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Original Article

Influence of visual impairment and hearing impairment on functional dependence status among people in Taiwan—An evaluation using the WHODAS 2.0 score

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Abstract

Background: Visual impairment (VI) and hearing impairment (HI) are the two most common types of sensory disability encountered clinically. However, VI and HI result in different limitations in daily life. We assessed the level of functioning in patients with VI or HI based on the International Classification of Functioning, Disability, and Health.

Methods: This nationwide, cross-sectional study included 312 people with VI and 540 people with HI. Each participant's degree of functioning and disability was evaluated using the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0). The standardized WHODAS 2.0 scores ranged from 0 (least difficulty) to 100 (most difficulty).

Results: Patients with VI and those with HI had a mean (±standard error) 32-item WHODAS 2.0 score of 42.4 ± 2.9 and 27.1 ± 1.6, respectively. The degree of restriction was positively related to the level of VI. Specifically, the patients with VI and a WHODAS 2.0 score of 33.7–35.3 or higher were likely to experience barriers to accessing *mobility products*, *communication products*, and *education products*. Furthermore, patients with a score of 42.9 or higher might experience barriers to accessing *ingestion products* and *living products*.

Conclusion: WHODAS 2.0 scores are strongly correlated with the severity of VI. Mild VI should be targeted for treatment and referral as early as possible. Compared with the patients with HI, the patients with VI more frequently experience barriers to accessing environmental factors.

Keywords: Disability; Functioning; Hearing impairment; International Classification of Functioning (ICF); Visual impairment; WHODAS 2.0

1. Introduction

Partly because of the absence of visual feedback, people with visual impairment (VI) may be less active in their daily lives.[1] VI includes both low vision and blindness. According to the criteria established by the World Health Organization (WHO), low vision

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and blindness are defined by a best-corrected visual acuity (BCVA) score worse than 20/60 to a lower limit of 20/400 and BCVA score worse than 20/400 in the eye with better vision, respectively. In Taiwan, the estimated prevalence of blindness and low vision among people older than 65 years is 0.59–0.82% and 2.94–4.06%, respectively.[2,3]

The presence of VI negatively affects a person's quality of life and is related to low physical and mental functioning.[4] VI is also associated with an increased risk of depression,[5] falls,[6] mortality[7] and poor quality of life.[8–11] Visual functioning entails receiving information from the environment,[12] and people with VI usually experience restrictions in daily activities.[13,14] Therefore, visually impaired people might have considerable requirements regarding the environment, which must be assessed.

The ICF categories of hearing functions evaluate hearing impairment in both ears using hearing handicap (HH) with percentage loss of hearing (PLH) worksheet, first suggested by American Academy of Otolaryngology (AAO) in 1979 and further modified by using pure-tone average of thresholds at frequencies 0.5, 1, 2, 4 KHz in calculating equations instead of using frequencies 0.5, 1, 2, 3 KHz as in 1979 version.[15] If that average was less than 25 dB hearing loss (HL) in both ears, HH was zero. For every dB above 25, HH was increased by 1.5%, reaching a maximum at 92 dB. If the two ears had unequal pure-tone averages, HH was calculated by a weighted average giving the better ear 5 times the weight of the worse ear. Mild disability in hearing function was defined as the HH from both ears between 50% and 70%. Moderate disability was defined as HH between 70% and 90%, Severe disability in hearing function was defined as that higher than 90%.[16] Hearing impairment (HI) also affects the quality of life on many dimensions. HI in older age was associated with significantly more depressive symptoms, lower self-efficacy and mastery, more feelings of loneliness, and a smaller social network than normally hearing peers.[17] Individuals with moderate to severe hearing loss were found more likely than individuals without hearing loss to have impaired activities of daily living (ADLs) and instrumental ADLs. Severity of hearing loss is also associated with reduced quality of life in older adults.[18]

The WHO Disability Assessment Schedule, Second Edition (WHODAS 2.0) was developed based on the International Classification of Functioning, Disability, and Health (ICF) and closely corresponds to the ICF component of *activities and participation*.[19] WHODAS 2.0 assesses a person's level of functioning in the following six domains: *understanding and communicating*, *mobility*, *self-care*, *getting along with people*, *life activities* (*household activities* and *work and school activities*), and *participation*. The psychometric properties of WHODAS 2.0 have been evaluated for numerous clinical conditions, including osteoarthritis,[20] stroke,[21] psychiatric conditions,[22] cancer,[23] hearing loss,[24] and visual disability.[25]

VI and hearing impairment (HI) are the two most common types of sensory disability encountered clinically, although they result in different limitations in daily life. In this nationwide study, we used the WHODAS 2.0 to assess the functioning and disability of patients with VI and to evaluate the difference in functioning between patients with VI and those with HI.

2. Methods

In this study, our data were obtained from the Taiwan Data Bank of Persons with Disability (TDPD). According to government statistics, the number of people eligible for disability support before 2010 was estimated to be 1,063,624 by using the Disability Eligibility Determination Scale, version 1980 (DES-1980). Between 2010 and 2012, the eligibility criteria for disability support were based on the medical model. An authorized physician was required to evaluate and report an applicant's impairments or problems in body functions and structures by using official DES-1980. In July 2012, the process of disability evaluation in Taiwan was again amended according to the *People with Disabilities Rights Protection Act*. In addition to evaluating applicants' impairments in bodily functions and structures, an assessment of their needs in daily life is currently required.[26] The content of the official DES was revised, and the updated version was issued as DES, version 2012 (DES-2012). The DES-2012 is based on the ICF framework and incorporates the Functioning Scale of the Eligibility Determination System of Disability. This functioning scale comprises an interviewer-administered version of WHODAS 2.0 in Chinese and evaluates the influence of environmental factors on a person's level of activities and participation.[26]

We conducted a nationwide pilot study in Taiwan between January 1, 2011 and June 30, 2012, in which the DES-2012 was used to assess 6244 people. Specifically, we used the DES-2012 data to construct the TDPD.[27] In the near future, all patients eligible for disability will be evaluated using DES-2012, thereby gradually leading to a larger TDPD. The present study was approved by the Joint Institutional Review Board of Taipei Medical University.

2.1. Participants

In the present study, patients with VI were recruited from the TDPD between August 1, 2011 and February 29, 2012. The TDPD provides information on the participants' sex, age, caregivers, work or school status, urbanization (based on their residential address), disability-related diseases or medical conditions, and major impairments in bodily functions and structures (coded as ICF categories). The TDPD also contains information on the patients' total and domain WHODAS 2.0 scores. The ICF Chapter b2 *sensory functions and pain* includes both *seeing functions* (ICF category b210) and *hearing functions* (ICF category b230). Both functions entail receiving information from the environment.[4] Therefore, patients with HI were recruited during the same period as those with VI. Patients younger than 18 years were excluded from this study.

2.2. Measurements

Using the Interviewer's Training Manual and Interview Guide of WHODAS 2.0, we trained five or more interviewers

in each qualifying hospital to use DES-2012. One of the trained interviewers administered the 32-item WHODAS 2.0 to evaluate each participant's degree of difficulty in each domain of daily life. The responses were graded on a 5-point Likert scale, with 5 indicating an item that was performed with extreme difficulty; 4, severe difficulty; 3, moderate difficulty; 2, mild difficulty; and 1, no difficulty.

On the basis of the item−response theory, the domain score was calculated as the sum of item scores within each domain. Notably, the domain score was not calculated if any item score within the domain was missing. The total WHODAS 2.0 score was calculated using the 32-item version, because only a small proportion of our study population was participating in the domain of *work and school activities*. In addition to the total score, a standardized score for each domain was calculated based on the WHODAS 2.0 manual. The standardized scores ranged from 0 (least difficulty) to 100 (most difficulty).

According to the recommendation of Von Korff et al.,[28] we classified participants who obtained a standardized domain score of ≥45 as having a substantial disability. The DES-2012 was utilized to classify the degrees of HI and VI according to expert consensus. The degree of HI in both ears was assessed by calculating the hearing handicap (HH) by using a percentage loss of hearing formula.[15] These formulas were proposed by the American Academy of Otolaryngology (AAO) in 1979 and are used to calculate HH by selecting the pure-tone average thresholds for the frequencies of 0.5, 1, 2, and 4 KHz. The amendment enabled a comprehensive assessment of high-frequency hearing loss, which is often observed in presbycusis. Mild HI was defined by a HH (both ears) between 50% and 70%, moderate HI by a HH between 71% and 90%, and severe HI by a HH higher than 90%.

Mild VI was defined by any one of the following criteria: a BCVA score worse than 20/60 and better than 20/200 in the eye with better vision, visual field examination (in both eyes) that showed 20° or less, or mean deviation (MD) of less than −10 dB in central 30° perimetry from the eye with better vision. Moderate VI was defined by a BCVA score worse than 20/200 to a lower limit of 20/2000 in the eye with better vision or a MD of less than −15 dB in central 30° perimetry from the eye with better vision. Finally, severe VI was defined by a BCVA score worse than 20/2000 in the eye with better vision or a MD of less than −20 dB in central 30° perimetry from the eye with better vision.

We also assessed barriers to the ICF categories of environmental factors for both groups of patients (HI and VI) by using "yes" or "no" (1/0) questions. These included e110, *products or substances for personal consumption*; e115, *products and technology for personal use in daily living*; e120, *products and technology for personal indoor and outdoor mobility and transportation*; e125, *products and technology for communication*; e130, *products and technology for education*; e165, *assets*; e225, *climate*; and e570, *social security services, systems and policies*.[26] These environmental factors were selected according to expert opinion and consensus.[26]

2.3. Data analysis

The Pearson chi-square test was used to compare the distribution of variables between the HI and VI groups. The variables analyzed in this study were sex, age, work or school status, urbanization (based on the residential address), and the influence of environmental factors. The Mann−Whitney *U* test was used to compare the differences in age and sex between the VI and HI groups, and one-way analysis of variance was used to compare the total scores among patients with varying degrees of functional impairment, differing work or school statuses, and those residing in various areas. A post hoc Dunnett T3 procedure was then used to perform multiple comparisons.

We also conducted a correlational analysis (Spearman's rank correlation coefficient, rho) to assess the relationship between the degree of impairment (VI or HI) and the mean standardized WHODAS 2.0 total score and domain scores. Notably, a Spearman's rho ranging from 0.3 to 0.6 indicates a moderately strong relationship. We used receiver operating characteristic (ROC) analyses to predict which participants experience environmental barriers, referring to the 32-item WHODAS 2.0 score. The number of participants analyzed for each domain differed because missing data were not included in the analysis.

The data were analyzed using SPSS (SPSS, version 15.0, Chicago, IL, USA). Between-group differences or correlations were considered significant if the p value was <0.05.

3. Results

We collected the data of 318 patients with VI and 546 patients with HI from the TDPD; the clinical characteristics of the participants are detailed in Table 1 and their domain scores are summarized in Table 2. Six patients with both VI and HI were excluded from the study. Overall, we found that more patients with VI experienced environmental barriers than patients with HI. Specifically, more than 50% of patients with VI had substantial disability in the *household activities* and *participation* domains; a median score of ≥45 was obtained for both of these domains. Notably, more than 50% of patients with HI did not have substantial disability in any of these domains.

The degree of restriction showed a positive relationship with the level of VI (Fig. 1); this relationship was more noticeable in patients older than 65 years than in those younger than 65 years. Moreover, compared with patients who performed *household activities* or who had already retired, participants with VI in both age groups experienced more difficulty in daily living when they lost their job.

In both HI and VI groups, the scores for each domain and for the total 32-item scale did not differ significantly between the sexes. In older patients with VI, the degree of impairment was moderately correlated with scores for the domains of *mobility* (rho = 0.33, $p < 0.001$), *getting along with people* (rho = 0.30, $p = 0.02$), and *household activities* (rho = 0.35, $p < 0.001$). Compared with patients with HI, patients with VI

Table 1
Comparison of clinical characteristics between patients with visual impairment (VI) and patients with hearing impairment (HI).

Variable, unit	VI (n = 312)	HI (n = 540)	p[a]
Age, years	63.8 ± 0.9	67.4 ± 0.6	0.012
Gender, female	163 (52.2%)	330 (61.1%)	0.021
Impairment degrees of the respective function			
Mild	150 (48.1%)	152 (28.1%)	
Moderate	89 (28.5%)	65 (12.0%)	
Severe	73 (23.4%)	323 (59.8%)	
Work or school			<0.001
Having a job	26 (8.3%)	115 (21.3%)	
Housekeeping or retirement	101 (32.4%)	288 (53.3%)	
Loss of job	185 (59.3%)	137 (25.4%)	
Urbanization levels of living area			0.588
Urban	125 (40.1%)	202 (37.4%)	
Suburban	137 (43.9%)	252 (46.7%)	
Rural	51 (16.3%)	94 (17.4%)	

Note: Data are given as the mean ± standard error for age and number (%) for categorical variables.
Abbreviation: WHODAS 2.0, World Health Organization Disability Assessment Schedule second edition.
[a] Using Mann–Whitney U test for age and Pearson Chi-squared test for categorical variables.

Table 2
Summary report of standardized capacity score[a] of each WHODAS 2.0 domain in subjects with visual function impairment (VI) and subjects with hearing function impairment (HI).

WHODAS 2.0 domain	Mean ± SE	Median (IQR)
Understanding and communicating		
VI (n = 250)	34.8 ± 1.8	30.0 (10.0–53.8)
HI (n = 433)	34.5 ± 1.3	30.0 (15.0–50.0)
Mobility		
VI (n = 275)	42.5 ± 2.0‡	37.5 (12.5–68.8)
HI (n = 490)	21.6 ± 1.3	6.3 (0.0–34.4)
Self-care		
VI (n = 228)	30.4 ± 2.2‡	20.0 (0.0–50.0)
HI (n = 382)	10.1 ± 1.0	0.0 (0.0–10.0)
Getting along with people		
VI (n = 146)	40.3 ± 2.9	33.3 (0.0–66.7)
HI (n = 271)	39.8 ± 1.9	41.7 (14.6–66.7)
Household activities		
VI (n = 243)	58.4 ± 2.5‡	60.0 (22.5–100.0)
HI (n = 439)	29.7 ± 1.7	10.0 (0.0–50.0)
Work and school activities		
VI (n = 93)	50.4 ± 4.6‡	42.9 (0.0–100.0)
HI (n = 221)	20.1 ± 2.2	0.0 (0.0–28.6)
Participation		
VI (n = 215)	47.8 ± 2.0‡	45.8 (25.0–70.8)
HI (n = 377)	35.5 ± 1.4	29.2 (12.5–54.2)
32-item		
VI (n = 98)	42.4 ± 2.9‡	40.2 (16.6–63.0)
HI (n = 183)	27.1 ± 1.6	21.7 (9.8–38.6)

Abbreviation: WHODAS 2.0, World Health Organization Disability Assessment Schedule second edition; SE, standard error; IQR, interquartile range; 32-item, summary score of 32 WHODAS 2.0 items. Those items within domain "work and school activities" were not included in the 32-item.
‡$P < 0.001$ (vs. patients with HI, Mann–Whitney U test).
[a] The standardized score was computed based on the manual for WHODAS 2.0. The range of scores was from 0 point (least difficulty) to 100 points (most difficulty).

more frequently experienced barriers to environmental factors (Table 3). Table 4 presents a list of the results of the ROC analyses that used the total 32-item score to predict which patients experience barriers to each environmental factor. Cronbach's α for the responses to the 32-item scale was 0.98 for patients with VI and 0.96 for those with HI.

4. Discussion

The present study revealed that more patients with VI had substantial disabilities in the *household activities* and *participation* domains than did patients with HI. In addition, the patients with VI were likely to experience barriers to accessing various environmental factors if they had a 32-item score ≥42.9. Our results also indicated that the degree of restriction was related to the level of VI, with patients with severe VI reported the highest restriction; similar findings were reported by the Malay Eye Study, a population-based cross-sectional eye health survey conducted in Singapore.[29] This finding is highly relevant to eye health professionals and suggests that patients with mild VI should be targeted for treatment and referral as early as possible.

The difference between the VI and HI groups was highest in the domains of *mobility*, *self-care*, *household activities, participation*, and *work and school activities*. Our findings are consistent with those of previous studies, in which patients with severe VI demonstrated a high degree of disability. For example, the Los Angeles Latino Eye Study Group demonstrated that more severe impairment is associated with difficulties in several subscales, such as driving, distance vision, vision-related dependency, and mental health.[30] Meanwhile, the Blue Mountains Eye Study revealed that age-related VI is associated with diminished well-being, functional status, and independence.[31] According to the ICF, a person's functionality or disability represents a dynamic interaction between health conditions and contextual factors (i.e., environmental and personal factors). Our study demonstrated that people with VI exhibited a low level of participation and activities.

Fisher et al. determined that vision loss exerts a higher impact on physical and emotional heath than hearing loss.[32,33] The Alameda County Study revealed that VI has a more extensive impact on quality of life, but HI has a significant impact on social functioning.[34] This is verified by other research that suggests that effective social functioning involves communication, both oral and written, whereas physical functioning is more concentrated on visual-dependent activities.[32] Our study findings also indicate that compared with patients with HI, patients with VI experienced greater restrictions in the domains related to physical functioning, such as *mobility*, *self-care*, *household activities*, and *participation*. However, no significant differences were observed in the scores of domains related to social functioning (*understanding and communication* and *getting along with people*) between the two groups.

We also found that patients with VI experienced certain environmental barriers and required assistance in their daily

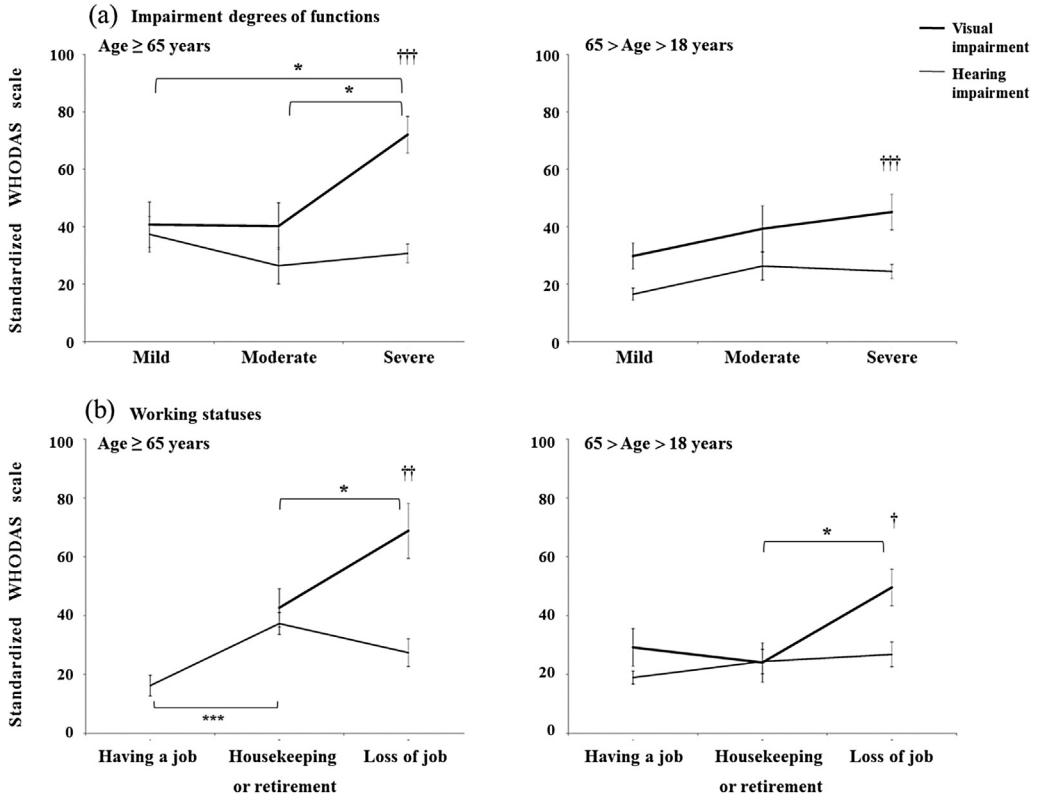

Fig. 1. Comparisons of the standardized scores between patients with visual impairment (thick lines) and those with hearing impairment (thin lines) according to age and (a) impairment degree of the respective function and (b) working status. Patients with visual impairment had greater disability than those with hearing impairment when both groups, irrespective of the age, had severe impairment of the respective function or when they lost their job. The standardized score was computed based on the manual for WHODAS 2.0. No patient aged >65 years with visual impairment had a job. The bars indicate ±1 standard error. Abbreviation: WHODAS 2.0, World Health Organization Disability Assessment Schedule, Second Edition. *$p < 0.05$, ***$p < 0.001$ (one-way analysis of variance with Dunnett T3 test). $^{\dagger}p < 0.05$, $^{\dagger\dagger}p < 0.01$, $^{\dagger\dagger\dagger}p < 0.001$ (vs. patients with hearing impairment, Mann−Whitney *U* test).

Table 3
Comparison of having an access barrier to environmental factors between subjects with visual and hearing impairments.[a]

Environmental factors	Visual impairment ($n = 312$)	Hearing impairment ($n = 540$)	p[a]
e110 Products or substances for personal consumption	93 (29.8%)	65 (12.0%)	<0.001
e115 Products and technology for personal use in daily living	102 (32.7%)	65 (12.0%)	<0.001
e120 Products and technology for personal indoor and outdoor mobility and transportation	158 (50.6%)	133 (24.6%)	<0.001
e125 Products and technology for communication	92 (29.5%)	235 (43.5%)	0.319
e130 Products and technology for education	98 (31.4%)	91 (16.9%)	<0.001
e165 Assets	108 (34.6%)	89 (16.4)	<0.001
e225 Climate	146 (46.8)	182 (33.7)	<0.001
e570 Social security services, systems and policies	80 (25.6)	80 (14.8)	<0.001

[a] Using Pearson Chi-squared test.

Table 4
ROC analyses to predict subjects having a access barrier to environmental factors by using the standardized 32-item WHODAS 2.0 score in subjects with visual impairment.

ICF categories[a]	Number	AUC (95% CI)	Cutoff value[b]	Sensitivity	Specificity
e110	99	0.824‡	42.9	0.79	0.77
e115	99	0.754‡	42.9	0.70	0.73
e120	94	0.733 (0.624−0.843)‡	33.7	0.71	0.71
e125	82	0.838 (0.756−0.921)‡	35.3	0.77	0.74
e130	72	0.841 (0.747−0.936)‡	33.7	0.77	0.84

Abbreviation: AUC (95% CI), The area under the curve (95% confidence interval); ICF, International Classification of Functioning, Disability and Health; ROC, Receiver operating characteristic; WHODAS 2.0, World Health Organization Disability Assessment Schedule second edition. Those items within domain "work and school activities" were not included in the 32-item.
‡$p < 0.001$.
[a] ICF categories of environmental factors: e110, Products or substances for personal consumption; e115, Products and technology for personal use in daily living; e120, Products and technology for personal indoor and outdoor mobility and transportation; e125, Products and technology for communication; e130, Products and technology for education.
[b] Indicating the best probabilistic cutoff value.

lives. Specifically, patients with VI that had a 32-item score of 33.7−35.3 or higher were likely to experience barriers to accessing *mobility products*, *communication products*, and *education products* (Table 4). In addition, patients with a score of 42.9 or higher might experience barriers to accessing *ingestion products* and *living products*. The discrimination is considered accurate because the area under the ROC curve was >0.75.

Compared with able-bodied people, those with VI may require more resources to overcome their difficulties in daily living. Our ROC analyses of the 32-item score identified patients with VI who were likely to experience barriers to accessing certain environmental resources; this finding offers a possible method for the early identification of people with VI who require specific environmental resources. Such early identification might be crucial for limiting the level of disability in people with VI, with implications for Taiwan's social security system.

Our study has five limitations. First, we obtained the data from the TDPD; because of the lack of controls, we could only compare the level of functioning between patients with VI and patients with HI. Second, this study had a cross-sectional design. We could not specify the duration of VI and HI, nor the socioeconomic statuses of the patients; thus, we could not adjust for these effects. Third, because of the cross-sectional design, we could not investigate possible causal relationships. Fourth, the degree of VI or HI was assessed by more than one clinician, and the WHODAS 2.0 questionnaires were evaluated by more than one interviewer. Although all clinicians and interviewers had received a 1-day training program and were qualified to complete the assessment, possible differences among the assessors might have influenced our results. Fifth, the baseline demographic data (Table 1) indicated that patients with HI were older than those with VI (67.4 ± 0.6 versus 63.8 ± 0.9; $p = 0.012$), which may have influenced the WHODAS 2.0 scores.

In conclusion, patients with severe VI experience more restrictions in their daily lives than those with mild or moderate VI, with the degree of VI correlating positively to the degree of restriction. In addition, our findings showed that patients with VI require specific environmental resources and provide strategies to potentially enhance the environment for patients with VI. Finally, our study also indicated that compared with patients with HI, a higher proportion of patients with VI have a substantial disability in the *household activities* and *participation* domains, and often experience more barriers to accessing environmental factors.

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