Review

# Recurrence of foot ulcers in people with diabetes mellitus: a scoping review


## ABSTRACT

**Background** Recurrent foot ulcers in people with Diabetes Mellitus (DM) represent a significant clinical challenge, with rates that can reach between 28% and 42% in the first year, and 69% in five years.

**Aim** This study conceptualises the recurrence of foot ulcers in individuals with DM and the incidence between the concepts.

**Methods** A scoping review was conducted according to the Joanna Briggs Institute (JBI) guidelines. Eight databases were searched (LILACS, Medline, BDENF, SciELO, PubMed, Web of Science, Science Direct, and Embase), 2976 studies were identified. Of these, 2939 did not meet the inclusion criteria or were duplicates, resulting in 37 studies included in the research.

**Results** A narrative description revealed a lack of consensus in defining diabetic foot ulcer recurrence (DFUR), with significant variations among the analysed studies and variations in incidence rates reported by the different classifications of diabetic foot ulcer recurrence concept in the studies. Within one, three, and five years following complete healing of the initial ulcer, DFUR1 showed incidence rates ranging from 24.1% to 42.4%, DFUR2 from 40% to 60.5%, and DFUR3 from 32.4% to 70%.

**Future Directions** Currently, there is great heterogeneity in the concept of what constitutes a recurrence. The DFUR standard represents a significant change for the field of scientific research, facilitating the communication and understanding of preventive strategies and therapeutic measures effective in reducing DFUR.

**Conclusion** The results reinforce the need to standardise concepts for effective prevention and treatment strategies .associated with developing a recurrence.



**Keywords** diabetic foot, diabetic foot ulcer, incidence, prevalence, recurrence

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## INTRODUCTION

According to the International Diabetes Federation (IDF), more than 537 million people are diagnosed with diabetes mellitus (DM) worldwide. It is estimated to reach 1.31 billion in 2050.[1] Particularly, diabetic foot ulcers (DFUs) are among the most common, serious, and costly complications in people with DM.[2] They tend to occur more frequently among males over 50 years of age, with low income and a lower education level.[3]

Negative outcomes in people with DFU, such as infection and amputation, are mainly due to delayed healing, related to persistent hyperglycemia, reduction in tissue oxygenation, and changes in plantar protective sensitivity due to changes in peripheral innervation.[4]


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As a result, few patients achieve satisfactory healing within a reasonable timeframe. However, those who achieve healing often experience physical weaknesses, changes in foot biomechanics and sensory loss. Therefore, there remains a high risk of the recurrence of a new lesion.[5] It is worth noting that people with DM have a significant risk of DFU recurrence (DFUR). Despite being in a preventable condition, most scientific studies focus on investigating advanced treatments and technologies to promote healing.

As a premise for this study, it is noted that the scientific community did not find a consensus on what would be considered a DFUR, including terminological variations. That fact may result in a significant gap in understanding the incidence and care directed to people with DM to prevent a new DFUR after the first occurrence has healed.[6] This conceptual diversity justified the present study.

The objective of this study was to conceptualise the DFUR in individuals with DM and show the incidence between the concepts.

## METHODS

This scoping review is based on the precepts defined in the JBI Manual for Evidence Systhesis. The construction of this review also used the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA-ScR), the version for scoping reviews as a reporting tool. It consists of a model for collecting, analysing and synthesising the researched studies to assist authors in the health area in the transparency of their data collection.[7] The study protocol was registered in the Open Science Framework (doi: 10.17605/OSF.IO/N2CS8).

The research question: "What is the concept of foot ulcer recurrence in people with diabetes mellitus and its incidence?" was developed using the PCC acronym: Population = People with DM; Concept = Foot ulcer recurrence and incidence; Context = Scientific literature.

The included studies were those fully available and addressed the incidence and prevalence of DFUR in individuals diagnosed with type 1 and type 2 DM. There were no restrictions regarding geographic location or publication period. The selected languages were English, Spanish and Portuguese.

Studies in other languages were excluded due to the potential for inaccurate data filtering using current electronic translation tools. A reliable translation between languages could not be guaranteed, as the researchers do not possess fluency or basic knowledge of languages beyond the three mentioned above. Additional criteria included the concept of recurrence, incidence and clinical/demographic profile data of the study population. Accepted methodological designs included randomised clinical trials (RCTs), prevalence studies, retrospective and prospective studies, cross-sectional studies, narrative reviews and cohort studies.

The following studies were excluded: conference proceedings, book chapters, brief reports that did not allow data extraction, duplicates, animal or in vitro studies, expert opinions, case series and case reports, quasi-experimental studies, and those focusing on wound-healing technology assessments. Studies that did not address the recurrence of diabetic foot ulcers or investigated populations other than individuals diagnosed with DM were also excluded.

The electronic sources of information used in this scoping review were: Latin American and Caribbean Health Sciences Literature (LILACS) and Nursing Databases (BDENF) via the Virtual Health Library (VHL); Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed (US National Library of Medicine); Scientific Electronic Library Online (SciELO); Web of Science; Scopus; Science Direct; and Embase. Additionally, searches were conducted in the gray literature databases through Google Scholar.

The search strategy used a combination of keywords, applied in databases to identify titles and abstracts of scientific documents, answering the research question that guides this scoping review.[8] Accordingly, specific search terms (descriptors) and keywords were identified based on the elements of the PCC strategy. The correct selection of these terms is essential for ensuring that the review represents the existing body of knowledge on the intended topic.

The following terms were identified through preliminary searches in PubMed: *diabetic ulcer*, *diabetic foot*, *incidence*, *prevalence*, and *recurrence*. In the VHL, the DeCS (Health Sciences Descriptors) used were: *pé diabético*, *úlcera do pé*, *incidência*, *prevalência*, *recorrência*, and *recidiva*. Additionally, Emtree thesaurus terms were defined: *diabetic ulcer*, *diabetic foot*, *diabetic foot ulcer*, *diabetic wound*, *incidence*, *prevalence*, and *recurrence*.

Keywords identified on MeSH, DeCS, and Emtree platforms were also added to the search strategy. Titles and abstracts of the retrieved studies were analysed, along with the indexing terms (descriptors) used to describe each publication related to the research topic. The identified descriptors, entry terms, and keywords were combined using Boolean operators AND and OR to formulate the final search strategies, as shown in Table 1.

The search strategy was developed with the support of a specialist in scoping reviews. Searches were conducted in July 2024 and updated in November of the same year, using publication date filters to identify newly published studies. The study selection process was carried out using the Rayyan® platform independently and blindly by two reviewers. Disagreements were resolved by consensus in virtual meetings.

Data was extracted and organised in an Excel spreadsheet, including study location, authors, language, study design, objectives, sample size, definition of recurrence, and clinical profile of participants. Clinical variables were based on the International Consortium for Health Outcomes Measurement (ICHOM) guidelines, including gender, type and duration of diabetes diagnosis, glycated hemoglobin (HbA1c), neuropathy, foot deformities, and vascular disease.

*Table 1. Database and final search strategies.*

| Information sources | Search strategy | Number of records identified |
|---|---|---|
| *LILACS and BDENF* | (("Pé Diabético" OR "úlcera do pé" OR "úlcera do pé diabético" OR "feridas nos pés" OR "úlceras nos pés" OR "feridas diabéticas")) AND (("Incidência" OR "Prevalência" OR "Recorrência" OR "Recidiva")) | 250 |
| *MEDLINE/ PubMed* | ("Diabetic Foot"[MeSH Terms] OR "Diabetic Foot"[All Fields] OR "Diabetic ulcer"[All Fields] OR "Diabetic foot ulcer"[All Fields] OR "diabetic wound"[All Fields] OR "diabetic ulcers"[All Fields]) AND ("incidence"[MeSH Terms] OR ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "incidence"[All Fields] OR "incidence"[MeSH Terms] OR "incidences"[All Fields] OR "incident"[All Fields] OR "incidents"[All Fields]) OR "prevalence"[MeSH Terms] OR ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "prevalence"[All Fields] OR "prevalence"[MeSH Terms] OR "prevalance"[All Fields] OR "prevalences"[All Fields] OR "prevalence s"[All Fields] OR "prevalent"[All Fields] OR "prevalently"[All Fields] OR "prevalents"[All Fields])) AND ("recurrence"[MeSH Terms] OR ("recurrance"[All Fields] OR "recurrence"[MeSH Terms] OR "recurrence"[All Fields] OR "recurrences"[All Fields] OR "recurrencies"[All Fields] OR "recurrency"[All Fields] OR "recurrent"[All Fields] OR "recurrently"[All Fields] OR "recurrents"[All Fields])) | 283 |
| *SciELO* | (("Pé Diabético" OR "úlcera do pé" OR "úlcera do pé diabético" OR "feridas nos pés" OR "úlceras nos pés" OR "feridas diabéticas") ) AND (("Incidência" OR "Prevalência" OR "Recorrência" OR "Recidiva")) | 40 |
| *Web of Science* | ("Diabetic ulcer" OR "Diabetic Foot" OR "Diabetic foot ulcer" OR "diabetic wound" OR "diabetic ulcers") (All Fields) AND (Incidence OR prevalence) (All Fields) AND Recurrence (All Fields) | 117 |
| *Scopus* | TITLE-ABS-KEY ("Diabetic ulcer" OR "Diabetic Foot" OR "Diabetic foot ulcer" OR "diabetic wound" OR "diabetic ulcers") AND TITLE-ABS-KEY (incidence OR prevalence) AND TITLE-ABS-KEY (recurrence) | 173 |
| *Science Direct* | ("Diabetic ulcer" OR "Diabetic Foot" OR "Diabetic foot ulcer" OR "diabetic wound" OR "diabetic ulcers") AND (Incidence OR prevalence) AND Recurrence | 1839 |
| *Embase* | ('diabetic ulcer'/exp OR 'diabetic foot'/exp OR 'diabetic foot ulcer'/exp OR 'diabetic wound'/exp OR 'diabetic ulcers') AND ('incidence'/exp OR 'prevalence'/exp) AND recurrence AND [embase]/lim | 71 |
| *Google Scholar* Portuguese | Pé Diabético OR úlcera do pé OR úlcera do pé diabético AND Incidência OR Prevalência OR Recorrência OR Recidiva | 100 |
| *Google Scholar* English | Diabetic ulcer OR Diabetic Foot OR Diabetic foot ulcer OR diabetic wound OR diabetic ulcers AND Incidence OR prevalence AND Recurrence | 100 |

The data synthesis was descriptive and categorical, supported by tables and figures. A simple frequency analysis was also conducted regarding the incidence of DFUR.

The critical appraisal of the studies was based on the Joanna Briggs Institute (JBI) checklists, according to study design: randomised controlled trials, cross-sectional studies, cohort studies, prevalence studies, and narrative reviews. For retrospective, prospective, and observational studies, the cohort checklist was used, with appropriate methodological adaptations.

For the final analysis, the checklist results of each article, as proposed by the JBI model, were compiled into a "traffic light" graph using RoBVis (Risk of Bias Visualisation), generated in Excel. The horizontal axis displayed the domains coded as "Q" followed by the question number in the JBI checklist (for example, Q1 corresponds to question 1 of the respective checklist for that study design). Vertically, studies were identified by the main author(s).[9]

## RESULTS

The initial search yielded a total of 2976 studies. In the first screening phase, 1935 records were excluded because they did not align with the topic or required type, such as book chapters and conference proceedings. Additionally, 775 duplicate records were identified and removed, along with 93 ineligible articles that could not be accessed through the provided links, and 13 articles that were not retrievable.

In the second phase, 160 full-text articles were assessed for eligibility. The predominant exclusion criterion at this stage was the absence of data regarding the incidence of recurrence. After the two screening phases, a total of 37 studies were included in the final review (Figure 1).

The studies were published from 1993 to 2024. The predominant language was English, with 94.6%, 35, of the

studies. The five continents were represented in the study samples.

The methodology of the selected articles was predominantly cohort studies, with 20 studies, followed by prospective studies.

After selecting and compiling the concepts of what DFUR would be, two main references were used. The term 'reulceration' was conceptualised as a variant of recurrence, as "a new ulcer located in the same place as the first occurrence". The term 'reulceration' was not linked so as not to limit the classification, or whether the terminology 'recurrence' was approached with this same type of concept, thus creating the DFUR1 classification for this study.

The second scientific framework for conceptualising recurrence was based on the International Working Group on the Diabetic Foot (IWGDF) Guideline. Recurrence was conceptualised as: "a new ulcer in the patient with a history of ulceration, regardless of location or time, since the previous ulcer". This was then used as DFUR2 in this study.

The third variable was created to track the concept of DFUR3, as a "no specific concept/other", in case the authors did not choose these concepts mentioned above to deal with episodes of recurrence in their respective studies. Thus, for a different concept, the classification applied was DFUR3.

Of the 37 studies selected to compose the research results, three (8.1%) used scientific references to determine a DFUR. The others fit the above determinations in the concept analyses but did not use a scientific reference to base themselves on.

Incidence analysis was incorporated into the concepts of recurrence defined by the present study. The percentages found were analysed between the three definitions of recurrence.

The studies that defined their DFUR sample as DFUR1 presented in one year 24.13%, 42.40% in three years, and no study with this classification reported data in five years.

The DFUR2 concept presented rates of 39.88% in the first year, 56.55% in three years, and 69.50% in five years.

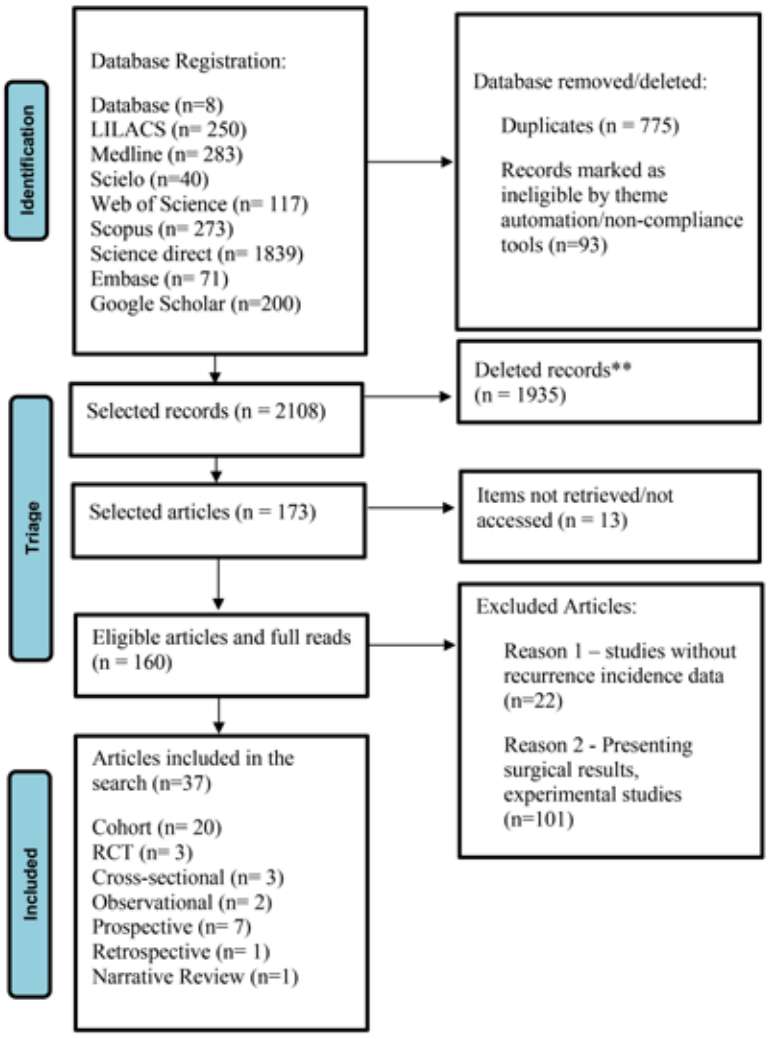



*Figure 1. Flowchart of the screening process and study selection built by the PRISMA recommendation.*

*Table 2. Methodological critical analysis of the quality of the studies according to the JBI model.*

| Article | Year | Author/s | Study | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2024 | Hu et al[10] | Retrospective cohort | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ! | ✓ | ⊘ | ⊘ |
| 2 | 2024 | Thomas et al[11] | RCT | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | 2024 | Van Netten et al[12] | RCT | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | 2024 | Thorne et al[13] | RCT | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | 2023 | Huynh et al[14] | Observational | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 6 | 2023 | Bundó et al[15] | Observational | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 7 | 2023 | Guzmán et al[16] | Retrospectivo | ✓ | ✓ | ✓ | ! | ! | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 8 | 2023 | Alkhatieb et al[17] | Transversal | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ |
| 9 | 2022 | Petersen et al[18] | Prospective cohort | ✓ | ✓ | ✓ | ! | ! | ✓ | ✗ | ✗ | ! | ! | ✓ | ⊘ | ⊘ |
| 10 | 2022 | Ogurtsova et al[19] | Retrospective cohort | ✗ | ✗ | ✓ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 11 | 2022 | Zhang et al[20] | Observational | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 12 | 2021 | Keukenkamp et al[21] | Retrospective cohort | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ! | ! | ✓ | ⊘ | ⊘ |
| 13 | 2021 | Fournier et al[22] | Retrospective cohort | ✓ | ✓ | ✓ | ! | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 14 | 2021 | Felipe; Plate-Que[23] | Prospective | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ! | ! | ✓ | ⊘ | ⊘ |
| 15 | 2021 | Cheng et al[24] | Prospective | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ! | ✓ | ⊘ | ⊘ |
| 16 | 2020 | Engberg et al[25] | Prospective cohort | ✗ | ✗ | ✓ | ✗ | ✗ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 17 | 2020 | Hicks et al[26] | Prospective cohort | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ! | ✓ | ⊘ | ⊘ |
| 18 | 2020 | Gazzaruso et al[27] | Prospective cohort | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ! | ✓ | ⊘ | ⊘ |
| 19 | 2020 | Tabanjet et al[28] | Prospective cohort | ✓ | ✓ | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 20 | 2020 | Freitas et al[29] | Retrospective cohort | ✓ | ✓ | ! | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 21 | 2019 | Khalifa[30] | Retrospective cohort | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 22 | 2019 | Van Netten et al[31] | Retrospective cohort | ✗ | ✗ | ! | ✓ | ! | ✓ | ✓ | ✓ | ✓ | | ✓ | ⊘ | ⊘ |
| 23 | 2019 | Blanchette; Hains; Cloutier[31] | Narrative | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ |
| 24 | 2018 | Iwase et al[32] | Retrospective cohort | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 2018 | Jimenez et al[33] | Prospective | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 26 | 2017 | Assaad-Khalil et al[34] | Retrospective cohort | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ! | ! | ✓ | ! | ✓ | ⊘ | ⊘ |
| 27 | 2017 | Roth-Albin et al[35] | Prospective | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 28 | 2017 | Orneholm et al[36] | Prospective | ✗ | ✗ | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 29 | 2015 | Assaad-Khalil et al[37] | Transversal | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ |
| 30 | 2015 | Ferguson et al[38] | Transversal | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ | ⊘ | ⊘ | ⊘ |
| 31 | 2008 | Ghanassia et al[39] | Prospective cohort | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ! | ✓ | ⊘ | ⊘ |
| 32 | 2007 | Winkley et al[40] | Prospective cohort | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 33 | 2007 | Iribarren et al[41] | Prospective cohort | ✗ | ✗ | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 34 | 2007 | Peters; Armstrong; Lavery[42] | Prospective cohort | ✓ | ! | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ! | ! | ✓ | ⊘ | ⊘ |
| 35 | 2003 | Paola et al[43] | Prospective cohort | ✗ | ✗ | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 36 | 1999 | Dargis et al[44] | Prospective | ✓ | ✓ | ✓ | ✓ | ! | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |
| 37 | 1993 | Apelqvist et al[45] | Prospective | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ⊘ | ⊘ |

For studies that did not conceptualise or bring different recurrence conceptualisations, entering the DFUR3 category, the rates in one year were 32.40%, 79.65% in three years, and 70% in five years.

Some studies considered more than one type of concept about DFUR. Therefore, in this classification, the samples studied obtained 31.73% in one year, 60.50% in three years, and no data on DFUR in five years.

For demographic data, the percentage of males was collected. All studies presenting this data showed an average of 65.08% of the sample studied as male.

The average age was also part of the demographic data. The average range in years varied between 52.1 years and 75 years.

The overall average time since DM diagnosis was over 16 years, and the prevalence was in those diagnosed with Type 2 DM. It was observed that seven studies (16%) indicated in their samples 100% of people diagnosed with Type 2 DM. However, 21 studies (56.75%) did not present this last data.

To control the pathology, the International Consortium for Health Outcomes Measurement (ICHOM Diabetes in Adults Working Group, Type 1 and Type 2 Diabetes in Adults, November 2018, (available at: www.ichom.org/medical-conditions/diabetes) recommends the results of blood tests for glycated hemoglobin. This data was presented in 19 studies (51.4%). The average glycated hemoglobin for people with DFUR was 8.32%, with rates ranging from 7.39% to 12.34%.

When tracing the clinical profile of patients, the generalised parameters were used, inspired by the guide, such as neuropathy present (%), foot complications (%), and vascular impairment (%).

## DISCUSSION

The conceptual variations in DFUR reflect the lack of uniformity in the diagnostic criteria and the consequent difficulty in comparing studies. The selected studies traced research on a variety of concepts that did not exactly communicate with each other.

Surprisingly, of the 37 studies in the survey, only three included a scientific reference to base the concept of DFUR and the chosen terminology, which also proved to be diverse. Despite that, the recurrence concept was an inclusion factor of the population studied by each article, as all studies focused on people with DFUR.

The lack of consensus on the definition of DFUR contributes to the variation in incidence rates and hinders the consolidation of prevention strategies. There is an urgent need for a conceptual standard to support more effective and comparable interventions.

*Table 3. Characteristics of the studies included in the scoping review.*

| Variables | N of studies | Percentage (%) |
|---|---|---|
| **Publication years** | | |
| 1993–2003 | 4 | 10.8% |
| 2004–2014 | 6 | 16.2% |
| 2015–2024 | 27 | 73% |
| *Total* | *37* | *100%* |
| **Study design** | | |
| Cohort | 20 | 54.1% |
| Prospective | 8 | 21.6% |
| Retrospective | 1 | 2.7% |
| Observational | 2 | 5.4% |
| RCT | 3 | 8.1% |
| Transversal | 3 | 8.1% |
| *Total* | *37* | *100%* |
| **Type of Diabetes** | | |
| Type 1 | 0 | 0% |
| Type 2 | 6 | 16.2% |
| Both | 12 | 32.4% |
| Not specified | 19 | 51.4% |
| *Total* | *37* | *100%* |
| **Sample size** | | |
| 0–35 | 1 | 2.7% |
| 35–200 | 19 | 51.4% |
| 201–400 | 9 | 24.3% |
| 401–600 | 3 | 8.1% |
| 601–4850 | 4 | 10.8% |
| 4851–78,716 | 1 | 2.7% |
| *Total* | *37* | *100%* |
| **Concept of Recurrence** | | |
| DFUR1 | 12 | 27.3% |
| DFUR2 | 18 | 40.9% |
| DFUR3 | 14 | 31.8% |
| *Total* | *44* | *100%* |

The results indicate that DFUR is a frequent phenomenon, with rates ranging from 33% to 70% after healing the first ulcer. These indices corroborate the literature, such as this study published in 2021, which presents the range of recurrence of DFU, from 28% in the first year, up to 70% in 10 years.[18] The 2017 study by Armstrong[46] also corroborates these rates, with 40% of people with DM developing a recurrence within one year after the first healed ulcer, and 65% within five years.

The incidence by concept showed different indices, for example, the single classification as a DFUR1 has a rate below the average. To highlight this difference, studies that adopted the DFUR1 concept present 24.13% in the first year and 42.40% in three years. Comparing the incidence of DFUR in studies that add more than one concept of recurrence, the rates jumped to 31.73% and 60.5%, respectively.

The concept DFUR2 was the most popular among the researchers (48.6%), being the broadest term of the categories, which considers any ulcer after the first occurrence as a DFUR.

The incidence of DFUR for studies that used this concept was also more like those found in the literature, approximately 40% in the first year, 56.5% in three years, and 69.5% in five years.

As can be seen, the term recurrence also has terminological varieties among the concepts. Therefore, the following terms were presented: new ulcer, reulceration, re-ulceration, and recurrence.[13,25,36,40]

The discussion permeates the very divergence of terminology recurrence. While the IWGDF guide (2023)[48] conceptualises recurrence as "a new ulcer in the patient with a history of ulceration, regardless of the location and time since the previous ulcer", other studies have used the word "reulceration" with the concept: "new ulcer that arises at the same site as the previous lesion".[42] For Iribarren (2007),[41] the term recurrence was linked to another form of concept, where the person with DFUR would be the one with any ulcer that occurred after the first healed, but necessarily at the same foot.

Some concepts included clinical characteristics, such as considering the thickness of the epithelial rupture or considering the ulcer based on the full-thickness lesion. Those facts can change the way we define the recurrence population and how this will reflect in the studies.[19,40]

An example of the conceptual adoption of DFUR that can change research outcomes is this work published by Örneholm in 2017 in Sweden. The authors conceptualised recurrence as an ulcer that appears on the same foot and in the same place as the healed index ulcer, and the term "new ulcer" for ulcers occurring at any other site of the same foot or any site of the contralateral foot. The article presented a low percentage of recurrence (8%), and the percentage of "new ulcers" was significantly higher, 42% within two years.[36]

Two years after this publication, Engberg and colleagues in 2019[25] described recurrence as "an ulcer in the same place/place as the previous ulcer", and a new ulcer as "an ulcer in another place". In their results, the authors unified the terms and concepts of recurrence and "new ulcers" and presented a single incidence. However, in the discussion, there was a comparison between the two concepts, which included the percentage of "new ulcers", the highest among them, representing 77.3% of the cases.

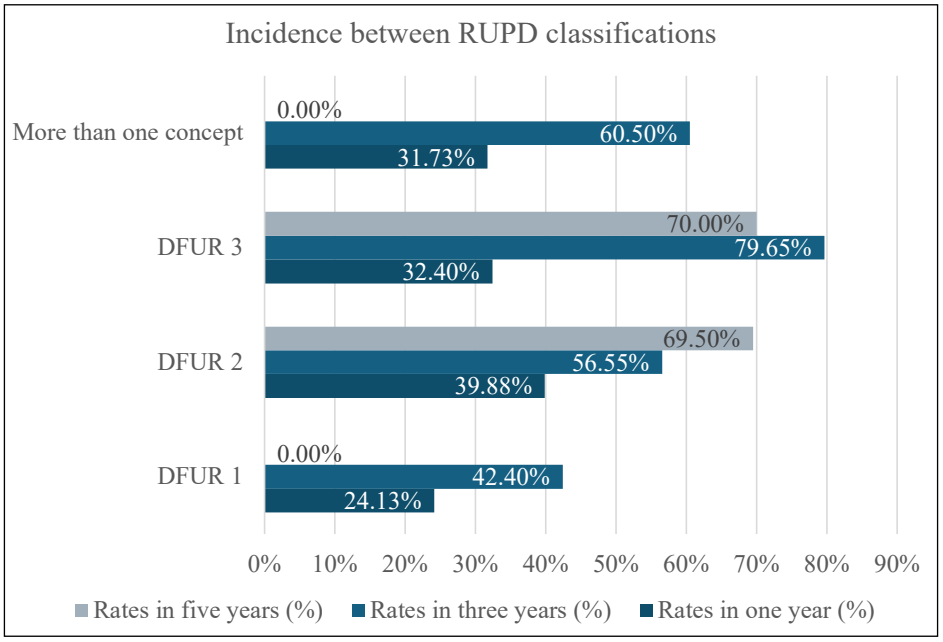
For effective action in the treatment and care of patients with DM, who need constant health care, multiprofessional teams with a full understanding of the concept of DFUR will be able to follow correctly the comorbidity progression. National and international studies indicate that DFUR is a critical factor

in diabetic foot, requiring preventive interventions and specialised follow-up.[5,47,49]

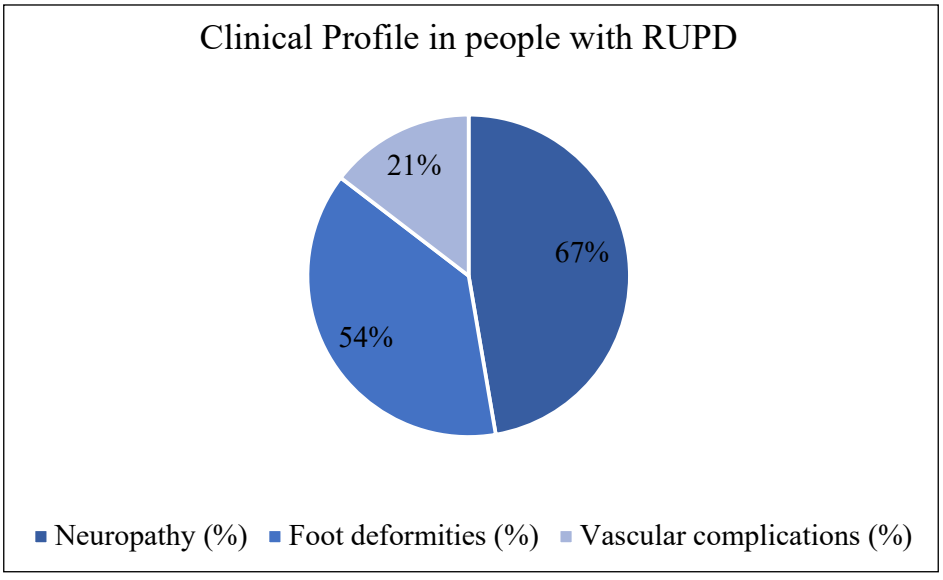
The patient's DFUR clinical profile, divided into three concepts, presented a cause-and-effect scenario for the development of this reasoning, with results showing that around 67% of people with DFUR had concomitant peripheral neuropathy present, however, these rates could reach to 100%.[22] Most people with DFUR and diagnosed with peripheral neuropathy had resultant muscle atrophy and weakness of the lower limb, especially within the feet, plus impaired sensation or complete loss of protective sensation in the foot. Further, they generally experienced motor neuropathy resulting in muscle atrophy and weakness leading to mechanical alterations in gait and walking. In addition, autonomic neuropathy adversely affects sweat gland function and secretion levels that alter the natural moisture content of the skin causing skin dryness. Collectively, these factors are impediments to wound healing and contribute to DFUR.[50]

Neuropathy can also contribute to the appearance of foot deformities. For this, it was found that 54% of the population with DFUR had some foot deformities, which cause difficulties in healing and appear as one of the precursors of DFUR. Alkhatieb (2023)[17] states that the presence of foot deformities is directly related to cases of recurrence, regardless of other factors.

The mean percentage for vascular complications was 21%. Low oxygenation of the peripheral limbs linked to vascular comorbidity, with peripheral arterial disease is the one that most affects people with DM. It is the main factor for the




*Graph 1. Mean incidence of DFUR, classified in the concepts of recurrence between one, three and five years.*




*Graph 2. Clinical profile of the person with RUPD.*

development and risk associated with the emergence of a DFUR.[50] Despite this, 26 studies (70.27%) did not present these statistics.

The present study shows the DFUR concept remains heterogeneous among the studies, with significant variations in terminology across the analysed studies. The lack of a universal consensus on the recurrence concept compromises data comparability and may lead to underreporting of cases.

## CONCLUSION

A variety of concepts relating to DFUR are presented in this scoping review. The different DFUR indexes and the scientific basis or not used to justify these are dependent on how it was conceptualised.

This lack of consensus significantly compromises the consistency and comparability between different studies, hindering scientific progress in understanding risk factors, preventive strategies, and effective therapeutic measures to reduce DFUR. A standardised concept would facilitate future research, allowing clearer and more effective communication.

The standardisation of the DFUR concept represents a significant challenge for scientific research, clinical practice and people with a recurrence.

The current review would tend to support the IWGDF's concept or definition of a DFUR as being "a new ulcer in the patient with a history of ulceration, regardless of the location and time since the previous ulcer on the foot". Adoption of this specific terminology and concept would facilitate greater understanding and identification of DFUR for the purpose of clinical care, clinical data capture or research that would enhance communication between clinicians and researchers and improve clinical outcomes.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## ETHICAL APPROVAL

The design of a scope review doesn't need an ethical analysis.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.


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