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Exercise-Based Physiotherapy in Diabetic Foot Ulcer: A Case Report

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Abstract

Background: Diabetic Foot Ulcer (DFU) is a serious complication of diabetes mellitus associated with pain, impaired mobility, functional limitation, and increased risk of amputation. Physiotherapy may support safe mobilization and functional recovery in patients with active DFU; however, evidence regarding exercise-based physiotherapy during acute DFU management remains limited.

Objective: To evaluate the short-term clinical outcomes of exercise-based physiotherapy intervention in a patient with DFU.

Methods: This case report followed the CARE guideline and involved a 60-year-old female patient with DFU treated at PKU Muhammadiyah Hospital, Yogyakarta, Indonesia. The patient received four physiotherapy sessions consisting of active range of motion exercise, quadriceps setting exercise, stretching, ankle pump exercise, and diaphragmatic breathing exercise. Outcomes were evaluated using the Numeric Rating Scale (NRS), goniometric range of motion (ROM) measurement, Manual Muscle Testing (MMT), sensory examination, and Barthel Index.

Results: Movement pain decreased from 4/10 to 1/10 on the NRS. Hip flexion ROM improved from 100° to 120°, while knee flexion ROM increased from 85° to 90°. Muscle strength remained stable at MMT grade 4/5, and sensory examination findings remained hypoesthetic. Although the Barthel Index score remained 25, the patient demonstrated improved independent sitting ability. No adverse events were identified during intervention.

Conclusion: Exercise-based physiotherapy demonstrated positive short-term clinical outcomes in reducing pain, improving joint mobility, and supporting early functional mobility in a patient with DFU. Further studies with objective wound-healing parameters and longer follow-up periods are recommended.

Keywords
Diabetic Foot; Exercise Therapy; Physical Therapy Modalities; Rehabilitation; Diabetic Neuropathies

Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both. The global prevalence of diabetes continues to increase substantially and has become a major public health burden worldwide.[1] According to the International Diabetes Federation, approximately 537 million adults were living with diabetes in 2021, and this number is projected to increase to 783 million by 2045.[2] Chronic hyperglycemia contributes to various microvascular and macrovascular complications that significantly reduce quality of life and increase morbidity and mortality rates.[3] Among these complications, Diabetic Foot Ulcer (DFU) is considered one of the most serious and disabling manifestations because it is strongly associated with infection, prolonged hospitalization, lower extremity amputation, and high mortality rates.[4]

Diabetic foot ulcer (DFU) is defined as a full thickness wound located below the ankle in a person with diabetes and is commonly associated with peripheral neuropathy and peripheral artery disease, which may contribute to impaired tissue healing.[5] The pathophysiology of DFU is multifactorial and involves chronic inflammation, endothelial dysfunction, oxidative stress, impaired angiogenesis, and abnormal immune responses caused by prolonged hyperglycemia. Persistent hyperglycemia promotes the formation of advanced glycation end products (AGEs), activation of inflammatory pathways, and microvascular dysfunction, which collectively impair tissue regeneration and increase susceptibility to infection.[6] In addition, diabetic peripheral neuropathy contributes to the loss of protective sensation, thereby increasing the risk of repetitive and unnoticed trauma and delayed detection of tissue injury.[6] These mechanisms explain why DFU frequently develops into chronic wounds with poor healing outcomes and elevated amputation risk.[4]

The clinical burden of diabetic foot ulcers remains substantial worldwide. The lifetime risk of developing a DFU is estimated at 19%–34%, and approximately 20% of affected individuals may require lower-extremity amputation, representing one of the most severe complications of diabetic foot disease.[7] In Indonesia, DFU prevalence is also considered high and contributes significantly to hospitalization among patients with diabetes mellitus.[8] Delayed wound healing, recurrent infection, pain, impaired mobility, and functional dependency further worsen the physical and psychosocial condition of affected individuals. Therefore, comprehensive multidisciplinary management is required to optimize wound healing, maintain functional independence, and reduce disability.[9]

Current DFU management primarily focuses on glycemic control, infection management, wound debridement, pressure offloading, vascular management, and appropriate wound dressing.[10] However, prolonged immobilization during hospitalization often contributes to muscle weakness, joint stiffness, impaired circulation, reduced mobility, and decreased functional capacity in patients with active DFU.[11] In this context, physiotherapy may provide an important adjunctive role in maintaining joint mobility, improving circulation, preserving muscle performance, reducing pain, and supporting early functional mobilization through safe and individualized exercise interventions.[12] Exercise-based physiotherapy interventions such as range of motion (ROM) exercise, ankle

pump exercise, stretching, breathing exercise, and isometric strengthening have been reported to improve peripheral circulation, venous return, pain modulation, and physical function in patients with diabetes-related lower extremity disorders.[13]

Despite the potential benefits of physiotherapy, evidence regarding exercise-based physiotherapy management in patients with active DFU remains limited. Most previous studies primarily focused on wound care management, pressure redistribution, or surgical and pharmacological interventions, while the role of physiotherapy in improving short-term clinical and functional outcomes during acute DFU management has not been extensively reported.[12] Furthermore, concerns regarding exercise safety in patients with neuropathy and active ulceration often limit early mobilization approaches in clinical practice.[13] Consequently, additional clinically detailed case-based evidence is needed to describe the feasibility, safety, and potential benefits of physiotherapy interventions in patients with active DFU.

This case report has important clinical and educational value because it demonstrates the implementation of exercise-based physiotherapy intervention in a hospitalized patient with active DFU who experienced pain, limited joint mobility, hypoesthesia, and severe functional dependency. In addition to reporting objective clinical outcomes, this report also highlights the role of physiotherapy in facilitating early mobilization and short-term functional improvement while maintaining patient safety during intervention. Therefore, this case report aimed to evaluate the short-term clinical outcomes of exercise-based physiotherapy intervention on pain, range of motion, muscle strength, sensory status, and functional ability in a patient with Diabetic Foot Ulcer.

Methods

This study was conducted using a case report design following the CARE (CAse REport) guideline for clinical case reporting. The study was carried out at PKU Muhammadiyah Hospital, Yogyakarta, Indonesia, in September 2025**.** Written informed consent was obtained from the patient prior to participation and publication of clinical information. The patient agreed to undergo physiotherapy intervention and clinical evaluation throughout the treatment period.[14] Ethical approval information from the institutional review board should be added if available.

The subject was a 60-year-old female patient diagnosed with DFU who was hospitalized due to lower extremity weakness, edema, pain, and mobility limitation. The patient had experienced progressive lower extremity symptoms for approximately 20 days prior to hospitalization and had remained bedridden for four days after admission to the emergency department. Initial clinical examination revealed ulceration in the lower extremity region accompanied by swelling and previous purulent discharge. The patient also demonstrated limited active lower limb movement, hypoesthesia, and severe functional dependency during early hospitalization.

The patient had a body weight of 75 kg, height of 156 cm, body mass index (BMI) of 30.8 kg/m², blood pressure of 140/95 mmHg, pulse rate of 89 beats/minute, and random blood glucose level of 387 mg/dL. Clinical inspection demonstrated redness around the patellar, gastrocnemius, and tibialis anterior regions with bandaged ulcer areas on the lower extremity. The patient also presented with arterial ulcer characteristics around the knee region without visible active purulent exudate after debridement. Palpation examination demonstrated tenderness surrounding the wound area. Active movement assessment revealed limited hip and knee flexion associated with pain, whereas passive movement could achieve full range of motion despite discomfort. Isometric examination demonstrated reduced lower extremity muscle strength during resistance testing.

Sensory examination was performed using sharp and dull discrimination and light touch testing, with hypoesthetic responses indicating impaired peripheral sensation consistent with diabetic peripheral neuropathy. Functional ability was assessed using the Barthel Index, with an initial score of 25 indicating severe dependence in activities of daily living. Pain intensity was evaluated using the Numeric Rating Scale (NRS), while joint range of motion (ROM) was measured using a standard goniometer. Muscle strength was assessed using Manual Muscle Testing (MMT). These instruments are widely used in rehabilitation practice because of their clinical practicality, although their reliability and measurement properties may vary according to the instrument, testing procedure, and patient population.[15]

The ulcer condition was classified according to the Wagner classification system for diabetic foot ulcers. Based on clinical examination, the patient was categorized as Wagner grade 3 due to deep ulceration accompanied by infection signs requiring previous debridement management.[16] Although detailed wound surface measurement and objective wound assessment tools such as the Bates-Jensen Wound Assessment Tool or PUSH score were not available during hospitalization, wound monitoring was conducted regularly through observation of edema, erythema, exudate, and tissue condition throughout physiotherapy sessions.[17]

During hospitalization, the patient also received standard medical management from the hospital team, including wound care and debridement procedures. However, detailed pharmacological information and dressing protocols were not fully accessible during data collection. Therefore, these concomitant interventions were considered potential confounding factors influencing clinical outcomes.

Physiotherapy intervention was administered for four treatment sessions over the hospitalization period. Prior to intervention, the patient underwent clinical screening to ensure exercise safety considering the presence of active ulceration and diabetic neuropathy. Exercise intensity and progression were adjusted according to patient tolerance, pain response, fatigue level, and wound condition. Continuous monitoring was performed during intervention sessions to identify adverse responses such as increased pain, worsening edema, bleeding, excessive fatigue, or signs of wound aggravation.

The physiotherapy program consisted of active range-of-motion exercises, quadriceps setting, stretching, ankle pump exercises, and diaphragmatic breathing. Active range-of-motion exercises targeted hip flexion, knee flexion-extension, and ankle dorsiflexion-plantarflexion to maintain joint mobility and support lower-limb physical function. Quadriceps setting was used as an isometric strengthening exercise, while gastrocnemius stretching was performed to address lower-limb stiffness and maintain ankle flexibility. The exercise dosage was individualized according to the patient's clinical condition and tolerance.[18] Ankle pump exercise was prescribed to facilitate venous return and reduce edema through repetitive dorsiflexion and plantarflexion movements.[19] In addition, diaphragmatic breathing exercise was implemented to promote relaxation and reduce pain perception during hospitalization.[20]

To provide a clearer description of the clinical course and intervention process according to the CARE guideline, the patient timeline is presented below.

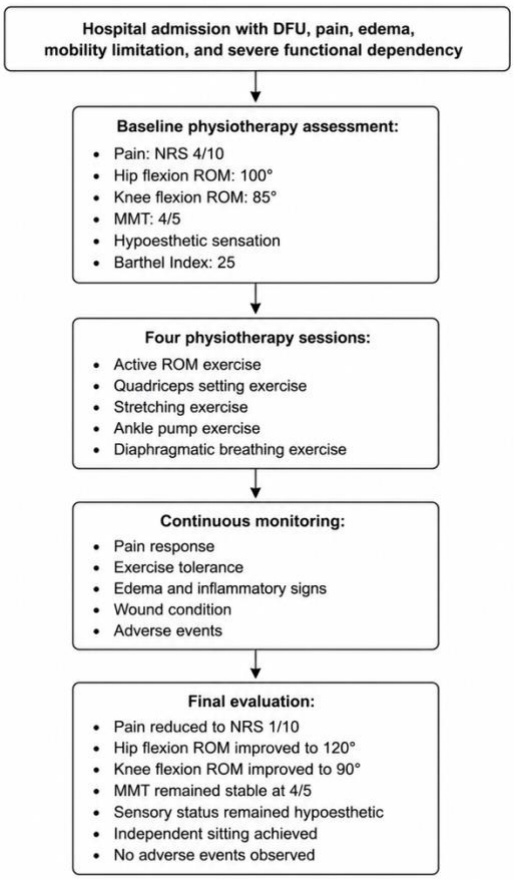

Figure 1. Clinical Flowchart of Exercise-Based Physiotherapy Intervention and Patient Progression in Diabetic Foot Ulcer

Data analysis was performed descriptively by comparing baseline and post-intervention clinical findings. Outcome changes were interpreted narratively to evaluate short-term clinical responses following physiotherapy intervention. Due to the single-patient case report design, no inferential statistical analysis was conducted.

Results

The patient completed four physiotherapy sessions during hospitalization without adverse events or worsening wound conditions. Throughout the intervention period, the patient demonstrated gradual improvement in pain intensity, joint mobility, and functional sitting ability. Clinical monitoring was also performed regularly to observe edema, inflammatory signs, wound condition, and exercise tolerance during each session. No increase in erythema, bleeding, excessive fatigue, or additional tissue injury was identified during physiotherapy intervention.

To provide a clearer overview of the patient's clinical progression, the main outcomes before and after physiotherapy intervention are presented in Table 1.

Table 1. Clinical Outcomes Before and After Physiotherapy Intervention

Outcome Measure	Baseline (T1)	Final Evaluation (T4)
Numeric Rating Scale (NRS)	4/10	1/10
Hip Flexion ROM	100°	120°
Knee Flexion ROM	85°	90°
Manual Muscle Testing (MMT)	4/5	4/5
Sharp-Dull Sensation	Hypoesthetic	Hypoesthetic
Light Touch Sensation	Hypoesthetic	Hypoesthetic
Barthel Index	25	25

Abbreviations: NRS, Numeric Rating Scale; ROM, range of motion; MMT, Manual Muscle Testing.

At baseline assessment, the patient reported movement-related pain in the hip region with an NRS score of 4/10. Following four physiotherapy sessions, pain intensity decreased to 1/10, indicating clinically meaningful pain reduction during movement activities. The patient also reported improved comfort during lower extremity mobilization and exercise participation at the end of the intervention period.

Joint mobility assessment demonstrated improvement in lower extremity ROM after intervention. Hip flexion ROM increased from 100° at baseline to 120° during the final evaluation, while knee flexion ROM improved from 85° to 90°. Clinically, the patient demonstrated better tolerance during active lower limb movement and sitting activities compared with the initial assessment. Improvement in ROM was also accompanied by reduced movement guarding and lower pain response during exercise sessions.

Muscle strength evaluation using MMT showed stable findings throughout the intervention period, with muscle strength remaining at grade 4/5 from baseline until the fourth session. Although no numerical increase in MMT score was identified, maintenance of muscle performance during acute hospitalization and limited mobility was considered clinically beneficial because the patient was able to participate actively in transfer and sitting activities without additional strength deterioration.

Sensory examination findings remained unchanged during the intervention period. The patient continued to demonstrate hypoesthetic responses in both sharp-dull discrimination and light touch assessment at the final evaluation. Nevertheless, no

additional sensory deterioration, new necrotic tissue, or worsening inflammatory signs were identified during physiotherapy intervention. Continuous monitoring was performed throughout the exercise sessions considering the patient's diabetic neuropathy and reduced protective sensation.

Functional evaluation using the Barthel Index demonstrated a stable score of 25, indicating severe dependency in activities of daily living both before and after intervention. However, despite the unchanged quantitative score, qualitative functional improvement was observed clinically. During the final session, the patient was able to maintain independent sitting without assistance, which had not been achieved during the initial assessment. This finding indicated improvement in early functional mobility despite the absence of measurable changes in overall Barthel Index classification.

In addition to musculoskeletal outcomes, regular wound observation was performed during each physiotherapy session to monitor patient safety and tissue response to exercise intervention. Although objective wound-healing parameters such as wound area measurement or standardized wound assessment scores were unavailable, observational findings demonstrated no visible worsening of edema, exudate, or inflammatory signs during the treatment period. The wound remained adequately protected with dressing management throughout hospitalization.

To summarize the overall clinical progression according to the CARE guideline, the patient flow during intervention and evaluation is presented below.

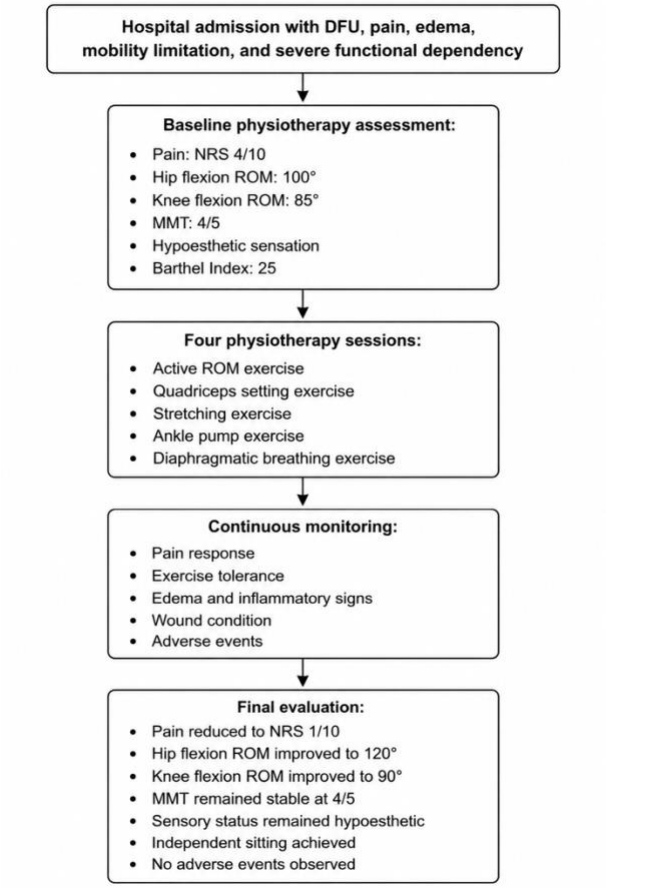

Figure 2. Clinical Flowchart of Physiotherapy Intervention and Outcome Progression in a Patient With Diabetic Foot Ulcer

Overall, the findings demonstrated that exercise-based physiotherapy intervention was associated with positive short-term clinical outcomes, particularly in pain reduction, joint mobility improvement, exercise tolerance, and early functional sitting ability during acute DFU management.

Discussion

This case report demonstrated that exercise-based physiotherapy intervention was associated with positive short-term clinical outcomes in a hospitalized patient with Diabetic Foot Ulcer (DFU), particularly in reducing pain, improving joint mobility, maintaining muscle performance, and facilitating early functional mobility. Although objective wound-healing parameters were unavailable, the patient tolerated the intervention safely without worsening inflammatory signs, edema, or adverse events during the treatment period. These findings support the potential role of physiotherapy as an adjunctive intervention in the multidisciplinary management of active DFU.

One of the main findings of this study was the reduction in movement-related pain from 4/10 to 1/10 after four physiotherapy sessions. Pain reduction is clinically important in patients with DFU because pain frequently limits mobility, delays rehabilitation, and contributes to prolonged physical inactivity during hospitalization.[21] Previous studies suggested that controlled therapeutic exercise and joint mobilization may improve pain modulation through stimulation of mechanoreceptors and enhancement of local circulation.[22] Exercise-induced sensory stimulation may activate large-diameter afferent fibers, thereby modulating nociceptive transmission at the spinal level through neurophysiological pain inhibitory mechanisms.[23] However, compared with the initial manuscript version, the present discussion intentionally focuses more on the clinical relevance of pain reduction rather than excessive molecular or neurophysiological explanation, in accordance with reviewer recommendations.

Improvement in lower extremity range of motion (ROM), particularly hip flexion and knee flexion, also represented an important functional outcome in this patient. Reduced ROM in hospitalized DFU patients is commonly associated with pain, edema, prolonged bed rest, muscle guarding, and decreased movement tolerance.[21] In the present case, active ROM exercise, stretching,

and ankle pump exercise were prescribed to maintain soft tissue extensibility and facilitate safe mobilization without excessive mechanical loading on the ulcerated area. Previous literature reported that therapeutic exercise may improve peripheral circulation, reduce joint stiffness, and preserve lower extremity mobility in patients with diabetes-related complications.[24] Improved ROM in this patient contributed directly to better sitting tolerance and transfer preparation during hospitalization, indicating that even short-duration physiotherapy intervention may provide meaningful functional benefits.

Although MMT scores remained stable at grade 4/5 throughout the intervention period, maintenance of muscle strength should still be interpreted as a positive clinical outcome considering the patient's acute condition, immobilization period, and severe functional dependency. Patients with prolonged bed rest frequently experience rapid muscle deconditioning and functional decline, particularly among older adults with chronic metabolic disorders.[25] Therefore, preservation of muscle performance during hospitalization may indicate that the intervention successfully minimized further physical deterioration. This interpretation is consistent with previous evidence suggesting that low-intensity isometric exercise may safely maintain lower extremity muscle activation in patients with active DFU while minimizing plantar mechanical stress and excessive tissue loading.[11]

The patient's sensory status remained hypoesthetic during the intervention period, reflecting the chronic nature of diabetic peripheral neuropathy. This finding was expected because peripheral nerve regeneration and sensory recovery generally require substantially longer intervention periods than the four treatment sessions performed in this case. Persistent hypoesthesia also indicates ongoing loss of protective sensation, which remains a major risk factor for recurrent trauma and delayed wound healing in DFU.[26] Nevertheless, despite the absence of sensory improvement, careful monitoring throughout the intervention demonstrated that physiotherapy exercises did not aggravate tissue condition or provoke additional injury. This finding is clinically important because concerns regarding exercise safety in neuropathic patients often limit mobilization during acute DFU management.[21]

Consequently, improvement in a single functional domain may not produce a substantial change in the total Barthel Index score because the overall score is derived from multiple activities of daily living. Nevertheless, the ability to sit independently without assistance may represent clinically meaningful functional progress, as supported sitting and progression toward independent sitting constitute important early stages of mobilization before transfer, standing, and walking.[27] In rehabilitation settings, small functional changes during acute hospitalization may have considerable implications for discharge preparation and prevention of further disability.[28]

Another important aspect highlighted in this case was the safety and feasibility of exercise-based physiotherapy intervention in a patient with active DFU. Historically, mobilization in patients with diabetic ulcers has often been restricted because of concerns regarding tissue damage, wound aggravation, or increased plantar pressure.[12] However, recent evidence suggests that carefully monitored low-intensity exercise may provide circulatory and functional benefits without negatively affecting wound healing when appropriately prescribed.[12,29] In this study, intervention intensity was adjusted according to pain response, wound condition, and patient tolerance, while continuous monitoring was performed throughout each session. No adverse events, worsening edema, bleeding, or additional tissue complications were identified, suggesting that individualized physiotherapy intervention may be safely implemented during acute DFU management.

Compared with previous DFU case reports and rehabilitation studies, the present case specifically emphasizes short-term functional rehabilitation during acute hospitalization rather than focusing exclusively on wound closure outcomes. Most published DFU studies primarily evaluate wound-healing parameters, pressure redistribution, or surgical management, whereas functional mobility outcomes and physiotherapy safety during active ulcer conditions remain underreported.[12] Therefore, this case contributes additional clinical insight regarding the role of early physiotherapy intervention in maintaining mobility and supporting functional recovery among hospitalized patients with DFU.

Several limitations should be acknowledged in this report. First, this study involved only a single patient, thereby limiting generalizability of the findings. Second, the intervention duration was relatively short and insufficient to evaluate long-term wound healing, neuropathy recovery, or sustained functional outcomes. Third, objective wound-healing measurements such as wound area assessment, PUSH score, or Bates-Jensen Wound Assessment Tool were unavailable during hospitalization. Finally, concomitant medical interventions including debridement, wound dressing, glycemic management, and pharmacological treatment may have influenced the observed outcomes and could not be fully controlled. Future studies involving larger samples, objective wound-healing parameters, and longer follow-up periods are necessary to clarify the effectiveness and safety of physiotherapy interventions in patients with active DFU.

Overall, this case highlights an important clinical lesson that exercise-based physiotherapy may support safe early mobilization and short-term functional improvement in patients with active DFU when delivered through individualized monitoring and multidisciplinary collaboration. Careful exercise prescription, continuous wound observation, and consideration of neuropathic safety remain essential components of physiotherapy management in this population.

Conclusion

Exercise-based physiotherapy intervention demonstrated positive short-term clinical outcomes in a hospitalized patient with Diabetic Foot Ulcer (DFU). After four physiotherapy sessions, the patient showed reduced pain intensity, improved lower extremity range of motion, preserved muscle strength, and better early functional mobility, particularly independent sitting ability, without adverse events during intervention.

These findings suggest that individualized and carefully monitored physiotherapy may serve as a safe adjunctive approach to support early mobilization and functional recovery in patients with active DFU. However, the findings of this report are limited to a single case and cannot be generalized to broader patient populations.

Clinical Implications

This case highlights the potential role of exercise-based physiotherapy in supporting safe mobilization and preventing further functional decline during acute hospitalization in patients with active DFU. Careful exercise prescription, continuous monitoring of wound condition, and interdisciplinary collaboration are essential to ensure intervention safety in patients with diabetic neuropathy and mobility limitation.

Study Limitations

Several limitations should be considered in interpreting the findings of this report. First, the study involved only a single patient, thereby limiting generalizability of the outcomes. Second, the intervention duration was relatively short and did not allow evaluation of long-term functional recovery or wound healing progression. Third, objective wound-healing assessments such as

wound area measurement, PUSH score, or Bates-Jensen Wound Assessment Tool were unavailable during hospitalization. Finally, concomitant medical management including debridement, wound dressing, and pharmacological therapy may have influenced the observed clinical outcomes.

Recommendations for Future Studies

Future studies involving larger sample sizes, objective wound-healing parameters, and longer follow-up durations are recommended to further evaluate the effectiveness and safety of physiotherapy interventions in patients with active DFU. Randomized controlled trials comparing different physiotherapy approaches may also provide stronger evidence regarding optimal rehabilitation strategies for this population.

Informed Consent

Written informed consent was obtained from the patient prior to participation and publication of clinical information.

Conflict of Interest

The authors declare no conflict of interest related to this study.

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The authors received no specific funding for this study.

Author Contributions

Nasywa Amila Shabira: Conceptualization, Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing.
Arin Supriyadi: Methodology, Supervision, Validation, Writing – Review & Editing.
Galih Adhi Isak Setiawan: Clinical Supervision, Resources, Investigation, Writing – Review & Editing.

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Revised Methods Statement

This study used a case report design following the CARE (CAse REport) guideline for clinical case reporting. The study was conducted at PKU Muhammadiyah Hospital, Yogyakarta, Indonesia, in September 2025. Written informed consent was obtained from the patient prior to participation and publication of clinical information. The patient agreed to undergo physiotherapy intervention and clinical evaluation throughout the treatment period.

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