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DOI: 10.4103/jehp.jehp_468_24

# An observational study to find out the relationship between the types of headaches and balance dysfunction by using Fukuda test among young individuals

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## Abstract:

Headache disorders are reported by more than 50% of adults during the previous year in India. In addition to their great prevalence, the World Health Organization lists them as among the top ten conditions that are the most disabling. The high disability levels among headaches can also occur with several conditions such as vestibular symptoms, and balance alterations. Among these, balance dysfunction is often verified in patients with migraine, followed by tension-type and cervicogenic headaches. With this background in mind, the present study aims to use the Fukuda stepping test (FST) to look at the occurrence of balance disturbances in headache patients. A total of 40 headache subjects aged between 18 and 25 years volunteered to participate as subjects in this study according to the inclusion and exclusion criteria. Headache questionnaire and Headaches Impact Test scale were used to analyze the severity of headache in each subject. The FST is used for analyze balance dysfunction in headaches subject and it helps to identify vestibular system weakness by observing any deviation of the body while an individual performs the test. The Four-Stage Balance Test is used to assess an individual's ability to maintain balance and control in various positions and movements, helping to identify any deficits in their balance. Using Pearson's correlation coefficient, a weak positive correlation ( $r = 0.273$  and  $P \leq 0.005$ ) was observed between Headache Impact Test (HIT) scores in F50 and F100. The relationship between FSBT in F50 and F100 also shows a moderate negative correlation ( $r = -0.516$  and  $P \leq 0.005$ ) and is statistically significant. The study shows that individuals experiencing headaches exhibited balance disturbances when they performed the FST, indicating a potential association between headaches and balance.

## Keywords:

BMI, Fukuda stepping test, headache, HIT-6, postural balance

## Introduction

Headache disorders are reported by more than 50% of adults during the previous year in India. In addition to their great prevalence, the World Health Organization lists them as among the top 10 conditions that are the most disabling. Headaches are a pretty common condition that almost

everyone will suffer at some point in their lives.<sup>[1]</sup> According to International classification of headache disorder- II (ICHD-II), headaches are classified into primary headaches, secondary headaches, cranial neuralgia, and facial pain. The high disability levels among headaches can also occur with several conditions such as mental health disorders, neck pain, vestibular

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**How to cite this article:** Riyas Basheer KB, Archana TH, Premkumar M, Madhuripu P, Arunkrishnan VR, Kolar R. An observational study to find out the relationship between the types of headaches and balance dysfunction by using Fukuda test among young individuals. J Edu Health Promot 2024;13:493.

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Received: 11-03-2024  
Accepted: 06-05-2024  
Published: 28-12-2024

symptoms, and balance alterations. Among these, balance dysfunction is often verified in patients with migraine, followed by tension-type and cervicogenic headaches.<sup>[1]</sup>

A main headache illness called migraine can impair the vestibular system of the inner ear, which in turn affects how the brain regulates balance and how a person perceives their surroundings.<sup>[2]</sup> When this system is not functioning properly, a person may feel unsteady, dizzy, or vertigo, which might be brought on by movement. Balance dysfunction is one of the components causing migraine headaches.<sup>[3]</sup>

The capacity to keep the center of mass of the body above the base of support is known as balance.<sup>[4]</sup> The three components of balance comprise the visual system, the proprioceptive system, and the vestibular system. In this, the vestibular system mainly helps to control balance. The balance and sense of orientation in space are controlled by the vestibular system, a sophisticated sensory system. It is situated in the vestibular labyrinth, an area of the inner ear.<sup>[5,6]</sup>

The Fukuda stepping test (FST), a vestibulospinal examination, has been proposed as a gauge of asymmetric labyrinthine function. It is the test to find out if one side of the body has a weak vestibular system. It has been demonstrated that the walking test with closed eyes is more sensitive than the Romberg test, which calls for the patient to remain stationary while keeping his or her eyes closed.<sup>[7]</sup> The purpose of the study was to use the FST to look at the occurrence of balance disturbances in headache patients.

## Materials and Methods

### Study design and setting

The current observational study was conducted at Mangalore, Karnataka during the eight months from Feb 2023 to Oct 2023.

### Study participants and sampling

A total of 40 headache subjects aged between 18 and 25 years volunteered to participate as subjects in this study according to the inclusion and exclusion criteria (40 out of 160). Subjects between the ages of 18–25 years with a history of headaches of both genders were included and gait difficulties arising from orthopedic or spinal disorders, syndromes, or neurological diseases that affect balance, history of traumatic brain injury, or any musculoskeletal injury were excluded from the study.

Sample size was calculated by considering the study of Gabriela Carvalho, et al. (2022)<sup>[8]</sup> and they observed 80% self-reported body instability among young individuals with migraine, at a 95% confidence level and absolute

precision of 13%, and the estimated sample size was 36, this was further rounded off to 40 considering a 10% drop-outs. The formula used was  $N = [(Z_{1-\alpha/2})^2 \times P(1-P)]/l^2$ , where  $(Z_{1-\alpha/2})^2 = 1.96$ ,  $P = 80\%$  and  $l = 13\%$ .

### Data collection tool and technique

Headache questionnaire and Headaches Impact Test scale were used to analyze the severity of headache in each subject. The FST is using for analyze balance dysfunction in headache subjects and it helps to identify vestibular system weakness by observing any deviation of the body while an individual performs the test. The Four-Stage Balance Test is used to assess an individual's ability to maintain balance and control in various positions and movements, helping to identify any deficits in their balance.

### Outcome measures

FST: involves having the patients stand straight, stretch both arms and take 50–100 steps while keeping their eyes closed. After completing the FST, compare the angle of a short piece of tape placed along the front of your toes with the angle of your initial line. An angle of 30 degrees or more after 50 steps may indicate vestibular impairment on the side of the body turned, and an angle exceeding 45 degrees after 100 steps suggests single-sided vestibular impairment during the Fukuda test.

*The Four-Stage Balance Test:* is based on a person's capacity to maintain four positions that get progressively harder (it assesses static equilibrium). Stand with your feet side by side, Place the instep of one foot so it is touching the big toe of the other foot, Tandem stance place one foot in front of the other, heel touching toes, stand on one foot. Not being able to hold the tandem stance for 10 seconds is an indication of an increased risk of fall.

*HIT:* is a tool designed to assess how headaches affect the capacity for work, study, home life, and social interaction. Headache Impact Test (HIT) score (%) interpreted as  $\leq 49$  showing little or no impact, 50–55 mild impact, 56–59 substantial impact, and  $\geq 60$  with severe impact.

### Statistical analysis

All the data were analyzed by SPSS 21.0. The normality test was evaluated by using Shapiro–Wilk and found that data followed a normal distribution. All the quantitative data and descriptive analysis were expressed in mean and standard deviation (age, height, weight, BMI, HIT score, F50 score, and F100 score), and qualitative data was expressed in percentage (gender, Fukuda 50 deviation, Fukuda 100 deviation, and FSBT stages). The relationship between the variables was evaluated by using the Pearson correlation coefficient. The significant level of the study was 95% C.I ( $P < 0.05$ ).

## Results

The literature review was summarized in Table 1, which give the importance of understanding the importance of current study. The demographic data of the study, relationship of HIT score on Fukuda stepping test and relationship of FSBT with Fukuda stepping test were tabulated in Table 2, Table 3 and Table 4 respectively.

Figures 1-11 shows the headache characteristics of the study participants, Figures 12 and 13 indicates the Fukuda stepping test results, Figure 14 and 15 illustrates the results of four stage balance test, whereas Figure 16 represents the types of headache based on IHS criteria.

## Discussion

The purpose of the study was to determine whether specific headache sub-diagnosis and/or the presence of vestibular symptoms can indicate balance dysfunction in headache patients by using the Fukuda test.

The study's results indicate a fair to moderate positive statistically significant correlation between HIT scores at F50 and F100, as well as a moderate to good negative statistically significant correlation between the FSBT

scores at F50 and F100. These findings suggest that individuals experiencing headaches, particularly migraine, tension-type, and cluster-type headaches, may exhibit balance disturbances as assessed by the Fukuda test.

Among the 40 participants aged 18 to 25 years with headaches, the current study found that the majority experienced severe headaches, as indicated by high HIT scores ( $67.75 \pm 7.94$ ). The analysis of the headache questionnaire revealed that many participants reported high-intensity headaches, with migraine (45%), tension-

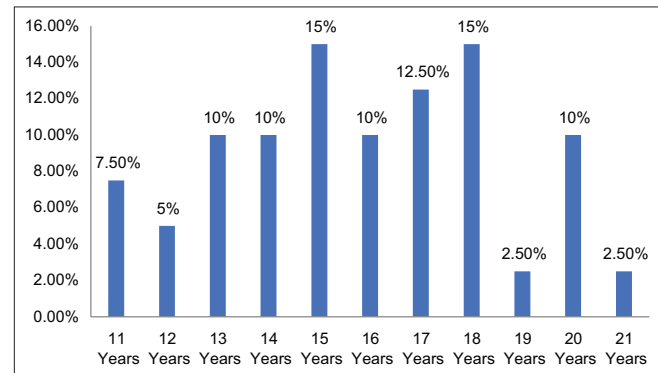


Figure 1: Onset of headache (age)

Table 1: Literature review

Authors	Conclusion
Carvalho G F, et al. (2022) <sup>[8]</sup>	Patients with migraines, particularly those experiencing aura and chronic migraines, displayed signs of balance impairment, but this impairment was not associated with a diagnosis of vestibular migraine.
Carvalho G F, et al. (2017) <sup>[9]</sup>	The presence of aura and chronicity negatively influence the postural control performance in relation to patients without aura and controls.
Rossi C, et al. (2005) <sup>[10]</sup>	The study demonstrated that postural abnormalities are effectively present in over half of the headache patient group, and notably, the tension-type headache (TTH) group exhibits increased postural sway accompanied by proprioceptive alterations.
Carvalho G F, et al. (2013) <sup>[11]</sup>	Aura has a detrimental impact on the static balance of individuals with migraine. While migraine itself, both with and without aura, impairs mobility and often results in the prevalent symptom of dizziness.
L Bernetti, et al. (2018) <sup>[12]</sup>	Migraineurs, who have never complained about vertigo, dizziness, or imbalance, show an alteration of the vestibular system, at low and high frequency of stimulation.
Leslie Palma Gorski, et al. (2019) <sup>[13]</sup>	Patients with vestibular migraine showed compromised body balance at the static posturography test.
Carlyn Patterson Gentile, et al. (2023) <sup>[14]</sup>	Measuring a larger range of headache-related symptoms revealed symptom clustering and a substantial connection with headache load.
Stokell R, et al. (2011) <sup>[15]</sup>	Subjects with higher levels of pain and disability, as well as dizziness handicap, may have greater deficits, as significant moderate correlations were observed between dizziness handicap and measures of tandem walk, and stairs.
Asai M, et al. (2009) <sup>[16]</sup>	Individuals with migraine or tension-type headaches have subclinical deviations of the subjective visual vertical, which may be related to their subjective imbalance.
Lipton R B, et al. (2011) <sup>[17]</sup>	CM occurs less commonly in adolescents than in adults, but adolescents, like adults, are highly affected by the disorder.
Ishizaki K, et al. (2002) <sup>[18]</sup>	Patients with migraine had a considerable increase in body sway, indicating an underlying vestibulospinal system malfunction.
Reilly, et al. (2010) <sup>[19]</sup>	Sensorineural hearing loss, syncope, and headache all have significant connections in children with balance issues.
Y Sai Sudha Samaja, et al. (2020) <sup>[20]</sup>	The Fukuda walking test is not a reliable tool for diagnosing side vestibular impairment in college students.
Cohen J M, et al. (2011) <sup>[21]</sup>	Vestibular migraine is a diverse illness with varied symptomatology.
Sremakaew M, et al. (2018) <sup>[22]</sup>	This study concluded that those with cervicogenic headache and migraine have reduced balance while standing.

type headaches (42.50%), and cluster-type headaches (12.50%) being the most prevalent types.

We assessed the balance function in these participants using the FST and the Four-Stage Balance Test. When analyzing the FST, a notable observation was that the majority of participants exhibited a leftward deviation (57.50%). Furthermore, in the Four-Stage Balance Test, it was observed that most participants successfully completed all four stages (55%), while a subset of participants could only complete up to the third or second stage. It provides a potential relationship between balance dysfunction and headache types.

Currently, several researchers manifest the correlation between postural control and different types of headaches. There are some studies assessing the balanced sensory organization among patients with migraine. Migraine has been associated with vestibular symptoms and balance dysfunction. Patients with migraine, particularly those with chronic migraine, may experience vestibular symptoms and disturbances in balance.<sup>[8,10]</sup>

Rossi C, et al. (2005) conducted a study on balance disorders in headache patients, and stabilometric parameters are used to assess equilibrium disturbances in headache patients under various conditions such as eye closed and eye open. The postural instability may be linked to alterations in proprioceptive inputs, particularly from the cranio-cervical area, and is

exacerbated when visual information is lacking, such as when the eyes are closed. These insights shed light on the mechanisms underlying balance disturbances in individuals with tension-type headaches. The study's findings revealed that more than half of the headache patients exhibited postural abnormalities. Notably, the tension-type headache (TTH) group displayed increased postural sway coupled with changes in proprioception, indicating that balance issues were prevalent in this particular subgroup of headache sufferers.<sup>[10]</sup> L Bernetti, et al. (2018), in their study, proved that migraineurs, who have never complained about vertigo, dizziness, or imbalance, show an alteration of the vestibular system, at a low and high frequency of stimulation.<sup>[12]</sup>

Balance factors play a critical role in maintaining an individual's stability and preventing falls or loss of equilibrium.<sup>[5]</sup> The FST is a diagnostic tool used to assess an individual's balance and detect any abnormalities or impairments in their vestibular system, which is closely related to balance control. It helps to identify vestibular system weakness by observing any deviation of the body while an individual performs the test.<sup>[7]</sup> The FST primarily assesses the function of the vestibular system, which includes the inner ear and its connections to the brain.<sup>[23]</sup> The vestibular system plays a crucial role in detecting changes in head position and motion, providing information to the brain for balance control. Any dysfunction in the vestibular system can lead to balance issues, which may be detected through the Fukuda test. Proprioception refers to the body's ability to sense its position and movement in space.<sup>[6]</sup> Impairments in proprioception can affect balance and may be revealed during FST.

**Table 2: Demographic data of the study subjects**

Variables	Mean±SD (n=40)
Age (Years)	20.65±1.36
Male/Female	12 (30%)/28 (70%)
Height (cm)	158.94±10.27
Weight (kg)	52.0±10.38
BMI (kg/M2)	20.51±3.64
HIT Score	67.75±7.94
Fukuda 50 (Degree)	21.37±14.63
Fukuda 100 (Degree)	34.0±22.75

**Table 3: Relationship between HIT score and Fukuda stepping test**

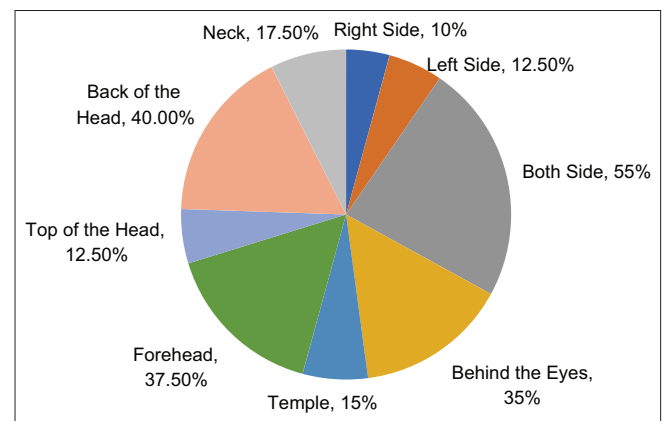
Variables		Fukuda 50			Fukuda 100		
		Total	Males	Females	Total	Males	Females
HIT	r	0.273	0.276	0.320	0.479	0.446	0.485
Score	Sig.	0.033*	0.006*	0.009*	0.012*	0.003*	0.003*

\*Statistically significant (P<0.05)

**Table 4: Relationship between Four-Stage Balance Test and Fukuda stepping test**

Variables		Fukuda 50			Fukuda 100		
		Total	Males	Females	Total	Males	Females
Four-Stage Balance Test	r	-0.516	-0.506	-0.526	-0.637	-0.612	-0.662
	Sig.	0.002*	0.001*	0.001*	0.001*	0.001*	0.001*

\*Statistically significant (P<0.05)



**Figure 2: Location of headache**

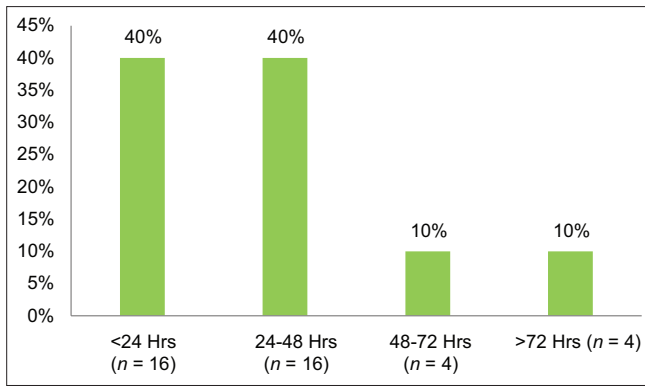


Figure 3: Duration of headache

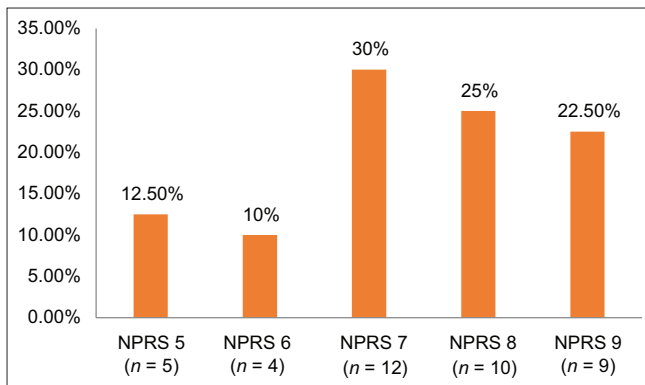


Figure 5: Intensity of headache

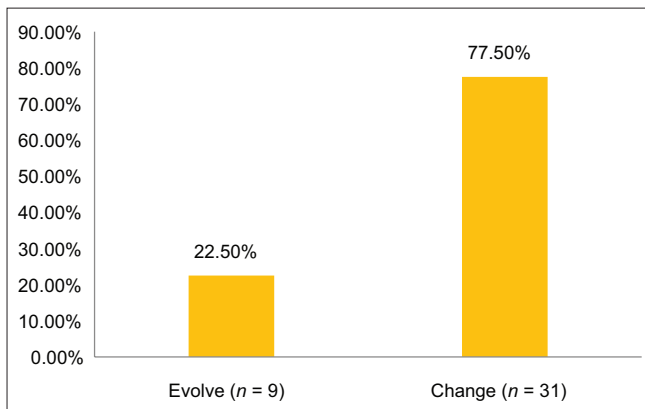


Figure 7: Course of headache

Most participants in the study exhibited a leftward deviation in the FST at both F50 and F100. The leftward deviation may indicate a bias or asymmetry in the functioning of the participants' vestibular systems. It is possible that the majority of participants have a dominant right side, which could influence motor control and balance. The leftward deviation may be related to a preference for using the right side for balance corrections. It provides valuable insights into the relationship between balance dysfunction and headache types.

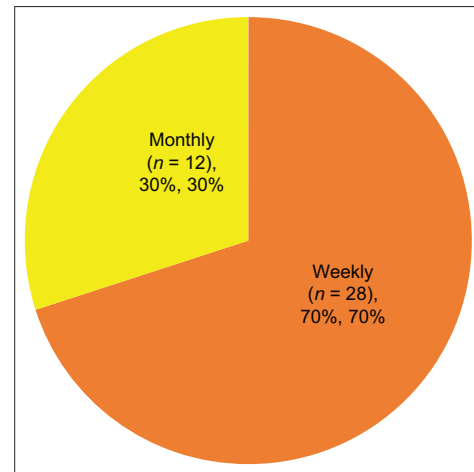


Figure 4: Frequency of headache

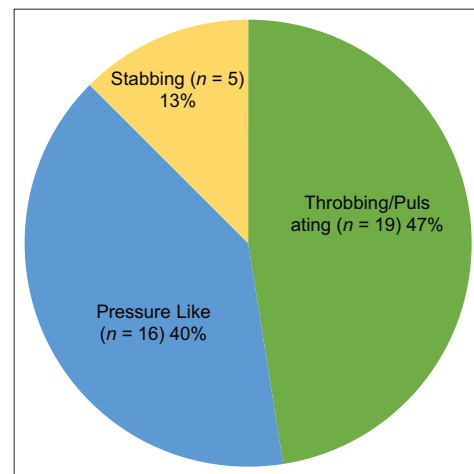


Figure 6: Pain characteristics of headache

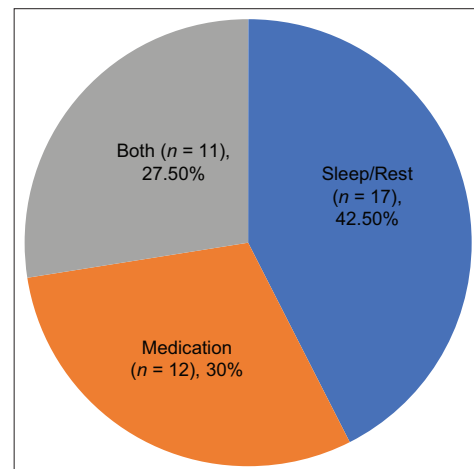


Figure 8: Headache management

The study's results corroborate some existing research that has explored the connection between headaches and balance issues. Prior studies have also suggested a link between vestibular system dysfunction and certain



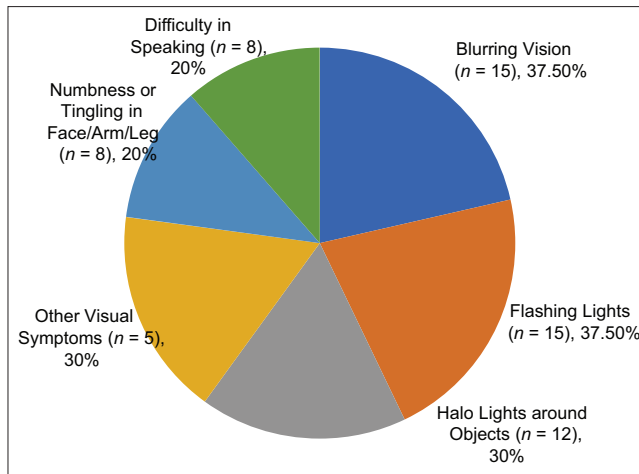


Figure 9: Symptoms of headaches

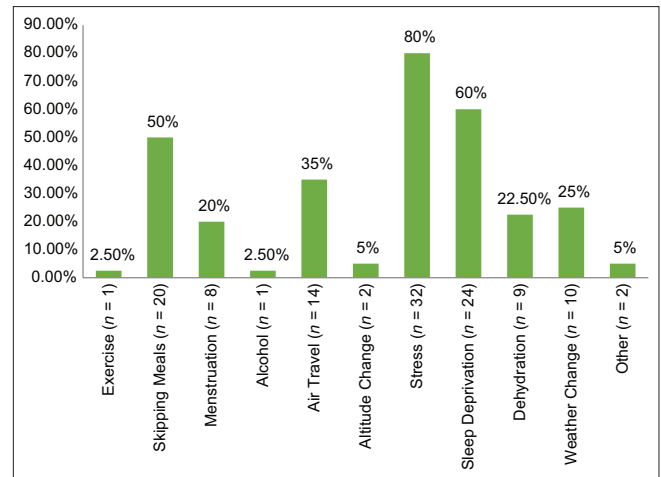


Figure 10: Trigger factors of headache

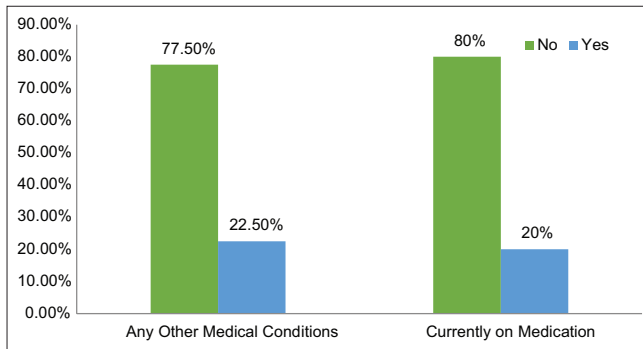


Figure 11: Medical history and pharmacological status

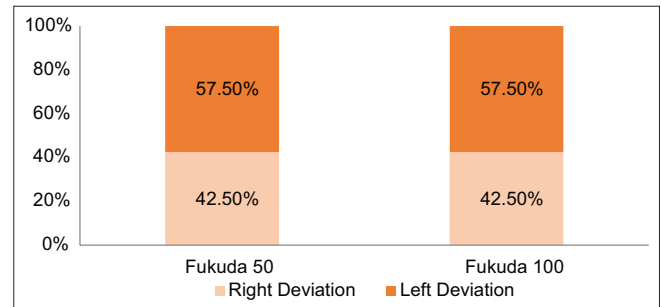


Figure 12: Deviations in Fukuda 50 and 100 stepping test

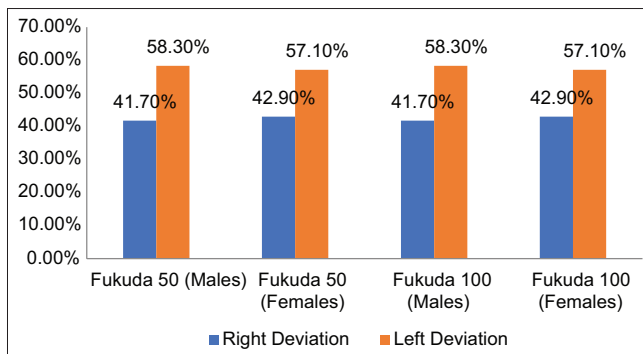


Figure 13: Gender-wise deviation in Fukuda 50 and 100 stepping test

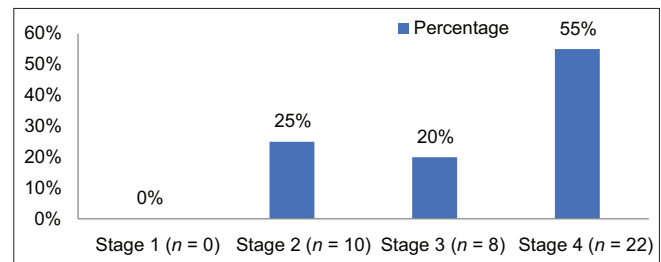


Figure 14: Four-Stage Balance Test performance

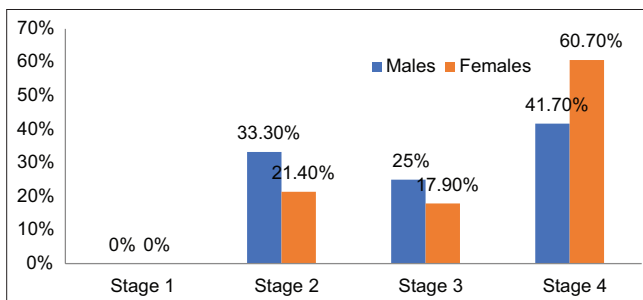


Figure 15: Gender-wise completion of Four-Stage Balance Test

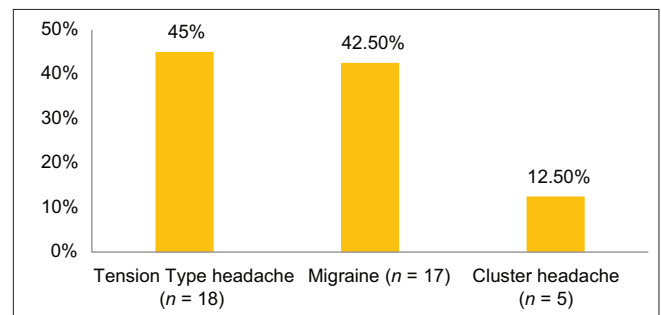


Figure 16: Types of headache based on IHS criteria

headache types. However, it is important to note that the strength of the correlation in this study was weak, indicating that other factors may contribute to balance disturbances in headache patients.

One potential explanation for the observed relationship is the impact of headaches on the vestibular system. The vestibular system plays a crucial role in maintaining balance, and any disruption in its function can lead to balance problems.<sup>[24]</sup> Headaches, especially migraines, are known to cause sensory sensitivities, including visual disturbances and dizziness, which might affect the vestibular system. Additionally, neck pain commonly associated with tension-type and cervicogenic headaches may influence postural control, contributing to balance issues.<sup>[25]</sup>

The findings of the current study have important clinical implications. Healthcare professionals, especially those working with headache patients, should be aware of the potential for balance disturbances in this population. Screening for balance issues, especially in patients with migraine, tension-type, or cervicogenic headaches, may be warranted. Early detection and appropriate interventions, such as physical therapy or vestibular rehabilitation, could help to improve the quality of life for these patients and reduce the risk of falls and related injuries.

The current study suggests that individuals with headaches, particularly those with migraine, tension-type, or cluster-type headaches, may experience balance disturbances as indicated by the FST. While the correlation observed is fair to moderate, it highlights the need for healthcare professionals to consider balance issues in their evaluation and management of headache patients. Further research is warranted to better understand the complex relationship between headaches and balance dysfunction and to improve clinical care for individuals with these conditions. Ultimately, addressing balance issues in headache patients could enhance their overall well-being and reduce the disability associated with these common conditions.

## Conclusion

The current study revealed that a significant number of young adults with headaches, particularly migraine, tension-type, and cluster-type headaches, experienced severe headache intensity and impact, as indicated by HIT scores and a headache questionnaire.

## Ethical approval

The study was approved by the Institutional Review Board Committee of Tejasvini Physiotherapy College, Mangalore (TPC/PT/2019B/05/2023).

## Acknowledgments

The authors would like to sincerely thank all the participants, students, and faculty for their support for the community study.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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