

## Original article

# Prevalence of dry eyes in elderly Thai population (the Romklao eye study)

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**Background:** Dry eye syndrome is a common worldwide problem that can decrease the quality of life and vision among the general population. The prevalence of dry eye varied according to diagnostic criteria, population, and age distribution. Information on the prevalence and risk factors of dry eye can be used to ensure that the appropriate treatment for dry eye patients and the general population are administered correctly.

**Objective:** Determined the prevalence and risk factors for dry eye syndrome in Thai population.

**Methods:** Six hundred twenty five subjects between the ages of 50 to 90 were recruited from the Romklao District, Bangkok, Thailand. Subjects were interviewed to assess whether they currently have symptoms of dry eyes, grade the severity, and to determine the risk factors. Associations between dry eyes and risk factors were determined by binary logistic regression.

**Results:** Out of 625 subjects, 89 subjects (14.2%) had dry eye syndrome. The prevalence of dry eyes was greater in females (16.6%) compared to males (10.6%),  $p = 0.029$ . Dry mouth symptoms, allergic history, and previous eye surgery were significantly associated with dry eyes ( $p = 0.005, 0.013, \leq 0.001$ , respectively).

**Conclusion:** Prevalence of dry eyes in the elderly Thai population is 14.2% in our urban study.

**Keywords:** Dry eye prevalence, population-based survey, risk factor, Thai population

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Dry eye syndrome is a common problem among the general population, especially in the elderly. This syndrome can cause dryness, discomfort, burning, grittiness, foreign body sensation, itching, photophobia, tearing, and temporary suffering from blurred vision. Symptoms of this syndrome can range from mild to severe and can affect the quality of life. According to the global definition provided by the National Eye Institute (NEI) Industry workshop in 1995, dry eye is a disorder of the tear film due to lack of tears or excessive evaporation of the tears, which in turn can damage the ocular surface and is associated with symptoms of ocular discomfort. The working group also developed global criteria for diagnosing dry eye as follows, any symptoms of dried eyes, interpalpebral

ocular surface damage, tear instability, and tear hyperosmolarity. Moreover, in 2007, the Dry Eye Workshop (DEWS) has extensively defined dry eye disease as a multifactorial condition of tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. The Epidemiology Subcommittee of the Dry Eye Workshop also assessed and summarized the epidemiology of dry eye syndrome in various populations and described the risk factors for dry eyes. A questionnaire is a useful tool to assess the symptoms of dry eyes and can be used to obtain demographic data as well as identify medical and other risk factors [1]. Aside from using the questionnaire, there are several tests that can be used to assess people with dry eyes such as the use of vital dyes to pinpoint damage on the eye's ocular surface, fluorescein dye to measure the stability of tears, and measurements of the tear film's osmolality.

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Previous researchers have shown that clinical tests measuring the signs of tear deficiency and ocular surface damage are weakly associated with the patients' symptoms [2-4]. Since there is a poor correlation between dry eye symptoms and signs, the important tool to diagnose dry eyes, especially in population-based study, is by using a questionnaire of symptoms. Many studies reported prevalence of dry eyes with questionnaire-based surveys documenting rates ranging from 5.5% to 33% [5-10]. However, there are a few population-based studies that have been done in Asians and none in Thais.

The purpose of this study was to assess the prevalence of dry eyes in the elderly population of Bangkok and identify the risk factors associated with it.

## Materials and methods

### Study population

Our study population had participated in other studies conducted by the Department of Geriatric Medicine of Chulalongkorn University Hospital, Bangkok. It was done in all households located in Rom Klao district, Bangkok, Thailand. The cohort was composed of subjects in their 50s. This study collected the following data, medical problems, risk factors, and health determinants. Rom Klao is a suburban area of Lat Krabang district, which is located approximately 35 kilometers southeast of the center of Bangkok metropolis. In order to qualify for the study, one of the members in the household had to be a homeowner. In addition, to prevent participants from being lost to follow-up, they had to state that they would not move from the area for the next three years. This would allow the study to follow the participants longitudinally. Out of 15,003 people, 941 were enrolled into the study.

Our dry eye study was launched after receiving the appropriate approval from the Ethical Committee of Chulalongkorn University Hospital. During an eight months period, our study distributed the dry eye questionnaire to everyone in the longitudinal cohort. From 941 participants, only 625 completed the questionnaires. The rest had either moved to other provinces or died whereas others refused to participate. Informed consent was obtained from everyone who participated in the study.

### Questionnaires

Trained interviewers contacted the participants and administered the eight-item questionnaire. This

questionnaire assessed the prevalence of dry eyes. Symptoms of dry eyes were eye discomfort, sensation of having a foreign body in the eyes, dryness, tearing, itching, photophobia, burning sensations and blurred vision after prolonged reading. The first six symptoms were modified from the questionnaires used by McCarty et al [7]. According to the Report of the National Eye Institute/Industry Workshop on Clinical Trial in Dry Eye, burning sensation was the most common symptom reported [1]. Blurred vision after prolonged reading was later added to the list of dry eye symptoms after it was shown to be one of the symptoms of dry eyes [2,11-13]. When any participant indicated the presence of any of the symptoms mentioned above, he or she was asked to grade the severity of the symptom(s) as mild, moderate, and/or severe as shown in **Table 1**. Dry eyes were clinically diagnosed if one or more symptoms were severe.

In addition, all participants were asked whether they had any risk factors for acquiring dry eyes. Variables for potential risk factors were age, sex, history of allergy, symptoms of dry mouth, smoking, alcohol consumption, glaucoma, use of contact lens, previous eye surgery and associated systemic diseases such as diabetes, rheumatoid arthritis, thyrotoxicosis, systemic lupus erythematosus, and hypertension.

### Data analysis

The prevalence of dry eye symptoms was calculated by having a confidence interval (CI) of 95%. Binary logistic regression was used to evaluate associations between dry eyes and its risk factors. All risk factors mentioned above were included in the multivariate modeling and the binary logistic regression analysis was determined by forward LR method. P-value and adjusted odd ratio of 95% CI was used for each risk factor. Any risk factor with  $p \leq 0.05$  was considered significantly associated with dry eyes.

## Results

### Characteristics of the participants

Six hundred and twenty-five people participated in this population-based study: 233 (37.3%) were males and 392 (62.7%) were females. Demographic data of the participants are in **Table 2**. Their mean age was 65.33 years (SD = 7.45) and the mean age for males and females was 65.47 (SD = 7.38) and 65.24 (SD = 7.50), respectively. The distribution of their systemic diseases and potential risk factors are listed in **Table 3**. Dry mouth (24.8%) and history of

allergy (20.3%) were common in our population. Hypertension (12.6%) and diabetes (7.0%) were the most common systemic diseases. Five of our participants regularly used contact lenses and none

reported regularly using the computer more than three hours per day. All female participants were menopausal and none of them used hormonal replacement therapy.

**Table 1.** Definition of Dry Eye Symptoms (English summary of questionnaire)

Symptom	Mild	Moderate	Severe
Discomfort	Awareness of one's eyes, difficulty in describing specific types of discomfort	Ability to describe the pain modality in specific terms	Exquisite ocular, periocular, or radiating pain requiring analgesia
Foreign body sensation	Similar to the sensation of fine dust or powder in the eye	Similar to the sensation of sand or dust in the eye	Similar to the sensation of a hot ember in the eye
Dryness	Infrequent or intermittent discomfort in the eye	More frequent but less than constant symptoms	Constant or near constant symptoms of dryness that require lubricating drops 4+ times per day
Tearing	Positive sensation of fullness of the conjunctival sac without tear spilling over the lid margin	Infrequent or intermittent spilling of tear over the lid margin	Constant or nearly constant spilling of tear over the lid margins
Itching	Awareness of intermittent sensation	Intermittent sensation with desire to rub	Constant awareness of sensation with rubbing
Photophobia	Very minimal light intolerance which may require some degree of sunglasses protection to eliminate the symptom	Infrequent or intermittent discomfort in the globe associated with exposure to room light or sunlight which is only partially relieved by dark glasses or subdued light	Constant or nearly constant pain in the eye that is not relieved by sunglasses and is only relieved by total occlusion of the eye
Burning sensation	Infrequent or intermittent burning sensation in the eye	More frequent but less than constant burning sensation in the eye	Constant or nearly constant burning sensation in the eye
Blurred vision after prolonged reading	Infrequent or intermittent blurred vision after prolonged reading or intense use of the eye	More frequent blurred vision after prolonged reading but symptoms do not preclude ability to read	Constant or near constant blurred vision that preclude ability to read

**Table 2.** Demographic data of study population

Age	Gender		Total n (%)
	Male n (%)	Female n (%)	
50-59	60 (9.6)	89 (14.2)	149 (23.8)
60-69	110 (17.6)	211 (33.8)	321 (51.4)
70-79	51 (8.2)	70 (11.2)	121 (19.4)
80-89	11 (1.8)	19 (3.0)	30 (4.8)
90+	1 (0.2)	3 (0.5)	4 (0.7)
Total	233 (37.3)	392 (62.7)	625 (100)

**Table 3.** Distribution of potential risk factors and systemic diseases

Condition	Number (%)
Rheumatoid arthritis	2 (0.32)
Thyrotoxicosis	1 (0.2)
SLE	1 (0.2)
Diabetes	44 (7.0)
Hypertension	79 (12.6)
History of Allergy	127 (20.3)
Dry mouth symptom	155 (24.8)
Smoking	85 (13.6)
Alcohol consumption	101 (16.2)
Contact lens usage	5 (0.8)
Previous eye surgery	10 (1.6)
Glaucoma	10 (1.6)

**Prevalence of dry eye symptoms**

The frequency of dry eye symptoms in our population is shown in **Table 4**. Blurred vision after prolonged reading was the most reported symptom. For our study, dry eyes were diagnosed when the participant had at least one severe symptom; 89 participants were clinically diagnosed to have dry eyes. Therefore, the prevalence of dry eyes was 14.2%. The prevalence of dry eyes in males and females was 10.3% and 16.6%, respectively. The prevalence of dry eyes were 11.0%, 15.9%, 14.9%, 13.3%, and 25.0% in participants between the ages of 50 to 59, 60 to 69, 70 to 79, 80 to 89, and older than 90 years old, respectively (**Table 5**).

**Risk factors for developing dry eyes**

Gender, history of allergy, symptoms of dry mouth and previous eye surgery were significantly associated with dry eyes. Females were more likely to have dry eyes, with adjusted odd ratio of 1.796 (95% CI = 1.062 to 3.037,  $p = 0.029$ ). Previous eye surgery was most strongly associated with dry eyes, with adjusted odd ratio of 19.459 (95% CI = 4.620 to 81.949,  $p < 0.001$ ). History of allergy and symptoms of dry mouth were also significantly associated with dry eyes with adjusted odd ratio of 1.942 (95% CI = 1.152 to 3.272,  $p = 0.013$ ) and 2.008 (95% CI = 1.228 to 3.285,  $p = 0.005$ ) respectively. Age, rheumatoid arthritis, thyrotoxicosis, systemic lupus erythematosus, diabetes, hypertension, smoking, alcohol consumption, glaucoma,

and use of contact lens were not correlated with symptoms of dry eyes. The  $p$ -value and adjusted odds ratio for each risk factor are shown in **Table 6**.

**Discussion**

Because there are no gold standard tests for diagnosing dry eyes, many different studies have used various diagnostic criteria. Some studies used only symptoms whereas others used both symptoms and signs to diagnose the syndrome. However, prevalence studies that used both symptoms and signs reported the prevalence for symptoms separately from clinical signs [5, 7, 17, 18]. Several studies in the last 15 years have shown that there was a poor association between symptoms and clinical signs for dry eyes [2-4, 19-21]. Lin et al. commented that frequently used dry-eye tests cannot reliably reflect the tear film conditions in the non-clinic-based general population and consequently have limited value as screening tests.<sup>[17]</sup> Moreover, prevalence of dry eyes varied according to diagnostic criteria, population, and age distribution of each study; consequently it is difficult to compare prevalence from one study to another. Most of the population-based studies reported prevalence of dry eyes based only on symptoms that dramatically ranged from 5.5% to 33.7% depending on the study population and diagnostic criteria used [5-10, 14, 17]. These studies defined dry eyes as having one or more severe symptoms [5, 7, 14, 17] or frequent dry eye symptoms [15, 16] as shown in **Table 7**.

**Table 4.** Prevalence of dry eye symptoms

Symptom	None n (%)	Mild n (%)	Moderate n (%)	Severe n (%)
Discomfort	585 (96.3)	16 (2.6)	15 (2.4)	9 (1.4)
Foreign body sensation	559 (89.4)	28 (4.5)	28 (4.5)	10 (1.6)
Dryness	599 (95.8)	11 (1.8)	9 (1.4)	6 (1.0)
Tearing	518 (82.9)	45 (7.2)	52 (8.3)	10 (1.6)
Itching	525 (84.0)	45 (7.2)	43 (6.9)	12 (1.9)
Photophobia	544 (87.0)	25 (4.0)	42 (6.7)	14 (2.2)
Burning sensation	558 (89.3)	35 (5.6)	24 (3.8)	8 (1.3)
Blurred vision after prolonged reading	412 (67.4)	70 (11.2)	68 (10.9)	66 (10.6)
Any severe symptom				89 (14.2)
Any severe symptom except blurred vision after prolong reading				45 (7.2)

**Table 5.** Prevalence of dry eye by age

Age	Prevalence (%)
50-59	11.0
60-69	15.9
70-79	14.9
80-89	13.3
90+	25.0

**Table 6.** P-value and odd ratio of dry eye risk factors

Risk factors	p-value	Adjusted odd ratio	95% CI
Age	0.381		
Gender	*0.029	1.796	1.062-3.037
Rheumatoid arthritis	0.568		
Toxic thyroidopathy	0.721		
SLE	0.721		
Diabetes	0.208		
Hypertension	0.125		
History of Allergy	*0.013	1.942	1.152-3.272
Dry mouth symptom	*0.005	2.008	1.228-3.285
Smoking	0.606		
Alcohol consumption	0.066		
Contact lens usage	0.490		
Previous eye surgery	*<0.001	19.459	4.620-81.949
Glaucoma	0.228		

\*Indicates significant risk factors. Adjusted odd ratio was calculated only for significant risk factors.

**Table 7.** Population-based studies on dry eye symptoms

Reference	Name of study	Site of study	Sample size	Age (years)	Prevalence rate (%)	Mode of diagnosis of dry eye
Schein [5], 1997	SEE Study	Maryland, USA	2,420	65-84	14.6	Six item questionnaire (one or more of six dry eye symptoms often or all the time)
McCarty [7], 1997	Melb-VIP	Melbourne, Australia	926	40-97	5.5	Six item questionnaire (any severe symptom not attribute to hay fever)
Caffery [8], 1998	CANDEES	Canada	13,517	All ages	28.7	Questionnaire
Shimmura [9], 1999	-	Tokyo, Japan	598	mean = 35.2	33	Self-administered questionnaire
Moss [10], 2000	Beaver Dam	Wisconsin, USA	3,722	48-91	14.4	Questionnaire
Lee [14], 2002	Riau Eye Study	Riau, Indonesia	1,058	21+	27.5	Six item questionnaire (one or more of six dry eye symptoms often or all the time)
Schaumburg [15], 2003	Women's health	USA	39,876	45-84	7.8	Questionnaire (presence of clinically diagnosed dry eye or severe symptoms constant or often)
Chia [16], 2003	Blue Mountains	Sydney, Australia	1,174	>50	15.3	Three or more symptoms of any severity
Lin [17], 2003	Shihpai	Taiwan	1,361	>65	33.7	Six item questionnaire (one or more of six dry eye symptoms often or all the time) add stickiness and tearing
This study, 2010	Romklao	Romklao, Thailand	625	>50	14.2	Eight item questionnaire (any severe symptom)



The definition of dry eyes in our study was based on McCarty et al.'s population-based study as follows: dry eyes were diagnosed when there were one or more severe symptoms [7]. Based on this definition, the prevalence of dry eyes in our elderly population (age  $\geq 50$  years) was 14.2%. In a previous study conducted by Schein et al., the prevalence of dry eyes in the elderly population (age  $\geq 65$  years) of the United States, based on a six-item questionnaire, was 14.6% [5]. In another study, McCarty et al. used a six-item questionnaire to diagnosed dry eye and reported prevalence of dry eye in Australia to be 5.5% [7]. This low prevalence in the Melbourne VIP study is likely due to its strict diagnostic criteria. As for studies conducted in the Asian population, Lee et al. reported the prevalence in Indonesian adults (age  $\geq 21$  years), using diagnostic criteria similar to those used by Schein et al., to be 27.5% [14] whereas Lin et al. reported a dry eye prevalence in Taiwan of 33.7% using an eight-item questionnaire [17]. To further complicate things, in a recent study conducted by Lekhanont et al. who used a six-item questionnaire, the prevalence of dry eyes in a hospital-based elderly Thai population was 34.0% [18]. The prevalence of dry eyes in a hospital-based study was two times higher when compared to our study. The reason for this discrepancy is that the study volunteers who came for the annual eye examinations were more symptomatic, and thus, the prevalence of dry eyes were higher [18]. Furthermore, Lekhanont et al. indicated that Asians had a higher prevalence of dry eyes, which was in agreement to the findings reported by Schaumberg et al. who claimed that Hispanic and Asian women were more likely to have severe dry eye symptoms compared to Caucasians [15]. These two findings contradicted reports issued by Schein et al. [5], McCarty et al. [7], Caffery et al. [9], Moss et al. [10] as well as our study which had a prevalence of 14.2%. The prevalence in our study was similar to the reports from Western countries [5,7,9,10]. In our study, the prevalence of dry eyes increased significantly in females (16.6%) compared to males (10.6%) and this difference was statistically significant ( $p = 0.029$ ). Our study corroborates findings from other studies that show women were significantly more likely to develop dry eye symptoms [7-10, 15, 18-22]. Lamberts et al. showed that women had significantly less tear production as compared to men around 60 years old ( $p < 0.05$ ) [23]. Moreover, all of the female participants in our study were menopausal and a hormonal effect

could have increased the symptoms of dry eyes. Many studies have suggested that sex hormones could influence the conditions on the ocular surface and affect the secretion of tears, meibomian gland function, and conjunctival goblet cell density [24-26]. Lin et al. showed that women taking sex hormones tended to have a higher rate of dry eye symptoms, but this difference was not statistically significant [17]. Along the same lines, Schaumberg et al. reported that hormone replacement therapy significantly increased the risk of developing dry eye symptoms by 15% [27].

In some studies, age was also reported to be correlated with dry eyes [7, 10, 15]. However, some studies did not find any correlation between age and dry eyes [5, 14, 16, 17]. The reason why some studies, including our study, did not find any correlation between age and dry eyes may be due to the narrow age range of the study population.

Our study indicated that history of allergy was significantly associated with dry eyes ( $p = 0.013$ ). However, the findings from The Melbourne VIP Study and The Beaver Dam Eye Study did not support this [7, 10]. Allergic diseases can often cause symptoms similar to dry eyes and this may have caused some confusion in the diagnosis of the syndrome. In these cases, more investigations for dry eye signs may improve detection of dry eye diseases [7]. Symptoms of dry mouth also showed significant association with dry eye symptoms in our study ( $p = 0.005$ ) even though The Melbourne VIP Eye study [7] did not find this significant whereas Hay et al. showed a weak association between dry eyes and symptoms of dry mouth [4]. Although the presence of dry eyes and symptoms of dry mouth are important criteria for diagnosing Sjogern's syndrome [28], we did not clarify the frequency and intensity of the symptoms of dry mouth. Future studies are needed to clarify this issue.

We did not find any significant association between smoking and alcohol consumption with dry eyes symptoms. Smoking, unlike alcohol consumption, was reported to be significantly associated with dry eyes symptoms in the Beaver Dam Eye Study and Riau Eye Study from Indonesia [10, 14]. They proposed that smoking acted as a direct irritant for the eyes and represented a modifiable risk factor for developing dry eyes symptoms.

Our study found that previous eye surgery was significantly associated with dry eyes symptoms ( $p < 0.001$ ). In contrast, the Beaver Dam Study and the Blue Mountains Eye Study reported no association

between lens surgery and dry eye symptoms [10, 16]. Inflammation of the ocular surface and use of topical anti-inflammatory or other medications after any type of eye surgery can disrupt the neural feedback loop and cause insufficient tear production, which in turn can cause people to develop symptoms of dry eye.

Moss et al. reported that history of arthritis, history of thyroid disease and diabetes were also associated with dry eyes [10]. In 2007, the Epidemiology Subcommittee of the International Dry Eye Workshop [29] (DEWS) reported substantiated risk factors for dry eyes include older age, female sex, postmenopausal estrogen therapy, low Omega-3 and Omega-6 fatty acids diet, use of antihistamines, connective tissue disease, refractive surgery, radiation therapy, hematopoietic stem cell transplantation, vitamin A deficiency, hepatitis C infection and androgen deficiency. Other less evidences but suggestive risk factors included Asian race, diabetes mellitus, HIV infection, systemic chemotherapy, large incision extracapsular cataract extraction (ECCE) and penetrating keratoplasty, isotretinoin use, low humidity environments, sarcoidosis, ovarian dysfunction and use of tricyclic antidepressants, selective serotonin reuptake inhibitors, diuretics, and Beta-blockers. However, some risk factors had unclear evidences or inconclusive information including cigarette smoking, Hispanic ethnicity, menopause, botulinum toxin injection, acne, gout, oral contraceptives, pregnancy, alcohol, use of anxiolytics and antipsychotics. In contrast, we did not find any systemic diseases such as diabetes, hypertension, thyrotoxicosis, rheumatoid arthritis, and systemic lupus erythematosus to be associated with dry eyes. In spite of the fact that blurred vision after prolonged reading usually results from dry eyes, some of the limitations of this study may explain why temporary blurred vision was the most common symptom of dry eyes. Because we did not perform any ocular examinations and refraction tests, it is possible that our findings were slightly biased. Therefore, caution is warranted in interpreting these results.

Conclusion, this is the first population-based study to report prevalence of dry eyes symptoms in 14.2% of elderly Thais. Women were more likely to report dry eyes symptoms. We also found that symptoms of dry mouth, history of allergy and previous eye surgery were associated with risk factors for developing the syndrome. Future studies utilizing population-based data are warranted to define other risk factors

associated with dry eyes such as age, health, drug history, personal habits, lifestyle, and other ocular conditions.

The authors have no conflicts of interest to declare.

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