Original Article

Epidemiological Characteristics of Dry Eye Disease in Asian and Asian Female Populations: A Database-Driven Descriptive Study

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Abstract

Purpose: To investigate the epidemiological characteristics of dry eye disease (DED) in Asian populations and among females.

Methods: This study utilized the literature-derived database on DED risk factors, which includes data from 119 studies, and followed an evidence-based medicine retrieval strategy, searching globally for studies on risk factors for DED. Specifically, we focused on the Asian and Asian female populations. A descriptive statistical analysis was conducted on the definitions and prevalence of DED as provided in the database.

Results: The study included a total of 139,556 participants, of which 74,258 were females. The overall prevalence of DED in Asians was found to be 23.9%, and it was observed to increase with age. Specifically, the prevalence was 16.2% in the group aged <30 years, and it increased to 26.7% in the group aged over 70 years. Among females, the prevalence of DED was higher at 28.1% compared to males at 20.1%. Furthermore, the prevalence of DED in females also increased with age, ranging from 39.9% in the group aged <40 years to 42.2% in the group aged over 60 years. The prevalence of DED between 2016 and 2022 was 35.3%, which indicated a significant increase of 14.6% compared to the period between 2008 and 2015. Notably, there were variations in the prevalence of DED across different regions and levels of development.

Conclusions: This study reveals a common occurrence of DED among Asians and women. The prevalence rates vary among different countries, regions, development levels, and sample sizes, and there is an observed upward trend with the increase in survey year and age.

Keywords: Asian region, Descriptive study, Dry eye disease, Female

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Introduction

Dry eye disease (DED) is a prevalent and complex ocular surface disease characterized by tear film instability. It leads to ocular discomfort, visual impairment, and damage to the ocular surface tissue.[1] The occurrence of DED is influenced by various factors, including age, gender, environment, lifestyle, nutrition, cosmetics, drugs, systemic diseases, and ocular surgery.[2,3] According to the Tear film and ocular surface Society's Dry Eye Workshop II (TFOS DEWS II) epidemiological report,[4] DED has a prevalence ranging from 5% to 50%, making it a significant global public health concern. Yu *et al*. estimated that managing DED in the United States costs approximately 5.5 billion USD annually.[5] This condition imposes a substantial burden on patients' quality of life and socioeconomic aspects, impacting their work efficiency, learning ability, mental health, and social activities.

Asia is known for having a high incidence of DED, and being of Asian race is considered a significant risk factor. In fact, the prevalence of DED among Asians is estimated to be

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1.5–2.2 times higher compared to Caucasians.[4] The Asian region is made up of several subregions, namely East Asia, Southeast Asia, South Asia, and West Asia. These subregions have large populations with varying densities, diverse lifestyles, and different levels of economic development. Consequently, the epidemiological characteristics of DED in the Asian region can exhibit significant variations and complexities.

Females are often considered a high-risk group for DED, exhibiting a higher prevalence compared to males.[6,7] This difference may be attributed to changes in female hormone levels,[8] including those associated with the menstrual cycle, pregnancy, lactation, and menopause. Other factors such as the use of certain drugs like contraceptives and diuretics,[9] ocular structure, genetic susceptibility,[8] and various other factors may also contribute to the occurrence of DED in women. Furthermore, the severity and impact of DED in female patients may be greater than in male patients.[10]

The studies of DED in Asia have mostly concentrated on various countries, with little information available on the overall prevalence among Asian people. Furthermore, there is a need to explore the prevalence of DED among Asian women to fill gaps in existing studies and highlight prevention in this specific demographic. This study aims to perform a descriptive analysis of the epidemiology of DED in Asia, particularly among females, and examine its prevalence, distribution characteristics, and associated factors.

Methods

This study utilized a dataset on risk factors for DED (DrDED) developed by our team.[11] The DrDED offers a comprehensive collection of demographic, clinical, and lifestyle data derived from both patients with DED and matched control groups across diverse geographical locations. The DrDED compiles risk factors for DED from a systematic review of 119 observational studies conducted from 2000 to 2022. These studies were carefully selected from databases including PubMed, Embase, Web of Science, and the Cochrane Library, following evidence-based medicine search strategies. Each study underwent a thorough quality assessment using the Newcastle–Ottawa Scale, ensuring that only high-quality data were incorporated. This meticulous approach provides a robust foundation for analyzing the complex risk factors associated with DED. The database is publicly accessible at https://doi.org/10.1038/s41597-023-01931-8. Given the reliance of database on publicly accessible data, whose original studies had already obtained the necessary ethical approvals and consents, no further ethical clearance was deemed necessary for this study.

To investigate the epidemiological characteristics of DED in Asian and female populations, the DrDED database underwent a systematic selection process. Initially, studies conducted in different regions of Asia including East Asia, Southeast Asia, West Asia, and South Asia were filtered based on the provided geographical information. Subsequently, studies that specifically focused on female populations were chosen. This included studies that either only had women as participants or did subgroup analyses for women in studies with people of both sexes. Finally, studies reflecting DED prevalence and distribution in Asian regions and female populations were chosen based on the provided information. Following these selection steps, the study identified 24 eligible articles. It is possible to get the 24 studies that were collected from DrDED information as well as all of the data that were used for statistical analysis from Supplementary Table 1.

This study conducted descriptive statistical analysis on the screened 24 literature, including basic information (such as author, year, country or region, and sample size), DED definition (such as diagnostic criteria and method), and DED prevalence (such as overall prevalence, stratified prevalence by gender, age, region, development level, and other factors). Statistical analyses were performed using the SPSS 20 (SPSS Inc., USA) and Stata 16 (Stata Corp., College Station, TX, USA). The results were summarized using a forest plot (random effects model) to present the prevalence data derived from DrDED. To ensure that the results are trustworthy, it is important to access them with updated studies.[12] In this study, we followed the previous systematic search method and conducted an updated search for studies to compare our findings. The inclusion criteria for updated studies were as follows: (1) studies reported in the English language, (2) studies from which the prevalence of Asian females can be derived from the complete text, (3) studies of the same type as those extracted by DrDED: cross-sectional studies, and (4) studies providing complete information on the research and subjects (author, publication year, country, participant age, and gender). The exclusion criteria primarily included nonoriginal research, case reports, studies with unextractable data on Asian female populations, and noncross-sectional studies. Figure 1 provides a concise overview of the study selection process and the inclusion and exclusion criteria.

Results

The characteristics of the 24 studies obtained from DrDED are summarized in Table 1. These studies were published between 2002 and 2020, with 66.7% of them being published in the last 10 years (2012–2022). The studies involved 7 countries or regions in Asia, primarily China ($n = 6$), South Korea ($n = 9$), and Japan ($n = 4$). The sample size of these studies ranged from 356 to 17,364 people, with a total sample size of 139,556 people, including 74,258 women, with a median of 2565 people and an average of 5815 people. All these studies were cross-sectional studies.

The primary definitions of DED encompass three approaches: symptom-based, clinical examination-based, and comprehensive assessment-based definitions, as shown in Table 2. Symptom-based definition is to use questionnaires or scales as tools to assess and diagnose dry eye symptoms. Questionnaires or scales usually include a series of questions

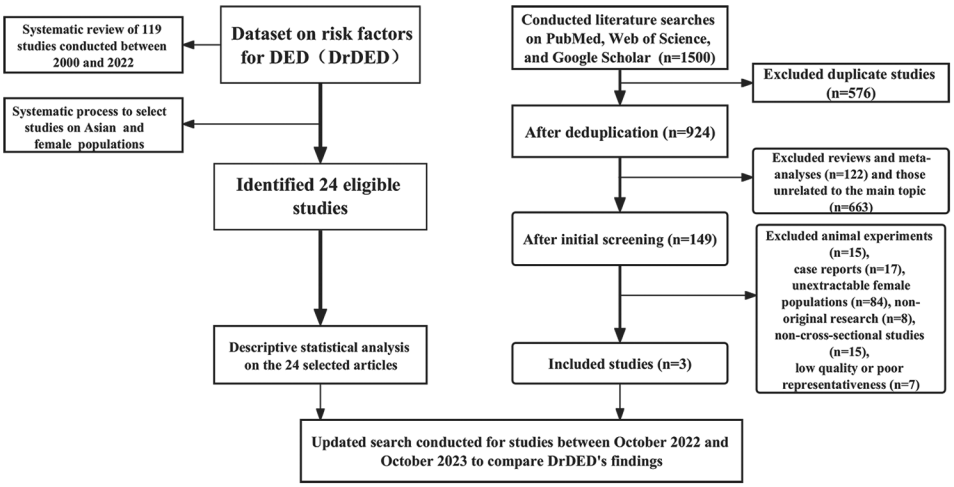

Figure 1: A concise overview of the study selection process and the inclusion and exclusion criteria. DED: Dry eye disease

Table 1: Characteristics of included studies exported from dataset on risk factors for dry eye disease

Author	Year	Country	Sample			Prevalence (%, female)	Definition	Development level	Age	Survey year	PMID
			Total	Male	Female						
Lee *et al*.	2002	Indonesia	1058	505	553	27.5 (24.9~30.3)	Symptom-based	Developing	>21	2001	12446361
Lin *et al*.	2003	China	1361	822	539	33.7 (31.3~36.3)	Symptom-based	Developing	>65	1999	12799232
Lu *et al*.	2008	China	1840	1031	809	52.4 (50.2~54.7)	Symptom-based	Developing	≥40	2006	18520503
Uchino *et al*.	2008	Japan	4393	2640	909	NA	Comprehensive assessment	Developed	22–60	2006	18708259
Jie *et al*.	2009	China	1957	845	1112	21.0 (19.3~22.9)	Clinical examination	Developing	≥40	2001	18309341
Guo *et al*.	2010	China	2486	979	837	45.3 (43.3~47.2)	Symptom-based	Developing	≥40	2006	20642346
Uchino *et al*.	2011	Japan	2644	1221	1423	NA	Comprehensive assessment	Developed	≥40	2010	21889799
Tan *et al*.	2015	Singapore	1004	443	561	13.2 (10.4~14.4)	Symptom-based	Developed	15–83	2010	25269444
Roh *et al*.	2016	Korea	17,364	7365	9999	10.4 (10.0~10.9)	KNHANES-derived DED	Developed	≥20	2010–2012	26488632
Shanti *et al*.	2020	Palestine	769	364	405	64.0 (60.5~67.3)	Comprehensive assessment	Developing	18–90	2016–2017	31931756
Um *et al*.	2014	Korea	16,431	7033	9398	NA	KNHANES-derived DED	Developed	≥30	2010–2012	25128034
Gong *et al*.	2017	China	1015	301	714	27.8 (25.1~30.6)	Comprehensive assessment	Developing	>18	2013	28276756
Ahn *et al*.	2017	Korea	16,824	7104	9720	NA	KNHANES-derived DED	Developed	≥19	2010–2012	28860734
Jeong *et al*.	2018	Korea	9752	4441	5311	8.4 (7.9~9.0)	KNHANES-derived DED	Developed	≥19	2010–2012	30049179
Kim *et al*.	2019	Korea	4185	1787	2398	19.3 (18.1~20.5)	KNHANES-derived DED	Developed	≥65	2010–2012	30369215
Inomata *et al*.	2020	Japan	4454	1483	2972	NA	Symptom-based	Developed	NA	2016–2018	32113987
Lee *et al*.	2015	Korea	6023	3203	2820	16.0 (15.1~16.9)	KNHANES-derived DED	Developed	25–65	2010–2012	26511443
Park *et al*.	2016	Korea	15,294	6526	8768	17.7 (17.1~18.3)	KNHANES-derived DED	Developed	≥19	2010–2012	27366012
Arita *et al*.	2019	Japan	356	133	223	33.4 (28.7~38.5)	Comprehensive assessment	Developed	6–96	NA	30851269
Tandon *et al*.	2020	India	9735	4426	5307	26.2 (25.3~27.1)	Comprehensive assessment	Developing	≥40	2010–2016	32783926
Chatterjee *et al*.	2020	India	2378	1397	981	11.4 (10.2~12.7)	Symptom-based	Developing	≥20	2019–2020	33913832
Choi *et al*.	2021	Korea	475	184	291	48.4 (44.0~52.9)	Symptom-based	Developed	<50–≥70	2013	33522358
Wu *et al*.	2021	China	1287	433	854	54.2 (51.4~56.9)	Comprehensive assessment	Developing	>40	2020–2021	34901096
An *et al*.	2022	Korea	16,471	6937	9534	17.8 (17.3~18.4)	KNHANES-derived DED	Developed	≥20	2010–2012	35773440

PMID: PubMed unique identifier, NA: Not available, DED: Dry eye disease, KNHANES: Korea National Health and Nutrition Examination Survey

about eye discomfort, visual symptoms, environmental factors, and impact on quality of life. The presence of dry eye and foreign body symptoms such as sensation is diagnosed as dry eye. The definition based on clinical examination is to evaluate the degree of eye dryness through examination indicators such as tear secretion volume and tear film break-up time (TBUT). If the examination indicators are lower than the threshold, dry eye is diagnosed. The definition based on comprehensive assessment is the presence of dry eye-related symptoms and the clinical examination index is below the threshold. Korea National Health and Nutrition Examination Survey (KNHANES)-derived DED is the analysis of DED data from the KNHANES. KNHANES included health interviews, nutritional status, and exams. Ophthalmologic questionnaires and examinations in KNHANES were administered to participants aged 40 years and older. The questionnaires covered various ocular diseases, including DED, but were not exclusively tailored for DED assessment.[13]

Table 2: Definitions of dry eye disease used in the included studies

Definition types	Definition	Diagnostic criteria/method	PMID
Symptom-based definition	Frequently or always have one or more of the six common dry eye symptoms	Assess symptoms according to the six-item questionnaire on dry eye symptoms by Schein *et al*.	12446361; 12799232; 18520503; 20642346
	Frequently or always have one of the five common self-reported symptoms	Assess symptoms according to the McMonnies scale	25269444
	OSDI ≥13	Assess symptoms according to the OSDI questionnaire	32113987; 33522358
Clinical examination-based definition	Involving six definitions that combined TBUT, Schirmer score, fluorescein score eyelid margin features, and meibomian gland status	Asian Dry Eye Society diagnostic criteria; China Dry Eye Diagnostic Criteria	18309341
Comprehensive assessment-based definition	OSDI score ≥13 and at least one of the following signs in the affected eye: TBUT ≤10 s, Schirmer score ≤5 mm, fluorescein corneal staining ≥1 grade	Assess symptoms according to the OSDI questionnaire; China Dry Eye Diagnostic Criteria	31931756
	Presence of dry eye symptoms and at least two clinical signs	Asian Dry Eye Society diagnostic criteria	28276756
	Presence of any DED symptoms; FBUT ≤5 seconds	Japan Dry Eye Diagnostic Criteria	30851269
	OSDI score ≥13 and either TBUT <10 s or evidence of ocular surface staining in either eye	Assess symptoms according to the OSDI questionnaire; TFOS DEWS II report	32783926
	OSDI score ≥13 and one of the following: (1) TBUT ≤10 s (2) Schirmer score ≤10 mm	Assess symptoms according to the OSDI questionnaire; China Dry Eye Diagnostic Criteria	34901096
	Presence of previous clinical diagnosis of DED by an eye specialist or severe symptoms of DED (persistent or frequent dryness and irritation)	Japan Dry Eye Diagnostic Criteria; Assess symptoms based on the dry eye questionnaire by Schaumberg *et al*.	18708259; 21889799
KNHANES-derived DED	Diagnosed with DED by an ophthalmologist	Assess symptoms using the KNHANES	35773440; 26488632
	Diagnosed with DED by an ophthalmologist or presence of dry eye symptoms	Assess symptoms using the KNHANES	25128034; 28860734; 30049179; 30369215
	Have dry eye-related symptoms	Assess symptoms using the KNHANES	26511443; 27366012

PMID: PubMed unique identifier, OSDI: Ocular surface disease index, KNHANES: Korea National Health and Nutrition Examination Survey, TBUT: Tear break-up time, FBUT: Fluorescein break-up time, TFOS DEWS II: Tear film and ocular surface Society's Dry Eye Workshop II, DED: Dry eye disease

The literature commonly uses a symptom-based definition, which was employed in seven studies. Questionnaires or scales such as the ocular surface disease index and McMonnies scales were frequently utilized for this approach. In contrast, the use of a clinical examination-based definition was less common, with only one study employing it. Indicators such as TBUT and the Schirmer I score were commonly used in this approach. A comprehensive assessment-based definition was employed in 7 studies, with commonly used standards such as the Chinese dry eye diagnostic criteria and the Asian dry eye society diagnostic criteria. Furthermore, eight studies focused on defining KNHANES-derived DED, representing a noteworthy segment of the research.

The overall prevalence of DED in the Asian population was 23.9% (95% confidence interval [CI]: 21.2%~26.7%). Figure 2 presents an overview of the prevalence rates for Asian individuals as a whole, along with separate rates for Asian women and Asian men. Notably, there has been a significant increase in DED prevalence from 2016 to 2022, reaching 35.3% (95% CI: 22.2%~48.4%). This represents a 14.6% increase compared to the period from 2008 to 2015 [Table 3]. The overall prevalence of DED varies significantly across different samples, ranging from a minimum of 5.2%[9] to a maximum of 64.0%,[14] with a median of 17.8%.[15]

The prevalence of DED in the female population was 28.1% (95% CI: 25.0%~31.2%), which was higher than the prevalence of DED in the male population at 20.1% (95% CI: 17.5%~22.8%). Among different samples, there was also significant variation in the prevalence of DED among females, ranging from a minimum of 7.9% to a maximum of 70.4%. The median prevalence was 23.5%, with an average of 28.4%.

Among the 24 pieces of literature screened, 19 came from East Asia, 2 from Southeast Asia, 2 from South Asia, and 1 from West Asia. This study found that the prevalence of DED in the female population in West Asia was 70.4% (95% CI: 65.7%~74.8%), significantly higher than other regions, followed by East Asia with a prevalence of 28.4% (95% CI: 19.4%~37.3%), among which China had the highest prevalence of 41.8% (95% CI: 30.1%~53.6%). In addition, it was also found that in Asia, the prevalence of DED in the female population in developing countries was 37.9% (95% CI: 26.8%~49.0%), significantly higher than that in developed countries, which was 23.4% (95% CI: 20.5%~26.3%) [Table 3]. Given that the sole study from Western Asia had the highest prevalence, the adjusted prevalence of DED in Asia, excluding Western Asia, stands at 21.6% (95% CI: 18.5%~24.8%). This prevalence may more accurately reflect the situation in Eastern and Central Asian countries, as the majority of the data in our study comes

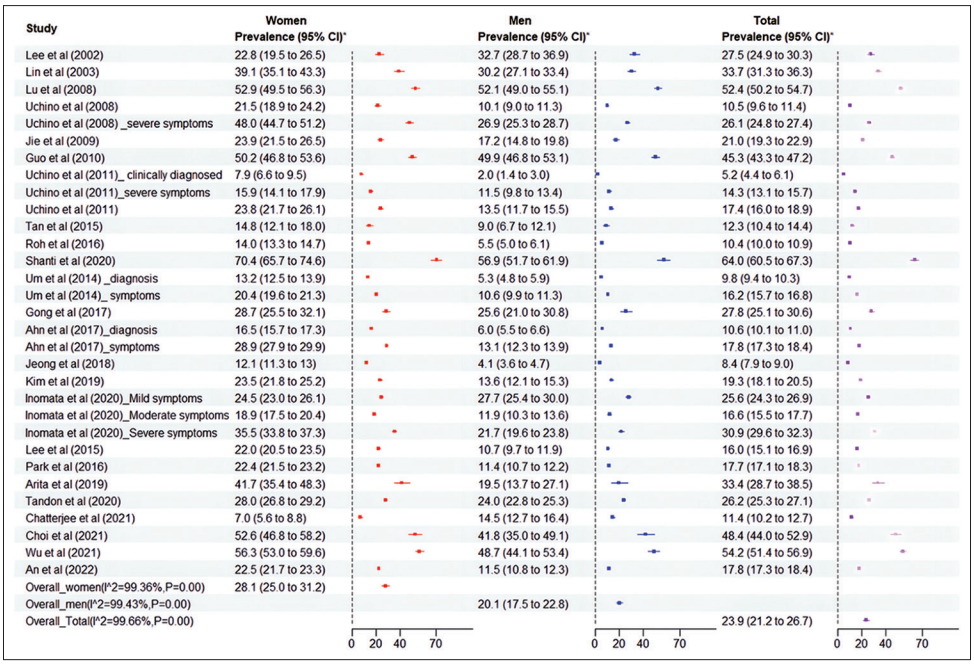

Figure 2: A comprehensive summary of prevalence rates, encompassing rates for the Asian population, Asian women, and Asian men. CI: Confidence interval. I^2: Statistical measure used to assess the degree of heterogeneity, P: The significance test for I^2, with $P < 0.05$, suggests a significant heterogeneity among the results

from Eastern and Central Asian populations, with a significant number of studies – 23 in total – originating from these regions.

The prevalence of DED in the Asian population has an increase with age, from 16.2% for the age group <30 years to 26.7% for the age group >70 years. Similarly, the prevalence of DED in the female population also showed a similar trend, from 39.9% for the age group <40 years to 42.2% for the age group >60 years, which means that elderly women are more likely to suffer from DED than middle-aged and young women. This study also described the prevalence distribution by sample size and other characteristics, as shown in Table 3.

When categorizing the prevalence of DED in Asia by definition, we noted variations across different diagnostic approaches. For the symptom-based definition, the lowest reported prevalence is 11.4%, and the highest is 52.4%. In the comprehensive assessment category, the lowest reported prevalence is 26.2%, and the highest reaches 64.0%. Under the clinical examination definition, there is only one study, which reports a prevalence of 21.0%. For KNHANES-derived DED, the lowest reported prevalence is 8.4%, and the highest is 19.3% [Table 1].

In analyzing the prevalence of DED among Asian females categorized by different diagnostic criteria, we find variations in the reported rates. The symptom-based definition, as represented by eight studies, reports an overall prevalence of 31.7% (range, 23.0%–40.5%). This indicates a relatively high prevalence, suggesting that symptom-based assessments commonly detect a significant prevalence of DED among females. The comprehensive assessment-based definition, represented by seven studies, shows the highest overall prevalence at 34.1% (range, 24.4%–43.8%), likely due to its inclusion of multiple diagnostic criteria which may capture a broader spectrum of symptoms and conditions. In contrast, the clinical examination-based definition, covered in only one study, reports the prevalence at 23.9% (range, 21.5%–26.5%). Finally, the KNHANES-derived DED, which includes eight studies, reveals a lower prevalence of 19.5% (range, 16.2%–22.8%), potentially reflective of the specific demographic and methodological approaches of the KNHANES studies [Table 3]. This analysis suggests that the method of assessment may influence the reported prevalence of DED among Asian females.

The system retrieved and screened three updated studies for comparison with the results from DrDED. These studies include research published by Albdaya *et al*. in 2022, a study by Murakami *et al*. published in March 2023, and a study by Li *et al*. published in May 2023.[16-18] Figure 3 displays a comparison of the prevalence of DED among female participants in these three updated research studies and those that have been conducted by DrDED at the national and regional levels. About 71.6% of females are affected by DED, according to the findings of a study that was conducted by Albdaya *et al*.[18] These data are consistent with the findings of another study included in DrDED, also originating from West Asia, indicating further evidence that the West Asian region exhibits the highest incidence rate among Asian women.[14,18] The study by Li *et al*. reflects that the prevalence of diagnosed DED among women in the Xinjiang region of China is 41.9%, indicating a moderate distribution in the country.[16] According to the findings of the study conducted by Murakami *et al*., the prevalence of women who experience DED, as perceived by them, is 39.8%, while the prevalence of female patients who

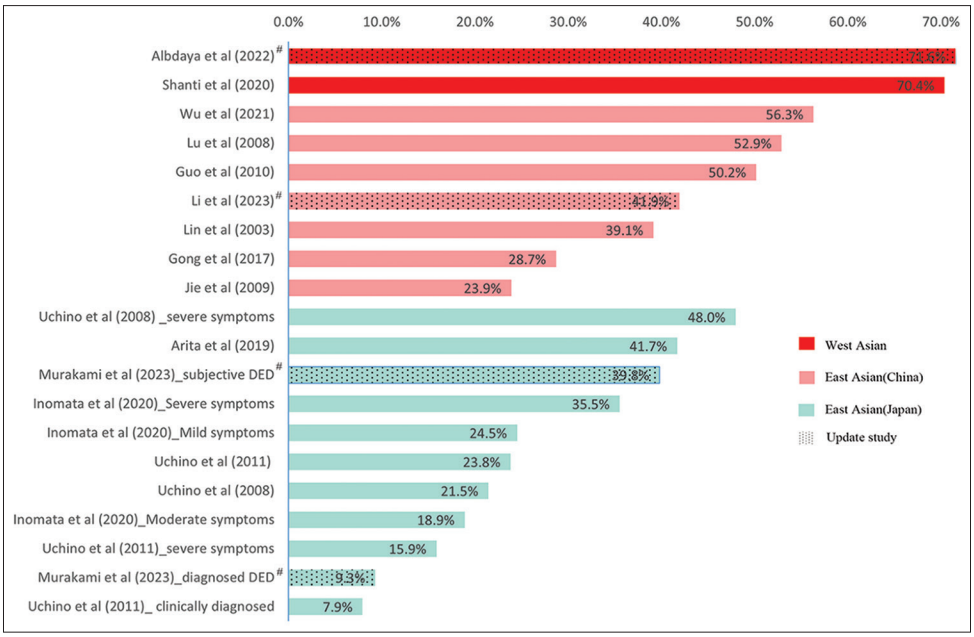

Figure 3: The three update studies involve the prevalence rates of Asian women, comparing them with the previous research conducted by dataset on risk factors for dry eye disease at the national and regional levels

are diagnosed with DED is 9.3%.[17] Hence, when considering a combined prevalence, the results reported by Murakami *et al*. regarding the prevalence of DED in women could be considered moderately consistent with the evidence provided by DrDED. In conclusion, the observed consistency between the results of the three updated studies on the prevalence of DED in Asian women and those derived from internal studies in DrDED is relatively acceptable.

Discussion

The objective of this study is to investigate the epidemiological characteristics of DED in Asian regions, particularly among female populations. The findings indicate a high prevalence of DED in Asian regions, especially among women. According to recent studies, the prevalence of DED in Europe is 13.7%, while South America and Oceania have rates of 14.7% and 14.9%, respectively.[19] In our study, DED appears to be common in the Asian region at a rate of 23.9%, which is higher than in most other regions; furthermore, the prevalence grows with age, which is consistent with previous findings.[4,20] Similar trends can be recognized among Asian women, with a notably higher prevalence of DED compared to males.

The number of studies investigating the relationship between DED and socioeconomics is currently limited.[21] A review indicated that the prevalence of DED tends to decrease from low- and middle-income nations to high-income countries when the economic level is measured by per capita GDP.[22] According to our study, the prevalence of DED among women in developing countries was nearly 1.6 times higher than that of women in developed countries. However, further research is needed to confirm this association.

The prevalence of DED in Asian women raised further significantly between 2016 and 2022, increasing by 14.6% over the 2008–2015 period. This upward trend is believed to be associated with changes in lifestyle, particularly the increased use of visual display terminals, as well as the impact of the new coronavirus epidemic. Previous studies have shown a significant increase in the prevalence of DED among users of visual display terminals[23] and individuals infected with the new coronavirus.[24-26] The assumption has three supporting aspects. First, the popularity of video terminals such as mobile phones and computers in Asia during this period may have contributed to the development of video terminal-related DED.[26] Furthermore, the emergence of the novel coronavirus in 2019 has caused a rise in individuals isolating at home, leading to heightened engagement with video screens, and a decrease in the demand for treatments associated with DED.[26] Finally, direct infection with the virus may also be a contributing factor.[25]

The prevalence of DED in the Asian region has been extensively studied.[19,27,28] Reports indicate rates ranging from 20.0% to 52.4% in East Asia (China, Japan, and Korea), as documented in the TFOS DEWS II epidemiological study on DED.[4] Our findings in the same region align with these results, showing a prevalence of 28.4%. However, the study also reported a lower prevalence among Asian women at 21.6%, contrasting with our research result of 28.1%. In addition, a review of DED prevalence in China estimated it to be 13.55% based on symptoms and signs, which is lower than the result of our study of 41.8%.[29] We identified several factors that could contribute to the disparities in these prevalence estimates. First, variations in participant characteristics, such as age, gender, race, level of development in the country or region,

Table 3: Subgroup analysis of the prevalence of dry eye disease in female population in Asia

	Study (*n*)	Population (*N*)	Prevalence (%) (95% CI)	I^2	*P*
Gender					
Female	24	101,701	28.1 (25.0~31.2)	99.4	<0.001
Male	24	82,560	20.1 (17.5~22.8)	99.4	<0.001
Age (total)					
<30	5	7269	16.2 (11.9~20.5)	95.9	<0.001
30~40	7	20,011	15.3 (11.9~18.7)	97.7	<0.001
40~50	12	26,396	18.4 (14.8~22.0)	98.6	<0.001
50~60	12	24,533	22.0 (18.0~26.0)	98.6	<0.001
60~70	13	22,785	25.7 (21.0~30.4)	98.9	<0.001
>70	12	23465	26.7 (21.1~32.2)	99.4	<0.001
Age (female)					
<40	3	5707	39.9 (1.20~90.0)	99.9	<0.001
40~60	4	10,673	40.7 (7.20~74.1)	99.9	<0.001
>60	4	7917	42.2 (7.60~76.9)	99.9	<0.001
Region					
East Asia	19	93,894	28.4 (19.4~37.3)	99.8	<0.001
China	6	4865	41.8 (30.1~53.6)	98.7	<0.001
Japan	4	15,226	26.2 (19.1~33.4)	99.2	<0.001
Korea	9	73,803	21.9 (18.6~25.3)	99.3	<0.001
Southeast Asia	2	1114	18.7 (10.9~26.6)	91.5	<0.001
Indonesia	1	553	22.8 (19.3~26.3)	NA	<0.001
Singapore	1	561	14.8 (11.9~17.7)	NA	<0.001
South Asia	2	6288	24.7 (23.7~25.8)	NA	<0.001
India	2	6288	24.7 (23.7~25.8)	NA	<0.001
West Asia	1	405	70.4 (65.9~74.8)	NA	<0.001
Palestine	1	405	70.4 (65.9~74.8)	NA	<0.001
Definition					
Symptom-based	8	13,487	31.7 (23.0~40.5)	99.3	<0.001
Comprehensive assessment	7	13,590	34.1 (24.4~43.8)	99.5	<0.001
Clinical examination	1	1112	23.9 (21.5~26.5)	NA	<0.001
KNHANES-derived DED	8	73,512	19.5 (16.2~22.8)	99.4	<0.001
Development level					
Developed	14	89,590	23.4 (20.5~26.3)	99.2	<0.001
Developing	10	12,111	37.9 (26.8~49.0)	99.5	<0.001
Survey year					
2000–2007	5	5129	36.5 (24.5~48.5)	98.9	<0.001
2008–2015	13	88,208	20.7 (18.0~23.3)	99.0	<0.001
2016–2022	4	11,156	35.3 (22.2~48.4)	99.7	<0.001
Sample					
<1000	3	919	55.0 (38.0~72.0)	96.5	<0.001
1000–5000	13	14,662	28.6 (22.6~34.6)	99.3	<0.001
>5000	8	67,023	20.0 (16.5~23.5)	99.4	<0.001

I^2: Statistical measure used to assess the degree of heterogeneity, N/A: Not applicable, CI: Confidence interval, DED: Dry eye disease, KNHANES: Korea National Health and Nutrition Examination Survey

lifestyle, and environmental differences, may influence the results.[30] Second, inconsistencies in the diagnostic criteria included in the literature may also play a role. While some studies suggest that 97.2% of patients diagnosed with DED in China also meet the criteria for Asian dry eye diagnosis,[31] there is a lack of research on the concordance rates between other diagnostic criteria. Moreover, many studies relied on subjective symptoms as the definition of DED. Among the selected literature in this study, 10 articles used definitions based solely on patients' subjective symptoms. Studies based on subjective symptoms often report higher and more variable disease prevalence, reaching up to 70.4% in certain populations.[14] These discrepancies impact the comparability and reliability of DED prevalence data.

Our study has several limitations. First, the majority of our research focuses on East Asia, with limited studies from Southeast Asia and Western Asia. For instance, there is only one study from Western Asia that reports a notably higher prevalence, significantly influencing the overall prevalence. Future research should therefore prioritize these

regions. Increased attention to these areas will contribute to a more accurate representation of the prevalence of DED across the entire Asian continent. In addition, we found significant variation in the prevalence of DED across the literature (I^2 = 99.6%) [Figure 1]. Therefore, the representativeness of the entire Asian region may be compromised. Second, when designing DrDED, we only considered high-quality English studies, potentially excluding some high-quality studies in other languages. Third, the studies included in our analysis used different definitions of DED, so the results should be interpreted with caution added a discussion about the limitations of our study regarding the lack of attention to the male population. Finally, the lack of attention of our study to the male population may lead to an unbalanced representation of both genders.

Despite the aforementioned limitations, our study has several strengths. First, it is based on high-quality research included in the peer-reviewed DrDED. Second, at the regional and national levels, we compared updated studies with the prevalence of DED among Asian women derived from DrDED. The findings of this comparison are relatively similar, suggesting that DrDED is credible and could be employed to investigate the prevalence and distribution characteristics of DED in Asian populations, including Asian women. In addition, by utilizing this database of risk factors for DED, researchers can expedite the collection of more information about DED, contributing to advancements in this research field. Finally, building upon this foundation, our study explores the prevalence and distribution characteristics of DED in the Asian region and among female populations. The findings of a higher prevalence of DED in Asian populations and among Asian women, combined with the provided data support, can contribute to increasing awareness in the region and emphasize the need for preventive measures.

In summary, this article described the epidemiological characteristics of DED in the Asian region and among female populations, revealing its widespread presence in both groups along with an increasing trend and significant disparities and variations. The study also found that there are substantial differences and inconsistencies in the definitions, diagnostic criteria, and methods for DED across different literature sources, which affected the comparability and credibility of DED prevalence data. Therefore, it is suggested that future epidemiological studies of DED should follow internationally recognized or recommended DED definitions or diagnostic criteria or methods to improve the quality and comparability of DED prevalence data. In addition, future epidemiological studies of DED should conduct causal inference analysis to determine the relationship or mechanism between DED prevalence and various potential risk factors, as well as the sources or explanations of heterogeneity among different literature. This study aspires to contribute to the prevention and treatment of DED.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary File

Supplementary Table 1 provides detailed prevalence of dry eye disease (DED) derived from dataset on risk factors for DED sources, including data related to Asia, Asian women, and Asian men. Also include specific distribution information on the age, countries, regions, survey periods, and sample sizes of Asian women.

Supplementary Table 1: Inclusion of literature prevalence - related data

PMID	Age 40-50 (Case_ Total)	Age 50-60 (N_Total)	Age 50-60 (Case_ Total)	Age 60-70 (N_Total)	Age 60-70 (Case_ Total)	Age >70 (N_Total)	Age >70 (Case_ Total)	Age <40 (N_Women)	Age <40 (Case_ Women)	Age 40-60 (N_Women)	Age 40-60 (Case_ Women)	Age >60 (N_Women)	Age >60 (Case_ Women)
12446361	70	90	30	94	28								
12799232				481	155	880	304						
18520503	279	396	205	389	238	362	243						
18708259	69	411	26										
18708259	196	411	93										
18309341													
20642346	297	539	273	317	189	204	150						
21889799	5	289	10	290	6	426	4						
21889799	21	289	33	290	30	426	56						
21889799	24	289	38	290	33	426	58						
25269444													
26488632	284	3,371	371	3,017	385	2,894	285	2,950	392	3,703	526	3,346	482
31931756													
25128034	284	3,534	371	3,146	385	3,054	285						
25128034	463	3,534	595	3,146	582	3,054	519						
28276756													
28860734	275	2,876	367	2,526	374	2,518	274						
28860734	462	2,653	590	2,324	576	2,274	518						
30049179													
30369215				1,392	287	2,793	519						
32113987													
32113987													
32113987													
26511443													
27366012								2,709	2,108	3,328	2,613	2,731	2,087
30851269	15	64	21	74	24	100	41	48	15	71	32	104	46
32783926	828	2,438	653	1,981	576	1,316	490			3,571	896	1,736	589
33913832													
33522358		155	68	171	93	120	58						
34901096													
35773440	451	3,194	584	2,857	573	2,618	493						