e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(7); 800-807

Original Research Article

A Study on Prevalence of Meibomian Gland Dysfunction among Patients with Dry Eye Disease: An Observational Study in a Tertiary Center

Mohanta S.[1], Pattnaik B.K.[2], Panda T.K.[3]

[1]Senior Resident, Department of Ophthalmology, SCB Medical College & Hospital, Cuttack, Odisha, India

[2A]ssistant Professor, Department of Ophthalmology, PGIMER & Capital Hospital, Bhubhaneswar, Odisha, India

[3]Professor, Department of Ophthalmology, SCB Medical College & Hospital, Cuttack, Odisha, India

Received: 01-04-2026 / Revised: 15-05-2026 / Accepted: 21-06-2026

Corresponding author: Dr. Mohanta S.

Conflict of interest: Nil

Abstract

Background: Meibomian gland dysfunction (MGD) is a leading cause of evaporative dry eye disease (DED) and disruption of meibomian gland function affects both the quality and quantity of meibum secreted, which in turn affects ocular surface health through changes in tear film composition. Increased tear evaporation, hyperosmolarity, inflammation, and ocular surface damage can subsequently occur leading to ocular discomfort, visual disruption, and sensation of dry eye. This article studied the prevalence of MGD among dry eye disease.

Aim: To study the prevalence of MGD among patients diagnosed with DED and to explore correlations between MGD and various clinical parameters. Additionally, to explore the accuracy of the ocular surface disease index score (OSDI) as an extensively applied tool to assess the severity of dry eye symptoms and MGD diagnosis.

Materials and Methods: A total of 269 patients presenting with dry eye symptoms attending dry eye clinic in department of Ophthalmology in tertiary center in Odisha, over a period of 1.5yrs from September 2022 to May 2024, were included in this prospective observational study. Clinical evaluation included Schirmer's test, tear break up time (TBUT), meibography, fluorescein staining, blink rate, blink interval, lower tear meniscus height, and Marx line score. The association between MGD and its severity in relation to symptom severity defined by OSDI-score was examined. Data was analyzed using statistical programming language R (version 4.3.2). Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test. Categorical variables were analyzed using Chi-square test. A p value <0.05 was considered statistically significant.

Results: The study found a prevalence of MGD of 57.62% among participants. The mean age was 47.97 years, with a slightly higher prevalence in males (1.06:1). Correlation analysis indicated significant relationships between MGD and various parameters, including tear break up time (TBUT), Schirmer-I test, meibomian orifice characteristics, fluorescein staining, meibography grades, Schirmer's test, tear break-up time (TBUT), and Ocular Surface Disease Index (OSDI) scores.

Conclusion: This study underscores the high prevalence of MGD in patients with DED and highlights the need for routine assessment of meibomian gland function in the management of dry eye disease.

Keywords: Meibomian Gland Dysfunction; Dry Eye Disease; Meibomian Orifice; Fluorescein Staining; OSDI Score; Meibography; Marx Line Score; Tear Break Up Time.

DOI: 10.25258/ijcpr.18.7.125

Introduction

Dry eye disease is a common eye condition that, if neglected, can lead to serious complications, such as corneal perforation, necessitating corneal transplantation [1, 2] Ocular symptoms are the primary concern for patients with dry eye disease [3] and can aid in the earlier diagnosis of this potentially sight-threatening condition [1] The meibomian gland is a type of sebaceous gland with tubulo-acinar structure and holocrine function, located in the upper and lower eyelids.1 secrete meibum, it coats the outermost layer of the tear film and contributes to ocular surface lubrication. Meibum, a compound made up of polar lipids (phospholipids) and nonpolar lipids (cholesterol, wax esters, cholesterol esters). [4] (Meibomian gland dysfunction (MGD) cause functional abnormalities of the meibomian glands characterized by a reduction in meibum secretion

and/or a change in meibum composition that results in the disruption of the tear film lipid layer and an increase in the tear film evaporation rate, hyperosmolarity, inflammation, and ocular surface damage can subsequently resulting in a continuous cycle of DED and experience a spectrum of symptoms ocular burning sensation, foreign body sensation, pain, and substantially impacting both visual comfort and overall quality of life for millions of individuals. [6] It is now widely recognized as a leading cause of evaporative dry eye disease worldwide. [5,6] Asian countries tend to have higher rates of MGD compared with other regions, such as the United States and Europe. [7,8]

MGD management involves a multifaceted approach that targets gland dysfunction, symptom relief, and ocular surface protection. Clinical guidelines recommend combining self-care and medical treatments based on disease severity [2,6]. Lid hygiene, warm compress, and lid massage form the foundation of MGD management by reducing debris and improving glandular secretions [7]. Pharmacological options include topical antibiotics such as azithromycin for bacterial control and oral antibiotics such as azithromycin and doxycycline for anti-inflammatory effects [7]. Anti-inflammatory agents, including cyclosporine and corticosteroids, are used to treat severe inflammation [7]. Advanced therapies such as Intense Pulsed Light (IPL) and thermal pulsation systems effectively unblock glands and improve meibum quality [8–11]. Supportive measures, such as preservative-free artificial tears and dietary omega-3 fatty acids, further enhance gland function [2]. These evidence-based strategies emphasize the need for comprehensive MGD care and reflect the progress made in managing this common condition.

IPL therapy is a novel and effective treatment for MGD that targets key pathophysiological mechanisms such as abnormal telangiectatic vessel coagulation, reduction of pro-inflammatory mediators, melting meibum, and stimulation of meibomian gland secretion [8].

The primary treatment goal for DED associated with MGD is to restore the tear film lipid layer and decrease evaporation, thereby reducing ocular signs and symptoms. Eyelid hygiene, warm compresses and ocular lubricants are ways for patients to manage their DED associated with MGD before moving on to office-based therapies (manual expression, microblepharoexfoliation, thermal pulsation, intense pulsed light, intraductal probing).

The study was done to reveal the asymptomatic and symptomatic patients having MGD and dry eyes and to establish their association. In the Indian scenario, most of the studies are related to dry eyes but very less are related to MGD. Few have been providing data from West Bengal and Northern India but no such study has ever been done in the Eastern part of the country. Thus, the aim of this study was to find out the prevalence of MGD among DED patients in the region of eastern India.

According to the DEWS, the OSDI questionnaire has been a valuable tool in numerous clinical studies on dry eye syndrome [9]. The questionnaire consists of 12 items that evaluate three subscales of dry eye, consisting of experiencing symptoms of ocular irritation in the eyes, change in functional quality of vision, and environmental factors related to dry eye [10].

In this questionnaire, each question can be answered in a five-point Likert scale from a maximum (grade 4) to a minimum (grade 0) [6, 14, 46]. The five grades are “all of the time (4),” ‘‘most of the time (3),” “half of the time (2),” “some of the time (1),” and “none of the time (0),” referring to experiences during the previous week. The OSDI questionnaire consists of four sections, i.e., the instructions, items, categorical responses, and grading calculation [24]. The total score for all items therefore ranges from 0 to 48 [47], which is then standardized to 100 [7, 47], where 100 reflects the highest disability, using the following equation: Overall OSDI grade = (sum of scores of questions) × 100 / (number of questions answered by the patient) × 4 [46]. The final OSDI score thus ranges from 0–100 (0–12 points reflect having a normal ocular surface, 13–22 points reflect mild dry eye disease, 23–32 points reflect moderate dry eye disease, and 33–100 points reflect severe dry eye disease)

Objective: To do an observational study on prevalence of Meibomian Gland Dysfunction among patients with Dry Eye Disease

Materials and Methods

This observational study was conducted in the Department of Ophthalmology of a tertiary center of Odisha from September 2022 to May 2024. The study aimed to assess the prevalence Meibomian gland dysfunction among patients with dry eye disease.

Patients presenting with subjective dry eye related symptoms were included in the study, and their demographic information such as age and gender, along with details of any associated conditions, were meticulously recorded. Informed consent was obtained from all participants. A total of 269 patients were randomly selected who were attended the OPD, and only the right eyes of these patients were included in the analysis. In cases where the right eye did not fulfill the inclusion criteria, the left eye of the patient was considered.

Inclusion Criteria:

1. Patients with age between 18-70 years

2. Patients having subjective symptoms of dry eye like ocular discomfort, itching, foreign body sensation, photophobia, pain.

Exclusion Criteria:

1. Acute ocular infections like keratoconjunctivitis or Inflammatory ocular surface disorders unrelated to MGD
2. H/O ocular surgery, alteration of lacrimal drainage system
3. Patients already on treatment for dry eye or MGD
4. Patients on topical medications that can cause ocular surface disorder

In this study, we defined the prevalence of MGD as the proportion of patients with MGD of the total number of patients in the study group, in the group as a whole or in age- and sex-stratified groups and in each symptom-category.

A comprehensive ophthalmic examination including assessment of subjective symptoms using Ocular Surface Disease Index (OSDI) questionnaire, and objective clinical signs/measurements including tear break-up time (TBUT), ocular surface staining (OSS), Schirmer-I test , and meibomian gland function evaluation were performed. [5,6]

For assessing dry eye-related symptoms, we applied the OSDI-score, which ranges from 0 to 100, where 100 reflects highest disability, using the following equation: Overall OSDI grade = (sum of scores of questions) × 100 / (number of questions answered by the patient) × 4. The final OSDI score thus ranges from 0–100 (0–12 points reflect having a normal ocular surface, 13–22 points reflect mild dry eye disease, 23–32 points reflect moderate dry eye disease, and 33–100 points reflect severe dry eye disease. The last three categories constituted the symptomatic group that is all patients with OSDI ≥ 13. [12]

After best corrected visual acuity (BCVA) assessment, the fluorescein tear film break-up time (TBUT) was determined after the application of dye into the tear film by a fluorescein strip moistened with physiological saline. The patient was instructed to blink a few times and then to keep the eyes open. The precorneal tear film was observed at 10-fold magnification using a slit lamp with cobalt blue illumination. By a stopwatch, the time until the break-up of the tear film was measured with values ≤ 10 s defined as unstable tear film. [5] The Schirmer test was carried out without prior application of a local anesthetic, strips were bent at the notch and hooked over the lateral lower lid margin for 5 min, with the patient instructed to keep the eyes closed gently. The wetting length of the filter paper strip was read from the calibrated scale, in millimeters and documented.5 The staining of interpalpebral cornea and conjunctiva with fluorescein constituted ocular surface staining (OSS) was used to evaluate ocular surface damage, which was graded according to the Oxford grading scheme, ranging on a scale from 0 to 1532,37. The presence of telangiectasia, erythema and irregularity of the lid margins, a shifting of the openings of the meibomian glands, together with changes in the expressibility and quality of the meibum, for example waxy secretion or no secretion at all, or plugging of the orifices, was counted as signs of MGD. [7]

Meibomian gland orifices were evaluated under a slit-lamp microscope. The orifice morphology is classified as normal, capping, retroplacement, obliteration narrowing, pouting, and opaque orifices. The meibomian orifices may exhibit elevations above the surface level of the lid, referred to as plugging or pouting, which are due to obstruction of the terminal ducts and extrusion of a mixture of meibomian lipid and keratinized cell debris. This is a pathognomonic clinical sign of MGD. Hykin PG, Bron AJ. Age-related morphological changes in lid margin and meibomian gland anatomy. Cornea. 1992;11:334–342

A detailed assessment of the ophthalmological condition carried out under the following headings.

1. Vision- Best corrected visual acuity (BCVA)
2. Slit lamp bio microscopy including inspection of meibomian orifices in lid margin. (Normal, capping, retroplacement, obliteration narrowing, pouting, and opaque orifices).
3. Schirmer's test (ST)
4. Tear Break up time (TBUT) Test
5. Fluorescein staining of ocular surface.
6. Measurement of blink rate and blink interval
7. Measurement of lower tear meniscus height
8. Meibography
9. Marx Line Score (ML Score)

Statistical Analysis: The continuous data were expressed as mean ± SD and the categorical data expressed as proportions. The difference between the groups for continuous data was analyzed by Student's t-test or Mann-Whitney U test based on the normality of the data. Normality was assessed by Shapiro-Wilk test. The difference in the categorical data between the two groups was analyzed by Fisher's exact test. Data was analyzed using statistical programming language R (version 4.3.2). The continuous data was expressed as mean and SD and categorical data was expressed as frequency. Pearson correlation test was performed as the data was normally distributed.

All the data was combined, and statistical analysis

had done. P value less than 0.05 had considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Committee, SCB Medical College and Hospital, Cuttack. Written informed consent was obtained from all participants before enrolment. The study adhered to the principles outlined in the Declaration of Helsinki

Results

Demographics: In this study encompassing 269 adult patients with dry eye disease, Signs of meibomian gland dysfunction were found in 155 patients (57.6%). The average mean age was found to be 47.97 years, with a sex ratio indicating a slightly higher proportion of males to females, yielding a ratio of 1.06 males per female with dry eye disease. Furthermore, 122 patients (45.35%) resided in urban or semi-urban areas, while the remaining patients were from rural areas.

Age distribution: Out of 269 patients in this study, 46 (17%) patients were in the age group of 17 – 30 years, 55 (20.40%) patients between 31 – 40 years, 109 (40.52%) patients between 41-50 years of age group and 59 (21%) patients were between 51-70 years of age group.

Table 1: Demographic Distribution of Study Participants (n = 269)

Age (years)	Female	Male	Total
17-30	16	30	46
31-40	29	26	55
41-50	56	53	109
51-70	30	29	59
Total	131	138	269

A total of 269 participants were included in the study. The majority belonged to the 41–50 years age group (40.52%), regarding gender distribution, showing a nearly equal distribution with slight male predominance.

Visual Acuity Distribution:

Table 2: Distribution of Visual Acuity among Study Participants

Visual Acuity	Frequency (n)	Percentage (%)
6/6 – 6/9	119	44.23%
6/12 – 6/36	104	38.66%
≥ 6/60	46	17.10%
Total	**269**	**100%**

Overall, more than half of the participants (55.76%) had some degree of visual impairment (<6/9), indicating a significant burden of reduced visual acuity within the study population.

Table 3: Distribution of Schirmer's Test and TBUT (n = 269)

Parameters	Category	Frequency	Percentage (%)
Schirmer's Test	Normal(>10mm)	222	82.52
	Mild-Moderate(6-10)	35	13.00
	Severe (<5mm)	12	4.46
TBUT	>10 sec	128	47.58
	6-10 sec	119	44.23
	2-5 sec	15	5.57
	< 2 sec	8	2.97

The majority of subjects demonstrated normal Schirmer's test values (82.52%) which is widely used test for clinical assessment of tear production, while 17.46% showed varying degrees of aqueous deficiency.

In contrast, to Schirmer's test TBUT assessment revealed that 52.77% of participants had tear film instability (≤10 seconds), indicating a higher prevalence of evaporative component compared to aqueous deficiency in the study population.

Meibomian Orifice Characteristics: Table-4 exhibited diverse characteristics of Meibomian orifices across participants, crucial for maintaining tear film stability. The majority (42.4%) were classified as normal, indicating unobstructed glandular function. Other observed characteristics included capping (22.3%), retroplacement (10.0%), obliteration narrowing (6.7%), pouting (12.6%), and opaque orifices (5.9%).

Table 4: Meibomian orifices Characteristics among study population

Meibomian Orifice	Frequency (n = 269)	Percentage (%)
Normal	114	42.4
Capping	60	22.3
Pouting	34	12.6
Retro placement	27	10.0
Obliteration narrowing	18	6.7
Opaque orifices	16	5.9

The high prevalence of abnormal meibomian orifice findings suggests a significant burden of meibomian gland dysfunction (MGD) in the study population.

Ocular Surface Staining: Table-5, showed 19.7% proportion exhibited no staining, indicative of intact corneal epithelium. Mild staining was observed in 31.2% of participants, suggesting minor epithelial defects or irregularities.

Moderate staining was present in 22.7% of participants, indicating more significant epithelial disruption. Severe staining was observed in 26.4% of participants, signifying extensive epithelial damage or dysfunction.

Table 5:

Fluorescein Staining	Frequency (n=269)	Percentage (%)
Grade 0 (None)	53	19.7
Grade 1 (Mild staining)	84	31.2
Grade 2 (Moderate staining)	61	22.7
Grade 3(severe Staining)	71	26.4

Meibography Findings: Meibography demonstrated by Infrared meibography shown varying degrees of gland dropout and atrophy. As shown in Table 6, Grade 1 was the most frequently encountered grade (30.9%).

Table 6:

Meibography grade Gland loss	Frequency(n=269)	Percentage (%)
Grade 0, No loss	44	16.4
Grade 1, 1-25%	83	30.9%
Grade 2, 26-50%	45	16.7%
Grade 3, 51-75%	53	19.7%
Grade 4, >75%	44	16.4%

Symptom Severity (OSDI Score): Table -7 showed, symptoms related to ocular surface disease assessed using the Ocular Surface Disease Index (OSDI) score, with a mean score of 51.35 and a standard deviation of 12.97. A notable proportion (23.04%) reported no symptoms (OSDI score <12), indicating overall ocular comfort and well-being. Mild symptoms (OSDI score 13-22) were reported by 41.26% of participants, suggesting minor discomfort or irritation. Moderate symptoms (OSDI score 23- 32) were reported by 23.04% of participants, indicating more pronounced ocular discomfort and functional impairment.

Severe symptoms (OSDI score 33-100) were reported by 12.63% of participants, signifying significant ocular discomfort and functional limitation.

Table 7: OSDI Score

OSDI Score	Frequency (n=269)	Percentage (%)
Normal (<12)	62	23.04%
Mild (13-22)	111	41.26%
Moderate (23-32)	62	23.04%
Severe (33-100)	34	12.63%

Correlation test: We have used Pearson correlation test to compute the relationship between MGD and other parameters. (Table-8)

Table 8: Correlation parameters with MGD

Parameter	Correlation (R)	p-value	Intercept	Significance
Meibomian Orifices	-0.45	0.002	0.12	Significant
Fluorescein Staining	0.62	0.001	0.08	Significant
Meibography grade	-0.37	0.004	0.15	Significant
Schirmer's Test (mm)	-0.28	0.022	0.18	Significant
TBUT (seconds)	-0.34	0.011	0.20	Significant
Blink Rate (blinks/min)	0.15	0.247	0.05	Not Significant
Blink Interval (seconds)	-0.18	0.189	0.22	Not Significant
Symptoms (OSDI Score)	0.51	0.001	0.11	Significant
Lower Tear Meniscus Height	-0.26	0.058	0.24	Not Significant

Interpretation: There is a weak negative correlation between MGD and lower tear meniscus height, indicating that as MGD severity increases, the height of the tear meniscus tends to decrease. These correlation results provide insights into the relationships between various clinical parameters and the presence of Meibomian Gland Dysfunction among the patients with dry eye syndrome.

Prevalence of meibomian gland dysfunction = (Number of patients with obstructed or partially obstructed meibomian orifices) / Total number of patients × 100

Prevalence = (60+27+18+34+16) / 269 × 100 = 57.62 %. MGD was observed in 57.6% of dry eye patients in our study

Table 9: Consolidated datas of various clinical parameters of MGD among Dry eye Disease

Parameter	Mean	Std. Deviation
Schirmer's Test (mm)	14.32	4.04
TBUT (seconds)	9.72	2.42
Blink Rate (blinks/min)	15.57	2.31
Blink Interval (seconds)	5.12	1.08
Symptoms (OSDI Score)	51.35	12.97
Lower tear meniscus height	0.29	0.11

Discussion

Dry eye may be divided into two major pathogenetic categories. Either caused by a lack of tears or by excessive evaporation. Meibomian gland dysfunction (MGD) is recognized as a leading cause of evaporative dry eye, contributing significantly to the multifactorial etiology of this prevalent ocular condition [13,14]. Very often, a hyposecretory, obstructive condition of the meibomian glands can be observed. This is thought to be due to an increased keratinization of the terminal ducts, the presence of squamous debris and a more viscous meibomian lipid. Our study aimed to investigate the prevalence of MGD among patients diagnosed with dry eye syndrome, as well as to explore the correlation between MGD and various clinical parameters associated with dry eye. MGD was observed in 57.6% of dry eye patients in our study, highlighting its substantial burden. This aligns with previous research, including Amano et al. (47.5%) and Lemp et al. (79 of 224 patients). [15]

In our study mean age of the MGD subjects was found 47.97 years similar to the Chatterjee et al [19] Mehta et.al also found the mean age 53.54yrs. We found the prevalence of MGD is slightly more in male similar to the Central India study [19], in Indonesia study 23and Singapore study [20]. However, In Basak et al West Bengal study [22] and Korean study [21] dry eye diseases were significantly higher in females than in males. Also we found 142 (52.7%) patients had TBUT <10s compared to Mehta et al study which showed 88.82% eyes had TBUT <10s. Among 269 patients, 257 patients showed Schirmer's >10mm, suggesting these eyes have evaporative dry eyes with normal aqueous production similar to that of Norwegian Dry Eye Clinic Study in 2019 24 which showed no significant difference in value of Schirmer's test in different grades of MGD.

Our correlation analysis revealed significant associations between clinical parameters and MGD, offering insights into its manifestations in dry eye. Meibomian gland orifice status showed a moderate negative correlation with MGD severity, with more obstructed orifices linked to greater dysfunction. This highlights the importance of assessing gland morphology and function to guide disease stratification and treatment. Similar associations were reported by Wu et al. in dry eye patients.

Our study found positive correlations between meibography grade, Marx line score, and MGD, indicating that greater gland dropout and eyelid margin abnormalities are associated with higher MGD prevalence. These findings support the clinical importance of meibography as a

noninvasive tool for assessing gland morphology, disease severity, and guiding management. [17] Although methodological approaches, diagnostic criteria, and patient demographics vary across studies, the prevalence rate observed in our study (57.62%) falls within the range reported in the literature. This consistency strengthens the evidence that meibomian gland dysfunction represents a fundamental and universally relevant component of dry eye disease. [16,17]

Our findings align with those of Mehta et al. [18], who reported a high prevalence of MGD (97.4%) and dry eye (88.82%) in rural Gujarat, with over half of participants asymptomatic. Increasing age was associated with greater disease severity, and MGD severity correlated with dry eye severity (TBUT ≤5 seconds). These results highlight the need for early detection and management. [18]

Early detection and targeted management of MGD can slow disease progression, relieve symptoms, and enhance ocular surface health.

Conclusion

In conclusion, our study highlights the prevalence and clinical relevance of MGD in patients with dry eye disease. Meibomian glands are essential for tear film stability, and their dysfunction contributes to tear film instability and ocular surface inflammation. Assessing gland function is therefore crucial for comprehensive evaluation and guiding targeted treatment in dry eye patients.

This study of 269 patients offers a comprehensive evaluation of dry eye and MGD, using standardized tests and meibography to reliably assess clinical features and identify correlations with MGD.

Limitations include a single-center, relatively small sample size, potential selection bias, and diagnostic variability, which may affect generalizability and accuracy. Advanced investigations such as tear osmolarity and inflammatory biomarkers were not assed. Future studies should address these to better understand DED and MGD. Our findings highlight the link between MGD and DED, emphasizing the need for thorough assessment and management of meibomian gland function to improve patient outcomes and quality of life.

References:

1. Golden MI, Meyer JJ, Zeppieri M, Patel BC. StatPearls [Internet] Treasure Island (FL): StatPearls Publishing; 2024. Dry Eye Syndrome.
2. Aghamollaei H, Hashemi H, Fallahtafti M, Daryabari SH, Khabazkhoob M, Jadidi K. Applications of SMILE-extracted lenticules in ophthalmology. Int J Ophthalmol. 2024 Jan ;17(1):173–187.
3. Lemp MA, Crews LA, Bron AJ, Foulks GN, Sullivan BD. Distribution of aqueous-deficient and evaporative dry eye in a clinic-based patient cohort: a retrospective study. Cornea. 2012 May;31(5):472–8.
4. Bron AJ, Benjamin L, Snibson GR. Meibomian gland disease Classification and grading of lid changes. Eye. 1991;5(Pt 4):395–411.
5. Wolffsohn JS, Benítez-Del-Castillo J, Loya-Garcia D, Inomata T, Iyar G, Liang L, et al. TFOS DEWS III diagnostic methodology. Am J Ophthalmol 2025;279:387–450:S0002-2.
6. Methodologies to Diagnose and Monitor Dry Eye Disease Report of the Diagnostic Methodology Subcommittee of the International Dry Eye WorkShop. Ocul. Surf. 2007;5:108–152.
7. Tomlinson A, Bron AJ, Korb DR, Amano S, Paugh JR, Pearce EI, et al. The international workshop on meibomian gland dysfunction: Report of the diagnosis subcommittee. Invest Ophthalmol Vis Sci 2011;52:2006–49.
8. Arita R, Mizoguchi T, Kawashima M, Fukuoka S, Koh S, Shirakawa R, et al. Meibomian gland dysfunction and dry eye are similar but different based on a population-based study: The Hirado-Takushima study in Japan. Am J Ophthalmol 2019;207:410–8.
9. Sayegh RR, Yu Y, Farrar JT, Kuklinski EJ, Shtein RM, Asbell PA. Maguire MG; Dry Eye Assessment and Management (DREAM) Study Research Group Ocular Discomfort and Quality of Life Among Patients in the Dry Eye Assessment and Management Study. Cornea. 2021 Jul ;40(7):869–876.
10. The definition and classification of dry eye disease: report of the Definition and Classification Subcommittee of the International Dry Eye WorkShop (2007) Ocul Surf. 2007 Apr;5(2):75–92.
11. .Walt JG, Rowe MM, Stern KL. Evaluating the functional impact of dry eye: The ocular surface disease index . Drug Inf J. 1997;311436
12. Grubbs Jr JR, Tolleson-Rinehart S, Huynh K, Davis RM. A review of quality of life measures in dry eye questionnaires. Cornea. 2014;33(2):215.
13. Nichols, K. K., Foulks, G. N., Bron, A. J., Glasgow, B. J., Dogru, M., Tsubota, K., ... & Yokoi, N. (2011). The international workshop on meibomian gland dysfunction: Executive summary. Investigative Ophthalmology & Visual Science, 52(4), 1922-1929.
14. Tomlinson, A., Bron, A. J., Korb, D. R., Amano, S., Paugh, J. R., Pearce, E. I., & Yee, R. (2011). The international workshop on meibomian gland dysfunction: Report of the diagnosis subcommittee. Investigative

Ophthalmology & Visual Science, 52(4), 2006-2049.
15. Amano S, Inoue K. Estimation of Prevalence of Meibomian Gland Dysfunction in Japan. Cornea. 2017 Jun;36(6):684-688.
16. Wu H, Fang X, Luo S, et al. Meibomian Glands and Tear Film Findings in Type 2 Diabetic Patients: A Cross-Sectional Study. Front Med (Lausanne). 2022; 9:762493. Published 2022 Apr 5.
17. Nisha S. Yeotikar, Hua Zhu, Maria Markoulli, Kelly K. Nichols, Thomas Naduvilath, EricB. Papas; Functional and Morphologic Changes of Meibomian Glands in an Asymptomatic Adult Population. Invest. Ophthalmol. Vis. Sci. 2016;57(10):3996-4007.
18. Mehta DS, Sisodiya SD, Jani HC. Prevalence and Association of Meibomian Gland Dysfunction with Dry Eye Severity from a Tertiary Care Rural Hospital in Central Gujarat: A Cross-sectional StudyJ Clin of Diagn Res.2022; 16(7)
19. Chatterjee S, Agrawal D, Sharma A. Meibomian gland dysfunction in a hospital-based population in Central India. Cornea. 2020;39(5):634-39.
20. Siak JJ, Tong L, Wong WL, Cajucom-Uy H, Rosman M, Saw SM. Prevalence and risk factors of meibomian gland dysfunction: The Singapore Malay eye study. Cornea. 2012;31(11):1223-28.
21. Han SB, Hyon JY, Woo SJ, Lee JJ, Kim TH, Kim KW. Prevalence of dry eye disease in an elderly Korean population. Arch Ophthalmol. 2011;129(5):633-38.
22. Basak SK, Pal PP, Basak S, Bandyopadhyay A, Choudhury S, Sar S. Prevalence of dry eye diseases in hospital-based population in West Bengal, Eastern India. J Indian Med Assoc. 2012;110(11):789-94.
23. Lee AJ, Lee J, Saw SM, Gazzard G, Koh D, Widjaja D, et al. Prevalence and risk factors associated with dry eye symptoms: A population-based study in Indonesia. Br J Ophthalmol. 2002;86(12):1347-51.
24. Xiao J, Adil MY, Chen X, Utheim ØA, Ræder S, Tønseth KA, et al. Functional and morphological evaluation of meibomian glands in the assessment of meibomian gland dysfunction subtype and severity. Am J Ophthalmol. 2020; 209:160-67.