Postural control behavior in women with dizziness

Comportamento do controle postural em mulheres com tontura

Comportamiento de control postural en mujeres con mareos

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ABSTRACT
Vestibular dysfunctions normally manifest as dizziness, which is characterized by a subjective body balance disturbance. The present study aimed to analyze the
influence of women’s self-perception of the level of dizziness on their postural behavior. This cross-sectional research was conducted with women 30 years old or more with a complaint of dizziness for at least three months. Anthropometric data were collected, as well as information on the level of dizziness and static postural control assessment (both with eyes open and closed). The descriptive and inferential analyses of the data were carried out with the SPSS 23.0 software. The clinical test scores were submitted to the Kolmogorov-Smirnov normality test and Student’s t-test for independent samples. The sample comprised 59 women, mean age 69.05 (±13.77) years. Regarding intensity, 37.2% had mild dizziness, 32.2% had moderate dizziness, and 30.5% had severe dizziness. The balance motor control pattern identified a lower limb prevalence on the total sway surface of the elliptic area both with eyes open (p = 0.012) and closed (p = 0.024), as well as anteroposterior sway with eyes open in the group with severe dizziness (p = 0.041). The self-perception of the level of dizziness influenced these women’s postural behavior.

Keywords: imbalance, dizziness, posture, postural balance.

RESUMO
As disfunções vestibulares normalmente se manifestam como tontura, que se caracteriza por um distúrbio subjetivo do equilíbrio corporal. O presente estudo teve como objetivo analisar a influência da autopercepção das mulheres sobre o nível de tontura no seu comportamento postural. Esta pesquisa transversal foi realizada com mulheres de 30 anos ou mais com queixa de tontura há pelo menos três meses. Foram coletados dados antropométricos, informações sobre nível de tontura e avaliação do controle postural estático (tanto com olhos abertos quanto fechados). As análises descritivas e inferenciais dos dados foram realizadas no software SPSS 23.0. Os escores dos testes clínicos foram submetidos ao teste de normalidade Kolmogorov-Smirnov e ao teste t de Student para amostras independentes. A amostra foi composta por 59 mulheres, com idade média de 69,05 (±13,77) anos. Quanto à intensidade, 37,2% apresentaram tontura leve, 32,2% tontura moderada e 30,5% tontura grave. O padrão de controle motor equilíbrio identificou prevalência de membros inferiores na superfície de oscilação total da área elíptica tanto com olhos abertos (p = 0,012) quanto fechados (p = 0,024), bem como oscilação anteroposterior com olhos abertos no grupo com tontura grave (p = 0,041). A autopercepção do nível de tontura influenciou o comportamento postural dessas mulheres.

Palavras-chave: desequilíbrio, tontura, postura, equilíbrio postural.

RESUMEN
Las disfunciones vestibulares normalmente se manifiestan como mareos, que se caracterizan por una alteración subjetiva del equilibrio corporal. El presente estudio tuvo como objetivo analizar la influencia de la autopercepción de las mujeres sobre el nivel de mareo en su comportamiento postural. Esta investigación transversal se realizó con mujeres de 30 años o más con quejas de mareos durante al menos tres meses. Se recogieron datos antropométricos,
así como información sobre el nivel de mareo y valoración del control postural estático (tanto con los ojos abiertos como cerrados). Los análisis descriptivos e inferenciales de los datos se realizaron con el software SPSS 23.0. Los puntajes de las pruebas clínicas se sometieron a la prueba de normalidad de Kolmogorov-Smirnov y a la prueba t de Student para muestras independientes. La muestra estuvo compuesta por 59 mujeres, edad media 69,05 (±13,77) años. En cuanto a la intensidad, el 37,2% presentó mareos leves, el 32,2% presentó mareos moderados y el 30,5% presentó mareos severos. El patrón de control motor del equilibrio identificó una prevalencia de miembros inferiores en la superficie total de balanceo del área elíptica tanto con los ojos abiertos (p = 0,012) como cerrados (p = 0,024), así como balanceo anteroposterior con los ojos abiertos en el grupo con mareos severos. (p = 0,041). La autopercepción del nivel de mareo influyó en el comportamiento postural de estas mujeres.

**Palabras clave:** desequilibrio, mareos, postura, equilibrio postural.

### 1 INTRODUCTION

Postural control has been defined as a set of processes through which the central nervous system performs the necessary muscle activities to regulate the relationship between the center of mass and the base of support. The harmonic interaction between various systems of the organism – e.g., the visual, vestibular, and somatosensory ones – enables additional information to be sent to the nervous system, thus allowing for the necessary balance adjustments\(^1\). Balance depends on various sensory inputs, and a flaw in any of the systems involved may lead to postural imbalance and, consequently, falls\(^2\).

The vestibular system is quite complex and works together with other systems of the human body to perform three important functions, namely: stabilization of the image on the retina, postural adjustment, and gravitational orientation. For these to happen, information on the head position and movement, which is detected by the labyrinth, must be provided. When its function is interrupted, unpleasant sensations occur, such as nausea, dizziness, vertigo, imbalance, and nystagmus\(^3\). The vestibulopathies encompass the diseases with changes in body balance, of either peripheral or central origin. When caused by vestibular system
disorders, they are called peripheral vestibulopathy, which represent most of the cases of changes in balance\textsuperscript{4,5}. Statistical data reveal that approximately 85\% of the cases of dizziness are of peripheral origin, triggered by a vestibular system dysfunction\textsuperscript{6,7}. The vestibular dysfunctions commonly manifest as dizziness, characterized by a subjectively disturbed body balance – which is an important risk factor for falls\textsuperscript{8,9}.

The balance changes must be analyzed considering all the clinical variables that may potentially be changed. Patients with vestibulopathies must be assessed regarding both their living habits and underlying diseases – such as cardiovascular, metabolic, and hormonal problems, depression and anxiety symptoms, sensory condition, and postural changes – to identify factors that lead to imbalance. When there are various simultaneous affections (which is common in older people), each one must be considered as a possible etiologic factor for vestibulopathy\textsuperscript{10,11,12}. This study aimed to analyze the influence of women’s self-perception of the level of dizziness on their postural behavior.

\section*{2 METHODOLOGY}

\subsection*{2.1 STUDY DESIGN/SAMPLE CHARACTERISTICS}

This cross-sectional research was conducted in the Genetics Research Laboratory at the State University of Goiás, Brazil – ESEFFEGO campus. It was approved by the Research Ethics Committee of the State University of Goiás, under CAAE number: 03689518.0.0000.8113. The volunteers agreed to participate in the research and signed the informed consent form (ICF). The data was collected between March and August 2019, in the municipality of Goiânia, Goiás, Brazil.

The following inclusion criteria were considered: (1) women; (2) at least 30 years old; (3) with a complaint of dizziness for at least three months; (4) able to walk independently. People with (1) neurological diseases; (2) central
vestibulopathies; (3) uncorrected visual dysfunction; (4) or undergoing some type of treatment for dizziness in the preceding months were excluded from the study.

2.2 INSTRUMENTS AND PROCEDURES

Information on dizziness was collected based on the patients' reports. They answered a questionnaire on the intensity of the dizziness, movements that triggered or worsened the symptoms, and history of treatment for dizziness. Information on weight, height, and body mass index (BMI) was also collected, as well as their history of surgeries, diseases, and lesions. The clinical assessment protocol included the visual analog scale (VAS) for dizziness and postural control assessment with a force platform.

The symptom of dizziness was assessed with VAS – a procedure in which the patient marks, in a line numbered from zero to ten, the point that best relates to their symptom. In this case, zero corresponds to no symptom, and ten, to maximum symptoms. The participants in the study were divided into three groups regarding their VAS score, as follows: mild dizziness (zero to three points), moderate dizziness (four to seven points), and severe dizziness (eight to ten points)\textsuperscript{13,14,15}.

The participants' postural control was assessed with a pressure platform (Footwork IST Informatique, manufactured by Arkipelago). Its various movement sensors assess the pressure distribution at different points of the plantar region, such as mean pressure, peak pressure, and foot surface area. The polycarbonate-covered device dimensions 565 x 420 x 25 mm, active surface 490 x 490 mm, with capacitive sensors 4096 / 6x6, frequency of 200 Hz and maximum pressure per sensor of 120 N/cm\textsuperscript{2}, Footwork Pro\textsuperscript{®} software. It assesses postural instability and can be used in different testing conditions, such as eyes open, eyes closed, and with the platform on unstable surfaces. The platform is guided by the Footwork program, a professional analysis system that furnishes real-time data. The anteroposterior and latero-lateral body sways were analyzed with stabilometry\textsuperscript{16}. The sample was instructed to remain in bipedal
stance, their feet slightly apart, in a comfortable position, and their arms hanging beside the body. The test lasted 30 seconds and was individually conducted in two conditions: eyes open and eyes closed.

2.3 DATA ANALYSIS

The descriptive and inferential analyses of the data were performed with the SPSS 23.0 software. The clinical test scores were submitted to the Kolmogorov-Smirnov normality test. The data with non-normal distribution (p < 0.05) underwent logarithmic transformation. The variables were submitted to Student’s t-test for independent samples. The groups were compared in pairs (mild with moderate dizziness; moderate with severe dizziness; mild with severe dizziness). The 95% statistical confidence level was used.

3 RESULTS

The sample comprised 59 women – mean age 69.05 (±13.77) years, minimum 31 and maximum 93 years. Approximately 48.6% of the total sample wore corrective lenses. The mean BMI was 26.21 (±4.19) kg/m², which points to overweight. In the present sample, the mean VAS score was 5.05 (±2.75) – minimum 1 and maximum 10 points.

Regarding intensity, 37.2% had mild dizziness, 32.2% had moderate dizziness, and 30.5% had severe dizziness. When asked what movements aggravated their dizziness, 66.7% of the sample reported their symptoms worsened with quick movements, and 53.3% when they bent forward. No significant differences between age and level of dizziness were found.

The balance measured with stabilometry identified a prevailing lower limb pattern in the group with severe dizziness in the elliptic surface both with eyes open (p = 0.012) and closed (p = 0.024). The elliptic area was greater in the group with severe dizziness, both with eyes open and closed. As for body sway, there was a significant difference in the anteroposterior direction with eyes open in the
group with severe dizziness \( (p = 0.041) \) in relation to the group with mild dizziness, observed in the elliptic radius, as described in Table 1.

Table 1. Comparison of the data obtained with stabilometry with eyes open and sensitized eyes closed, in relation to the level of dizziness.

<table>
<thead>
<tr>
<th>Levels of dizziness</th>
<th>Comparisons between levels of dizziness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild ((n=22))</td>
<td>Moderate ((n=19))</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>EO</td>
<td></td>
</tr>
<tr>
<td>Elliptic Surface</td>
<td></td>
</tr>
<tr>
<td>(cm²)</td>
<td></td>
</tr>
<tr>
<td>(±3.11)</td>
<td>3.96 (±5.71)</td>
</tr>
<tr>
<td>Elliptic AP Radius</td>
<td></td>
</tr>
<tr>
<td>(cm)</td>
<td></td>
</tr>
<tr>
<td>1.73 (±0.61)</td>
<td>1.88 (±1.21)</td>
</tr>
<tr>
<td>Elliptic LL Radius</td>
<td></td>
</tr>
<tr>
<td>(cm)</td>
<td></td>
</tr>
<tr>
<td>1.58 (±1.30)</td>
<td>1.82 (±1.32)</td>
</tr>
<tr>
<td>EC</td>
<td></td>
</tr>
<tr>
<td>Elliptic Surface</td>
<td></td>
</tr>
<tr>
<td>(cm²)</td>
<td></td>
</tr>
<tr>
<td>(±2.26)</td>
<td>2.65 (±2.98)</td>
</tr>
<tr>
<td>Elliptic AP Radius</td>
<td></td>
</tr>
<tr>
<td>(cm)</td>
<td></td>
</tr>
<tr>
<td>1.74 (±0.69)</td>
<td>1.72 (±0.85)</td>
</tr>
<tr>
<td>Elliptic LL Radius</td>
<td></td>
</tr>
<tr>
<td>(cm)</td>
<td></td>
</tr>
<tr>
<td>1.50 (±1.59)</td>
<td>1.59 (±1.77)</td>
</tr>
</tbody>
</table>

Values referring to the t-test for independent samples. EO: testing condition with eyes open; EC: testing condition with eyes closed; SD: standard deviation; AP: anteroposterior; LL: laterolateral.

Source: Prepared by the author, 2019

4 DISCUSSION

The analysis of the comparison of results in the present sample reveals that the self-perception of the level of dizziness influenced the postural control pattern in the analyzed groups. Also, the group with severe dizziness had greater elliptic surfaces both with eyes closed and open, besides higher postural sway indexes in the anteroposterior direction with eyes closed.

When assessing patients with vestibular dysfunctions, it is expected that a reduction in visual and/or proprioceptive stimuli will lead to an increase in postural sway. Visual afferences are estimated to reduce body sway by 50\%\textsuperscript{16}. However, this study identified differences in both visual conditions. The findings verified that more weight was loaded on the left forefoot with eyes open in the group with mild dizziness than in the group with moderate dizziness. With eyes closed, less
weight was loaded on the right hindfoot in the group with moderate dizziness than in the group with severe dizziness. Valero et al. describe the predominance of weight loaded on the left lower limb as characteristic of adaptations to maintain a dynamic balance in older adults at greater risk of falls.

In the present sample, 84.7% were older than 60 years, and 48.6% wore corrective lenses due to visual dysfunctions. Most of the time, these visual deficits are associated with the risk of falls – particularly in older adults, as the contribution of vision to postural control increases with age. Hence, when there are visual disturbances or diseases of the retina, such control is impaired. The study by Shäfer et al. used baropodometry to assess static balance in 19 physical therapy students to analyze the influence of vision on that parameter. The result of the study showed that, in those 19 people, the change from eyes open to eyes closed had little impact on the balance assessment – i.e., although vision is suggested as an important factor to maintain balance, it had no significant relationship in the present study.

Elliptic surface follow-up is an important clinical practice parameter, as indications of an increased elliptic area may be associated with loss in postural stability. The body balance of people with vestibulopathies tends to grow worse as the sensory conditions become more challenging. In the present sample, the lack of visual input combined with a higher level of dizziness resulted in greater postural instability. It is known that the visual system furnishes important information on the environment and objects, which is essential to maintain posture. Nevertheless, even in the absence of vision, it is possible to maintain satisfactory postural control. Body balance is better when both feet are on the ground because of the peripheral information provided by the feet’s contact with the floor, sending information on the environment to the central nervous system.

The findings in this study indicated that people with severe dizziness had a greater mean anteroposterior sway when compared with the group with mild symptoms. This reveals that these people’s self-perception of the level of dizziness influenced their postural control. Body balance results from the summed postural control actions that stabilize the center of gravity. The
distribution of the center of pressure results from neuromuscular adjustments responding to sways\textsuperscript{21}. When deprivation of one of the systems occurs, such as in vestibular dysfunctions, the postural control is impaired.

The greater anteroposterior sway is similar to that found by Varela et al.\textsuperscript{21}, who assessed body sway in 23 healthy women and 15 women with vestibular dysfunction. The data picked up with static posturography revealed greater anteroposterior sways, in both stable and unstable surfaces, in the group with peripheral vestibular dysfunctions. Similar results were also described by Bastos et al.\textsuperscript{23}, who assessed a sample of 22 patients with a complaint of dizziness and a control group with 25 healthy subjects. They observed a greater displacement of the anteroposterior center of pressure in the group with dizziness, with greater orthostatic instability when compared with a healthy group. The present study obtained different results from those of Bastos et al.\textsuperscript{23}, in which the anteroposterior sway was greater in the group with dizziness and without the visual system.

The means of the elliptic surface were directly proportional to the level of dizziness – the group with severe dizziness had higher means when compared with the other groups, both with eyes open and closed. The increase in the elliptic surface in women with severe dizziness is suggestive of greater postural instability. The results in this study are similar to those found by Bueno et al.\textsuperscript{24}, who assessed a group of 62 older women to compare the effect of Pilates and multimodalities on their muscle strength and balance. No significant differences were identified in it regarding elliptic area oscillation, in either of the conditions.

The greater anteroposterior body sway in the group with severe dizziness may be related to the impairments in the vestibular system of the present sample. The subjects with peripheral vestibular disorders and complaints of vertigo and dizziness mainly manifest these as postural balance sways, gait disorders, falls, and reduced stability limit and functional capacity\textsuperscript{25}. Dizziness gives the person a false perception of body movement, changing the sensory responses to control the posture. This finding corroborates the results described by Clapp and Wing\textsuperscript{26}, who stated that higher anteroposterior sway values are approximately twice as
often as those of latero-lateral sways, thus suggesting greater lateral stability with bipedal support. Lateral sways are suggestive of dysfunctions in the central nervous system – hence, the findings in the present sample are characteristic of normal body sways\textsuperscript{26}.

It should be highlighted that this study used dizziness-related data collected from the patients' reports. Dizziness is a subjective and unspecific symptom that can only be accurately diagnosed with clinical examination. The subjectivity of the participants’ judgment must be considered, as well as the temporality of the complaints. Nonetheless, we restate the relevance of using subjective assessment instruments in clinical practice, as they can quantify the person’s self-perception concerning their symptoms, which is hardly identified in clinical and laboratory examinations.

5 CONCLUSION

This study found that women's postural behavior was influenced by their self-perceived level of dizziness, with greater anteroposterior postural sway observed in women with higher VAS scores, indicating increased postural instability. Understanding this link could lead to more effective interventions, improving the quality of life for affected women. Healthcare professionals can use this information to create personalized rehabilitation programs aimed at reducing postural instability and fall risk. The study's limitations include the subjectivity of self-reported dizziness and the focus on women, which may limit applicability to men. The variability of dizziness symptoms over time should also be considered. Future research should include a more diverse sample, incorporating men, to determine if results are consistent across genders. Longitudinal studies are needed to understand changes in dizziness and postural behavior over time, and it would be beneficial to assess the effectiveness of various therapeutic interventions for reducing postural instability in individuals with dizziness.
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Optional section, where the author can thank the funding agencies, or other applicable thank you.
REFERENCES


