

Kelly Van De Wyngaerde<sup>1</sup>, Minji Lee<sup>2</sup>, Gary Jacobson<sup>1</sup>, Kalyan Pasupathy<sup>3</sup>, Santiago Romero-Brufau<sup>2</sup>, & Devin McCaslin<sup>4</sup>

<sup>1</sup>Department of Hearing & Speech Sciences, Vanderbilt University, <sup>2</sup>Kern Center for the Science of Healthcare Delivery, Department of Health Sciences Research, Kern Center for the Science of Healthcare Delivery<sup>3</sup>, Department of Otolaryngology, Mayo Clinic, Rochester<sup>4</sup>

## OBJECTIVES

- The DHI (Jacobson & Newman, 1990) is one of the most commonly used self-report questionnaires to measure the impact dizziness has on a patient's quality of life.
- Since its publication, reports have challenged the *a priori* sub-scaling of the 25 items into the Physical, Emotional, and Functional consequences of vestibular impairment.
- The present investigation was conducted in an effort to re-assess the factor structure of the DHI. Specifically, analyses were completed to determine whether the total score of the DHI reflects the variability of a single factor or multiple factors.

## METHODS

### Participants:

- Subjects were 1,991 patients who were evaluated in the Mayo Clinic-Rochester Vestibular and Balance Laboratory for a history of dizziness, vertigo, and/or imbalance.
- Investigation #1: n = 999 (mean age 57.6 yrs, SD 17.7, 585 men)
- Investigation #2: n = 992 (mean age 56.0 yrs, SD 18.05, 599 men)

### Procedures:

- The DHI was administered to all participants using paper and pencil. A “yes” response was awarded 4 points, “sometimes” was rewarded 2 points, and “no” was awarded 0 points.
- Investigation #1: Exploratory Factor Analysis (EFA)
  - EFA with bifactor rotation was used to determine the dominance of the general factor (i.e., total score) relative to the group factor (i.e., subscales)
- Investigation #2: Confirmatory Factor Analysis (CFA)
  - CFA with a bifactor graded response model was fit with appropriate item-to-group relationships discovered by the EFA. Using these specifications, a bifactor model with three group factors were fit to a new sample.

## RESULTS

### Investigation #1:

Initial analyses in the first investigation revealed 1) the DHI is unidimensional, and, 2) there were five factors whose eigenvalues exceeded the criterion of 1.0. Therefore, EFA was completed by extracting one general factor and four group factors. All item loadings exceeded the criterion of 0.30 with the exception of item 13 on the general factor. Because this item had a strong factor loading on the first group factor, it was retained for further analysis. As there were only two items with a strong factor loading on subfactor 4, this was removed entirely.

Factor	Eigenvalue	Items	Variance
General – Total score	9.23	1-12, 14-25	70%
Subfactor 1 – Positional vertigo screener	1.98	1, 5, 11, 13, 25	12.9%
Subfactor 2 – Fear of catastrophic events	1.15	9, 16, 20	5.9%
Subfactor 3 – Emotional impact	1.14	2, 22, 23	6.4%
Subfactor 4 – Activity restrictions	1.07	3, 6	4.7%

### Investigation #2:

In the CFA, all items had a positive factor loading on the general factor. Fourteen of the 25 items loaded onto the general factor only while the remaining 11 items loaded onto both the general factor and one of the three subfactors. The fit of the new model was excellent. All item loadings exceeded the criterion of 0.30 with the exception of item 13 on the general factor. The proportion of the variance in an item explained by the model ranged from 0.32 to 0.89. Proportional reduction in mean squared error (PRMSE) of the subscale score was greater than the PRMSE of the total score revealing there is added value of reporting the subscale score.

	General Factor	Physical Manifestations	Emotional Impact	Catastrophic Impact	Factor communality estimates <sup>1</sup>
P1. Does looking up increase your problem	0.39	0.51	0	0	0.41
E2. Because of your problem, do you feel frustrated?	0.65	0	0.35	0	0.54
F3. Because of your problem, do you restrict your travel for business or pleasure?	0.76	0	0	0	0.57
P4. Does walking down the aisle of a supermarket increase your problem?	0.69	0	0	0	0.48
F5. Because of your problem, do you have difficulty getting into or out of bed?	0.44	0.50	0	0	0.44
F6. Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to movies, dancing or to parties?	0.86	0	0	0	0.73
F7. Because of your problem, do you have difficulty reading?	0.66	0	0	0	0.43
F8. Does performing more ambitious activities like sports, dancing, and household chores, such as sweeping or putting dishes away; increase your problem?	0.78	0	0	0	0.61
E9. Because of your problem, are you afraid to leave your home without having someone accompany you?	0.75	0	0	0.57	0.89
E10. Because of your problem, have you been embarrassed in front of others?	0.61	0	0	0	0.37
P11. Do quick movements of your head increase your problem?	0.47	0.62	0	0	0.60
F12. Because of your problem, do you avoid heights?	0.59	0	0	0	0.35
P13. Does turning over in bed increase your problem?	0.27	0.66	0	0	0.51
F14. Because of your problem, is it difficult for you to do strenuous housework or yard work?	0.86	0	0	0	0.74
E15. Because of your problem, are you afraid people may think that you are intoxicated?	0.57	0	0	0	0.32
F16. Because of your problem, is it difficult for you to go for a walk by yourself?	0.80	0	0	0.27	0.72
P17. Does walking down a sidewalk increase your problem?	0.70	0	0	0	0.49
E18. Because of your problem, is it difficult for you to concentrate?	0.72	0	0	0	0.52
F19. Because of your problem, is it difficult for you to walk around your house in the dark?	0.68	0	0	0	0.46
E20. Because of your problem, are you afraid to stay home alone?	0.67	0	0	0.39	0.60
E21. Because of your problem, do you feel handicapped?	0.81	0	0	0	0.66
E22. Has your problem placed stress on your relationship with members of your family or friends?	0.68	0	0.34	0	0.57
E23. Because of your problem, are you depressed?	0.65	0	0.66	0	0.85
F24. Does your problem interfere with your job or household responsibilities?	0.84	0	0	0	0.70
P25. Does bending over increase your problem?	0.59	0.52	0	0	0.61
PRMSE <sub>x</sub> > PRMSE <sub>s</sub>		Yes	Yes	Yes	

Factor loadings from the confirmatory bifactor model with three group factors (n=992)

## DISCUSSION

- Several researchers recommend reporting only the total score for the DHI as the original subscales are not statistically valid.
- The present investigation confirmed the dominance of the general factor suggesting that clinicians may continue to compute one total score for the DHI.
- The original subscales developed in 1990 were not supported by our analyses. Instead, we have demonstrated validity for the creation of three new subscales: Physical Manifestations, Catastrophic Impact, and Emotional Impact
- Interestingly, items in the Physical Manifestations subscale have previously been grouped together to explore its predictive properties in identifying BPPV. Whitney et al. (2005) found these items were a significant predictor of BPPV and this was later validated by Chen et al. (2016).

## CONCLUSION

- Results of this investigation support the reporting of the DHI as a single total score. Should the clinician prefer a more detailed analysis, reporting the total score with an additional three scores reflecting the Physical Manifestations, Catastrophic Impact, and the Emotional Impact of dizziness, vertigo, and/or imbalance is recommended.

## REFERENCES

- Van De Wyngaerde KM., Lee MK, Jacobson GP, Pasupathy K., Romero-Brufau S, & McCaslin DL. The component structure of the Dizziness Handicap Inventory (DHI): A reappraisal. *Otol Neurotol*. 2019;40(9): 1217-1223.
- Jacobson GP, Newman CW. The development of the Dizziness Handicap Inventory. *Arch Otolaryngol Head Neck Surg*. 1990;116:424-7.
- Whitney SL, Marchetti GF, Morris LO. Usefulness of the Dizziness Handicap Inventory in the screening of benign paroxysmal positional vertigo. *Otol Neurotol* 2005;26:1027-33.
- Chen W, Shu L, Wang Q, et al. Validation of 5-item and 2-item questionnaires in Chinese version of Dizziness Handicap Inventory for screening objective benign paroxysmal positional vertigo. *Neurol Sci* 2016;37:1241-6.

## ACKNOWLEDGEMENTS

- I would like to thank Dr. Jacobson for his mentorship during my 2018-2019 Vestibular Sciences Fellowship as well as my co-authors for their efforts on this project.