

# CUTANEOUS MANIFESTATIONS IN DIABETES MELLITUS: A SYSTEMATIC REVIEW OF PREVALENCE AND CLINICAL CORRELATES

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## ABSTRACT

### Objective

This review was undertaken to determine the frequency and clinical correlates of cutaneous lesions in individuals with diabetes mellitus (DM).

### Materials and methods

PRISMA guidelines were followed for this review. From January 2016 to July 2025, PubMed, Scopus, Web of Science, and Google Scholar were searched using relevant keywords and medical subject headings. A thorough analysis of the references from the selected research was performed to identify literature that was not included in digital repositories. After an impartial search, two reviewers assessed the records using the evaluation criteria. The selected observational studies were evaluated using a cross-sectional critical evaluation tool developed from the Newcastle-Ottawa quality assessment scale for cohort studies.

### Results

Following a rigorous search, 70 duplicates were deleted from 252 records before screening. Title and abstract screening eliminated 118 redundant studies from the remaining 182 records. Seven of 64 requested full-text papers were unavailable, leaving 57 for eligibility evaluation and 25 cross-sectional studies for the review. Fungal, bacterial, pruritus, xerosis, diabetic dermopathy, and ulcers were common cutaneous symptoms. Necrobiosis lipoidica, alopecia areata, scleredemadiabeticorum, and granuloma annulare were rare. Except for two poor-quality studies and two good-quality studies, the remaining studies were of fair quality.

### Conclusion

This investigation delineates the importance of early identification and understanding of the aetiology of cutaneous manifestations in DM. These approaches can prevent complications, reduce impairment, and enhance quality of life in afflicted individuals by enabling rapid intervention, enhancing glycaemic control, and addressing modifiable risk factors such as obesity and poor disease management.

### Keywords

*Acanthosis nigricans, Diabetes Mellitus, Infections, Pruritis, Skin manifestations*

## INTRODUCTION

Diabetes Mellitus (DM) is a global health concern that seriously impacts healthcare systems.<sup>1</sup> High glucose levels can cause non-infectious and infectious skin diseases. About one-third of DM patients have cutaneous symptoms. Additionally, antidiabetic drugs may cause dermatological problems.<sup>2</sup> DM affects 589 million people worldwide.<sup>3</sup> One-third of people get skin lesions, affecting 179 million people with DM.<sup>4</sup> Hyperglycemia leads to cell injury in the dermis, epidermis, keratinocytes, and fibroblasts, as well as secondary damage from advanced glycation end products (AGEs). AGEs cause oxidative stress by generating free

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radicals. Suppressing the nitric oxide pathway impairs cutaneous vasodilation and blood flow.<sup>5</sup>

The increased sorbitol pathway also increases oxidative stress.<sup>6</sup> AGEs bind to their receptor to stimulate activated B cells' nuclear factor kappa-light-chain-enhancer, which produces proinflammatory cytokines, worsening inflammation, epithelial damage, and skin lesions.<sup>7</sup> DM patients have a higher risk of infection and mortality. This is caused by immunological dysfunction, decreased leukocyte chemotaxis and phagocytosis, diabetic neuropathy, and decreased blood flow. Patients with poor metabolic control and high HbA1c levels were more likely to be at risk.<sup>8,9</sup> Insulin abnormalities and high blood glucose cause metabolic, vascular, neurological, and immunological dysfunctions. Metabolic damage, chronic degenerative effects of diabetes, lipid profile changes, protein glycosylation, and deposition produce DM skin symptoms. Therefore, cutaneous symptoms may be early signs of DM and vary with disease duration and blood glucose levels.<sup>10</sup>

Skin diseases affect one-third of DM patients and often present before diagnosis, helping detect the condition early. Dermatologic symptoms of DM include infectious and non-infectious disorders. Diabetic neuropathy and angiopathy may also affect the skin. Common noninfectious dermatological diseases include pruritus, necrobiosis lipoidica (NL), scleredema adutorum of Buschke, and granuloma annulare. Individuals with diabetes have an increased risk of developing bacterial and fungal skin infections. Diabetic foot syndrome and dermopathy result from neuropathy and angiopathy.<sup>2</sup> Therefore, the purpose of this review was to establish the frequency and clinical correlations of cutaneous lesions in diabetic patients.

## MATERIALS AND METHODS

This review was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).<sup>11</sup>

### Research Question

The research topic was, "What is the prevalence and clinical correlation of dermatological lesions in patients with DM?"

### Information Sources and Search Strategy

A methodical literature search was conducted across the PubMed, Scopus, Web of Science and Google Scholar, from January 2016 to July 2025, employing appropriate

combinations of pertinent keywords and medical subject headings as follows: "(Acanthosis nigricans OR fungal infections OR skin tags OR acrochordons OR diabetic dermopathy OR necrobiosis lipoidica OR scleroderma diabeticorum OR eruptive xanthomas OR granuloma annulare OR pruritus OR rubeosis faciei OR xerosis OR bullosis diabeticorum OR diabetic foot ulcers) AND (diabetes mellitus OR diabetes OR diabetic OR diabetics OR non-insulin dependent diabetes mellitus OR Type 2 diabetes mellitus OR Type 1 diabetes mellitus OR insulin dependent diabetes OR hyperglycaemia OR insulin resistance OR impaired carbohydrate metabolism OR hyperinsulinaemia)". A comprehensive examination of the references from the chosen research was conducted to identify literature absent from digital repositories. Two reviewers performed an impartial search and evaluated the records according to the evaluation criteria.

### Eligibility Criteria

The eligibility criteria were formulated using the PEO (Population, Exposure, and Outcomes) paradigm to provide a systematic and comprehensive selection process.

**Population:** Individuals aged 18 years or older with a prior diagnosis of DM over the globe.

**Exposure:** DM patients exhibiting cutaneous symptoms linked to DM

**Outcome:** Investigations demonstrating measurable outcomes, particularly prevalence rates of cutaneous symptoms related to DM.

Randomised and non-randomized controlled studies, and observational research were incorporated. Case reports, narrative reviews, animal experiments, pilot studies, and editorial reviews without peer-reviewed full-text publications were excluded. We excluded studies including individuals with confounding factors such as malignancies, thyroiditis, gestational diabetes, other types of diabetes (e.g., type 1 diabetes, secondary diabetes), and pharmacological treatments other than for DM that have an impact on the skin.

### Study Selection Process

Initially, two separate experts assessed titles and abstracts to exclude irrelevant materials. Secondly, full-text publications of potentially pertinent research were assessed based on the defined criteria. Inconsistencies among reviewers were settled through discussion or by contacting a third expert to reach consensus.

## Data Extraction Process

A structured data extraction form was utilised to systematically document critical characteristics and study results. Two specialists simultaneously extracted information regarding research design, demographics, intervention protocols, and primary outcomes. The retrieved data were verified for reliability, and discrepancies were resolved through iterative conversations.

## Risk of Bias Evaluation

The quality of the chosen observational studies was appraised utilising a critical appraisal instrument for cross-sectional research, adapted from the Newcastle-Ottawa quality assessment scale (NOS) for cohort studies.<sup>12,13</sup> A study may receive an aggregate of five stars in the Selection domain, two stars in the Comparability domain, and three stars in the Outcome domain. A study is considered of high quality when it attains 4 or 5 stars in the selection domain, 1 or 2 stars in the compatibility domain, and 2 or 3 stars in the outcome domain. Fair

quality is designated when 2 or 3 stars are attained each in the selection and outcome domains, and 1 or 2 stars in the comparability domain. A poor quality designation is assigned if 0 or 1 stars are awarded each in the selection and outcome domains, and 0 stars in the comparability domain. Two experts conducted the evaluations simultaneously, and any inconsistencies were resolved through consultation with a third expert.

## RESULTS

The systematic search yielded 252 records, from which 70 duplicates were removed prior to screening. From the remaining 182 records, title and abstract screening resulted in the exclusion of 118 redundant studies. Of the 64 papers requested for full-text review, seven were unavailable, leaving 57 research available for eligibility assessment. After excluding review articles (n = 15), and publications not focused on DM-associated cutaneous lesions (n = 17), 25 cross-sectional studies<sup>14-38</sup> were incorporated into the review (Figure 1).

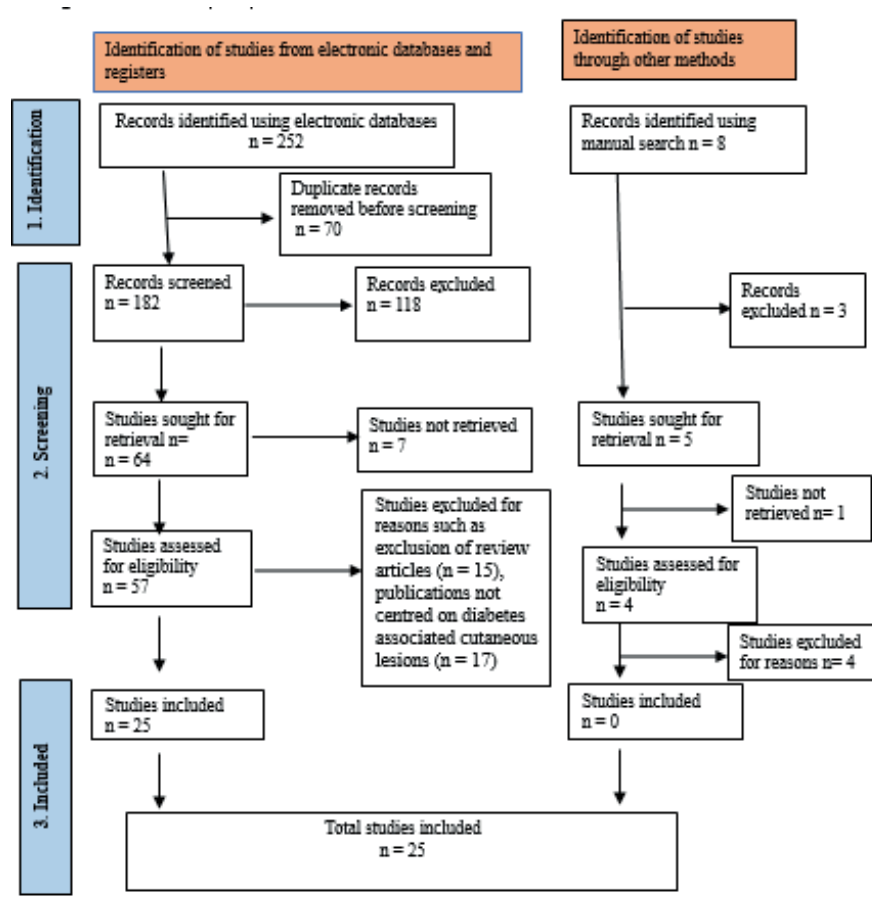


Figure 1: PRISMA (2020) flow chart of the reviewed studies

Kandaswamy et al.<sup>36</sup> found candidalintertrigo in 12.04% of DM patients, followed by tinea cruris and pedis. The frequency of fungal infections in immunocompromised situations like DM is high. Bhardwaj et al.<sup>30</sup> found mucocutaneous symptoms in 73.7% of patients. Common cutaneous signs included fungal infections (28.1%), bacterial infections (8.8%), pruritus (12.5%), xerosis (10.3%), DD (9.5%), and diabetic ulcers (6.4%). NL, alopecia areata, scleredemadiabeticorum, and GA were rare. In 1% of patients, DM therapy caused cutaneous reactions.<sup>30</sup> Durgavathi et al.<sup>17</sup> found that poor glycaemic management and long-term DM increased skin disease incidence and prevalence.<sup>17</sup> Pruritus was the most common DM skin symptom. Acanthosis nigricans (AN), skin infections, and achordons were common among diabetics (Table 1).<sup>14,16,17,20–22,24,26,35,38</sup>

In a study of North West Nigerian DM cases,<sup>25</sup> idiopathic guttate hypomelanosis was present in 61% of patients, while infections affected 30%. Other symptoms included pruritus (12%), palmoplantar hyperpigmentation (13%), and dysdyschromatosis (17%). A separate study in South-West India<sup>33</sup> linked neurovascular symptoms to metabolic manifestations of DM, although lichen planus and vitiligo were not directly associated with it. Research in Libya<sup>15</sup> identified a prevalence peak in the 44-53 years age group. This finding matches Indian studies from several places.<sup>14,16,17,28,30,34</sup> Trihan et al.<sup>27</sup> found that non-infectious DM dermatological symptoms may indicate vascular risk. The connection with vascular involvement was stronger in DD, macroangiopathy, NL, and microangiopathy in the French study population. The Chinese population<sup>31</sup> had 59.4% cutaneous symptoms. Skin infections (43.6%), atopic eczema and seborrhoeic keratosis (29.4%), and diabetes-related skin illnesses such as AN, DD, and diabetic thick skin (24.6%) dominated dermatological problems. The two predominant diagnoses were fungal skin diseases and xerosis. Male gender and increased BMI were statistically significant risk variables for skin diseases.<sup>31</sup>

Alsunousi et al.<sup>15</sup> found that female patients represented 68% of the total sample, outnumbering males. Studies in Karachi<sup>38</sup> and Romania<sup>19</sup> confirmed this trend, showing a predominance of females. Budair et al.<sup>22</sup> associated skin lesions in Iraqi DM patients with female gender and other factors, while Verma et al.<sup>29</sup> observed more fungal skin manifestations in women. Conversely,

Khuraiya et al.<sup>28</sup> and Kandaswamy et al.<sup>36</sup> noted greater susceptibility to cutaneous symptoms in men. Neha et al.<sup>37</sup> reported a higher incidence of eczema in men, but non-Candidalintertrigo, psoriasis, dermatitis, and prurigo were more prevalent in women; differences lacked statistical significance.

Kakroo et al.<sup>14</sup> found that high HbA1c levels increased PASI and lesion severity, with the highest quartile experiencing the worst outcomes. High levels of CRP, IL-6, and TNF- $\alpha$  were linked to severe skin illness, confirming the impact of chronic systemic inflammation. In a multivariate regression research, HbA1c, diabetes duration, and inflammatory markers predicted severe dermatological problems. Glycaemic management interventions throughout 24 months improved PASI scores and lesion severity indicators, demonstrating metabolic regulation's therapeutic efficacy.

Chate et al.<sup>23</sup> found that 52% of patients had DM for 5-10 years, 36% for over 10 years, and 24% for less than 5 years, indicating a relationship between illness duration and skin signs. Alsunousi et al.<sup>15</sup> reported that cutaneous manifestations appeared between 9.6 and 17 weeks, consistent with findings from Roslind et al.,<sup>26</sup> where symptoms developed 10 to 14 weeks after disease onset. Yeung et al.<sup>31</sup> noted an average DM duration of 13.5 years, with an average HbA1c of 8.0%; 32.5% of patients used insulin, and 74.9% were overweight or obese. Burman et al.<sup>16</sup> described an average DM duration of  $4.1 \pm 3$  years. Verma et al.<sup>29</sup> found a correlation between skin manifestations and HbA1c levels, particularly with skin tags, DD, and bacterial skin manifestations, though no significant link between symptoms and DM duration was observed. However, a significant association was noted between DM duration and dermatological symptoms, with 30.1% of patients with under 5 years of illness history showing skin abnormalities compared to 43.3% with over 5 years.

Niaz et al.<sup>38</sup> found glycosylated haemoglobin levels ranging from 6 to 13, higher than the findings of Alsunousi et al.<sup>15</sup> ranging from 6 to 10. Both studies reported similar fasting blood sugar levels, indicating generally poor glycaemic control. Burman et al.<sup>16</sup> noted that 81% of patients used oral hypoglycemic medication and 6% used insulin, with infections being the most frequent skin complications linked to glycosylated haemoglobin levels. Skin tags and acanthosis nigricans (AN) followed pruritus in non-infectious cases.

Poor glycaemic control correlated with bacterial and fungal infections, particularly affecting women with AN. Furthermore, 44% of the sample managed DM effectively while 56% had uncontrolled DM, with significant differences in skin symptoms and a higher incidence of cutaneous infections and diabetic foot ulcers among uncontrolled DM.<sup>23</sup> Neha et al.<sup>37</sup> observed non-Candidal intertrigo in 20% of subjects, possibly linked to increased adiposity in DM patients.

### Quality assessment of the reviewed studies

The study faced criticism for selecting participants primarily from diabetic clinics, thus raising concerns about generalizability. Key issues include the lack of sample size calculations and blinding of participants and physicians, which may introduce bias. Additionally, the use of inconsistent methodologies contributed to criticism. Overall, most studies reviewed showed fair quality, apart from two poor-quality<sup>15,19</sup> and two good-quality studies<sup>23,30</sup> (Table 2).

## DISCUSSION

The cutaneous signs of DM usually appear after the disease begins, but they may also be early markers or precede the disease by years. Type 1 and 2 DM patients have similar skin involvement rates. In type 2 DM, infection-related skin lesions are more common than autoimmune ones.<sup>2,19,39</sup> Antidiabetic medicines can also cause adverse reactions that require allergy testing.<sup>2</sup> Detecting dermatological symptoms of DM is essential for early diagnosis and efficient treatment. However, detecting early changes like xerosis, hyperkeratosis, and cutaneous infections and treating them may prevent DM's severe complications.<sup>40</sup> HbA1c monitored blood glucose levels for three months. With high HbA1c values, dermatological problems were common.<sup>41</sup> Verma et al.<sup>29</sup> found that hyperglycemia causes skin lesions in 64.64% of patients with HbA1c levels over 7.

Global investigations reveal that skin abnormalities in type 1 and type 2 DM vary by type and region, with dermatological problems reported in 51.1% to 97% of cases.<sup>42</sup> Infection is prevalent among DM patients, with fungal infections most common in specific areas like interdigital regions and skin folds,<sup>43,44</sup> while environmental and socioeconomic factors contribute to study differences.<sup>37</sup> Type 2 DM is increasingly associated with psoriasis, prompting recommendations for screening psoriasis patients for

DM.<sup>45,46</sup> Rubeosis faciei occurs in 7% of type 1 DM patients<sup>47</sup> and may indicate DM prevalence and severity of microangiopathy. All patients exhibiting GA should undergo screening for DM, and those over the age of 30 with generalised GA be examined periodically.<sup>48</sup> NL may mimic GA and is frequently linked to DM. The pathophysiology remains unclear, potentially attributable to microangiopathic alterations and hypoxia,<sup>49</sup> however an antibody-mediated vasculitis has also been proposed.<sup>50</sup> Regular DM screening is advised for those with GA and associated conditions like NL, which has a low incidence but is common in women.

Skin tag (ST) patients have high HbA1c and hyperinsulinaemia.<sup>51</sup> Diabetics have a much higher rate of ST than non-diabetics.<sup>52</sup> Similar to AN, ST patients have a high body mass index, especially if they have additional diabetogenic indications.<sup>52,53</sup> DD is connected to other diabetes issues, requiring further study.<sup>54</sup> DD is pathognomonic for DM, but iron supplements, antimalarials, and quinolones may cause DD-like lesions.<sup>54,55</sup> The upper back, shoulder, and posterior neck have less range of motion due to thicker skin. Scleroedemadiabeticorum (SD) is most common among obese diabetics with poorly controlled DM from highly selected groups like diabetes clinics.<sup>56-59</sup> Thus, the prevalence may transcend the general diabetes community. However, the findings support the idea that prolonged exposure to high blood glucose levels thickens skin collagen and causes SD. Bullosisdiabeticorum (BD) is unique to DM, indicating a clinical link. Given the small sample sizes in all the work on BD in diabetics, its prevalence may be underrecognized. A criticism of various papers is that many participants had comorbidities that may cause bullae.<sup>48</sup>

DM patients had increased vascular permeability, decreased sympathetic vascular response, and impaired heat and hypoxia stress tolerance.<sup>19,21,32</sup> Due to microvascular abnormalities and large vessel atherosclerosis, diabetic ulcers occur. DM also degrades cutaneous sensory innervation, making patients susceptible to infections and lesions.<sup>44</sup> The absence of neuroinflammatory signaling cells hinders lower extremity ulcer healing.<sup>27,38</sup> DM may also have immunoregulatory deficiencies. Hyperglycemia and ketoacidosis impair leukocyte chemotaxis, phagocytosis, and bactericidal activity. Antibiotics and improved blood glucose management have changed this. Despite these advances, DM patients are more

likely to get otitis externa, necrotising infections, and mucormycosis.<sup>27,28</sup> Most dermatological illnesses require proper treatment, but improving blood sugar levels, patient education, and lifestyle changes are key. DM patients can improve their quality of life with these essentials.<sup>40</sup> Regular skin evaluations and education of DM patients and their families about common dermatological problems, especially their infectious causes, are crucial.

## CONCLUSION

Most diabetics have at least one dermatological problem, and many have numerous. Among the most common dermatoses include fungal infections, xerosis, pruritus, skin tags, and acanthosis nigricans.

Female sex, obesity, prolonged disease duration, poor glycaemic management, and raised inflammatory markers increased skin involvement risk and severity. Additionally, particular cutaneous diseases have been linked to metabolic parameters like HbA1c, highlighting the importance of poor glycaemic control and systemic inflammation in disease progression. The data also show that tailored metabolic management strategies improve skin complaints and patient outcomes. The systematic review found that early recognition, continuous monitoring, and comprehensive management of dermatological signs in diabetes mellitus are indicators of metabolic control and predictors of systemic complications, guiding timely preventive and therapeutic strategies.

**Table 1: Summary of the salient features of the reviewed studies**

Author-year, Location; study design	Age [Mean (SD) years]	Sample size	Gender (M/F)	Duration of T2DM	Prevalence of cutaneous lesions									
					AN	NL	BD	DF	SD	GA	DD	EX	GP	Others
Kakroo et al., 2025 <sup>14</sup> North India; prospective observational study	52.4 (8.1)	N=100 T1DM: n=40 T2DM: n=60	58/42	9.3 (4.7)	38%	15%	-	-	10%	-	52%	-	-	FI: 60% BI: 42% P: 25%
Alsunousi et al., 2024 <sup>15</sup> Libya; prospective observational study	Peak of age between 44 and 53 years	N=66 T1DM: n=35 T2DM: n=31	21/45	peaks of incidence of disease duration between 9.6 and 17 years	7%	-	6%	-	15%	-	11%	-	-	FI: 27% BI: 6% XR: 17%
Burman et al., 2024 <sup>16</sup> Eastern India; prospective observational study	53 (11)	N=80	42/38	4.1 (3)	10%	1%	-	6%	-	2%	1%	1%	16%	FI: 77% BI: 25% VI: 5% ST: 12% LP: 7% P: 5%
Durgavathi et al., 2024 <sup>17</sup> South India; prospective observational study	41-50 years: 39.3%	N=200 T1DM: n=55 T2DM: n=145 CL Present: 70.5%	98/102	5.9	11%	0.7%	2%	8.5%	1.4%	0.7%	-	3.5%	37%	XR: 10% P: 6% LP: 1.5% FI: 59.5% BI: 25.5%

Author-year, Location; study design	Age [Mean (SD) years]	Sample size	Gender (M/F)	Duration of T2DM	Prevalence of cutaneous lesions										
					AN	NL	BD	DF	SD	GA	DD	EX	GP	Others	
Karra et al., 2024 <sup>18</sup> South-East India; prospective observational study	-	N=100 T1DM: n=4 T2DM: n=96	60/40	-	3%	-	-	-	-	-	1%	2%	-	9%	FI: 19% BI: 13% VI: 3% XR: 6%
Vata et al., 2023 <sup>19</sup> Romania; Retrospective Study	63.3	T1DM: n=6 T2DM: n=421 CL Present: n=103	43/60	-	4.9%	6.8%	5.8%	18.4%	-	3.9%	-	-	15.5%	XR: 42.7% P: 10.6% LP: 8.7% RF: 5.8% FI: 78.6% BI: 33.9%	
Pradhan et al, 2022 <sup>20</sup> Eastern India; Retrospective Study	42.26	Overall N=150 T1DM: n=70 T2DM: n=80	-	8.6%	2.3%	2.8%	1.4%	-	4%	2.7%	17.8%	-	41.33%	CA: 1.9% SB: 1.4%	
Mandal et al., 2023 <sup>21</sup> Eastern India; prospective observational study	48.97 (17.5)	N=103 CL Present: n=89	59/44	12.07 (7.08)	15.55%	-	-	-	-	-	7.8%	-	22.33%	FI: 41.73% BI: 18.45% LP: 3.9%	
Budair et al. 2022 <sup>22</sup> Iraq; ; prospective observational study	49.2 (14.4)	T1DM: n=72 T2DM: n=275 CL Present: n=347	153/194	9.4 (6.8)	17.9%	1.1%	-	4.6%	3.7%	0.6%	18.15%	0.3%	26.8%	XR: 19.1% RF: 6.6% P: 1.1%	
Chate et al., 2021 <sup>23</sup> Western India; Prospective observational study	63.48 (18.12)	N=100	54/46	5-10 years: 52	6%		5%	23%				2%	12%	ST: 8% BI: 21% FI: 18% VI: 3%	
Garg 2021 <sup>24</sup> North-West India; Retrospective Study	52 (10.52)	N=100 T1DM: n=1 T2DM: n=99 CL Present: n=99	55/45	-	18%	-	-	-	-	1%	7%	-	12%	ST: 33% P: 5% LP: 4% RF: 2%	



Author-year, Location; study design	Age [Mean (SD) years]	Sample size	Gender (M/F)	Duration of T2DM	Prevalence of cutaneous lesions									
					AN	NL	BD	DF	SD	GA	DD	EX	GP	Others
Sani et al., 2020 <sup>25</sup> Nigeria; Prospective observational study	55.9 (13.11)	N=100 CL Present: n=92	22/78	Less than 10 years: n=72%	1%	-	-	-	-	-	17%	1%	12%	XR: 10% PPH: 13% FI: 26% BI: 2% VI: 2% IGH: 61% DPN: 7% AD: 3% ST: 1%
Roslind et al., 2020 <sup>26</sup> South-West India; Prospective observational study	Between 50 and 59 years: 39%	N=100	47/53	Between 10 and 14 years: 39%	13%	1%	3%	-	1%	1%	16%	-	-	BI: 36% VI: 11% FI: 55% ST: 27% XR: 21%
Trihan et al., 2020 <sup>27</sup> France; Prospective observational study	66.2 (12.64)	T2DM: n=213 CL Present: n=77	M:F: 1.41	10.9 (7..31)	2.3%	2.8%	1.4%	-	-	-	17.8%	-	-	HP: 8.5% CA: 1.9% SB: 1.4%
Khuraiya et al., 2019 <sup>28</sup> Central part of India; Prospective observational study	Between 41 and 50 years: 33%	N=300 CL Present: n=189	M:F: 1.85:1	Between one and five years: 51.3%	6%	-	1.3%	3%	-	1%	5.33%	-	15.3%	P: 4.33% LP: 3.66%
Verma et al., 2019 <sup>29</sup> Central part of India; Prospective observational study	Between 51 and 80 years: 55.8%	T2DM: n=300 CL Present: n=181; 60.33%	103/78	Greater than 10 years: 58%	4.7%	-	-	-	-	-	4.7%	-	13%	BI: 18.7% FI: 14.3% VI: 5% P: 2.7% ST: 4.3%
Bhardwaj et al., 2018 <sup>30</sup> North India; Prospective observational study	Between 51 and 60 years: 30.2%	Overall N=377 T1DM: n=20 T2DM: n=357	Males: 59.1%	Between one and five years: 35.5%	4.2%	0.5%	2.7%	6.4%	0.3%	0.3%	9.5%	-	12.5%	FI: 28.1% BI: 8.8% VI: 1.3% XR: 10.3% P: 4.5% LP: 1.1%
Yeung et al., 2018 <sup>31</sup> China; Prospective observational study	62.5 (9.3)	Overall n=271 CL Present: n=161	M: 52.8%	13.5±7	0.9%	-	-	-	0.9%	-	1.4%	-	-	XR: 19% P: 2.4% IGH: 2.4% AD: 3.3%

Author-year, Location; study design	Age [Mean (SD) years]	Sample size	Gender (M/F)	Duration of T2DM	Prevalence of cutaneous lesions										
					AN	NL	BD	DF	SD	GA	DD	EX	GP	Others	
Alwaash 2017 <sup>32</sup> Iraq; Retrospective study	50.9	Overall N=1002 [T1DM: n=490 T2DM: n=512] CL Present: n=379	464/538	Less than 5 years: n=41.7%	2.4%	1.3%	0.3%	7.4%	-	-	-	-	-	-	XR: 9.5% ST: 1.1% SI: 14.8% SS: 41.2% CA: 1.6%
Asokan et al., 2017 <sup>33</sup> South-West India; Retrospective study	73.45 (6.72)	N=287	133/154	9.72 (7.78)	4.2%	0.3%	0%	0.3%	0%	0%	1.4%	-	-	RF: 0.3% BI: 1.7% FI: 39% ST: 9.1% LP: 0.7%	
Baghel et al., 2016 <sup>34</sup> North India; Prospective observational study	Between 41 and 70 years: 73.5%	N=200	119/81	-	2%	-	-	5.5%	-	-	-	-	-	FI: 24.5% BI: 15.5% VI: 7% XR: 6% P: 6%	
Deepika et al., 2016 <sup>35</sup> North-West India; Prospective observational study	54.49 (13.057)	Overall N=500 T1DM: n=25 T2DM: n=475 CL Present: n=384	311/189	one and five years: n=375	10.9%	-	0.8%	2.3%	-	-	-	-	9.4%	ST: 17.2% LP: 4.7% XR: 3.4%	
Kandaswamy et al., 2016 <sup>36</sup> South-East India; Prospective observational study	Between 40 and 49 years: 37.95%	T2DM: n=166	122/44	Less than 5 years: n=51.2%	2.4	-	1.2	8.43	-	-	-	-	-	ST: 5.42 XR: 8.43 IGH: 1.2 P: 7.83 LP: 0.6	
Neha et al., 2016 <sup>37</sup> South-West India; Prospective observational study	54 (17)	T2DM: n=151 CL Present: 85.4%	45/106	11 (4)	-	0.6%	-	1.3%	0.6%	-	11.2%	1.9%	-	P: 11.2% RF: 3.3% BI: 4.6% VI: 3.9% FI: 24.5%	
Niaz 2016 <sup>38</sup> Karachi; Prospective observational study	50 (11)	T2DM: n=203	83/120	8.5 (7)	20%	9%	2%	16%	-	0.5%	9%	1%	8%	BI: 26% RF: 1% VI: 8% FI: 22% LP: 0.5%	

T2DM: Type 2 Diabetes Mellitus; T1DM: Type 1 Diabetes Mellitus; AN: Acanthosis nigricans; NL: Necrobiosis lipoidica; BD: Bullosisdiabeticorum; DF: Diabetic foot; SD: Scleredemadiabeticorum; GA: Granuloma annulare; DD: Diabetic dermopathy; EX: Eruptive xanthomas; GP: Generalized pruritis; P: Psoriasis; LP: Lichen planus; RF: Rubeosisfaciei; XR: Xerosis; PPH: Palmoplantar hyperpigmentation; SI: Skin infections; BI: Bacterial infections; VI: Viral infections; FI: Fungal infections; IGH: Idiopathic guttatehypomelanosis; AD: Atopic dermatitis; DPN: Dermatosi papulosanigra; ST: Skin tag; SS: Shine spot; HP: Huntley's papules; CA: Cheiroarthropathy; SB: Scleredemaadulteriorum of Buschke; CL: Cutaneous lesion

**Table 2: Quality assessment of the reviewed studies using Newcastle-Ottawa Scale**

Author-Year	Selection				Comparability	Outcome		Study quality
	Representativeness of sample	Sample size	Non-respondents	Exposure ascertainment		Based on design and analysis	Outcome assessment	
Kakroo et al. <sup>14</sup>	*	-	-	**	**	**	*	Fair
Alsunousi et al. <sup>15</sup>	*	-	-	*	*	-	-	Poor
Burman et al. <sup>16</sup>	*	-	-	**	**	**	*	Fair
Durgavathi et al. <sup>17</sup>	*	-	-	*	**	**	*	Fair
Karra et al. <sup>18</sup>	*	-	-	**	*	**	-	Fair
Vata et al. <sup>19</sup>	*	-	-	-	**	**	*	Poor
Pradhan et al. <sup>20</sup>	*	-	-	*	**	**	*	Fair
Mandal et al. <sup>21</sup>	*	-	-	*	**	**	*	Fair
Budair et al. <sup>22</sup>	*	-	-	**	**	**	*	Fair
Chate et al. <sup>23</sup>	*	*	-	**	**	**	*	Good
Garg et al. <sup>24</sup>	*	-	-	*	**	**	-	Fair
Sani et al. <sup>25</sup>	*	-	-	*	**	**	*	Fair
Roslind et al. <sup>26</sup>	*	-	-	**	**	**	*	Fair
Trihan et al. <sup>27</sup>	*	-	-	**	**	**	*	Fair
Khuraiya et al. <sup>28</sup>	*	-	-	**	**	**	*	Fair
Verma et al. <sup>29</sup>	*	-	-	**	**	**	*	Fair
Bhardwaj et al. <sup>30</sup>	*	*	-	**	**	**	-	Good
Yeung et al. <sup>31</sup>	*	-	-	**	**	**	*	Fair
Alwaash et al. <sup>32</sup>	*	-	-	*	**	**	-	Fair
Asokan et al. <sup>33</sup>	*	*	-	*	**	**	*	Fair
Baghel et al. <sup>34</sup>	*	-	-	**	**	**	-	Fair
Deepika et al. <sup>35</sup>	*	-	-	*	**	**	-	Fair
Kandaswamy et al. <sup>36</sup>	*	-	-	*	**	**	-	Fair
Neha et al. <sup>37</sup>	*	-	-	**	**	**	*	Fair
Niaz et al. <sup>38</sup>	*	-	-	**	**	**	*	Fair



## REFERENCES

1. Jaacks LM, Siegel KR, Gujral UP, Narayan KM. Type 2 diabetes: A 21st century epidemic. *Best Pract Res ClinEndocrinolMetab.* 2016;30:331-43.
2. Lima AL, Illing T, Schliemann S, Elsner P. Cutaneous Manifestations of Diabetes Mellitus: A Review. *Am J ClinDermatol.* 2017;18:541-553.
3. Duncan BB, Magliano DJ, Boyko EJ. IDF diabetes atlas 11th edition 2025: global prevalence and projections for 2050. *Nephrology Dialysis Transplantation.* 2025 Aug 28;gaf177.
4. Abate MCMO, Aroucha PMT, Nóbrega DVMD, Rocha IPM, Soares SD, Reis AA, et al. Cutaneous manifestations of diabetes mellitus: a narrative review. *Einstein (Sao Paulo).* 2025;23:eRW1193.
5. Blakytyn R, Jude EB. Altered molecular mechanisms of diabetic foot ulcers. *Int J Low Extrem Wounds.* 2009;8:95-104
6. Obrosova IG. Increased sorbitol pathway activity generates oxidative stress in tissue sites for diabetic complications. *Antioxid Redox Signal.* 2005 Nov-Dec;7(11-12):1543-52.
7. Stern D, Yan SD, Yan SF, Schmidt AM. Receptor for advanced glycation endproducts: a multiligand receptor magnifying cell stress in diverse pathologic settings. *Adv Drug Deliv Rev.* 2002;54:1615-25.
8. Dryden M, Baguneid M, Eckmann C, Corman S, Stephens J, Solem C, et al. Pathophysiology and burden of infection in patients with diabetes mellitus and peripheral vascular disease: focus on skin and soft-tissue infections. *ClinMicrobiol Infect.* 2015;21:S27-32.
9. Sanches MM, Roda Â, Pimenta R, Filipe PL, Freitas JP. Cutaneous Manifestations of Diabetes Mellitus and Prediabetes. *Acta Med Port.* 2019;32:459-65.
10. Salari N, Hosseini-Far A, Hosseini-Far M, Kavoussi H, Jalali R, Vaisi-Raygani A, et al. Evaluation of skin lesions in diabetic patients: a systematic review and meta-analysis. *J Diabetes MetabDisord.* 2020;19:1909-16.
11. Page MJ, Mckenzie JE, Bossuyt PM, Boutron I, Hoffmann C, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71.
12. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality if nonrandomized studies in meta-analyses, 2012. Available from: [http://www.ohrica/programs/clinical\\_epidemiology/oxfordasp.](http://www.ohrica/programs/clinical_epidemiology/oxfordasp.)
13. Herzog R, Álvarez-Pasquín MJ, Díaz C, Del Barrio JL, Estrada JM, Gil Á. Are healthcare workers' intentions to vaccinate related to their knowledge, beliefs and attitudes? A systematic review. *BMC Public Health.* 2013;13:154.
14. Kakroo S, Khan MA, Beg MA, Kakroo B. Exploring The Relationship Between Diabetes Mellitus and Chronic Skin Disease. *Eur J Cardiovasc Med.* 2025;15:47-56.
15. Alsunousi S, Baleid A, Mansur H, Swire A, Hussin H, Abuamra M, et al. Skin manifestation of diabetes at Benghazi Diabetic centre. *Benghazi Univ Med J.* 2024;1:66-74.
16. Barman S, Achar A, Sengupta N, Chowdhury J, Bhakta A. Cutaneous Manifestations of Diabetes Mellitus in a Tertiary Care Hospital in Eastern India: A Cross-sectional Study. *J Dermatol Dermatol.* 2024;28:29-32.
17. Durgavathi C, Deepa K, Daniel SJ, Sampath V. A clinicoepidemiological study of pattern of skin disorders among diabetes mellitus in a tertiary care centre. *IP Indian J Clin Exp Dermatology.* 2024;10:51-9.
18. Karra MC, Maheswari PM, Atluri S, Samanthula H. Dermatological manifestations in diabetes mellitus and its relation with HbA1c levels – An observational study. *IP Indian J ofClinical Exp Dermatology* 2024;10:393-7.
19. Vâță D, Stanciu DE, Temelie-Olinici D, Porumb-Andrese E, Tarcău BM, Grecu VB, et al. Cutaneous Manifestations Associated with Diabetes Mellitus-A Retrospective Study. *Diseases.* 2023;11:106.
20. Pradhan K, Patro S. Evaluation of the prevalence and clinical correlation of skin lesions in patients with diabetes mellitus. *Int J Health Sci (Qassim).* 2022;6:7836-40.
21. Mandal N, Praveen P, Sen S, Banerjee S, Dey P, Mandal S. Cutaneous manifestations of diabetes mellitus: Correlation with HbA1C level — A cross-sectional observational study from a tertiary care center in Eastern India. *Ann Med Sci Res.* 2023;2:144-50.
22. Sabah AbdulridhaBudair A, Ismail Al Hamdi K, Ali Mansour A. Non-Infectious Dermatological Manifestations among Patients with Diabetes Mellitus in Basrah, Iraq. *Arch Razi Inst.* 2022;77:467-75.
23. Chate A, Swami A, Rane MS, Gosavi R. A Cross-Sectional Study to Evaluate Cutaneous Manifestations in Diabetic Patients and their Correlation with Sugar Control at Tertiary Care Center in Western Maharashtra. 2021;8:104-8.
24. Garg P, Chandra M. Cutaneous Manifestation of Diabetes mellitus. *J Adv Med Dent Sci Res.* 2021;9:100-5.
25. Sani H, Abubakar AB, Bakari AG. Prevalence and pattern of skin diseases in patients with diabetes mellitus at a tertiary hospital in Northern Nigeria. *Niger J ClinPract.* 2020;23:970-74.
26. Roslind S, Muhammed K, Kumar KGS. Cutaneous manifestations in patients with type 2 diabetes mellitus and normal controls. *J Ski Sex Transm Dis.* 2020;2:26-30.
27. Trihan JE, Lanéelle D, Metcalfe N, Martin A, Frances P. Diabetes-associated dermatological manifestations in primary care and their association with vascular complications. *J Diabetes Metab Disord.* 2020;19:989-96
28. Khuraiya S, Lal N, Naseerudin, Jain V, Kachhawa D. A cross sectional study of cutaneous manifestations in 300 patients of diabetes mellitus. *Int J Adv Med.* 2019;6:150-4.
29. Verma A, Pandya P, Sharma D. Skin Manifestations in Patients with Type-II Diabetes Mellitus. *Int J Res Rev.* 2019;6:59-65.
30. Bhardwaj N, Roy S, Jindal R, Ahmad S. Cutaneous



- manifestations of diabetes mellitus: a clinical study. *Int J Res Dermatology*. 2018;4:352–6.
31. Yeung SW, Chan PF, Ping K, Lai L, Chow KL, Tsang ML, et al. The Prevalence and the Associated Factors of Cutaneous Manifestations in Chinese Patients with Type II Diabetes Mellitus in a Primary Care Diabetes Clinic in Hong Kong. *J Diab Res Ther*. 2018;4:4–7.
  32. Alwaash SS, Al-Shibly K. Dermatological Manifestations of Diabetes Mellitus in Hilla City. *Med J Babylon*. 2017;14:495–500.
  33. Asokan N, Binesh VG. Cutaneous problems in elderly diabetics: A population-based comparative cross-sectional survey. *Indian J Dermatol Venereol Leprol*. 2017;83:205-11.
  34. Baghel NR, Awasthi S, Kumari S, Rao P, Agrawal S, Rajpoot RS. A Study of Cutaneous Manifestations Associated with Diabetes Mellitus at a Tertiary Care Teaching Hospital. *Int Arch Biomed Clin Res*. 2016;2:89–92.
  35. Deepika, Gupta SK, Singh P, Monika. Pattern of dermatological diseases in patients of diabetes mellitus. *J Pakistan Assoc Dermatologists*. 2016;26:214–8.
  36. Kandaswamy, Kanagarajan P, Suganthi K, Lokeshmaran A. Study on cutaneous manifestation among type II diabetes mellitus in rural Pondicherry, India. *Int J Community Med Public Heal*. 2016;3:948–51.
  37. Neha S, Shafeeq R. Prevalence of skin disorders in patients with Type-2 Diabetic patients attending a tertiary care Hospital in Kerala. *Indian J Clin Exp Dermatology*. 2016;2:143–5.
  38. Niaz F, Bashir F, Shams N, Shaikh Z, Ahmed I. Cutaneous manifestations of diabetes mellitus type 2: prevalence and association with glycemic control. *J Pakistan Assoc Dermatologists*. 2016;26:4–11.
  39. Hines A, Butterfield R, Boudreaux B, Bhullar P, Severson KJ, McBane RD, et al. Characteristics of ulcerated and non-ulcerated necrobiosis lipoidica. *Int J Dermatol*. 2023;62:790-6.
  40. Dourmishev L, Pozharashka J. Dermatoses Associated with Diabetes Mellitus. *J Ski Stem Cell*. 2020;6:e101180.
  41. Majeed N, Iqbal F, Iqbal Z, Mahboob A. Frequency and Association of Cutaneous Manifestations of Diabetes Mellitus with HbA1c. *Proc Shaikh Zayed Postgr Med Inst*. 2004;18:85–9.
  42. de Macedo GM, Nunes S, Barreto T. Skin disorders in diabetes mellitus: an epidemiology and physiopathology review. *DiabetolMetabSyndr*. 2016;8:63.
  43. Sanad EM, Elfangary MM, Sorour NE, Elnemisy NM. Skin manifestations in Egyptian diabetic patients: a case series study. *Egypt J Dermatology Venereol*. 2013;33:56–62.
  44. Goyal A, Raina S, Kaushal SS, Mahajan V, Sharma NL. Pattern of cutaneous manifestations in diabetes mellitus. *Indian J Dermatol*. 2010;55:39-41.
  45. Gyldenløve M, Knop FK, Vilsbøll T, Zachariae C, Skov L. Psoriasis er associeret med type 2-diabetes [Psoriasis is associated with type 2 diabetes]. *UgeskrLaeger*. 2013;175:652-4.
  46. Coto-Segura P, Eiris-Salvado N, González-Lara L, Queiro-Silva R, Martinez-Cambor P, Maldonado-Seral C, et al. Psoriasis, psoriatic arthritis and type 2 diabetes mellitus: a systematic review and meta-analysis. *Br J Dermatol*. 2013;169:783-93.
  47. Pavlović MD, Milenković T, Dinić M, Misović M, Daković D, Todorović S, Daković Z, Zecevi RD, Doder R. The prevalence of cutaneous manifestations in young patients with type 1 diabetes. *Diabetes Care*. 2007;30:1964-7.
  48. Bustan RS, Wasim D, Yderstræde KB, Bygum A. Specific skin signs as a cutaneous marker of diabetes mellitus and the prediabetic state - a systematic review. *Dan Med J*. 2017;64:A5316.
  49. Ngo B, Wigington G, Hayes K, Huerter C, Hillman B, Adler M, et al. Skin blood flow in necrobiosis lipoidicadiabeticorum. *Int J Dermatol*. 2008;47:354-8.
  50. Quimby SR, Muller SA, Schroeter AL. The cutaneous immunopathology of necrobiosis lipoidicadiabeticorum. *Arch Dermatol*. 1988;124:1364-71.
  51. Sari R, Akman A, Alpsoy E, Balci MK. The metabolic profile in patients with skin tags. *ClinExp Med*. 2010;10:193-7.
  52. Akpınar F, Dervis E. Association between acrochordons and the components of metabolic syndrome. *Eur J Dermatol*. 2012;22:106-10.
  53. Rasi A, Soltani-Arabshahi R, Shahbazi N. Skin tag as a cutaneous marker for impaired carbohydrate metabolism: a case-control study. *Int J Dermatol*. 2007;46:1155-9.
  54. Wigington G, Ngo B, Rendell M. Skin blood flow in diabetic dermopathy. *Arch Dermatol*. 2004;140:1248-50.
  55. McCash S, Emanuel PO. Defining diabetic dermopathy. *J Dermatol*. 2011;38:988-92.
  56. Sinha S, Haque M. Juvenile diabetes, its pervasiveness, and action plan for determent. *Bangladesh J Med Sci*. 2023;22(2):249-255. doi:10.3329/bjms.v22i2.64979.
  57. Afroz A, Alam K, Ali L, Karim A, Alramadan MJ, Habib SH, et al. Cost-of-illness and its determinants for type 2 diabetes mellitus in Bangladesh. *Bangladesh J Med Sci*. 2019;18(3):491-497. doi:10.3329/bjms.v18i3.41617.
  58. Ghazali FMM, Ahmad WMAW, Srivastava KC, Shrivastava D, Noor NFM, Akbar NAN, Aleng NA, Alam MK. A study of creatinine level among patients with dyslipidemia and type 2 diabetes mellitus using multilayer perceptron and multiple linear regression. *J Healthc Eng*. 2021;2021:5524356. doi:10.1155/2021/5524356.
  59. Sghaireen MG, Alduraywish AA, Srivastava KC, Shrivastava D, Patil SR, Hardeep S, Alam MK. Comparative evaluation of dental implant failure among healthy and well-controlled diabetic patients: a 3-year retrospective study. *Int J Environ Res Public Health*. 2020;17(14):5253. doi:10.3390/ijerph17145253.