# Predicting Discharge Walking Ability in Diabetic Foot Ulcer Patients Using Machine Learning

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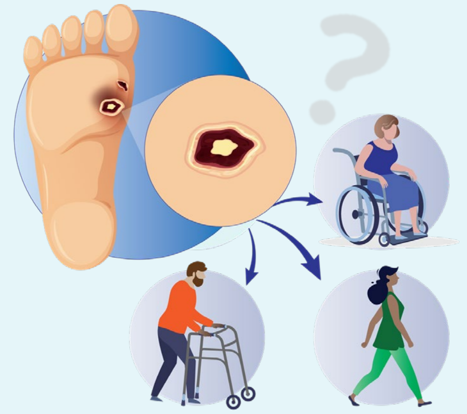
## Introduction



Diabetic foot ulcer (DFU) is a common complication of diabetes, significantly impacting mobility and quality of life.

Assessing walking ability at discharge provides a critical measure of rehabilitation success.

This study leverages machine learning techniques, decision trees to identify factors influencing discharge walking ability and improve predictive accuracy.

## Study design

Retrospective multicenter

## Patients and study setting

Patients admitted for DFU treatment at 11 hospitals (April 2021–March 2023)

Chart review abstraction (March 2024–June 2024)

## Data collection

Patient demographics (age, sex, height, and body weight)

Wound characteristics (wound, ischemia, and foot infection [WIfI] classification)

Complications like hypertension, coronary artery disease, Lower Extremity Arterial Disease (LEAD), and hemodialysis (HD)

Rehabilitation interventions

Laboratory data: C-reactive protein (CRP), hemoglobin A1c (HbA1c), hematocrit, hemoglobin (Hb), and serum albumin (alb)

Walking ability at discharge (three classes)

Class 1 Unable to walk

Class 2 Able to walk with assistive devices

Class 3 Independent walk

## Results

**Table 1: Patient's background**

Number of subjects (N = 303)

Male (n = 194) | Female (n = 109)

| Characteristics | Numbers/values |
|---|---|
| Age (years) | 74 ± 17 |
| Weight (kg) | 58.2 ± 19.1 |
| Height (m) | 1.61 ± 0.14 |
| Body mass index (kg/m2) | 23.6 ± 3.6 |
| Hypertension (%) | 198 (65.3) |
| Coronary artery disease (%) | 186 (61.4) |
| LEAD (%) | 247 (81.5) |
| HD (%) | 116 (38.3) |

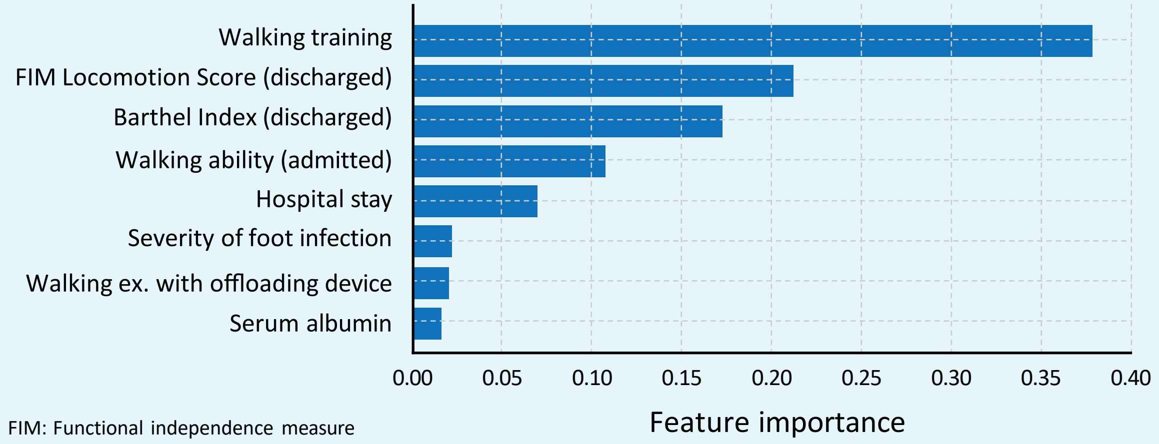
**Table 2: Laboratory data**

| Indices | Values |
|---|---|
| CRP | 3.50 (10.85) |
| HbA1c | 6.60 (1.90) |
| Hematocrit | 35.10 (7.60) |
| Hb | 11.40 (2.45) |
| Alb | 3.20 (0.70) |

**Table 3: Wound characteristics (WIfI classification)**

| Score | Wound | Foot infection |
|---|---|---|
| Score 0 | 5 (1.7%) | 61 (20.1%) |
| Score 1 | 105 (34.7%) | 104 (34.3%) |
| Score 2 | 118 (38.9%) | 86 (28.4%) |
| Score 3 | 37 (12.2%) | 12 (4.0%) |
| Missing data | 38 (12.5%) | 40 (13.2%) |

**Figure 1: Top-8 ranked features identified using the decision tree model**




FIM: Functional independence measure

**Figure 2: Receiver operating characteristic plots for the top-8-ranked features utilizing the walking ability at discharge**

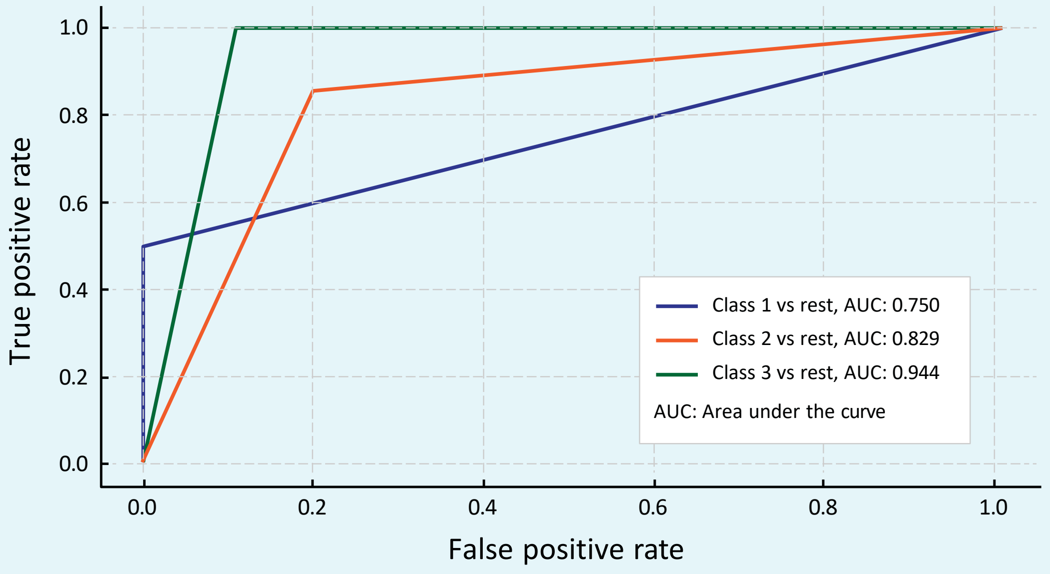



**Table 4: Average performance matrix**

| Class | Sensitivity | Specificity | Accuracy | Precision | F1 score |
|---|---|---|---|---|---|
| Class 1 vs rest | 0.50 | 1.00 | 0.92 | 1.00 | 0.67 |
| Class 2 vs rest | 0.86 | 0.80 | 0.83 | 0.86 | 0.86 |
| Class 3 vs rest | 1.86 | 0.89 | 0.92 | 0.75 | 0.86 |

## Statistical analysis

- Data were presented as proportions, means ± stand deviation (SD), or median (IQR), and analyzed using SPSS® Version 29.0 (IBM Corporation, Armonk, NY, USA).
- A decision tree model was developed with an 80–20% train-test split, imputing missing values and normalizing continuous variables.
- Feature importance identified key predictors and model performance was evaluated using sensitivity, specificity, accuracy, precision, F1 score, and AUC.

## Ethical considerations

This study was approved by the ethics committee of Aichi, Shukutoku University (Approval No. 2023-3), and the Clinical Research Committee of 11 hospitals.

## Discussion/conclusion

**Walking training, functional independence, and nutritional status (albumin) are key factors influencing discharge walking ability. A multidisciplinary approach integrating physical therapy, nutrition, and discharge planning is essential for optimal outcomes. Machine learning holds the potential to predict walking ability for personalized rehabilitation. However, larger studies are needed to validate and refine clinical applications.**

**Acknowledgements**

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