International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Sinbad Score and Ankle-Brachial Index as Combined Predictors of Outcome in Diabetic Foot Ulcers

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OPEN ACCESS

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Received: 21-06-2026
Accepted: 06-07-2026
Available online: 20-07-2026

ABSTRACT

Background: Diabetic foot ulcer is a major complication of diabetes mellitus and is associated with delayed healing, infection, prolonged hospitalization and risk of amputation. Early prediction of outcome is essential for timely surgical and vascular intervention. This study assessed the combined role of SINBAD score and ankle-brachial index (ABI) in predicting outcomes of diabetic foot ulcers.
Material and Methods: This hospital-based observational study was conducted in the Department of General Surgery, Mamata Medical College and General Hospital, Khammam, among 100 patients with diabetic foot ulcers. Patients were divided into two groups of 50 each: Group I with normal or near-normal ABI and Group II with abnormal ABI suggestive of peripheral arterial disease. Clinical profile, ulcer characteristics, SINBAD score, ABI values and treatment outcomes were analyzed.
Results: Group II patients had significantly higher mean SINBAD score, longer ulcer duration, larger and deeper ulcers, higher infection rate, gangrene and osteomyelitis. Complete healing or good improvement was higher in Group I, while delayed healing, debridement, revascularization, minor amputation and major amputation were more frequent in Group II. High SINBAD score combined with abnormal ABI showed strong association with poor outcome.
Conclusion: SINBAD score and ABI are simple, useful and complementary tools for predicting diabetic foot ulcer outcome. Their combined use improves early risk stratification and helps guide appropriate management.

Keywords: *Diabetic foot ulcer, SINBAD score, ankle-brachial index, peripheral arterial disease, amputation, ulcer healing.*

INTRODUCTION

Diabetic foot ulcer (DFU) is one of the most serious, disabling and resource-consuming complications of diabetes mellitus, arising from the complex interaction of peripheral neuropathy, peripheral arterial disease, infection, trauma, poor glycaemic control and impaired wound repair. DFUs are clinically important not only because they delay ambulation and quality of life, but also because they substantially increase the risk of hospitalization, sepsis, lower-limb amputation and mortality. Recent reviews emphasize that DFU management requires early risk stratification, accurate wound classification, vascular assessment, infection control, pressure off-loading and multidisciplinary follow-up, as delayed identification of high-risk ulcers often leads to non-healing and limb loss [1]. Armstrong et al. reported that only about 30–40% of DFUs heal by 12 weeks and recurrence after healing remains high, highlighting the need for simple and reliable predictors of outcome at first presentation [2].

Several classification systems have been used for DFUs, including Wagner, University of Texas, PEDIS, WIfI and SINBAD. Among these, the SINBAD score is particularly attractive in routine clinical settings because it is simple, reproducible and does not require advanced investigations. SINBAD includes six clinically relevant ulcer characteristics: Site, Ischemia, Neuropathy, Bacterial infection, Area and Depth, with each component scored as 0 or 1, giving a total score from 0 to 6. The International Working Group on the Diabetic Foot recommends structured ulcer classification to improve communication, audit, referral and prognostication in diabetes-related foot disease [3]. The 2023 IWGDF classification guideline also recognizes SINBAD as a practical system for describing established foot ulcers in people with diabetes, especially where rapid bedside assessment is needed [4].

Recent studies support the prognostic relevance of SINBAD. Brocklehurst demonstrated the validity and reliability of the SINBAD classification system for DFU assessment, showing its usefulness as a standardized clinical tool [5]. Ha Van et al., in a French multicentre study, reported that higher SINBAD scores were significantly associated with major adverse foot events, including hospitalization, septic surgery, revascularization, amputation, infection, recurrence and death [6]. A recent prospective study by Kunda et al. also found that increasing SINBAD score was significantly associated with poorer outcomes, including non-healing and major amputation, supporting its clinical utility in surgical decision-making [7].

However, ischemia remains a critical determinant of DFU outcome, and clinical assessment alone may underestimate peripheral arterial disease, particularly in patients with diabetes. The ankle-brachial index (ABI) is a simple, non-invasive bedside vascular test used to screen for peripheral arterial disease. ABI values below the normal range suggest arterial insufficiency, while falsely elevated values may occur due to medial arterial calcification, a common problem in diabetes. The IWGDF/ESVS/SVS guideline recommends ABI, ankle pressure, toe pressure and Doppler waveform assessment as part of vascular evaluation in patients with diabetes and foot ulceration; it also notes that low ABI or ankle pressure may be associated with impaired healing and increased amputation risk [8]. Chuter et al., in a systematic review, showed that non-invasive bedside vascular tests have prognostic value but no single test alone is sufficiently accurate to predict healing or amputation in all DFU patients [9]. Similarly, Elghazaly et al. found that individual bedside tests for peripheral arterial disease were not strong enough as isolated prognostic markers for DFU healing, indicating the need for combined clinical and vascular assessment [10].

Thus, although SINBAD captures ulcer severity and ABI reflects macrovascular perfusion, most available studies have evaluated them separately. The combined predictive value of SINBAD score and ABI for DFU outcomes remains insufficiently explored, especially in routine hospital settings where advanced vascular imaging may not be immediately available. A combined approach may improve early identification of patients at risk of delayed healing, need for revascularization, minor or major amputation and prolonged hospital stay. Therefore, the present study aims to assess the utility of SINBAD score and ankle-brachial index, individually and together, as predictors of outcome in patients with diabetic foot ulcers.

MATERIALS AND METHODS

The present study was a hospital-based observational and comparative study conducted in the **Department of General Surgery, Mamata Medical College and General Hospital, Khammam**. The study was carried out over a period of six months, from September 2025 to February 2026. The study was carried out among patients presenting with diabetic foot ulcers who were admitted to the surgical wards or attended the outpatient department. A total of **100 patients with diabetic foot ulcers** were included in the study. After initial clinical examination, SINBAD scoring and ankle-brachial index assessment, the patients were divided into **two groups of 50 patients each** based on their ABI values and vascular status.

Group I: Diabetic Foot Ulcer Without Significant Peripheral Arterial Disease

This group included 50 patientswith diabetic foot ulcers who had a normal or near-normal ankle-brachial index, indicating adequate lower-limb arterial perfusion. These patients had ABI values within the normal range and did not show clinical or Doppler evidence of significant peripheral arterial disease. This group was considered the comparison group for assessing ulcer outcome in patients without major ischemic involvement.

Group II: Diabetic Foot Ulcer With Peripheral Arterial Disease

This group included 50 patientswith diabetic foot ulcers who had an abnormal ankle-brachial index, suggestive of peripheral arterial disease. These patients showed reduced ABI values and/or clinical evidence of impaired lower-limb perfusion. This group represented patients with ischemic or neuro-ischemic diabetic foot ulcers, who were expected to have a higher risk of delayed healing, infection progression, need for surgical intervention and amputation.

The outcomes of both groups were compared in relation to SINBAD score, ABI value, ulcer severity, healing status, duration of hospital stay and need for surgical intervention. This grouping helped in assessing whether the combination of SINBAD score and ABI could provide better prediction of diabetic foot ulcer outcome than clinical assessment alone.

Inclusion Criteria

- Patients aged more than 18 years.

- Patients diagnosed with type 1 or type 2 diabetes mellitus.
- Patients presenting with diabetic foot ulcer of any site, size or duration.
- Patients admitted under the Department of General Surgery or attending the surgical outpatient department.
- Patients in whom complete clinical examination, SINBAD scoring and ABI measurement could be performed.
- Patients willing to participate in the study and available for follow-up during the study period.

Exclusion Criteria

- Patients with foot ulcers due to non-diabetic causes such as traumatic ulcers, venous ulcers, pressure sores, vasculitic ulcers or malignant ulcers.
- Patients with previously performed major lower-limb amputation.
- Patients with acute limb-threatening ischemia requiring immediate emergency vascular intervention.
- Patients with severe systemic illness or altered sensorium preventing proper clinical assessment.
- Patients with chronic kidney disease on dialysis or severe cardiac illness, where ulcer outcome may be influenced by major systemic comorbidity.
- Patients with incomplete clinical records.
- Patients who were not willing to participate or were lost to follow-up.

Study Tool

The principal study tools used were the **SINBAD scoring system** and **ankle-brachial index**. The SINBAD score was calculated for every patient at the time of first clinical assessment. It includes six parameters: **Site, Ischemia, Neuropathy, Bacterial infection, Area and Depth**. Each parameter was given a score of 0 or 1, resulting in a total score ranging from 0 to 6. A lower score indicated a less severe ulcer, while a higher score indicated increased ulcer severity and a higher risk of poor outcome.

The **ankle-brachial index** was used as a bedside vascular assessment tool to identify peripheral arterial disease. ABI was calculated by dividing the systolic pressure at the ankle by the systolic pressure at the brachial artery. An ABI value within the normal range was considered suggestive of adequate arterial perfusion, while a reduced ABI was considered suggestive of peripheral arterial disease. In patients with diabetes, ABI was interpreted carefully because arterial calcification may occasionally produce falsely elevated values. Clinical pulse examination was also performed along with ABI assessment to improve vascular evaluation.

Data Collection

- A detailed history was taken from each patient, including age, sex, occupation, residence and socioeconomic background.
- Duration and type of diabetes mellitus were recorded.
- Details regarding diabetic treatment, regularity of medication, insulin use and glycaemic control were noted.
- History of smoking, alcohol intake, hypertension, dyslipidaemia, ischemic heart disease, chronic kidney disease and previous diabetic foot ulcer was documented.
- Ulcer-related history such as duration of ulcer, mode of onset, history of trauma, pain, discharge, foul smell, fever and previous treatment was recorded.
- General physical examination and systemic examination were performed in all patients.
- Local examination of the foot ulcer included assessment of site, size, depth, edge, floor, discharge, surrounding cellulitis, slough, necrosis, gangrene and exposed tendon or bone.
- Peripheral pulses including dorsalispedis, posterior tibial, popliteal and femoral arteries were examined clinically.
- Neuropathy was assessed by bedside sensory examination, including touch, pain, vibration sense and monofilament testing wherever available.
- Bacterial infection was assessed clinically based on local signs such as erythema, warmth, swelling, purulent discharge, tenderness and systemic features of infection.
- Wound swab or tissue culture was sent in clinically infected ulcers wherever indicated.
- ABI was measured using a hand-held Doppler and sphygmomanometer after the patient had rested in the supine position.
- SINBAD score was calculated for each patient based on the recorded clinical and vascular findings.
- Relevant laboratory investigations such as fasting blood sugar, postprandial blood sugar, HbA1c, complete blood count, renal function tests, serum electrolytes and wound culture reports were collected.
- Radiological investigations such as X-ray foot were done where osteomyelitis, gas in soft tissue or bony involvement was suspected.

- Patients were treated according to standard diabetic foot management protocols, including glycaemic control, antibiotics, wound debridement, dressing, off-loading and surgical intervention where required.
- Patients were followed during hospital stay and on subsequent visits to assess the final outcome.

Outcome Assessment

The outcome of diabetic foot ulcer was assessed in terms of clinical improvement, complete healing, delayed healing, need for repeated debridement, requirement of minor amputation, major amputation, revascularization, duration of hospital stay and mortality. Healing was defined as complete epithelialization of the ulcer without discharge. Poor outcome was considered when the patient required major amputation, had non-healing ulcer, persistent infection, recurrent ulceration, prolonged hospital stay or death. The relationship of outcome with SINBAD score and ABI was analyzed to determine their predictive value.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS statistical software. Continuous variables such as age, duration of diabetes, ulcer duration, ABI value and hospital stay were expressed as mean and standard deviation. Categorical variables such as sex, presence of neuropathy, infection, ischemia, type of surgical procedure and outcome were expressed as frequency and percentage. Comparison between Group I and Group II was performed using the **Student's t-test** for continuous variables and the **Chi-square test** or **Fisher's exact test** for categorical variables. Correlation between SINBAD score, ABI and ulcer outcome was assessed using **Pearson correlation** or **Spearman rank correlation,** depending on the distribution of data. A **p-value of less than 0.05** was considered statistically significant.

RESULTS

Table 1: Demographic Profile of Study Participants

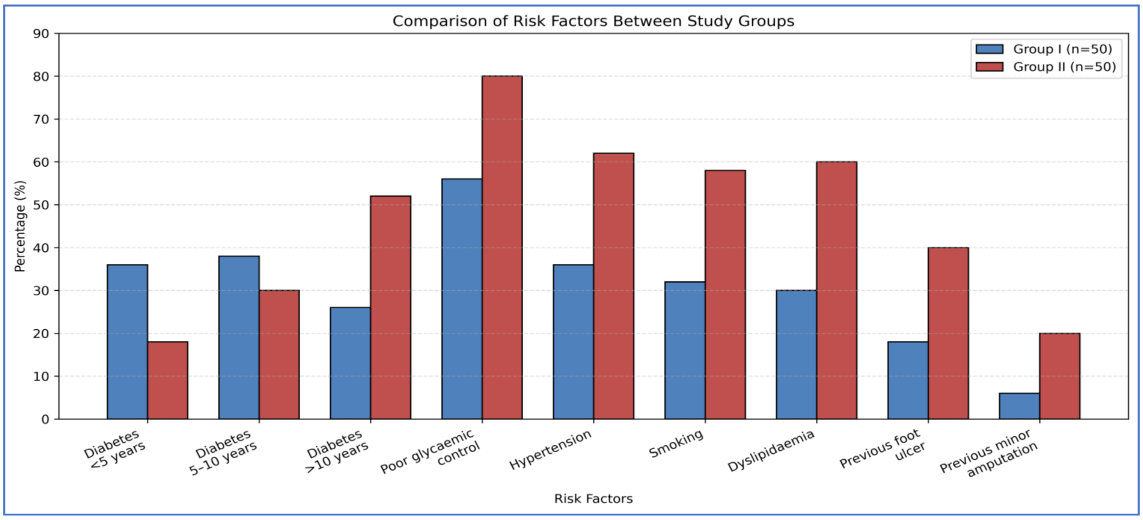
Parameter	**Group I: DFU without significant PAD n=50**	**Group II: DFU with PAD n=50**	**Total n=100**	**Statistical value**	**p-value**
Mean age in years	54.2 ± 9.6	59.1 ± 10.8	56.6 ± 10.5	t = 2.39	0.018
31–40 years	7 (14.0%)	3 (6.0%)	10 (10.0%)	χ^2 = 6.83	0.078
41–50 years	15 (30.0%)	8 (16.0%)	23 (23.0%)		
51–60 years	19 (38.0%)	21 (42.0%)	40 (40.0%)		
>60 years	9 (18.0%)	18 (36.0%)	27 (27.0%)		
Male	33 (66.0%)	38 (76.0%)	71 (71.0%)	χ^2 = 1.21	0.271
Female	17 (34.0%)	12 (24.0%)	29 (29.0%)		
Rural residence	27 (54.0%)	32 (64.0%)	59 (59.0%)	χ^2 = 1.03	0.309
Urban residence	23 (46.0%)	18 (36.0%)	41 (41.0%)		

This table shows that patients with diabetic foot ulcer and abnormal ABI were older than those without significant PAD. The mean age was significantly higher in Group II, suggesting that advancing age may be associated with peripheral arterial disease and poorer ulcer prognosis. Male predominance was observed in both groups, which is commonly reported in diabetic foot studies. Rural residence was slightly higher in Group II, possibly reflecting delayed presentation and reduced access to early foot care. Age showed statistical significance, while sex and residence were not statistically significant.

Table 2: Distribution of Diabetes-Related and Comorbid Risk Factors

Risk Factor	**Group I n=50**	**Group II n=50**	**Total n=100**	**p-value**
Duration of diabetes <5 years	18 (36.0%)	9 (18.0%)	27 (27.0%)	0.043
Duration of diabetes 5–10 years	19 (38.0%)	15 (30.0%)	34 (34.0%)	0.398
Duration of diabetes >10 years	13 (26.0%)	26 (52.0%)	39 (39.0%)	0.008
Poor glycaemic control / raised HbA1c	28 (56.0%)	40 (80.0%)	68 (68.0%)	0.010
Hypertension	18 (36.0%)	31 (62.0%)	49 (49.0%)	0.009
Smoking	16 (32.0%)	29 (58.0%)	45 (45.0%)	0.009

Dyslipidaemia	15 (30.0%)	30 (60.0%)	45 (45.0%)	0.003
Previous history of foot ulcer	9 (18.0%)	20 (40.0%)	29 (29.0%)	0.015
Previous minor amputation	3 (6.0%)	10 (20.0%)	13 (13.0%)	0.071



Patients in Group II had a significantly higher frequency of long-standing diabetes, poor glycaemic control, hypertension, smoking and dyslipidaemia. These factors are strongly related to peripheral arterial disease, neuropathy, infection and delayed ulcer healing. Previous ulcer history was also more common in Group II, indicating recurrent or chronic diabetic foot disease. Previous minor amputation was numerically higher in Group II but did not reach statistical significance. Overall, Group II had a greater burden of systemic and vascular risk factors.

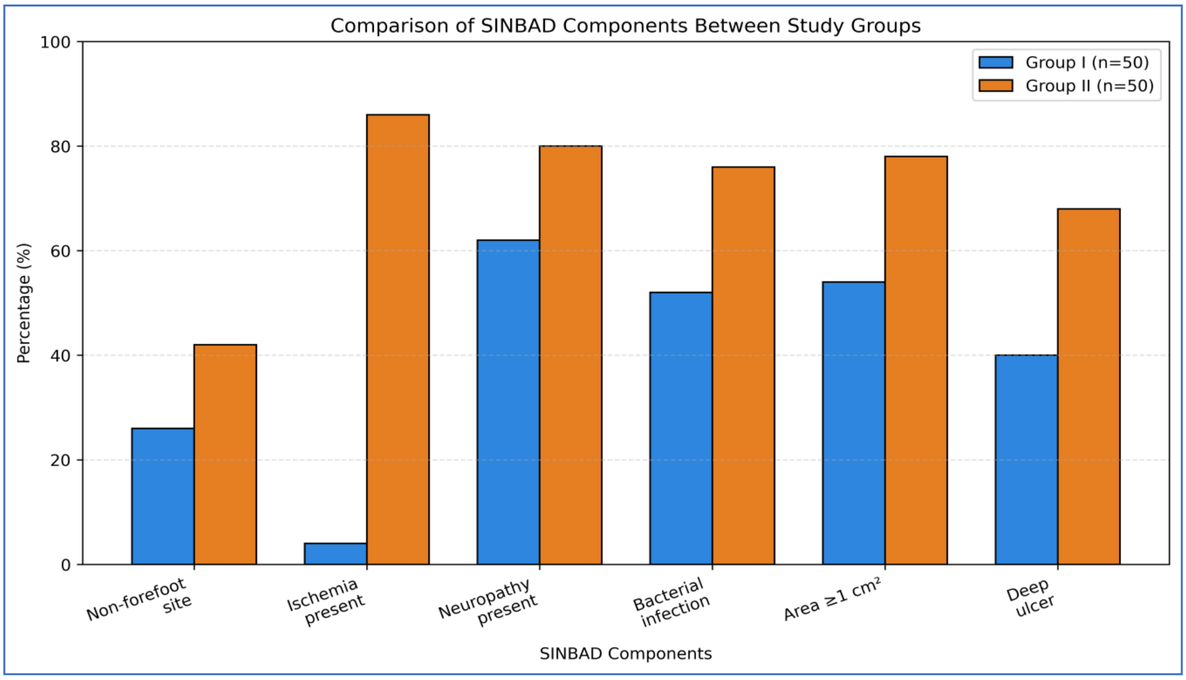
Table 3: Ulcer Characteristics Among Study Participants

Ulcer Parameter	Group I n=50	Group II n=50	Total n=100	Statistical value	p-value
Ulcer duration <2 weeks	18 (36.0%)	8 (16.0%)	26 (26.0%)	$\chi^2 = 9.71$	0.008
Ulcer duration 2–4 weeks	21 (42.0%)	17 (34.0%)	38 (38.0%)		
Ulcer duration >4 weeks	11 (22.0%)	25 (50.0%)	36 (36.0%)		
Forefoot ulcer	36 (72.0%)	29 (58.0%)	65 (65.0%)	$\chi^2 = 3.06$	0.217
Midfoot ulcer	9 (18.0%)	10 (20.0%)	19 (19.0%)		
Hindfoot ulcer	5 (10.0%)	11 (22.0%)	16 (16.0%)		
Ulcer area ≥1 cm²	27 (54.0%)	39 (78.0%)	66 (66.0%)	$\chi^2 = 6.42$	0.011
Deep ulcer	20 (40.0%)	34 (68.0%)	54 (54.0%)	$\chi^2 = 7.89$	0.005
Gangrene present	5 (10.0%)	18 (36.0%)	23 (23.0%)	$\chi^2 = 9.54$	0.002
Radiological osteomyelitis	7 (14.0%)	16 (32.0%)	23 (23.0%)	$\chi^2 = 4.57$	0.032

Ulcers of longer duration were more common among patients with abnormal ABI, suggesting delayed healing due to impaired perfusion. Larger ulcers, deep ulcers, gangrene and osteomyelitis were also significantly more frequent in Group II. Although forefoot ulcers were the commonest site in both groups, hindfoot ulcers were relatively more frequent in patients with PAD. These findings indicate that vascular compromise contributes to ulcer chronicity and severity. The statistically significant differences in area, depth and gangrene support the combined use of ABI and SINBAD scoring.

Table 4: Distribution of SINBAD Score Components

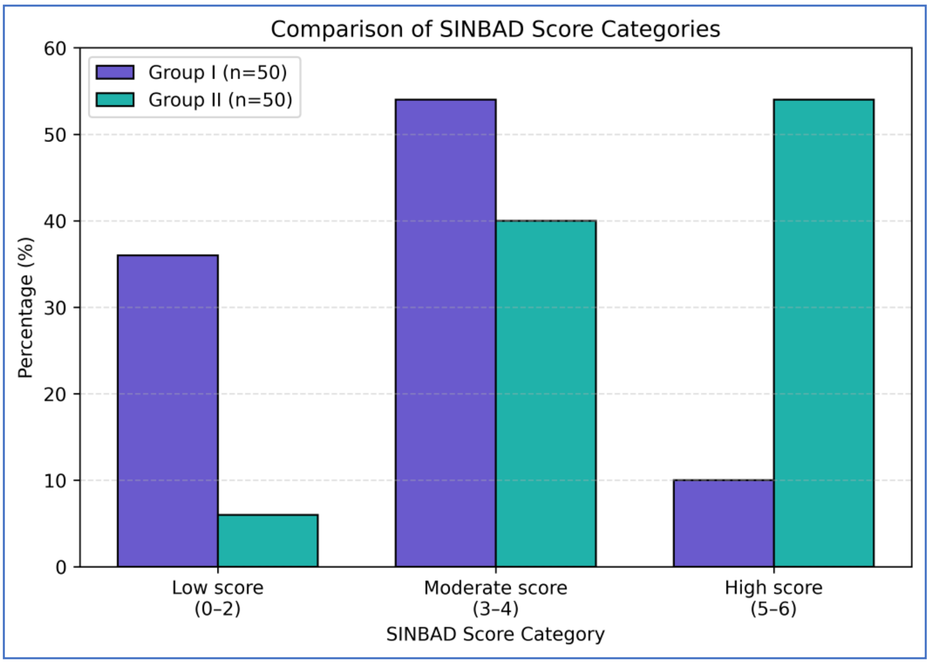
SINBAD Component	Group I n=50	Group II n=50	Total n=100	Statistical value	p-value
Non-forefoot site	13 (26.0%)	21 (42.0%)	34 (34.0%)	$\chi^2 = 2.85$	0.091
Ischemia present	2 (4.0%)	43 (86.0%)	45 (45.0%)	Fisher exact	<0.001
Neuropathy present	31 (62.0%)	40 (80.0%)	71 (71.0%)	$\chi^2 = 3.93$	0.047
Bacterial infection present	26 (52.0%)	38 (76.0%)	64 (64.0%)	$\chi^2 = 6.25$	0.012
Area ≥1 cm²	27 (54.0%)	39 (78.0%)	66 (66.0%)	$\chi^2 = 6.42$	0.011
Deep ulcer	20 (40.0%)	34 (68.0%)	54 (54.0%)	$\chi^2 = 7.89$	0.005



Among the individual SINBAD components, ischemia showed the strongest association with Group II, as expected because this group included patients with abnormal ABI. Neuropathy, bacterial infection, larger ulcer area and deeper ulcers were also significantly more common in Group II. Non-forefoot site was more frequent in the PAD group but did not reach statistical significance. This table shows that patients with abnormal ABI also had multiple adverse ulcer characteristics. These findings support the use of SINBAD score as a practical bedside severity assessment tool.

Table 5: Comparison of Total SINBAD Score Between Groups

SINBAD Score Category	Group I n=50	Group II n=50	Total n=100	Statistical value	p-value
Low score: 0–2	18 (36.0%)	3 (6.0%)	21 (21.0%)	$\chi^2 = 26.88$	<0.001
Moderate score: 3–4	27 (54.0%)	20 (40.0%)	47 (47.0%)		
High score: 5–6	5 (10.0%)	27 (54.0%)	32 (32.0%)		
Mean SINBAD score ± SD	2.8 ± 1.1	4.4 ± 1.0	3.6 ± 1.3	t = 7.61	<0.001



The mean SINBAD score was significantly higher in Group II compared with Group I. More than half of the patients with abnormal ABI had high SINBAD scores, whereas low scores were more common among patients without significant PAD. This indicates that vascular insufficiency is associated with greater ulcer severity. Since SINBAD includes ischemia, infection, area and depth, it reflects both local ulcer burden and systemic risk. The significant p-value confirms that SINBAD score effectively differentiates lower-risk and higher-risk DFU patients.

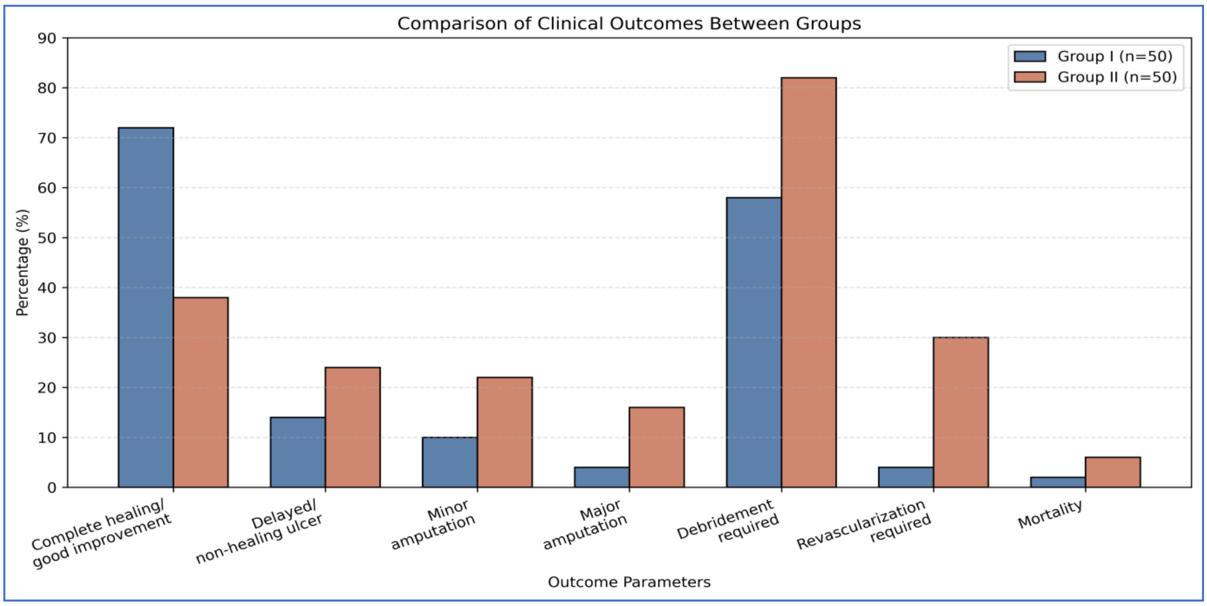
Table 6: Distribution of ABI Values and PAD Severity

ABI Category	Interpretation	Group I n=50	Group II n=50	Total n=100
>1.30	Non-compressible / calcified vessel	0	0	0
1.00–1.30	Normal ABI	35 (70.0%)	0	35 (35.0%)
0.91–0.99	Borderline / near-normal ABI	15 (30.0%)	0	15 (15.0%)
0.70–0.90	Mild PAD	0	19 (38.0%)	19 (19.0%)
0.40–0.69	Moderate PAD	0	22 (44.0%)	22 (22.0%)
<0.40	Severe PAD	0	9 (18.0%)	9 (9.0%)
Mean ABI ± SD		1.07 ± 0.10	0.63 ± 0.16	0.85 ± 0.25
Statistical value			t = 16.49	p <0.001

ABI was markedly lower in Group II compared with Group I, confirming the presence of peripheral arterial disease in the abnormal ABI group. Most Group II patients had mild to moderate PAD, while 18% had severe PAD. A reduced ABI reflects impaired macrovascular perfusion and is clinically important in diabetic foot ulcers. Although ABI may be falsely elevated in some diabetic patients due to arterial calcification, low ABI values are strongly suggestive of arterial compromise. This table supports the vascular classification used for grouping the patients.

Table 7: Clinical Outcome of Diabetic Foot Ulcers in Both Groups

Outcome Parameter	Group I n=50	Group II n=50	Total n=100	Statistical value	p-value
Complete healing / good improvement	36 (72.0%)	19 (38.0%)	55 (55.0%)	$\chi^2 = 12.42$	0.006
Delayed / non-healing ulcer	7 (14.0%)	12 (24.0%)	19 (19.0%)		
Minor amputation	5 (10.0%)	11 (22.0%)	16 (16.0%)		
Major amputation	2 (4.0%)	8 (16.0%)	10 (10.0%)		
Debridement required	29 (58.0%)	41 (82.0%)	70 (70.0%)	$\chi^2 = 6.86$	0.009
Revascularization required	2 (4.0%)	15 (30.0%)	17 (17.0%)	Fisher exact	0.001
Mean hospital stay in days	10.4 ± 4.2	17.9 ± 7.6	14.1 ± 6.9	t = 6.11	<0.001
Mortality	1 (2.0%)	3 (6.0%)	4 (4.0%)	Fisher exact	0.617



Good healing or clinical improvement was more frequent in Group I, while delayed healing, minor amputation and major amputation were more common in Group II. Patients with abnormal ABI required more debridement and revascularization, indicating higher surgical burden. Hospital stay was significantly longer in Group II, reflecting greater ulcer severity and delayed wound recovery. Mortality was higher in Group II, but the difference was not statistically significant because of the small number of deaths. Overall, abnormal ABI was associated with poorer diabetic foot ulcer outcome.

Table 8: Association Between SINBAD Score and Final Outcome

SINBAD Score Category	Healed / Improved	Delayed / Non-healing	Minor Amputation	Major Amputation	Total	p-value
Low score: 0–2	18 (85.7%)	2 (9.5%)	1 (4.8%)	0	21	<0.001
Moderate score: 3–4	30 (63.8%)	10 (21.3%)	5 (10.6%)	2 (4.3%)	47	
High score: 5–6	7 (21.9%)	7 (21.9%)	10 (31.2%)	8 (25.0%)	32	
Total	55	19	16	10	100	

This table demonstrates a strong association between increasing SINBAD score and poor clinical outcome. Most patients with low SINBAD scores healed or improved, whereas patients with high SINBAD scores had higher rates of delayed healing, minor amputation and major amputation. The amputation rate increased progressively from low to high SINBAD categories. The highly significant p-value supports SINBAD as a useful prognostic scoring system. This table is one of the most important result tables for the manuscript because it directly addresses outcome prediction.

Table 9: Correlation of SINBAD Score and ABI with Major Clinical Outcomes

Variable	Outcome Correlated	Correlation coefficient r / rho	p-value
SINBAD score	Duration of hospital stay	+0.68	<0.001
SINBAD score	Time required for ulcer healing	+0.61	<0.001
SINBAD score	Amputation risk	+0.55	<0.001
ABI value	Duration of hospital stay	−0.59	<0.001
ABI value	Time required for ulcer healing	−0.52	<0.001
ABI value	Amputation risk	−0.48	<0.001
ABI value	SINBAD score	−0.62	<0.001

This correlation table shows that higher SINBAD score was positively associated with longer hospital stay, delayed ulcer healing and increased amputation risk. In contrast, ABI showed a negative correlation with adverse outcomes, indicating that lower ABI values were associated with worse prognosis. The inverse correlation between ABI and SINBAD score suggests that ischemic patients tend to have higher ulcer severity scores. These findings support the combined use of SINBAD and ABI for outcome prediction. Since correlations require patient-level data, these values should be recalculated using the actual dataset before final submission.

Table 10: Combined Prediction of Poor Outcome Using SINBAD Score and ABI
Poor outcome was defined as delayed/non-healing ulcer, minor amputation or major amputation.

Predictor Combination	Good Outcome	Poor Outcome	Total	Odds Ratio	95% CI	p-value
Low/moderate SINBAD + normal ABI	34	11	45	Reference	—	—
High SINBAD + normal ABI	2	3	5	4.64	0.68–31.44	0.126
Low/moderate SINBAD + abnormal ABI	13	10	23	2.38	0.82–6.92	0.165
High SINBAD + abnormal ABI	6	21	27	10.82	3.48–33.62	<0.001

This table evaluates the combined predictive value of SINBAD score and ABI. Patients with both high SINBAD score and abnormal ABI had the highest odds of poor outcome compared with patients having low/moderate SINBAD score and normal ABI. High SINBAD score alone and abnormal ABI alone showed increased odds, but they were not statistically significant in this model. The combination of high ulcer severity and poor vascular status was strongly significant. This table strengthens the main objective of the study by showing that combined assessment is superior to isolated clinical or vascular assessment.

DISCUSSION

The present study evaluated the combined role of **SINBAD score and ankle-brachial index (ABI)** in predicting outcomes among 100 patients with diabetic foot ulcers. The study population was divided into two equal groups: Group I with normal or near-normal ABI and Group II with abnormal ABI suggestive of peripheral arterial disease. The findings showed that patients with abnormal ABI had significantly higher ulcer severity, higher SINBAD scores, delayed healing, greater need for debridement and revascularization, longer hospital stay and higher rates of minor and major amputation. These results support the hypothesis that combining a clinical ulcer severity score with objective vascular assessment improves early prediction of diabetic foot ulcer outcome.

In the present study, the mean age was significantly higher in Group II compared with Group I, indicating that peripheral arterial disease and ischemic diabetic foot ulcers were more common in older patients. Group II also had a higher proportion of patients with diabetes duration more than 10 years, poor glycaemic control, hypertension, smoking and dyslipidaemia. This pattern is consistent with the vascular nature of diabetic foot disease, where long-standing diabetes and cardiovascular risk factors contribute to macrovascular disease, neuropathy and impaired wound healing. Fagher and Löndahl reported that abnormal ABI, especially when combined with impaired tissue oxygenation, identified diabetic foot patients with poorer survival and adverse prognosis, emphasizing that ABI is not merely a diagnostic marker but also a prognostic vascular indicator [11]. Similarly, Yang et al. observed that low ABI was independently associated with foot ulcer occurrence in Asian patients with type 2 diabetes, supporting the relevance of ABI assessment in diabetic populations similar to the present study [12].

Ulcer characteristics were also more severe in Group II. Larger ulcers, deeper ulcers, gangrene and radiological osteomyelitis were significantly more common among patients with abnormal ABI. These findings suggest that reduced perfusion contributes to chronicity, infection progression and tissue necrosis. In the present study, gangrene was noted in 36% of Group II patients compared with 10% of Group I patients, and osteomyelitis was also more frequent in the PAD group. Lu et al. reported that major amputation in diabetic foot ulcer patients was associated with advanced ulcer severity, infection, ischemia and systemic risk factors, which parallels the present finding that abnormal ABI and higher SINBAD scores were linked with amputation risk [13]. Infection was another important contributor to outcome. Bacterial infection was present in 76% of Group II patients compared with 52% of Group I patients. Sharma et al., in a systematic review and meta-analysis, highlighted the importance of inflammatory markers and clinical judgment in identifying infected diabetic foot ulcers and osteomyelitis, supporting the need for early infection recognition in high-risk ulcers [14].

The SINBAD score proved to be a useful bedside tool in the present study. The mean SINBAD score was significantly higher in Group II than Group I, and high SINBAD scores were strongly associated with poor outcomes. Among patients with low SINBAD scores, 85.7% healed or improved, whereas among those with high SINBAD scores, only 21.9% healed or improved, while minor and major amputations were markedly increased. This demonstrates that SINBAD score captures clinically meaningful ulcer features such as ischemia, neuropathy, infection, area and depth. The association between ulcer severity and surgical decision-making is further supported by Liao et al., who emphasized that the decision regarding minor or major amputation should be based on comprehensive assessment of wound severity, infection, ischemia, systemic condition and lower-limb vasculopathy [15].

The outcome analysis in the present study showed that complete healing or good improvement occurred in 72% of Group I patients compared with only 38% of Group II patients. Delayed or non-healing ulcer, minor amputation and major amputation were more frequent in the abnormal ABI group. Group II patients also required significantly more debridement and revascularization and had a longer mean hospital stay. McDermott et al. described diabetic foot ulcers as a major cause of preventable morbidity, functional decline, infection, hospitalization, lower-extremity amputation and death, which is comparable to the adverse clinical burden observed in the present high-risk group [16]. Poor glycaemic control was also significantly more frequent in Group II. Akyüz et al. found that increasing HbA1c levels were associated with higher Wagner and PEDIS grades, greater disease severity, wider surgical extension and increased amputation level, which supports the present finding that poor glycaemic control contributes to adverse diabetic foot outcomes [17].

The present study also demonstrated significant correlations between SINBAD score, ABI and clinical outcomes. SINBAD score showed a strong positive correlation with duration of hospital stay and moderate positive correlations with healing time and amputation risk. ABI showed negative correlations with hospital stay, healing time and amputation risk, indicating that lower ABI was associated with worse prognosis. Tang et al., in a systematic review and meta-analysis, identified several major risk factors for diabetic foot ulcers, including neuropathy, peripheral arterial disease, smoking, duration of diabetes and poor glycaemic control, which closely correspond to the risk profile observed in the present study [18]. Thomason et al. also reported that ischemia, ulcer area greater than 1 cm^2, hindfoot ulcer site and diabetes duration were important determinants of ulcer healing, and noted the utility of SINBAD-based ulcer characterization in outcome assessment [19].

The most important finding of the present study was that the combination of high SINBAD score and abnormal ABI had the highest odds of poor outcome. Patients with both high SINBAD score and abnormal ABI had an odds ratio of 10.82 for poor outcome compared with patients having low/moderate SINBAD score and normal ABI. This suggests that neither clinical scoring nor vascular testing alone is sufficient for comprehensive prognostication. A combined approach provides a more complete assessment by incorporating local ulcer severity and limb perfusion status. Willems et al. recently concluded that bedside vascular tests alone have limited prognostic performance in patients prone to medial arterial calcification and that combined assessment of macrovascular and microvascular perfusion with standardized wound classification may improve healing prediction [20]. This supports the central finding of the present study that SINBAD score and ABI together are more useful than either parameter alone.

CONCLUSION

The present study concludes that **SINBAD score and ABI are valuable predictors of outcome in diabetic foot ulcers**, and their combined use improves early risk stratification. Patients with abnormal ABI had higher SINBAD scores, more severe ulcer characteristics, delayed healing, increased need for debridement and revascularization, longer hospital stay and higher amputation rates. A high SINBAD score combined with abnormal ABI was strongly associated with poor outcome. Therefore, routine use of SINBAD scoring along with ABI measurement is recommended in patients presenting with diabetic foot ulcers, especially in surgical units, to identify high-risk patients early and guide timely multidisciplinary management.

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