



Review article

Research hotspots and trends in nursing for diabetic foot ulcers: A bibliometric analysis from 2013 to 2023

Xiaoyun Li^a, Dongfeng Chen^b, Chen Wang^b, Jingna Fan^c, Zhixin Wang^b, Yingjun Liu^b, Wenkuan Wang^b, Chang Kong^{a,*}

^a School of Nursing, Shandong University of Traditional Chinese Medicine, Jinan, 250355, China

^b First Clinical Medical School, Shandong University of Traditional Chinese Medicine, Jinan, 250355, China

^c College of Integrative Chinese and Western Medicine, Jining Medical University, Jining, 272067, China

ARTICLE INFO

Keywords:

Diabetic foot ulcers
DFU
Nursing
Bibliometrics
CiteSpace

ABSTRACT

Background: Nursing can effectively prevent and ameliorate diabetic foot ulcers (DFU). However, there is a lack of literature on the bibliometric analysis of DFU nursing. This study aimed to analyze the research hotspots and development trends in DFU nursing over the past 10 years to provide references for future related research.

Methods: The Web of Science Core Collection was used to retrieve literature related to DFU nursing from 2013 to 2023. Analyses included the annual publication trends; author, institution, and country collaborations; journal and literature co-citation; and keyword co-occurrence, clustering, and bursting, performed using CiteSpace 5.8 R3.

Results: A total of 229 papers were included, showing an upward trend in annual publications. American scholar David G Armstrong (n = 3) and King's College Hospital London (n = 4) were the most productive authors and institutions, respectively. The United States ranked first (n = 45) in national contributions, followed by China and Brazil. The overall research strength between authors and institutions was relatively scattered, and intensive cooperation has not yet been formed. National collaborations resulted in a core team dominated by Europe and North America with concentrated research strengths. The most frequently co-cited journal and co-cited reference were *Diabetes Care* (111 citations) and Armstrong DG (2017) (131 citations), separately. Research hotspots mainly focused on risk assessment, classification systems, protective measures, and clinical management of DFU. "Primary care" and "intervention efficacy" were identified as the research trends in the coming years.

Conclusion: The field of DFU nursing requires more attention. Academic exchange and cooperation between authors, institutions, and countries should be strengthened. Our future research will focus on the latest hotspots and trends, conducting more in-depth and comprehensive studies on DFU management.

1. Introduction

Diabetic foot ulcer (DFU) is a severe complication of diabetes mellitus, primarily caused by a combination of neuropathy and

* Corresponding author.

E-mail address: 60060055@sdutcm.edu.cn (C. Kong).

<https://doi.org/10.1016/j.heliyon.2024.e36009>

Received 18 March 2024; Received in revised form 1 August 2024; Accepted 7 August 2024

Available online 8 August 2024

2405-8440/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

varying degrees of vascular disease due to poor glycemic control. It manifests as lower extremity infections, ulcer formation, or deep tissue damage. In severe cases, amputation may be required, significantly increasing the risk of death [1]. Data show that approximately 18.6 million people worldwide are affected by DFU each year [2], with approximately 20 % undergoing amputation [3], and the 5-year mortality rate exceeds 70 % post-amputation [4]. Additionally, the high cost of DFU treatment places a heavy burden on patients, their families, healthcare professionals, and the society [4]. Therefore, it is vital to effectively prevent the occurrence and development of DFU.

Nursing is critical for preventing ulcer recurrence and promoting wound healing. As educators, nursing specialists [5], can provide patients and their families with relevant foot care knowledge and teach foot care skills to reduce ulcer recurrence and amputation rates. Moreover, professional nursing staff can monitor and comprehensively evaluate wounds [6], providing a basis for medical decision-making by healthcare professionals and increasing the treatment efficacy by selecting adjunctive measures based on assessment results.

Currently, there have been many achievements in the field of DFU nursing, mainly focusing on interventions, health education, risk factors, and management of foot ulcers. However, most studies are relatively single and need more integration of the overall content. Additionally, the outcomes of traditional literature reviews are susceptible to subjective factors and lack sufficient credibility [7], while the field lacks quantitative studies using numerical tools and statistical methods.

Bibliometrics is an effective method used in medical research to effectively analyze and describe research trends [8]. CiteSpace, a commonly used analytical tool in bibliometrics, is a Java application developed by Chaomei Chen for visual analysis [9,10]. It can extract, process, and identify key points and generate network views to analyze the current situation and frontiers of the field [11]. Therefore, this study aimed to use CiteSpace 5.8 R3 to visually analyze the pertinent literature on DFU nursing research from 2013 to 2023. We aimed to summarize the research status, research hotspots, and frontier trends in the past decade, offering a reference point for subsequent research.

2. Materials and methods

2.1. Data source and search strategy

The Web of Science Core Collection (WOSCC) was selected as the search database for this study. Using a combination of subject words and free words for search, the search strategy was TS= ('diabetic foot' OR 'diabetic feet' OR 'diabetic foot ulcer' OR 'DFU') AND TS= (nursing OR nurse*). This strategy retrieved a total of 327 documents.

2.2. Data collation and download

The following inclusion criteria were applied: 1. Publication years: 2013–2023; 2. Literature types: articles and reviews; 241 studies were screened. Second, the titles, abstracts, and related content were independently and manually screened by two researchers, resulting in the exclusion of 12 papers due to irrelevance or poor relevance to the topic of this study, incomplete information, and repeated publications. The results were cross-checked after completion, and disagreements were adjudicated in consultation with a third party. Finally, 229 articles were exported as plain text files, named “download_diabetic foot,” and placed in the input folder. To

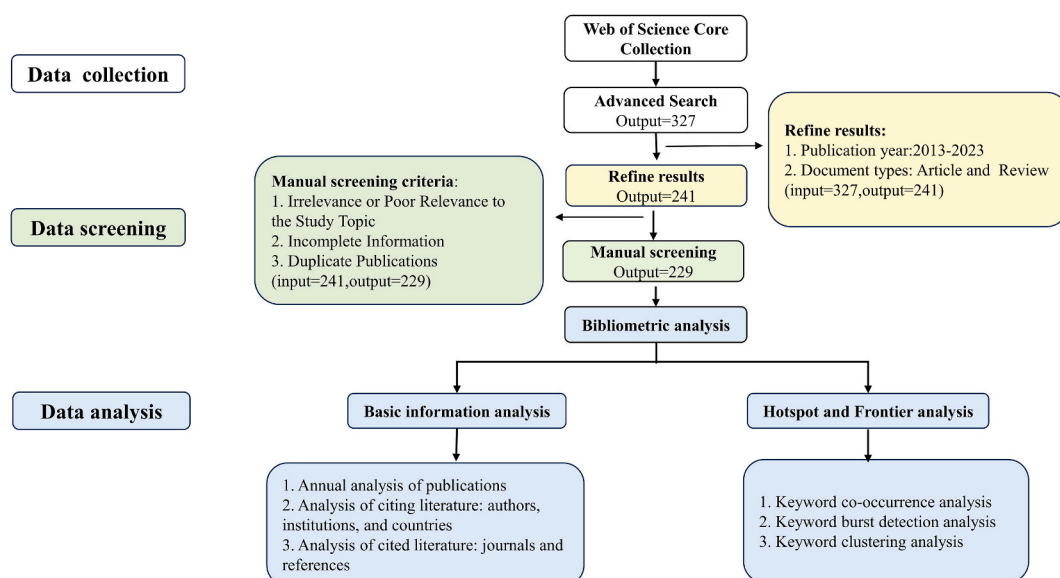


Fig. 1. Bibliometric analysis of nursing of diabetic foot ulcer in the workflow.

avoid any discrepancies resulting from daily updates, the search was completed on the same day (October 10, 2023).

2.3. Bibliometrics analysis

This study used Microsoft Excel 2021 to plot annual publication trends and CiteSpace 5.8 R3 for visual analysis. The fixed parameter settings for CiteSpace were as follows: (1) time span from 2013 to 2023, time slice of one year; (2) association strength using the cosine algorithm; (3) threshold selection of g-index, $k = 25$; and (4) pruning method selection of pathfinder, pruning sliced networks, and pruning the merged network.

3. Results

3.1. Analysis of annual publications

According to the literature-screening flowchart (Fig. 1), 229 publications related to DFU nursing were included between 2013 and 2023, comprising 193 articles and 36 reviews. As shown in Fig. 2, the annual number of publications increased from 13 in 2013 to 31 in 2022 (with incomplete data for 2023), with the highest output being 41 publications in 2020. Although the number of publications fluctuated over the years, the overall trend continues to increase. Additionally, the linear trend line shows a relatively steady increase in publications from 2013 to 2023, predicting that the increasing trend may continue in the coming years.

3.2. Analysis of authors, institutions, and countries

In Table 1, the top 10 authors in terms of publications were all from Europe or North America, with David G. Armstrong ranking first with three publications. The institution with the highest number of papers was King's College Hospital, followed by Bergen University College, and the University of Toronto. As listed in Table 2, the United States was the most productive country (45 articles), followed by China (21 articles) and Brazil (18 articles). Fig. 3 presents collaborative network maps of authors, institutions, and countries. These maps reflect the collaboration among authors, countries, and institutions in this field and can be used to evaluate their impact [12]. The node size represents the frequency or influence of a research object, with its importance is measured by mediating centrality [11], which is proportional to the size of the purple outer circle. The thickness of the lines indicates the strength of the connections between nodes [13]. As shown in Fig. 3(A), the author teams led by Chris Manu collaborated on the largest scale, focusing on topics related to treatment delay. The University of Toronto-led research clusters occupied a central position in Fig. 3(B), with emerging collaborations observed among diverse teams. Moreover, cooperation among nations is relatively close, particularly in the international collaborative force centered around England (Fig. 3(C)).

3.3. Analysis of co-cited journals and references

The top three journals with the highest co-citation frequencies were *Diabetes Care* (IF = 16.2), *International Wound Journal* (IF = 3.1), and *Diabetes-Metabolism Research and Reviews* (IF = 8) (Table 3). In Table 4, Armstrong DG (2017) [14] was the most cited reference, with 26 citations and Lipsky BA (2016) [15] had the strongest betweenness centrality of 0.5. Fig. 4(A) and (B) display the co-citation analysis networks of journals and references, reflecting the disciplinary foundation and developmental changes in the field, as well as the evolution of research topics [12]. The nodes in these maps represent journals or studies, with larger nodes indicating higher frequency of citations. As shown in Fig. 5, we performed a burst analysis of literature co-citations. Based on the burst terms and annual publication volume, 2013–2023 could be divided into three stages: 2013–2016, 2017–2020, and 2021–2023. The studies with the highest burst values during the three periods were Bakker K (2012) [16], Bakker K (2016) [17], and Schaper NC (2020) [18].

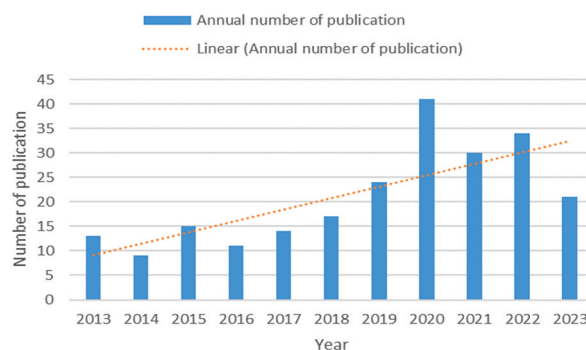


Fig. 2. The annual quantities of nursing of diabetic foot ulcer.

Table 1

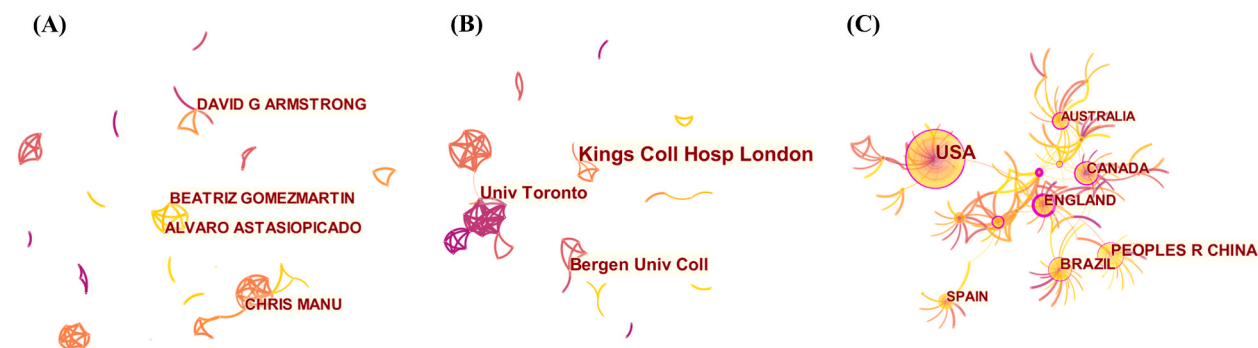
Top 10 contributory authors and institutions.

Rank	Author	Frequency	Institution	Frequency
1	David G. Armstrong	3	King's College Hospital	4
2	Álvaro Astasio-Picado	3	Bergen University College	3
3	Chris Manu	3	University of Toronto	3
4	Beatriz Gómez-Muñoz	3	Health Sciences University	2
5	Barbara L. Davies	2	Universidade Federal de São Paulo	2
6	Paula Cobos Moreno	2	Complutense University of Madrid	2
7	Anna Polak	2	Universidade Federal do Ceará	2
8	Jon S. Woods	2	Duke University	2
9	Marjolein M. Lversen	2	Bispebjerg Hospital	2
10	Benjamin Bouillet	2	University of Arizona	2

Table 2

Top 10 contributory countries.

Rank	Country	Frequency	Centrality	Percent
1	USA	45	0.35	19.65 %
2	China	21	0.17	9.17 %
3	Brazil	18	0.2	7.86 %
4	Canada	17	0.34	7.42 %
5	England	16	0.7	6.99 %
6	Spain	14	0.09	6.11 %
7	Australia	12	0.23	5.24 %
8	Germany	10	0.09	4.37 %
9	France	9	0.23	3.93 %
10	Denmark	7	0.08	3.06 %

**Fig. 3.** (A) Authors cooperation network; (B) Institutions cooperation network; (C) Countries cooperation network.**Table 3**

Top 10 co-cited journals.

Rank	Frequency	Co-cited Journal
1	131	<i>Diabetes Care</i>
2	102	<i>International Wound Journal</i>
3	98	<i>Diabetes-Metabolism Research and Reviews</i>
4	88	<i>Diabetic Medicine</i>
5	71	<i>Journal of Wound Care</i>
6	67	<i>Wound Repair Regen</i>
7	63	<i>Journal of Vascular Surgery</i>
8	61	<i>Advances in Skin & Wound Care</i>
9	57	<i>Diabetes Research and Clinical Practice</i>
10	55	<i>Diabetologia</i>

Table 4
Top 10 co-cited references.

Rank	Frequency	Author	Source	DOI
1	26	David G. Armstrong	New England Journal of Medicine	10.1056/NEJMr1615439
2	21	Pengzi Zhang	Annals of Medicine	10.1080/07853890.2016.1231932
3	9	Nicolaas C. Schaper	Diabetes/Metabolism Research and Reviews	10.1002/dmrr.3266
4	8	Karel. Bakker	Diabetes/Metabolism Research and Reviews	10.1002/dmrr.2694
5	8	Anil Hingorani	Journal of Vascular Surgery	10.1016/j.jvs.2015.10.003
6	7	Laura Coffey	International Wound Journal	10.1111/iwj.13010
7	7	Sicco A. Bus	Diabetes/Metabolism Research and Reviews	10.1002/dmrr.3269
8	6	Benjamin A. Lipsky	Diabetes/Metabolism Research and Reviews	10.1002/dmrr.2699
9	6	David G. Armstrong	Journal of Foot and Ankle Research	10.1186/s13047-020-00383-2
10	5	Karel. Bakker	Diabetes/Metabolism Research and Reviews	10.1002/dmrr.2253

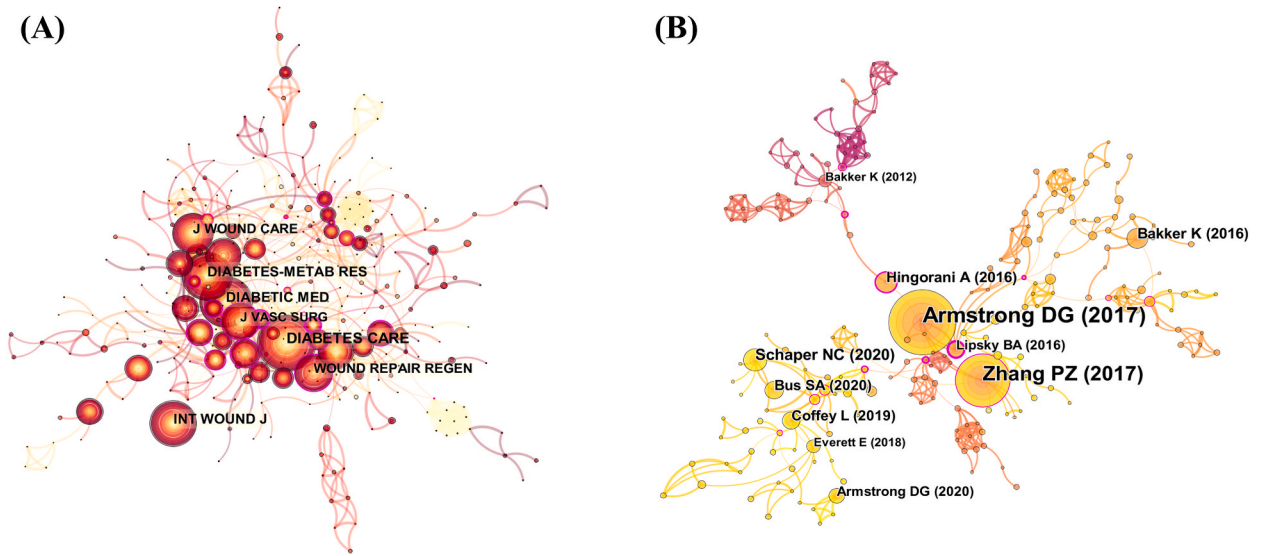


Fig. 4. (A) Co-cited journals network; (B) Co-cited references network.

Top 5 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2013 - 2023
Bakker K, 2012, DIABETES-METAB RES, V28, P225, DOI 10.1002/dmrr.2253	2012	2.68	2015	2017	
Bakker K, 2016, DIABETES-METAB RES, V32, P2, DOI 10.1002/dmrr.2694	2016	3.15	2019	2020	
Schaper NC, 2020, DIABETES-METAB RES, V36, P0, DOI 10.1002/dmrr.3266	2020	3.38	2021	2023	
Bus SA, 2020, DIABETES-METAB RES, V36, P0, DOI 10.1002/dmrr.3269,	2020	3.15	2021	2023	
Coffey L, 2019, INT WOUND J, V16, P183, DOI 10.1111/iwj.13010	2019	2.62	2021	2023	

Fig. 5. The burst detection of co-cited references.

3.4. Analysis of keyword co-occurrence

The keywords were selected as nodes to generate a keyword co-occurrence network map (Fig. 6). The lines in the map reflect the correlation between keywords, with their thickness indicating the frequency of co-occurrence. The size of the nodes represents the frequency of keyword occurrence. To facilitate processing, keywords with the same meaning were merged as follows: diabetic foot ulcer, diabetic foot, foot ulcer, leg ulcer, diabetic foot infection, diabetic foot disease, and diabetic foot were merged as diabetic foot ulcer; care, nursing, nursing care, and care were merged as care; ulcer and ulceration were merged as ulcer; primary health care and primary care were merged as primary; and foot care, diabetic foot care, and diabetic foot ulcer care were merged as foot care. After merging, keywords were introduced into Excel 2021 for statistical analysis. The top 20 high-frequency keywords are listed in Table 5. Keywords such as prevention, risk, wound healing, and management were highly consistent with the clustered content.

3.5. Analysis of keyword clustering

Keyword clustering is a categorical aggregation of similar or related keywords [11], reflecting hotspots in a research field [12]. Using the LLR algorithm, a timeline map (Fig. 7) and clustering map (Fig. 8) were generated, resulting in 15 clusters with clustering module values of $S = 0.8932$ and $Q = 0.7438$. Generally, $Q > 0.3$ represents that the clustering structure is significant. When $S \geq 0.7$, the results are convincing, and when $S > 0.5$, the clustering structure is reasonable [12]. Thus, this clustering has high confidence and a significant structure.

3.6. Analysis of keywords burst detection

A keyword burst refers to a sudden increase in keywords in a particular period, which is usually associated with hotspot transitions in the research field. As shown in Fig. 9, the burst words from 2021 to 2023 included “nursing,” “efficacy,” “outcome,” “primary,” and “leg ulcer.”

4. Discussion

4.1. General information

Annual publications in DFU nursing research showed integral growth, with a relatively stable annual growth rate, indicating increasing attention from researchers to this field. However, the total number of publications over the last decade has been relatively low, which could be attributed to the late start of nursing research [19] and the weak research strength. There is still considerable space and potential for future development in this field. Regarding publication time, fluctuations in 2013–2016 may be related to the early stage of the exploration period, and the slower growth from 2020 to 2023 may be related to the shift in research focus caused by the COVID-19 pandemic [20,21]. Moreover, because this study was conducted until October 2023, the number of publications for the year was limited.

Regarding research power, the top 10 authors with publications were all from North America or Europe, suggesting that the number of publications was influenced by the economy to some extent [22]. High-producing institutions were dominated by universities, which may be related to the attention and solid academic atmosphere of higher education institutions and universities [22]. Among the

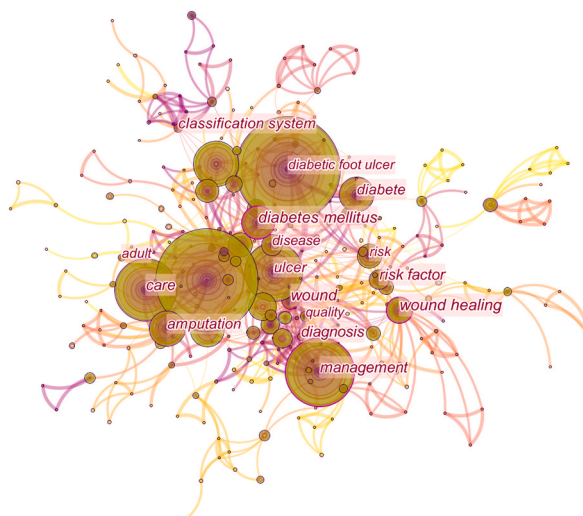


Fig. 6. Co-occurrence keywords network.

Table 5
Top 20 keywords of nursing of diabetes foot ulcer.

Rank	Frequency	Keyword	Rank	Frequency	Keyword
1	164	diabetic foot ulcer	11	19	wound healing
2	70	care	12	17	risk
3	69	diabetic foot	13	17	infection
4	52	ulcer	14	16	disease
5	48	management	15	16	prevalence
6	31	prevention	16	14	risk factor
7	25	amputation	17	13	wound
8	23	quality of life	18	13	pressure ulcer
9	23	diabetic	19	11	guideline
10	23	diabetes mellitus	20	10	wound care

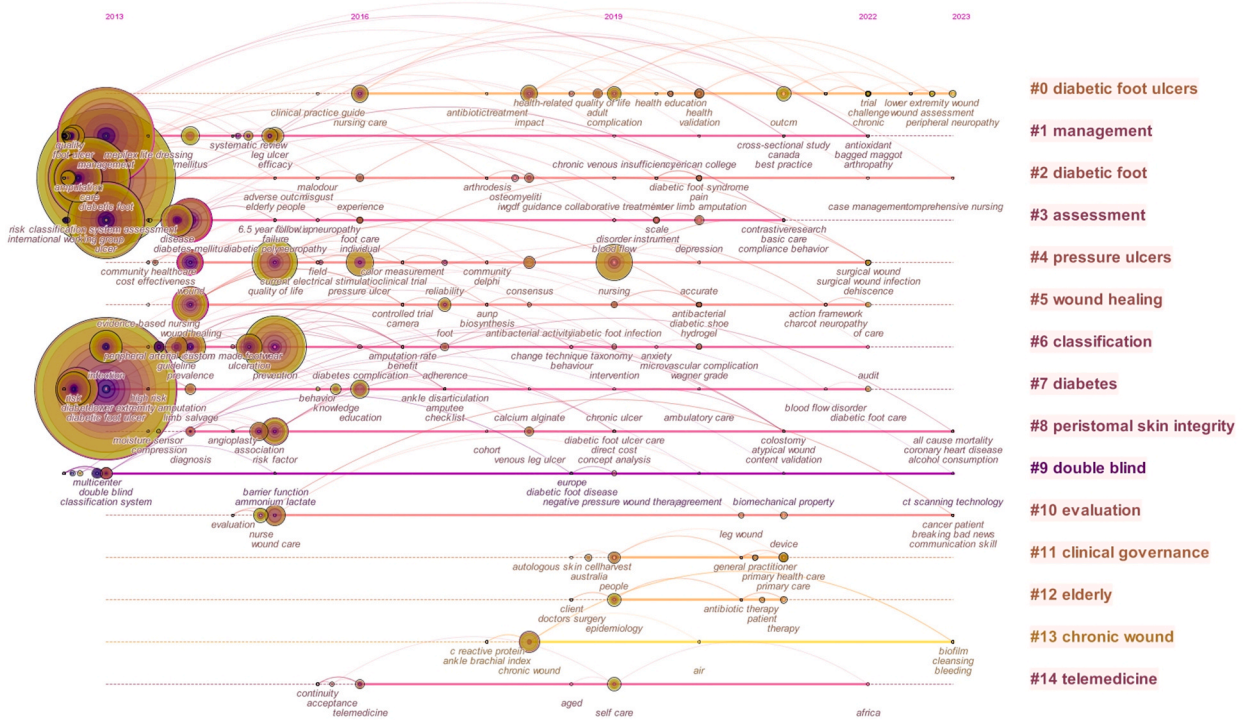


Fig. 7. The timeline view of keywords.

top 10 countries in terms of publications, developed and developing countries accounted for 80 % and 20 %, respectively. China and Brazil ranked second and third, respectively, but their intermediary centrality was low, indicating that developing countries have paid more attention to this field and published more papers in recent years; however, academic influence still needs to be enhanced. The United Kingdom had a strong intermediary centrality and was leading in this field. From the cooperation network diagram, it is not difficult to see that the cooperation between authors and institutions was in a state of overall dispersion and local concentration and had not yet formed intensive cooperation. This suggests that communication and cooperation between the authors and institutions should be strengthened. Collaboration between countries has formed a core team dominated by Europe and North America, indicating that they hold a particular discourse in the field of DFU nursing. Future research in this area could consider the literature from this region as a primary reference.

At the co-citation level, journals mainly covered skin wound repair, endocrine metabolism, and vascular surgery. Most of the top 10 cited journals were in the Q1 or Q2 area of the JRC partition, with high article quality. The journal with the highest IF index was *Diabetes Care* (IF = 16.2) from the United States, which primarily publishes clinical nursing research, cardiovascular and metabolic risks, and so on, and prefers to publish high-quality original articles reflecting advances and trends in endocrinology and metabolism. As Fig. 4(A) and (B) showed, the high number of reference co-citations suggests similarities in knowledge structure, and the close links between journals indicate a strong correlation between knowledge foundations. Among the reference co-citations, Bakker K (2012) [16], Bakker K (2016) [17], and Schaper NC(2020) [18] played a significant role in the three periods. Bakker K (2012) described the principles of prevention and treatment based on the International Consensus on Diabetic Foot, includ foot management, wound assessment, treatment, and tissue management. Based on a systematic review, Bakker (2016) provided guidance related to foot

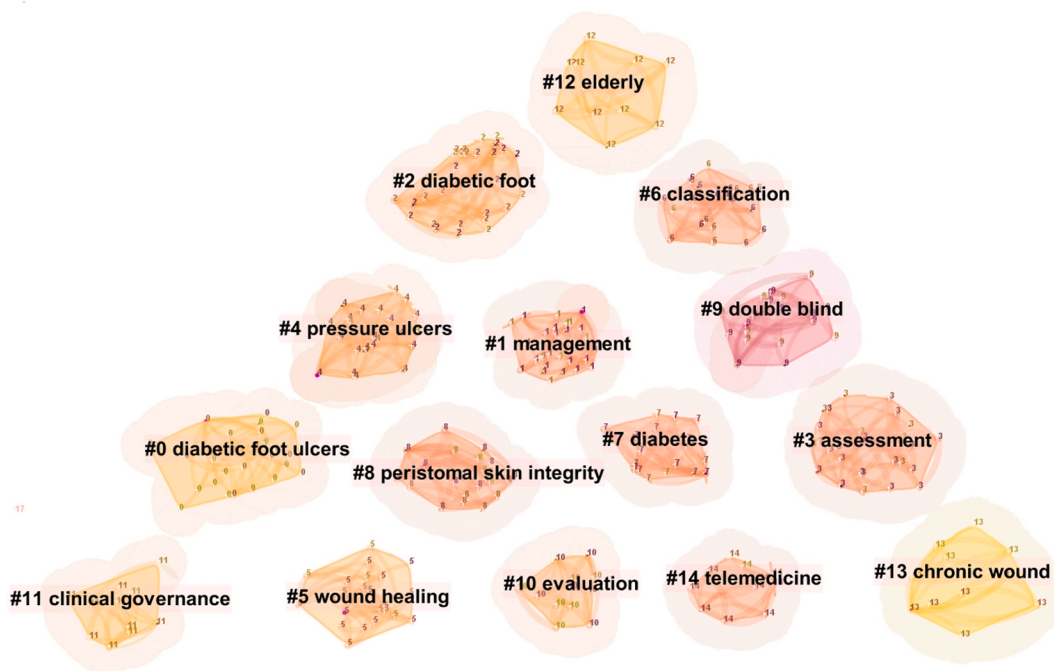


Fig. 8. Cluster analysis of keywords.

Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2013 - 2023	Keywords	Year	Strength	Begin	End	2013 - 2023
multicenter	2013	2.99	2013	2014		guideline	2013	2.09	2017	2018	
foot ulcer	2013	2.1	2013	2015		ulceration	2013	1.56	2017	2019	
international working group	2013	1.43	2013	2016		iwgdf guidance	2013	1.29	2018	2020	
quality	2013	1.39	2013	2015		people	2013	1.61	2019	2021	
double blind	2013	1.34	2013	2019		limb salvage	2013	1.28	2020	2021	
wound	2013	3.51	2014	2017		nursing	2013	2.71	2021	2023	
peripheral arterial disease	2013	2.89	2014	2015		efficacy	2013	2.39	2021	2023	
diabetes mellitus	2013	1.34	2014	2017		outcome	2013	2.36	2021	2023	
pressure ulcer	2013	1.97	2016	2018		primary care	2013	1.68	2021	2023	
nursing care	2013	1.42	2016	2018		leg ulcer	2013	1.27	2021	2023	

Fig. 9. The burst detection of co-cited references.

complications in patients with diabetes regarding prevention, footwear and offloading, peripheral artery disease, infections, and wound-healing interventions. Schaper (2020) summarized the basic principles of DFU prevention and management into six categories, described the organizational levels to successfully prevent and treat diabetic foot disease according to these principles, and provided an addenda to assist with foot screening.

4.2. Research hotspots

By analyzing high-frequency keywords and clustering labels, this study summarized the research hotspots in DFU nursing, which focuses on four hotspots: risk assessment, classification systems, protective measures, and clinical management of DFU.

4.2.1. Risk assessment

Comprehensive foot evaluation in patients with DFU can reduce disability and amputation rates and improve prognosis [1]. The

IWGDF recommends that diabetic patients who are not at risk undergo an annual foot examination to identify the potential risk of foot ulcers and amputations, and at-risk patients require more frequent foot screening [23]. Foot examinations mainly involved the patient's medical history and the nerves, blood vessels, skin, and musculoskeletal aspects of the lower extremities [24]. Currently, most studies have focused on abnormal skin and musculoskeletal changes in the feet, such as skin temperature [25–27], skin color [28,29], and pressure [27,30], with less attention paid to peripheral neurological and vascular aspects. Additionally, the application of new technologies has also improved the efficiency of diabetic foot risk assessment, for instance, the “Exame dos Pés” application by Cuidar Tech [31] and the digital tool D-Foot software [32].

4.2.2. Classification systems

The DFU classification system is widely used to predict the risk and outcome of foot amputation and influences treatment strategies [33]. Numerous classification systems for DFU have been promoted [34], with the Meggitt-Wagner system and the Texas system being the most frequently utilized. The Meggitt-Wagner system divides foot ulcers into six grades based on the depth of the ulcer, presence or absence of complications, and degree of gangrene, with higher grades associated with more severe injuries [35]. The Texas system categorizes wounds into four classes based on lesion type and ulcer depth, presented in a 4×4 matrix table, which helps predict ulcer amputations [35,36]. Compared to the Meggitt-Wagner system, the Texas system demonstrated greater accuracy and utility in prediction and assessment [37].

4.2.3. Protective measures

Auxiliary therapy, including wound dressing, negative-pressure wound therapy, and hyperbaric oxygen, plays a vital role in DFU nursing. Dressing is one of the first-line therapeutic approaches for wound management and is used to provide a favorable wound environment for healing [38,39]. The application of advanced dressings such as gels made from amniotic fluid (AF), novel multi-functional amorphous hydrogels, and recombinant human epidermal growth factor dressings positively affects DFU healing [40–42]. Negative-pressure wound therapy should be considered if the wound dressing does not have the desired effect after 4–8 weeks of application [43]. Although negative pressure therapy has demonstrated superiority in treating complex wounds [44–46], particularly in terms of safety and efficacy [45,47,48], the level of research evidence for negative pressure therapy in foot ulcers to date is low [44, 49,50], and the research depth in this field should be strengthened in the future.

A lack of diabetes-related knowledge and foot care practices is a risk factor for DFU [51]. Health education can improve the self-protection potential of patients and play a positive role in the prevention [31,52–54]. The IWGDF Prevention Guidelines (2023) recommend that professional trainers provide patients with structured education on foot self-care, that is, any form of structured education offered to individuals in a structured way. The content includes providing general information about the disease (e.g., clinical manifestations, treatment measures, risk factors, and prognostic outcomes) [55], developing individualized preventive plans [56], conducting foot self-care education (e.g., foot examination, keeping the feet clean and dry, choosing the proper footwear), identifying problems, and seeking help promptly [53]. However, current research has mostly neglected mental health education, which should be emphasized in future studies.

Moreover, the development of new technologies, such as the increasing attention paid to sensor-based monitoring tools, has contributed significantly to prevention [30]. Liliana B Sousa presented a sensor-based therapeutic footwear program for DFU prevention by monitoring plantar pressure, temperature, and humidity [57]. The AI wound imaging mobile application (C4W system), which uses sensors as a 3D wound measurement tool with depth perception, verified the reliability of its measurement values among and within evaluators [58].

4.2.4. Clinical management

Multidisciplinary teams have shown significant effectiveness in reducing amputation rates [46,59–63]. These teams are typically comprised of specialists in endocrinology, peripheral vascular surgery, orthopedics, podiatric surgery, and nurse specialists. They provide a wide range of nursing services through transparent referral processes and care algorithms. However, delay in treatment may be related to the patient's cognitive level, healthcare professionalism, structural barriers in referral pathways, etc., with direct detrimental effects on patient prognosis [59,64–66]. Thus, to decrease the incidence of treatment delays, it is necessary to establish education programs [67], improve the foot nursing education system, encourage professional nurses to participate in relevant training and education [53,68], and reinforce team communication and cooperation. Furthermore, telemedicine care models with Internet-based access facilitate communication within the cross-team, improve the knowledge of professionals, and have become an essential way to manage DFU patients during the COVID-19 pandemic [69,70]. In summary, a multidisciplinary team is the best approach for the treatment of complex wounds. However, treatment delays remain a challenge in current clinical management and this aspect needs to be studied more thoroughly in the future.

4.3. Research trends

Based on a burst word analysis from 2021 to 2023, the research trends in DFU nursing are expected to focus on primary care and intervention efficacy in the coming years. In many European countries, primary care is usually the first stage of treatment for patients with chronic wounds [64,71], involving assessment, diagnosis, treatment, and referral by qualified healthcare professionals [64,72]. To avoid early diagnostic errors, primary care medical personnel should enhance their management, improve professionalism [64] emphasize health education, enhance self-management ability, and optimize team structures to formulate the best treatment strategies. Relevant institutions and departments should also improve the primary health care system by establishing a “one-stop” service for

chronic diseases, optimizing the “admission-discharge-continuing care” procedure, strengthening the development and utilization of new technologies, and applying offline-based and online-assisted treatment methods to coordinate and arrange the best treatment pathways. More importantly, the state should provide applicable policies and financial support based on its national conditions and establish relevant laws and regulations to ensure regular operation of the healthcare system [73]. Recently, the focus of wound management has shifted to intervention efficacy, aiming to reduce the amputation rate, with a particular emphasis on the intervention effects of adjunctive therapies. For instance, it summarizes the relevant usage of dressings, existing evidence [74], and the effectiveness of negative pressure therapy [43].

5. Limitations

This study has some limitations. First, the data for this study were obtained only from the WOSCC database; other databases were ignored, which may have omitted some relevant studies and led to biased results. Second, we only included studies published until October 2023, which may have caused research content biases. Third, the CiteSpace software is challenging to control because of time zones and related parameter settings, resulting in an inability to ensure that all critical key points are found [11]; therefore, the results are limited to the procedures and rules followed in this study. In the future, searches should be expanded to obtain more comprehensive and up-to-date data and reduce the adverse effects of language and time of publication.

6. Conclusions

In this study, we used bibliometric methods to analyze the literature related to DFU nursing research from 2013 to 2023, and summarized the general situation, hotspots, and trends in the field. To a certain extent, this study provides a reference for future studies. Despite the rising interest in the field, the annual and total number of publications is relatively low compared with other medical disciplines; therefore, it still needs more attention. There remains a need to strengthen communication and cooperation among authors, institutions, and countries. The most prominent research hotspots in the last decade have been risk assessment, protective measures, and clinical management of DFU. It is predicted that future research on DFU nursing will develop towards primary care and intervention efficacy.

Ethics approval and consent to participate

Not applicable.

Funding statement

This study was supported by the National Natural Science Foundation of China (82104727).

Data availability statement

Data openly available in a public repository: <https://www.webofscience.com/wos>.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Xiaoyun Li: Writing – original draft. **Dongfeng Chen:** Visualization, Software. **Chen Wang:** Validation, Software. **Jingna Fan:** Visualization, Software. **Zhixin Wang:** Visualization, Software. **Yingjun Liu:** Investigation. **Wenkuan Wang:** Investigation. **Chang Kong:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

This research work was supported by the National Natural Science.

References

- [1] A. Wang, G. Lv, X. Cheng, X. Ma, W. Wang, J. Gui, J. Hu, M. Lu, G. Chu, J. Chen, H. Zhang, Y. Jiang, Y. Chen, W. Yang, L. Jiang, H. Geng, R. Zheng, Y. Li, W. Feng, B. Johnson, W. Wang, D. Zhu, Y. Hu, Guidelines on multidisciplinary approaches for the prevention and management of diabetic foot disease (2020 edition), *Burns & Trauma* 8 (2020) tkaa017, <https://doi.org/10.1093/burnst/tkaa017>.
- [2] Y. Zhang, P.A. Lazzarini, S.M. McPhail, J.J. van Netten, D.G. Armstrong, R.E. Pacella, Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016, *Diabetes Care* 43 (2020) 964–974, <https://doi.org/10.2337/dcl19-1614>.
- [3] K. McDermott, M. Fang, A.J.M. Boulton, E. Selvin, C.W. Hicks, Etiology, epidemiology, and disparities in the burden of diabetic foot ulcers, *Diabetes Care* 46 (2023) 209–221, <https://doi.org/10.2337/dci22-0043>.
- [4] D.G. Armstrong, M.A. Swerdlow, A.A. Armstrong, M.S. Conte, W.V. Padula, S.A. Bus, Five year mortality and direct costs of care for people with diabetic foot complications are comparable to cancer, *J. Foot Ankle Res.* 13 (2020) 16, <https://doi.org/10.1186/s13047-020-00383-2>.
- [5] H. Chen, X. Lv, Y. Zhang, Effect of nursing intervention on promoting healing of rw in patients with diabetic foot: a systematic review and meta-analysis, *Comput. Math. Methods Med.* 2022 (2022) e8284870, <https://doi.org/10.1155/2022/8284870>.
- [6] N.O. Addison, S. Pfau, E. Koka, S.Y. Aboagye, G. Kpeli, G. Pluschke, D. Yeboah-Manu, T. Junghans, Assessing and managing wounds of Buruli ulcer patients at the primary and secondary health care levels in Ghana, *PLoS Neglected Trop. Dis.* 11 (2017) e0005331, <https://doi.org/10.1371/journal.pntd.0005331>.
- [7] H. Aguinis, R.S. Ramani, N. Abduljader, What you see is what you get? Enhancing methodological transparency in management research, *ANNALS* 12 (2018) 83–110, <https://doi.org/10.5465/annals.2016.0011>.
- [8] T. Liu, L. Yang, H. Mao, F. Ma, Y. Wang, Y. Zhan, Knowledge domain and emerging trends in podocyte injury research from 1994 to 2021: a bibliometric and visualized analysis, *Front. Pharmacol.* 12 (2021), <https://doi.org/10.3389/fphar.2021.772386>.
- [9] C. Chen, M. Song, Visualizing a field of research: a methodology of systematic scientometric reviews, *PLoS One* 14 (2019) e0223994, <https://doi.org/10.1371/journal.pone.0223994>.
- [10] C. Chen, Searching for intellectual turning points: progressive knowledge domain visualization, *Proc. Natl. Acad. Sci. U.S.A.* 101 (2004) 5303–5310, <https://doi.org/10.1073/pnas.0307513100>.
- [11] C. Chen, CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature, *J. Am. Soc. Inf. Sci. Technol.* 57 (2006) 359–377, <https://doi.org/10.1002/asi.20317>.
- [12] Y. Chen, C. Chen, Z. Liu, Z. Hu, X. Wang, The methodology function of CiteSpace mapping knowledge domains, *Studies in Science of Science* 33 (2015) 242–253, <https://doi.org/10.16192/j.cnki.1003-2053.2015.02.009>.
- [13] Y. Shi, J. Luo, X. Wang, Y. Zhang, H. Zhu, D. Su, W. Yu, J. Tian, Emerging trends on the correlation between neurotransmitters and tumor progression in the last 20 Years: a bibliometric analysis via CiteSpace, *Front. Oncol.* 12 (2022) 800499, <https://doi.org/10.3389/fonc.2022.800499>.
- [14] D.G. Armstrong, A.J.M. Boulton, S.A. Bus, Diabetic foot ulcers and their recurrence, *N. Engl. J. Med.* 376 (2017) 2367–2375, <https://doi.org/10.1056/NEJMra1615439>.
- [15] B.A. Lipsky, J. Aragón-Sánchez, M. Diggle, J. Embil, S. Kono, L. Lavery, É. Senneville, V. Urbančić-Rovan, S. Van Asten, E.J.G. Peters, International Working Group on the Diabetic Foot, IWGDF guidance on the diagnosis and management of foot infections in persons with diabetes, *Diabetes Metab Res Rev* 32 (Suppl 1) (2016) 45–74, <https://doi.org/10.1002/dmrr.2699>.
- [16] K. Bakker, J. Apelqvist, N.C. Schaper, on behalf of the I.W.G. on the D.F.E. Board, Practical guidelines on the management and prevention of the diabetic foot 2011, *Diabetes Metabol. Res. Rev.* 28 (2012) 225–231, <https://doi.org/10.1002/dmrr.2253>.
- [17] K. Bakker, J. Apelqvist, B.A. Lipsky, J.J. Van Netten, On behalf of the I.W.G. on the D. Foot (IWGDF), the 2015 IWGDF guidance documents on prevention and management of foot problems in diabetes: development of an evidence-based global consensus, *Diabetes Metabol. Res. Rev.* 32 (2016) 2–6, <https://doi.org/10.1002/dmrr.2694>.
- [18] N.C. Schaper, J.J. van Netten, J. Apelqvist, S.A. Bus, R.J. Hinchliffe, B.A. Lipsky, I.E. Board, Practical Guidelines on the prevention and management of diabetic foot disease (IWGDF 2019 update), *Diabetes Metabol. Res. Rev.* 36 (2020) e3266, <https://doi.org/10.1002/dmrr.3266>.
- [19] J.M. Stolley, K.C. Buckwalter, L. Garand, The evolution of nursing research, *J. Neuromusculoskeletal Syst* 8 (2000) 10–15, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6739074/>. (Accessed 16 December 2023).
- [20] S.B.S. Kambhampati, R. Vaishya, A. Vaish, Unprecedented surge in publications related to COVID-19 in the first three months of pandemic: a bibliometric analytic report, *J Clin Orthop Trauma* 11 (2020) S304–S306, <https://doi.org/10.1016/j.jcot.2020.04.030>.
- [21] O. Delardas, P. Giannos, How COVID-19 affected the journal impact factor of high impact medical journals: bibliometric analysis, *J. Med. Internet Res.* 24 (2022) e43089, <https://doi.org/10.2196/43089>.
- [22] Z. Çağırın, N. Sertöz, S. Karaman, Did we get lost in space A step away from 2020? Bibliometric analysis of Turkish-based publications from 2008 to the present in science citation index and citation index-expanded indexed journals in the field of anaesthesiology, *Turk J Anaesthesiol Reanim* 48 (2020) 235–243, <https://doi.org/10.5152/TJAR.2019.19942>.
- [23] S.A. Bus, J.J. van Netten, L.A. Lavery, M. Monteiro-Soares, A. Rasmussen, Y. Jubiz, P.E. Price, On behalf of the I.W.G. on the D. Foot (IWGDF), IWGDF guidance on the prevention of foot ulcers in at-risk patients with diabetes, *Diabetes Metabol. Res. Rev.* 32 (2016) 16–24, <https://doi.org/10.1002/dmrr.2696>.
- [24] R. Johnson, A. Osbourne, J. Rispoli, C. Verdin, The diabetic foot assessment, *Orthop. Nurs.* 37 (2018) 13–21, <https://doi.org/10.1097/NOR.0000000000000414>.
- [25] A. Skaafeld, M.M. Iversen, I. Holme, L. Ribu, K. Hvalb, B.K. Kilhøvd, A pilot study testing the feasibility of skin temperature monitoring to reduce recurrent foot ulcers in patients with diabetes – a randomized controlled trial, *BMC Endocr. Disord.* 15 (2015) 1–7, <https://doi.org/10.1186/s12902-015-0054-x>.
- [26] M. Lazo-Porras, A. Bernabe-Ortiz, K.A. Sacksteder, R.H. Gilman, G. Malaga, D.G. Armstrong, J.J. Miranda, Implementation of foot thermometry plus mHealth to prevent diabetic foot ulcers: study protocol for a randomized controlled trial, *Trials* 17 (2016) 206, <https://doi.org/10.1186/s13063-016-1333-1>.
- [27] N. Mehmood, A. Hariz, R. Fitridge, N.H. Voelcker, Applications of modern sensors and wireless technology in effective wound management, *J. Biomed. Mater. Res.* 102 (2014) 885–895, <https://doi.org/10.1002/jbm.b.33063>.
- [28] K. Huimin, A.M. Rowledge, C.J. Borzdynski, C. Miller, N. Frescos, G. McKenzie, E. Perry, W. McGuiness, Reliability of a skin diagnostic device in assessing hydration and erythema, *Adv. Skin Wound Care* 30 (2017) 452–459, <https://doi.org/10.1097/01.ASW.0000520117.58976.32>.
- [29] L. Wang, P.C. Pedersen, D.M. Strong, B. Tulu, E. Agu, R. Ignatz, Smartphone-based wound assessment system for patients with diabetes, *IEEE Trans. Biomed. Eng.* 62 (2015) 477–488, <https://doi.org/10.1109/TBME.2014.2358632>.
- [30] M.-T. Tran, A. Kumar, A. Sachan, M. Castro, W. Allegre, J.-F. Feller, Emerging strategies based on sensors for chronic wound monitoring and management, *Chemosensors* 10 (2022) 311, <https://doi.org/10.3390/chemosensors10080311>.
- [31] J.B. Moreira, E.S. Muro, L.A. Monteiro, D.H. Iunes, B.B. de Assis, E. de C.L. Chaves, Efeito do grupo operativo no ensino do autocuidado com os pés de diabéticos: ensaio clínico randomizado, *Rev. Esc. Enferm. USP* 54 (2020) e03624, <https://doi.org/10.1590/S1980-220X2019005403624>.
- [32] R. Zügner, G. Jarl, L. Sundberg, U.H. Tang, Experiences of using a digital tool, the D-foot, in the screening of risk factors for diabetic foot ulcers, *J. Foot Ankle Res.* 15 (2022) 90, <https://doi.org/10.1186/s13047-022-00594-9>.
- [33] S.O. Oyibo, E.B. Jude, I. Tarawneh, H.C. Nguyen, L.B. Harkless, A.J.M. Boulton, A comparison of two diabetic foot ulcer classification systems: the wagner and the university of Texas wound classification systems, *Diabetes Care* 24 (2001) 84–88, <https://doi.org/10.2337/diacare.24.1.84>.
- [34] S.A. Bus, D.G. Armstrong, C. Gooday, G. Jarl, C. Caravaggi, V. Viswanathan, P.A. Lazzarini, On behalf of the I.W.G. on the D. Foot (IWGDF), Guidelines on offloading foot ulcers in persons with diabetes (IWGDF 2019 update), *Diabetes Metabol. Res. Rev.* 36 (2020) e3274, <https://doi.org/10.1002/dmrr.3274>.
- [35] X. Wang, C.-X. Yuan, B. Xu, Z. Yu, Diabetic foot ulcers: classification, risk factors and management, *World J. Diabetes* 13 (2022) 1049–1065, <https://doi.org/10.4239/wjcd.v13.i12.1049>.
- [36] M. Monteiro-Soares, E.J. Boyko, W. Jeffcoate, J.L. Mills, D. Russell, S. Morbach, F. Game, Diabetic foot ulcer classifications: a critical review, *Diabetes Metabol. Res. Rev.* 36 (2020) e3272, <https://doi.org/10.1002/dmrr.3272>.
- [37] D.G. Armstrong, E.J.G. Peters, Classification of wounds of the diabetic foot, *Curr Diab Rep* 1 (2001) 233–238, <https://doi.org/10.1007/s11892-001-0039-1>.

- [38] S. Wu, A.J. Applewhite, J. Niezgod, R. Snyder, J. Shah, B. Cullen, G. Schultz, J. Harrison, R. Hill, M. Howell, M. Speyrer, H. Utra, J. de Leon, W. Lee, T. Treadwell, Oxidized regenerated cellulose/collagen dressings: review of evidence and recommendations, *Adv. Skin Wound Care* 30 (2017) S1, <https://doi.org/10.1097/01.ASW.0000525951.20270.6c>.
- [39] A. Hingorani, G.M. LaMuraglia, P. Henke, M.H. Meissner, L. Loretz, K.M. Zinszer, V.R. Driver, R. Frykberg, T.L. Carman, W. Marston, J.L. Mills, M.H. Murad, The management of diabetic foot: a clinical practice guideline by the society for vascular surgery in collaboration with the American podiatric medical association and the society for vascular medicine, *J. Vasc. Surg.* 63 (2016) 3S–21S, <https://doi.org/10.1016/j.jvs.2015.10.003>.
- [40] J. Verdú-Soriano, M. de Cristino-Espinar, S. Luna-Morales, C. Dios-Guerra, J. Caballero-Villarraso, P. Moreno-Moreno, A. Casado-Díaz, M. Berenguer-Pérez, I. Guler-Caamaño, O. Laosa-Zafra, L. Rodríguez-Mañas, J.L. Lázaro-Martínez, Superiority of a novel multifunctional amorphous hydrogel containing olea europaea leaf extract (EHO-85) for the treatment of skin ulcers: a randomized, active-controlled clinical trial, *J. Clin. Med.* 11 (2022) 1260, <https://doi.org/10.3390/jcm11051260>.
- [41] B.G.R.B. de Oliveira, B.C. Oliveira, G. Deutsch, F.S. Pessanha, R.M. da S.M. Thiré, S.R. de Castilho, rhEGF-loaded hydrogel in the treatment of chronic wounds in patients with diabetes: clinical cases, *Gels* 8 (2022) 523, <https://doi.org/10.3390/gels8080523>.
- [42] F. Niami, S. Molavynjad, A.A. Hemmati, D. Bijan Nejad, L. Yazdanpanah, N.S. Maram, A. Saki Malehi, M. Mahmoudi, Evaluation of the effect of a gel made with amniotic fluid formulation on the healing of diabetic foot ulcers: a triple-blind clinical trial, *Front. Public Health* 10 (2022). <https://www.frontiersin.org/articles/10.3389/fpubh.2022.1025391>. (Accessed 12 November 2023).
- [43] Á. Astasio-Picado, M.D.M. Montero, M. López-Sánchez, J. Jurado-Palomo, P. Cobos-Moreno, B. Gómez-Martín, The effectiveness of negative pressure therapy: nursing approach, *J. Personalized Med.* 12 (2022) 1813, <https://doi.org/10.3390/jpm12111813>.
- [44] D. Zhang, L. He, A systemic review and a meta-analysis on the influences of closed incisions in orthopaedic trauma surgery by negative pressure wound treatment compared with conventional dressings, *Int. Wound J.* 20 (2022) 46–54, <https://doi.org/10.1111/iwj.13835>.
- [45] E.F. McElroy, Use of negative pressure wound therapy with instillation and a reticulated open cell foam dressing with through holes in the acute care setting, *Int. Wound J.* 16 (2019) 781–787, <https://doi.org/10.1111/iwj.13097>.
- [46] B. Xu, X. Song, Y. Weng, A multidisciplinary team approach for diabetic foot ulcer: a case study, *Adv. Skin Wound Care* 36 (2023) 1, <https://doi.org/10.1097/01.ASW.0000920512.88426.90>.
- [47] L. Chen, S. Zhang, J. Da, W. Wu, F. Ma, C. Tang, G. Li, D. Zhong, B. Liao, A systematic review and meta-analysis of efficacy and safety of negative pressure wound therapy in the treatment of diabetic foot ulcer, *Ann. Palliat. Med.* 10 (2021) 108300839–108310839, <https://doi.org/10.21037/apm-21-2476>.
- [48] E.S. Révész, Á. Altorjay, V. Montskó, L. Hangody, Effectiveness of negative pressure wound therapy: minimum five-year follow-up and review of the literature, *Jt Dis Relat Surg* 33 (2022) 51–56, <https://doi.org/10.52312/jdrs.2022.547>.
- [49] G. Rayman, P. Vas, K. Dhatriya, V. Driver, A. Hartemann, M. Londahl, A. Piaggese, J. Apelqvist, C. Attinger, F. Game, On behalf of the I.W.G. on the D. Foot (IWGDF), Guidelines on use of interventions to enhance healing of chronic foot ulcers in diabetes (IWGDF 2019 update), *Diabetes Metabol. Res. Rev.* 36 (2020) e3283, <https://doi.org/10.1002/dmrr.3283>.
- [50] P. Chen, N.C. Vilorio, K. Dhatriya, W. Jeffcoate, R. Lobmann, C. McIntosh, A. Piaggese, J. Steinberg, P. Vas, V. Viswanathan, S. Wu, F. Game, Guidelines on interventions to enhance healing of foot ulcers in people with diabetes (IWGDF 2023 update), *Diabetes/Metabolism Research and Reviews* n/a (n.d.) e3644. <https://doi.org/10.1002/dmrr.3644>.
- [51] S. Singh, S. Jajoo, S. Shukla, S. Acharya, Educating patients of diabetes mellitus for diabetic foot care, *J. Fam. Med. Prim. Care* 9 (2020) 367, <https://doi.org/10.4103/jfmpc.jfmpc.861.19>.
- [52] Á. Astasio-Picado, P. Cobos-Moreno, B. Gómez-Martín, Self-care planning and sanitary education in the prevention of the diabetic foot, *Appl. Sci.* 11 (2021) 7281, <https://doi.org/10.3390/app11167281>.
- [53] H.K. Abdulwassi, M.A. Safhi, R.T. Hashim, A.M. Fallatah, S.S. Hussein, S.A. Almusallam, M.S. Alsaad, M.T. Alkhatieb, Knowledge of diabetic foot care management among medical students at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, *Saudi Med. J.* 41 (2020) 59–67, <https://doi.org/10.15537/smj.2020.1.24812>.
- [54] M.I. Anselmo, M. Nery, M.C. Parisi, The effectiveness of educational practice in diabetic foot: a view from Brazil, *Diabetol. Metab. Syndrome* 2 (2010) 45, <https://doi.org/10.1186/1758-5996-2-45>.
- [55] X.-J. Fu, S.-D. Hu, Y.-F. Peng, L.-Y. Zhou, T. Shu, D.-D. Song, Observation of the effect of one-to-one education on high-risk cases of diabetic foot, *World Journal of Clinical Cases* 9 (2021) 3265–3272, <https://doi.org/10.12998/wjcc.v9.i14.3265>.
- [56] M.W.J. Woo, J. Cui, Factors influencing foot care behaviour among patients with diabetes: an integrative literature review, *Nursing Open* 10 (2023) 4216–4243, <https://doi.org/10.1002/nop2.1710>.
- [57] L.B. Sousa, I. Almeida, R.A. Bernardes, T.R. Leite, R. Negrão, J. Apóstolo, A. Salgueiro-Oliveira, P. Parreira, A three step protocol for the development of an innovative footwear (shoe and sensor based insole) to prevent diabetic foot ulceration, *Front. Public Health* 11 (2023). <https://www.frontiersin.org/articles/10.3389/fpubh.2023.1061383>. (Accessed 12 November 2023).
- [58] K.S. Chan, Y.M. Chan, A.H.M. Tan, S. Liang, Y.T. Cho, Q. Hong, E. Yong, L.R.C. Chong, L. Zhang, G.W.L. Tan, S. Chandrasekar, Z.J. Lo, Clinical validation of an artificial intelligence-enabled wound imaging mobile application in diabetic foot ulcers, *Int. Wound J.* 19 (2022) 114, <https://doi.org/10.1111/iwj.13603>.
- [59] D.J. Roberts, C. Murphy, S.A. Strauss, T. Brandys, V. Corrales-Medina, J. Zhang, K.-A. Lalonde, B. Meulenkamp, A. Jennings, A.J. Forster, D.I. Mclsaac, S. K. Nagpal, Structure, processes, and initial outcomes of The Ottawa Hospital Multi-Specialist Limb-Preservation Clinic and Programme: a unique-in-Canada quality improvement initiative, *Int. Wound J.* 19 (2022) 326–338, <https://doi.org/10.1111/iwj.13633>.
- [60] J. Musuza, B.L. Sutherland, S. Kurter, P. Balasubramanian, C.M. Bartels, M.B. Brennan, A systematic review of multidisciplinary teams to reduce major amputations for patients with diabetic foot ulcers, *J. Vasc. Surg.* 71 (2020) 1433–1446.e3, <https://doi.org/10.1016/j.jvs.2019.08.244>.
- [61] G. Wang, L. Wang, Y. Wang, X. Xu, Multidisciplinary approach to scheduling surgery for diabetic foot: a case report, *BMC Musculoskel. Disord.* 20 (2019) 168, <https://doi.org/10.1186/s12891-019-2522-3>.
- [62] C.M. Walker, F.T. Bunch, N.G. Cavros, E.J. Dippel, Multidisciplinary approach to the diagnosis and management of patients with peripheral arterial disease, *CIA* 10 (2015) 1147–1153, <https://doi.org/10.2147/CIA.S79355>.
- [63] J. Chung, J.G. Modrall, C. Ahn, L.A. Lavery, R.J. Valentine, Multidisciplinary care improves amputation-free survival in patients with chronic critical limb ischemia, *J. Vasc. Surg.* 61 (2015) 162–169.e1, <https://doi.org/10.1016/j.jvs.2014.05.101>.
- [64] K. Ahmajärvi, K. Isoherranen, M. Venermo, Cohort study of diagnostic delay in the clinical pathway of patients with chronic wounds in the primary care setting, *BMJ Open* 12 (2022) e062673, <https://doi.org/10.1136/bmjopen-2022-062673>.
- [65] A.T.O. Nickinson, B. Bridgwood, J.S.M. Houghton, S. Nduwayo, C. Pepper, T. Payne, M.J. Bown, R.S.M. Davies, R.D. Sayers, A systematic review investigating the identification, causes, and outcomes of delays in the management of chronic limb-threatening ischemia and diabetic foot ulceration, *J. Vasc. Surg.* 71 (2020) 669–681.e2, <https://doi.org/10.1016/j.jvs.2019.08.229>.
- [66] E. Faglia, G. Clerici, M. Caminiti, A. Quarantiello, M. Gino, A. Morabito, The role of early surgical debridement and revascularization in patients with diabetes and deep foot space abscess: retrospective review of 106 patients with diabetes, *J. Foot Ankle Surg.* 45 (2006) 220–226, <https://doi.org/10.1053/j.fjas.2006.04.002>.
- [67] L. Connell, Y. Finn, J. Sixsmith, Health literacy education programmes developed for qualified health professionals: a scoping review, *BMJ Open* 13 (2023) e070734, <https://doi.org/10.1136/bmjopen-2022-070734>.
- [68] K. Fujii, T. Komoda, A. Maekawa, M. Nishikawa, Foot care knowledge and practices among Japanese nurses and care workers in home care and adult service center: a cross-sectional study, *BMC Nurs.* 19 (2020) 75, <https://doi.org/10.1186/s12912-020-00467-1>.
- [69] L. Shin, F.L. Bowling, D.G. Armstrong, A.J.M. Boulton, Saving the diabetic foot during the COVID-19 pandemic: a tale of two cities, *Diabetes Care* 43 (2020) 1704–1709, <https://doi.org/10.2337/dc20-1176>.
- [70] M.M. Iversen, J. Igländ, H. Smith-Strøm, T. Østbye, G.S. Tell, S. Skeie, J.G. Cooper, M. Peyrot, M. Graue, Effect of a telemedicine intervention for diabetes-related foot ulcers on health, well-being and quality of life: secondary outcomes from a cluster randomized controlled trial (DiaFOTO), *BMC Endocr. Disord.* 20 (2020) 157, <https://doi.org/10.1186/s12902-020-00637-x>.

- [71] J.L. García-Klepzig, J.P. Sánchez-Ríos, C. Manu, R. Ahluwalia, C. Lüdemann, M. Meloni, E. Lacopi, V.R.-S. De Buruaga, B. Bouillet, J. Vouillarmet, J.L. Lázaro-Martínez, K. Van Acker, Perception of diabetic foot ulcers among general practitioners in four European countries: knowledge, skills and urgency, *J. Wound Care* 27 (2018) 310–319, <https://doi.org/10.12968/jowc.2018.27.5.310>.
- [72] J.P. Sánchez-Ríos, J.L. García-Klepzig, C. Manu, R. Ahluwalia, C. Lüdemann, M. Meloni, E. Lacopi, V.R.-S. De Buruaga, B. Bouillet, J. Vouillarmet, J.L. Lázaro-Martínez, K. Van Acker, Referral of patients with diabetic foot ulcers in four European countries: patient follow-up after first GP visit, *J. Wound Care* 28 (2019) S4–S14, <https://doi.org/10.12968/jowc.2019.28.Sup8.S4>.
- [73] C.D. Foo, S. Surendran, C.H. Tam, E. Ho, D.B. Matchar, J. Car, G.C.H. Koh, Perceived facilitators and barriers to chronic disease management in primary care networks of Singapore: a qualitative study, *BMJ Open* 11 (2021) e046010, <https://doi.org/10.1136/bmjopen-2020-046010>.
- [74] C.D. Weller, V. Team, G. Sussman, First-line interactive wound dressing update: a comprehensive review of the evidence, *Front. Pharmacol.* 11 (2020). <https://www.frontiersin.org/articles/10.3389/fphar.2020.00155>. (Accessed 12 November 2023).