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Original Research

Knowledge and practice of community pharmacists in identifying and managing dry eye disease in Klang Valley of Malaysia. A cross-sectional study

Tzu Hang Sia, Mei Qian Yau, Raja Ahsan Aftab, Renukha Sellappans, Bee Kim Tan

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Abstract

Background: Inadequately managed dry eye disease (DED) causes complications and poor quality of life. Studies exploring the role of community pharmacists (CP) in identifying and managing DED are scarce. We aimed to determine the level of DED knowledge and practice among CPs and their associated factors in Malaysia's rapidly developing Klang Valley area. **Methods:** An online self-administered survey on DED knowledge and practice was conducted from April to June 2023. CPs practising in 10 urban, suburban, and rural districts of Klang Valley were recruited using stratified sampling. Univariate analysis was conducted using the independent T-test, Mann-Whitney U test, analysis of variance, Kruskal-Wallis H test with Dunn-Bonferroni tests, and multivariate analysis by general linear regression. **Results:** Of the 360 CPs who responded, the majority (87.2%) had an intermediate level of DED knowledge (score 40% to 74%), and 2.5% had a high level of knowledge (score ≥ 75%). Pharmacists with higher academic degrees ($P < 0.001$) and working in chain pharmacies ($P < 0.05$) were significantly associated with good DED knowledge. The DED practices of CPs were moderate, with 73.9% scoring 40% to 74%, and 6.9% scoring 75% or above. Younger pharmacists ($P < 0.001$) with higher academic degrees ($P < 0.05$) reported comparatively better DED practices. **Conclusions:** Suboptimal DED knowledge and practices among CPs indicate the need for capacity-building programs to disseminate consistent and updated information on DED management. Specialization modules for ophthalmology should be developed where CPs can be certified as specialists in area such as ophthalmology.

Keywords: CPs; Community pharmacies; Dry eye disease; Knowledge; Practice; Malaysia

INTRODUCTION

Dry eye disease (DED) results from tear film homeostasis disruptions to tear secretion and/or tear evaporation. DED symptoms include eye discomfort and visual disturbances[1] with untreated DED culminating in chronic inflammation, damage, and neurosensory abnormalities of the ocular surface. The 2017 Tear Film and Ocular Society (TFOS) Dry Eye Workshop (DEWS) II Epidemiology Report showed a global DED incidence of 5 to 50%, and 15% among Malaysians[2,3].

Community pharmacists (CPs) provide counselling[4], filling of prescriptions[5], or treatment for minor ailments[6]. In many countries, DED is a minor ailment managed at community pharmacies[7], with programs to facilitate pharmacist-provided services[6]. These include DED treatments[8] such as artificial tears, mucin secretagogues, topical antibiotics, topical corticosteroids, lid hygiene products, and fatty acid supplements. CPs must identify DED aetiologies accurately and tailor treatments[1]. Yet, distinguishing aqueous-deficient dry eye (ADDE) from evaporative dry eye (EDE) can be challenging[1].

The Asia Dry Eye Society (ADES) classifies DED differently[9] as aqueous-deficient, decreased wettability, or increased evaporation DED, based on the abnormal constituents in each tear film layer and their treatment, thus facilitating tear film-oriented therapy. Meibomian gland dysfunction (MGD) must be treated if MGD causes abnormal lipid layers and DED. Sjögren or non-Sjögren aqueous tear deficiency leading to DED requires the provision of aqueous components, including artificial tears or tear secretagogues such as diquafosol sodium (DQS). Abnormal mucins require mucin secretagogues such as DQS or rebamipide. Hence, tear film dysfunction or abnormality determines DED treatment.

DED management by CPs may be suboptimal. In one publication, 58% of DED diagnoses by British community pharmacy staff (pharmacists and pharmacy assistants) were incorrect[10], while 31% of Romanian CPs recommended ocular decongestants

Tzu Hang Sia. B (Pharm), School of Pharmacy, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia.
Mei Qian Yau. PhD, B (Pharm), School of Pharmacy, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia; Digital Health and Medical Advancement Impact Lab, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia.
Raja Ahsan Aftab. PhD, Pharma-D, Faculty of Pharmacy, Universiti Malaya, 50603 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur, Malaysia.
Renukha Sellappans. PhD, M (Pharm), School of Pharmacy, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia.
Bee Kim Tan*. PhD, B (Pharm), School of Pharmacy, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia; Digital Health and Medical Advancement Impact Lab, Taylor's University, Subang Jaya, 47500, Selangor, Malaysia. beekim.tan@taylors.edu.my

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that may exacerbate DED.

Understanding CPs' knowledge and practices in identifying and managing DED facilitates the development of systematic strategies to optimise care. These data are lacking in developing countries, even though consumers increasingly seek CPs' advice on minor ailments. In 2016, Malaysia registered 2,780 community pharmacies, half in the Klang Valley[11] and within communities, making over-the-counter medications such as ocular lubricants publicly accessible[12]. Thus, CPs must be knowledgeable about DED to identify and treat it.

This study aimed to determine the level of DED knowledge and practice among CPs in Malaysia's Klang Valley and to understand the influence of their socio-demographic factors.

METHODS

Study Design and Population

This cross-sectional study used a self-administered online survey of community pharmacy CPs in Klang Valley, which comprises 25% of Malaysia's population. Community pharmacies were recruited via stratified sampling (Table 1), with CPs chosen for adequate representation of urban, suburban, and rural communities. Only CPs fully registered with the Pharmacy Board of Malaysia were included. Using a 5% margin of error, 95% confidence interval, and 50% response distribution, the calculated sample size was 339 CPs (Raosoft® software, 2004, USA)[13]. Taylor's University Human Ethics Committee (HEC 2023/040) provided ethics approvals.

Questionnaire

A 64-item, multiple-choice and 'true' or 'false' questionnaire (Supplementary Appendix 1) was adapted from validated questionnaires[1,14,15], to collect demographic information and assess CP's DED knowledge [on DED subtypes, DED risk factors, DED-associated medical conditions and medications; DED signs and symptoms, DED differential diagnosis, lifestyle and/or environmental modifications; DED treatments; side effects of ocular lubricants, and precautions with ophthalmic preparations] and practice patterns (DED information source, form(s) of training, scenario-based questions, referral circumstances and frequency, patient counselling, checking drug-drug interactions, and confidence in treatment recommendations). The 4-point Likert scale was used to rate practice frequency (1, never; 2, sometimes; 3, often; and 4, always) and assess confidence (1, very unconfident; 2, fairly unconfident; 3, fairly confident; and 4, very confident).

Each correct knowledge or positive practice response scored 1 point, up to 70 and 61 points, respectively. Six experts reviewed the content, rated each item's relevance, and established an acceptable level of item-level content validity index (I-CVI) of 0.83[16]. In-person validation was conducted through a pilot study with 30 CPs.

Data Collection

From April to June 2023, data were collected from CPs who received study information and online survey links, and provided informed consents. No incentives were provided.

Table 1. Socio-demographic Characteristics of the Respondents

Socio-demographic Characteristics		**n (%)**
Gender	Male	148 (41.1%)
	Female	212 (58.9%)
Age groups	25 and below	23 (6.4%)
	26 – 30	134 (37.2%)
	31 – 35	103 (28.6%)
	36 – 40	57 (15.8%)
	41 – 45	26 (7.2%)
	46 and above	17 (4.7%)
Ethnicity	Malay	92 (25.5%)
	Chinese	210 (58.3%)
	Indian	58 (16.1%)
Highest education level	Bachelor's Degree	276 (76.7%)
	Master's Degree	76 (21.1%)
	Doctorate Degree	8 (2.2%)
Years of experience in community pharmacy practice	5 years and below	112 (31.1%)
	6 – 10 years	105 (29.2%)
	11 – 15 years	73 (20.3%)
	16 – 20 years	46 (12.8%)
	20 years and above	24 (6.7%)

Type of pharmacy	Chain (4 or more stores)	276 (76.7%)
	Independent	84 (23.3%)
Employment status	Full-time	281 (78.1%)
	Part time/Locum	79 (21.9%)
Location of pharmacy practice	Ampang Jaya	32 (8.9%)
	Kajang	38 (10.6%)
	Klang	34 (9.4%)
	Kuala Lumpur	38 (10.6%)
	Petaling Jaya	39 (10.8%)
	Putrajaya	34 (9.4%)
	Selayang	35 (9.7%)
	Sepang	35 (9.7%)
	Shah Alam	37 (10.3%)
	Subang Jaya	38 (10.6%)
Number of patients served per day	Less than 25 patients	22 (6.1%)
	25 – 50 patients	203 (56.4%)
	More than 50 patients	135 (37.5%)
Amount of time spent with each patient	Less than 3 minutes	25 (6.9%)
	3 – 7 minutes	236 (65.6%)
	7 – 10 minutes	87 (24.2%)
	More than 10 minutes	12 (3.3%)

Data Analysis

Data were analysed using SPSS (version 27, SPSS Inc., USA). Descriptive statistics were presented as frequencies, percentages, median ± interquartile range, and mean ± standard deviation. The average scores (%) of DED knowledge and practice were categorised using Bloom's cut-off point[17-19], where 75% was the threshold score indicating a high knowledge or practice level, 40% to 74% indicated an intermediate knowledge or moderate practice level, and scores below 40% indicated low knowledge or poor practice levels. Average scores between two socio-demographic groups were compared using independent T-tests and Mann-Whiney U tests, while CPs in more than two socio-demographic groups were compared using Analysis of Variance (ANOVA) and Kruskal-Wallis H Test. Factors associated with respondents' DED knowledge and practice were determined using multivariate linear regression while controlling for confounders. Variables of the regression model with smaller Bayesian Information Criteria values were chosen using backward elimination. Statistical significance was set at $P < 0.05$.

RESULTS

Respondents' Socio-demographic Characteristics

Most participating CPs (n=360) were female (58.9%), aged 26–30 years (37.2%), ethnically Chinese (57.9%), and bachelor's degree holders (76.7%) (Table 1). Most (31.1%) had 5 years or less of experience, worked full-time (78.1%) at chain pharmacies (76.7%), served 25–50 patients daily (56.4%), and spent 3–7 min per patient (65.6%). The percentage of respondents from each Klang Valley District ranged from 8.9% to 10.8%.

Respondents' Knowledge of DED

DED knowledge was high in 2.5% (n=9; score ≥52.5 over 70), intermediate in 87.2% (n = 314; score <52.5 and ≥28 over 70), and low in 10.3% (n = 37; score <28 over 70) of respondents. DED subtypes were unfamiliar (Table 2) as only 22.8% knew the aetiology of wettability, while most (62.2%) were unaware that tear film lipid layer abnormalities caused EDE, or that ADDE was associated with thicker lipid layers and accumulated mucin (85.8%). Respondents were aware of most DED risk factors, except androgen deficiency (13.3%). Most were unaware that autoimmune diseases, such as Sjögren's syndrome (61.4%), thyroid disease (63.9%), and MGD (85%), were potential causes, or that antidepressants (66.7%), anxiolytics (64.4%), and hormone replacement therapy (90%) could worsen or induce DED. Most could identify common ocular symptoms [burning sensations (90.0%), dryness (90.6%), and foreign body sensations (89.2%)], but not stringy mucus around the eye (24.2%) or sore red eyes (32.2%). Most could differentiate runny nose (69.2%) and constant watery eyes (62.8%) in allergic conjunctivitis and yellow or green discharge (88.9%) in bacterial conjunctivitis from DED. However, 45.6% could not differentiate viral conjunctivitis symptoms from DED.

Most lifestyle modifications were known, except for lid hygiene and warm compression (37.5%), and nutritional supplementation (35.6%). The main functions of certain DED nutritional supplements were unfamiliar, including

Table 2. Respondent's Responses on DED Knowledge Items

Items	Correct n (%)	Incorrect n (%)
K1(i) Definition of aqueous-deficient dry eyes		
Caused by reduced lacrimal secretion but tear evaporation rate is normal	181 (50.3%)	179 (49.7%)
Associated with thicker lipid layer and accumulated mucus	51 (14.2%)	309 (85.8%)
More prevalent than evaporative dry eye	302 (83.9%)	58 (16.1%)
Due to the abnormal quality of the lipid layer in the tear film	343 (95.3%)	17 (4.7%)
K1(ii) Definition of evaporative dry eyes		
More prevalent than aqueous-deficient dry eye	66 (18.3%)	294 (81.7%)
Due to the abnormal quality of the lipid layer in the tear film	136 (37.8%)	224 (62.2%)
Caused by reduced lacrimal secretion but tear evaporation rate is normal	350 (97.2%)	10 (2.8%)
Associated with thicker lipid layer and accumulated mucus	322 (89.4%)	38 (10.6%)
K1(iii) Definition of wettability dry eyes		
Due to the deficiency/abnormality of mucin layer in the tear film	82 (22.8%)	278 (77.2%)
More likely to occur in those with prolonged screen time	55 (15.3%)	305 (84.7%)
Caused by reduced lacrimal secretion but tear evaporation rate is normal	348 (96.7%)	12 (3.3%)
Due to the abnormal quality of the lipid layer in the tear film	353 (98.1%)	7 (1.9%)
K2 Risk factors		
Androgen deficiency	48 (13.3%)	312 (86.7%)
Cold, dry, dusty, polluted or windy environment	354 (98.3%)	6 (1.7%)
Female gender	179 (49.7%)	181 (50.3%)
Old age/elderly	350 (97.2%)	10(2.8%)
Prolonged computer/handphone use	339 (94.2%)	21(5.8%)
Wearing contact lenses	256 (71.1%)	104 (28.9%)
Being underweight	358 (99.4%)	2 (0.6%)
Wearing eyeglasses	314 (87.2%)	46 (12.8%)
K3 Medical conditions		
Allergic Conjunctivitis	261 (72.5%)	99 (27.5%)
Autoimmune diseases (e.g., Sjögren syndrome, SLE)	139 (38.6%)	221 (61.4%)
Diabetes	275 (76.4%)	85 (23.6%)
Meibomian gland dysfunction	54 (15.0%)	306 (85.0%)
Thyroid disease	130 (36.1%)	230 (63.9%)
Hypertension	342 (95.0%)	18 (5.0%)
K4 Medications		
Antidepressants	120 (33.3%)	240 (66.7%)
Antihistamine	293 (81.4%)	67 (18.6%)
Anxiolytics (e.g., benzodiazepines)	128 (35.6%)	232 (64.4%)
Beta blockers	186 (51.7%)	174 (48.3%)
Diuretics	268 (74.4%)	92 (25.6%)
Hormone replacement therapy	36 (10.0%)	324 (90.0%)
Alpha blockers	243 (67.5%)	117 (32.5%)
ACE inhibitors	334 (92.8%)	26 (7.2%)
K5 Symptoms		
Blurred vision	155 (43.1%)	205 (56.9%)
Burning or stinging sensation in the eyes	324 (90.0%)	36 (10.0%)
Eye dryness	326 (90.6%)	34 (9.4%)

Gritty/sandy eyes (foreign body sensation)	321 (89.2%)	39 (10.8%)
Photophobia	180 (50.0%)	180 (50.0%)
Red and sore eyes	116 (32.2%)	244 (67.8%)
Stringy mucus in or around the eyes	87 (24.2%)	273 (75.8%)
Watery eyes	197 (54.7%)	163 (45.3%)
Floaters	351 (97.5%)	9 (2.5%)
K6(i) Differential diagnosis of allergic conjunctivitis		
Those with dry eye disease may experience dryness elsewhere	184 (51.1%)	176 (48.9%)
Those with allergic conjunctivitis may have runny nose	249 (69.2%)	111 (30.8%)
Those with allergic conjunctivitis may constantly have watery eyes	226 (62.8%)	134 (37.2%)
Allergic conjunctivitis will cause lesser intense itching	334 (92.8%)	26 (7.2%)
Allergic conjunctivitis is more likely caused by antihistamine	335 (93.1%)	25 (6.9%)
K6(ii) Differential diagnosis of bacterial conjunctivitis		
Bacterial conjunctivitis – yellow/green discharge throughout the day	320 (88.9%)	40 (11.1%)
Bacterial conjunctivitis – stringy mucus around the eye	238 (66.1%)	122 (33.9%)
Bacterial conjunctivitis – only have one eye affected	314 (87.2%)	46 (12.8%)
None of the above	345 (95.6%)	15 (4.2%)
K6(iii) Differential diagnosis of viral conjunctivitis		
Viral conjunctivitis may cause fever, runny nose or sore throat	196 (54.4%)	164 (45.6%)
Viral conjunctivitis may constantly cause watery eyes	281 (78.1%)	79 (21.9%)
Viral conjunctivitis will cause lesser intense itching	317 (88.1%)	43 (11.9%)
None of the above	259 (71.9%)	101 (28.1%)
K7a Lifestyle modification advice		
Avoid windy and smoky environment	336 (93.3%)	24 (6.7%)
Get enough sleep	214 (59.4%)	146 (40.6%)
Improved lid hygiene and warm compress	135 (37.5%)	225 (62.5%)
Limit screen time	350 (97.2%)	10 (2.8%)
Nutritional supplements	128 (35.6%)	232 (64.4%)
Using a humidifier	200 (55.6%)	160 (44.4%)
Wear contact lenses	358 (99.4%)	2 (0.6%)
K7b(i) Vitamin A		
Improves smoothness of tear film	84 (23.3%)	276 (76.7%)
Improves tear quality	154 (42.8%)	206 (57.2%)
Reduces inflammation	289 (80.3%)	71 (19.7%)
Reduces burning sensation associated with dry eyes	339 (94.2%)	21 (5.8%)
Reduces the rate of tear evaporation	334 (95.6%)	16 (4.4%)
Repairs the corneal nerve layer	330 (91.7%)	30 (8.3%)
K7b(ii) Vitamin B12		
Reduces burning sensation associated with dry eyes	95 (26.4%)	265 (73.6%)
Repairs the corneal nerve layer	255 (70.8%)	105 (29.2%)
Improves smoothness of tear film	348 (96.7%)	12 (3.3%)
Improves tear quality	340 (94.4%)	20 (5.6%)
Reduces inflammation	311 (86.4%)	49 (13.6%)
Reduces the rate of tear evaporation	350 (97.2%)	10 (2.8%)
K7b(iii) Vitamin D		
Improves tear quality	86 (23.9%)	274 (76.1%)

Reduces inflammation	143 (39.7%)	217 (60.3%)
Improves smoothness of tear film	340 (94.4%)	20 (5.6%)
Reduces burning sensation associated with dry eyes	334 (92.8%)	26 (7.2%)
Reduces the rate of tear evaporation	350 (97.2%)	10 (2.8%)
Repairs the corneal nerve layer	343 (95.3%)	17 (4.7%)
K7b(iv) Essential fatty acids		
Reduces inflammation	207 (57.5%)	153 (42.5%)
Reduces the rate of tear evaporation	113 (31.4%)	247 (68.6%)
Improves smoothness of tear film	311 (86.4%)	49 (13.6%)
Improves tear quality	308 (85.6%)	52 (14.4%)
Reduces burning sensation associated with dry eyes	339 (94.2%)	21 (5.8%)
Repairs the corneal nerve layer	350 (97.2%)	10 (2.8%)
K8 First-line pharmacotherapy		
Artificial tears/ocular lubricant	357 (99.2%)	3 (0.8%)
Oral antibiotics	359 (99.7%)	1 (0.3%)
Topical anti-inflammatory medications	358 (99.4%)	2 (0.6%)
K9 Treatment recommendations for DED (True/false)		
(i) Low-viscosity preservative-free eye drops – usually for mild DED.	336 (93.3)	24 (6.7)
(ii) Aqueous and lipid-based eye drops relieve MGD-induced DED.	196 (54.4)	164 (45.6)
(iii) Active ingredients of the aqueous eye drops – carbomer, carboxymethylcellulose, hypromellose and sodium hyaluronate.	356 (98.9)	4 (1.1)
(iv) Lipid-based eye drops have greater effects in relieving the symptoms of dry eyes compared to aqueous eye drops.	250 (69.4)	110 (30.6)
(v) Preservatives-free eye drops – for habitual users of the eye drops.	328 (91.1)	32 (8.9)
(vi) Eye gels with preservatives – for moderate DED.	129 (35.8)	231 (64.2)
(vii) For moderate DED, eye ointment is recommended to be used during the day whereas eye gel is recommended to be used at night.	283 (78.6)	77 (21.4)
(viii) Second-line treatments of DED: topical anti-inflammatory med, topical antibiotics and ocular decongestants/antihistamines.	302 (83.9)	58 (16.1)
(ix) Diquafosol sodium can be used to relieve all types of dry eye.	107 (29.7)	253 (70.3)
(x) Diquafosol sodium (Diquas®) is the only mucin secretagogue that is available in Malaysia – treat decreased wettability dry eye.	280 (77.8)	80 (22.2)
K10 Common side effects of using eye drops		
Blurry vision	226 (62.8%)	134 (37.2%)
Unpleasant or bitter taste in the mouth	162 (45.0%)	198 (55.0%)
Stinging or irritation	267 (74.2%)	93 (25.8%)
Eye discoloration	348 (96.7%)	12 (3.3%)
Light sensitivity	218 (60.6%)	142 (39.4%)
K11 Precautions when using ophthalmic preparations		
(i) Once opened, eye drops should be thrown away after the expiry date.	328 (91.1)	32 (8.9)
(ii) Shake the eye drops that contain suspension before using them.	323 (89.7)	37 (10.3)
(iii) Wipe the dropper tip with tissue before closing the cap.	250 (69.4)	110 (30.6)
(iv) Leftover solution of single-used eye drop vials still can be re-used.	349 (96.9)	11 (3.1)
(v) Eye drop vials should be stored in the fridge.	356 (98.9)	4 (1.1)
(vi) Contact lenses must be removed before application of eye ointment.	346 (96.1)	14 (3.9)

vitamin A (76.7%) and essential fatty acids (68.6%). Most respondents (99.2%) knew that artificial tears were the first-line pharmacotherapy for DED, the common side effects of eye drops [stinging or irritation (74.2%), blurry vision (62.8%)], the active ingredients of ocular lubricants (98.9%), and that low-viscosity preservative-free eye drops were suitable for mild DED (93.3%). Only 54.4% knew that not all eye drop types relieved MGD-induced DED. Most participants thought that eye gels with preservatives were suitable for moderate DED (64.2%) and were unaware that DQS relieved all types of DED (70.3%). While almost all were aware that leftover solutions in eye drop vials should not be used (96.9%), and the vials should not be stored refrigerated (98.9%), 30.6% thought that after drop administration, dropper tips should be wiped with tissues before bottle cap closure.

Factors Associated with DED Knowledge Score

Educational level and pharmacy type were significantly associated with DED knowledge scores (P<0.001 and P=0.004, respectively) (Table 3). Doctorate holders had significantly higher mean DED knowledge scores (48.3±6) than bachelor'sholders (36.8±7.5l; P<0.001) and master'sholders (40.3±7.9; P=0.013). Pharmacy type was also a significant factor (P<0.05), despite a non-significantly (P=0.428) higher mean DED knowledge score (37.9) among chain versus independent pharmacy respondents (37.2).

Respondent's Practice on DED Identification and Management

DED practice levels were good in 6.9% of respondents (n=25; score ≥45.75 over 61), intermediate in 73.9% (n=266; score <45.75 and ≥24.4 over 61) and poor in 19.2% (n=69; score<24.4 over 61). Continuing education (CE; 86.1%) and online sources (80.3%) were the main sources of DED information (Table 4). Training was mostly provided in-house by a company or suppliers (69.7%), via conferences and seminars (61.7%). However, 10.0% received no DED training. Over half (55.3%) would directly recommend ophthalmic products to walk-in customers for DED symptom relief. Among the remainder (n=161), 135 (83.9%) always established patient identity and 129 (80.1%) tried to identify all relevant symptoms, 97 (60.2%) always took past medical history, 94 (58.4%) always took past medication history, and 99 (61.5%) always tried to identify causative or potential risk factors. Over 50% did not always assess symptom recurrence (52.8%), and few could always identify the causative factors or potential risk factors (14.3%).

Also, 284 (78.9%) respondents would provide recommendations only if DED symptoms appeared mild or moderate (Table 4), while 192 (53.3%) would provide specialist referrals for severe symptoms. Almost all could identify the DED presentations requiring referrals, including severe photophobia (94.7%) or uncontrolled symptoms despite daily eye drop use (92.8%). Only half (50.3%) would refer patients with medication-

Table 3. Factors associated with respondents' DED knowledge score

Variables		Univariate Analysis				Multivariate Analysis		
		t-value[a]	*F-value*[b]	*H-value*[c]	*p-value*	Adjusted β (95% CI)	t-statistics	*p*
Gender	**Mean (SD)**	1.09			0.277			
Male	37.2 (7.7)							
Female	38.1 (8.0)							
Age groups	**Median (IQR)**			14.702	**0.012**[d]			
≤25	35.0 (15.0)							
26 – 30	36.3 (10.1)							
31 – 35	38.5 (11.0)							
36 – 40	39.0 (9.8)							
41 – 45	37.8 (9.5)							
≥46	43.0 (16.8)							
Ethnicity	**Median (IQR)**			1.498	0.473			
Malay	37.5 (10.3)							
Chinese	37.5 (9.5)							
Indian	38.3 (13.8)							
Highest education level	**Mean (SD)**		14.543		**<0.001**	0.261 (2.268 to 6.13)	4.277	**<0.001**
Bachelor's degree	36.8 (7.5)							
Master's degree	40.3 (7.9)							
vs bachelor's degree					**<0.001**			
Doctorate degree	48.3 (6.0)							
vs bachelor's degree					**<0.001**			
vs master's degree					**0.013**			

Community pharmacy practice (years)	**Median (IQR)**			16.251	**0.003**			
≤5 years (ref)	35.8 (11.8)							
6 – 10 years	38.0 (9.5)							
11 – 15 years	39.5 (10.5)				**0.003**[e]			
16 – 20 years	39.0 (9.8)							
≥21 years	37.5 (17.6)							
Type of pharmacy	**Mean (SD)**	0.79			0.428	-0.155 (-4.813 to -0.92)	-2.896	**0.004**
Chain (≥4 stores)	37.9							
Independent	37.2							
Employment status	**Mean (SD)**	1.989			**0.047**			
Full-time	38.2							
Part time/Locum	36.2							
Location of pharmacy practice	**Mean (SD)**		0.902		0.524			
Ampang Jaya	37.3 (7.9)							
Kajang	34.7 (8.9)							
Klang	38.6 (6.9)							
Kuala Lumpur	38.0 (8.0)							
Petaling Jaya	38.0 (9.2)							
Putrajaya	38.4 (6.0)							
Selayang	38.1 (7.8)							
Sepang	37.9 (8.5)							
Shah Alam	39.2 (7.3)							
Subang Jaya	37.7 (6.8)							
Number of patients served per day	**Mean (SD)**		8.175		**<0.001**			
<25 patients	33.5 (9.8)				**0.004**			
25 – 50 patients (ref)	39.1 (7.3)							
>50 patients	36.5 (7.8)				**0.008**			
Time spent with each patient	**Mean (SD)**		0.34		0.797			
<3 minutes	37.5 (8.9)							
3 – 7 minutes	37.9 (7.9)							
7 – 10 minutes	37.3 (7.5)							
>10 minutes	39.5 (5.3)							

*Variables of the multivariate linear regression model with smaller Bayesian Information Criteria values were chosen using backward elimination.
**R^2: 0.108; there was no significant interaction and multicollinearity issues; model assumptions were met
Abbreviations: SD = Standard Deviation; IQR = Interquartile Range; ref = reference; a = Independent Sample T-test; b = One-way ANOVA; c = Kruskal-Wallis H Test; d = Adjusted p-value using Dunn-Bonferroni correction method > 0.05; e = Adjusted p-value for comparison between 5 years of experience and below, and 11 – 15 years of experience using Dunn-Bonferroni correction (0.003)

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Table 4. Respondent's responses to DED Practice items

Description of Question	**Option**	**n (%)**
P1a Source(s) of information related to dry eye disease and its management	Books	22 (6.1%)
	Continuing education	310 (86.1%)
	Eye specialists and/or ophthalmologists	37 (10.3%)
	Online sources	289 (80.3%)
	Pharmacy school	100 (27.8%)
	Work training	276 (76.7%)
P1b Form(s) of training received	Conferences/seminars	222 (61.7%)
	Formal training	30 (8.3%)
	In-house training	251 (69.7%)
	No training	36 (10.0%)
P2a Would you straightaway recommend ophthalmic preparations to those seeking DED relief?	Yes	199 (55.3%)
	No	161 (44.7%)
P2b If no, what would you do before providing recommendations to the customer?		161[a]

Statement	**No, n (%)**	**Sometimes, n (%)**	**Always, n (%)**
P2b(i) Establish patient identity	5 (3.1%)	21 (13.0%)	135 (83.9%)
P2(b)ii Take past medical history	4 (2.5%)	60 (37.3%)	97 (60.2%)
P2(b)iii Take past medication history	4 (2.5%)	63 (39.1%)	94 (58.4%)
P2(b)iv Try to identify all relevant symptoms	0 (0.0%)	32 (19.9%)	129 (80.1%)
P2(b)v Able to identify all relevant symptoms	0 (0.0%)	57 (35.4%)	104 (64.6%)
P2(b)vi Ask about the duration of symptoms	0 (0.0%)	35 (21.7%)	126 (78.3%)
P2(b)vii Ask about the recurrence of symptoms (if applicable)	0 (0.0%)	85 (52.8%)	76 (47.2%)
P2(b)viii Try to identify causative factors/potential risk factors from relevant social history	0 (0.0%)	62 (38.5%)	99 (61.5%)
P2(b)ix Able to identify causative factors/potential risk factors from relevant social history	0 (0.0%)	138 (85.7%)	23 (14.3%)

Description of Question	**Option**	**n (%)**
P3 If a customer visits the pharmacy without previously diagnosed with dry eye disease, will you still provide recommendations to the customer or refer the customer to the eye specialist?	Yes, if symptoms are mild or moderate.	284 (78.9%)
	No, if symptoms are severe but refer to an eye specialist.	192 (53.3%)
P4 Under what circumstances will you refer customers to the eye specialist?	Elderly with severe photophobia.	341 (94.7%)
	Student who uses computer all day.	1 (0.3%)
	Middle-aged customer who has taken metoprolol as prescribed for weeks.	183 (50.8%)
	Middle-aged customer who has dry mouth, dry skin, and joint swelling.	138 (38.3%)
	A regular customer that uses eye drops daily for 2 months.	334 (92.8%)
	A customer recently returned from South Korea in winter.	2 (0.6%)

Statement	**Never, n (%)**	**Sometimes, n (%)**	**Often, n (%)**	**Always, n (%)**
Refer the customers to eye specialist.	19 (5.3%)	118 (32.8%)	152 (42.2%)	71 (19.7%)
Inform customers about the side effects of the recommended ophthalmic preparations.	10 (2.8%)	115 (31.9%)	198 (55.0%)	37 (10.3%)
Advise the customers about the dosage and administration of the recommended ophthalmic preparations.	0 (0.0%)	6 (1.7%)	130 (36.1%)	224 (62.2%)

Check the drug-drug interaction between ophthalmic preparations and the current medication(s) taken when needed.	60 (16.7%)	224 (62.2%)	68 (18.9%)	8 (2.2%)
Inform customers about possible drug-drug interactions between the ophthalmic preparations and the current medication(s) taken by the customers (if any).	149 (41.4%)	169 (46.9%)	35 (9.7%)	7 (1.9%)

Level of confidence	**Very unconfident n (%)**	**Fairly unconfident n (%)**	**Fairly confident n (%)**	**Very confident n (%)**
When recommending ophthalmic preparations.	4	104	224	28
	-1.10%	-28.90%	-62.20%	-7.80%
When advising on lifestyle/environmental modifications.	5	61	208 (57.8%)	86 (23.9%)
	-1.40%	-16.90%		

a. Total number of respondents that choose to gather relevant information before providing recommendations to customers is 161, which was used to make comparisons from Question P2(b)i to Question P2(b)ix.

induced risk factors and fewer (38.3%) would refer patients with Sjögren's syndrome. Over half (62.2%) would always advise on the dosage and administration of the recommended ophthalmic preparations. Most respondents referred to eye specialists 'often' (42.2%) and informed customers about eye drop side effects (55.0%). However, 62.2% 'sometimes' checked drug-drug interactions between ophthalmic preparations and customers' existing medications, and 46.9% 'sometimes' informed customers about possible interactions. Most (62.2%) were fairly confident when recommending ophthalmic preparations and advising on lifestyle and/or environmental modifications (57.8%).

Factors Associated with DED Practice Score

CP age and education level were significantly associated with DED practice score (P<0.001, P=0.011; Table 5). CPs aged 25 years and younger had a significantly higher median practice score (39; IQR 15.5) than respondents aged 41–45 (25; IQR 17, P=0.023). Education level was a significant factor (P=0.011), despite a non-significantly higher median DED practice score (36.3; IQR 18) among doctorate holders than bachelor'sholders (31.5; IQR 16.4) and master'sholders (30.5; ICR 15.5, P=0.533).

Table 5. Factors Associated with Respondent's DED Practice Score

Variables		**Univariate Analysis**			**Multivariate Analysis**		
	Median (IQR)	***Z-value*[a]**	***H-value*[b]**	***p-value***	**Adjusted β (95% CI)**	**t-statistics**	***p***
Gender		-1.438		0.15			
Male	31.8 (14.5)						
Female	29.5 (17.5)						
Age groups			14.859	**0.011**	-0.213 (-2.437 to -0.681)	-3.491	**<0.001**
25 and below	39.0 (15.5)						
26 – 30 (ref)	31.8 (15.5)						
31 – 35	30.5 (16.5)						
36 – 40	29.5 (14.0)						
41 – 45	25.0 (17.0)			**0.023**[c]			
46 and above	31.5 (20.0)						
Ethnicity			3.581	0.167			
Malay	32.8 (18.5)						
Chinese	31.0 (16.5)						
Indian	29.0 (14.5)						
Highest education level			1.259	0.533	0.162 (0.695 – 5.29)	2.561	**0.011**
Bachelor's Degree	31.5 (16.4)						
Master's Degree	30.5 (15.5)						
Doctorate Degree	36.3 (18.0)						
Community pharmacy practice (years)			11.675	**0.02**[d]			
≤5 years	32.0 (15.5)						

6 – 10 years	31.5 (15.5)						
11 – 15 years	31.5 (14.8)						
16 – 20 years	27.5 (14.8)						
≥21 years	26.5 (14.8)						
Type of pharmacy		-2.038		**0.042**			
Chain (≥4 stores)	31.5 (16.5)						
Independent	28.5 (16.5)						
Employment status		-0.859		0.39			
Full-time	31.5 (16.5)						
Part time/Locum	29.5 (16.5)						
Location of pharmacy practice			11.787	0.226			
Ampang Jaya	28.5 (18.3)						
Kajang	28.5 (14.9)						
Klang	31.5 (15.8)						
Kuala Lumpur	32.0 (14.8)						
Petaling Jaya	29.0 (18.5)						
Putrajaya	33.5 (14.0)						
Selayang	37.0 (18.5)						
Sepang	29.5 (18.5)						
Shah Alam	28.5 (14.0)						
Subang Jaya	31.0 (16.5)						
Number of patients served per day			0.366	0.833			
<25 patients	39.0 (17.0)						
25 – 50 patients	31.5 (17.5)						
>50 patients	29.5 (15.5)						
Time spent with each patient			5.481	0.14			
<3 minutes	29.5 (16.8)						
3 – 7 minutes	29.5 (15.5)						
7 – 10 minutes	32.5 (16.0)						
>10 minutes	41.0 (19.0)						

Note. ref = Reference
*Variables of the multivariate linear regression model with smaller Bayesian Information Criteria value were chosen by using the backward elimination method
**R^2: 0.065; there was no significant interaction and multicollinearity issues; model assumptions were met
a. Mann-Whitney U Test.
b. Kruskal-Wallis H Test.
c. Adjusted p-value using Dunn-Bonferroni correction method for age group of 26 – 30 and 41 – 45 was 0.023.
d. Adjusted p-value using Dunn-Bonferroni correction method for different years of experience in community pharmacy practice was > 0.05.

DISCUSSION

Of 360 CPs, 87.2% had intermediate DED knowledge, and 2.5% had a high level of knowledge. Pharmacists with higher academic degrees and working in chain pharmacies were significantly associated with good DED knowledge. DED practices were moderate, but younger pharmacists with higher academic degrees had better practices. Like other studies,[48] our CPs were well distributed across Malaysia's populous Klang Valley. Most CPs had insufficient knowledge of the DED subtypes, as evidenced by misconceptions regarding the use of artificial tears for MGD-induced EDE. While CP's mostly had intermediate DED knowledge, they were less knowledgeable about DED induced or associated with comorbidities and medications, or that alpha blockers cause dry mouth while ACEi cause dry cough but confer anti-inflammatory protection.[16] Since CPs are a first point-of-care for minor ailments, they must acquire the critical analytical skills for sound differential diagnoses.[17-18] Our CPs also had inadequate knowledge of the differential diagnosis of viral conjunctivitis and DED. As viral conjunctivitis is self-limiting, only symptomatic relief is required.[19] Misdiagnosis of viral conjunctivitis as DED and subsequent frequent and prolonged treatment with artificial tears can lead to preservative-induced eye irritation and secondary DED.

To improve outcomes, CPs must understand the DED subtypes (per guidelines), move beyond symptom-based treatments, and know how to tailor recommendations to DED subtypes. However, this may be impractical in community pharmacy settings due to limitations in DED diagnoses. While the public approaches CPs for minor health issues and specific medications[12], few studies exist on CPs' management of minor ailments, such as DED. CPs have counselled 54.4% of customers requiring medications or health supplements but remain concerned about their own inadequate knowledge of new product indications(4) or usage. CPs' DED treatments may resemble their treatment of other minor ailments and be associated with factors including ethnicity, position, and duration of professional experience, which must be addressed to maintain consistent public health services.

Even if DED guidelines are unfamiliar, ADES may be more locally relevant. For ADDE, ADES recommends artificial tear substitutes containing hyaluronic acid and carboxymethylcellulose and tear secretagogues such as DQS. ADES also recommends improving symptoms, tear stability, and secretion with anti-inflammatory treatments like cyclosporin A, or lifitegrast to improve symptoms. Patients with autoimmune disease may require steroids or immunosuppressants to control the disease and improve DED, but autologous serum eye drops are beneficial for severe ADDE. For increased evaporation DED, lid hygiene is the recommended first-line treatment, along with lipids or lipid-containing eye drops, warm compresses, and maintenance of periocular humidity. Rebamipide and DQS are recommended for decreased wettability DED, mucin layer deficiency, and instability.

CPs also help ensure eye drop treatment success, as proper drop usage prevents progression of ocular diseases and medication burdens[20,21]. Poor drop instillation techniques occurred in 76% of users who purchased them from community pharmacies, yet most individuals receiving pharmacist counselling found pharmacists to be knowledgeable on instillation, and provide helpful counselling[20,22,23]. Thus, pharmacists should be leveraged as key healthcare providers in minor ailment management[23].

TFOS DEWS II recommends pre-surgical prophylaxis of DED with dietary modifications[24], as nutritional deficiencies can affect tear film composition[25]. Consistent with other studies[26], many respondents were unfamiliar with the role of nutrition in DED. Furthermore, 64.2% believed that preservative-containing eye gels were appropriate for moderate DED. One study[27] reported reduced DED severity in habitual users of preserved artificial tears, with a strong preference for preservative-free drops. Additionally, artificial tears containing preservatives produced greater harm than traditional preservatives, even when used briefly. Hence, TFOS recommendations were less appropriate since preservatives may worsen eye irritation in moderate DED requiring frequent or daily artificial tears[28] Most (70.5%) respondents were unaware that the mucin secretagogue, DQS, treats all DED classes (under ADES classification). DQS enhances lipid layer spreading[9] and can thus treat abnormalities in each tear film layer. Malaysian CPs have inadequate exposure to novel therapeutics for DED and/or understanding of their mechanisms.

DED knowledge was significantly associated with educational level and pharmacy type. Doctorate holders were more knowledgeable than bachelor's holders and master's holders, similar to postgraduate-qualified CPs[29]. Doctorate holders may have more CE, professional development, and access to experts and resources. Greater knowledge among those in chain pharmacies resulted from the Knowledge-to-Action Framework[30] capacity-building programs, and the implementation of standardised protocols and guidelines, which provide a structured framework to disseminate consistent and up-to-date information on DED[31]. Chain pharmacies also provide larger pharmacist networks for information sharing. From a practice perspective, continuing education on eye health needs to be intensified to address gaps in CPs' knowledge especially among those from the independent practice. Continuing professional development not only boosts CP's confidence but also improve their engagement in clinical practice.

Despite the high utilisation of CE, online information, in-house training, conferences, and seminars, the respondents' DED practice scores remained poor. While most (80.1%) claimed to always try to identify all relevant symptoms, only 64.6% always succeeded; thus, effectively applying theoretical knowledge to real-life settings may be challenging. Only 10.3% gained treatment updates via collaborative practices with ophthalmologists, potentially because of insufficient interprofessional education.

Over half (55.3%) of respondents would provide recommendations to individuals with DED symptoms without first collecting patient information. The accessibility of over-the-counter eye drops in retail outlets makes it common for patients to purchase eye drops without pharmacist intervention. However, CPs must proactively engage with patients to increase eye health awareness and prevent uncontrolled symptoms causing DED progression. Among those who would collect relevant information before making recommendations, almost 40% did not always take past medical and/or medication histories, likely due to time constraints and the perception that this was inessential for prescribing treatments[32]. However, both are essential for identifying and resolving secondary causes of DED symptoms[33].

Also, 78.9% of respondents would provide recommendations only when DED was mild or moderate, whereas 53.3% would refer to specialists when DED was severe. Recommendations based on severity allow timely specialist referral, facilitate proper symptom evaluations, and enhance clinical decision-making. Although most respondents made referrals under appropriate circumstances (e.g., severe photophobia), only 38.3% would refer patients with symptoms of Sjögren's syndrome, perhaps due to its relatively low prevalence in community pharmacies[34].

Over half (62.2%) of respondents always advised on dosage and administration, versus 10% of British CPs.(10) This may be due to differences in respondent backgrounds; the British study recruited non-pharmacist pharmacy staff, while we recruited only pharmacists. Nevertheless, 41.4% of our respondents never checked interactions between the recommended

ophthalmic preparations and a patient's existing medications, or educated patients on possible interactions, similar to other studies[35-37].

Age and education level were significantly associated with overall practice scores. Younger CPs may be more enthusiastic about continuous professional development, while older CPs may resist new practices and treatments. Respondents with advanced education had significantly higher practice scores. Doctorate-holders may have the skills, confidence, clinical expertise and judgment to conduct proactive, thorough assessments, and to personalise recommendations[38]. Those with less advanced qualifications may lack the training and specialized knowledge and skills to effectively manage DED[39]. These findings affect policy, practice and future research in optimising DED management in community pharmacies, providing a foundation for developing continuing professional educational intervention targeting older CPs. For example, specialisation modules for ophthalmology can be developed where CPs could be certified as specialists in area such as ophthalmology.

To our knowledge, this is the first study to investigate DED knowledge and practice levels among CPs in Malaysia or Asian countries. It was limited by its small population of older pharmacists due to either technological barriers (online survey tools) or a lack of interest, similar to previous studies[40]. Our response rate of 58% was likely due to high customer loads causing time constraints. Finally, unlike the simulated patient visit designs in other studies[10,41]. our study relied on respondents' self-rated assessments of their DED knowledge and practice, which may have introduced recall and social desirability biases.

CONCLUSIONS

The current levels of DED knowledge and practice among CPs in Malaysia's Klang Valley are suboptimal despite the high utilisation of CE and in-house training, and Malaysia's high DED burden. Recent revolution in DED classification and management demands CPs to stay up-to-date so as they can confidently play their role in DED care. It is thus necessary to narrow this knowledge-practice gap, ensure that CPs meet health system demands, periodically revise pharmacy education curricula[42], and incorporate pharmacy programs with interprofessional and interdisciplinary clinical education[43-48]. Pharmacists should also receive updates on international practice standards for DED such as the TFOS DEWS II and ADES guidelines. Capacity-building programs such as specialisation modules for DED should be developed to disseminate consistent and updated information on DED management. New policy allowing CPs to be certified as specialists in area such as ophthalmology should also be introduced by the professional body to improve CPs' competency in DED management in the community pharmacy setting. Finally, the availability of an ophthalmologist-collaborative practice platform may enhance CP's understanding of DED management[49], while more effective policies and updated professional pharmacy standards are important to optimise care for patients with DED.

AUTHOR CONTRIBUTIONS

Study design: All authors. Data collection: THS. Data analysis: THS, MQY, BKT. Manuscript writing: THS. Manuscript review and approval: BKT, MQY, RAA, RS.

CONFLICTS OF INTEREST

No conflicts of interest are reported. Study design, management, analysis and reporting were conducted independently of the funding agency.

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