-remunerative employment)	Linking process	100%	100%
	Complex economic transaction (maintaining a bank account, exchange of a property, or buying a business)	Expert review	35%	29%
Community, social and civic life	Community life (engaging in all aspects of community social life)	Expert review	65%	65%
	Recreation and leisure (engaging in any form of play, recreational, or leisure activities)	Linking process	82%	88%
	Sports (engaging in competitive and formal or informal organized games, performed alone or in a group)	Linking process	88%	94%
	Arts and culture (e.g. reading or playing a musical instrument)	Linking process	53%	47%
	Socializing (e.g. visiting friends or relatives, going to dinner, movies, or parties)	Linking process	88%	94%
	Organized religion (engaging in organized religious ceremonies, activities, & events)	Expert review	35%	29%

[a]Source of items: Linking process- linking instruments' items to the best fitting ICF categories; Expert review- reviewing the entire pool of activities and participation categories in the ICF and selecting items not included in the other instruments that might be affected when a person sustains a vestibular disorder.

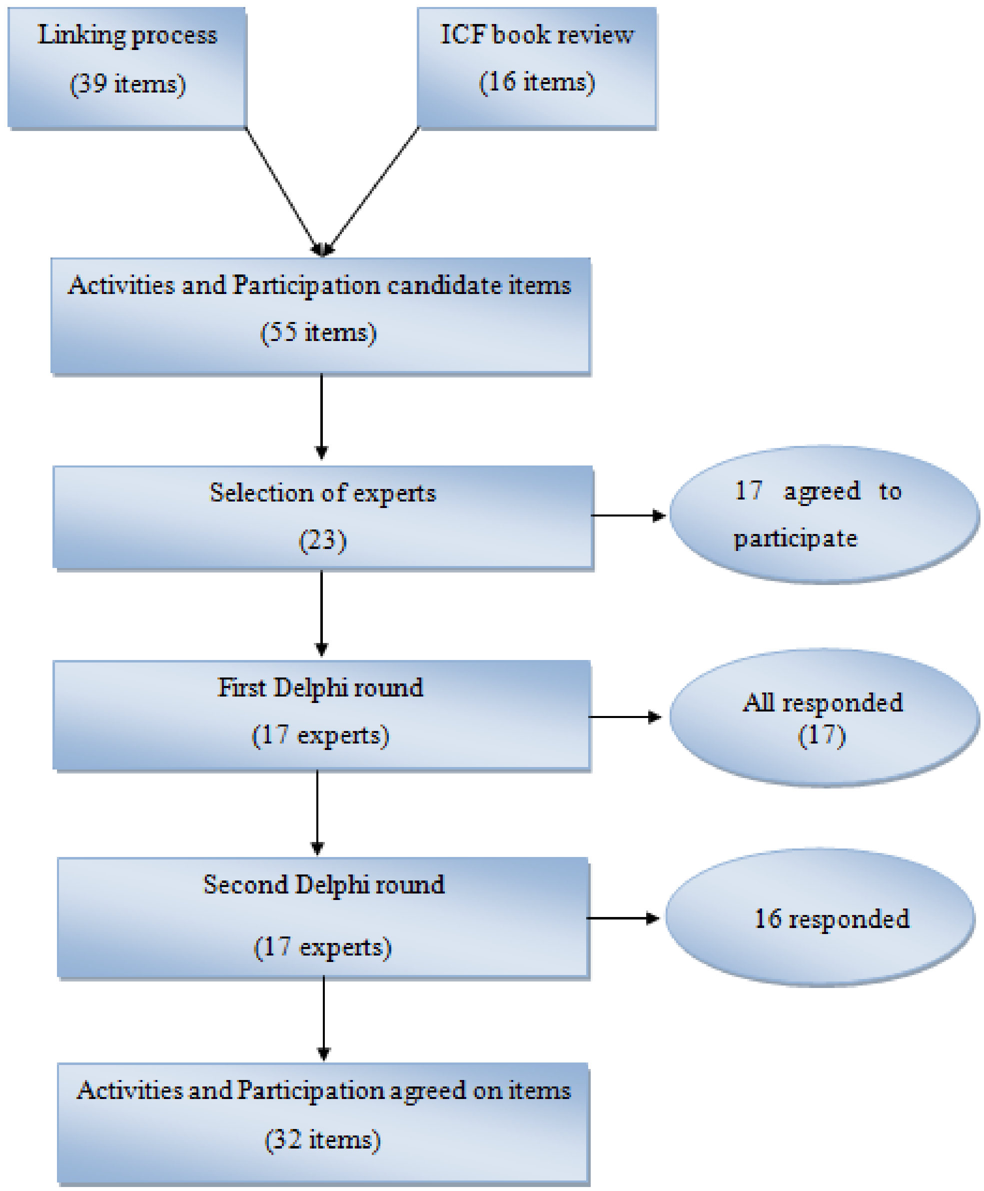

Figure 3: A flow chart describing the steps of generating a list of activities and participation candidate items and the Delphi method

Table 8: The Vestibular Activities and Participation (VAP) measure

This measure evaluates the effect of dizziness and/or balance problems on your ability to perform activity and participation tasks. Please rate your difficulty without the assistance of other persons on each task.

If your performance varies due to intermittent dizziness or balance problems please select the greatest level of difficulty. If you never do a particular task, please check the box in column NA (not applicable).

Due to your dizziness/imbalance, how much difficulty did you have recently in:		None	Mild	Moderate	Severe	Unable to do	NA
1	Focusing attention (concentration, remembering)						
2	Carrying out your daily routine (managing and completing your daily routine)						
3	Handling stress & other psychological demands (driving a vehicle during heavy traffic or taking care of many children)						
4	Lying down (get into or out of bed) or turning over in bed						
5	Sitting from lying down						
6	Moving from sitting to standing						
7	Bending over or picking up objects from the ground						
8	Lifting and carrying objects						
9	Reaching overhead and down						
10	Walking short distances (e.g. around the house, outside to a nearby car)						
11	Walking long distances						
12	Walking on different surfaces (icy sidewalks, uneven surfaces)						
13	Walking around obstacles: in crowds, across parking lot						
14	Climbing (up & down stairs, elevator, escalator)						

15	Running						
16	Moving around within the home (e.g. moving between rooms or from floor to floor)						
17	Moving around within buildings other than your home						
18	Moving around using equipment (e.g. cane, walker, wheelchair)						
19	Using transportation (traveling using private or public transportation-being a passenger)						
20	Operating a vehicle: driving a car or riding a bicycle						
21	Washing whole body (bathing in a bathtub or shower)						
22	Shopping						
23	Preparing meals (planning, organizing, cooking and serving meals for oneself and others)						
24	Doing housework: washing & drying clothes & garments; cleaning cooking area & utensils; cleaning living area; & disposing of garbage						
25	Taking care of animals (e.g. feeding, cleaning & exercising pets or farm animals)						
26	Assisting household members with self care (e.g. eating, bathing, dressing) and/or assisting household members in movement (e.g. moving outside the home)						
27	Family relationships						
28	School education (engaging in all school related responsibilities & privileges)						
29	Vocational training (engaging in all activities at a trade school)						
30	Higher education (engaging in all the activities of advanced educational programs beyond high school)						
31	Maintaining a job (e.g. remunerative employment, non-remunerative employment)						
32	Recreation and leisure (engaging in any form of play, recreational, or leisure activities)						

33	Sports (engaging in competitive and formal or informal organized games, performed alone or in a group)						
34	Socializing (e.g. visiting friends or relatives, going to dinner, movies, or parties)						

5.0 RELIABILITY AND VALIDITY OF THE VESTIBULAR ACTIVITIES AND PARTICIPATION (VAP) MEASURE

5.1 INTRODUCTION

The functioning and disability part of the International Classification of Functioning, Disability and Health (ICF) consists of two components: (1) body functions and body structures and (2) activities and participation.[10] The negative aspect of body functions and body structures can be expressed as impairments, whereas activity limitations and participation restrictions are the negative aspects of activities and participation.[10] Impairments of vestibular disorders may include unilateral vestibular weakness, reduced vestibulo-ocular reflex gain, dizziness, vertigo, imbalance, nausea, oscillopsia, and motion sickness.[4] Measurements that quantify the extent of impairments in people with vestibular disorders are well established (e.g. caloric, rotational testing, visual analogue scales, and computerized dynamic posturography). However, the extent of activity limitations and participation restrictions created by vestibular disorders is largely unknown due to the absence of specialized measures in the area of activities and participation. The current widely used self-report measures in vestibular rehabilitation include the Dizziness Handicap Inventory (DHI),[19] the Vertigo Handicap Questionnaire (VHQ),[20] the Activities-specific Balance Confidence (ABC) scale,[39] the UCLA Dizziness Questionnaire (UCLA-DQ),[18] the Vestibular Disorders Activities of Daily Living (VADL) scale,[17] and the Vestibular Rehabilitation Benefit Questionnaire (VRBQ).[42] All the mentioned instruments have mixed items of body functions and activities and participation (Alghwiri, Marchetti & Whitney, in press), meaning that none of them exclusively includes activities and participation items from the ICF.

Activities and participation domains are affected in people with vestibular disorders due to the disabling sequelae produced by the pathology and impairments.[4,9,27,31,32] Many studies have shown the effectiveness of vestibular rehabilitation in reducing functional disability and improving patients' activities and participation.[40,50-52] Therefore, quantifying activity limitations and participation restrictions in patients with vestibular disorders should be considered during the evaluation and follow up processes. The Vestibular Activities and Participation (VAP) measure was developed based on the ICF to meet this need (Alghwiri et al. under review).

The VAP measure is a self-report instrument for assessing the disabling effect of vestibular disorders on individuals' activities and participation. The VAP measure could be used for assessment, intervention planning, and outcome evaluation of activity limitations and participation restrictions in people with vestibular disorders. The VAP measure has 34 activities and participation items that map directly to the activities and participation component of the ICF. Respondents use a 5-point scale: "none=0", "mild=1", "moderate=2", "severe=3" and "unable to do=4" to indicate the level of difficulty in performing the activities and participation tasks due to their dizziness and/or imbalance. If a particular task is not part of respondents' routine, then they can select the "not applicable (NA)" response. The total score is computed by calculating the average of the item scores after excluding the "not applicable" answered questions.

The psychometric properties (reliability and validity) of a new measure are important to establish in order for the tool to be useful. Reliability is defined as consistency of scores which reflects the stability of the measure over time.[81] Test-retest reliability is the most common method used to assess the reliability of clinical measures and implies that the scores of a measure remain similar between the first and a subsequent administration under constant conditions.[81] After establishing the reliability of a measure, validity is usually assessed. An instrument is considered valid when it measures what it is supposed to measure.[92] The main types of validity are content validity, criterion-related validity, and construct validity.[91,92] Content validity infers that an instrument is representative of the concept that one is attempting to measure and free from the influence of irrelevant factors.[91,92] Content validity is usually examined by asking a panel of experts to review and comment on the relevance of the measure's items.[92] Content validity of the VAP was established in another study (Alghwiri et al., under review). Concurrent validity is a subtype of criterion-related validity in which the test to be validated and a criterion measure are administered at the same time to the same group of people.[92] The correlation of the scores between the target test and the criterion measure is then computed. A high correlation would indicate that the target test has concurrent validity with the criterion measure. Construct validity implies that an instrument measures the underlying construct of interest and can be assessed by comparing the new measure to other established instruments with similar or related constructs.[92] Construct validity can be subdivided into convergent and discriminant validity.[91] Convergent validity indicates that the new measure and other instruments that examine the same phenomena will be highly correlated, while discriminant validity implies that little relationships will be obtained between the new measure and other instruments that examine different characteristics.[91] Discriminant validity can be also evaluated by comparing different groups that are not supposed to have similar results in the new measure.[92]

The objectives of this study were: (1) to describe the subjects and condition-specific factors that are associated with perceived disability as measured by the VAP scores. It was hypothesized that demographic factors such as age and gender and clinical features such as diagnosis and complaint of imbalance would have significant contribution to explaining the VAP total score. The second objective was to examine the test-retest reliability of the VAP at the total score and item levels in people with vestibular disorders and to calculate the minimum detectable change (MDC) of the VAP. The third objective was to determine the concurrent validity of the VAP with the World Health Organization Disability Assessment Schedule II (WHODAS II)[16] and the convergent validity of the VAP with the DHI.[19]

5.2 METHODS

5.2.1 Participants

A convenience sample of subjects who were referred to a neuro-otologist at the Jordan Center of Balance and Hearing Disorders at the University of Pittsburgh medical Center were used. Patients who had dizziness, balance problems, or a combination of both between the ages of 18 and 85 years old were recruited. This study was performed with the approval of the University of Pittsburgh Institutional Review Board.

5.2.2 Procedures

The clinic nurse introduced the study to patients and asked them if they were interested in learning more about the research from the study team. The study procedures were explained to subjects by the project's primary investigator and informed consent was obtained. Subjects then completed the VAP measure (the first administration) and the WHODAS II 12-item self administered form. To ensure that the dizziness and/or imbalance condition of subjects was stable during the test-retest interval, subjects were asked to complete the VAP for the second time on the same day (between 2 and 5 hours later). To minimize recall bias, the order of the VAP items was changed in the second administration.

5.2.3 Outcome measures

5.2.3.1 The VAP measure

The research team changed the written directions at the beginning of the VAP measure after the 33rd subject because we felt that additional clarifications were required. The directions used with the first 33 subjects were: "*This questionnaire evaluates the effect of dizziness and/or balance problems on your ability to do things. Please rate your difficulty (if any) on each item. If you do not perform a particular activity or it is not part of your lifestyle, check NA (not applicable)*". The directions used with the last 27 subjects were: "*This questionnaire evaluates the effect of dizziness and/or balance problems on your ability to perform activity and participation tasks.*

Please rate your difficulty without the assistance of other persons on each task. If your performance varies due to intermittent dizziness or balance problems please select the greatest level of difficulty. If you never do a particular task, please check the box in column NA (not applicable)".

5.2.3.2 The WHODAS II

The WHODAS II[16] was developed by the World Health Organization (WHO) to assess activity limitations and participation restrictions experienced by individuals irrespective of medical diagnosis. The WHODAS II provides a standardized way to measure activities and participation according to the ICF.[16] The WHODAS II has 3 versions: 36-item, 12-item, and 12+24-item versions. It is also available in 3 different forms: interviewer-administered, self-administered, and proxy-administered.[16] The psychometric properties (reliability and validity) of the WHODAS II have been assessed internationally on 4 different groups: the general population; people with physical problems; people with mental and emotional problems; and people with problems related to alcohol and drug use.[16] The intraclass correlation coefficient (ICC) values for the test-retest reliability results of the WHODAS II within 7 days were as follows: at the item level (ICC=.69-.89), at the domain level (ICC=.93-.96), and at the overall level (ICC=.98).[16] The internal consistency of the WHODAS II ranged from "acceptable" to 'very good".[16] Face validity was examined by asking experts if the WHODAS II content measures disability as defined by the ICF and 64% of experts agreed. Many health status and functioning instruments were administered simultaneously with the WHODAS II to assess concurrent validity. These instruments included the London Handicap Scale (LHS);[96] the Medical Outcomes Study's 36-

Item Health Survey (SF-36);[97] the SF-12;[98] the Functional Independence Measure (FIM);[99] the WHO Quality of Life (WHOQOL-100);[100] and the WHO Quality of Life Brief Scale (WHOQOL-BREF).[101] Most correlation coefficients ranged between .45 and .65.[16]

The WHODAS II was used in this study as the criterion measure because the WHODAS II examines the activities and participation component according to the ICF. The 12-item, self administered form of the WHODAS II was used in this study to examine the concurrent validity of the VAP. A nonexclusive, royalty free license to use the WHODAS II in our study was obtained from the WHO.

5.2.3.3 The DHI

The DHI is a 25-item self-report instrument that examines the impact of dizziness on daily life.[19] The DHI items are divided into 3 domains: functional, emotional, and physical. A total score and domain scores can be obtained from the DHI. The total score ranges between 0 and 100 with the higher score indicating greater perceived handicap due to dizziness. The DHI had good internal consistency for the total score (α=.89) and satisfactory internal consistency for the domain scores (α=.72-.85).[19] Additionally, the DHI had high test-retest reliability (r=.97).[19]

The DHI was sent to all subjects one week before their clinic appointment as part of the normal clinic routine and permission to use their medical records was obtained through the informed consent process. The DHI was used in this study to examine the convergent validity of the VAP.

5.2.4 Data analysis

The SPSS 16.0 program (Chicago IL) and Microsoft Excel 2008 for Mac version 12.1.0 (Microsoft Corp., Redmond, WA) were used for the statistical analysis of the descriptive analysis, the total score test-retest reliability, and the correlations. Stata version 9.2 (StataCorp, College Station, TX) was used to calculate the unweighted and weighted kappa statistics for item agreement.

5.2.4.1 Reliability

Test-retest reliability of the VAP total score was estimated using the ICC (3,1) and the 95% confidence interval (CI). The ICC is a reliability coefficient used with interval and ratio data. An ICC of >.75 indicates "excellent" reliability, .40-.74 indicates "fair to good" reliability, and <.40 indicates "poor" reliability.[102]

Agreement (above chance level) between subject ratings on successive test administrations for individual items was estimated using Cohen's kappa statistics (weighted and unweighted). Cohen's kappa is a widely used measure of agreement for nominal scale data. Kappa ranges from 0 to 1, in which 0 indicates no agreement and 1 indicates perfect agreement.[80,81] A kappa of ≥.75 indicates excellent agreement, .4-.74 indicates good agreement, and <.4 indicates poor agreement. For the unweighted kappa, the "NA" responses were considered a separate response category. Weighted kappa was estimated using linear weights determined by the number of answered categories with "NA" responses excluded.

The minimum detectable change at 95% confidence level (MDC_{95}) was calculated for the VAP measure. The MDC is the smallest difference between 2 measurements that can be interpreted as a real change, i.e. above measurement error.[103,104] With a MDC, a clinician can consider a difference between 2 scores to represent a genuine change in performance when the difference exceeds the MDC_{95}. The MDC_{95} was calculated using the following formula: **SEM*√2*1.96**. The standard error of measurement (SEM) was calculated by taking the square root of the within subject variance ($SEM=SD\sqrt{1-ICC}$).

5.2.4.2 Validity

Spearman rank order correlation coefficient (*rho*) was used to estimate the concurrent validity between the VAP and the WHODAS II and the convergent validity between the VAP and the DHI. A Spearman correlation coefficient of $\geq$ 0.60 indicates strong correlation, 0.31-0.59 indicates moderate correlation, and $\leq$ 0.30 indicates poor correlation. We expected strong association between the VAP and the WHODAS II because both instruments have items that map directly to the activities and participation component of the ICF. However, the WHODAS II quantifies functioning and disability of people regardless of their medical diagnosis. In contrast, the VAP is a disease-specific measure that assesses the disabling effect of vestibular disorders on a person's activities and participation. The VAP and the DHI scores were expected to be associated because both instruments are self-report measures that assess the disabling effect of vestibular disorders. However, the DHI has mixed body functions and activities and participation items (Alghwiri, Marchetti, & Whitney, in press); whereas, the VAP has activities and participation items only.

In order to explore the contribution of the sample characteristics on measures' scores, we performed the Mann-Whitney U test for 2 independent samples among categorical variables (gender, diagnosis and self-reported imbalance) and the non-parametric Spearman rank order correlation coefficient (*rho*) among continuous variables (age, duration of symptoms, number of medications and number of co-morbid conditions).

The VAP total score was tested for normality using the Shapiro-Wilk test. If the normality assumption was violated, a transformation of the VAP total score was preformed. The association between the VAP total score and multiple predictor variables that reached significance (using the Mann-Whitney and Spearman correlation coefficient) was tested using a generalized linear model (GLM) in order to determine the predictive value that variables contribute in explaining the VAP total score. Predictor variables were tested individually for significance, and the best subset of variables that was significantly associated with the VAP total score was identified. The coefficient of determination (r^2) for the percent of variance in the VAP total score that predicted the predictor variables was described for models that were estimated to be significant at $p < 0.05$.

5.3 RESULTS

A total of 60 subjects were recruited; however, two subjects were excluded from the analysis because they did not meet the inclusion criteria of age; one subject was younger than 18 and the other was older than 85 years.

There were no differences between the first (1-33) and second (34-60) groups in the VAP total score test-retest reliability and the VAP correlations with the DHI total and dimension scores. The correlation between the VAP total score and the WHODAS II total score was strong (rho=.9) in the first group and moderate (rho=.5) in the second group. Therefore, subsequent analyses were conducted for the overall group since only one difference was found between the groups in the correlations (i.e. the VAP and the WHODAS II).

5.3.1 Descriptive statistics

A description of the characteristics of the 58 subjects is presented in Table 9. The 58 subjects who participated in this study ranged from 20 to 85 years old (Figure 4). The mean age of subjects was 52.6 years (SD 16 years) including 39 women (67%) and 19 men (32%). The subjects had reported duration of symptoms (dizziness and/or imbalance) ranging from 11 days to 40 years (median 1.5 years). The number of medications used by subjects ranged from 0 to 37 with a median of 7.5. The number of co-morbid conditions ranged from 0 to 8 conditions with a median of 1. Forty-four subjects (76%) reported balance difficulties; however, only 3 of them reported falls. Clinical diagnoses for vestibular disorders were categorized as peripheral vestibular dysfunction (62%), vestibular dysfunction with central involvement (35%), and unspecified dizziness (3%). The percentages of subjects who had abnormal vestibular testing findings are presented in Table 10.

5.3.2 Reliability

The mean VAP total score was 1.4 (SD .94) ranging from 0 to 3.67. The average test-retest interval of the VAP was 160 minutes (SD 58 minutes) with a range between 65 and 315 minutes. The test-retest reliability of the total score between the first and second administrations of the VAP was excellent (ICC=.95), (CI=.91-.97). Un-weighted kappa and weighted kappa values for the VAP agreement per-item were good to excellent (.41-.80) and (.58-.94) respectively (Table 11). A weighted kappa statistic was used to estimate agreement between the first and second administrations of the VAP based on valid ordinal responses (i.e. excluding the "NA" answers). The linear weighting matrix was adjusted for each item based on the number of valid ordinal response pairs. Therefore, 9 items had higher weighted kappa because of the low number of valid responses including: "running", "moving around using equipment", "taking care of animals", "assisting household members with self care and/or assisting household members in movement", "school education", "vocational training", "higher education", "maintaining a job", and "sports". The SEM of the VAP was .21 and the minimum detectable change (MDC) for the VAP total score was .58.

5.3.3 Concurrent validity

All subjects (58) completed the WHODAS II at the same time as the first administration of the VAP. A significant strong correlation (*rho*=.7, $p<.05$) was found between the VAP and the WHODAS II total scores indicating that the VAP has concurrent validity with the WHODAS II.

5.3.4 Convergent validity

The DHI was sent to all subjects prior to arrival into the clinic; however, only 36 out of 58 subjects completed the DHI. Moderate to strong correlations (*rho*=.54-.74) were found between the VAP total score and the DHI dimensions and total scores (Table 12).

5.3.5 Discriminant validity

Using the Mann-Whitney U test, women had significantly higher VAP total scores and WHODAS II total scores than men (Table 13) indicating that women had higher perceived activity limitations and participation restrictions than men. Additionally, subjects with central involvement had significantly higher VAP total scores, WHODAS II total scores, DHI total scores, DHI functional scores, and DHI emotional scores than subjects without central involvement (Table 13). Moreover, subjects with self-reported imbalance had significantly higher VAP total scores, DHI total scores, and DHI physical scores than people with no self-reported imbalance (Table 13).

Using the Spearman rank order correlation coefficient (*rho*), there was a moderate inverse correlations between the age of subjects and the VAP total score (*rho*=-.37, $p<.05$), DHI total score (*rho*=-.44, $p<.05$), and DHI emotional score (*rho*=-.42, $p<.05$) (Table 12). These findings suggest that younger subjects tend to have higher perception of disability. There was no significant correlation between the VAP total score and duration of symptoms (*rho*= -.23, p=.08), number of medications (*rho*= .04, p =.74), or with the number of co-morbid conditions (rho=-

.06, *p*=.64) (Table 12). Additionally, we found no significant correlation between the number of "NA" responses and age (rho=.2, *p*=.14) (Figure 4).

The raw VAP total score did not meet the assumption of normality (*p*=.002). Therefore, the VAP total score was transformed to the natural logarithm of the VAP total score (lnVAPtotal) and after removal of outliers (n = 6) beyond two standard deviations of the mean for the transformed variable, the assumption of normality was met (*p*>.05). The mean age of the removed subjects was 54.5 years (SD 12.52) with 4 men and 2 women. The mean VAP total score of the removed subjects was .12 (SD .06) with 2 subjects reporting imbalance.

The results of the GLM for the lnVAPStotal as an outcome and demographic and clinical predictors are shown in Table 14. After adjustment for age, gender and self-reported imbalance were found independent predictors of the lnVAPtotal. A model which significantly predicted 29% of the variance of the lnVAPtotal included age ($p \leq .07$), gender ($p < .01$) and self-reported imbalance ($p \leq .02$). Diagnosis was not significant as a predictor of the lnVAPtotal in the multivariate GLM (Table 14). Age was retained in the GLM despite not being independently significant ($p < 0.07$) as a predictor due to its univariate association ($p < 0.03$, $r^2 = 10\%$) with the lnVAPtotal. Figures 2 and 3 present the age-adjusted means and 95% confidence intervals for VAP total scores by gender and by self-reported imbalance. Estimated at the mean age of 52.4 years, females and persons reporting imbalance reported significantly higher VAP total scores compared with males and persons without imbalance respectively.

5.4 DISCUSSION

The reliability and validity of the VAP measure were established in this study. The VAP measure demonstrated excellent test-retest reliability of the total score and good to excellent agreement at the item level. The VAP was strongly correlated with the WHODAS II and moderately to strongly correlated with the DHI dimensions and total scores.

A strong correlation was found between the VAP and the WHODAS II as expected because both instruments examine the difficulty persons have in performing activities and participation tasks. However, the association between the VAP and the WHODAS II was not perfect (i.e rho≠1) because they examine different activities and participation items and were developed for different populations. The WHODAS II is a generic measure that aims at examining the functional limitation in people irrespective to their health conditions; whereas, the VAP was developed for people with vestibular disorders. The correlation between the VAP and the physical dimension of the DHI was moderate (*rho* =.54) whereas strong correlations were found between the VAP and other DHI dimensions and total scores (Table 12). The VAP includes a large number of items related to mobility categories of the ICF which may explain the moderate correlation between the VAP and the physical dimension of the DHI; however, most of the mobility items in the VAP can be explained as functional rather than physical and that explains the strong correlation between the VAP and the functional dimension of the DHI (*rho*=.68). The DHI has been frequently used to describe the disabling effect of dizziness in people with vestibular disorders.[52,54,105-108] The strong correlation between the VAP and the DHI total score (*rho*=.74) supports the future use of the VAP with people with vestibular disorders.

Women with vestibular disorders had higher perceived disability than men, reflected by higher scores on all the measures (Table 13). Even though women's DHI scores were higher than men (Table 13), the difference was not statistically significant. In contrast, women had significantly higher scores on the VAP and WHODAS II than men. Other studies have found that women with vestibular disorders reported higher perceived disability than men.[37,52,109] In our study, we found that 75% of subjects who have central involvement were women, which may explain the higher VAP total score but this was not statistically significant (p=.3).

Subjects who reported balance problems had higher VAP and DHI total and physical scores than people without reported balance problems (Table 13). Subjects with and without reported imbalance did not have significant difference on the WHODAS II, or on the functional and emotional DHI. Balance problems may affect functional and emotional status of patients indirectly; however, the direct effect of imbalance on the VAP and the total and physical dimension of the DHI was stronger.

Central vestibular disorders usually cause more severe symptoms than peripheral vestibular disorders.[2] Therefore, patients who have central vestibular disorders are more impaired, require longer rehabilitation and rarely have complete recovery.[51] In our study, all measure scores (except for the physical dimension of the DHI) showed that people with central involvement had higher perceived disability than people without central involvement (Table 13). However, this effect was not significant as a predictor of lnVAPtotal in the multivariate GLM (Table 14).

Younger subjects had slightly higher scores on the VAP, DHI total and emotional dimension than older subjects indicating that younger patients perceive their disability to be worse and are more emotionally affected than older patients. Younger patients may perceive their disability to be worse because of the higher involvement of younger individuals within the community with work and family responsibilities. Therefore, younger patients may perceive vestibular impairments to have greater disabling effect on their productivity than older patients. Meli et al. reported that younger patients with vestibular disorders perceived their quality of life to be worse than older patients.[52]

When examining the discriminant validity of the VAP, we found that the VAP discriminates between individuals with and without reported balance problems as well as between patients with and without central involvement. Additionally, the VAP total score was higher in women, a finding consistent with other studies' findings in this population. [37,52,109] The reason of the higher perceived disability in women compared to men might be due to the harder lives of women between work and family responsibilities.[52]

5.4.1 Study limitations

Even though we recruited adult subjects from 20-85 years old (Figure 4) for testing the psychometric properties of the VAP, the mean age was 52 years and there were few younger subjects who perform sports, go to the school, or work. Consequently, 9 items of the VAP had a large number of "NA" responses (Table 11), meaning that we have little information about these items. Therefore, a larger sample size with younger patients with vestibular disorders may have provided us with greater information about the items that had large number of "NA" responses.

5.5 CONCLUSION

The VAP measure is a newly developed functional tool that examines the effect of vestibular disorders on patients' activities and participation. The VAP demonstrates good reliability and validity. Further research on other psychometric properties (e.g. responsiveness) of the VAP is needed in order to continue validating the instrument for use with persons with balance and vestibular disorders.

Table 9: Characteristics of subjects (n=58)

Characteristic	Mean±SD	Range	n (%)
Age (years)	52.6± 16.23	19-85	
Gender			
Female			39 (67)
Male			19 (33)
Duration of symptoms (years)	5.7±9.9	.03-40	
Number of medications	8.6±7.1	0-37	
Number of co-morbid conditions	1.6±1.57	0-8	
Imbalance			44 (76)
Vestibular diagnoses			
Peripheral involvement			36 (62)
Central involvement			20 (35)
Unspecified dizziness			2 (3)

Table 10: Vestibular testing results (n=58)

Vestibular testing	Abnormal results: n (%)
Oculomotor	5 (9)
Positional testing	18 (31)
Caloric	20 (36)
Rotational	20 (35)
VEMP-right	21 (50)
VEMP-left	20 (48)
Bilateral hearing loss (audiometry)	29 (50)

VEMP: Vestibular Evoked Myogenic Potential.

Table 11: Kappa and weighted kappa for test-retest item agreement of the VAP (n=58) and the number of valid responses for each item

	Items	Kappa (CI)[a]	Weighted kappa (CI)	No. of valid responses[b]
1	Focusing attention (concentration, remembering)	.56 (.41-.71)	.68 (.51-.86)	58
2	Carrying out your daily routine (managing and completing your daily routine)	.62 (.48-.76)	.77 (.61-.94)	58
3	Handling stress & other psychological demands (driving a vehicle during heavy traffic or taking care of many children)	.50 (.37-.63)	.69 (.51-.87)	56
4	Lying down (get into or out of bed) or turning over in bed	.52 (.37-.67)	.69 (.50-.88)	57
5	Sitting from lying down	.55 (.40-.70)	.68 (.50-.85)	58
6	Moving from sitting to standing	.45 (.30-.59)	.58 (.41-.75)	58
7	Bending over or picking up objects from the ground	.46 (.32-.60)	.65 (.47-.82)	58
8	Lifting and carrying objects	.41 (.27-.55)	.62 (.44-.80)	53
9	Reaching overhead and down	.70 (.55-.84)	.80 (.63-.97)	58
10	Walking short distances (e.g. around the house, outside to a nearby car)	.58 (.42-.74)	.69 (.50-.87)	58
11	Walking long distances	.55 (.42-.67)	.79 (.60-.98)	56
12	Walking on different surfaces (icy sidewalks, uneven surfaces)	.57 (.44-.69)	.76(.58-.94)	55
13	Walking around obstacles: in crowds, across parking lot	.43 (.29-.57)	.64 (.46-.83)	57
14	Climbing (up & down stairs, elevator, escalator)	.58 (.44-.71)	.70 (.52-.89)	56
15	Running	.80 (.66-.93)	.94 (.67-1.0[c])	38
16	Moving around within the home (e.g. moving between rooms or from floor to floor)	.42 (.26-.58)	.61 (.43-.79)	58
17	Moving around within buildings other than your home	.60 (.45-.75)	.73 (.55-.91)	57
18	Moving around using equipment (e.g. cane, walker, wheelchair)	.41(.23-.60)	.78 (.20-1.0[c])	13
19	Using transportation (traveling using private or public transportation-being a passenger)	.52 (.38-.65)	.69 (.50-.88)	50
20	Operating a vehicle: driving a car or riding a bicycle	.69 (.56-.82)	.82 (.63-1.0[c])	56

21	Washing whole body (bathing in a bathtub or shower)	.45 (.28-.62)	.58 (.40-.76)	58
22	Shopping	.64 (.49-.78)	.74 (.56-.91)	58
23	Preparing meals (planning, organizing, cooking and serving meals for oneself and others)	.60 (.46-.75)	.73 (.55-.91)	56
24	Doing housework: washing & drying clothes & garments; cleaning cooking area & utensils; cleaning living area; & disposing of garbage	.57 (.42-.71)	.71 (.53-.88)	56
25	Taking care of animals (e.g. feeding, cleaning & exercising pets or farm animals)	.54 (.39-.68)	.66 (.42-.90)	37
26	Assisting household members with self care (e.g. eating, bathing, dressing) and/or assisting household members in movement (e.g. moving outside the home)	.49 (.35-.63)	.73 (.47-.99)	34
27	Family relationships	.71 (.55-.87)	.82 (.62-1.0[c])	57
28	School education (engaging in all school related responsibilities & privileges)	.56 (.40-.72)	.84 (.45-1.0[c])	17
29	Vocational training (engaging in all activities at a trade school)	.44 (.25-.63)	.84 (.12-1.0[c])	10
30	Higher education (engaging in all the activities of advanced educational programs beyond high school)	.69 (.53-.85)	.83 (.41-1.0[c])	15
31	Maintaining a job (e.g. remunerative employment, non-remunerative employment)	.65 (.53-.78)	.84 (.61-1.0[c])	41
32	Recreation and leisure (engaging in any form of play, recreational, or leisure activities)	.67 (.54-.80)	.75 (.57-.93)	57
33	Sports (engaging in competitive and formal or informal organized games, performed alone or in a group)	.53 (.40-.67)	.60 (.33-.86)	33
34	Socializing (e.g. visiting friends or relatives, going to dinner, movies, or parties)	.52 (.38-.66)	.63 (.45-.80)	56

[a]CI: confidence interval.
[b]Total number of responses excluding the not applicable “NA” responses.
[c] The upper bound was more than 1.0 but theoretically, kappa ranges between 0 and 1.

Table 12: Correlations among the VAP total score, the WHODAS II total score, the DHI total score, the DHI functional, emotional, and physical scores, age of subjects, duration of symptoms, and number of medications (Spearman's correlation coefficients)

	VAP	WHODAS II	DHI-Total	DHI-Functional	DHI-Emotional	DHI-Physical	Age	Duration of symptoms	No. of medications
WHODAS II	.70*								
DHI-Total	.74*	.69*							
DHI-Functional	.68*	.69*	.89*						
DHI-Emotional	.72*	.65*	.89*	.78*					
DHI-Physical	.54*	.47*	.82*	.66*	.56*				
Age	-.31*	-.18	-.40*	-.30	-.42*	-.32			
Duration of symptoms	-.23	-.18	-.44*	-.48*	-.33*	-.44*	.27*		
No. of medications	.04	.16	.15	.29	.01	.14	.47*	-.09	
No. of comorbid conditions	-.06	.10	.04	.12	-.04	-.02	.06	-.01	.23

*Correlation is significant at $p<.05$.
VAP: the Vestibular Activities and Participation, WHODAS II: the World Health Organization Disability Assessment Schedule II, DHI: the Dizziness Handicap Inventory.

Table 13: Mean and standard deviation of measures' scores between genders, diagnoses, and subjects with and without reported balance problems

Instruments	Gender		Central involvement		Balance problems	
	Female	Male	Yes	No	Yes	No
VAP	1.6*±.8	.97*±.98	1.7*±.85	1.2*±.89	1.57*±.95	.86*±.7
WHODAS II	27*±9.4	20*±8	29.3*±10.9	22.7*±8.3	26.2±10.2	22.1±7
DHI-Total	49.1±22	36±23.7	55.4*±21.2	39.3*±22.3	47.7*±22.9	24*±13.8
DHI-Functional	17±9	12.8±9.1	19.5*±8.9	13.5*±8.6	16.7±9	7.6±5.9
DHI-Emotional	16.4±8.9	10.6±8.9	19.1*±8.1	11.9*±8.9	15.1±9.2	9.6±8.4
DHI-Physical	16.2±8.2	12.6±8.3	16.8±6.9	14.3±8.8	16.9*±7.8	6.8*±6.7

*Mann-Whitney U test is significant at $p<.05$.

VAP: the Vestibular Activities and Participation, WHODAS II: the World Health Organization Disability Assessment Schedule II, DHI: the Dizziness Handicap Inventory.

Table 14: The GLM for lnVAPtotal as outcome and demographic and clinical predictors

Model Predictors for lnVAPtotal	Model significance	Coefficient of determination
Age	*P* < .03	10%
Age + Gender	*P* < .01	19%
Age* + Gender + imbalance	*P* < .01	29%
Age + Gender + imbalance + diagnosis†	*P* < .01	34%

*parameter estimate for age $p < 0.07$
†parameter estimate for diagnosis $p < 0.30$

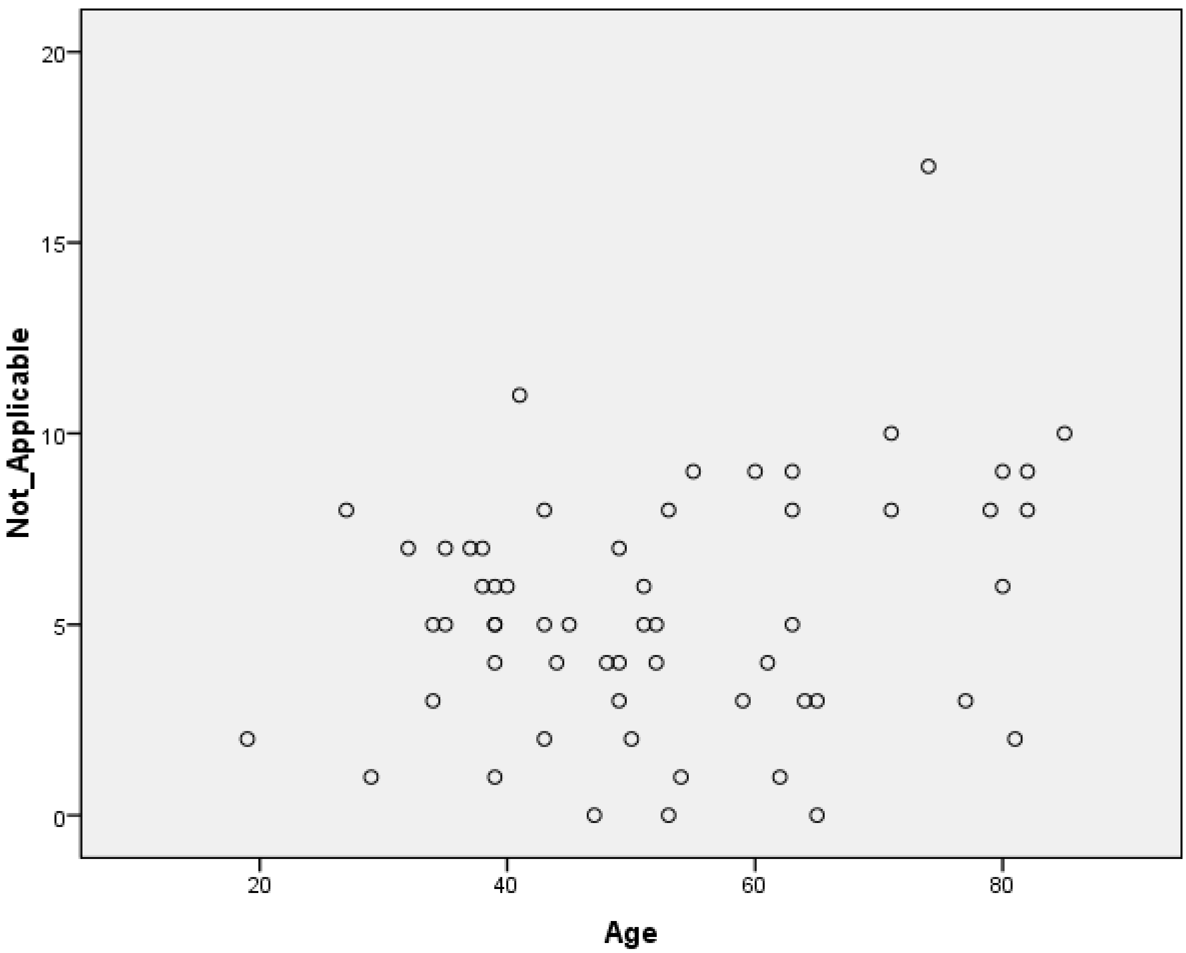

Figure 4: A scatter plot demonstrating the number of “not applicable” responses across age for each subject

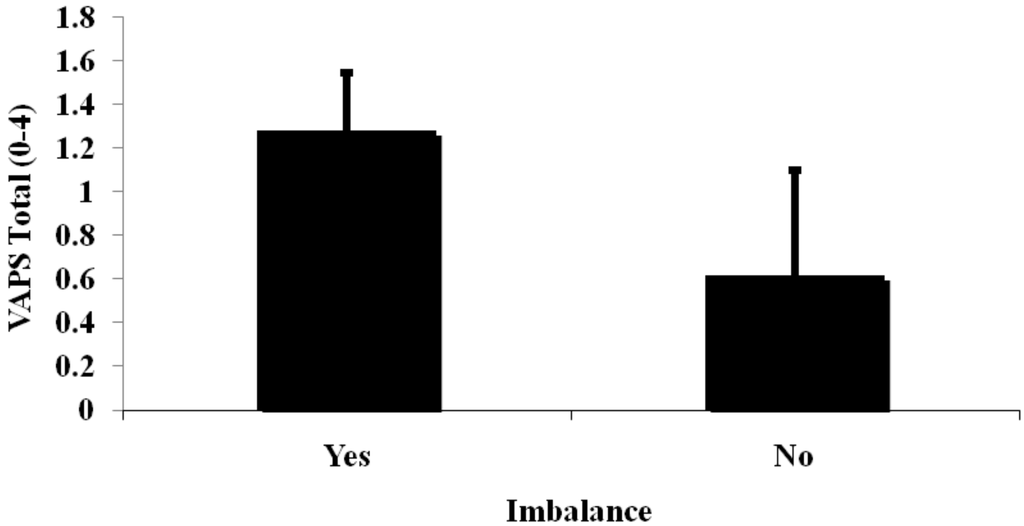

Figure 5: A bar graph of the age-adjusted means and 95% confidence intervals for VAP total scores by self-reported imbalance

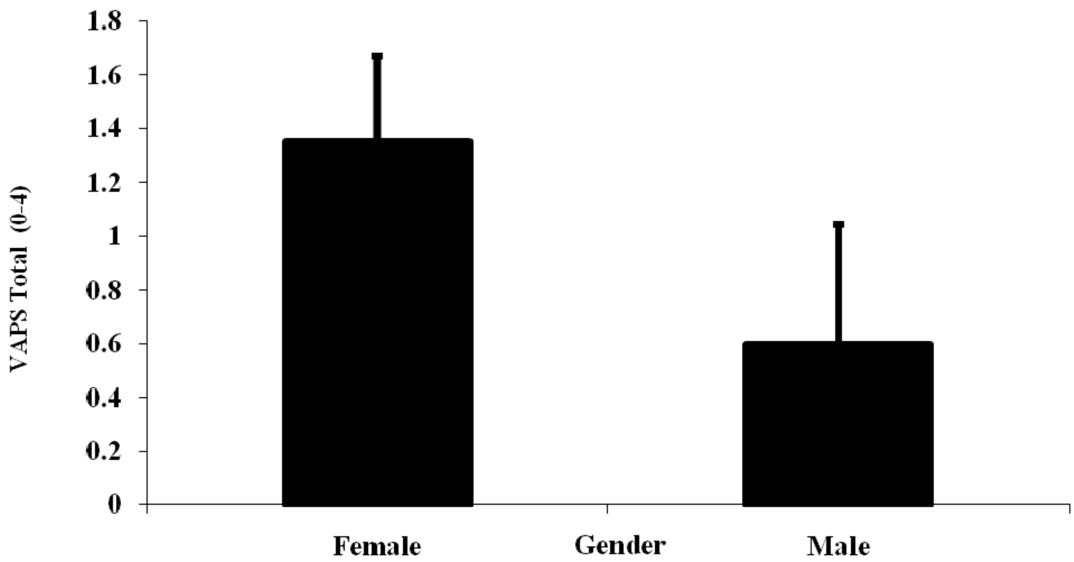

Figure 6: A bar graph of the age-adjusted means and 95% confidence intervals for VAP total scores by gender

6.0 SIGNIFICANCE, FUTURE CONSIDERATIONS AND DIRECTIONS

6.1 SIGNIFICANCE

The negative impact of vestibular disorders on patients' activities and participation and the absence of specialized outcome measures that examine the activity limitations and participation restrictions in people with vestibular disorders emphasized the need for developing an instrument that fulfils this need. We developed the VAP outcome measure based on the ICF, a worldwide accepted framework, to examine the disabling effect of vestibular disorders on patients' activities and participation. The VAP demonstrates excellent test-retest reliability of the total score and strong concurrent validity with the WHODAS II and DHI. These results demonstrate that the VAP is a reliable and valid measure that can be used clinically in assessment, intervention planning, and outcome evaluation of activity limitations and participation restrictions in people with vestibular disorders. Additionally, the VAP measure asks about the difficulty experienced due to dizziness and/or imbalance unlike other instruments that asks about either dizziness (the DHI[19]) or balance problems (the ABC scale[39]). Therefore, the VAP is "efficient" because clinicians might be able to use one tool to identify difficulties patients have due dizziness and/or imbalance instead of using two or more instruments. Moreover, the fact that all of the VAP's items map directly to the ICF activities and participation categories has many advantages.

Clinicians and researchers can interpret the obtained information from the VAP correctly and report them precisely. The second advantage is that the VAP can be easily compared to other instruments because it was based on a standardized framework (ICF).

6.2 FUTURE CONSIDERATIONS

Based on the limitations presented at the end of each study, I have the following suggestions for future considerations. In the first study we attempted to explore the content covered by the current self-report instruments used in vestibular rehabilitation. We chose the instruments that are widely used in this field. However, a systematic search of the literature with clear key words, dates, inclusion, and exclusion criteria would be a more robust method of selecting vestibular instruments. Another suggestion for the first study is related to the number of raters who did the linking process of the instruments' items to the ICF. Using more than 2 raters for the linking process of the instruments to the ICF may have added to the precision of the linkage process.

When we developed the VAP measure, we established the items using a panel of experts in vestibular dysfunction and we did not include patients' input. The combination of patients' input along with experts' input in the development of the VAP measure would have added greater benefit to the content validity of the VAP. Even though the selected experts have great expertise in the field of vestibular disorders and the selected criterion for agreement among experts was high (70%), patients who live with vestibular disorders and experience activity limitations and participation restrictions in their daily lives may have added crucial information to the development of the VAP. The problems that may face researchers from getting proper input from patients with vestibular disorders can be categorized as problems related to the wide spectrum of vestibular disorders' causes that have various effects on patients' daily lives and problems related to personal factors. Differences in patients' background, social economic status, level of education, and cognitive level are personal factors that would affect their input for the development of a vestibular tool.

In examining the psychometric properties of the VAP, a larger sample size would have provided us with greater information about all the VAP's items. We had little data to analyze for nine of the VAP's items (Table 11) because of the large number of "NA" responses, most likely because the sample age included more people who were retired and who were less active than younger people.

6.3 FUTURE DIRECTIONS

The VAP was developed as an outcome measure to assess the disabling effect of vestibular disorders on patients' activities and participation. The VAP demonstrates excellent test retest reliability of the total score over 2-5 hours and strong concurrent validity with the WHODAS II and the DHI. Further research on other psychometric properties of the VAP is needed in order to continue validating the instrument for the use with persons with balance and vestibular disorders. Responsiveness of the VAP is one of the important psychometric properties that should be established in order for the VAP to be used as an outcome measure that reliably assesses the progress of patients before and after vestibular rehabilitation. The correlation of the VAP with other self-report instruments (e.g. the ABC[39]) and performance based measures (e.g. the Dynamic Gait Index,[110] Functional Gait Assessment,[111] and Computerized Dynamic Posturography[112]) would be also useful to establish.

BIBLIOGRAPHY

1. Agrawal Y, Carey J, Della Santina C, Schubert M, Minor L. Disorders of balance and vestibular function in US adults: Data from the National Health and Nutrition Examination Survey, 2001-2004. Arch Intern Med 2009;169:938-944.

2. Karatas M. Central vertigo and dizziness: epidemiology, differential diagnosis, and common causes. Neurologist 2008;14:355-364.

3. Kerber K, Brown D, Lisabeth L, Smith M, Morgenstern L. Stroke among patients with dizziness, vertigo, and imbalance in the emergency department: a population-based study. Stroke 2006;37:2484-2487.

4. Mira E. Improving the quality of life in patients with vestibular disorders: the role of medical treatments and physical rehabilitation. Int J Clin Pract 2008;62:109-114.

5. Yardley L. Overview of psychologic effects of chronic dizziness and balance disorders. Otolaryngol Clin North Am 2000;33:603-616.

6. Yardley L, Burgneay J, Nazareth I, Luxon L. Neuro-otological and psychiatric abnormalities in a community sample of people with dizziness: a blind, controlled investigation. J Neurol Neurosurg Psychiatry 1998;65:679-684.

7. Yardley L, Owen N, Nazareth I, Luxon L. Panic disorder with agoraphobia associated with dizziness: characteristic symptoms and psychosocial sequelae. J Nerv Ment Dis 2001;189:321-327.

8. Yardley L, Redfern MS. Psychological factors influencing recovery from balance disorders. J Anxiety Disord 2001;15:107-119.

9. Yardley L, Dibb B, Osborne G. Factors associated with quality of life in Meniere's disease. Clin Otolaryngol Allied Sci 2003;28:436-441.

10. World Health Organization. International Classification of Functioning, Disability and Health. Geneva 2001.

11. Gandek B, Sinclair SJ, Jette AM, Ware JE, Jr. Development and initial psychometric evaluation of the participation measure for post-acute care (PM-PAC). Am J Phys Med Rehabil 2007;86:57-71.

12. Ostir GV, Granger CV, Black T, Roberts P, Burgos L, Martinkewiz P, Ottenbacher KJ. Preliminary results for the PAR-PRO: a measure of home and community participation. Arch Phys Med Rehabil 2006;87:1043-1051.

13. Post MW, de Witte LP, Reichrath E, Verdonschot MM, Wijlhuizen GJ, Perenboom RJ. Development and validation of IMPACT-S, an ICF-based questionnaire to measure activities and participation. J Rehabil Med 2008;40:620-627.

14. van Brakel WH, Anderson AM, Mutatkar RK, Bakirtzief Z, Nicholls PG, Raju MS, Das-Pattanayak RK. The Participation Scale: measuring a key concept in public health. Disabil Rehabil 2006;28:193-203.
15. Wilkie R, Peat G, Thomas E, Hooper H, Croft PR. The Keele Assessment of Participation: a new instrument to measure participation restriction in population studies. Combined qualitative and quantitative examination of its psychometric properties. Qual Life Res 2005;14:1889-1899.
16. World Health Organization. Measuring Health and Disability: Manual for WHO Disability Assessment Schedule (WHODAS 2.0) Malta: World Health Organization; 2010.
17. Cohen HS, Kimball KT. Development of the vestibular disorders activities of daily living scale. Arch Otolaryngol Head Neck Surg 2000;126:881-887.
18. Honrubia V, Bell TS, Harris MR, Baloh RW, Fisher LM. Quantitative evaluation of dizziness characteristics and impact on quality of life. Am J Otol 1996;17:595-602.
19. Jacobson GP, Newman CW. The development of the Dizziness Handicap Inventory. Arch Otolaryngol Head Neck Surg 1990;116:424-427.
20. Yardley L, Putman J. Quantitative analysis of factors contributing to handicap and distress in vertiginous patients: a questionnaire study. Clin Otolaryngol Allied Sci 1992;17:231-236.
21. Neuhauser HK. Epidemiology of vertigo. Curr Opin Neurol 2007;20:40-46.
22. Neuhauser HK, von Brevern M, Radtke A, Lezius F, Feldmann M, Ziese T, Lempert T. Epidemiology of vestibular vertigo: a neurotologic survey of the general population. Neurology 2005;65:898-904.
23. Burt CW, Schappert SM. Ambulatory care visits to physician offices, hospital outpatient departments, and emergency departments: United States, 1999--2000. Vital Health Stat 13 2004;1-70.
24. Nagy E, Feher-Kiss A, Barnai M, Domjan-Preszner A, Angyan L, Horvath G. Postural control in elderly subjects participating in balance training. Eur J Appl Physiol 2007;100:97-104.
25. Pothula VB, Chew F, Lesser TH, Sharma AK. Falls and vestibular impairment. Clin Otolaryngol Allied Sci 2004;29:179-182.
26. Yardley L, Beech S, Zander L, Evans T, Weinman J. A randomized controlled trial of exercise therapy for dizziness and vertigo in primary care. Br J Gen Pract 1998;48:1136-1140.
27. Monzani D, Casolari L, Guidetti G, Rigatelli M. Psychological distress and disability in patients with vertigo. J Psychosom Res 2001;50:319-323.
28. Smith P, Zheng Y, Horii A, Darlington C. Does vestibular damage cause cognitive dysfunction in humans? Journal of Vestibular Research : Equilibrium & Orientation 2005;15:1-9.
29. Jacob RG, Furman JM, Durrant JD, Turner SM. Surface dependence: a balance control strategy in panic disorder with agoraphobia. Psychosom Med 1997;59:323-330.
30. Jacob RG, Redfern MS, Furman JM. Space and motion discomfort and abnormal balance control in patients with anxiety disorders. J Neurol Neurosurg Psychiatry 2009;80:74-78.

31. Cohen H. Vestibular rehabilitation reduces functional disability. Otolaryngol Head Neck Surg 1992;107:638-643.
32. Vogel JJ, Godefroy WP, van der Mey AG, le Cessie S, Kaptein AA. Illness perceptions, coping, and quality of life in vestibular schwannoma patients at diagnosis. Otol Neurotol 2008;29:839-845.
33. Cohen H, Kimball K, Adams A. Application of the vestibular disorders activities of daily living scale. Laryngoscope 2000;110:1204-1209.
34. Cohen HS. Disability and rehabilitation in the dizzy patient. Curr Opin Neurol 2006;19:49-54.
35. Beidel DC, Horak FB. Behavior therapy for vestibular rehabilitation. J Anxiety Disord 2001;15:121-130.
36. Redfern MS, Yardley L, Bronstein AM. Visual influences on balance. J Anxiety Disord 2001;15:81-94.
37. Yardley L, Verschuur C, Masson E, Luxon L, Haacke N. Somatic and psychological factors contributing to handicap in people with vertigo. Br J Audiol 1992;26:283-290.
38. Bronstein A. Visual symptoms and vertigo. Neurol Clin 2005;23:705-713.
39. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) Scale. J Gerontol A Biol Sci Med Sci 1995;50A:M28-34.
40. Black FO, Angel CR, Pesznecker SC, Gianna C. Outcome analysis of individualized vestibular rehabilitation protocols. Am J Otol 2000;21:543-551.
41. Morris AE, Lutman ME, Yardley L. Measuring outcome from Vestibular Rehabilitation, Part I: Qualitative development of a new self-report measure. Int J Audiol 2008;47:169-177.
42. Morris AE, Lutman ME, Yardley L. Measuring outcome from vestibular rehabilitation, part II: refinement and validation of a new self-report measure. Int J Audiol 2009;48:24-37.
43. Enloe LJ, Shields RK. Evaluation of health-related quality of life in individuals with vestibular disease using disease-specific and general outcome measures. Phys Ther 1997;77:890-903.
44. Fielder H, Denholm SW, Lyons RA, Fielder CP. Measurement of health status in patients with vertigo. Clin Otolaryngol Allied Sci 1996;21:124-126.
45. Duracinsky M, Mosnier I, Bouccara D, Sterkers O, Chassany O. Literature review of questionnaires assessing vertigo and dizziness, and their impact on patients' quality of life. Value Health 2007;10:273-284.
46. Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. J Gerontol 1990;45:P239-243.
47. Whitney SL, Hudak MT, Marchetti GF. The activities-specific balance confidence scale and the dizziness handicap inventory: a comparison. J Vestib Res 1999;9:253-259.
48. Lajoie Y, Gallagher S. Predicting falls within the elderly community: comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch Gerontol Geriat 2004;38:11-26.
49. Cohen HS, Kimball KT, Adams AS. Application of the vestibular disorders activities of daily living scale. Laryngoscope 2000;110:1204-1209.

50. Cohen HS, Kimball KT. Changes in a repetitive head movement task after vestibular rehabilitation. Clin Rehabil 2004;18:125-131.
51. Whitney SL, Rossi MM. Efficacy of vestibular rehabilitation. Otolaryngol Clin North Am 2000;33:659-672.
52. Meli A, Zimatore G, Badaracco C, De Angelis E, Tufarelli D. Vestibular rehabilitation and 6-month follow-up using objective and subjective measures. Acta oto-laryngologica 2006;126:259-266.
53. Brown KE, Whitney SL, Marchetti GF, Wrisley DM, Furman JM. Physical therapy for central vestibular dysfunction. Arch Phys Med Rehabil 2006;87:76-81.
54. Gill-Body K, Beninato M, D. K. Relationship among balance impairments, functional performance, and disability in people with peripheral vestibular hypofunction. Phys Ther 2000;80:748-758.
55. Dahl T. International Classification of Functioning, Disability and Health: An introduction and discussion of its potential impact on rehabilitation services and research. J Rehabil Med 2002;34:201-204.
56. Jette AM. Toward a common language for function, disability, and health. Phys Ther 2006;86:726-734.
57. Cieza A, Stucki G. Content comparison of health-related quality of life (HRQOL) instruments based on the international classification of functioning, disability and health (ICF). Qual Life Res 2005;14:1225-1237.
58. Reed GM, Lux JB, Bufka LF, Peterson DB, Threats TT, Trask C, Stark S, Jacobson JW, Hawley JA. Operationalization the International Classification of Functioning, Disability and Health in clinical settings. Rehabilitation Psychology 2005;50:122-131.
59. Cieza A, Ewert T, Ustun B, Chatterji S, Kostanjsek N, Stucki G. Developement of ICF core set for patients with chronic conditions. J Rehabil Med 2004;36:9-11.
60. Stucki G. International Classification of Functioning, Disability, and Health (ICF): a promising framework and classification for rehabilitation medicine. Am J Phys Med Rehabil 2005;84:733-740.
61. Badley EM. Enhancing the conceptual clarity of the activity and participation components of the International Classification of Functioning, Disability, and Health. Soc Sci Med 2008;66:2335-2345.
62. Jette AM, Haley SM, Kooyoomjian JT. Are the ICF Activity and Participation dimensions distinct? J Rehabil Med 2003;35:145-149.
63. Nordenfelt L. Action theory, disability and ICF. Disabil Rehabil 2003;25:1075-1079.
64. Hemmingsson H, Jonsson H. An occupational perspective on the concept of participation in the International Classification of Functioning, Disability and Health--some critical remarks. Am J Occup Ther 2005;59:569-576.
65. Wilkie R, Peat G, Thomas E, Croft P. Factors associated with participation restriction in community-dwelling adults aged 50 years and over. Qual Life Res 2007;16:1147-1156.
66. Cardol M, de Haan RJ, van den Bos GA, de Jong BA, de Groot IJ. The development of a handicap assessment questionnaire: the Impact on Participation and Autonomy (IPA). Clin Rehabil 1999;13:411-419.

67. Fougeyrollas P, Noreau L, Bergeron H, Cloutier R, Dion SA, St-Michel G. Social consequences of long term impairments and disabilities: conceptual approach and assessment of handicap. Int J Rehabil Res 1998;21:127-141.
68. Gray DB, Hollingsworth HH, Stark SL, Morgan KA. Participation survey/mobility: psychometric properties of a measure of participation for people with mobility impairments and limitations. Arch Phys Med Rehabil 2006;87:189-197.
69. Dalkey N. The Delphi method: An experimental study of group opinion. 1969; http://www.rand.org/pubs/research_memoranda/2005/RM5888.pdf.
70. Williams PL, Webb C. The Delphi technique: a methodological discussion. J Adv Nurs 1994;19:180-186.
71. Lawrence P, Alexander R, Bell R, Folse R, Guy J, Haynes J, Lauby V, Stillman R, Cockayne T. Determining the context of a surgical curriculum. Surgery 1983;94:309-317.
72. Matthews ME, Mahaffey MJ, Lerner RN, Bunch WL. Profiles of the future for administrative dietitians via the Delphi Technique. J Am Diet Assoc 1975;66:494-499.
73. Spivey BE. A technique to determine curriculum content. J Med Educ 1971;46:269-274.
74. Card I, Fielding R. Caring for the cancer sufferer: a survey of therapy radiographers' problems. Radiography 1986;52:57-59.
75. Maarsingh OR, Dros J, van Weert HC, Schellevis FG, Bindels PJ, van der Horst HE. Development of a diagnostic protocol for dizziness in elderly patients in general practice: a Delphi procedure. BMC Fam Pract 2009;10:12.
76. Cieza A, Brockow T, Ewert T, Amman E, Kollerits B, Chatterji S, Ustun TB, Stucki G. Linking health-status measurements to the international classification of functioning, disability and health. J Rehabil Med 2002;34:205-210.
77. Cieza A, Geyh S, Chatterji S, Kostanjsek N, Ustun B, Stucki G. ICF linking rules: an update based on lessons learned. J Rehabil Med 2005;37:212-218.
78. Escorpizo R, Cieza A, Beaton D, Boonen A. Content comparison of worker productivity questionnaires in arthritis and musculoskeletal conditions using the International Classification of Functioning, Disability, and Health framework. J Occup Rehabil 2009;19:382-397.
79. Sigl T, Cieza A, Brockow T, Chatterji S, Kostanjsek N, Stucki G. Content comparison of low back pain-specific measures based on the International Classification of Functioning, Disability and Health (ICF). Clin J Pain 2006;22:147-153.
80. Bartko JJ, Carpenter WT, Jr. On the methods and theory of reliability. J Nerv Ment Dis 1976;163:307-317.
81. Gliner JA, Morgan GA, Harmon RJ. Measurement reliability. J Am Acad Child Adolesc Psychiatry 2001;40:486-488.
82. Whiteneck G, Dijkers MP. Difficult to measure constructs: conceptual and methodological issues concerning participation and environmental factors. Arch Phys Med Rehabil 2009;90:S22-35.
83. Jette A, Tao W, Haley S. Blending activity and participation sub-domains of the ICF. Disabil Rehabil 2007;29:1742-1750.
84. Okochi J, Utsunomiya S, Takahashi T. Health measurement using the ICF: test-retest reliability study of ICF codes and qualifiers in geriatric care. Health Qual Life Outcomes 2005;3:46.

85. Perenboom RJM, Chorus AMJ. Measuring participation according to the International Classification of Functioning, Disability and Health (ICF). Disabil Rehabil 2003;25:577-587.
86. Schuntermann MF. The implementation of the International Classification of Functioning, Disability and Health in Germany: experiences and problems. Int J Rehabil Res 2005;28:93-102.
87. Mallinson T, Hammel J. Measurement of participation: intersecting person, task, and environment. Arch Phys Med Rehabil 2010;91:S29-33.
88. Linstone H, Turoff M. The Delphi method: Techniques and applications. London: Addison-Wesley; 1975.
89. Hasson F, Keeney S, McKenna H. Research guidelines for the Delphi survey technique. J Adv Nurs 2000;32:1008-1015.
90. Goodman CM. The Delphi technique: a critique. J Adv Nurs 1987;12:729-734.
91. Portney L, Watkins M. Foundations of Clinical Research: Applications to Practice 3ed. Upper saddle River: Prentice Hall; 2008.
92. Morgan GA, Gliner JA, Harmon RJ. Measurement validity. J Am Acad Child Adolesc Psychiatry 2001;40:729-731.
93. Crisp J, Pelletier D, Duffield C, Adams A, Nagy S. The Delphi method? Nurs Res 1997;46:116-118.
94. Lacour M, Barthelemy J, Borel L, Magnan J, Xerri C, Chays A, Ouaknine M. Sensory strategies in human postural control before and after unilateral vestibular neurotomy. Exp Brain Res 1997;115:300-310.
95. Nascimbeni A, Gaffuri A, Penno A, Tavoni M. Dual task interference during gait in patients with unilateral vestibular disorders. J Neuroeng Rehabil 2010;7:47.
96. Harwood RH, Rogers A, Dickinson E, Ebrahim S. Measuring handicap: the London Handicap Scale, a new outcome measure for chronic disease. Qual Health Care 1994;3:11-16.
97. Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473-483.
98. Ware J, Jr., Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996;34:220-233.
99. Granger CV, Hamilton BB, Linacre JM, Heinemann AW, Wright BD. Performance profiles of the functional independence measure. Am J Phys Med Rehabil 1993;72:84-89.
100. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med 1995;41:1403-1409.
101. Development of the World Health Organization WHOQOL-BREF quality of life assessment. The WHOQOL Group. Psychol Med 1998;28:551-558.
102. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychol Bull 1979;86:420-428.
103. Ottenbacher KJ, Johnson MB, Hojem M. The significance of clinical change and clinical change of significance: issues and methods. Am J Occup Ther 1988;42:156-163.
104. Guyatt GH, Kirshner B, Jaeschke R. Measuring health status: what are the necessary measurement properties? J Clin Epidemiol 1992;45:1341-1345.

105. Whitney SL, Wrisley DM, Marchetti GF, Furman JM. The effect of age on vestibular rehabilitation outcomes. Laryngoscope 2002;112:1785-1790.

106. Jacobson GP, Newman CW, Hunter L, Balzer GK. Balance function test correlates of the Dizziness Handicap Inventory. J Am Acad Audiol 1991;2:253-260.

107. Whitney SL, Marchetti GF, Morris LO. Usefulness of the dizziness handicap inventory in the screening for benign paroxysmal positional vertigo. Otol Neurotol 2005;26:1027-1033.

108. Vereeck L, Truijen S, Wuyts FL, Van de Heyning PH. The dizziness handicap inventory and its relationship with functional balance performance. Otol Neurotol 2007;28:87-93.

109. Robertson DD, Ireland DJ. Dizziness Handicap Inventory correlates of computerized dynamic posturography. J Otolaryngol 1995;24:118-124.

110. Shumway-Cook A, Woollacott MH. Motor Control: Theory and Practical Applications. Baltimore, MD: Lippincott Williams & Wilkins; 1995.

111. Wrisley DM, Marchetti GF, Kuharsky DK, Whitney SL. Reliability, internal consistency, and validity of data obtained with the functional gait assessment. Phys Ther 2004;84:906-918.

112. Nashner LM, Peters JF. Dynamic posturography in the diagnosis and management of dizziness and balance disorders. Neurol Clin 1990;8:331-349.