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Systematic Review

Nursing-Led Self-Care Education and Rehabilitation for Diabetic Foot Ulcers: A Systematic Review

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Abstract

Introduction: Diabetic foot ulcer (DFU) is a disabling complication of diabetes mellitus associated with delayed healing, reduced quality of life, and increased risk of lower-limb amputation. Nursing-led interventions integrating self-care education with rehabilitation may improve outcomes, but evidence for combined approaches remains limited.To evaluate the effects of nursing-led self-care education and rehabilitation interventions on clinical, functional, and behavioral outcomes in adults with DFU.

Methods: This systematic review followed PRISMA 2020. PubMed, Embase, Scopus, Web of Science, Cochrane Library, ProQuest, Ovid, Google Scholar, SID, and Magiran were searched for English and Persian studies from 1 January 2015 to 20 May 2025. Quantitative studies evaluating nursing-led education-focused, combined education–rehabilitation, or telehealth/digital interventions in adults with DFU were included. Quality was appraised using Joanna Briggs Institute (JBI) checklists. Due to heterogeneity, meta-analysis was not performed and findings were synthesized narratively.

Results: We identified 4,241 records (2,891 databases; 1,350 registers). After removing 1,095 duplicates, 3,146 records were screened; 66 full texts were assessed; and 16 studies were included. Participants totaled 1,208 (34–182 per study). Seven studies examined combined interventions, five education-focused interventions, and four telehealth/digital approaches. Combined interventions tended to show broader improvements in wound-related indicators, perfusion, pain, and quality of life. Education-focused interventions most consistently improved knowledge, self-care behaviors, self-efficacy, and adherence.

Conclusion: Nursing-led DFU interventions appear beneficial, with combined education–rehabilitation approaches tending to yield broader improvements than education-focused strategies alone. Standardized trials with longer follow-up are needed.

Keywords: Diabetic Foot, Self Care, Patient Education as Topic, Rehabilitation, Nursing Care, Systematic Review

Introduction

Diabetic foot ulcer (DFU) is one of the most serious and costly complications of diabetes mellitus, resulting from peripheral neuropathy, vascular insufficiency, and susceptibility to infection.[1,2] This condition significantly impairs patients' quality of life and is a leading cause of prolonged hospitalization and non-traumatic lower-limb amputation worldwide.[2-4] Global estimates indicate that approximately 15–25% of individuals with diabetes will develop a DFU during their lifetime, and a history of DFU accounts for over 80% of diabetes-related lower-limb amputations.[2,3] These findings underscore the need for effective, preventive, and multidisciplinary management strategies.[9,10] *(Optionally add:)* DFU is also associated with substantial healthcare utilization and costs, particularly in cases complicated by infection or ischemia.[2,4]

DFU also imposes substantial psychological, social, and economic consequences.[2,4] Patients often experience restricted mobility, decreased social participation, emotional distress, and high treatment costs.[2,4] Limited access to specialized services and multidisciplinary teams further worsens outcomes, highlighting the critical role of nurses in continuous care delivery.[4,10]

Nursing-led interventions, particularly structured self-care education and movement-based rehabilitation, have been recognized as key components of DFU management.[5-10] Self-care education enables patients to adopt preventive behaviors such as daily foot inspection, proper hygiene, appropriate footwear, glycemic control, and dietary modification.[5,6,10] Rehabilitation-

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based interventions, including movement and exercise programs, aim to improve circulation, muscle strength, joint mobility, and pressure redistribution, thereby facilitating wound healing and preventing tissue damage.[7-9]

Nurses play a pivotal role by integrating these interventions through patient education, monitoring, behavior modification, and coordination within multidisciplinary teams.[5,6,10] In the included literature, "nursing-led" care may be delivered directly by nurses, coordinated by nurses within multidisciplinary teams, or supported through nurse-led telehealth/remote monitoring approaches.[6,10] Telehealth and remote monitoring technologies have expanded nurses' capacity to deliver continuous, patient-centered care.[6,10]

Despite the recognized benefits of both self-care education and rehabilitation, several gaps remain. Most studies have examined these interventions independently, with limited attention to their combined effects.[5-9] Variability in intervention protocols, outcome measures, and study quality further limits generalizability.[5-9] To date, no comprehensive systematic review has specifically focused on evaluating integrated nursing-led self-care education combined with rehabilitation interventions in DFU management. *(Optional very small add:)* Existing reviews have often addressed education or exercise separately, leaving uncertainty about potential added benefits when these components are combined.[5-9]

This review was conducted to synthesize evidence on the effectiveness of combined nursing-led education and rehabilitation interventions, identify key components, and provide guidance for clinical practice and future research.

Materials and Methods

Study Design

This systematic review was conducted and reported in accordance with the PRISMA 2020 statement. All stages (searching, screening, eligibility assessment, data extraction, risk of bias appraisal, and synthesis) were planned a priori. The protocol was not registered (e.g., in PROSPERO) because the project had commenced before registration was considered; however, PRISMA 2020 reporting standards were followed throughout.

Research Question

The review question was structured using the PICO framework:

- **Population:** Adults (≥18 years) with diabetic foot ulcer (DFU) and/or post-amputation due to DFU.
- **Intervention:** Nursing-led self-care education, rehabilitation interventions (e.g., mobility/foot exercises, Buerger–Allen exercise, functional training), or combined programs (education + rehabilitation).
- **Comparison:** Usual care, no intervention, or baseline (pre–post comparisons).
- **Outcomes:** Wound healing (e.g., HEAL, Wagner grade, wound depth/ulcer size), perfusion (e.g., ABI), pain (e.g., VAS), glycemic outcomes (e.g., HbA1c/FBS), quality of life, functional status (e.g., Barthel), and self-care behaviors/knowledge.

Eligibility Criteria

Inclusion Criteria

1. Quantitative interventional studies evaluating the effect of nursing-led interventions on DFU outcomes, including randomized controlled trials (RCTs), cluster RCTs, quasi-experimental studies, and pre–post interventional designs.
2. Adult participants (≥18 years) with DFU.
3. Interventions explicitly involving nursing professionals in a leading role (see definition below).
4. Published in English or Persian, full text available, from 2015 to 2025.
5. Methodological quality threshold: studies scoring ≥60% on the relevant JBI critical appraisal checklist.

Exclusion Criteria

- Reviews, protocols, qualitative-only studies, conference abstracts, editorials/commentaries, animal/laboratory studies, duplicate publications, irrelevant population /outcomes, or insufficient data for extraction.
- Cross-sectional studies were excluded from the final synthesis because they measure associations rather than evaluating the effectiveness of an intervention.

Definition of "nursing-led"

For this review, an intervention was classified as nursing-led if a nurse had a primary role in designing/coordinating and/or delivering the intervention content (education, follow-up, monitoring, coaching, or rehabilitation guidance). Because the included literature used heterogeneous models, "nursing-led" was further categorized during synthesis as:

1. Nurse-delivered (direct face-to-face education/ rehabilitation delivery by nurses),
2. Nurse-coordinated (nurse manages the care pathway, referrals, monitoring, and follow-up), and
3. Nurse-involved telehealth/digital models (nurse delivers education/follow-up via telemedicine/ mobile platforms).

Information Sources and Search Strategy

Electronic searches were conducted in Cochrane Library, PubMed/MEDLINE, Embase, Web of Science, Scopus, ProQuest, Ovid, SID, Google Scholar, and Magiran from 1 January 2015 to 20 May 2025. Search terms included MeSH and free-text keywords related to diabetic foot ulcer, nursing, self-care education, rehabilitation/exercise, and telehealth.

All retrieved records were exported to EndNote X9, and duplicates were removed prior to screening.

Reproducible Search String (PubMed/MEDLINE)

To ensure reproducibility, the complete PubMed search strategy is provided below and is provided in Supplementary File 1 exactly as shown:

PubMed Search String (copy/paste)

((“Diabetic Foot”[Mesh] OR “diabetic foot”[tiab] OR “diabetic foot ulcer*”[tiab] OR DFU[tiab] OR “foot ulcer*”[tiab])

AND

(nurs*[tiab] OR “Nursing Care”[Mesh] OR “nurse-led”[tiab] OR “nurse delivered”[tiab] OR “nurse-coordinated”[tiab])

AND

(“Health Education”[Mesh] OR educat*[tiab] OR “self-care”[tiab] OR “self management”[tiab] OR “Self Care”[Mesh])

AND

(rehabilitat*[tiab] OR exercise[tiab] OR “Exercise Therapy”[Mesh] OR “Buerger-Allen”[tiab] OR mobility [tiab] OR “physical training”[tiab] OR “functional training”[tiab] OR telehealth[tiab] OR telemedicine [tiab] OR “mobile application”[tiab] OR mHealth [tiab]))

AND (“2015/01/01”[Date - Publication]: “2025/12/31”[Date - Publication])

Study Selection

A total of 4241 records were identified from databases and registers (databases: n = 2891; registers: n = 1350). After removing 1095 records in total (1015 duplicates, 30 marked ineligible by automation tools, and 50 removed for other reasons), 3146 records remained for title and abstract screening. Of these, 3020 records were excluded.

Full-text versions of 126 potentially relevant reports were sought for retrieval. 60 reports could not be retrieved, leaving 66 reports to be assessed for eligibility. At this stage, 50 reports were excluded due to wrong study design or population (n = 29), insufficient data (n = 11), not being nursing-led (n = 10), or other reasons.

Ultimately, 16 studies met all eligibility criteria and were included in the final systematic review. The study selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1).

Data Extraction

Two reviewers independently extracted data using a standardized form, including: author/year/country, study design, sample size, DFU characteristics (if reported), intervention components (education, rehabilitation, telehealth modality), comparator, follow-up duration, measurement tools, and outcome results.

Methodological Quality Appraisal (JBI)

Methodological quality was assessed independently by two reviewers using the relevant JBI critical appraisal checklists according to study design. Inter-rater agreement was high ($\kappa = 0.82$). Studies scoring <60% were excluded (Table 4).

Data Synthesis (SWiM-informed narrative synthesis)

Because of substantial heterogeneity, meta-analysis was not performed and findings were synthesized narratively following the SWiM (Synthesis Without Meta-analysis) framework. Specifically, pooling was not appropriate due to heterogeneity in:

1. Study designs (RCT, cluster RCT, quasi-experimental, pre–post, quality improvement),
2. Intervention content and intensity (education-only vs combined education + rehabilitation; varying duration and frequency),
3. Delivery modality (in-person vs telehealth/mobile programs),
4. Outcome measures and reporting (different healing

definitions/scales; varied follow-up time points; inconsistent reporting of variance/SD), and

5. Clinical variability (baseline DFU severity and comorbidity profiles variably reported).

Because no meta-analysis was conducted, heterogeneity statistics such as I2I^2I2 were not calculated.

Table 2. Number of Records Retrieved from Databases

Cochrane Library	PubMed/Medline	Embase	Web of Science	Scopus	ProQuest	Ovid	SID	Google Scholar	Total
302	150	45	200	189	150	35	1570	250	2891

Table 3. Summary of Studies on the Effect of Combined Nursing Interventions of Self-Care Education and Physical Rehabilitation on the Conscious Healing Process of Diabetic Foot Ulcers

No.	Author (Year)	Country	Design	Nursing-led intervention type	Sample / Groups	Outcomes (tools)	Main findings (as reported)	JBI score
1	Imaoka (2025)	Japan	RCT	Education + nursing rehabilitation	68 / 2 groups	Wagner, DFS-SF, VAS	Faster healing and pain reduction	10/10
2	Zhou (2024)	China	Developmental study	Stepwise education + active exercise	56	DFS-SF, adherence	Reduced recurrence; improved adherence	8.5/10
3	Abbass (2024)	Pakistan	Quasi-experimental	Education + Buerger–Allen exercise	80	ABI, HEAL	Improved perfusion and healing	8.8/10
4	Xu (2024)	China	Semi-experimental	Video-based education	92	DMFC	Improved knowledge/performance	7.5/10
5	Toygar (2023)	Turkey	Interventional	Rehabilitation education/support	45	Barthel, DFS	Improved mobility/function	9/10
6	Ju (2023)	USA	Pre–post	Nurse-led telehealth education	34	Healing, adherence	Improved adherence (and healing as reported)	8/10
7	Geiger (2021)	USA	QI project	Home-health nurse protocol/education	48	Healing outcomes	Reduced delays; improved healing processes	7.8/10
8	Damhudi (2021)	Indonesia	Randomized	Education + foot exercise	72	Wound depth, QoL	Improved QoL; improved wound outcomes	9/10
9	Ahrary (2020)	Iran	RCT	Orem-based education	60	FSQ, Orem Index	Improved self-care	8.5/10
10	Vakilian (2019)	Iran	RCT	Education + physical activity	74	FBS, QoL, HEAL	Reduced recurrence; improved outcomes	9/10
11	Abood (2019)	USA	Quasi-experimental	Foot-care education	64	Knowledge, practice	Improved knowledge/practice	7.5/10
12	Dehghan Nayeri et al. (2020)	Iran	RCT	Structured nurse-led care	52	Care model, HbA1c	Improved care quality and wound outcomes	8/10
13	Malabu et al. (2025)	Australia	RCT	Telemedicine nursing care	151	Education & follow-up	Comparable healing vs face-to-face	7/10
14	Iversen et al. (2020)	Norway	Cluster RCT	Telemedicine (DiaFOTo)	182	Quality of life	Improved QoL; earlier detection	8/10
15	Anthony et al. (2020)	USA	Randomized observational	Digital DFU surveillance	88	SP/AD/OP groups	Improved monitoring/adherence	6/10
16	Marques et al. (2023)	Brazil	RCT	Mobile application	42	Self-care adherence	Improved adherence behaviors	7/10

Direction of Effect (vote counting)

To reduce vagueness, a direction-of-effect vote counting approach was applied (Cochrane-recommended for heterogeneous evidence when meta-analysis is not feasible). For each outcome domain, studies were coded as:

- Positive effect (intervention favored),
- No clear difference, or
- Negative effect (comparator favored).

Results were summarized by intervention category (combined vs education-only vs telehealth) and by outcome domain.

Table 4. Summary of Methodological Quality (JBI) of Included Studies (n = 16)

JBI score category	Number of studies (n)
≥ 8/10	10
7.0–7.9/10	5
6.0–6.9/10	1
Total	16

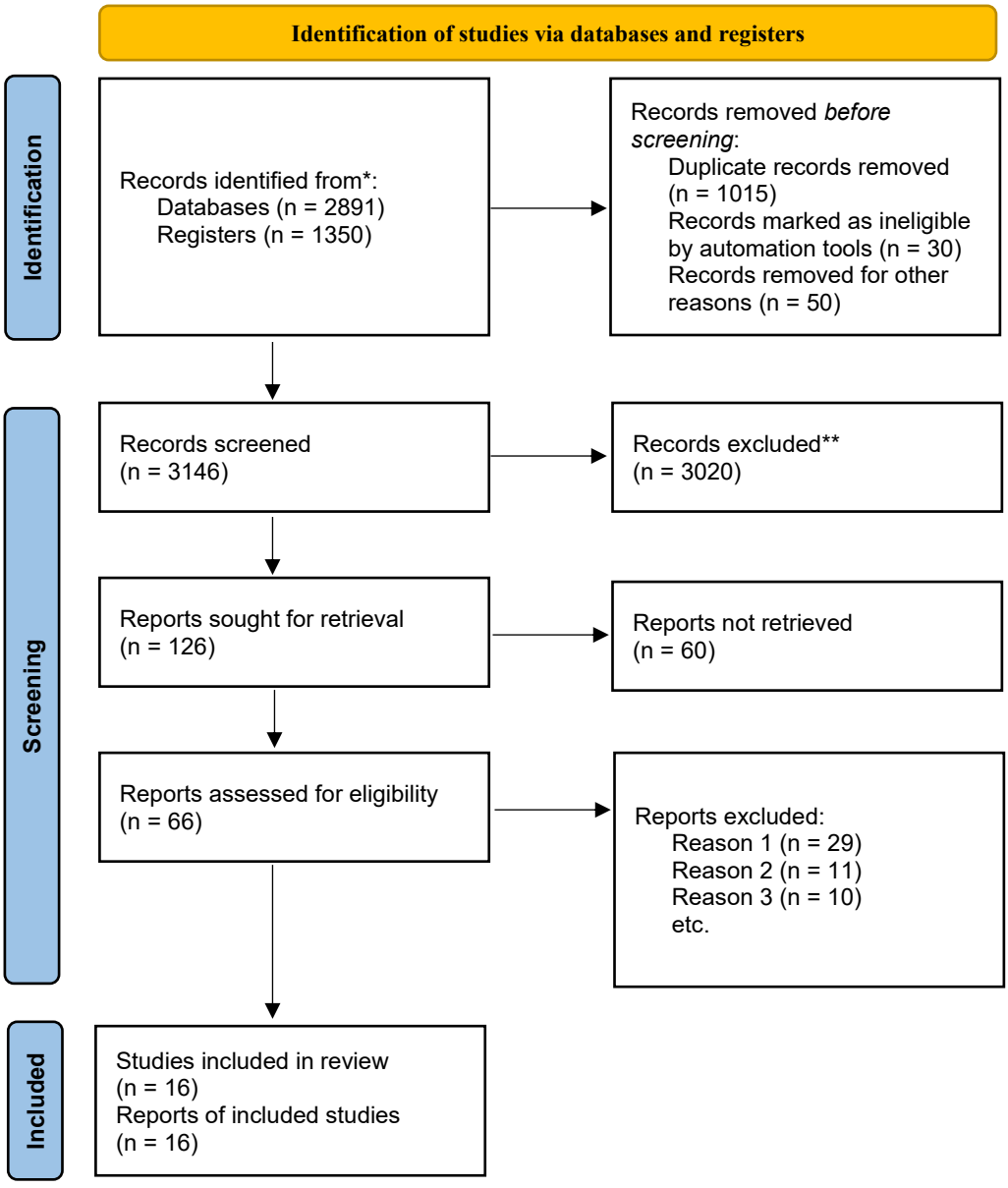


Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process.

Ethical Considerations

This review used published data only; therefore, ethics approval and informed consent were not required.

Results

General Characteristics

Sixteen studies published between 2015 and 2025 were included in the final synthesis. The included

studies comprised randomized controlled trials, cluster randomized trials, quasi-experimental studies, pre–post designs, quality-improvement projects, and other interventional designs; cross-sectional studies were excluded to maintain a focus on intervention effectiveness. Sample sizes ranged from 34 to 182 participants. Most studies involved patients with diabetes-related foot ulcers, predominantly those with type 2 diabetes. JBI quality scores ranged from 6.0 to 10.0, indicating overall moderate to high methodological quality. Because of substantial heterogeneity in intervention content, delivery mode, comparator conditions, outcome definitions, and follow-up duration, meta-analysis was not undertaken; instead, findings were synthesized narratively in accordance with SWiM principles.

Categories of Nursing-Led Interventions

The included interventions were grouped into three broad categories: combined or multicomponent interventions (n = 7), education-focused interventions (n = 5), and telehealth/digital interventions (n = 4).

Combined or multicomponent interventions typically integrated self-care education with exercise, rehabilitation, structured follow-up, or nurse-led care models. These studies commonly assessed wound healing, perfusion, pain, glycemic indicators, mobility, and quality of life. Education-focused interventions mainly targeted patient knowledge, self-care performance, adherence, and self-efficacy through face-to-face, video-based, or structured nurse-delivered education. Telehealth/digital interventions included tele-nursing, telemedicine, digital surveillance, and mobile application-based follow-up, with outcomes related to adherence, monitoring, early detection, quality of life, and in some cases healing.

Combined or Multicomponent Interventions

Seven studies evaluated combined or multi-component nursing-led interventions. Across these studies, the reported direction of effect was generally positive. Improvements were described in wound healing indicators, limb perfusion (e.g., ABI), pain reduction, mobility or functional status, recurrence-related outcomes, and quality of life. These interventions appeared to produce broader benefits across both clinical and behavioral domains than single-component approaches, although the type of outcome and follow-up period varied considerably between studies.

Education-Focused Interventions

Five studies evaluated primarily education-focused interventions. These interventions most consistently improved knowledge, self-care practices, adherence, performance, and related behavioral outcomes. Their effects on direct physiological outcomes were less frequently assessed than in the combined-intervention studies. Overall, education-focused interventions appeared particularly useful for strengthening patient competence and self-management capacity.

Telehealth and Digital Interventions

Four studies assessed telehealth- or digital-based nursing-led interventions, including telemedicine, tele-nursing, digital surveillance, and mobile application support. These interventions mainly improved monitoring, adherence, self-care behavior, early detection, and patient follow-up. Evidence for wound-healing superiority over conventional care was less consistent, although telehealth approaches appeared to offer practical advantages for continuity of care and access to monitoring.

Synthesis of Outcomes and Direction of Effect

Following SWiM guidance, findings were synthesized using a direction-of-effect approach rather than statistical pooling. Overall, most included studies reported findings in favor of nursing-led interventions, although the affected outcome domains differed by intervention type. Combined or multicomponent interventions were more often associated with improvements in clinical and functional outcomes such as healing, perfusion, pain, mobility, and quality of life, whereas education-focused and telehealth/digital interventions more consistently influenced knowledge, adherence, self-care behavior, and follow-up-related outcomes. However, the magnitude and consistency of effect varied across studies because of differences in design, intervention intensity, outcome measurement, and duration of follow-up.

Discussion

This systematic review synthesized evidence from 16 studies published between 2015 and 2025 to evaluate the effectiveness of nursing-led interventions for

diabetic foot ulcers (DFU). The findings indicate that nursing interventions can be broadly categorized into combined/multicomponent interventions and education -focused interventions; however, several studies used telehealth or digital delivery and monitoring approaches, which may represent a distinct modality and a potential source of heterogeneity across outcomes. Overall, DFU healing appears to be a multidimensional process that benefits most from integrated interventions addressing both behavioral and physiological components of care.

Effectiveness of Combined Education–Rehabilitation Interventions

Studies evaluating combined interventions demonstrated more consistent and robust improvements in physiological and functional outcomes compared with education-only approaches. These interventions, which integrated structured self-care education with movement -based and rehabilitation strategies, were associated with improved wound healing indicators, enhanced limb perfusion, reduced pain intensity, better glycemic control, and improved quality of life. Reduced ulcer recurrence and improved adherence to treatment were also reported in several studies.

The observed benefits of combined interventions can be attributed to their capacity to simultaneously address behavioral adherence and physiological impairments. While self-care education enhances patients' engagement in preventive behaviors, rehabilitation interventions improve circulation, mobility, and pressure redistribution —key factors in tissue repair. The presence of randomized controlled trials among the included studies strengthens the credibility of these findings. Nevertheless, heterogeneity in intervention protocols, duration, and outcome assessment tools limited direct comparison and precluded meta-analysis; effects were generally positive but appeared outcome- and modality -dependent across studies.

Effectiveness of Education-Only Interventions

Education-only interventions primarily influenced cognitive, behavioral, and psychosocial outcomes. Improvements in foot care knowledge, self-care behaviors, self-efficacy, and treatment adherence were consistently reported across studies. Tele-nursing and digital education approaches demonstrated comparable effectiveness to face-to-face education in enhancing patient engagement and adherence.

However, evidence supporting the direct impact of education-only interventions on physiological wound healing outcomes was limited. In the absence of functional or rehabilitation components, improvements in clinical indicators such as wound healing rate or perfusion were inconsistent or indirect. These findings suggest that while education is a necessary foundation for DFU management, it is insufficient as a standalone strategy for achieving sustained physiological healing. Notably, physiological endpoints were assessed in only a subset of included studies, whereas knowledge and adherence outcomes were more frequently reported, which may partly explain variability in observed clinical effects.

Comparison With Existing Evidence

The findings of this review are consistent with established international literature. Previous systematic reviews have confirmed that educational interventions primarily enhance foot-care knowledge, self-efficacy, and preventive behaviors,[5,6] whereas rehabilitation and exercise-based strategies are more directly linked to improved physiological indicators like perfusion and wound healing trajectories.[7] Furthermore, international guidelines and comprehensive systematic reviews underscore the multifaceted nature of DFU management, advocating for a combination of behavioral and functional strategies to prevent recurrence and optimize healing.[9,10] Compared with prior reviews that pooled multidisciplinary or non-nurse-led programs, the present review restricted inclusion to explicitly nurse-led delivery or coordination, enabling clearer attribution of observed effects to nursing models. Telehealth/digital nursing models in the included evidence more consistently influenced adherence and monitoring than clear healing superiority, suggesting delivery mode may modify which outcome domains improve.

Interpretation of these findings is constrained by heterogeneity in what constituted "nursing-led" care (e.g., education delivery, protocolized follow-up, telemonitoring, or integration with exercise/rehabilitation), variability in intervention intensity and follow-up, and diverse outcome measures. These differences likely contributed to inconsistency in physiological endpoints and limited direct comparability across trials.

Implications for Nursing Practice

The results of this review highlight the critical role of

nurses in delivering integrated, patient-centered DFU care. Nursing-led programs that combine structured self-care education with rehabilitation strategies appear to provide the greatest clinical benefit. Accordingly, DFU management should move beyond single-component educational approaches toward comprehensive nursing models that incorporate behavioral support, functional rehabilitation, and ongoing monitoring (including telehealth where appropriate) within multi-disciplinary care frameworks.

Limitations

Despite its strengths, this review has several limitations that require cautious interpretation. First, there was substantial heterogeneity across included studies in intervention duration and follow-up (ranging from short-term programs to several-month follow-ups), delivery format (individual vs. group education; education-focused vs. combined/multicomponent education–rehabilitation approaches), and DFU severity and case-mix (e.g., studies reporting Wagner classification vs. broader clinical presentations). These differences likely influenced both the magnitude and sustainability of outcomes and limited comparability across studies.

Second, several included studies used telehealth or digital delivery modalities (e.g., tele-nursing, telemedicine, digital surveillance, and mobile applications), representing a distinct mode of care. While these approaches may enhance access, monitoring, and adherence, they differ from in-person delivery in their capacity for hands-on wound assessment and supervised rehabilitation. Therefore, their effects may not be directly comparable with face-to-face interventions and may partly reflect improved follow-up and detection rather than physiological healing alone.

Finally, methodological variability in study design and outcome measurement precluded meta-analysis; accordingly, heterogeneity statistics (e.g., I2I^2I2) were not calculated. In addition, limited availability of raw data and variability in reporting may have constrained the depth of synthesis.

Conclusion

- Overall effectiveness: Nursing-led interventions for people with diabetic foot ulcers (DFU) show potential benefit, with the most consistent improvements observed in self-care knowledge, adherence, and related behaviors.
- Modality matters: Combined/multicomponent programs (education plus movement-based rehabilitation or functional support) tended to yield broader and more consistent improvements across patient-centered and some physiological outcomes than education-focused approaches alone, although effects varied by outcome and study design.
- Telehealth/digital delivery: Telehealth and digital modalities appear feasible adjuncts in certain settings (e.g., limited access), but their effectiveness is likely implementation-dependent and not directly comparable with face-to-face care in all contexts.
- Implications and research needs: These findings support strengthening DFU nursing practice through structured education, ongoing monitoring, and safe activity/rehabilitation guidance, while avoiding overgeneralization given heterogeneity. Future studies should use robust designs, standardized outcome definitions/reporting, and longer follow-up to clarify active components, optimal delivery modalities, and durability of effects.

Conflict of Interest

The authors declare no conflicts of interest.

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