

The **Berg Balance Scale (BBS)** is used to objectively figure out a patient's ability (or inability) to safely balance during a series of predetermined tasks.

Intended Population:

Elderly population with balance impairments, patients with acute stroke

Equipements:

- A ruler
- 2 standard chairs (one with arm rests, one without)
- A footstool or step
- 15 ft walkway
- Stopwatch or wristwatch

The Scale:

ITEM DESCRIPTION SCORE (0-4)

PROPOSED METHOD

(Ref. Table 1 for details)

Sitting to standing _____	(pose detection)
Standing unsupported _____	(anomaly detection)
Sitting unsupported _____	(anomaly detection)
Standing to sitting _____	(pose detection)
Transfers _____	(gait recognition)
Standing with eyes closed _____	(face recognition)
Standing with feet together _____	(biomechanics analysis)
Reaching forward with outstretched arm _____	(biomechanics analysis)
Retrieving object from floor _____	(biomechanics analysis)
Turning to look behind _____	(pose detection)
Turning 360 degrees _____	(biomechanics analysis)
Placing alternate foot on stool _____	(biomechanics analysis)
Standing with one foot in front _____	(biomechanics analysis)
Standing on one foot _____	(biomechanics analysis)

Total _____

In most items, the subject is asked to keep a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met. **(biomechanics analysis)**
- The subject's performance calls for supervision.

- the subject touches an external support or receives help from the examiner.
(anomaly detection)

The subject should understand that they must keep their balance while trying the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Interpretation:

Cut-off scores for the elderly were reported by Berg et al 1992 as follows:

- A score of 56 shows functional balance.
- A score of < 45 shows individuals may be at greater risk of falling.
- A score of ≤ 49 shows a risk of falls in individuals with stroke

in the elderly population a change of 4 points is needed to be 95% confident that true change has occurred if a patient scores within 45–56 initially, 5 points if they score within 35–44, 7 points if they score within 25–34 and, finally, 5 points if their initial score is within 0–24 on the Berg Balance Scale.

Limitations:

In ataxic clients it cannot, however, reflect problems in the performance of daily living activities, which are caused by the effects of ataxia on the upper extremities, because none of the items are designed to do this.

The **Short Physical Performance Battery (SPPB)** is an objective measurement instrument of balance, lower extremity strength, and functional ability in older adults (>65 years of age). The test includes three different domains (walking, sit-to-stand and balance) to assess functional mobility.

Intended Population:

The SPPB is used to assess functional mobility in community-dwelling older adults, people with Multiple Sclerosis, pulmonary diseases or cognitive impairment/dementia

Method of Use:

The test is easy to administer and takes approximately 10 mins. The SPPB includes three subtests.

1. Chair Stand Test

- Participant stood without using arms: Go to Repeated Chair Stand Test **(anomaly detection)** Participant used arms to stand: End test; score as 0 points **(anomaly detection)**
- Test not completed: End test; score as 0 points **(anomaly detection)**

The participant is asked to perform 5 sit-to-stand movements as quickly as possible. The time is recorded.

Scoring:

- Participant unable to complete 5 chair stands or completes stands in >60 sec: 0 points
- If chair stand time is 16.70 sec or more: 1 point
- If chair stand time is 13.70 to 16.69 sec: 2 points
- If chair stand time is 11.20 to 13.69 sec: 3 points
- If chair stand time is 11.19 sec or less: 4 points

2. Balance Test:

The participant is asked to stand unsupported for 10 seconds with their feet in a certain position (feet together, semi tandem, full tandem). **(biomechanics analysis)**

Scoring:

Side-by-side stand:

- Held for 10 sec: 1 point
- Not held for 10 sec: 0 points
- Not tried: 0 points

Semi-Tandem Stand:

- Held for 10 sec: 1 point
- Not held for 10 sec: 0 points
- Not tried: 0 points
- If 0 points, end Balance Tests

Tandem Stand:

- Held for 10 sec: 2 points
- Held for 3 to 9.99 sec: 1 point
- Held for < than 3 sec: 0 points
- Not tried: 0 points

3. Gait Speed Test:

The test measures gait speed. The participant walks to the line on the floor (3 or 4 meters) at a normal pace. The time is recorded. **(gait recognition)**

Scoring;

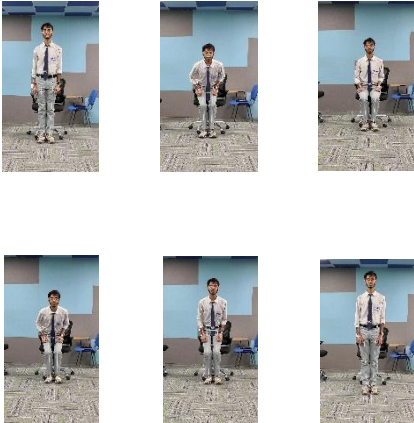
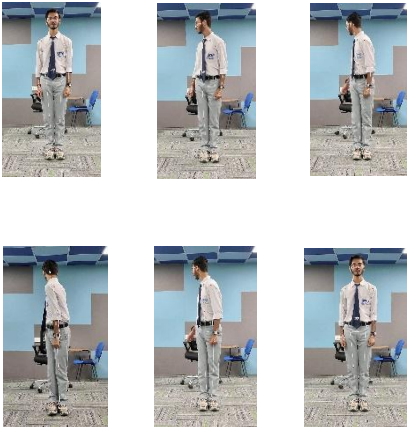


For 4-Meter Walk:

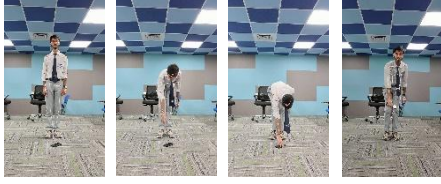





- If time is more than 8.70 sec: 1 point
- If time is 6.21 to 8.70 sec: 2 points
- If time is 4.82 to 6.20 sec: 3 points
- If time is less than 4.82 sec: 4 points


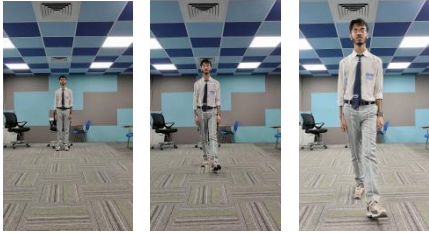
For 3-Meter Walk:

- If time is more than 6.52 sec: 1 point
- If time is 4.66 to 6.52 sec: 2 points
- If time is 3.62 to 4.65 sec: 3 points
- If time is less than 3.62 sec: 4 points

TABLE 1: DESCRIPTION OF PROPOSED METHODS FOR SPBB/BBS COMPONENTS

Components	Demonstration	ML Model	Explanation
Sitting to Standing & Standing to Sitting		Blaze Pose / Dense Pose with Transfer Learning on Problem Data. (Human Pose Estimation)	Using transfer learning with human pose estimation models like BlazePose or DensePose, we can accurately classify the transitions between sitting and standing in the Berg Balance Test based on problem-specific data.
Turning to Look Behind			Leveraging transfer learning with BlazePose or DensePose, we can precisely identify and analyze the "turning to look behind" movement in the Berg Balance Test using customized problem-specific data.
Standing with feet together		Pose Net / TF-Pose / Alpha Pose. (Biomechanics Analysis)	Using PoseNet, TF-Pose, or AlphaPose, we can conduct a detailed biomechanics analysis of the positions in the Berg Balance Test.
Reaching forward with outstretched arm			

Retrieving object from floor		Pose Net / TF-Pose / Alpha Pose. (Biomechanics Analysis)	Using PoseNet, TF-Pose, or AlphaPose, we can conduct a detailed biomechanics analysis of the positions in the Berg Balance Test.
Turning 360 degrees			
Placing alternate foot on stool			
Standing with one foot in front			
Standing on one foot			
Standing unsupported		Variational Autoencoders / Anomaly Detection GAN (Anomaly Detection)	Employing Variational Autoencoders or Anomaly Detection GAN, we can effectively detect anomalies in the "standing unsupported" task of the Berg Balance Test, aiding in the assessment of balance impairments.

Sitting unsupported		Variational Autoencoders / Anomaly Detection GAN (Anomaly Detection)	Employing Variational Autoencoders or Anomaly Detection GAN, we can effectively detect anomalies in the "standing unsupported" task of the Berg Balance Test, aiding in the assessment of balance impairments.
Transfers		GAIT Recognition	Utilizing Gait Recognition technology, we can analyze and assess the efficiency and stability of transfers involved in the Berg Balance Test, providing valuable insights into mobility and balance capabilities.
