ORIGINAL ARTICLE

Prevalence and associated factors of meibomian gland dysfunction and dry eye disease among subjects presenting for transepithelial photorefractive keratectomy

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ABSTRACT

Introduction: Transepithelial Photorefractive Keratectomy (Trans-PRK) is a modern refractive surgery that improves comfort and recovery but may predispose to meibomian gland dysfunction (MGD) and dry eye disease (DED), causing postoperative discomfort. Preoperative assessment of meibomian glands among Trans-PRK candidates remain limited. This study aimed to determine the prevalence of MGD and DED, identify associated factors, and assess the correlation of meibomian gland loss (MGL) among subjects undergoing Trans-PRK at Hospital Pakar Universiti Sains Malaysia.

Materials and Methods: A descriptive cross-sectional study was conducted from January 2024 to January 2025 among 110 subjects aged 20–45 years undergoing preoperative Trans-PRK evaluation. Demographic, occupational, and lifestyle data were collected, while ocular surface parameters were assessed through clinical examination, meibography, and standardized questionnaires. MGD and DED were diagnosed based on established criteria. Statistical analyses were performed using SPSS version 29.0.

Results: The prevalence of MGD and DED was 17.3% and 19.1%, respectively, with a mean age of 32.76 ± 7.65 years. Screen exposure exceeding four hours daily was significantly associated with MGD (OR = 9.05, 95% CI: 2.14–38.28, p = 0.003) and DED (OR = 8.12, 95% CI: 2.16–30.54, p < 0.001). Increasing age increased the odds of MGD (OR = 3.65, 95% CI: 1.15–11.51, p = 0.027), while male gender was a significant risk factor for both. MGL correlated moderately with OSDI (r = 0.58) and meibum quality (r = 0.46), and weakly with meibum expressibility (r = 0.35) and corneal fluorescein staining (r = 0.36). Common gland changes were dropout (29.1%), tortuosity (25.5%), and shortening (20.9%).

Conclusion: MGD and DED were observed in 17.3% and 19.1% of Trans-PRK candidates. Age, male gender, and screen exposure were associated with MGD, while male gender and screen exposure were associated with DED. MGL correlated with key ocular surface indices, highlighting the importance of comprehensive preoperative ocular surface assessment.

KEYWORDS:
Meibomian gland dysfunction, transepithelial photorefractive keratectomy, dry eye diseases, meibomian glands, tear film, ocular surface

INTRODUCTION

Laser corneal refractive surgery, particularly Transepithelial Photorefractive Keratectomy (Trans-PRK), has gained popularity for its safety and efficacy in correcting refractive errors.[1] Unlike conventional PRK, Trans-PRK ablates both the corneal epithelium and stroma in a single step using an excimer laser, potentially reducing discomfort and promoting faster recovery.[2,3] Despite its advantages, Trans-PRK may induce ocular surface changes that disrupt corneal innervation and meibomian gland function. These changes can lead to meibomian gland dysfunction (MGD) and dry eye disease (DED), both of which impact postoperative comfort and visual outcomes.[4–10]

Several studies have emphasized the significance of preoperative ocular surface health, particularly the condition of the meibomian glands, in predicting postoperative dry eye symptoms, dry eye severity and tear film stability. Recognizing and addressing these pre-existing conditions is essential for optimizing surgical outcomes and minimizing postoperative complications.[1,4,5,11]

Prevalence of MGD and DED in subjects undergoing Trans-PRK remain scarce although Trans-PRK is increasingly used. This study aims to determine the prevalence of MGD and DED among Trans-PRK candidates, identify associated risk factors and examine the correlation between MGL and ocular surface parameters. The findings may support the development of targeted preoperative screening strategies to optimize refractive surgery outcomes.

MATERIALS AND METHODS

Study design and study population

A descriptive cross-sectional study was conducted at the Laser Refractive Service, Hospital Pakar Universiti Sains Malaysia (HPUSM), from January 2024 to January 2025. This study was approved by the Human Research Ethics Committee of

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Universiti Sains Malaysia (JEPeM Code: USM/JEPeM/KK/23080628) and was carried out in accordance with the principles of the Declaration of Helsinki.

Participants were screened based on specific inclusion and exclusion criteria. A total of 110 participants presenting for Trans-PRK, aged 20 to 45 years were recruited. Exclusion criteria included those who were contraindicated for Trans-PRK and those with systemic diseases (e.g., diabetes), ocular surface disorders, recent contact lens use (within three months) or prior ocular surgery.

Sample size calculation
The sample size was determined according to each study objective. Calculations were performed using the single mean formula (Ariffin sample size calculator) and G*Power version 3.1.9.4 for linear multiple regression (fixed model, R^2 deviation from zero) and correlation analyses.[12] The largest estimated sample size, derived from the meibomian gland meiboscale using the single mean formula, was 108 participants, which was adopted to ensure adequate statistical power across all objectives.

Demographic data, systemic and ocular history
Sociodemographic data (age, gender, occupation, screen time, smoking status, contact lens use) and refractive measurements were recorded. Manifest spherical equivalent (SE) and astigmatism were categorised by standard refractive error classifications.

Ocular examination
Participants who provided informed consent underwent thorough examinations at the Laser Refractive Service. Subjects then completed the Ocular Surface Disease Index (OSDI) questionnaire.[4] The examination sequence commenced with assessment of visual acuity, non-invasive and non-contact meibography, followed by a slit-lamp examination.

Meibography was conducted using infrared Schwind Sirius® Scheimpflug-Placido Topography System (manufactured by CSO Srl, Italy). Meibomian gland loss and morphology were evaluated. The right upper eyelid was utilised to assess gland structure, degree of gland loss, and severity, as the upper eyelid contains more meibomian glands structural features and exhibits more prominent dropout areas.[13] To ensure accuracy, the principal investigator manually delineated the upper eyelid boundaries for analysis while minimizing the impact of glare and repeating this process three times. Meibomian gland loss (MGL) was calculated as the proportion of gland loss relative to the total upper tarsal area and classified into five grades: Grade 0 for no MGL, grade 1 for equal or less than 25% loss, grade 2 for 26 to 50% loss, Grade 3 for 51 to 75% loss, and Grade 4 for more than 75% loss.[1] Meibomian gland morphology was assessed and categorised based on characteristic features, including ghost areas, dropout, shortened, thickened, thinned, tortuous, hooked, and overlapping patterns.[13]

Subsequently, non-invasive tear break-up time (NIBUT) was measured. It measures the time for the first dry spot to appear on the corneal surface after a blink. The three readings of the first and the average NIBUT were documented, with a cut-off value of less than or equal to 10 seconds indicating tear film instability and DED.[14]

On slit lamp examination, first the lid margin was examined for abnormalities such as irregularities, vascular engorgement, plugged meibomian gland orifices, and anterior or posterior displacement of the mucocutaneous junction, with findings scored as either present (1) or absent (0).[15] Meibomian gland expression was assessed by applying digital compression over five visible meibomian gland orifices of the upper or lower lids. Meibomian gland expression was evaluated and categorized into the following grades: Grade 0 if all glands were expressible, Grade 1 if 3 to 4 glands were expressible, Grade 2 if only 1 to 2 glands were expressible, and Grade 3 if no glands were expressible. Meibum quality was graded as follows: Grade 0 for clear fluid, Grade 1 for cloudy or particulate fluid, and Grade 2 for opaque, toothpaste-like secretions.[16] Tear break-up time (TBUT) was measured using fluorescein strips, and dry spots appearing in under 10 seconds were considered abnormal.[14] Corneal fluorescein staining was graded using the Oxford grading scale. Grade 0 indicates no or minimal staining. Grade I shows slight staining, more than Grade 0. Grade II shows moderate staining, greater than Grade I. Grade III indicates dense staining, more than Grade II. Grade IV shows confluent staining, more severe than Grade III. Grade V represents very severe staining, greater than Grade IV.[17] Schirmer I testing without anaesthesia was performed to assess basal and reflex tearing, with values below 10 mm at five minutes considered abnormal.[14] To minimize errors, all ocular examinations were conducted by the primary principal investigator.

MGD was diagnosed in participants who met all the following criteria, as adapted from the 2011 International Workshop on MGD[5,18]:
- Ocular Surface Disease Index (OSDI) score >12,
- Presence of at least one lid margin abnormality, and
- Meibum expressibility or meibum quality grading ≥1.

DED was defined based on the TFOS DEWS II criteria[5,14], requiring:
- OSDI score >12, and
- The following objective signs:
- Corneal fluorescein staining score ≥1,
- Tear Break-Up Time (TBUT) or Non-Invasive TBUT (first or average) < 10 seconds, or
- Schirmer I test result <10 mm in five minutes.

Statistical analysis
All data were analysed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Simple and multiple logistic regression analyses were performed to identify factors associated with MGD and DED.

Pearson correlation analysis was used to examine the relationship between the percentage of MGL and clinical parameters including OSDI score, meibum expressibility score, meibum quality score, lid margin scores, TBUT, first and average NIBUT, Oxford corneal fluorescein staining score and Schirmer I test values. A p-value < 0.05 was

Table I: Demographic and clinical characteristics for subjects presenting for Trans-PRK

Variable	n (%)
Age (years), mean ± SD	32.76 (7.65)
< 35	62 (56.4)
≥ 35	48 (43.6)
Gender	
Male	46 (41.8)
Female	64 (58.2)
Race,	
Malay	104 (94.5)
Chinese	6 (5.5)
Working environment	
Indoor	76 (69.1)
Outdoor	34 (30.9)
Screen time	
< 4 hours	49 (44.5)
≥ 4 hours	61 (55.5)
Smoking	
No	98 (89.1)
Yes	12 (10.9)
Contact lens	
No	52 (47.3)
Yes	58 (52.7)
Degree myopia (dioptres), Mean ± SD	-3.98 ± 0.15
Low (<-3.0)	30 (27.3)
Moderate (-3.0 to -6.0)	69 (62.7)
High (>-6.0)	11 (10.0)
Degree of astigmatism (dioptres), Mean ± SD	-0.83 ± 0.06
Mild (<1.5)	97 (87.4)
Moderate (1.5 to 2.5)	10 (9.0)
Severe (>2.5)	3 (2.7)
UCDVA (LogMAR)	
Normal (0.00 to 0.30)	1 (0.9)
Mild (0.50)	7 (6.4)
Moderate (0.60 to 1.00)	65 (59.1)
Severe (1.10 to 1.30)	37 (33.6)
Blind (Worse than 1.30)	-
BCDVA (LogMAR)	
Normal (0.00 to 0.30)	72 (65.5)
Mild (0.50)	13 (11.8)
Moderate (0.60 to 1.00)	20 (18.2)
Severe (1.10 to 1.30)	5 (4.5)
Blind (Worse than 1.30)	-
Manifest spherical equivalent in dioptres, mean ± SD	-4.37 ± 0.17

Abbreviations: SD: standard deviation, UCDVA: uncorrected distant visual acuity, BCDVA: best corrected distant visual acuity

considered statistically significant. The strength of correlation was interpreted using r-values according to the classification by Schober et al.[19]

RESULTS

Demographic characteristics

A total of 110 subjects who presented for Trans-PRK were included in the study. The mean age ⌖ standard deviation (SD) was 32.76 years ± 7.65, with a majority being female (58.2%, 64 subjects) and of Malay ethnicity (94.5%, 104 subjects). Majority worked in indoor environments (69.1%, 76 subjects) and 55.5% (61 subjects) reported screen time of more than four hours per day.

Clinical characteristics

Contact lens wear was reported in 52.7% (58 subjects), while smoking was noted in 12 participants (10.9%). Most subjects having moderate myopia (62.7%, 69 subjects). Astigmatism was generally mild, with 97 of subjects (87.4%) fell within the mild astigmatism category. Regarding visual acuity, most subjects had moderate uncorrected distance visual acuity (UCDVA) (59.1%, 65 subjects) and about 72 subjects (65.5%) fell within normal category of best corrected distance visual acuity (BCDVA). (Table I)

Meibomian gland characteristics

Table II describes the characteristics of meibomian gland parameters among subjects. OSDI had a mean score of 9.51 ± 4.33, with the majority of subjects falling within the normal range (80.9%), which suggest most subjects were asymptomatic. In terms of meibomian gland, it revealed that most participants had good meibum expressibility and quality score, indicating good meibomian gland function, which seen in 57 (51.8%) and 63 participants (57.3%) respectively. Abnormal lid margin findings were observed in 77 participants (70%), with the most common signs being meibomian gland capping (71.4%), suggesting some degree

Table II: Meibomian gland parameters and prevalence among subjects presenting for Trans-PRK

VariablesMeibomian gland parameters	n (%)
OSDI, Mean ± SD	9.51 (4.33)
Normal: 0 to 12	89 (80.9)
Mild: 13 to 22	19 (17.3)
Moderate: 23 to 32	2 (1.8)
Severe: 33 and above	-
Lid margin score, Mean ± SD	0.70 (0.46)
Score 0: Normal	33 (30.0)
Score 1: Abnormal	77 (70.0)
• Telangiectatic vessel	10 (13.0)
• Meibomian capping	55 (71.4)
• Vascular engorgement	5 (6.5)
• Mucocutaneous junction	7 (9.1)
Meibum expressibility score, Mean ± SD	0.53 (0.59)
Grade 0: All glands	57 (51.8)
Grade 1: 3 to 4 glands	48 (43.6)
Grade 2: 1 to 2 glands	5 (4.5)
Grade 3: No glands	0
Meibum quality score, Mean ± SD	0.45 (0.54)
Grade 0: Clear fluid	63 (57.3)
Grade 1: Cloudy or particulate	45 (40.9)
Grade 2: Opaque	2 (1.8)
Area of MGL (%), Mean ± SD	20.84 (13.27)
Grade 0	0
Grade 1 (<25)	78 (70.9)
Grade 2 (26 to 50)	30 (27.3)
Grade 3 (51 to 75)	2 (1.8)
Grade 4 (>75)	0
Meibomian gland morphology	
Ghost area	8 (7.3)
Dropped out	32 (29.1)
Shortened	23 (20.9)
Thickened	0
Thinned	15 (13.6)
Tortuous	28 (25.5)
Hooked	3 (2.7)
Overlapping	1 (0.9)
MGD	
No	91 (82.7)
Yes	19 (17.3)

Abbreviation: OSDI: Ocular Surface Disease Index, SD: standard deviation, MGL: meibomian gland loss
MGD: meibomian gland dysfunction
MGD criteria: OSDI > 12, presence of at least one lid margin abnormality, and meibum expressibility or meibum quality grading ≥1.

of obstruction of the gland orifices. Meibography examination showed the mean percentage of MGL was 20.84% ± 13.27, with the majority (70.9%, 78 subjects) classified as grade 1 loss (<25%). Morphological abnormalities such as gland dropout (29.1%), tortuosity (25.5%), and shortened glands (20.9%) were commonly observed. Overall, 17.3% of the participants (19 participants) met the diagnostic criteria for MGD.

Tear film parameters

Table III summarizes dry eye parameters among subjects. OSDI was predominantly in the normal range (80.9%, 89 subjects), suggesting most of the subjects do not any dry eye symptoms. The mean tear break-up time (TBUT) was 8.85 ± 2.81 seconds, with more than half of the subjects (51.8%, 57 subjects) having TBUT less than 10 seconds, implying tear film instability. The mean first NIBUT were 9.97 ± 5.68 seconds with majority (57.3%, 63 participants) score less than 10 seconds. However, for average NIBUT, 77 participants (70%) scored more than 10 seconds, indicating normal value. The mean corneal fluorescein staining was 1.55 ± 0.60, with most eyes graded as Grade 1 (49.1%, 54 participants) or 2 (46.4%, 51 participants). Schirmer I test without anaesthesia showed a mean value of 16.1 ± 4.69 mm, with 88.2% (97 subjects) having normal reflex tear secretion. 21 of the subjects (19.1%) met the diagnostic criteria for DED.

Associated factors for MGD and DED

Table IV and V showed the associated factors of MGD and DED among participants presenting for Trans-PRK. Multivariate logistic regression revealed that older age (OR 3.65, 95% CI 1.15–11.51, p = 0.027) and screen time of more than four hours daily (OR 9.05, 95% CI 2.14–38.28, p = 0.003) were significantly associated with the presence of MGD. Furthermore, table IV demonstrates that, using males as the reference group, female gender was significantly associated with 81% reduced odds of developing MGD compared to males (OR = 0.19, 95% CI: 0.055–0.68, p = 0.011).

In relation to DED, individuals with screen time exceeding four hours per day demonstrated significantly higher odds of developing DED, with an eightfold increase in risk (OR=8.12,

Table III: Dry eye parameters and prevalence among subjects presenting for Trans-PRK

VariablesDry eye parameters	n (%)
OSDI, Mean ± SD	9.51 (4.33)
Normal: Score 0 to 12	89 (80.9)
Mild: 13 to 22	19 (17.3)
Moderate: 23 to 32	2 (1.8)
Severe: 33 and above	-
TBUT (sec), Mean ± SD	8.85 (2.81)
< 10 seconds	57 (51.8)
≥ 10 seconds	53.0 (48.2)
Corneal fluorescein staining, Mean ± SD	1.55 (0.60)
Grade 1	54 (49.1)
Grade 2	51 (46.4)
Grade 3	5 (4.5)
Grade 4	0
Grade 5	0
NIBUT first (sec), Mean ± SD	9.97 (5.68)
< 10 seconds	63 (57.3)
≥ 10 seconds	47 (42.7)
NIBUT average (sec), Mean ± SD	11.9 (3.72)
< 10 seconds	33 (30.0)
≥ 10 seconds	77 (70.0)
Schirmer I, Mean ± SD	16.1 (4.69)
< 10mm	13 (11.8)
≥ 10mm	97 (88.2)
DED	
No	89 (80.9)
Yes	21 (19.1)

Abbreviation: OSDI: Ocular Surface Disease Index, SD: standard deviation, TBUT: tear break up time , NIBUT: non-invasive break up time, DED: dry eye disease
DED criteria: OSDI score >12, and the following objective signs: corneal fluorescein staining score ≥1, TBUT or NIBUT (first or average) < 10 seconds or schirmer I test result <10 mm in five minutes

95% CI: 2.16–30.54, p=0.002). Additionally, female gender appeared to be a protective factor, with females exhibiting 74% lower odds of developing DED compared to their male counterparts (OR=0.26, 95% CI: 0.08–0.80, p=0.019). Age was not found to be a statistically significant factor associated with the development of DED. Other variables such as myopia, working environment (indoor or outdoor), contact lens wear and smoking status did not show significant associations with either MGD or DED.

Correlation analysis between meibomian gland parameters and tear film parameters

Correlation analysis showed a moderate positive correlation between meibomian gland loss and OSDI scores (r=0.58, p<0.001) and meibum quality scores (r=0.46, p<0.001). Whereas weak correlation was seen in oxford cornea fluorescent staining (r=0.36, p<0.001) and meibum expressibility (r=0.35, p<0.001). However, there was no significant correlations (p value of >0.05) were observed with TBUT, first and average NIBUT, Schirmer I test, and lid margin scores.

DISCUSSION

In this study, we investigated the prevalence of MGD and DED among subjects presenting for Trans-PRK. There have been limited reviews of the prevalence of MGD and DED in Malaysia, especially among subjects presenting for refractive surgery. To our knowledge, there is no published data looking into the prevalence of MGD and DED among subjects presenting for Trans-PRK. The findings of this study allow for better preoperative risk stratification, more targeted patient counselling and the integration of MGD and DED management into the refractive surgery workflow. This proactive approach may enhance postoperative outcomes and patient satisfaction, while also reducing long-term complication rates.

The demographic characteristics of our cohort are largely consistent with international studies involving refractive surgery candidates. Our study population, with a mean age of 32.76 ± 7.65 years, reflects the typical age group seeking refractive correction, comparable to the slightly younger cohorts reported by Li et al. and Gong et al. in China and similar to Brooks and Gupta's US-based study.[1,4,20] Female predominance in our sample aligns with findings from Brooks and Gupta and may reflect greater aesthetic motivation or health-seeking behaviour among women.[1] Our sample comprising majority of Malay ethnicity, reflective of the general population demographics accessing refractive surgery services in our geographic location.[21,22] Contact lens use was reported by over half of our participants, consistent with international data, and is a relevant factor as prior contact lens wear has been associated with lid margin changes and meibomian gland dropout.[23] Most participants worked indoors and had prolonged screen exposure, which may exacerbate evaporative dry eye, a risk factor less frequently documented in the reviewed studies but highly relevant in modern clinical settings.[10,24] The majority also had moderate degrees of myopia and mild astigmatism, further

Table IV: Associated factors of MGD among subjects presenting for Trans-PRK

Variable	MGD		Simple Logistic Regression		Multiple Logistic Regression	
	No n (%)	Yes n (%)	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age (years)						
< 35	56 (90.3)	6 (9.7)	3.47	0.021*	3.65	0.027*
≥ 35	35 (72.9)	13 (27.1)	(1.21, 9.96)		(1.15, 11.51)	
Gender						
Male	35 (76.1)	11 (23.9)	0.46	0.124	0.19	0.011*
Female	56 (87.5)	8 (12.5)	(0.17, 1.24)		(0.055, 0.68)	
Myopia						
Grade 0	26 (86.7)	4 (13.3)	1.50	0.505		
Grade 1-2	65 (81.3)	15 (18.7)	(0.46, 4.95)			
Indoor						
No	31 (91.2)	3 (8.8)	2.76	0.129		
Yes	60 (78.9)	16 (21.1)	(0.75, 10.18)			
Outdoor						
No	60 (78.9)	16 (21.1)	3.67	0.129		
Yes	31 (91.2)	3 (8.8)	(0.1, 1.34)			
Screen time						
No	45 (91.8)	4 (8.2)	3.67	0.030*	9.05	0.003*
Yes	46 (75.4)	15 (24.6)	(1.13, 11.90)		(2.14, 38.28)	
Contact Lens						
No	41 (78.8)	11 (21.2)	0.60	0.311		
Yes	50 (86.2)	8 (13.8)	(0.22, 1.62)			
Smoking						
No	81 (82.7)	17 (17.3)	0.95	0.953		
Yes	10 (83.3)	2 (16.7)	(0.19, 4.74)			

Abbreviations: OR: odds ratio, CI: confidence interval
p-value <0.05 is significant for simple logistic regression and multiple logistic regression
*Statistically significant value
Forward LR method was applied for variable selection. No multicollinearity and no interaction detected. Hosmer Lemeshow test, p-value=0.119, Classification table 81.8% correctly classified

Table V: Associated factors of DED among subjects presenting for Trans-PRK

Variable	DED		Simple Logistic Regression		Multiple Logistic Regression	
	No n (%)	Yes n (%)	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age (years)						
< 35	54 (87.1)	8 (12.9)	2.51	0.065		
≥ 35	35 (72.9)	13 (27.1)	(0.94, 6.67)			
Gender						
Male	35 (76.1)	11 (23.9)	0.59	0.278	0.26	0.019*
Female	54 (84.4)	10 (15.6)	(0.23, 1.53)		(0.08, 0.80)	
Myopia						
Grade 0	25 (83.3)	5 (16.7)	1.25	0.692		
Grade 1-2	64 (80.0)	16 (20.0)	(0.41, 3.78)			
Indoor						
No	31 (91.2)	3 (8.8)	3.21	0.078		
Yes	58 (76.3)	18 (23.7)	(0.88, 11.74)			
Outdoor						
No	58 (76.3)	18 (23.7)	0.312	0.078		
Yes	31 (91.2)	3 (8.8)	(0.09, 1.14)			
Screen time						
No	45 (91.8)	4 (8.2)	4.35	0.013*	8.12	0.002*
Yes	44 (72.1)	17 (27.9)	(1.36, 13.95)		(2.16, 30.54)	
Contact Lens						
No	41 (78.8)	11 (21.2)	0.78	0.603		
Yes	48 (82.8)	10 (17.2)	(0.3, 2.01)			
Smoking						
No	79 (80.6)	19 (19.4)	0.83	0.821		
Yes	10 (83.3)	2 (16.7)	(0.17, 4.11)			

Abbreviations: OR: odds ratio, CI: confidence interval
p-value <0.05 is significant for simple logistic regression and multiple logistic regression.
*Statistically significant value
Forward LR method was applied for variable selection. No multicollinearity and no interaction detected.
Hosmer Lemeshow test, p-value=0.671, Classification table 80.0% correctly classified

supporting their suitability for Trans-PRK. Understanding these demographic trends is essential in tailoring refractive services, identifying at-risk groups for preoperative dry eye screening and enhancing patient education and postoperative care planning.

In our study, the prevalence of MGD and DED among Trans-PRK candidates was 17.3% and 19.1%, respectively. These rates are consistent with those reported in prior studies on refractive surgery populations, albeit with some variability due to differences in geographic, ethnic, and methodological factors. For instance, Li et al. reported a broad range of DED prevalence (14.7% to 63.4%) among refractive surgery candidates in China, while Maychuk observed DED rates between 15.6% and 55% among LASIK candidates in Russian.[20,25] Brooks and Gupta found a notably high prevalence of meibomian gland atrophy (72.5%) among U.S. candidates, highlighting the under-recognised presence of MGD even in asymptomatic individuals.[1] Gong et al. similarly demonstrated that preoperative meibomian gland loss was associated with worse postoperative dry eye symptoms, emphasizing the importance of baseline gland assessment.[4]

The relatively lower prevalence observed in our cohort can be attributed to a multitude of factors, including differences in diagnostic criteria, variations in testing methodologies for DED assessment and differences in the demographic and environmental characteristics of the studied populations.[20] Aljarousha et al. also described this, explaining that the prevalence varies by location and depends on the type of clinical examination, the method of diagnosis, and the population studied.[26]

We also studied the morphological changes in meibomian gland of our patients. Our study reported the most common meibomian gland morphology observed was dropped out glands, followed by tortuous glands. Brooks and Gupta demonstrated higher degree of meibomian gland tortuosity in his study, using a different grading system.[1] The difference in the reported prevalence of meibomian gland morphology and MGD may reflect the discrepancy between structural changes and clinical function. While meibography can reveal gland atrophy or morphological abnormalities such as gland dropout, tortuosity, and shortening, these changes do not always correlate with symptomatic or functional MGD.[16,27] MGD diagnosis relies on clinical signs and symptoms like altered meibum quality and expressibility, lid margin abnormalities and tear film instability. Likewise, Daniel et al. suggested that further research is needed to establish the correlation between ocular imaging of the meibomian glands and clinical findings in DED.[13]

In this study, increasing age is associated with fourfold higher odds of developing MGD after adjusting potential confounding factors in multivariate logistic regression associated with MGD. Brooks and Gupta reported similar findings as their study focused on the relationship between meibomian gland atrophy and age.[1] With increasing age, it is postulated that there will be a decline in meibocyte differentiation and cell cycling, which can lead to meibomian gland atrophy over time.[23] Another hypothesis would be hyperkeratinization, stasis and increased pressure with gland dilatation, resulting in chronic MGD. This subsequently leads to atrophy of the meibomian glands.[1] Hormonal imbalances resulting from androgen deficiency may represent another underlying mechanism for age-related meibomian gland dysfunction.[28,29]

Our study population consisted primarily of female participants. After adjusting for screen time and age, males were found to be approximately four and five times more likely to develop MGD and DED, respectively. Traditionally, females have been more commonly associated with the development of MGD, although some studies have concluded that there is no gender predisposition to MGD.[23,24] Our findings, however, align with other studies that support a higher likelihood of males developing MGD and DED. Androgen deficiency is believed to be a key factor in the onset of MGD in males.[29–31]

Our data showed that screen time of more than four hours was associated with nine times and eight times higher odds to get MGD and DED. These findings are consistent with the existing literatures. Prolonged periods of screen exposure may lead to reduced blinking rates, resulting in tear film instability and subsequent desiccation of the ocular surface, potentially contributing or exacerbating of meibomian gland dysfunction.[10,21] Muniraju et al. have reported that prolonged screen time reduces the blink rate to approximately five to six times per minute due to continuous staring at the screen.[32] Moreover, the emission of blue light from visual display terminals, including computer and mobile screens, may further destabilize the tear film.[21]

Although no significant associations were found between myopia, environmental exposure, contact lens wear, or smoking with MGD and DED, these factors may still have exerted confounding effects on the observed associations. Contact lens wear can induce chronic structural and functional alterations in the meibomian glands, while environmental factors such as high temperature and low humidity which is common in the fluctuating hot and humid climate of East Coast Malaysia, may further destabilize the tear film and contribute to residual confounding.[10,23] While myopia is not directly associated with MGD, it is frequently linked to prolonged near work and screen use, which can reduce blink rate and lead to gland stasis and ocular surface instability.[33] Prolonged screen exposure which is often cumulative with increasing age, may exacerbate ocular surface stress and evaporative dry eye, potentially compounding these effects.[23,34]

The study also found that the meibum expressibility score and meibum quality score correlated with the degree of meibomian gland loss. These are clinical assessments of meibomian gland function.[1,16] This was also seen by MacHalińska et al, where severity of MGD correlates with meibum quality and quantity scores.[23] Besides that, Arita et al proposed that meibomian score as one of the reliable markers to differentiate obstructive MGD from healthy subjects.[35] The observed relationships align with the understanding of MGD, where stagnation of meibum is typically associated with alterations in both the quality and ease of meibum secretion.

Besides that, our study showed higher scores of corneal fluorescein staining correlates with meibomian gland loss, as seen in other studies.[16,18] Corneal staining is an indicator of corneal epithelial damage, which is often associated with tear film instability and meibomian gland dysfunction.[18] It is proposed that the release of inflammatory mediators such as breakdown products of meibomian lipids into the tear film results in ocular surface damage.[16]

We observed that OSDI scores, which reflects the subjective experience of ocular discomfort, were significantly elevated in participants exhibiting greater meibomian gland loss. This was also observed by MacHalińska et al who reported that OSDI can independently predict an abnormal meiboscore, emphasizing the importance of patient-reported outcomes in the assessment of meibomian gland dysfunction.[23,36] Interestingly, the majority of subjects in our study demonstrated clinical signs yet remained asymptomatic. The use of an OSDI cutoff of more than 12 may have influenced the estimated prevalence, as individuals with clinical ocular surface changes could remain asymptomatic despite low OSDI scores. This aligns with Craig et al., who reported that reduced corneal sensitivity from longstanding dry eye may mask discomfort despite evident clinical signs.[37]

Conventional measures of tear film function, including tear breakup time (TBUT), non-invasive tear breakup time (NIBUT), and Schirmer I testing, did not exhibit statistically significant correlations with the degree of meibomian gland loss. This was also highlighted in other studies.[23,35] It is probably due to TBUT having a relatively low power to differentiate MGD from healthy subjects, as described by Arita et al.[35] Besides that, Schirmer test is a measurement for aqueous component in the tear film, which is usually not seen in MGD.[38] This suggests that standard tear film assessment techniques may be insufficient for evaluating meibomian gland dysfunction-related pathology.

These findings have important implications for both clinical practice and future research. The results of this study can inform the development of a local institutional protocol that integrates meibography and comprehensive dry-eye screening into preoperative assessments to optimise patient selection and postoperative outcomes in refractive surgery. Future prospective or longitudinal studies should evaluate whether targeted preoperative management of MGD or DED can reduce postoperative complications and enhance ocular-surface recovery.

The limitations of this study include its cross-sectional design, which precludes establishing causal relationships between the identified risk factors and the development of MGD or DED. Furthermore, the findings may have limited generalisability beyond the East Coast region of Malaysia, where the population is predominantly Malay and the climate is hot and humid with seasonal monsoon influence. These environmental and demographic characteristics differ from other Malaysian regions. Hence, future longitudinal and multicentre studies across Malaysia are recommended to enhance external validity.

The grading scales used to assess meibomian gland morphology and function were subjective, which could have introduced intra-observer variability and biased the results. In the future, the integration of automated image analysis tools or AI-assisted software may enhance the consistency and reliability of assessments. Another limitation would be the reliance on recall-based estimations to assess working environment and screen time. To minimize recall bias in future research, standardized and validated questionnaires should be used to assess working environment and screen time.

CONCLUSION

This study found that the prevalence of MGD and DED among individuals undergoing Trans-PRK was 17.3% and 19.1%, respectively. MGD was significantly associated with age, gender, and screen time, while DED showed significant associations with gender and screen time, identifying these as potential risk factors in this population. The degree of MGL demonstrated weak to moderate positive correlations with OSDI scores, meibum quality, corneal fluorescein staining, and meibum expressibility. These findings offer important insights into the prevalence and associated factors of MGD and DED in refractive surgery candidates in East Coast Malaysia and highlight the importance of comprehensive preoperative ocular surface assessment.

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REFERENCES

1. Brooks CC, Gupta PK. Meibomian gland morphology among patients presenting for refractive surgery evaluation. Clin Ophthalmol 2021; 15: 315-321.
2. Chang JY, Lin PY, Hsu CC, Liu CJL. Comparison of clinical outcomes of LASIK, Trans-PRK, and SMILE for correction of myopia. J Chin Med Assoc 2022; 85(2): 145-51.
3. Way C, Elghobaier MG, Nanavaty MA. Transepithelial photorefractive keratectomy—Review. Vision 2024; 8(1): 16.
4. Gong Q, Li A, Chen L, Chen H, Gu J, Xu Z, et al. Evaluation of dry eye after refractive surgery according to preoperative meibomian gland status. Front Med (Lausanne). 2022;9:833984.
5. Jung JW, Kim JY, Chin HS, Suh YJ, Kim TI, Seo KY. Assessment of meibomian glands and tear film in post-refractive surgery patients. Clin Exp Ophthalmol 2017; 45(9): 857-66.
6. Mikalauskiene L, Grzybowski A, Zemaitiene R. Ocular surface changes associated with ophthalmic surgery. J Clin Med 2021; 10(8): 1642.
7. Ha M, Oh SE, Whang WJ, Na KS, Kim EC, Kim HS, et al. Relationship between meibomian gland loss in infrared meibography and meibum quality in dry eye patients. BMC Ophthalmol 2022; 22(1): 1-9.
8. Nair S, Kaur M, Sharma N, Titiyal JS. Refractive surgery and dry eye: An update. Indian J Ophthalmol 2023; 71(4): 1105-14.

9. Oleñik A, Mahillo-Fernández I, Alejandre-Alba N, Fernández-Sanz G, Alarcón Pérez M, Luxan S, et al. Benefits of omega-3 fatty acid dietary supplementation on health-related quality of life in patients with meibomian gland dysfunction. Clin Ophthalmol 2014 ;8: 831-6.
10. Rao SK, Mohan R, Gokhale N, Matalia H, Mehta P. Inflammation and dry eye disease—where are we? Int J Ophthalmol 2022; 15(5): 820.
11. Singh S, Shukla AK, Garkal P, Yadav V. Study of tear function before and after laser-assisted in-situ keratomileusis. Indian J Ophthalmol. 2023; 71(4): 1503-7.
12. Arifin WN. Sample size calculator. 2025 [cited Oct 2025]. Available from: https://wnarifin.github.io/ssc_web.html
13. Daniel E, Maguire MG, Pistilli M, Bunya VY, Massaro-Giordano GM, Smith E, et al. Grading and baseline characteristics of meibomian glands in meibography images and their clinical associations in the Dry Eye Assessment and Management (DREAM) study. Ocul Surf 2019; 17(3): 491–501.
14. Wolffsohn JS, Arita R, Chalmers R, Djalilian A, Dogru M, Dumbleton K, et al. TFOS DEWS II diagnostic methodology report. Ocul Surf 2017; 15(3): 539-74.
15. Arita R, Itoh K, Inoue K, Amano S. Noncontact infrared meibography to document age-related changes of the meibomian glands in a normal population. Ophthalmology 2008; 115(5): 911-5.
16. Tomlinson A, Bron AJ, Korb DR, Amano S, Paugh JR, Pearce IE, et al. The international workshop on meibomian gland dysfunction: Report of the diagnosis subcommittee. Invest Ophthalmol Vis Sci 2011; 52(4): 2006-49.
17. Bron AJ and Evans VE. Grading of corneal and conjunctival staining in the context of other dry eye tests. Cornea 2003; 22(7): 640-50.
18. Nichols KK, Foulks GN, Bron AJ, Glasgow BJ, Dogru M, Tsubota K, et al. The international workshop on meibomian gland dysfunction: Executive summary. Invest Ophthalmol Vis Sci 2011; 52(4): 1922–\-9.
19. Schober P, Schwarte LA. Correlation coefficients: appropriate use and interpretation. Anesth Analg 2018; 126(5): 1763-8.
20. Li M, Zeng L, Mi S, Li Y, Liu Z, Yu K, et al. Multicenter study of the prevalence of dry eye disease in Chinese refractive surgery candidates. Ophthalmic Res 2021; 64(2): 224-9.
21. John PA, Hussein A, Shamel K, Teo S. Evaluation of prevalence and associated factors of dry eye syndrome among medical students exposed to visual display terminal in Health Campus, Universiti Sains Malaysia. Mal J Med Health Sci 2023; 19(3): 45-52.
22. Mohd Ali B, Mohd-Ali B, Set Fee L, Abdul-Mutalib H, Mohidin N. Incidence of dry eye in a sample population in Kuala Lumpur. Int J Collab Res Intern Med Public Health 2011; 3(11): 839-45.
23. Machalińska A, Zakrzewska A, Safranow K, Wiszniewska B, Machaliński B. Risk factors and symptoms of meibomian gland loss in a healthy population. J Ophthalmol 2016; 2016:7526120.
24. Stapleton F, Abad JC, Barabino S, Burnett A, Iyer G, Lekhanont K, et al. TFOS lifestyle: Impact of societal challenges on the ocular surface. Ocul Surf 2023; 28: 165-199.
25. Maychuk DY. Prevalence and severity of dry eye in candidates for laser in situ keratomileusis for myopia in Russia. J Cataract Refract Surg 2016; 42(3): 427-34.
26. Aljarousha M, Abd Rahman AA, Badarudin NE, Che Azemin MZ, Awad K, Rahman AA, et al. Prevalence and risk factors of dry eye disease in Kuantan, Malaysia. Makara J Health Res 2018; 22(1): 5-10.
27. Crespo-Treviño RR, Salinas-Sánchez AK, Amparo F, Garza-Leon M. Comparative of meibomian gland morphology in patients with evaporative dry eye disease versus non-dry eye disease. Sci Rep 2021; 11(1): 20729.
28. Chatterjee S, Agrawal D, Sharma A. Meibomian gland dysfunction in a hospital-based population in Central India. Cornea 2020; 39(5): 634-9.
29. Daniel Nelson J, Shimazaki J, Benitez-del-Castillo JM, Craig J, McCulley JP, Den S, et al. The international workshop on meibomian gland dysfunction: Report of the definition and classification subcommittee. Invest Ophthalmol Vis Sci 2011; 52(4): 1930-7.
30. Huang B, Fei F, Wen H, Zhu Y, Wang Z, Zhang S, et al. Impacts of gender and age on meibomian gland in aged people using artificial intelligence. Front Cell Dev Biol 2023; 11: 1199440.
31. Siak JJK, Tong L, Wong WL, Cajucom-Uy H, Rosman M, Saw SM, et al. Prevalence and risk factors of meibomian gland dysfunction: The Singapore Malay Eye Study. Cornea 2012; 31(11): 1223-8.
32. Muniraju NK, Amarnath HK, Ashwini MJ. A review on effects of electronic gadgets on eye. J Ayurveda Physicians Surg 2017; 4(3): 72-5.
33. Wang X, Lu X, Yang J, Wei R, Yang L, Zhao S, et al. Evaluation of dry eye and meibomian gland dysfunction in teenagers with myopia through noninvasive keratograph. J Ophthalmol 2016; (2): 1-5.
34. Tangmonkongvoragul C, Chokesuwattanaskul S, Khankaeo C, Punyasevee R, Nakkara L, Moolsan S, et al. Prevalence of symptomatic dry eye disease with associated risk factors among medical students at Chiang Mai University during the COVID-19 pandemic. PLoS One 2022; 17(3): e0264462.
35. Arita R, Itoh K, Maeda S, Maeda K, Furuta A, Fukuoka S, et al. Proposed diagnostic criteria for obstructive meibomian gland dysfunction. Ophthalmology 2009; 116(11): 2058-63.
36. Rico-del-Viejo L, Benítez-del-Castillo JM, Gómez-Sanz FJ, García-Montero M, Llorens-Quintana C, Madrid-Costa D. The influence of meibomian gland loss on ocular surface clinical parameters. Cont Lens Anterior Eye 2019; 42(5): 562-8.
37. Craig JP, Nichols KK, Akpek EK, Caffery B, Dua HS, Joo CK, et al. TFOS DEWS II definition and classification report. Ocul Surf 2017; 15(3) :276-83.
38. Arita R, Morishige N, Koh S, Shirakawa R, Kawashima M, Sakimoto T, et al. Increased tear fluid production as a compensatory response to meibomian gland loss: A multicenter cross-sectional study. Ophthalmology 2015; 122(5): 925-33.