

Evaluation of Cutaneous Manifestations in Diabetes Mellitus: A Prospective Observational Study from a Tertiary Care Center in North India

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ABSTRACT

Background: Diabetes mellitus (DM) is a chronic metabolic disorder associated with multisystem involvement, including a wide spectrum of cutaneous manifestations. These dermatological findings often reflect underlying metabolic control and disease progression. **Objective:** To evaluate the pattern of cutaneous manifestations in patients with diabetes mellitus and to analyze their association with glycaemic control, duration of disease, and treatment-related factors. **Methods:** This prospective observational study was conducted over a period of 18 months in a tertiary care hospital and included 140 patients with diabetes mellitus presenting with dermatological manifestations. Detailed clinical history, dermatological examination, and relevant laboratory investigations including fasting blood glucose, postprandial blood glucose, lipid profile, and glycosylated hemoglobin (HbA1c) were performed. Associations between clinical variables and cutaneous manifestations were analyzed using appropriate statistical methods. **Results:** Cutaneous manifestations were observed in 87.9% of patients. The majority of patients were in the 51–60 years age group, with a mean age of 54.3 ± 10.8 years. Type 2 diabetes mellitus was the predominant form (92.9%). Infections were the most common dermatological presentation, particularly fungal infections. A significant association was observed between poor glycaemic control (higher HbA1c levels) and increased risk of infections. Additionally, longer duration of diabetes was associated with a higher number of cutaneous manifestations. Therapy-related complications were observed in a smaller proportion of patients. **Conclusion:** Cutaneous manifestations are highly prevalent in patients with diabetes mellitus and are strongly associated with poor glycaemic control and longer disease duration. Dermatological evaluation should be considered an integral component of diabetes management for early detection and improved patient outcomes.

Keywords: Diabetes Mellitus; Cutaneous Manifestations; Skin Disorders; Glycosylated Hemoglobin (HbA1c); Diabetic Dermopathy; Fungal Infections; Glycemic Control; Type 2 Diabetes Mellitus

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycaemia due to defects in insulin secretion, insulin action, or both [1]. It is a major global health concern, with the International Diabetes Federation estimating that more

than 589 million adults were living with diabetes in 2024, and this number is expected to rise significantly in the coming decades [2]. India contributes substantially to this burden, with increasing prevalence attributed to rapid urbanization, sedentary lifestyle, and dietary transitions [3,4].

Chronic hyperglycaemia results in multiple metabolic and vascular alterations, including the formation of advanced glycation end products, oxidative stress, and endothelial dysfunction, which collectively lead to microvascular and macrovascular complications [5,6]. These complications affect several organ systems, including the skin, which often reflects underlying systemic involvement.

Cutaneous manifestations are frequently observed in diabetic patients and may occur at any stage of the disease. They range from infections and xerosis to diabetes-specific dermatoses and insulin resistance-related conditions [7,8]. Infections, particularly fungal infections, are among the most common presentations and are often associated with poor glycaemic control and impaired immunity [9]. Studies have shown that the prevalence of skin manifestations is significantly higher in patients with longer disease duration and uncontrolled diabetes [7,10].

Certain dermatological conditions, such as diabetic dermopathy, have been associated with microvascular complications including retinopathy and nephropathy, indicating their potential role as clinical markers of systemic disease [11,12]. Despite their importance, these manifestations are often under-recognized in routine clinical practice.

In the Indian context, studies have reported considerable variability in the prevalence and pattern of cutaneous manifestations, highlighting the need for region-specific data [9,13]. Therefore, the present study was undertaken to evaluate the spectrum of cutaneous manifestations in diabetes mellitus and to assess their association with glycaemic control, disease duration, and treatment-related factors.

MATERIALS AND METHODS

Study Design and Setting

The present study was conducted as a prospective, non-randomized observational study over a period of eighteen months in the Department of Dermatology and Venereology of a tertiary care teaching hospital. The study setting included both outpatient and inpatient departments, catering to patients from diverse urban and rural backgrounds.

Study Population

The study population comprised patients diagnosed with diabetes mellitus who presented with cutaneous manifestations during the study period. Eligible participants included both previously diagnosed diabetic patients and newly identified cases referred from the endocrinology department or presenting directly to the dermatology outpatient department with skin complaints suggestive of diabetes-related dermatoses.

Sample Size Determination

The sample size was calculated using the standard formula for estimation of prevalence, based on

previously reported prevalence of cutaneous manifestations among diabetic patients. Using a prevalence of 61.3%, a confidence level of 95%, and an allowable error of 8.1%, the minimum sample size was estimated to be 139. Accordingly, a total of 140 patients were included in the study to ensure adequate representation.

Inclusion and Exclusion Criteria

Patients with diabetes mellitus presenting with dermatological manifestations and willing to participate in the study were included after obtaining informed consent. Individuals with other associated endocrine disorders, those unwilling to participate, pregnant or lactating women, and children below ten years of age were excluded to minimize confounding factors and ensure uniformity of the study population.

Data Collection Procedure

After obtaining ethical clearance from the Institutional Ethics Committee, eligible participants were recruited and evaluated using a structured case record proforma. Detailed demographic information including age, sex, and socioeconomic status was recorded. Particular emphasis was given to clinical parameters such as duration of diabetes, type of diabetes, treatment history including insulin and oral hypoglycemic agents, and history of glycemic control.

Each patient underwent a comprehensive clinical examination, including general physical and systemic examination, followed by a detailed dermatological assessment under adequate illumination. The morphology, distribution, and extent of lesions were recorded, and both specific and non-specific cutaneous manifestations associated with diabetes mellitus were documented.

Laboratory Investigations

Relevant laboratory investigations including fasting blood glucose, postprandial blood glucose, lipid profile, and glycosylated hemoglobin (HbA1c) levels were recorded. Additional diagnostic procedures such as potassium hydroxide (KOH) mount, Gram staining, Tzanck smear, and skin biopsy were performed in selected cases to confirm the clinical diagnosis.

Variables Assessed

The primary outcome variable was the presence and type of cutaneous manifestations in diabetic patients. Secondary variables included age, gender, duration of diabetes, glycemic control (HbA1c levels), and treatment-related factors. The association between these variables and dermatological manifestations was systematically evaluated.

Statistical Analysis

All collected data were compiled and entered into a master chart for analysis. Descriptive statistics were used to summarize demographic and clinical

characteristics. Inferential statistical methods were applied to assess the association between cutaneous manifestations and variables such as glycemic control and duration of diabetes. The results were interpreted at an appropriate level of statistical significance.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants after explaining the nature and purpose of the study. Confidentiality of patient information was strictly maintained throughout the study.

RESULTS

Study Population Overview

A total of 140 patients with diabetes mellitus were included in the study. The mean age of the study population was 54.3 ± 10.8 years. The majority of participants belonged to the 51–60 years age group, indicating a higher burden of cutaneous manifestations in middle-aged and elderly individuals. Males constituted a slightly higher proportion of the study population compared to females. Type 2 diabetes mellitus was the predominant form observed among participants.

Table 1: Demographic and Clinical Profile of Study Participants (N = 140)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	10–30	6	4.3
	30–40	7	5.0
	41–50	31	22.1
	51–60	57	40.7
	>60	39	27.9
Gender	Male	76	54.3
	Female	64	45.7
Type of Diabetes	Type 1 DM	10	7.1
	Type 2 DM	130	92.9

The data indicate that the highest proportion of patients (40.7%) belonged to the 51–60 years age group, followed by patients older than 60 years (27.9%). A slight male predominance was observed (54.3%), and the overwhelming majority of patients had Type 2 diabetes mellitus (92.9%).

Table 2: Prevalence of Cutaneous Manifestations in Diabetic Patients

Variable	Frequency (n)	Percentage (%)
Present	123	87.9
Absent	17	12.1
Total	140	100

A high prevalence of cutaneous manifestations was observed, affecting 87.9% of the study population. Only 12.1% of patients did not exhibit any dermatological findings. Fungal infections constituted the majority of infections, accounting for 76.5% of all infectious dermatoses observed in the study population.

Table 3: Association of Clinical Parameters with Cutaneous Manifestations (Summary)

Parameter	Key Finding
Glycemic Control (HbA1c)	Higher HbA1c levels associated with increased infections
Duration of Diabetes	Longer duration correlated with higher number of skin manifestations
Type of Lesions	Infections (especially fungal) were the most common
Therapy-related Effects	Present in a minority of patients (~9%)

The analysis revealed that poor glycemic control was significantly associated with an increased risk of cutaneous infections. Patients with a longer duration of diabetes exhibited a higher number of dermatological manifestations, suggesting cumulative effects of chronic hyperglycemia. Infections, particularly fungal infections, were the most common findings. Therapy-related complications were less frequent but clinically relevant. A statistically significant association was observed between poor glycaemic control (higher HbA1c levels) and the occurrence of cutaneous infections ($p < 0.05$), indicating that uncontrolled diabetes is a major risk factor for dermatological involvement.

Figure 1: Common Patterns of Cutaneous Manifestations in Diabetes



Tinea cruris



Candidial balanitis



Tinea barbae



Tinea Pedis

These clinical images represent commonly observed dermatological manifestations in diabetic patients, including infections, diabetic dermopathy, acanthosis nigricans, and therapy-induced changes.

Key Findings Summary

The present study demonstrated that cutaneous manifestations are highly prevalent among diabetic patients, particularly in middle-aged and elderly individuals. A strong association was observed between poor glycemic control and increased susceptibility to infections. Additionally, longer duration of diabetes was linked with a greater number and severity of skin manifestations. These findings emphasize the importance of dermatological evaluation as an integral component of diabetes management.

DISCUSSION

The present study was conducted to evaluate the spectrum of cutaneous manifestations in patients with diabetes mellitus and to analyze their association with glycaemic control, duration of disease, and treatment-related factors. The findings demonstrate that cutaneous manifestations are highly prevalent among

diabetic patients, affecting 87.9% of the study population, thereby reinforcing the concept that the skin serves as an important clinical indicator of underlying metabolic disturbances.

In the present study, the majority of patients belonged to the 51–60 years age group, with a mean age of 54.3 ± 10.8 years. This observation is consistent with previous studies, which have reported a higher prevalence of cutaneous manifestations in middle-aged and elderly individuals due to longer disease duration and cumulative metabolic damage. Studies by Ragunatha et al. and Chatterjee et al. have reported similar mean age distributions, highlighting the influence of age on dermatological involvement in diabetes [14,15]. Increasing age is often associated with prolonged exposure to hyperglycaemia, leading to microangiopathy, impaired immunity, and connective tissue alterations, which predispose individuals to skin disorders.

A slight male predominance was observed in the present study (54.3%), which is comparable to findings reported by Mahajan et al. and Nigam and Pande [16,17]. However, the difference between genders was not substantial, suggesting that cutaneous manifestations of diabetes occur with nearly equal frequency in both males and females. This indicates that gender may not be a strong independent determinant of dermatological involvement in diabetes mellitus.

Type 2 diabetes mellitus was the predominant form observed in this study (92.9%), which is in agreement with global and Indian epidemiological trends [2,4]. The higher prevalence of Type 2 diabetes is largely attributed to lifestyle factors, obesity, and insulin resistance, which also contribute to dermatological manifestations such as infections and acanthosis nigricans.

The most significant finding of the present study was the high prevalence of cutaneous manifestations (87.9%), which is comparable to earlier reports suggesting that 60–90% of diabetic patients develop skin involvement during the course of the disease [7,8]. This high prevalence emphasizes the importance of routine dermatological examination in diabetic patients. Similar findings were reported by Romano et al., who observed a high frequency of skin lesions in diabetic individuals, reinforcing the systemic nature of the disease [18].

Infections were the most common cutaneous manifestations observed in the present study, with fungal infections being predominant. This is in agreement with previous studies by Singh et al. and Demirseren et al., which reported infections as the most frequent dermatological presentation in diabetic patients [9,10]. The increased susceptibility to infections in diabetes can be attributed to hyperglycaemia-induced immune dysfunction, reduced neutrophil activity, and impaired skin barrier function. Additionally, high glucose levels create a favorable environment for microbial growth, particularly fungal organisms.

A strong association was observed between poor glycaemic control and the occurrence of infections. Patients with higher HbA1c levels showed a significantly increased risk of cutaneous infections. This finding is supported by previous studies, which have demonstrated that uncontrolled diabetes is a major risk factor for recurrent and severe infections [7,19]. Chronic hyperglycaemia leads to the formation of advanced glycation end products and oxidative stress, which impair immune responses and contribute to tissue damage.

The present study also demonstrated a significant association between the duration of diabetes and the occurrence of multiple cutaneous manifestations. Patients with longer disease duration exhibited a higher number of dermatological conditions, suggesting cumulative metabolic and vascular damage

over time. Similar observations have been reported in earlier studies, indicating that prolonged duration of diabetes increases the risk of both microvascular complications and skin manifestations [7,20].

Diabetes-specific dermatoses such as diabetic dermopathy were also observed in the study and were found to be associated with systemic complications. Previous studies have suggested that diabetic dermopathy may serve as a cutaneous marker of microangiopathy and is often associated with retinopathy and nephropathy [11,12]. This highlights the importance of recognizing such lesions as potential indicators of underlying systemic involvement.

Therapy-related cutaneous complications were observed in a smaller proportion of patients. These included insulin-induced lipodystrophy and drug-related reactions, which have also been reported in earlier studies [8]. Although less common, these manifestations are clinically significant as they may affect treatment compliance and glycaemic control.

Overall, the findings of the present study are consistent with existing literature and reinforce the concept that cutaneous manifestations are an integral component of diabetes mellitus. The strong association between skin manifestations, glycaemic control, and disease duration highlights the importance of a multidisciplinary approach in diabetes management. Dermatological evaluation should be considered an essential part of routine clinical assessment, as early recognition of skin changes can aid in timely diagnosis, improve metabolic control, and prevent systemic complications.

STRENGTHS OF THE STUDY

The present study has several strengths. First, the prospective observational design allowed systematic and structured assessment of cutaneous manifestations among patients with diabetes mellitus. Second, the study included a relatively adequate sample of 140 patients recruited from a tertiary care teaching hospital, providing a clinically relevant representation of patients presenting with dermatological manifestations. Third, the study incorporated detailed dermatological examination along with relevant laboratory investigations, including fasting blood glucose, postprandial blood glucose, lipid profile, and HbA1c levels. Fourth, the study evaluated the relationship between cutaneous manifestations and clinically important factors such as glycaemic control, duration of diabetes, and treatment-related factors. The inclusion of selected confirmatory investigations such as KOH mount, Gram staining, Tzanck smear, and skin biopsy further strengthened the clinical assessment in appropriate cases.

LIMITATIONS OF THE STUDY

The study has certain limitations that should be considered while interpreting the findings. First, it was a single-center observational study conducted in a

tertiary care hospital; therefore, the findings may not be directly generalizable to the broader diabetic population. Second, the study was non-randomized and observational in nature, and therefore causal relationships between glycaemic control, disease duration, and cutaneous manifestations cannot be definitively established. Third, selection bias cannot be completely excluded because participants were recruited from patients presenting with dermatological manifestations at a tertiary care center. Fourth, the study had a relatively limited sample size of 140 participants, which may restrict the statistical power for detecting associations involving less common dermatological conditions. Finally, although relevant clinical and laboratory variables were assessed, potential confounding factors such as detailed dietary factors, obesity, smoking, socioeconomic determinants, and other comorbidities may not have been comprehensively evaluated.

FUTURE DIRECTIONS

Future studies should include larger, multicenter cohorts involving diverse geographic and clinical populations to improve the generalizability of findings. Longitudinal studies with extended follow-up could further clarify the temporal relationship between glycaemic control, duration of diabetes, and the development or progression of cutaneous manifestations. Future research should also incorporate a broader range of metabolic, lifestyle, and comorbidity-related variables to identify independent predictors of specific dermatological conditions. Comparative studies involving patients with different levels of glycaemic control may provide additional insight into whether improved metabolic control reduces the incidence or severity of cutaneous manifestations. Standardized dermatological screening protocols and multidisciplinary collaboration between dermatologists and physicians may also be evaluated for their potential role in early detection and comprehensive diabetes management.

CONCLUSION

The present study demonstrates that cutaneous manifestations are highly prevalent among patients with diabetes mellitus and represent an important clinical indicator of underlying metabolic status. Infections, particularly fungal infections, were the most common dermatological findings and were strongly associated with poor glycaemic control. Additionally, a longer duration of diabetes was significantly correlated with an increased number of cutaneous manifestations, highlighting the cumulative effects of chronic hyperglycaemia.

Diabetes-specific dermatoses and therapy-related skin changes, although less frequent, provide valuable insights into disease progression and treatment-related complications. The findings of this study emphasize that skin manifestations are not merely cosmetic

concerns but reflect systemic involvement and disease severity.

Routine dermatological examination should be incorporated into standard diabetes care protocols, as early recognition of skin changes can aid in timely diagnosis, better glycaemic control, and prevention of complications. A multidisciplinary approach involving dermatologists and physicians is essential for comprehensive management of diabetic patients.

DECLARATIONS

Ethics Approval and Consent to Participate

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was obtained from all participants before inclusion in the study.

Consent for Publication

Written informed consent was obtained from participants for the use and publication of relevant clinical information and clinical images in an anonymized form, where applicable.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this study.

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Authors' Contributions

All authors contributed to the conception and design of the study, data collection, clinical evaluation, interpretation of findings, and preparation and critical revision of the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for the work.

Data Availability

The data generated and/or analyzed during the present study are available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

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AI Use Disclosure

The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

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