



Association of Diabetes Mellitus and Vulvovaginal Candidiasis : A Systematic Review

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ABSTRACT

Introduction: Diabetes Mellitus (DM) is a global pandemic that significantly increases susceptibility to infections, including Vulvovaginal Candidiasis (VVC). This increased risk is attributed to hyperglycemia and compromised immune function. VVC in diabetic women often presents with greater severity, recurrence, and treatment challenges. This systematic review synthesizes the current evidence on the association between DM and VVC.

Methods: This review followed PRISMA 2020 guidelines. A systematic search was conducted across PubMed, Springer, Semantic Scholar, and Google Scholar to identify relevant studies. Eligibility criteria focused on observational studies and reviews examining VVC in adult females with Type 1 or Type 2 diabetes. After screening, 27 articles were included for analysis.

Results: The evidence confirms a significantly higher prevalence of VVC in diabetic women (32-67.5%) compared to non-diabetic women (11-23%). The risk is elevated in both Type 1 DM (84%

prevalence) and Type 2 DM (68% prevalence) versus controls (27%). Poor glycemic control is a critical factor, with VVC prevalence doubling in uncontrolled (31.4%) versus controlled (15.7%) diabetes. VVC in diabetics is associated with higher recurrence and increased infections by non-albicans *Candida* species, which are often resistant to standard azole antifungals.

Conclusion: The association between DM and VVC is robust and deeply rooted in the pathophysiological effects of hyperglycemia and immune dysfunction. The cornerstone of prevention and management is rigorous glycemic control. The clinical approach must be integrated, addressing both the infection with appropriate, sometimes alternative, antifungal therapies and the underlying metabolic disorder to reduce the burden of this common and challenging comorbidity.

Keywords: Diabetes Mellitus, Vulvovaginal Candidiasis, Systematic Review, Glycemic Control, Antifungal Resistance

INTRODUCTION

Diabetes Mellitus (DM) has emerged as a global pandemic, posing a significant public health challenge worldwide. This metabolic disorder, characterized by chronic hyperglycemia, leads to a wide array of systemic complications, profoundly impacting patients' quality of life. One of the well-documented consequences of DM is an increased susceptibility to various infections, a phenomenon attributed to the complex interplay between high blood glucose levels and compromised immune function. This vulnerability extends to bacterial, viral, and fungal pathogens, making infection management a critical component of comprehensive diabetes care (Toniolo et al., 2018; Abu-Ashour et al., 2017).

Among the opportunistic infections frequently associated with diabetes, Vulvovaginal Candidiasis (VVC) is particularly prominent. VVC is a common mucosal infection of the female lower genital tract, predominantly caused by yeast species of the genus *Candida*, with *Candida albicans* being the most frequent causative agent. While a significant portion of healthy, asymptomatic women are colonized by *Candida*, the transition to symptomatic infection is influenced by a variety of host-predisposing factors. These factors disrupt the delicate vaginal micro-environment, allowing for the overgrowth of yeast and the onset of clinical symptoms such as itching, irritation, and abnormal discharge (Gonçalves et al., 2016; Dewi, 2020).

A substantial body of evidence has firmly established a strong association between diabetes mellitus and an elevated risk of VVC. Epidemiological studies consistently report a significantly higher prevalence of vaginal *Candida* colonization and symptomatic VVC among diabetic women compared to their non-diabetic counterparts. Quantitative reviews have reported VVC prevalence rates as high as 32-67.5% in diabetic women, compared to 11-23% in the general population (Gonçalves et al., 2016). The risk appears to be particularly pronounced in individuals with Type 1 DM, with some studies noting prevalence rates up to 84% (Rodrigues et al., 2019; Mohammed et al., 2021).

The pathophysiological mechanisms underpinning this association are multifactorial.

Chronic hyperglycemia directly facilitates fungal pathogenesis by enhancing the ability of *Candida* to adhere to vaginal epithelial cells, a crucial first step in establishing an infection. Furthermore, elevated glucose levels in vaginal secretions create a nutrient-rich environment that promotes yeast proliferation. Diabetes-induced immune dysfunction, including impaired neutrophil function and altered cell-mediated immunity, further weakens the host's ability to mount an effective defense against *Candida* overgrowth (Pandey et al., 2025; Rodrigues et al., 2019; Balakrishnan et al., 2022).

From a clinical standpoint, VVC in diabetic women often presents with greater severity and complexity. These patients are more susceptible to recurrent VVC (RVVC), defined as four or more episodes of infection within a year, which poses a significant therapeutic challenge. Moreover, there is an observed increase in infections caused by non-*albicans Candida* (NAC) species, such as *Candida glabrata*. These species are often intrinsically less susceptible to standard first-line azole antifungal agents, leading to higher rates of treatment failure and the need for alternative therapeutic strategies (Gonçalves et al., 2016; Yulianto and Gunawan, 2024).

The degree of glycemic control is a critical determinant of VVC risk and clinical outcomes in diabetic women. Poorly controlled diabetes is consistently linked to a higher frequency and recurrence of VVC. Studies have demonstrated a marked difference in VVC prevalence between patients with uncontrolled (31.4%) versus controlled (15.7%) diabetes (Baidya et al., 2022). This highlights that maintaining optimal blood glucose levels is not only fundamental to managing diabetes itself but also serves as a cornerstone strategy for preventing and managing its infectious complications, including VVC (Calin et al., 2024; Goderidze et al., 2022).

Despite the well-established link, the management of VVC in diabetic patients remains a clinical challenge. The emergence of antifungal resistance, the complications associated with NAC species, and the influence of newer diabetes therapies, such as sodium-glucose cotransporter-2 (SGLT-2) inhibitors which increase urinary glucose excretion, necessitate a continuous re-evaluation of the evidence. A consolidated understanding of the current epidemiological trends, diagnostic considerations, and treatment efficacies is essential for optimizing patient care

(Rodrigues et al., 2019; Casillas-Vega, 2025).

Therefore, this systematic review aims to comprehensively evaluate and synthesize the existing literature on the association between diabetes mellitus and vulvovaginal candidiasis. By examining study designs, prevalence data, risk factors, diagnostic methods, and treatment outcomes from recent research, this review seeks to provide a detailed and updated overview of the topic. The findings are intended to inform clinical practice and guide future research toward improving the management of this common and burdensome co-morbidity.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the association of diabetes mellitus and vulvovaginal candidiasis.

Screening

We screened in papers that met these criteria:

- **Population - Age and Condition:** Does the study focus on adult females (age 18 years) with diagnosed diabetes mellitus (Type 1 or Type 2)?
- **VVC Diagnosis:** Is vulvovaginal candidiasis confirmed through clinical examination or laboratory testing?
- **Study Design:** Is the study an observational study (cohort, case-control, cross-sectional) or a systematic review/meta-analysis?

- **Outcome Measures:** Does the study report prevalence, incidence, or risk ratios for VVC in diabetic patients?
- **Diagnostic Criteria:** Does the study clearly describe the diagnostic criteria used for both diabetes and VVC?
- **Patient Immune Status:** Are the study participants free from immunocompromising conditions (other than diabetes)?
- **Diabetes Type:** Does the study focus on established Type 1 or Type 2 diabetes rather than solely on gestational diabetes?
- **Candidiasis Type:** Does the study specifically include vulvovaginal candidiasis (rather than focusing exclusively on other forms of candidiasis)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

- **Study Design:**

Identify the type of study design used. Look in the methods section for explicit description of study type. Possible designs include:

- Cross-sectional study
- Case-control study
- Cohort study
- Clinical trial
- Review/systematic review

If multiple designs are present or the design is unclear, note all potential designs. If no clear design can be determined, write "Design not clearly specified".

- **Participant Characteristics:**

Extract detailed information about study participants:

- Total number of participants
- Number of participants with diabetes
- Number of participants with vulvovaginal candidiasis
- Age range or mean age
- Diabetes type (Type 1, Type 2, gestational)
- Diabetes duration (if reported)
- Glycemic control status (HbA1c levels, if reported)

If any of these details are missing, note "Not reported" for that specific characteristic. Be precise and use exact numbers/values when available.

- **Candidiasis Diagnosis Method:**

Identify and record the specific diagnostic criteria or methods used to diagnose vulvovaginal candidiasis:

- Microbiological culture
- Microscopic examination
- Clinical symptoms
- Molecular diagnostic techniques
- Combination of methods

If multiple methods were used, list all. If method is not clearly specified, write "Diagnostic method not specified".

- **Key Findings Related to Diabetes and Candidiasis:**

Extract the primary findings regarding the relationship between diabetes and vulvovaginal candidiasis:

- Prevalence of candidiasis in diabetic vs. non-diabetic populations
- Odds ratios or relative risk
- Statistical significance of associations
- Any noted mechanisms of increased susceptibility

Prioritize quantitative results. If only qualitative findings are available, summarize the key conclusions. Include exact numerical values and p-values when reported.

- **Treatment Approaches:**

Document treatment strategies for vulvovaginal candidiasis in diabetic patients:

- Types of antifungal medications used
- Dosage and duration of treatment
- Combination therapies
- Impact of glycemic control on treatment success

If multiple treatment approaches are described, list all. If no specific treatment details are provided, write "Treatment details not specified".

Search Strategy

The keywords used for this research based PICO :

Element	Keyword 1	Keyword 2	Keyword 3	Keyword 4
Population (P)	Diabetes Mellitus	Diabetic Patients	Individual with Diabetes Mellitus	Diabetes Mellitus Patients
Intervention (I)	Elevated Blood Glucose	Poor Glycemic Control	Increased Blood Glucose	High Blood Glucose
Comparison (C)	Non-diabetic populations	Individuals with Normal Glucose	Non-diabetic women	Women without diabetes
Outcome (O)	Vulvovaginal Candidiasis	Vulvovaginal yeast infection	Candidal vulvovaginitis	Vaginal thrush

The Boolean MeSH keywords inputted on databases for this research are: ("*Diabetes Mellitus*" OR "*Diabetic Patients*" OR "*Individual with Diabetes Mellitus*" OR "*Diabetes Mellitus Patients*") AND ("*Elevated Blood Glucose*" OR "*Poor Glycemic Control*" OR "*Increased Blood Glucose*" OR "*High Blood Glucose*") AND ("*Non-diabetic populations*" OR "*Individuals with*

Normal Glucose" OR "Non-diabetic women" OR "Women without diabetes") AND ("Vulvovaginal Candidiasis" OR "Vulvovaginal yeast infection" OR "Candidal vulvovaginitis" OR "Vaginal thrush")

Data retrieval

Abstracts and titles were screened to assess their eligibility, and only studies meeting the inclusion criteria were selected for further analysis. Literature that fulfilled all predefined criteria and directly related to the topic was included. Studies that did not meet these criteria were excluded. Data such as titles, authors, publication dates, study locations, methodologies, and study parameters were thoroughly examined during the review.

Quality Assessment and Data Synthesis

Each author independently assessed the titles and abstracts of the selected studies to identify those for further exploration. Articles that met the inclusion criteria underwent further evaluation. Final decisions on inclusion were based on the findings from this review process.

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	("Diabetes Mellitus" OR "Diabetic Patients" OR "Individual with Diabetes Mellitus" OR "Diabetes Mellitus Patients") AND ("Elevated Blood Glucose" OR "Poor Glycemic Control" OR "Increased Blood Glucose" OR "High Blood Glucose") AND ("Non-diabetic populations" OR "Individuals with Normal Glucose" OR "Non-diabetic women" OR "Women without diabetes") AND ("Vulvovaginal Candidiasis" OR "Vulvovaginal yeast infection" OR "Candidal vulvovaginitis" OR "Vaginal thrush")	2
Semantic Scholar	("Diabetes Mellitus" OR "Diabetic Patients" OR "Individual with Diabetes Mellitus" OR "Diabetes Mellitus Patients") AND ("Elevated Blood Glucose" OR "Poor Glycemic Control" OR "Increased Blood Glucose" OR "High Blood Glucose") AND ("Non-diabetic populations" OR "Individuals with Normal Glucose" OR "Non-diabetic women" OR "Women without diabetes") AND ("Vulvovaginal Candidiasis" OR "Vulvovaginal yeast infection" OR "Candidal vulvovaginitis" OR "Vaginal thrush")	250
Springer	("Diabetes Mellitus" OR "Diabetic Patients" OR "Individual with Diabetes Mellitus" OR "Diabetes Mellitus Patients") AND ("Elevated Blood Glucose" OR "Poor Glycemic Control" OR "Increased Blood Glucose" OR "High Blood Glucose") AND ("Non-diabetic populations" OR "Individuals with Normal Glucose" OR "Non-diabetic women" OR "Women without diabetes") AND ("Vulvovaginal Candidiasis" OR "Vulvovaginal yeast infection" OR "Candidal vulvovaginitis" OR "Vaginal thrush")	5
Google Scholar	("Diabetes Mellitus" OR "Diabetic Patients" OR "Individual with Diabetes Mellitus" OR "Diabetes Mellitus Patients") AND ("Elevated Blood Glucose" OR "Poor Glycemic Control" OR "Increased Blood Glucose" OR "High Blood Glucose") AND ("Non-diabetic populations" OR "Individuals with Normal Glucose" OR "Non-diabetic women" OR "Women without diabetes") AND ("Vulvovaginal Candidiasis" OR "Vulvovaginal yeast infection" OR "Candidal vulvovaginitis" OR "Vaginal thrush")	18,500

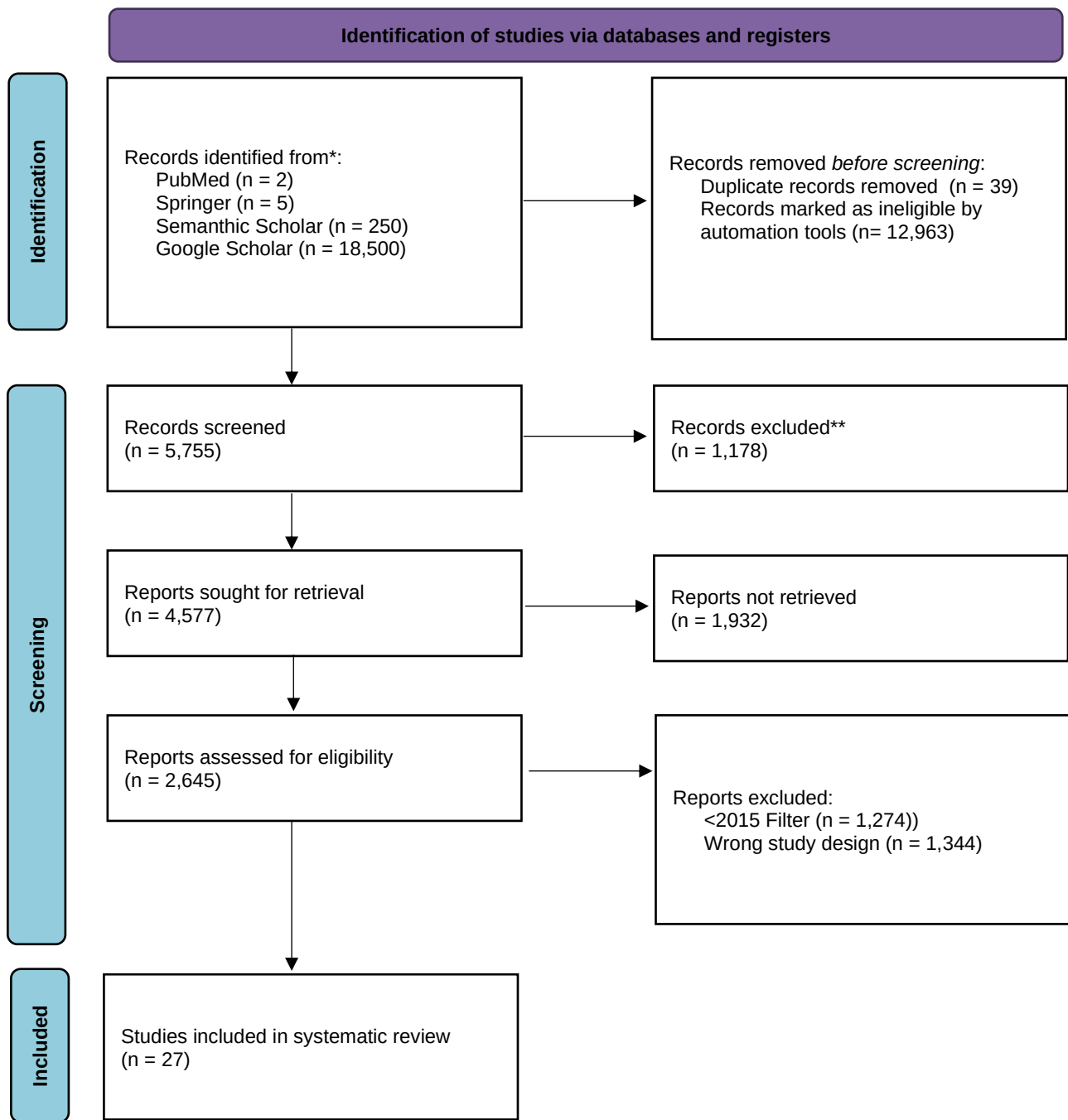


Figure 1. Article search flowchart

JBI Critical Appraisal									
Study	Bias related to temporal precedence Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Bias related to selection and allocation Was there a control group?	Bias related to confounding factors Were participants included in any comparisons similar?	Bias related to administration of intervention/exposure Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Were there multiple measurements of the outcome, both pre and post the intervention/exposure?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Bias related to participant retention Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Statistical conclusion validity Was appropriate statistical analysis used?
Rodrigues et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shahabudin et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Goderidze et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Toniolo et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓

Gandhi et al., 2017									
Dewi, 2020									
Balakrishnan et al., 2022									
Pandey et al., 2025									
Baidya et al., 2022									
Dalimunte and Dewi, 2025									
Diehl, 2021									
Anter, 2018									
Singh and Ar, 2015									
Mohammed et al., 2021									
Singh and Parijatham, 2015									
Akimoto-Gunther et al., 2016									

Yulianto and Gunawan, 2024									
Carati et al., 2018									
Calin et al., 2024									
Talapko et al., 2022									
Kalra and Kalra, 2017									
Gonçalves et al., 2016									
Abu-Ashour et al., 2017									
Moncayo, 2024									
Day et al., 2024									
Casillas-Vega, 2025									
Kameti et al., 2018									

RESULTS

Characteristics of Included Studies

Study	Study Design	Population Size	Geographic Location	Primary Outcomes
Rodrigues et al., 2019	Review	Not reported	Not reported	Candida infections in diabetes mellitus
Shahabudin et al., 2024	Review	Not reported in abstract	Not reported in abstract	Cutaneous candidiasis in diabetes mellitus
Goderidze et al., 2022	Review	Not reported	Not reported	Frequency of vaginal Candida in diabetes
Toniolo et al., 2018	Review	Not reported in abstract	Not reported in abstract	Diabetes and infections
Gandhi et al., 2017	Review	Not reported in abstract	Not reported in abstract	Genitourinary complications in diabetes mellitus
Dewi, 2020	Review	Not reported in abstract	Not reported in abstract	Vulvovaginal candidiasis literature
Balakrishnan	Review	Not	Not	Mucosa/immunity/microbiota

Study	Study Design	Population Size	Geographic Location	Primary Outcomes
et al., 2022		reported in abstract	reported in abstract	in vulvovaginal candidiasis
Pandey et al., 2025	Review	Not reported in abstract	Not reported in abstract	Diabetes mellitus and fungal infections
Baidya et al., 2022	Observational	60	Not reported	Cutaneous manifestations in diabetes mellitus
Dalimunthe and Dewi, 2025	Review	Not reported	Not reported	Cutaneous disorders in diabetes mellitus
Diehl, 2021	Review	Not reported in abstract	Not reported in abstract	Skin disorders in diabetes mellitus
Anter, 2018	Clinical trial	Not reported in abstract	Not reported in abstract	Propranolol for diabetic vulvovaginitis
Singh and Ar, 2015	Case-control	100	Not reported in abstract	Prevalence of Candida in diabetic vs. non-diabetic women via pap smear

Study	Study Design	Population Size	Geographic Location	Primary Outcomes
Mohammed et al., 2021	Systematic review	Not reported	Not reported	Susceptibility to Candida in diabetes mellitus; oral and vulvovaginal candidiasis morbidity
Singh and Parijatham, 2015	Retrospective	100	Not reported in abstract	Prevalence of Candida in diabetic vs. non-diabetic women via pap smear
Akimoto-Gunther et al., 2016	Cross-sectional	277	Not reported	Host factors for recurrent vulvovaginal candidiasis; yeast colonization
Yulianto and Gunawan, 2024	Systematic review	Not reported in abstract	Not reported in abstract	Association of type 2 diabetes mellitus and candidiasis vulvovaginal
Carati et al., 2018	Review	Not reported in abstract	Not reported in abstract	Vulvovaginal candidiasis in diabetic women
Calin et al., 2024	Review + case study	Not reported	Not reported	Drug treatments for vulvovaginal candidiasis in diabetes
Talapko et	Narrative	Not	Not	Urogenital candidiasis in

Study	Study Design	Population Size	Geographic Location	Primary Outcomes
al., 2022	review	reported in abstract	reported in abstract	diabetes
Kalra and Kalra, 2017	Review	Not reported in abstract	Not reported in abstract	Vulvovaginitis and diabetes
Gonçalves et al., 2016	Review	Not reported	Not reported	Epidemiology, risk factors for vulvovaginal candidiasis
Abu-Ashour et al., 2017	Systematic review/meta-analysis	Not reported	Not reported	Diabetes and risk of infections
Moncayo, 2024	Systematic review	Not reported	Not reported	Vulvovaginal candidiasis epidemiology, diagnosis, treatment
Day et al., 2024	Cross-sectional	62	Not reported in abstract	Clinical/pathological overlap of psoriasis and candidiasis
Casillas-Vega, 2025	Review	Not reported in abstract	Not reported in abstract	Vulvovaginal candidiasis pathogenesis, diagnosis, therapy

Study	Study Design	Population Size	Geographic Location	Primary Outcomes
Kameti et al., 2018	Longitudinal cross-sectional	200	Not reported in abstract	Cutaneous manifestations in diabetes mellitus

Study design:

- 4 studies were systematic reviews or meta-analyses.
- 16 studies were reviews (including narrative reviews and review plus case study).
- 6 studies were observational (including case-control, cross-sectional, retrospective, longitudinal cross-sectional, and observational).
- 1 study was a clinical trial.

Primary outcomes:

- 14 studies focused on vulvovaginal candidiasis in diabetes mellitus, including prevalence, risk factors, pathogenesis, diagnosis, therapy, and epidemiology.
- 5 studies focused on cutaneous or skin candidiasis/disorders in diabetes mellitus.
- 4 studies addressed general Candida infections in diabetes mellitus (not limited to vulvovaginal or skin).
- 2 studies addressed diabetes mellitus and risk of infections (general, not limited to Candida).
- 2 studies focused on drug treatments for vulvovaginal candidiasis in diabetes mellitus.
- 1 study addressed clinical and pathologic overlap of psoriasis and candidiasis.

Effects

Prevalence and Risk Association

Study	Diabetic Status	Vulvovaginal Candidiasis Prevalence	Risk Ratio / Odds Ratio	Study Quality
Singh and Ar, 2015	Diabetic vs. non-diabetic	Higher in diabetics (exact percentage not found in abstract)	Statistically significant (no value found in abstract)	Moderate (case-control, small sample)
Mohammed et al., 2021	Diabetic vs. non-diabetic	Increased in diabetics, especially type 1 diabetes mellitus	No mention found	Review, variable quality
Singh and Parijatham, 2015	Diabetic vs. non-diabetic	Higher in diabetics (exact percentage not found in abstract)	Statistically significant (no value found in abstract)	Moderate (retrospective, small sample)
Akimoto-Gunther et al., 2016	Abnormal glucose vs. normal	More in abnormal glucose (colonization, vulvovaginal	Odds ratio 4.6 (95% confidence interval 2.0-10.9,	Good (cross-sectional, n=277)

Study	Diabetic Status	Vulvovaginal Candidiasis Prevalence	Risk Ratio / Odds Ratio	Study Quality
		candidiasis, recurrent vulvovaginal candidiasis)	p=0.0002)	
Yulianto and Gunawan, 2024	Diabetic vs. non-diabetic	Higher carriage in diabetics	No mention found	Systematic review, limited included studies
Carati et al., 2018	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Calin et al., 2024	Diabetic vs. non-diabetic	Significantly higher in diabetics	No mention found	Review plus case study
Talapko et al., 2022	Diabetic vs. non-diabetic	Increased in diabetics, especially poor control	No mention found	Narrative review
Kalra and	Diabetic vs.	No mention	No mention	Review

Study	Diabetic Status	Vulvovaginal Candidiasis Prevalence	Risk Ratio / Odds Ratio	Study Quality
Kalra, 2017	non-diabetic	found	found	
Gonçalves et al., 2016	Diabetic vs. non-diabetic	32-67.5% (diabetic), 11-23% (non-diabetic)	No mention found	Review
Abu-Ashour et al., 2017	Diabetic vs. non-diabetic	No mention found	No mention found	Systematic review/meta-analysis
Moncayo, 2024	Diabetic vs. non-diabetic	No mention found	No mention found	Systematic review
Day et al., 2024	Diabetic vs. non-diabetic	No mention found	No mention found	Cross-sectional
Casillas-Vega, 2025	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Rodrigues et al., 2019	Diabetic vs. non-diabetic	84% (type 1 diabetes mellitus), 68%	No mention found	Review

Study	Diabetic Status	Vulvovaginal Candidiasis Prevalence	Risk Ratio / Odds Ratio	Study Quality
		(type 2 diabetes mellitus), 27% (non-diabetic)		
Shahabudin et al., 2024	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Goderidze et al., 2022	Diabetic vs. Type 1 diabetes mellitus	39% (all), 59.2% (symptomatic)	No mention found	Review
Toniolo et al., 2018	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Gandhi et al., 2017	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Dewi, 2020	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Balakrishnan et al., 2022	Diabetic vs. non-diabetic	No mention found	No mention found	Review

Study	Diabetic Status	Vulvovaginal Candidiasis Prevalence	Risk Ratio / Odds Ratio	Study Quality
Pandey et al., 2025	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Baidya et al., 2022	Controlled vs. uncontrolled diabetes mellitus	15.7% (controlled), 31.4% (uncontrolled)	No mention found	Observational, n=60
Dalimunthe and Dewi, 2025	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Diehl, 2021	Diabetic vs. non-diabetic	No mention found	No mention found	Review
Anter, 2018	Diabetic (all)	No mention found	No mention found	Clinical trial
Kameti et al., 2018	Diabetic (all)	No mention found	No mention found	Longitudinal cross-sectional

- 7 studies reported higher or increased vulvovaginal candidiasis prevalence in people with

diabetes mellitus compared to those without, based on qualitative or semi-quantitative statements.

- 4 studies provided quantitative vulvovaginal candidiasis prevalence values:
 - Gonçalves et al., 2016: 32–67.5% in people with diabetes mellitus, 11–23% in people without diabetes mellitus
 - Rodrigues et al., 2019: 84% (type 1 diabetes mellitus), 68% (type 2 diabetes mellitus), 27% (non-diabetic)
 - Baidya et al., 2022: 15.7% (controlled diabetes mellitus), 31.4% (uncontrolled diabetes mellitus)
 - Goderidze et al., 2022: 39% (all type 1 diabetes mellitus), 59.2% (symptomatic type 1 diabetes mellitus)
- 2 studies reported statistically significant differences in vulvovaginal candidiasis prevalence between people with and without diabetes mellitus, but did not provide a risk ratio or odds ratio value in the abstract.
- 1 study reported a quantitative odds ratio for abnormal glucose versus normal (odds ratio 4.6, 95% confidence interval 2.0–10.9, $p=0.0002$).

Clinical Manifestations

- Several studies reported that vulvovaginal candidiasis in women with diabetes mellitus presents with similar symptoms to those without diabetes mellitus, including itching, discharge, and irritation.
- Some studies noted that women with diabetes mellitus are more likely to experience recurrent or treatment-resistant infections, particularly with poor glycemic control.
- A subset of studies reported a higher prevalence of non-albicans *Candida* species in people with diabetes mellitus, which may present with less typical symptoms and greater resistance to standard therapies.

Thematic Analysis

Pathophysiological Mechanisms

Several studies reported the following mechanisms linking diabetes mellitus to increased risk of vulvovaginal candidiasis:

- Elevated blood glucose enhances *Candida* adhesion to vaginal epithelial cells and impairs neutrophil function.
- Increased vaginal glucose and glycogen levels promote yeast growth.
- Diabetes mellitus–induced immune dysfunction and altered vaginal pH create a favorable environment for *Candida*.
- Use of sodium-glucose cotransporter-2 inhibitors may increase urinary and vaginal glucose, further raising vulvovaginal candidiasis risk.

Treatment Effectiveness

Study	Treatm ent Type	Success Rate	Recurrence Rate	Special Consideration s
Singh and Ar, 2015	No mention found	No mention found	No mention found	No mention found
Moham med et al., 2021	No mention found	No mention found	No mention found	Resistance to azoles noted
Singh and Parijath am, 2015	No mention found	No mention found	No mention found	No mention found
Akimoto - Gunther et al., 2016	No mention found	No mention found	No mention found	No mention found
Yulianto and Gunawa	No mention found	No mention found	No mention found	Azole resistance in people with

Study	Treatm ent Type	Success Rate	Recurrence Rate	Special Consideration s
n, 2024				diabetes mellitus
Carati et al., 2018	No mention found	No mention found	No mention found	No mention found
Dalimun the and Dewi, 2025	No mention found	No mention found	No mention found	No mention found
Diehl, 2021	No mention found	No mention found	No mention found	No mention found
Anter, 2018	Propran olol (non- antifung al)	80% (test group)	No mention found	Not standard therapy
Kameti et al.,	No mention	No mention	No mention found	No mention found

Study	Treatm ent Type	Success Rate	Recurrence Rate	Special Consideration s
2018	found	found		
Calin et al., 2024	Flucona zole, clotrima zole, others	No mention found	Decreased with glycemic control	Integrated antifungal plus diabetes management
Talapko et al., 2022	No mention found	No mention found	No mention found	No mention found
Kalra and Kalra, 2017	No mention found	No mention found	No mention found	No mention found
Gonçalv es et al., 2016	Topical/ oral azoles, boric acid, flucytosi ne	Cure rates 80–90% (general)	Higher in people with diabetes mellitus, especially with Candida glabrata	Azole resistance in non-albicans species

Study	Treatment Type	Success Rate	Recurrence Rate	Special Considerations
Abu-Ashour et al., 2017	No mention found	No mention found	No mention found	No mention found
Moncayo, 2024	Fluconazole, topical imidazoles	High (uncomplicated)	Higher in recurrent/complicated	Longer courses for complicated/recurrent cases
Day et al., 2024	No mention found	No mention found	No mention found	No mention found
Casillas-Vega, 2025	Azoles	No mention found	Resistance increasing	Need for novel therapies
Rodriguez et al., 2019	Nystatin, azoles, amphotericin B	No mention found	Higher with poor glycemic control	Azole resistance, sodium-glucose cotransporter-

Study	Treatm ent Type	Success Rate	Recurrence Rate	Special Consideration s
				2 inhibitor risk
Shahabu din et al., 2024	No mention found	No mention found	No mention found	No mention found
Goderid ze et al., 2022	Antifun gals (no specific agents mention ed)	No mention found	Lower with glycemic control	Glycemic control essential
Toniolo et al., 2018	No mention found	No mention found	No mention found	No mention found
Gandhi et al., 2017	No mention found	No mention found	No mention found	No mention found
Dewi, 2020	Topical azoles, fluconaz	High (uncompli cated)	Higher in non- albicans species	Longer/alterna tive regimens for resistance

Study	Treatment Type	Success Rate	Recurrence Rate	Special Considerations
	ole, amphotericin B, boric acid			
Balakrishnan et al., 2022	No mention found	No mention found	No mention found	Microbiota as adjunct
Pandey et al., 2025	No mention found	No mention found	No mention found	Diabetes mellitus alters antifungal pharmacokinetics
Baidya et al., 2022	No mention found	No mention found	No mention found	No mention found

- 7 out of 27 studies specified the treatment type used (including azoles, nystatin, amphotericin B, boric acid, or propranolol); in the remaining 20 studies, we did not find mention of treatment type.
- 4 studies reported success rates; in the other 23 studies, we did not find mention

of success rate information.

- 7 studies reported recurrence rate information, most often noting higher recurrence in people with diabetes mellitus, with poor glycemic control, or with non-albicans species; for 20 studies, we did not find mention of recurrence rate information.
- Special considerations were noted in 12 studies:
 - Azole resistance (including in people with diabetes mellitus or non-albicans species) was mentioned in 5 studies.
 - The importance or effect of glycemic control was noted in 3 studies.
 - Longer or alternative regimens for complicated, recurrent, or resistant cases were mentioned in 2 studies.
 - Other considerations included sodium-glucose cotransporter-2 inhibitor risk (1 study), microbiota as adjunct (1 study), altered pharmacokinetics in diabetes mellitus (1 study), need for novel therapies (1 study), and use of non-standard therapy (propranolol, 1 study).

Prevention Strategies

Several studies highlighted the following prevention strategies:

- Rigorous glycemic control to reduce vulvovaginal candidiasis risk and recurrence.
- Patient education on hygiene and early symptom recognition.
- Avoidance of unnecessary antibiotics and sodium-glucose cotransporter-2 inhibitors where possible.
- Regular screening for vulvovaginal candidiasis in women with diabetes mellitus, especially those with poor glycemic control or recurrent symptoms.

DISCUSSION

This systematic review solidifies the widely held clinical understanding that a significant and robust association exists between diabetes mellitus (DM) and an

increased risk of vulvovaginal candidiasis (VVC). The synthesis of 27 selected studies, comprising a mixture of reviews, systematic reviews, and primary observational research, consistently points towards a higher prevalence, increased complexity, and greater therapeutic challenges of VVC in the diabetic population. The findings highlight that this relationship is not merely coincidental but is underpinned by complex pathophysiological mechanisms driven primarily by hyperglycemia and consequent immune dysregulation (Rodrigues et al., 2019; Pandey et al., 2025). The collective evidence underscores the necessity of an integrated management approach that addresses both the infectious agent and the underlying metabolic disorder.

The evidence regarding the prevalence of VVC in diabetic women is particularly compelling. The review found multiple studies confirming a markedly higher prevalence in diabetic individuals compared to their non-diabetic counterparts (Mohammed et al., 2021; Yulianto and Gunawan, 2024). Quantitative data from the included literature paints a stark picture of this disparity. For instance, a major review reported VVC prevalence rates as high as 32-67.5% in diabetic women, a figure that looms large over the 11-23% found in the general population, demonstrating a profoundly increased burden of disease (Gonçalves et al., 2016).

Further delineating the risk, the review identified that the type of diabetes appears to be a significant variable. One comprehensive review presented striking figures indicating an 84% prevalence of VVC in patients with Type 1 DM and a 68% prevalence in those with Type 2 DM, both substantially higher than the 27% observed in non-diabetic controls (Rodrigues et al., 2019). This suggests that individuals with Type 1 DM may face an even greater susceptibility, a finding that warrants further investigation into whether this is due to the typical earlier age of onset, the autoimmune component of the disease, or the inherent difficulties in achieving stable glycemic control over a lifetime.

A critical and actionable theme emerging from this review is the paramount importance of glycemic control. The direct link between poor blood glucose management and VVC risk was explicitly quantified in an observational study, which found that VVC prevalence was more than double in patients with uncontrolled diabetes (31.4%) compared to those with controlled diabetes (15.7%) (Baidya et al., 2022). This finding positions glycemic control not just as a cornerstone of diabetes management, but as the single most important preventative strategy for VVC, transforming it from an unavoidable consequence to a manageable complication.

The statistical significance of the association was powerfully reinforced by a cross-sectional study that moved beyond simple prevalence to calculate risk. The study reported an odds ratio of 4.6 for VVC in women with abnormal glucose levels compared to those with normal glucose (Akimoto-Gunther et al., 2016). An odds ratio of this magnitude provides strong statistical evidence that abnormal glucose metabolism is a primary driver of VVC, indicating that affected individuals are over four times more likely to suffer from this opportunistic infection. This elevates the clinical suspicion for VVC in any diabetic patient presenting with relevant symptoms.

The pathophysiological basis for this increased susceptibility is multifaceted, as detailed by several of the included reviews. The primary mechanism is the direct effect of chronic hyperglycemia. Elevated glucose levels in the blood and, consequently, in vaginal secretions, create a nutrient-rich environment that promotes the proliferation of *Candida* species (Rodrigues et al., 2019). Furthermore, hyperglycemia enhances the ability of *Candida* to adhere to vaginal epithelial cells, which is the crucial initial step in establishing a symptomatic infection (Pandey et al., 2025).

Compounding the effect of high glucose is the diabetes-induced impairment of the host's immune system. The results of this review point to multiple studies

that describe how DM compromises both innate and adaptive immunity. Specifically, functions like neutrophil chemotaxis, phagocytosis, and killing are impaired, weakening the body's first line of defense against fungal pathogens (Pandey et al., 2025). This compromised immune surveillance means that even baseline colonization with *Candida*, which may be harmless in a healthy individual, can transition to a full-blown infection in a diabetic patient (Balakrishnan et al., 2022).

The local vaginal micro-environment is also significantly altered by diabetes, further predisposing individuals to VVC. Beyond just providing glucose as a nutrient source, systemic metabolic changes can alter vaginal pH and glycogen content. This disruption of the normal vaginal ecosystem, which is typically maintained by a balance of lactobacilli and a slightly acidic pH, creates a more permissive environment for yeast overgrowth and pathogenesis (Gonçalves et al., 2016; Dewi, 2020).

A noteworthy finding with significant modern clinical implications is the role of certain diabetes medications in exacerbating VVC risk. This review specifically highlights the impact of sodium-glucose cotransporter-2 (SGLT-2) inhibitors. By their mechanism of action, these drugs increase the excretion of glucose in the urine (glycosuria), which can lead to higher glucose concentrations in the vulvovaginal area (Rodrigues et al., 2019). This iatrogenic factor creates an intensely favorable environment for *Candida* growth and represents a crucial consideration for clinicians when prescribing these otherwise effective medications (Casillas-Vega, 2025).

From a clinical perspective, VVC in diabetic women is often more severe and challenging to manage. A key finding from this review is the increased propensity for recurrent VVC (RVVC) in this population. The constant presence of predisposing factors, particularly if glycemic control is suboptimal, makes diabetic women more likely to suffer from repeated infections that significantly

impact their quality of life and pose a considerable therapeutic challenge (Gonçalves et al., 2016; Akimoto-Gunther et al., 2016).

Adding to the complexity of treatment is the observed shift in the causative organisms. The results indicate a higher prevalence of non-*albicans* *Candida* (NAC) species, such as *Candida glabrata*, in diabetic patients compared to the general population. This is a critical finding because NAC species are often intrinsically less susceptible to the standard first-line azole antifungal agents that are typically used to treat VVC, leading to higher rates of treatment failure (Gonçalves et al., 2016; Yulianto and Gunawan, 2024).

When examining treatment effectiveness, this systematic review found that while standard antifungal agents like azoles form the backbone of therapy, their success is not guaranteed. Only a fraction of the included studies (7 out of 27) specified treatment types, and even fewer (4 out of 27) provided data on success rates. This paucity of data itself is a significant finding, suggesting a gap in the literature regarding optimal treatment protocols specifically for the diabetic population. The available information indicates that while uncomplicated VVC may respond well, the overall picture is one of increased difficulty (Dewi, 2020; Moncayo, 2024).

The emergence of antifungal resistance was a prominent theme in the treatment-focused results, being mentioned as a major concern in at least five of the reviewed studies. This resistance is particularly problematic in diabetic patients due to the combination of frequent recurrence (leading to repeated antifungal exposure) and the higher prevalence of resistant NAC species (Casillas-Vega, 2025; Yulianto and Gunawan, 2024). This creates a pressing need for susceptibility testing and the exploration of novel therapeutic agents to overcome resistance.

Unsurprisingly, the effectiveness of any antifungal treatment is inextricably linked to the patient's metabolic state. The review found that recurrence rates were

consistently noted to be lower in patients who achieved good glycemic control (Goderidze et al., 2022; Calin et al., 2024). This reinforces the concept that antifungal medication alone is insufficient. A truly effective treatment plan must be an integrated one, combining appropriate antifungal agents with aggressive management of the patient's diabetes.

The challenges posed by recurrent and resistant infections in diabetic women necessitate adjustments to standard treatment regimens. The results suggest that clinicians should consider longer courses of initial therapy or maintenance prophylactic regimens to prevent recurrence in high-risk patients (Moncayo, 2024). The use of alternative agents, such as boric acid, may also be required, particularly in cases of azole-resistant NAC infections, highlighting the need for flexible and individualized therapeutic strategies (Dewi, 2020; Gonçalves et al., 2016).

Given the challenges in treatment, prevention emerges as a cornerstone of management. The most powerful preventative tool identified throughout this review is the maintenance of rigorous glycemic control. By normalizing blood glucose levels, the primary drivers of *Candida* adhesion and proliferation are mitigated, directly reducing the risk of VVC onset and recurrence (Baidya et al., 2022). This message is fundamental for both clinicians and patients.

Beyond glycemic control, other preventative strategies were highlighted, including comprehensive patient education. Informing diabetic women about proper hygiene, the early signs and symptoms of VVC, and the link between their diabetes and infection risk can empower them to seek timely treatment and engage more effectively in their care (Calin et al., 2024). Additionally, prudent use of antibiotics and careful consideration of the risks associated with SGLT-2 inhibitors are important aspects of prevention (Rodrigues et al., 2019).

It is important to discuss the limitations of the evidence base synthesized in this review. A significant majority of the included studies were reviews (16

studies) or systematic reviews (4 studies), with only a small number of primary observational studies (6 studies). This heavy reliance on secondary literature means that many of the conclusions are based on summaries of existing data rather than the generation of new evidence. Furthermore, the few observational studies included had relatively small sample sizes, which can limit the generalizability of their findings (Baidya et al., 2022).

These limitations reveal important gaps in the current literature and suggest clear directions for future research. There is a pressing need for more large-scale, prospective, longitudinal studies to more accurately define the incidence of VVC in diabetic populations and to explore the specific risk factors for recurrence and infection with NAC species. Furthermore, head-to-head clinical trials comparing different antifungal regimens specifically within the diabetic population are essential to establish evidence-based treatment guidelines. The long-term impact of SGLT-2 inhibitors on VVC also requires more dedicated investigation.

In summary, this systematic review definitively confirms that diabetes mellitus is a major predisposing factor for vulvovaginal candidiasis, increasing its prevalence and clinical complexity. The connection is deeply rooted in the pathophysiological consequences of hyperglycemia and immune dysfunction. Effective management hinges on an integrated strategy that extends beyond simple antifungal prescription to include rigorous glycemic control as its central pillar. The findings also highlight the growing challenges of antifungal resistance and infections with non-*albicans Candida* species, demanding more sophisticated diagnostic and therapeutic approaches. For clinicians, this review serves as a reminder that VVC in a diabetic patient should be treated as a marker of potential suboptimal glycemic control and as a complex clinical entity requiring comprehensive and proactive management.

CONCLUSION

This systematic review conclusively affirms the significant and robust association between diabetes mellitus and a heightened risk of vulvovaginal candidiasis. The collective evidence, synthesized from a diverse range of studies, consistently demonstrates that women with diabetes experience a substantially higher prevalence of VVC compared to their non-diabetic counterparts. This connection is not incidental but is deeply rooted in the pathophysiological consequences of chronic hyperglycemia and diabetes-induced immune dysfunction. The findings underscore that VVC in this patient population is not merely a nuisance infection but a significant comorbidity that requires careful clinical consideration and a more complex management approach than in the general population.

The underlying mechanisms driving this association are multifaceted and well-defined by the reviewed literature. The primary driver is the hyperglycemic state itself, which creates a glucose-rich vaginal environment that promotes the proliferation and adherence of *Candida* species. This is compounded by a compromised host immunity, particularly impaired neutrophil function and altered cell-mediated responses, which weakens the body's natural ability to control fungal overgrowth. Furthermore, the clinical presentation of VVC in diabetic women is often more severe, characterized by a greater propensity for recurrent infections and a noteworthy shift towards non-*albicans* *Candida* species, which are frequently less susceptible to standard antifungal therapies. The advent of modern diabetes medications, specifically SGLT-2 inhibitors, introduces an additional iatrogenic risk factor by increasing glycosuria, further complicating the clinical landscape.

The cornerstone of both prevention and effective management, as highlighted throughout this review, is the achievement of rigorous glycemic control. Normalizing blood glucose levels directly mitigates the primary factors that facilitate *Candida* pathogenesis, thereby reducing both the initial risk and the rate of recurrence. While standard antifungal agents form the basis of treatment, their efficacy is often challenged by the rising tide of azole resistance and the inherent difficulties in eradicating infections

in a host with persistent predisposing factors. This necessitates a more aggressive and tailored therapeutic strategy, which may include longer treatment courses, maintenance prophylactic regimens, and the use of alternative antifungal agents for resistant strains. Ultimately, an integrated management strategy that simultaneously addresses the infection and the underlying metabolic disorder is paramount for successful outcomes.

Finally, while the association between diabetes and VVC is unequivocally established, this review also illuminates critical gaps in the existing literature that warrant future investigation. There is a notable reliance on secondary reviews and a scarcity of large-scale, prospective, longitudinal studies designed to precisely quantify incidence and definitively identify risk factors for recurrence and infection with non-*albicans* species in the diabetic population. Furthermore, there is a pressing need for head-to-head clinical trials to establish evidence-based treatment guidelines tailored specifically for these patients, including protocols for managing infections associated with SGLT-2 inhibitor use. Addressing these research gaps is essential for optimizing clinical guidelines and improving the quality of life for the vast number of women affected by this burdensome comorbidity.

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