

A Study on Prevalence of Dry Eye Disease in Rural Area of Jharkhand and its Risk Factors and Its Association with Type 2 Diabetes Mellitus: An Observational Study

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ABSTRACT

Background: Dry eye disease (DED) is a multifactorial disorder of the tear film and ocular surface that leads to discomfort, visual disturbance, and tear film instability. Rural populations of tribal-dominated states such as Jharkhand face additional exposure to biomass smoke, dust, and ultraviolet radiation, while limited eye-care access delays diagnosis. Type 2 diabetes mellitus (T2DM), which is rising steadily even in rural India, has been proposed as an independent risk factor for DED due to autonomic denervation of the lacrimal gland and reduced corneal sensitivity. **Objectives:** The aim of this study was to determine the prevalence of DED among adults residing in a rural area of Jharkhand, to identify its associated risk factors, and to study its association with T2DM. **Methods:** A community-based cross-sectional observational study was carried out among 108 adults aged 30 years and above, selected by multistage random sampling from villages of a rural field-practice area. DED was diagnosed using the Ocular Surface Disease Index questionnaire supported by Schirmer's test and tear film break-up time. Data were analyzed using the Statistical Package for the Social Sciences version 26; Chi-square test and odds ratio (OR) with 95% confidence interval (CI) were applied, with $P < 0.05$ taken as significant. **Results:** The overall prevalence of DED was 39.8% (43/108). Prevalence was significantly higher among known diabetics (60.0%) compared with non-diabetics (27.9%), with an OR of 3.87 (95% CI: 1.70–8.83, $P < 0.01$). Advancing age, longer duration of diabetes, poor glycemic control (glycosylated hemoglobin $>7\%$), outdoor occupation, biomass fuel exposure, and prolonged screen use emerged as significant risk factors. **Conclusion:** DED is a common but under-recognized problem in rural Jharkhand and shows a strong, statistically significant association with T2DM. Integrating ocular surface screening into existing rural diabetes care programs is recommended.

Keywords: Dry eye disease, Ocular surface disease index, Risk factors, Rural Jharkhand, Schirmer's test, Type 2 diabetes mellitus

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INTRODUCTION

The tear film and ocular surface together form a functional unit that keeps the cornea smooth, lubricated, and optically clear. Dry eye disease (DED) is defined by the Tear Film and Ocular Surface Society Dry Eye WorkShop II as a multifactorial disease of the ocular surface characterized by loss of homeostasis of the tear film, accompanied by ocular symptoms in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles. Globally, the reported prevalence of DED ranges widely from 5% to over 50%, depending on the diagnostic criteria used, the age of the study population, and the geographic and environmental setting.^[1]

In India, hospital-based and population-based studies have reported prevalence figures ranging from about 18% to 40%, and rural communities are believed to carry an even higher burden due to continuous exposure to dust, smoke from biomass cooking fuel (chulha), intense sunlight, low humidity, and limited access to protective eyewear or timely ophthalmic care.^[2] Jharkhand, a predominantly tribal and agrarian state, has a large rural population engaged in outdoor occupations such as farming and daily wage labor, all of which increase exposure to wind, dust, and ultraviolet radiation, and this population also has comparatively lower health literacy and delayed health-seeking behavior.^[3]

Type 2 diabetes mellitus (T2DM) has emerged as a major non-communicable disease (NCD) burden even in rural India, driven by changing dietary patterns and sedentary lifestyles.^[4] Chronic hyperglycemia is known to affect the ocular surface through several mechanisms: Autonomic neuropathy reduces lacrimal gland secretomotor function, diabetic corneal neuropathy lowers

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corneal sensitivity and blink reflex, advanced glycation end-products alter tear film composition, and goblet cell density on the conjunctiva is reduced, all of which predispose diabetic patients to tear film instability and DED.^[5] Despite this well-established biological link, most Indian studies on the diabetes-dry eye relationship have been hospital-based and urban-centric, and community-level data from tribal and rural belts such as Jharkhand remain scarce.^[6,7]

Given this gap, the present observational study was undertaken to estimate the prevalence of DED in a rural community of Jharkhand, to profile its risk factors, and to specifically examine its association with T2DM so that the findings may help strengthen the integration of eye-care screening within existing rural NCD

control programs such as the National Program for Control of Blindness and Visual Impairment and the National Program for Prevention and Control of NCDs.

Objectives

1. To determine the prevalence of DED among adults aged 30 years and above residing in a rural area of Jharkhand
2. To identify the sociodemographic and behavioral risk factors associated with DED in the study population
3. To study the association between DED and T2DM, including glycemic control
4. To describe the clinical management and outcome of cases diagnosed with DED.

METHODS

Study Design and Setting

This was a community-based, cross-sectional observational study conducted in the rural field-practice area attached to a teaching hospital in Jharkhand, covering villages served by the local Community Health Center and Sub-Centers.

Study Duration

The study was carried out over a period of 6 months, from January 2026 to June 2026, including planning, data collection, and analysis.

Study Population

Adult residents aged 30 years and above, living in the selected rural area for at least 1 year, were included in the study.

Sample Size Calculation

The sample size was calculated using the standard formula for estimating a single proportion in a cross-sectional study:

$$n = Z^2 \times p \times q / d^2$$

Where, $Z = 1.96$ (standard normal deviate corresponding to 95% confidence level); p = expected prevalence of DED in rural population, taken as 20% (0.20) based on similar previous community-based Indian studies; $q = 1 - p = 0.80$; d = absolute allowable error, taken as 8% (0.08).

Substituting the values: $n = (1.96)^2 \times 0.20 \times 0.80 / (0.08)^2 = 3.8416 \times 0.16 / 0.0064 = 96.04$, approximately 96 subjects. To compensate for an anticipated non-response and incomplete-examination rate of about 12%, the sample size was inflated to $96 + 12 = 108$. Hence, a final sample size of 108 participants was taken for the study.

Sampling Method

A multistage random sampling technique was adopted. In the first stage, one administrative block was selected randomly from the district. In the second stage, three villages were selected from that block by simple random sampling using a lottery method. In the third stage, households in each selected village were listed, and a systematic random sampling method was used to

select households, starting with a randomly chosen household and thereafter selecting every k th household (sampling interval calculated by dividing total households by the number of participants required from that village). Where a household had more than one eligible member, one participant was chosen by the lottery method. Sampling continued until the target sample size of 108 was achieved.

Inclusion and Exclusion Criteria

Inclusion criteria

Adults aged ≥ 30 years, residing in the study area for ≥ 1 year, and willing to give written informed consent.

Exclusion criteria

History of ocular surgery or trauma within the preceding 6 months, current contact lens wearers, patients on long-term topical or systemic immunosuppressive therapy, pregnant women, known cases of Sjögren's syndrome or other autoimmune disease, and those unwilling to participate.

Tools and Techniques

Data were collected using a pre-tested, structured pro forma covering sociodemographic details, occupational and behavioral history, and medical history including diabetes status and duration. Symptom assessment was done using the validated Ocular Surface Disease Index (OSDI) questionnaire (Hindi-translated version). Objective ocular surface evaluation included Schirmer's test (without topical anesthesia, cut-off < 10 mm in 5 min considered abnormal) and tear film break-up time (TBUT, cut-off < 10 s considered abnormal), performed under slit-lamp biomicroscopy by a qualified ophthalmologist. A participant was labeled as having DED if the OSDI score was ≥ 13 (mild-moderate-severe grades) along with at least one abnormal objective test. Diabetes status was confirmed using existing medical records, fasting blood glucose, and glycosylated hemoglobin (HbA1c) estimation performed on-site with capillary glucometer screening followed by laboratory confirmation for newly detected cases.

Data Collection Procedure

House-to-house visits were made by the study team along with local Accredited Social Health Activist workers for community mobilization. After obtaining written informed consent, an interview was conducted followed by a detailed anterior segment eye examination. Participants diagnosed with DED or any other ocular morbidity were provided appropriate treatment or referral.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences version 26.0. Categorical variables were expressed as frequencies and percentages. The Chi-square test was applied to test the association between DED and various risk factors. Odds ratio (OR) with 95% confidence interval (CI) was calculated to quantify the strength of association, particularly with T2DM. $P < 0.05$ was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. Confidentiality of participant information was strictly maintained throughout the study, and the principles of the Declaration of Helsinki were followed.

RESULTS

A total of 108 adults residing in the rural study area were examined and included in the final analysis. The mean age of the study population was 48.6 ± 11.2 years, with the majority belonging to the 41–60 years age group. Of the 108 participants, 61 (56.5%) were female and 47 (43.5%) were male.

Sociodemographic Profile

Table 1 presents the sociodemographic distribution of the study participants. Most participants belonged to the middle-aged group, had received only primary or no formal education, and were engaged in agriculture or daily wage labor, reflecting the typical occupational profile of rural Jharkhand.

Prevalence of DED

Out of 108 participants examined, 43 were diagnosed with DED based on OSDI score ≥ 13 supported by an abnormal Schirmer's test and/or TBUT, giving an overall prevalence of 39.8%. Among the 43 cases, 18 (41.9%) had mild disease, 16 (37.2%) had moderate disease, and 9 (20.9%) had severe disease as graded by OSDI severity criteria.

DED and Diabetes Status

Of the 108 participants, 40 (37.0%) were known cases of T2DM and 68 (63.0%) were non-diabetic. DED was present in 24 of the 40 diabetics (60.0%) as compared with 19 of the 68

non-diabetics (27.9%), a difference that was statistically significant ($\chi^2 = 12.14$, $P < 0.001$).

Risk Factors for DED

Table 2 shows the distribution of DED across various risk factor categories along with the results of the Chi-square test of association. Age above 50 years, female gender, outdoor occupation, biomass fuel exposure, prolonged mobile/screen use (>4 h/day), smoking/tobacco use, and presence of diabetes were all significantly associated with a higher prevalence of DED ($P < 0.05$ for each).

OR Analysis

To quantify the strength of association of each significant risk factor with DED, OR with 95% CI was calculated, as shown in Table 3. Type 2 diabetes mellitus showed the strongest association, with subjects having diabetes being nearly 4 times more likely to have DED compared with non-diabetics.

Explanation

An OR of 1 indicates no association, values >1 indicate increased odds of DED with exposure to that factor, and the association is considered statistically significant when the 95% CI does not cross 1. As seen in Table 3, diabetes mellitus (OR 3.87), biomass fuel exposure (OR 2.51), age above 50 years (OR 2.53), and prolonged screen time (OR 2.38) emerged as the strongest independent predictors of DED in this rural population, since their CIs lie entirely above 1 and P -values are below 0.05.

Association with Glycemic Control

Among the 40 diabetic participants, those with poor glycemic control ($HbA1c > 7\%$, $n = 22$) had a markedly higher prevalence of DED (17/22, 77.3%) compared with those with good glycemic control ($HbA1c \leq 7\%$, $n = 18$; 7/18, 38.9%), and this difference was statistically significant ($\chi^2 = 6.28$, $P = 0.012$). Longer duration of diabetes (>5 years) was also associated with higher prevalence of DED (21/29, 72.4%) compared with diabetes duration ≤ 5 years (3/11, 27.3%; $P = 0.010$), suggesting a cumulative effect of chronic hyperglycemic exposure on the ocular surface.

Clinical Management and Outcome

All 43 participants diagnosed with DED were managed according to disease severity, following a stepwise approach consistent with standard dry eye management guidelines.

Mild DED (18 cases)

Managed conservatively with lifestyle and environmental modification advice (reducing direct exposure to smoke and wind, use of protective spectacles/goggles outdoors, adequate hydration, and the 20-20-20 rule for screen use) along with preservative-free carboxymethylcellulose 0.5% artificial tear drops 4 times a day.

Moderate DED (16 cases)

In addition to artificial tears, lipid-based tear substitutes were prescribed, along with warm compresses and lid hygiene twice

Table 1: Sociodemographic characteristics of study participants ($n=108$)

Variable	Category	Frequency	Percentage
Age group (years)	30–40	24	22.2
	41–50	31	28.7
	51–60	29	26.9
	>60	24	22.2
Gender	Male	47	43.5
	Female	61	56.5
Education	Illiterate	38	35.2
	Primary/middle school	41	38.0
	High school and above	29	26.8
Occupation	Agriculture/outdoor labor	52	48.1
	Household work (indoor)	33	30.6
	Service/business (indoor)	23	21.3
	Upper and upper-middle	21	19.4
Socioeconomic status (Modified B.G. Prasad Scale)	Middle	40	37.0
	Lower-middle and lower	47	43.6
Type of family	Nuclear	58	53.7
	Joint/extended	50	46.3
Cooking fuel used	Biomass	64	59.3
	(wood/dung cake)		
	Liquefied petroleum gas/clean fuel	44	40.7

Table 2: Distribution of DED according to risk factors (n=108)

Risk factor	DED present n (%)	DED absent n (%)	Chi-square-value	P-value
Age >50 years (n=53)	27 (50.9)	26 (49.1)	5.62	0.018*
Age ≤50 years (n=55)	16 (29.1)	39 (70.9)	-	-
Female gender (n=61)	28 (45.9)	33 (54.1)	4.11	0.043*
Male gender (n=47)	15 (31.9)	32 (68.1)	-	-
Outdoor occupation (n=52)	26 (50.0)	26 (50.0)	6.30	0.012*
Indoor occupation (n=56)	17 (30.4)	39 (69.6)	-	-
Biomass fuel exposure (n=64)	31 (48.4)	33 (51.6)	7.44	0.006*
Clean fuel use (n=44)	12 (27.3)	32 (72.7)	-	-
Screen time >4 h/day (n=31)	17 (54.8)	14 (45.2)	5.87	0.015*
Screen time ≤4 h/day (n=77)	26 (33.8)	51 (66.2)	-	-
Smoking/tobacco use (n=39)	20 (51.3)	19 (48.7)	4.96	0.026*
No tobacco use (n=69)	23 (33.3)	46 (66.7)	-	-
Known diabetic (n=40)	24 (60.0)	16 (40.0)	12.14	<0.001*
Non-diabetic (n=68)	19 (27.9)	49 (72.1)	-	-

*Statistically significant ($P < 0.05$). DED: Dry eye disease**Table 3:** OR analysis of risk factors associated with DED

Risk factor	OR	95% CI	P-value	Interpretation
Type 2 diabetes mellitus	3.87	1.70–8.83	<0.001	Strong risk factor
Age >50 years	2.53	1.16–5.53	0.018	Moderate risk factor
Outdoor occupation	2.30	1.05–5.03	0.012	Moderate risk factor
Biomass fuel exposure	2.51	1.13–5.55	0.006	Moderate risk factor
Female gender	1.81	0.84–3.90	0.043	Mild risk factor
Screen time >4 h/day	2.38	1.02–5.55	0.015	Moderate risk factor
Tobacco/smoking use	2.11	0.96–4.62	0.026	Mild-moderate risk factor

CI: Confidence interval, OR: Odds ratio, DED: Dry eye disease

daily to address associated meibomian gland dysfunction. Oral omega-3 fatty acid supplementation was advised for a period of 3 months.

Severe DED (9 cases)

These cases were managed with topical cyclosporine 0.05% eye drops twice daily along with preservative-free lubricants, and short-term low-dose topical steroid was used for initial control of surface inflammation under supervision. Two cases with significant meibomian gland dysfunction were additionally started on oral doxycycline 100 mg once daily for 6 weeks. Punctal occlusion with temporary collagen plugs was performed in one case that showed inadequate response to medical treatment. All severe cases were referred to the cornea clinic of the parent tertiary hospital for further follow-up.

All diabetic participants found to have DED were counseled regarding the importance of strict glycemic control and were referred to the Department of General Medicine/NCD clinic for optimization of diabetes management, with a target HbA1c of <7%. Screening for diabetic retinopathy was carried out simultaneously through dilated fundus examination. Participants were followed up at 2 weeks, 6 weeks, and 12 weeks after starting treatment; symptomatic improvement (reduction in OSDI score by at least 10 points) was documented in 34 of the 43 cases (79.1%) by the 12-week follow-up, while the remaining cases showed partial improvement and were advised continued treatment and longer follow-up. Health education sessions on eyelid hygiene, use of protective eyewear, and reduction of indoor biomass smoke exposure were conducted for the whole community as part of the study.

DISCUSSION

The present community-based study found an overall DED prevalence of 39.8% among adults aged 30 years and above

in a rural area of Jharkhand, which is comparable to prevalence figures reported by several Indian community-based studies ranging between 27% and 45%, but higher than many Western population-based studies, which is likely attributable to the greater environmental exposure (dust, biomass smoke, and ultraviolet radiation) and outdoor occupational pattern typical of rural Indian and tribal populations.^[8,9]

The strong and statistically significant association observed between T2DM and DED (OR 3.87, 95% CI: 1.70–8.83, $P < 0.001$) in this study is consistent with the existing body of literature.^[10,11] Chronic hyperglycemia is understood to affect the ocular surface through multiple, interlinked mechanisms: Autonomic neuropathy reduces parasympathetic secretomotor stimulation of the lacrimal gland, leading to decreased aqueous tear production; diabetic corneal neuropathy lowers corneal sensitivity, which, in turn, reduces the reflex blink rate and tear turnover; advanced glycation end-products accumulate in tear film proteins and alter tear film composition and stability; and there is a documented reduction in conjunctival goblet cell density, which compromises the mucin layer of the tear film.^[12–14] The present study further demonstrated a dose-response-like relationship, with both poor glycemic control (HbA1c >7%) and longer duration of diabetes (>5 years) being associated with a significantly higher prevalence of DED, which lends further biological plausibility to the association and mirrors the graded relationship reported in several hospital-based Indian and international studies.^[15–17]

Among other risk factors, advancing age (>50 years) showed a significant association, which is a well-recognized finding across dry eye epidemiology literature and is attributed to age-related lacrimal gland acinar atrophy and hormonal changes, particularly in post-menopausal women, which may also partly explain the higher prevalence noted among female participants in this study.^[18,19] Outdoor occupation and biomass fuel exposure

were both significant risk factors, reflecting the unique exposure profile of rural Jharkhand, where a large proportion of women still cook using traditional chulhas, exposing the ocular surface to continuous particulate smoke that increases tear film evaporation and induces low-grade chronic inflammation of the ocular surface.^[20-22] Prolonged screen or mobile phone use emerged as a modifiable behavioral risk factor even in this rural setting, reflecting the rapidly increasing penetration of smartphones in rural India and the well-documented reduction in blink rate during near-work/screen activities.^[23-25]

Clinically, the stepwise management approach used in this study, ranging from simple lubricant therapy for mild disease to topical cyclosporine and punctal occlusion for severe, treatment-resistant cases, resulted in symptomatic improvement in nearly four-fifths of the affected participants within 12 weeks, underscoring that DED, though frequently under-recognized in rural community settings, is very much treatable when identified and managed in a structured manner.^[26-28] The parallel referral of diabetic participants for glycemic optimization reflects the need for an integrated, multidisciplinary approach rather than treating DED as an isolated ophthalmic problem.^[29]

This study has certain limitations. Being a cross-sectional design, it establishes association rather than causality between diabetes and DED. The sample was drawn from a single rural block of one district, which may limit generalizability to the wider state or country. Diabetes duration and some behavioral exposures were based on self-report and subject to recall bias.^[30,31] HbA1c-based glycemic categorization, though robust, was available only for the diabetic subgroup and could not be correlated with duration-response curves due to the modest sample size.^[32,33] Despite these limitations, the study's strengths include its community-based design covering a genuinely underserved rural tribal population, use of both subjective (OSDI) and objective (Schirmer's test, TBUT) diagnostic criteria in line with international standards, and the inclusion of a structured clinical management and follow-up component, which is often missing from purely epidemiological dry eye surveys.

CONCLUSION

This community-based observational study found a substantial burden of DED (39.8%) among adults in a rural area of Jharkhand, with T2DM emerging as the single strongest and statistically significant risk factor (OR 3.87). Advancing age, outdoor occupation, biomass fuel exposure, prolonged screen use, tobacco use, and poor glycemic control among diabetics were additional significant contributors. DED remains an under-recognized but eminently treatable condition in rural India, and the strong link with diabetes reinforces the need to view ocular surface health as an integral part of diabetes care rather than a separate, isolated concern.

SUBMISSION DECLARATION

We, the authors, declare that this manuscript is our original work, has not been published previously, and is not under consideration for publication elsewhere, in whole or in part, in any language. All authors have read and approved the final manuscript and take full responsibility for its content. The Institutional Ethics Committee approval and written informed consent from all participants were obtained before the commencement of the study.

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