

# Relationship between age, the risk of falling and level of confidence in body balance with semicircular canal function

## Relação entre a idade, o risco de queda e o nível de confiança no equilíbrio corporal com a função dos canais semicirculares

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### ABSTRACT

**Purpose:** to verify the relationship between the risk of falling, the level of confidence in activities involving balance, and age with the values of gain and symmetry of the semicircular canals (SSCs), using the Head Video Impulse Test (vHIT) in patients with peripheral vestibular dysfunction. **Methods:** Cross-sectional study in 12 individuals submitted to functional evaluation using the Activities-specific Balance Confidence Scale (ABC Scale) and the Dynamic Gait Index (DGI), and vestibular evaluation with vHIT. The results were compared using Spearman's Correlation Coefficient. **Results:** There was a predominance of females (75%), with a mean age of 59 years and 8 months. The mean score in DGI was 19.70 points and on the ABC Scale, 43.65%, which is characteristic of a low confidence level. A moderate correlation was observed between age and DGI and between DGI and ABC Scale and SCC gain and symmetry values with vHIT. **Conclusion:** A relationship was observed between a higher risk of falling in patients with vestibular hypofunction and advanced age and between a low level of confidence to perform daily activities due to asymmetrical SCC gain.

**Keywords:** Dizziness; Head impulse test; Labyrinth diseases; Postural balance; Quality of life

### RESUMO

**Objetivo:** verificar a relação entre o risco de queda, o nível de confiança nas atividades que envolvem equilíbrio e a idade com os valores de ganho e simetria dos canais semicirculares (CSCs), por meio do Vídeo Teste do Impulso Cefálico (vHIT), em pacientes com disfunção vestibular periférica. **Método:** estudo transversal, composto por 12 indivíduos submetidos à avaliação funcional por meio da *Activities-specific Balance Confidence Scale (ABC Scale)* e do *Dynamic Gait Index (DGI)* e avaliação vestibular com o vHIT. Os resultados foram comparados por meio do Coeficiente de Correlação de Spearman. **Resultados:** observou-se predomínio do gênero feminino (75%), com média de idade de 59 anos e 8 meses. A média de escore no DGI foi de 19,70 pontos e 43,65% na *ABC Scale*, característico de baixo nível de confiança. Observou-se correlação de grau moderado entre os parâmetros idade com o DGI, DGI e *ABC Scale* com os valores de ganho e simetria dos CSCs do vHIT. **Conclusão:** Observaram-se relações entre o maior risco de queda em pacientes com hipofunção vestibular e idade avançada e entre o baixo nível de confiança para realizar atividades diárias diante da assimetria de ganho dos CSCs.

**Palavras-chave:** Tontura; Teste do impulso de cabeça; Doenças do labirinto; Equilíbrio postural; Qualidade de vida.

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**Conflict of interests:** No.

**Authors' contribution:** GFFN contributed to the collection, data analysis, writing and review of the manuscript; ESS, MCFA and MAMLS contributed to data collection and analysis; EASL was responsible for the statistical analysis of the study; JDJ was responsible for medical evaluation and referral of patients, as well as manuscript review; EBM was responsible for guidance in all stages of the study, data analysis and supervision of article writing.

**Funding:** None.

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**Received:** March 29, 2023; **Accepted:** May 24, 2023

## INTRODUCTION

Dizziness is one of the main symptoms of vestibular dysfunction and may result from a systemic or labyrinth-specific change. It is normally accompanied by imbalance and other complaints that may prevent patients from doing their home, social, and occupational activities<sup>(1)</sup>.

Dizziness and imbalance complaints occur in all age ranges and worsen when associated with organic or systemic impairments. Moreover, aging can contribute to aggravating these symptoms, with a greater risk of falls<sup>(2)</sup>.

Gait is an important activity of daily living, related to many functions. Neural control in gait depends directly on vestibular information – hence, patients with vestibular dysfunction can have abnormal body balance<sup>(3)</sup>.

Clinical, functional, and instrumental tests are important to assess body balance, vestibular function, and impairments in patients with otoneurological complaints. These include the Video Head Impulse Test (vHIT), which measures the vestibulo-ocular reflex (VOR) in the three pairs of semicircular canals (SCCs) and enables the analysis of parameters such as SCC symmetry and the occurrence, amplitude, and latency of compensatory saccades<sup>(4)</sup>. The Dynamic Gait Index (DGI) is a functional test useful to identify the risk of falls<sup>(5)</sup>. As the physical and instrumental assessments, patient-reported result measures furnish important information on how the disease affects their quality of life. These include the Activities-specific Balance Confidence Scale (ABC Scale) provide relevant data on their level of confidence to do tasks that require body balance<sup>(6)</sup>.

Vestibular symptoms like dizziness and imbalance affect about 30% of the world's population. Given the high incidence of these symptoms, this study aimed to verify the relationship between the risk of falls, the level of confidence in activities that require body balance, and age with VOR gain and SCC symmetry in patients with peripheral vestibular dysfunction.

## METHODS

This cross-sectional analytical, descriptive study was approved by the Research Ethics Committee of the Onofre Lopes University Hospital (HUOL) under number 2.809.558. All patients signed an informed consent form.

The patients were submitted to a clinical otoneurological assessment at the HUOL Otorhinolaryngology Outpatient Center, linked to the Federal University of Rio Grande do Norte (UFRN), and were referred for functional and instrumental vestibular assessment at the Hearing and Balance Laboratory (LAEq-UFRN) in the same institution between August 2018 and September 2019.

The sample was selected by convenience, based on the following inclusion criteria: patients whose vHIT resulted in hypofunction in or more SCCs, unilaterally or bilaterally, and with a nosological medical diagnosis of peripheral vestibular dysfunction, according to the analysis of clinical and instrumental otoneurological assessment. The study excluded patients with degenerative chronic diseases, and physical or cervical limitations that hindered them from doing the procedures.

After confirming the otoneurological medical diagnosis, 12 patients met the criteria and were included in the study sample.

Initially, patients answered a previous protocol to survey data on their clinical history and symptomatology. Other medical diagnosis data were collected from their electronic medical record.

VHIT was performed with ICS-Impulse equipment, manufactured by Otometrics®. The parameters considered for analysis were VOR gain and SCC symmetry. Hence, it used the normal VOR gain values – 0.8 ms to 1.20 ms for lateral canals and 0.7 ms to 1.20 ms for vertical canals – and normal SCC symmetry values – lower than 20%<sup>(4)</sup>.

Patients were also submitted to functional balance assessment tests, such as DGI<sup>(5)</sup>, whose eight tasks assess gait in different sensory situations, including flat surfaces, changes in gait speed, vertical and horizontal changes in head position, going ahead of or around obstacles, spinning around their body axis, and climbing up and down. Patients get a score in each task according to their performance, ranging from 0 to 3 points (3 = normal gait; 2 = mild impairment; 1 = moderate impairment; 0 = severe impairment). The maximum overall score is 24 points; scores equal to or below 19 points suggest a risk of falls.

Moreover, they responded to the ABC Scale<sup>(6)</sup>, whose 16 items verify the person's level of confidence to do activities of daily living involving balance. The score ranges from 0 to 100 (0 = no confidence and 100 = total confidence). The higher the score, the greater their confidence to do everyday activities.

Patients with an indication to vestibular rehabilitation were referred for treatment after finishing the research procedures.

Descriptive and inferential data analyses were performed with the Spearman correlation coefficient ( $\rho$ ). The following correlation values were used: weak (0.2 to 0.4), moderate (0.41 to 0.7), and strong (0.71 to 0.9)<sup>(7)</sup>. Results were obtained with SAS® software 9.2. The level of significance was set at a p-value lower than 5%.

## RESULTS

The participants' mean age was 59 years and 8 months, with a minimum of 24 years and a maximum of 79 years. Nine patients (75%) were females, and three (25%) were males.

The following etiological diagnoses were cited: Ménière's disease (MD-41.67%), persistent postural-perceptual dizziness (PPPD-25%), vascular dizziness (8.33%), metabolic dizziness (8.33%), motion sickness (8.33%), and imbalance syndrome in older adults (8.33%).

The mean DGI score was 19.70 points (SD = 3.54), ranging from 13 to 23 points. The mean ABC Scale score was 43.65 (SD = 20.80), with a minimum of 11.87 and a maximum of 85 points.

Also, the ABC Scale classified the level of confidence of nine patients (74.97%) as low, while in three (16.66%) it was moderate and in 1 (8.33%) it was high.

The Spearman correlation analysis of VOR gain and SCCs symmetry with age, DGI, and ABC Scale found some moderate correlations, highlighted in Table 1.

**Table 1.** Distribution of Spearman correlation values between vestibulo-ocular reflex gain and semicircular canal symmetry with age, Dynamic Gait Index, and Activities-Specific Balance Confidence Scale

Variable	AGE		DGI		ABC Scale		
	rho value	p-value	rho value	p-value	rho value	p-value	
SCC VOR gain	Lateral right	<b>0.47286*</b>	0.12	0.01786	0.95	0.13986	0.66
	Lateral left	0.24518	0.44	0.11074	0.73	-0.30769	0.33
	Posterior right	-0.33158	0.29	-0.24513	0.44	<b>-0.42382*</b>	0.16
	Posterior left	-0.01582	0.96	0.07170	0.82	-0.33684	0.28
	Anterior right	0.26889	0.39	-0.36744	0.24	<b>-0.68421*</b>	0.01
	Anterior left	-0.05965	0.85	<b>0.41511*</b>	0.17	-0.04553	0.88
SCC symmetry	Lateral	0.26270	0.40	<b>-0.55727*</b>	0.06	-0.01399	0.96
	Posterior	0.16169	0.61	0.30112	0.34	0.10526	0.74
	Anterior	-0.10702	0.74	-0.33101	0.29	<b>-0.48336*</b>	0.11
	Age	1.00000	X	<b>-0.51888*</b>	0.08	0.15061	0.64

\*Moderate Spearman correlation coefficient (rho)

**Subtitle:** DGI = Dynamic Gait Index; ABC Scale = Activities-Specific Balance Confidence Scale; VOR = vestibulo-ocular reflex; SCC = semicircular canal

## DISCUSSION

Women are more prone to developing vestibular disorders than same-age men due to hormonal and metabolic issues that affect females – particularly during menopause, which can trigger or aggravate vestibular dysfunctions<sup>(8)</sup>.

In this study, MD was the most recurrent medical etiological diagnosis, followed by PPPD. MD is among the peripheral vestibulopathies most diagnosed in specialized outpatient centers, mostly affecting women in their fifth decade of life<sup>(9)</sup>. PPPD is likewise more common in women and may be related to anxiety, depression, migraines, and even MD<sup>(10)</sup>. Both etiologies are associated with impaired vestibular function, which leads to an incomplete central vestibular compensation, causing chronic imbalance and a greater risk of falls<sup>(9,10)</sup>.

The mean DGI score was 19.70 (which is near the risk of falls) in patients with vestibular dysfunction. A study described patients with normal and abnormal DGI scores in VOR gain, which was justified by other processes that help the vestibular compensation mechanisms be active, such as the sensory substitution pathways in the visual and somatosensory systems, which help maintain postural balance, improving their performance in everyday tasks, as in DGI<sup>(11,12)</sup>.

In ABC Scale, the low level of confidence predominated. Another study demonstrated<sup>(13)</sup> that the lower the level of confidence, the greater the fear of falling in patients with vestibular dysfunction. This highlights the importance of assessing balance and the risk of falls in such patients.

The moderate correlation found between variables highlights the relationship between low DGI scores (and, therefore, greater risk of falls) with impaired VOR gain in the anterior left SCC, which is characteristic of hypofunction. This correlation between vHIT and DGI was also found in another study<sup>(12)</sup>, after vestibular rehabilitation.

The negative correlation between lower DGI scores and lateral SCC symmetry characterizes impaired generally unilateral VOR gain, leading to SCC asymmetry and affecting DGI tasks and, consequently, the risk of falls<sup>(12)</sup>.

The correlation that indicated that advanced age makes the patient more susceptible to the risk of falls agrees with another study<sup>(12)</sup>, which highlights the importance of multidisciplinary follow-up on these individuals to prevent the risk of falls and associated complications.

As for the correlation between the higher level of confidence and impaired VOR gain, no study in the researched literature was found for discussion. However, this result is believed to have led volunteers to misunderstand items assessed in the ABC Scale, as most of them had a low level of confidence to do tasks that required balance.

The ABC Scale also correlated with SCC asymmetry, which suggests a relationship between a possible unilateral decompensated vestibular dysfunction and the lower level of confidence in study participants. Vestibular dysfunctions cause symptoms such as imbalance and instability, which impacts the person's functional balance performance, justifying their low levels of confidence<sup>(13)</sup>.

The assessments made in this study with various instruments identified relationships between the greater risk of falls in patients with vestibular hypofunction (with vHIT), the low level of confidence to do activities of daily living due to SCC asymmetry, and the greater risk of falls with advancing age in study participants.

The tests or examinations chosen for otoneurological assessments must be sensitive and appropriate to help reach a diagnosis and outline an intervention program customized to the patient. Such choice also depends on the technological resources needed and available in each health service.

The limitation of this preliminary study was its small sample. It would be necessary to address larger ones, standardizing age ranges and diagnoses. Further research should also use other functional tests and instrumental examinations to contribute to the diagnosis and early treatment of individuals with vestibular dysfunction.

## CONCLUSION

Relationships were found between the patients' greater risk of falls and vestibular hypofunction and between older age and low level of confidence to do activities of daily living, due to gain asymmetry in SCCs.

## ACKNOWLEDGMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) – Finance Code 001.

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