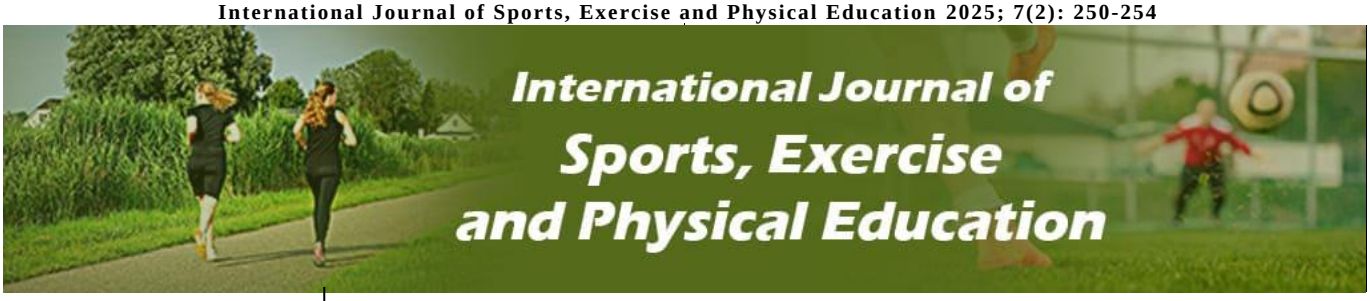

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The impact of balance and proprioception among diabetic population

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Abstract
Background: Diabetes mellitus is a chronic metabolic disorder that affects millions of people worldwide, leads to various complications that significantly impact the quality of life. Among these complications proprioception and balance are particularly concerning. Proprioception the body's ability to sense position and movement is essential for maintaining balance and preventing falls. Individuals with diabetes often experience impaired proprioception, leading to deterioration in balance and increasing the risk of falls and associated injuries.
Aim: This observational study aims to identify the impact of proprioception and balance among diabetic population.
Objective: To find out proprioception and balance impairments in patients with diabetes using a self-administered questionnaire.
Method: Observational study was conducted in Sri Ramakrishna Multi Specialty Hospital for 6 months including 150 participants diagnosed with diabetic age above 45 years based on the inclusion and exclusion criteria to find the impact of balance and proprioception with a self-administered questionnaire on demographic data and clinical variables were collected and analyzed.
Result: By conducting this study it has been observed that balance and proprioception does not affect only diabetic neuropathy patients but patients with diabetes were also affected.

Keywords: Diabetes, balance, proprioception

1. Introduction
Diabetes mellitus is a chronic metabolic disorder of increasing global prevalence, disproportionately affecting low- and middle-income countries (LMICs) due to rapid urbanization and lifestyle changes [1]. In 2013, 382 million people were living with diabetes, of which over 80% were in LMICs; India alone accounted for 65.1 million cases, projected to rise to 109 million by 2035 [1]. Type 2 diabetes, which constitutes 85-95% of cases, often remains undiagnosed during its asymptomatic stage, leading to vascular complications at diagnosis [1, 4]. Early prevention through lifestyle modification is feasible and effective across populations [2, 3], but implementation of culturally appropriate programs remains inadequate. Asian Indians, in particular, are at high risk of developing diabetes at a younger age compared to Western populations [5]. Despite the burden, awareness of diabetes and its complications remains poor, especially in rural areas [6, 7], although simple, non-invasive risk scores can identify at-risk individuals [8, 9].
Among the complications of diabetes, balance impairments and proprioceptive deficits are especially concerning, as they increase morbidity, risk of falls, and diminish quality of life [10, 11]. Nearly 50% of individuals with diabetes over 60 years develop diabetic peripheral neuropathy (DPN), the most common symptomatic complication, which contributes to postural instability and foot complications [12-14]. Balance deficits in DPN are largely due to impaired somatosensory feedback [12, 15-17], although vision (retinopathy), vestibular dysfunction (polyneuropathy), orthostatic intolerance, and autonomic neuropathy also contribute [20-26]. While compensatory mechanisms through feedforward prediction may partially mask instability [18, 19], novel sensor-based technologies now offer more objective assessments of balance control.
Proprioception, defined as the perception of body position and movement, integrates signals from muscle spindles, cutaneous receptors, and the vestibular and visual systems [27-32]. Muscle spindle afferents, modulated by the fusimotor (gamma) system, play a central role in

detecting length and velocity changes [32-34]. In diabetes, altered proprioceptive acuity further exacerbates postural instability.

This observational study therefore aims to assess balance and proprioception in 150 diabetic inpatients and outpatients using a structured 25-item self-administered questionnaire analyzed with a Likert scale. By evaluating these impairments, the study seeks to provide insight into the extent to which diabetes influences motor control, stability, and overall functional quality of life.

2. Research Questions

1. How does the severity of diabetes mellitus correlate with postural stability and proprioceptive accuracy in patients with diabetes?
2. How do age and gender influence balance and proprioception in diabetic patients?
3. How does the fell of walking on different surface affect balance and proprioception in individuals with diabetes? Is there a significant correlation between leg burning sensation and balance impairment in individuals with diabetes?
4. Do balance and proprioception deficits affect ADL performance in individuals with diabetes?

3. Materials and Methodology Required

3.1 Materials

- Consent form
- Self-administered Questionnaire form
- Pen
- Pencil

3.2 Methodology

3.2.1 Study Design: Observational study

3.2.2 Study Duration: 6 months

3.2.3 Study Setting: Sri Ramakrishna multi-speciality hospital, Coimbatore

3.2.4 Sampling Technique: Purposive sampling

3.2.5 Selection Criteria

Inclusion Criteria

- Diabetes mellitus both type 1 and type 2
  Age range: above 45 years
  All gender (both male and female)
- Patients with diabetes for more than 5 years

Exclusion Criteria

- Degenerative causes
- Musculoskeletal disorders
- Neurological disorders
- Peripheral vascular disease
- Foot ulcer
- Surgical procedures (amputation)
- Cardiovascular conditions
- Unwilling to participate
- Incomplete data (who's response is incomplete or lack of essential information)

3.2.6 Sample Size: 150 Diabetic patients

3.2.7 Parameters: Balance and Proprioception

3.2.8 Outcome Measures

Self-administered questionnaire, Romberg test, Vibration test, one leg standing, Toe tapping.

3.2.9 Method of Collection of Data

Out of 150 patients only 85 patients accepted to participate 58 males and 27 females. Participants with diabetes based on the inclusion criteria was first got with consent and asked to fill a questionnaire.This questionnaire captured their medical history and demographic information.

1. Romberg test

To assess postural stability and balance, participants stood with their feet together first with eyes open and then with eyes closed.

2. One leg standing test (OLST)

- To position the patient in comfortable, standing position.
- Ask the patient to stand in one leg, arms should be at side.
- Start timer and record the time (in seconds).

3. Toe tapping test

- To position the patient in comfortable, standing position.
- Ask the patient to stand with feet together and instruct to lift one feet.
- To tap toe on floor and record number of taps in 10 seconds, repeat with dominant foot.

3.2.10 Scoring System - Likert Scale Questions

1) **Never:** 4 points
2) **Rarely:** 3 points
3) **Often:** 2 points
4) **Always:** 1 point

- Total score range 0-100
- High proprioception and balance 75-100
- Moderate proprioception and balance 50-74
- Low proprioception and balance 25-49
- Very low proprioception and balance 0-24

Self-Administered Questionnaire History Collection

1. Name:
2. Age:
3. Gender: ☐ Male ☐ Female
4. Height (In cm):
5. Weight (In kg):
6. How long do you have diabetes?
7. Do you take medicines properly?
8. Please list all medications you take including dosage

Skip to question 8 if you do not take insulin

If you use insulin pump, Fill out the insulin pump section:

- Time of injection:
- Units and type of injection:
- Where do you give your injection:
- Do you rotate sites with each injection: Yes / No
- Any problem with sites lumping, pitting, etc:
- Have you been hospitalized for diabetes: Yes / No
- Date and which hospital:
- Reason HbA1c level:
- last checked date:

Subjective

1. Physical activity level -Sedentary little or no physical activity
☐ Never ☐ Rarely ☐ Often ☐ Always

2. Being lightly active -exercise 1 to 3 days a week
☐ Never ☐ Rarely ☐ Often ☐ Always

3. Being moderately active - exercise 3 to 5 days
☐ Never ☐ Rarely ☐ Often ☐ Always

4. Very active -exercise 6 to 7 days
☐ Never ☐ Rarely ☐ Often ☐ Always

5. Super active - exercise two times in a day
☐ Never ☐ Rarely ☐ Often ☐ Always

6. Do you experience issues with balance while standing or walking?
☐ Never ☐ Rarely ☐ Often ☐ Always

Do you face difficulties while walking?

	Never	Rarely	Often	Always
7. In house	☐	☐	☐	☐
8. In open area	☐	☐	☐	☐
9. In crowd	☐	☐	☐	☐
10. During Night time	☐	☐	☐	☐

11. How often do you walk with barefoot
☐ Never ☐ Rarely ☐ Often ☐ Always

12. How often do you walk with footwear
☐ Never ☐ Rarely ☐ Often ☐ Always

13. How frequently do you fall?
☐ Never ☐ Rarely ☐ Often ☐ Always

14. How frequently do you hit your feet?
☐ Never ☐ Rarely ☐ Often ☐ Always

15. Have you experienced like walking on wool (cotton)?
☐ Never ☐ Rarely ☐ Often ☐ Always

16. Have you experienced like walking on sand?
☐ Never ☐ Rarely ☐ Often ☐ Always

17. Do you choose footwear based on impact of your balance?
☐ Never ☐ Rarely ☐ Often ☐ Always

18. Do you look at your feet while walking to avoid tripping?
☐ Never ☐ Rarely ☐ Often ☐ Always

19. Do you experience any leg pain or burning sensation?
☐ Never ☐ Rarely ☐ Often ☐ Always

20. Have you noticed any changes in your ability to perform daily activities due to balance issues?
☐ Never ☐ Rarely ☐ Often ☐ Always

21. Do you experience any problem with your vision that affect your balance or walking?
☐ Never ☐ Rarely ☐ Often ☐ Always

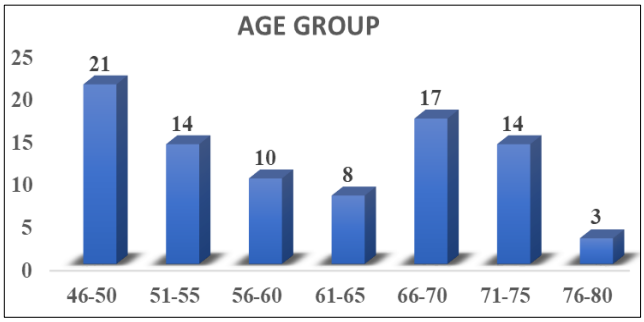
22. Do you have any difficulty with task requiring fine motor skills (buttoning a shirt)
☐ Never ☐ Rarely ☐ Often ☐ Always

23. Do you follow any specific strategies or technique to prevent falls
☐ Never ☐ Rarely ☐ Often ☐ Always

24. Do you have any concern or fear about falling that affect your daily activities?
☐ Never ☐ Rarely ☐ Often ☐ Always

25. How often do you feel tired (muscle fatigue)
☐ Never ☐ Rarely ☐ Often ☐ Always

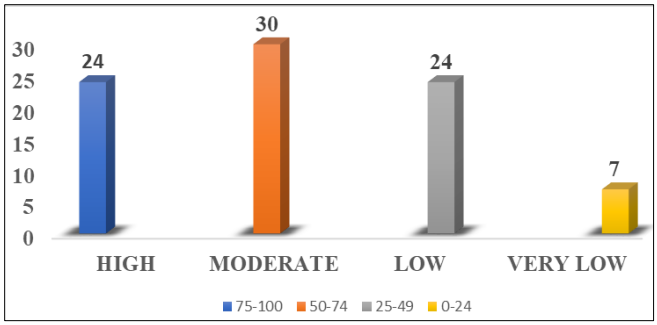
4. Data Analysis



Graph 1: Age Group Classification

Table 1: Likert Scale Level

Likert Scale Level	No of Subjects
High Proprioception and Balance	24
Moderate Proprioception and Balance	30
Low Proprioception and Balance	24
Very Low Proprioception and Balance	7



Graph 2: Likert Scale Level

5. Discussion

The present study explored the impact of diabetes mellitus on balance and proprioception in a cohort of 85 participants. The findings revealed that balance impairments were widespread, affecting not only individuals with diabetic neuropathy, who showed the most severe deficits, but also those without neuropathy. This observation underscores that balance problems in diabetes are multifactorial, extending beyond peripheral nerve involvement.

Consistent with previous reports, individuals with diabetic neuropathy demonstrated marked impairments in proprioception, with seven out of eight participants scoring very low on the Likert scale. However, significant deficits among non-neuropathic patients suggest additional contributors, including sedentary lifestyle, poor glycaemic

control, barefoot walking, and vision disturbances. These findings align with earlier studies linking diabetic retinopathy, vestibular dysfunction, and autonomic neuropathy with postural instability.

Clinical assessments provided further insights. Difficulty maintaining one-leg stance, increased postural sway. The Romberg test confirmed a heavy reliance on visual compensation, as balance deficits became more pronounced when visual input was removed. This reliance supports previous evidence that visual feedback often masks proprioceptive deficits during routine clinical assessments.

Functionally, the study demonstrated that balance impairments significantly affected activities of daily living (ADLs), with 60% of participants reporting limitations, frequent falls, and early muscle fatigue. These results mirror earlier findings that postural instability contributes to reduced independence, fear of falling, and diminished quality of life in diabetic populations.

Importantly, participants exhibited adaptive behaviors, such as selecting footwear based on balance needs and consciously relying on visual cues, reflecting compensatory strategies to mitigate instability. However, maladaptive habits such as frequent barefoot walking were identified as risk factors for worsening balance issues.

From a clinical perspective, these findings reinforce the need for comprehensive management strategies that address multiple domains. Beyond glycaemic control, targeted balance training, proprioceptive rehabilitation, fall-prevention programs, and vision care are essential to improving stability and safety. Education on footwear choices and environmental modifications may further reduce fall risk. Previous studies have shown that structured physical activity and exercise therapy are effective in improving balance in patients with chronic conditions, supporting the integration of such programs for diabetic individuals.

Taken together, this study highlights that balance and proprioception impairments in diabetes are not confined to neuropathic complications but represent a broader problem requiring early screening, multidisciplinary management, and proactive preventive strategies to reduce morbidity and improve quality of life.

6. Conclusion

In this observational study, we explored the impact of balance and proprioception among the diabetic population, revealing significant challenges across various demographics and health conditions. The findings indicated that while diabetic neuropathy patients exhibited the most severe impairments, individuals without neuropathy also faced notable balance and proprioception issues. Overall, the study underscores the multifactorial nature of balance and proprioception issues in diabetes mellitus and emphasizes the need for comprehensive management strategies to improve patient outcomes and quality of life.

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