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Operative Intervention Does Not Change Pain Perception in Patients With Diabetic Foot Ulcers

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Operative Intervention Does Not Change Pain Perception in Patients With Diabetic Foot Ulcers

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Researchers investigated pain perception in patients with diabetic foot ulcers (DFUs) by analyzing pre- and postoperative physical function (PF), pain interference (PI), and depression domains of the Patient-Reported Outcome Measurement Information System (PROMIS). They hypothesized that *1*) because of painful diabetic peripheral neuropathy (DPN), a majority of patients with DFUs would have high PROMIS PI scores unchanged by operative intervention, and *2*) the initially assessed PI, PF, and depression levels would be correlated with final outcomes. Seventy-five percent of patients with DFUs reported pain, most likely because of painful DPN. Those who reported high PI and low PF were likely to report depression. PF, PI, and depression levels were unchanged after operative intervention or healing of DFUs.

Diabetic foot ulcers (DFUs) are a debilitating and common side effect of diabetes, experienced by up to 25% of people with diabetes (1–3). Foot ulceration is caused by a combination of internal and external risk factors that lead to the breakdown of skin, resulting in an exposed wound that can quickly become infected (2). Repetitive trauma or pressure in an insensate foot due to diabetic peripheral neuropathy (DPN) is the most common cause of DFUs, which can present with numbness, pain, or weakness (1,2). Some patients with DFUs report foot numbness without pain, whereas some report a significant amount of pain that affects clinical care. An estimated 10–20% of all people with diabetes experience painful DPN, which can occur with or without the presence of a DFU and at any stage in the disease (4–6). In such cases, DPN pain can result in lower reported quality of life and carries a doubled risk of depression in patients with diabetes (1,4,7,8).

Because of varying symptoms and extent of infection, understanding the nature of a DFU patient's pain can be challenging for clinicians. Although many patients with DFUs expect decreased pain after successful treatment and healing of their ulcer, persistent pain after healing is prevalent (9).

Meanwhile, nontherapeutic opioid use has become a public health crisis, especially in the United States, where 80% of the global opioid supply is consumed (10). The opioid abuse epidemic that has enveloped the United States has not been slowing with awareness, but rather has increased threefold in recent years (10).

The Patient-Reported Outcomes Measurement Information System (PROMIS) is a patient health measurement instrument that has been funded by the National Institutes of Health since 2004. Studies have shown that PROMIS accurately reports changes in patient-reported conditions (11,12). Among various domains of PROMIS, the physical function (PF), pain interference (PI), and depression scales have been widely used in medicine (13). PROMIS has been identified as a more reliable measurement than the Numeric Pain Rating Scale (NPRS), the Foot and Ankle Ability Measure, and the Foot Function in Index in assessing foot and ankle pain and can benefit patient care, research, and communication (14,15). The PROMIS PI scale especially has been demonstrated to be superior to the NPRS in assessing pain levels in foot and ankle patients (14). PROMIS uses item response theory and computerized adaptive testing (CAT) to yield a high level of precision and specificity with the fewest responses required from patients (11,16,17). The questions are designed to be readable by individuals of various education levels to promote accuracy in a diverse patient population (18). Despite the widespread use of PROMIS,

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there has been no report of this tool being used to assess pain experienced by patients with DFUs. Accurate understanding of the nature of diabetic foot pain and how it changes with operative intervention for DFUs will help clinicians effectively manage, educate, and set expectations of patients regarding perioperative pain.

This study aimed to assess changes in pain intensity associated with operative intervention in DFU patients using the PROMIS PI domain and to investigate clinical factors that may influence pain perception. We hypothesized that *1*) patients with DFUs would experience higher levels of PI and depression and lower PF than the average U.S. population; *2*) PI, PF, and depression scores would not change significantly after operative intervention; and *3*) PI, PF, and depression would be correlated. In particular, we hypothesized that the combination of worse PF and PI compared with the general U.S. population would be correlated to more severe depression.

Research Design and Methods

Participants

Data collection was conducted in a single academic orthopedic surgeon's practice from February 2015 to November 2018. A total of 240 patients who underwent operative intervention of an infected DFU during this time period were identified using code E11.621 from the *International Statistical Classification of Diseases and Related Health Problems*, 10th revision (ICD-10). Patients were excluded from the study if they had fewer than three PROMIS assessments or incomplete PROMIS data, if their postoperative follow-up was <3 months, or they had recurrent infections within 3 months. Ninety-two patients met the inclusion criteria for this study, and their data were used to quantify PROMIS domain changes and make minimal clinically important difference (MCID) calculations from their initial visits to their final follow-up visits (Figure 1). An additional 19 patients were followed up for <3 months but met all other inclusion criteria. Patient demographics were calculated and χ^2 analysis of scores from the initial visits was performed using patient data from the combined total (n = 111).

PROMIS assessments considered complete included PROMIS CAT PI (version 1.1), PROMIS CAT PF (version 2.0), and PROMIS CAT depression (version 1.0) scales (19–21). They were completed by patients in the clinic's waiting area before scheduled visits. Demographic data, BMI, A1C, presence of chronic renal failure (CRF), type of amputation, and wound healing information were collected during follow-up appointments. Thorough chart reviews and physical exams, such as the 5.07 (10G) monofilament test, were conducted to diagnose or document the presence of DPN (1,3,6).

Statistical Analyses

Descriptive statistical analyses were conducted for patient factors, clinical variables, and PROMIS scores (PF, PI, and depression scales).

Severity of symptoms defined by the PROMIS scales were determined by calculating the proportion of patients in standard deviation (SD) increments above and below the U.S. averages (T-score 50) (hypothesis 1). The categories included at or better than (>0) the U.S. average (score = 0), 1 SD worse (0 to –9.99) than the U.S. average (score = –1), 2 SDs worse (–10 to –19.99) than the U.S. average (score = –2), 3 SDs worse (–20 to –29.99) than the U.S. average (score = –3), and >3 SDs worse (−30 or lower) than the U.S. average (score = –4). This calculation resulted in each

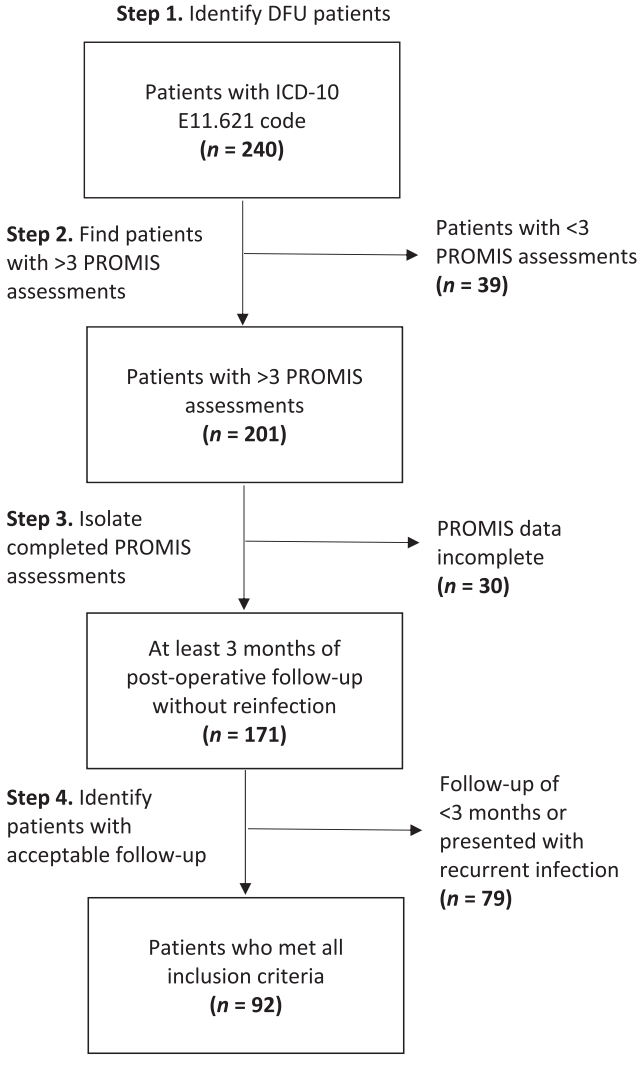

FIGURE 1 Patient selection flowchart.

PROMIS scale being converted to an ordinal scale varying from 0 to –4 to assess symptom severity.

To determine the association of clinical variables with symptom severity, clinical variables were coded as follows: glycemic control: A1C >7% = 1, A1C ≥7% = 0; renal function: CRF present = 1, CRF absent = 0; type of surgical intervention: irrigation and debridement = 0, forefoot (toe or ray) amputation = 1, mid/hind foot (Lisfranc, chopart, or calcanectomy) amputation = 2, Syme or above amputation = 3; and ulcer healing status: healed = 1, not healed = 0. Each of these clinical variables was assessed for association with symptom severity using χ^2 analysis.

Changes in clinical variables and PROMIS scores were evaluated using T-scores to calculate the proportions of patients achieving and not achieving an MCID. After evaluating normality (all PROMIS scales skewness and kurtosis were <2.0), changes in PROMIS scores (PF, PI, and depression) from the initial visit to the longest follow-up visit were calculated using paired *t* tests to test our second hypothesis. To further evaluate change in symptoms from the initial visit to longest follow-up, the proportions of patients with improvement in MCID, deterioration in MCID, and change in MCID were calculated for each PROMIS scale. Improvement in MCID is well discussed in PF and PI studies (22,23). Values for MCID improvement range from 3 to >5 T-score points (22,23). This study used 4 T-score points to determine an MCID improvement or deterioration, recognizing that future studies may further modify estimates of deterioration or improvement depending on their choice of MCID.

To assess the co-occurrence of symptoms defined by the PROMIS scales, Spearman correlations and χ^2 analyses were used. Spearman ρ statistics were used to calculate the correlation among PROMIS T-score values at the initial visit and among PROMIS score changes from the initial visit to the longest follow-up. Similar to prior studies using the PROMIS (14), correlation strengths were categorized as follows: strong (≥0.7), strong-moderate (0.61–0.69), moderate (0.4–0.6), moderate-poor (0.31–0.39), or poor (≤0.3).

To determine the association of symptom severity, 2 × 2 tables were analyzed using χ^2 statistics from the initial PROMIS assessments and for MCID categories of change.

To assess the combined influence of PROMIS PF and PI on depression, a composite score was used similar to a recent study (24). PROMIS PF and PI were summed to create a composite variable; the summed PF and PI score from initial PROMIS assessments ranged from –8 to 0. The summed PF and PI MCID categories ranged from –2 t o 2 . Examining the summed PF and PI from the initial PROMIS assessments and change scores allowed the evaluation of the combined severity of symptoms associated with depression (hypothesis #3). All analyses were done with SPSS version 25.0 software.

Results

Patient Characteristics

At the initial visit, 111 participants had data available, including 92 participants with a minimum of 3 months of postoperative follow-up (Table 1). For both samples, the majority were male (79.3 and 80.4%, respectively) with a mean age of 62.2 and 60.5 years and a mean BMI of 33.8 and 34.1 kg/m^2, respectively. The mean follow-up du-ration was 4.7 months (range 3–12) (Table 1). Operative procedures performed included irrigation and debride-ment (n = 39), forefoot amputations (n = 46), mid/hindfoot amputations (n = 14), and Syme or above amputations (n = 12). The average initial Wagner score was 2.92 (range 1.0–4.0). Sixty-three patients (68.5%) had healed DFUs by the longest follow-up. The average initial A1C was 8.1% (range 4.8–13.6), and the average final A1C was 7.8% (range 4.8–13.1). Twenty-two patients (23.9%) were diagnosed with CRF.

PROMIS Scores

The mean initial PROMIS PF, PI, and depression scores were 34.4 (range 19.1–53.1), 58.7 (range 38.7–76.5), and 51.4 (range 34.2–78.9), respectively. The majority of patients (57.6 and 76.5%, respectively) reported PI and PF at least 2 SDs worse than the U.S. average (Figure 2). Clinical variables that showed an association with PF symptom severity included amputation type (χ^2 42.1, P <0.01) and CRF (χ^2 9.7, P = 0.05). PI symptom severity was associated with ulcer healing status (χ^2 12.2, P <0.01). No other clinical variables were significantly associated with PI, PF, or depression symptom severity.

At the final follow-up, the mean PI score decreased by 0.1 (range –26.6 to 29.5), the mean PF score increased by 1.7 (range –23.2 to 25.4), and the mean depression score increased by 0.2 (range –25.2 to 32.7) (Table 1). Most patients did not achieve MCID in PF, PI, or depression from the initial visit to the longest follow-up visit (47.8, 40.2, and 46.7% remained the same, respectively). An improved MCID in PF, PI, or depression was noted in 33.7, 34.8, and 27.2% of patients, respectively. A decline equal to or greater than an MCID in PF, PI, or depression was noted in 18.5, 25.0 and 26.1% of patients, respectively (Figure 3).

TABLE 1 Patient Demographics

Prognostic Factors	Initial (n = 111)	Follow-Up >3 Months (n = 92)
Patient factors		
Age, mean (SD), range	62.2 (12.0), 33–96	60.52 (11.5), 33–96
Male sex, *n* (%)	88 (79.3)	74 (80.4)
BMI, mean (SD), range	33.8 (6.8), 22.0–57.5	34.1 (6.9), 22.0–57.5
Symptom severity (PROMIS scores)		
Initial, mean (SD), range		
PF	34.5 (7.8), 19.1–53.1	34.4 (7.7), 19.1–53.1
PI	58.9 (10.4), 38.7–77.8	58.7 (10.7), 38.7–76.5
Depression	51.1 (10.8), 34.2–78.9	51.4 (10.7), 34.2–78.9
Change from initial to longest follow-up, mean (SD), range		
PF		1.7 (8.9), –23.2 to 25.4
PI		–0.1 (9.7), –26.6 to 29.5
Depression (n = 83)		0.2 (8.9), –25.2 to 32.7
Clinical factors		
Wagner score, mean (SD), range	2.92 (0.41), 1.0–4.0	
A1C, %, mean (SD), range		
Initial (n = 78)	8.1 (1.9), 4.8–13.6	8.1 (1.9), 4.8–13.6
Latest follow-up (n = 76)		7.8 (1.9), 4.8–13.1
Chronic renal failure, *n* (%)		22 (23.9)
Type of operative procedure, *n* (%)		
Irrigation and debridement		39 (42.4)
Forefoot amputation Mid/	10 (9.0)	46 (50.0)
hind foot amputation Syme	9 (8.1)	14 (15.2)
or above amputation	6 (5.4)	12 (13.0)
Healed (yes), *n* (%)		63 (68.5)
Length of follow-up, months, mean (SD), range		4.7 (1.9), 3–12

Statistically significant moderate correlations among scales existed for PROMIS T-score values and symptom severity at the initial visit. The strongest correlation was noted between PI and depression (P <0.01, Spearman ρ = 0.44). χ^2 Analysis of PI and depression symptom severity showed a significant association (Table 2). The 2 × 2 table revealed that patients who reported a PI >60 were more likely to report depression. There was also a moderate to poor correlation between PF and depression (P <0.01, ρ = 0.39). χ^2 Analysis of PF and depression symptom severity also showed a significant association (Table 2). The 2 × 2 table showed that patients who reported a low PF were also more likely to report a depression score >50 (Table 2). The Spearman correlation between PF and PI was moderate to poor (P <0.01, ρ = –0.27), and the χ^2 analysis PI and PF symptom severity was also significant. At the initial time point, as the MCID sum of PF and PI increased, depression scores >50 decreased (Table 3).

There were also significant poor to moderate correlations among changes in PROMIS scales and among MCID change in PROMIS scales. The strongest correlation was between change in PI and change in depression (P <0.01, ρ = 0.47). χ^2 Analysis of MCID categories for PI and depression also showed a significant association (P <0.01). There was also a significantly poor correlation between MCID categories for PF and PI (P <0.01, ρ = –0.28). χ^2 Analysis of PF and depression symptom severity also showed a significant association (Table 2). There was no significant correlation between MCID categories for PF and depression (P = 0.15, ρ = –0.15), and χ^2 analysis of MCID categories for PF and depression showed significant association (P = 0.04). The correlation of the sum of the change in PF and PI scores was significant (P = 0.02, ρ = 0.24), and χ^2 analysis showed a significant association (P <0.01) of MCID categories of depression with the sum of categories of MCID change for PF and PI (Table 4).

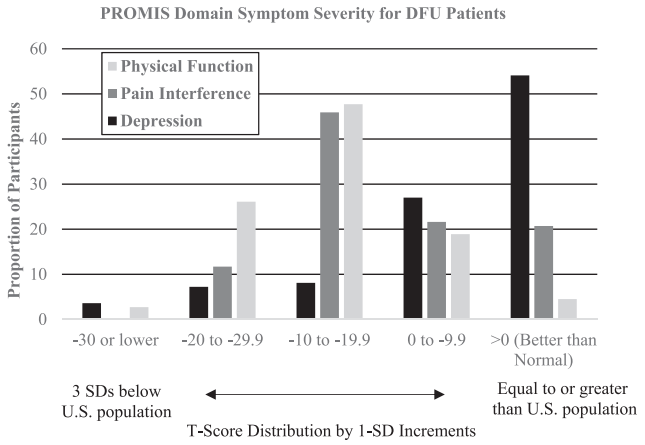

FIGURE 2 Symptom severity by 1-SD increments across PROMIS scales. Mean initial PROMIS PF, PI, and depression scores assessed by SDs below the U.S. population average. High raw PI T-scores were transformed into SDs lower than those of the U.S. population.

Discussion

Despite having reduced sensation, many DFU patients experience significant pain. Our results indicate that the pain perception of DFU patients is unlikely to change despite successful operative intervention. PROMIS assessments demonstrate the potential to improve care by allowing for better communication between patients and providers, in addition to more reliable pain assessment and valid data collection (11). The predictive nature of PROMIS data are especially helpful in improving operative decisions and patient care (25). This is the first study to use PROMIS scores in an attempt to characterize the pain experienced by DFU patients.

Our data showed that 75% of patients with infected DFUs report significant amounts of pain at initial presentation. The average PI score of our cohort was 58.9, with most patients reporting ~2 SDs above the U.S. average (Figure 2). Ulcer healing status was the only clinical factor that was significantly related to PI (χ^2 12.2, P <0.01). Other studies have found a similar percentage of patients with diabetes (40–60%) reporting pain (4,6).

Surprisingly, the average reported depression score (51.4) within the DFU population was not statistically significantly higher than in the general U.S. population (Table 1). Based on previous studies, we expected depression scores to be significantly higher among people with diabetes because of the bidirectional relationship between type 2 diabetes and depression (26). No clinical factors were significantly correlated with depression.

Reported PF was primarily 1.5 SDs below that in the average U.S. population (Figure 2). This was expected because of physical limitations caused by DFUs and resultant amputations (27–29). Amputation type (χ^2 42.1, P <0.01) and CRF (χ^2 9.7, P = 0.05) were the only clinical factors shown to affect PF.

From the initial visit to longest follow-up visit, mean changes in PI, PF, and depression were 1.7, –0.1, and 0.2, respectively (Table 1). Around one-third of our cohort showed an MCID improvement in PF, PI, or depression after operative intervention. The majority of our patients reported no change in PROMIS domains or sometimes worse outcomes after treatment (Figure 3). This finding indicates that operative intervention most likely did not change pain perception in the cohort.

Elevated depression and PI were commonly reported together (P <0.01, Spearman ρ = 0.44) at the initial time point in our study. Those who reported PI >60 were more likely to report depression >50 (Table 2). This observation is consistent with existing literature that also observed the coexistence of patient-reported pain and depression levels (4,30). Low PF and high PI scores were also found to be coexisting (P <0.01, ρ = –0.27) at the initial time point. DFU patients significantly reported both depression and low PF (P <0.01, ρ = 0.39) at the initial time point, and those who reported PF <40 were more likely to report depression (Table 2). Summing initial PF and PI MCIDs revealed that patients who simultaneously reported low PF and PI were more likely to report depression (Table 3). This finding held true for MCID assessment as well (Table 4).

MCID changes were statistically significant between depression and PI (P <0.01) as well as PF and PI (P = 0.02). On the other hand, MCID change for PF and

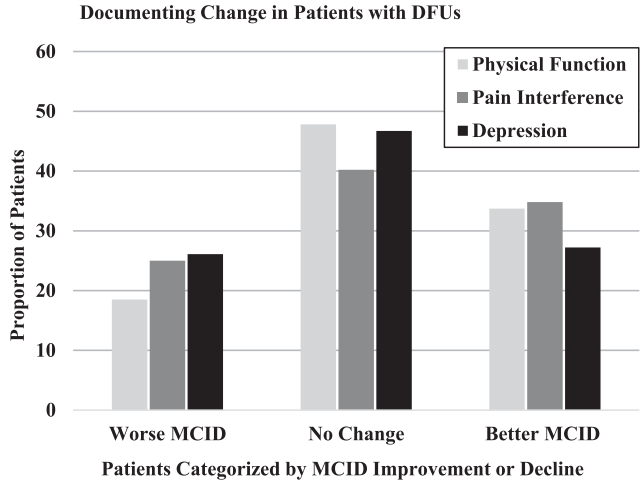

FIGURE 3 Documenting change in patients with DFUs. Patients are categorized by MCID improvement or decline from their initial appointment to their longest follow-up visit.

TABLE 2 χ^2 Analysis of PI and Depression at Initial Time Point ($P = 0.001$, Spearman $\rho = 0.49$)

		PI Score				
		<50	**50–59.9**	**60–69.9**	**≥70**	**Total**
Depression Score	**<50**	**16 (14.4)**	**18 (16.2)**	25 (22.5)	1 (0.9)	60 (54.1)
	50–59.9	**4 (4.5)**	**4 (3.6)**	**16 (14.4)**	**5 (4.5)**	30 (27.0)
	60–69.9	0 (0.0)	2 (1.8)	**6 (5.4)**	**1 (0.9)**	9 (8.1)
	70–79.9	2 (1.8)	0 (0.0)	**2 (1.8)**	**4 (3.6)**	8 (7.2)
	≥80	0 (0.0)	0 (0.0)	**2 (1.8)**	**2 (1.8)**	4 (3.6)
	Total	23 (20.7)	24 (21.6)	51 (45.9)	13 (11.7)	111 (100.0)

Data are *n* (%). Bold type indicates statistical significance.

depression was not statistically significant ($P = 0.08$). Other clinical factors tested for MCID were initial A1C, final A1C, CRF, type of operative intervention (irrigation and debridement, forefoot amputation, mid/hind foot amputation, and Syme or above amputation), wound-healing status, and length of follow-up (Table 1). No other clinical factors were found to be statistically significant for an MCID change ($P > 0.10$).

Several methods are used for diagnosing DPN, with the Semmes-Weinstein 5.07 (10G) monofilament test being the most prevalent among health care providers because of its convenience and availability. However, monofilament tests lack the standardization needed to confirm the range of nerve fiber damage, which can vary among individuals (31). Differences in test application, interpretation, and populations all contribute to the low specificity and sensitivity of the monofilament test (2). Ultimately, there is no universal standard for diagnosing neuropathic pain. It has been suggested that more than one test of neurological deficits is required for the diagnosis of DPN; recommendations in the literature include using a combination of both clinical and diagnostic testing (32,33). Screening tests such as the Neuropathy Symptom and Change Score, Neuropathy Impairment Score, and Michigan Neuropathy Screening Instrument help with accurate and reliable diagnosis of DPN (34).

In our cohort of 111 patients, 48 were diagnosed with DPN by the senior author, who performed the Semmes-Weinstein 5.07 (10G) monofilament test to diagnose DPN. Fifty-five of our patients were previously diagnosed with DPN by another physician (primary care provider, neurologist, or endocrinologist). However, because of the lack of diagnostic standardization and documentation, we were not able to clearly confirm the validity of DPN in these patients. The remaining eight patients were not formally diagnosed with DPN by the senior author or another physician, although they were documented to have reduced sensation at their appointments. Even though there were generally higher levels of reported PI, the patient-reported PROMIS data do not conclusively point to painful DPN as the origin of the pain. Active infections also may have played a role in aggravation of DPN. For further research, using a patient-reported PROMIS measure of neuropathic pain may provide additional information to determine whether experienced pain is related to painful DPN or a separate comorbidity (35).

Studies have shown clinical depression to be present in 25% of patients with type 2 diabetes, and, as previously noted, depression risk has been shown to double in populations with diabetes (7,26). However, a previous study also found that DFUs and depressive symptoms are not significantly related (33). The authors suggest that patients with a depressed affect shared two major variables: a concern for the unpredictability and lack of treatment for their condition and a change in social self-perception that is caused by a decrease in PF (33). Because most of our cohort had low PF scores, a possible ex-planation for the lack of depression might be related to the first variable. If DFU patients understood their condition and treatment options, they might experience less de-pression and anxiety about the outcome. Screening study participants with the Patient Health Questionnaire-9 or a social determinants of health questionnaire may better assess the source of patient-reported depression (36–38).

In terms of postoperative care, our results indicate that DFU patients' pain does not decrease postoperatively, suggesting that an opioid prescription is unlikely to benefit patients with DPN pain. Neuromodulating drugs such as amitriptyline, duloxetine, pregabalin, or gabapentin may be considered as initial treatment (39). Additionally, the DFU patient population appears to be particularly at risk

TABLE 3 χ^2 Analysis of PF and Depression at Initial Time Point ($P = 0.007$, Spearman $\rho = 0.41$)

		PF Score					
		<20	20–29.9	30–39.9	40–49.9	≥50	Total
Depression Score	<50	0 (0.0)	7 (6.3)	30 (27.0)	**18 (16.2)**	**5 (4.5)**	60 (54.1)
	50–59.9	**3 (2.7)**	**11 (9.9)**	**13 (11.7)**	**3 (2.7)**	**0 (0.0)**	30 (27.0)
	60–69.9	**0 (0.0)**	**5 (4.5)**	**4 (3.6)**	0 (0.0)	0 (0.0)	9 (8.1)
	70–79.9	**0 (0.0)**	**4 (3.6)**	**4 (3.6)**	0 (0.0)	0 (0.0)	8 (7.2)
	≥80	**0 (0.0)**	**2 (1.8)**	**2 (1.8)**	0 (0.0)	0 (0.0)	4 (3.6)
	Total	3 (2.7)	29 (26.1)	53(47.7)	21 (18.9)	5 (4.5)	111(100.0)

Data are *n* (%). Bold type indicates statistical significance.

for opioid abuse based on shared risk factors such as preoperative pain, depression, and low socioeconomic status (40). Studies have shown that benzodiazepine and antidepressant usage preoperatively puts patients at greater risk for opioid abuse postoperatively (40,41). Not only is there a chance of opioid abuse, but higher opioid dosages are also associated with increased complications, less satisfaction, and a greater pain intensity postoperatively (42,43).

This study is limited by its small sample size and lack of clinical variables assessed in the cohort. Despite initially recruiting 240 participants, only 111 were included in initial patient characteristic analyses, and 92 were included in further analyses of changes in PROMIS domains. The 111 patients met all inclusion criteria except for the criterion of 3-month postoperative follow-up. All analyses that identified change from the initial visit to the longest follow-up visit were conducted with the 92 participants who met all inclusion criteria and had at a minimum of 3 months of postoperative follow-up.

Demographic data such as race, ethnicity, and socioeconomic status were not included in the data analyses and could confound study results (2). Additionally, acknowledging that DFU patients often have multiple comorbidities, only a small number of possible diagnoses were used in analyses.

We chose a short follow-up duration to limit the confounding variables associated with multiple interventions. The longer the follow-up period, the more patients returned with recurrent DFUs at the same or different locations that required further operative interventions. To isolate the clinical analysis to a single operative event, we limited our follow-up to a 3- to 12-month period. Those who required an additional procedure within the time frame were excluded from the study.

Our average healing rate (68.5%) falls in the middle of those found in other studies, which have ranged from 33 to >80%, but studies have also shown that the average healing time is >2 months or, for uncomplicated cases, within 3 months (1,3). Although we found that depression in the DFU population was only slightly higher than in the general U.S. population (score of 51.4), this finding could be confounded by a short follow-up period. Studies have shown that patients with complications have higher depression rates (7). Therefore, if the follow-up
time frame had been longer in this study, higher depression levels could have been observed as more complications arose.

Conclusion

Our results show that PF, PI, and depression rates are likely to remain the same even after the successful healing of a DFU. In addition, PROMIS symptoms tended to occur

TABLE 4 χ^2 Analysis of MCID PF and PI Sum Versus MCID for Depression

		Depression (1-SD Intervals)			
		–1	**0**	**1**	**Total**
PF and PI Sum (1-SD Intervals)	**–2**	5	3	0	**8**
	–1	4	6	4	**14**
	0	13	17	3	**33**
	1	1	3	**1**	**21**
	2	1	4	1	1 **16**
	Total	**24**	**43**	**25**	**92**

Scores are separated by 1-SD intervals from the U.S. average, where –2 indicates a deterioration in both PF and PI and +2 indicates an improvement in both. Patients are totaled on the far right column and bottom row.

together, suggesting that providers should consider multidimensional assessment when attempting to address patients' needs. Continuing to investigate this challenging patient population will allow for improvement in the physical and psychological functioning of patients with DFUs.

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DUALITY OF INTEREST

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AUTHOR CONTRIBUTIONS

O.V.W. and S.P.H. contributed to the study design, data analysis, and manuscript writing. J.R.H. and N.J.L. contributed to data analysis and manuscript writing. J.F.B. contributed to the study design and manuscript writing. I.O. contributed to the study design, patient recruitment, data analysis, and manuscript writing. I.O. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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