

## Research Article



# The Translation and Psychometric Evaluation of the Persian Version of the Neuropsychological Vertigo Inventory

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## Highlights

- The aim of study was translation and validation of the P-NVI
- The Persian version of the NVI showed high validity and reliability
- The NVI can be utilized for physical, emotional and cognitive disturbances

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## ABSTRACT

**Background and Aim:** Experiencing dizziness/vertigo is often an indication of dysfunction in the vestibular system. Recent findings show a connection between peripheral vestibular dysfunction and cognitive impairments. The Neuropsychological Vertigo Inventory (NVI) can assess physical, emotional, and cognitive issues in individuals with dizziness/vertigo. The aim of this research was to translate, cultural adaptation and evaluation of the reliability and validity of NVI to Persian.

**Methods:** In this descriptive-analytical study, the NVI scale was translated and adapted to the Iranian cultural context following the international quality of life assessment protocol for translation and equivalence. After obtaining face validity, the scale was administered to 140 patients with peripheral vestibular system dysfunction and 70 control group (age between 25 and 80 years). After one week, 50 participants were asked to complete the questionnaire again. Eventually, reliability was evaluated with both methods of internal consistency and test-retest reproducibility.

**Results:** Out of the 28 items in the NVI scale, 3 items were modified to better align with the cultural conditions of Iranians. The impact scores for most items in this scale were found to be higher than 1.5. The Cronbach's alpha coefficient values for the overall scale (0.90) and test-retest reliability with intra-class correlation coefficient for the overall scale (0.91) were confirmed.

**Conclusion:** The Persian version of NVI scale demonstrates excellent validity and reliability, and it exhibits a high level of content alignment with the original version. Therefore, it can be a useful tool to better understand the physical, emotional and cognitive disturbances in patients with vertigo/dizziness.

**Keywords:** Validity; reliability; dizziness; vertigo; vestibular dysfunction; neuropsychological vertigo inventory

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## Introduction

**M**aintaining dynamic balance is a process resulting from complex interactions involving information from visual, vestibular, and proprioceptive systems in connection with the brainstem [1, 2]. Among a considerable number of individuals with balance disorders, peripheral vestibular dysfunction, is more prevalent. Its most significant manifestations include dizziness, vertigo, and lack of balance, which can lead to reduced postural control, falls, and various psychological consequences, such as anxiety, depression, and cognitive impairment, especially in older individuals [3, 4].

Dizziness is a broad term used by patients to describe a sense of lightheadedness, imbalance, head heaviness, floating sensation, presyncope, or a state resembling fainting. Vertigo, on the other hand, is described as a sensation of bodily movement or rotation in relation to the environment or vice versa [5]. The underlying cause of vertigo can be attributed to the transmission of abnormal or unrelated signals from visual, somatosensory, and vestibular sensory systems to the brain and the brain's interpretation of these signals [6].

The severity and duration of dizziness/vertigo significantly impact daily activity limitations and bodily instability, and when accompanied by degenerative disorders, it can lead to cognitive decline [7]. Recent findings have established a connection between the normal functioning of the vestibular system and various cognitive domains, such as visuospatial abilities, memory, attention, and executive function [8]. Therefore, individuals with vestibular system damage often complain of cognitive impairments, including attention deficits, memory loss, and visuospatial perception issues, likely due to a decrease in the necessary cognitive reserves for spatial orientation and balance maintenance [9].

Patients with vestibular-originating vertigo demonstrated an eightfold reduction in their ability to concentrate or focus and a fourfold increase in cognitive impairments compared to the control group [10].

Assessment of vestibular dysfunction primarily

begins with obtaining a patient's medical history, and subsequently, using relevant questionnaires can enhance the ability to diagnose the probable cause of dizziness/vertigo in the patient [11]. In this regard, the Neuropsychological Vertigo Inventory (NVI) was designed in 2016 by Lacroix et al. in French with the aim of evaluating cognitive and emotional issues associated with dizziness or vertigo. The questionnaire's questions specifically assess physical, emotional, and cognitive problems in a unified checklist, providing a suitable tool for investigating cognitive impairments in individuals with dizziness or vertigo. The main objective of this questionnaire is to diagnose cognitive and emotional issues related to dizziness or vertigo. NVI comprises 28 self-assessment questions, and its scoring system is based on a 5-point Likert scale, including options: never (0 points), rarely (1 point), sometimes (2 points), often (3 points), and always (4 points). The NVI scale consists of 7 subscales (spatial perception, temporal perception, attention, memory, emotions/feelings, and vision), evaluating patients' cognitive abilities in these domains. The maximum score is 140, and obtaining a higher score indicates an increased cognitive impairment resulting from dizziness or vertigo [12].

The original version of the NVI is in French [12], and in the past two years, English [13, 14] and Slovenian [15] versions have been prepared. Currently, the Turkish (Hatice Seyra Erbek, personal communication) and Japanese versions (Fumiyuki Goto, personal communication) of the NVI questionnaire are also being validated. Timely diagnosis and medical treatment of patients with dizziness/vertigo are crucial for maintaining their quality of life. Therefore, using the NVI questionnaire alongside other relevant assessments can aid in identifying cognitive impairments caused by dizziness/vertigo, which can have a significant negative impact on the lives of patients and their families. As the NVI questionnaire has not been validated in Iran yet, the objective of this research was to translate and validate the Persian version of the Neuropsychological Vertigo Inventory (P-NVI) in Persian-speaking patients suffering from dizziness/vertigo resulting from peripheral vestibular system damage. It is essential to note that the original French version of the NVI questionnaire is used in this study.

## Methods

After obtaining permission from the questionnaire's

designer (Lacroix), the study was conducted according to the protocol of International Quality of Life Assessment (IQOLA) [16, 17], for translation. Initially, the original NVI questionnaire was independently translated into Persian by two native Persian speakers who were proficient in French. The translators emphasized conceptual equivalence over literal translation. Subsequently, the translators individually assigned difficulty scores to each question in the questionnaire (on a 0 to 100 scale), where higher scores indicated higher difficulty, based on the clarity and comprehensibility of the language used.

During a meeting with the research team, questions with high difficulty scores were revised, and the final Persian version of the NVI questionnaire was prepared. This version was shared with two additional translators (translators 3 and 4), and they were asked to rate the translation quality of each question on a 100 point scale. The P-NVI was found to be satisfactory in terms of quality by translators 1, 2, 3, and 4.

Subsequently, the Persian version was translated back into French by two other translators (translators 5 and 6), both proficient in Persian and French. After consulting with the research team, a consensus was reached on a common French translation. The final translation, along with the original French text, was evaluated by 10 active experts in the field of balance. The translation quality and cultural adaptation were assessed using a 100 point scoring scale. The experts confirmed the semantic, conceptual, and specialized terminology equivalence used in the translation, along with its cultural compatibility with the Persian language. For face validity evaluation, the Persian version of the questionnaire was completed by 12 individuals (7 vertigo participants and 5 individuals of control group) as representatives of the study population. These individuals were asked to carefully read each question and express their understanding of the questions and instructions.

The participants in this study were individuals within the age range of 25 to 80 years. The reason for selecting this age group was due to their susceptibility to dizziness and vertigo caused by vestibular system damage within this age range. The selection of vertigo participants comprised patients who visited the balance evaluation Department at Amir Alam Hospital for

physician-requested tests. The control group consisted of companions or visitors to cultural centers and local community centers in districts 12–13 of Tehran. A total of 140 individuals were included in the patient group, and 70 individuals were included in the control group, based on the formula of 5 to 6 times the number of questionnaire items [18]. In both the patient and control group, satisfaction questionnaires, the Edinburgh handedness inventory to assess right or left-handedness of the participants, and the Montreal Cognitive Assessment (MOCA) were administered to determine the cognitive abilities of individuals aged between 60 and 80 years participating in this study and to exclude individuals with suspected cognitive impairments.

The inclusion criteria for this study were as follows: being within the age range of 25 to 80 years, not having any neurological disorders such as MS, Alzheimer's, dementia, etc., experiencing dizziness or vertigo caused by vestibular system damage for at least two weeks or more in the control group, confirmed by a physician, having the ability to walk and manage daily activities, having full proficiency in the Persian language, being literate and able to read and write, having acceptable vision to complete the questionnaire, and scoring 26 or higher in the MOCA test in the age group of 60 to 80 years.

The exclusion criteria were: unwillingness to continue participation or encountering any problems during the study that led to non-compliance with the current conditions, and inability to meet the entry criteria during the course of the study.

### Statistical analysis

The data analysis in this study was performed using LISREL version 8.7 for structural equation modeling and version 17 of SPSS for descriptive and inferential statistics. The data were analyzed in two parts: descriptive statistics and inferential statistics. Descriptive statistics included frequency tables, means, and standard deviations, as well as bar charts to evaluate the reliability of the questionnaire using Cronbach's alpha coefficient and Intra-Class Correlation (ICC).

For face and content validity, the impact score, Content Validity Index (CVI), and Content Validity Ratio (CVR) were calculated for all 28 items and the entire questionnaire in the patient group [18].

To confirm the Confirmatory Factor Analysis (CFA) of the questionnaire, the following fit indices were used: the standardized root mean square residual, the Comparative Fit Index (CFI), the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), and the Root Mean Square Error of Approximation (RMSEA).

To assess the discriminant validity of the test for independent groups, the chi-square difference test ( $\chi^2/\text{df}$ ), CFI, and GFI were used to compare the 7 factors and the total score of the questionnaire between the patient and control groups [16].

## Results

The participants in this study were 210 individuals, including 140 adults who suffered from vestibular-origin dizziness/vertigo and 70 control group aged 25 to 80 years. The final format of the inventory is presented in [Appendix A](#).

The impact score is used for assessing face validity. Considering the Likert scale, each item has a minimum score of 1, a maximum score of 5, and an average score of 3. With a minimum acceptable frequency of 50%, a score of 1.5 is considered as the cutoff for the impact factor. The effective factor for questions 4, 7, 8, and 25 was less than 1.5, indicating that the face validity for these items in the P-NVI questionnaire is not confirmed. However, the impact factor confirms the face validity for the remaining P-NVI items. The highest impact score is for question 28 (very poor balance), and the lowest impact score is for question 8 (I don't know what season it is now). Therefore, this questionnaire has a high face validity in Persian language population.

In the Lawshe method, the minimum CVR for a 10-member panel is 0.62. Based on the CVR coefficients table for all items (except item 7, 25, 27), the values are greater than 0.49, indicating acceptable CVR values. Additionally, CVI values for all items were greater than 0.79, which indicates content validity.

To determine the structural validity of the P-NVI, the method of CFA was employed, and various fit indices were calculated and evaluated. The ratio of chi-square to degrees of freedom for Model 2.14 was 2.14, indicating an acceptable fit and a relatively high

value. The CFI exceeded 0.9, which indicates good fit. The GFI also had a value of 0.93, and AGFI was 0.91, both indicating a satisfactory fit. Additionally, RMSEA was 0.58, suggesting that the model fits well with the data. Overall, the CFA results demonstrate that the developed model has a good fit with the data, confirming the structural validity of the P-NVI. To assess the discriminant validity, the distinction between two groups was examined: adults aged 25 to 80 years with vestibular-origin dizziness/vertigo and cognitive, emotional, and physical impairments, and the control group consisting of caregivers (patients and controls). For this purpose, the independent samples t-test was used to compare the seven factors and the total score of the questionnaire between the two groups.

The variance of the total score, time perception, memory, visual perception, and movement in the patient group was significantly higher than that in the control group. However, there was no significant difference in the variance of spatial perception and emotional factors between the two groups.

The mean total score, spatial perception, time perception, attention, memory, visual perception, and movement in the patient group were significantly higher than those in the control group. However, there was no significant difference in the mean scores of emotional factors between the two groups. Therefore, the total score and the six factors of spatial perception, time perception, attention, memory, visual perception, and movement can distinguish between the patient and control groups. These findings confirm the discriminant validity of the questionnaire.

Three items from the NVI scale (out of the total 28 items) were modified to better align with the cultural conditions of Iranians. The modifications were as follows:

Item 2: "I have difficulty finding myself on a map" was changed to "I have difficulty finding my location on a map."

Item 4: "When I go outside, I have difficulty finding familiar routes" was changed to "When I go outside, finding my way back is challenging for me."

Item 24: "I have difficulty finding information in a table or chart with two columns" was changed to "For me, the information placed in a newspaper table and

columns appears tangled.”

The Cronbach’s alpha coefficient, which is one of the most important characteristics of the scale, was calculated for the entire NVI scale and its subscales. The results showed that the Cronbach’s alpha coefficient for the total scale was 0.90. For the subscales, the Cronbach’s alpha coefficients were 0.64 for spatial perception, 0.64 for time perception, 0.66 for movement, 0.81 for emotions, 0.70 for attention, 0.73 for memory, and 0.73 for vision.

The test-retest reliability was calculated for a sample of 50 participants after a one-week interval. The test-retest reliability coefficients were 0.91 for the total scale, 0.72 for spatial perception, 0.72 for time perception, 0.79 for movement, 0.84 for emotions, 0.78 for attention, 0.81 for memory, and 0.79 for vision. These results indicate a high level of internal consistency and stability of the NVI scale.

The mean scores for the items ranged from 0.11 for “When I go out, I have difficulty finding my way back” to 1.87 for “I have difficulty concentrating”.

The correlation between each item and the total score ranged from 0.22 for “When I go out, I have difficulty finding my way back” to 0.68 for item22 (“When reading a text, I lose the line and have to start over”).

## Discussion

The purpose of using questionnaire NVI instead of dizziness handicap inventory is that, dizziness handicap inventory, as the common questionnaire in the field of vertigo has a Cronbach’s alpha coefficient equal to (0.72 to 0.89) and also an ICC (0.72 to 0.97), which is lower than the NVI questionnaire. Furthermore, there are only a few questions about cognitive complaints (difficulty of reading and difficulty to concentrate) [12].

So, the aim of this study was to prepare and validate the Persian version of the Neurophysiological Vertigo Inventory (P-NVI) questionnaire in adults aged 25 to 80 years with dizziness/vertigo. This research was of a descriptive/analytical, cross-sectional nature and falls under the category of applied research, aiming to identify factors that may underlie the items of the NVI through correlation and factor analysis.

After translating the NVI into Persian based on IQOLA protocol for translation and equivalence protocol, the initial version was provided to experts in the field of balance to assess the quality, appearance, and face validity of the translation. Overall, each item received a high score in terms of clarity and adequacy of translation and capturing the conceptual content of the original scale, as confirmed by the experts.

Considering the acceptable minimum impact score of 1.5, items 4, 7, 8, and 25 (“I don’t always know what year it is”, “I feel unsteady on my feet”, “I don’t know what season it is right now”, and “When I go out, I have difficulty finding my way back”) had scores lower than 1.5. However, the impact scores for the remaining P-NVI items confirm their face validity, indicating that the questionnaire has high face validity.

In order to assess content validity, two indices, CVR and CVI, were used. Each item was separately evaluated on a four-point Likert scale for simplicity (ranging from 0.69 to 0.93), relevance (ranging from 0.70 to 0.94), and clarity (ranging from 0.69 to 0.93). The results obtained from experts in the field of balance indicated that the P-NVI scale is psychometrically sound, coherent, transparent, and includes the meaningful content of the original scale.

The CFA was employed to determine structural validity. The GFI indices demonstrated that the chi-square ratio to degrees of freedom for the measurement model in this study was 2.14, indicating an acceptable fit of the model to the data. The CFI was above 0.9, GFI was 0.93, the AGFI was 0.91, and the RMSEA was 0.58. These values indicate good structural validity for the P-NVI on the seven factors of the scale among the adult population in Tehran.

It is worth noting that in previous studies, the NVI questionnaire had seven subscales or factors. However, in the study by Jacobson et al. in 2020, the seven factor structure was not confirmed [13].

The discriminant validity was assessed to distinguish between the two groups, patients and controls. The results indicated that the mean total score and the scores on the factors of spatial perception, time perception, attention, memory, visual perception, and movement were significantly higher in the patient group compared

to the control group. However, there was no significant difference in the mean score of emotions between the two groups. Therefore, the total score and the six factors of spatial perception, time perception, attention, memory, visual perception, and movement can effectively differentiate between the patient and control groups. This finding confirms the discriminant validity of the questionnaire.

In this study, the questionnaire items were classified using a 5 point Likert scale (4: always, 3: often, 2: sometimes, 1: rarely, 0: never), and each factor consists of 4 questions. If individuals have selected “rarely” for all 4 questions, the average score for that factor would be 4. If they have chosen “sometimes”, the average score would be 8.

Based on this evaluation, the mean scores for the factors of attention and movement, as well as memory, were higher for the patient group compared to the control group, indicating more frequent occurrences of difficulties in these areas. On the other hand, the mean scores for the factors of spatial perception and time perception in the patient group ranged from “never” to “rarely”, while the mean scores for emotions/feelings and visual perception were very low.

Overall, in this study, the mean total score was 25.75, suggesting the overall level of dizziness/vertigo experienced by the participants.

The results of studies conducted by Grimm and Hemenway et al. [19], Brandt et al. [20], Hanes and McCollum [21], Nascimbeni et al. [22], Smith [23], Kremmyda et al. [24], and Black et al. [25], clearly showed that patients with vestibular system damage, in addition to vestibular symptoms, also exhibit various cognitive/emotional symptoms such as memory and attention impairments, cognitive disorders like short-term memory loss, concentration problems, difficulties with word retrieval, and inability to prioritize tasks.

Xie et al. also examined cognitive/mental dysfunction in patients with dizziness /vertigo or imbalance, and the results showed that in more than 60% of the patients, significant cognitive impairments were observed compared to normal individuals. Among the non-cognitive subscales, the movement subscale had higher scores, and among the cognitive subscales, attention had

the most significant and consistent effect, followed by spatial and time perception. Additionally, no significant difference was observed in the memory subscale [26]. In this study, in order to assess reliability, the Cronbach's alpha coefficient and test-retest results were calculated for a one-week interval in 50 participants from the patient group for the entire P-NVI questionnaire and its seven subscales. The Cronbach's alpha coefficient was found to be 0.90 for the total scale, 0.64 for spatial perception, 0.63 for time perception, 0.66 for movement, 0.81 for emotions, 0.70 for attention, and 0.73 for memory and 0.73 for vision. The ICC was also calculated, and it was 0.91 for the total scale, 0.72 for spatial perception, 0.71 for time perception, 0.79 for movement, 0.84 for emotions, 0.78 for attention, 0.81 for memory, and 0.79 for vision, indicating an acceptable and suitable test-retest reliability for the scale and its subscales.

The mean scores for the items ranged from 0.11 for “Finding my way back when going out is difficult for me” to 1.87 for “I have difficulty concentrating”. The questionnaire items were rated on a four-point Likert scale from 0 (never) to 4 (always). The item-total correlations ranged from 0.22 for “Finding my way back when going out is difficult for me” to 0.68 for item 22 (“When reading a text, I lose the line and have to start over”).

The findings of this study were consistent with the results of other studies conducted in French [12], English [13], and Slovenian versions [15]. Lacroix et al. reported a Cronbach's alpha of 0.88 for the total scale, 0.82 for spatial perception, 0.55 for time and movement, 0.77 for emotions, 0.80 for attention, and 0.75 for vision in the original French version [12]. Vozel et al (2020) reported excellent test-retest reliability and a very good Cronbach's alpha for the Slovenian version compared to other questionnaires [15]. Jacobson and colleagues (2020) also confirmed the reliability of the English version of the NVI questionnaire in patients with dizziness in the United States [14].

Although studies on the Turkish (Hatice Seyra Erbek, personal communication) and the Japanese versions (Fumiyuki Goto, personal communication) have been conducted, as no articles from them have been published, it is difficult to rely on their findings. Generally, limited research has been published regarding the validation of NVI in different languages.

The minor changes observed in alpha coefficients are likely due to variations in translation, cultural adaptation of some questions to Persian, and the fact that the patient group, who were mostly referred to Amir Alam Hospital for the evaluation of their vestibular system, did not have serious problems related to dizziness/vertigo.

## Conclusion

The purpose of this study was to develop a Persian version of the Neuropsychological Vertigo Inventory (P-NVI) scale for adults aged 25 to 80 years with dizziness/vertigo and to assess its validity and reliability. The results showed that this scale has excellent validity and reliability. The findings of this study were in good agreement with the results of other studies that used the NVI scale, indicating its strong consistency. Considering these advantages, the P-NVI questionnaire can be used for cognitive assessment in individuals with dizziness/vertigo caused by vestibular dysfunction in all subscales, including spatial perception, time perception, attention, memory, vision, and movement.

## Ethical Considerations

### Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RETECH.REC.1401.612).

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### Authors' contributions

ZA: Study design, acquisition of data, statistical analysis, interpretation of the results, drafting the manuscript; HZ: Study design and supervision, interpretation of the results, and critical revision of the manuscript; NR: Interpretation of the results, and validation the final revision of the manuscript; AAB: Statistical analysis.

### Conflict of interest

There are no competing financial interests.

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