

Prevalence of Dry Eye Disease in an Elderly Korean Population

Sang Beom Han, MD; Joon Young Hyon, MD; Se Joon Woo, MD; Jung Jae Lee, MD; Tae Hui Kim, MD; Ki Woong Kim, MD, PhD

Objective: To evaluate the prevalence of and risk factors for dry eye disease (DED) in an elderly Korean population.

Methods: This population-based study in Yongin, Korea, included 657 individuals 65 years or older randomly selected from an official household registration database. Dry eye symptoms were assessed using a 6-item questionnaire, and DED was defined as having 1 or more dry eye symptoms often or all the time. Dry eye tests, including the Schirmer test, tear film break-up time measured using fluorescein, cornea fluorescein staining, and examination for meibomian gland dysfunction, were performed.

Results: The crude prevalence of DED was 30.3%, and the age-, sex-, and region (urban vs rural)-adjusted prevalence

was 33.2%. Women ($P=.01$) and urban dwellers ($P=.001$) were more likely to have DED. Of those with DED, 85.1% had tear film break-up time of 10 seconds or less, 54.1% had meibomian gland dysfunction, 39.2% had a fluorescein score of 1 or greater, and 32.8% had a Schirmer test score of 5 mm or less. A low Schirmer score was correlated with increased prevalence of DED, although sensitivity was low.

Conclusions: Dry eye disease is common in elderly Koreans; female sex and living in an urban region were strongly correlated with its frequency. We also noted a positive correlation between low Schirmer test scores and symptom-based DED.

Arch Ophthalmol. 2011;129(5):633-638

DRY EYE DISEASE (DED) IS one of the most common ocular diseases. Ocular symptoms of DED vary from mild discomfort to severe ocular fatigue and pain that may affect daily activities.¹⁻⁵ Several population-based studies^{2-4,6-15} have reported the prevalence of DED to range from 4.3% to 73.5%. The large disparity in the reported prevalence is attributed to the lack of a standardized diagnostic definition and differences in study populations.⁴ Although there is much inconsistency in the prevalence of DED in the literature, risk factors, such as old age, female sex, and hazardous environment, including air pollution and indoor air problems at work, are assumed to be associated with the prevalence of DED.⁴ The results of previous studies¹⁶⁻¹⁹ have also suggested ethnic differences in the prevalence of DED between white and Asian populations, although a direct comparison of such studies involves certain limitations, such as discrepancy in the definition of DED and a difference in the age group.

Meanwhile, information is limited on the prevalence of DED in certain population groups, including those in Korea, although the clinical importance of the disease seems to be high considering the adverse effects on quality of life.¹⁻⁵ In this study, we aimed to assess the population-based prevalence of and risk factors for DED in an elderly Korean population.

METHODS

SAMPLE

This study was conducted as a part of the Yongin Aging Study, a population-based longitudinal cohort study concerning the mood, memory, and sensory functions of elderly Korean individuals 65 years or older. This study was approved by the institutional review board of the Seoul National University Bundang Hospital and was conducted after obtaining informed consent in accord with the institutional guidelines for experimental investigations. The baseline visit for the Yongin Aging Study was conducted between May 1, 2008, and February 28, 2009, in Yongin, Korea; visits every 2 years are planned for the next 4 years, and long-term follow-up is

Author Affiliations: Departments of Ophthalmology (Drs Han, Hyon, and Woo) and Neuropsychiatry (Drs T. H. Kim and K. W. Kim), Seoul National University Bundang Hospital, Seongnam; Department of Ophthalmology, Seoul National University College of Medicine, Seoul (Dr Hyon); and Department of Psychiatry, Kyungbook National University Hospital, Daegu (Dr Lee), Korea.

Table 1. Questionnaire for Dry Eye Symptoms for the Initial Field Visit^a

During the past 2 weeks

1. Do your eyes feel dry?
2. Do you feel a gritty or sandy sensation in your eyes?
3. Do your eyes ever have a burning sensation?
4. Do your eyes ever feel sticky?
5. Do your eyes ever feel watery or tearing?
6. Are your eyes ever red?

^aAllowed responses to the questions were "none," "rarely," "sometimes," and "often or all the time." Subjective dry eye was defined as having 1 or more symptoms often or all the time.

under consideration. Yongin is a city located in the southern Gyeonggi province. In 2008, the total population of Yongin was 815 960, and 7.7% of the population was 65 years or older. Yongin was considered an ideal community for a population-based study because it is one of the largest cities in Korea with a rural/urban mixture. Then, regions within Yongin were randomly selected to cover approximately 10 000 residents 65 years or older, and 10% of the population was chosen through systematic random sampling based on residential rosters. Urban regions included the communities in the downtown of the city, and rural regions included the communities located approximately 20 km from the city center, where most inhabitants' livelihood is agriculture. Consequently, 1060 elderly individuals were included in the study sample. Invitation letters were sent to them stating that a general mental and ophthalmologic health evaluation would be performed. A specific statement about evaluation for DED was not included in the letter to avoid selection bias. Of the 1060 individuals, 657 (632 [96.2%] living independently in communities and 25 [3.8%] living in nursing homes or hospitals) agreed to participate in this study and completed a symptom questionnaire administered by trained interviewers. Interviews were performed at town offices or public health centers on a designated date. For participants with ambulation difficulty, the interviewers visited their homes or nursing homes or hospitals.

DESIGN

This study used a 2-stage design to estimate the DED prevalence. At the initial field survey, the Dry Eye Questionnaire (DEQ), which included 6 questions pertaining to dry eye symptoms, was administered to all the survey participants. The DEQ used at the initial field visit was created by adopting and modifying several dry eye symptom questions previously reported in the literature (**Table 1**).^{2,9,17,18} When a participant indicated the presence of a symptom, he or she was asked to specify whether the symptom was experienced rarely, sometimes, often, or all the time. Dry eye disease was defined as having 1 or more symptoms often or all the time during the past 2 weeks.

The Schirmer I test score was also determined. Without the installation of topical anesthetics, a precalibrated dry filter strip (ColorBar; EagleVision, Inc, Memphis, Tennessee) was placed temporally in each lower fornix. The strips were removed after 5 minutes, and the amount of wetting was recorded.

All 657 subjects who completed the initial field survey were asked to visit the Seoul National University Bundang Hospital and to undergo further ophthalmologic evaluations for dry eye signs. The diagnostic status of DED was masked to all the study participants. In the secondary evaluation, 21.2% of the enrolled individuals (139 of 657) (13.1% of those asked to participate in this study [139 of 1060]) visited the hospital.

Secondary ophthalmologic examinations included slit-lamp examination, tear film break-up time (BUT) testing, fluo-

rescein staining, and meibomian gland examination. All the tests were performed by an experienced cornea specialist without knowledge of the results of the initial field visit. The tear film BUT test was performed before the other tests to avoid interference from these tests. Tear film BUT was measured using fluorescein 3 times for each eye, and the average value was used. Fluorescein staining of the cornea, which indicates corneal damage, was graded as 0 (no staining), 1 (mild staining limited to less than one-third of the cornea), 2 (moderate staining of less than half of the cornea), or 3 (severe staining of half or more of the cornea).^{2,9}

Meibomian gland obstructions and quality of meibomian gland secretions were also graded (grade 0 indicates no obstruction and clear meibum; grade 1, plugging with translucent serous secretion when compressing the lid margin; grade 2, plugging with viscous or waxy white secretion when compressing the lid margin; and grade 3, plugging with no secretion when compressing the lid margin) and recorded.^{2,9} Meibomian gland dysfunction (MGD) was diagnosed as the presence of gland orifice plugging (grade ≥ 1).²⁰ Abnormal clinical test cutoff points were defined as a tear film BUT of 10 seconds or less, a Schirmer test score of 5 mm or less, a fluorescein score of at least 1, or the presence of MGD, as described by other researchers.⁹

STATISTICAL ANALYSIS

In each participant, the eye with worse signs was used for analyses. Determination of the eye with worse signs was made based on the clinical judgment of the examiner. The estimates of prevalence were adjusted by age, sex, and region (urban vs rural) to individuals 65 years or older in Yongin. Standardized national prevalence rates for Korean elders were also estimated using the direct standardization method, in which the prevalence rates were adjusted by age, sex, and urban vs rural region to the total Korean population, as given in the 2005 national census.

The association between demographic variables (age, sex, and urban vs rural region) and dry eye symptoms or signs was evaluated using Pearson χ^2 tests and multivariate analysis using logistic regression analysis. A $P < .05$ was considered statistically significant. We used a commercially available software program (SPSS for Windows, version 15.0; SPSS, Inc, Chicago, Illinois) for statistical analyses.

RESULTS

A total of 657 individuals participated in the field survey. Their mean (SD) age was 72.0 (5.9) years (age range, 65-95 years), and the male to female ratio was 48.2%: 51.8% (317:340). The Schirmer I test was completed in 648 of the 657 participants. Nine subjects refused Schirmer testing because of discomfort.

The crude prevalence rate of DED, defined as having 1 or more of the dry eye symptoms often or all the time, was 30.3% (199 of 657). The age-, sex-, and region-adjusted prevalence in elders in Yongin was 33.0% (95% confidence interval [CI], 28.8%-37.3%). The standardized prevalence in the Korean elderly population based on the 2005 national census population was 33.2% (95% CI, 28.9%-37.4%). The prevalence was significantly higher in women than in men ($P = .01$). Participants living in urban regions were more likely to report dry eye symptoms than were those living in rural regions ($P = .001$). No significant difference was noted in prevalence in the stratified age groups (**Table 2**). We noted an abnormal Schirmer test score (≤ 5

Table 2. Prevalence of Positive Dry Eye Symptoms According to the Potential Predictors

| Predictor | Positive Dry Eye Symptoms | | | | Odds Ratio (95% CI) |
|--------------|-------------------------------|---|--|---------|---------------------|
| | Crude Rate, % (No./Total No.) | Rate in Yongin, % (95% CI) ^a | Rate in Korea, % (95% CI) ^b | P Value | |
| Total rate | 30.3 (199/657) | 33.0 (28.8-37.3) | 33.2 (28.9-37.4) | NA | NA |
| Age group, y | | | | | |
| 65-69 | 30.4 (84/276) | 34.2 (27.7-40.7) | 34.3 (27.8-40.7) | .58 | NA |
| 70-74 | 27.7 (52/188) | 32.7 (25.0-40.4) | 33.3 (25.5-41.0) | | |
| 75-79 | 31.9 (36/113) | 35.5 (25.1-45.8) | 35.1 (24.7-45.5) | | |
| 80-84 | 28.8 (15/52) | 31.1 (16.2-46.0) | 31.1 (16.3-45.9) | | |
| ≥85 | 42.9 (12/28) | 35.6 (13.9-57.2) | 35.7 (13.9-57.5) | | |
| Sex | | | | | |
| Male | 25.6 (81/317) | 29.9 (24.1-35.7) | 29.8 (24.1-35.5) | .01 | 1.55 (1.11-2.17) |
| Female | 34.7 (118/340) | 37.9 (31.8-44.0) | 37.7 (31.6-43.8) | | |
| Region | | | | | |
| Urban | 36.1 (125/346) | 36.1 (31.1-41.2) | 36.5 (31.4-41.6) | .001 | 1.81 (1.29-2.55) |
| Rural | 23.8 (74/311) | 23.8 (19.0-28.5) | 23.7 (19.0-28.5) | | |

Abbreviations: CI, confidence interval; NA, not applicable.

^aAge-, sex-, and region (urban vs rural)-adjusted rate regarding the population 65 years or older in Yongin.

^bAge-, sex-, region (urban vs rural)-adjusted rate based on the Korean 2005 national census.

Table 3. Frequency of Abnormal Dry Eye Test Results According to the Presence or Absence of Dry Eye Symptoms

| Variable | Participants, No./Total No. (%) | | | P Value | Odds Ratio (95% CI) |
|---------------------------|---------------------------------|---------------------------|----------------|---------|---------------------|
| | Positive Dry Eye Symptoms | Negative Dry Eye Symptoms | Total | | |
| Schirmer test score ≤5 mm | 63/192 (32.8) | 113/456 (24.8) | 176/648 (27.2) | .04 | 1.48 (1.03-2.14) |
| Tear film BUT ≤10 seconds | 63/74 (85.1) | 56/65 (86.2) | 119/139 (85.6) | >.99 | 0.92 (0.36-2.38) |
| Fluorescein score ≥1 | 29/74 (39.2) | 21/65 (32.3) | 50/139 (36.0) | .47 | 1.35 (0.67-2.71) |
| Presence of MGD | 40/74 (54.1) | 32/65 (49.2) | 72/139 (51.8) | .61 | 1.21 (0.62-2.37) |

Abbreviations: BUT, break-up time; CI, confidence interval; MGD, meibomian gland dysfunction.

mm) in 32.8% of individuals with DED (63 of 192) and in 24.8% of those without DED (113 of 456), and the difference was significant ($P=.04$) (**Table 3**).

The secondary evaluation included 139 participants, of whom 74 (53.2%) had been diagnosed as having DED in the field survey. The group that received secondary evaluation had a significantly higher DED prevalence than did the group without secondary evaluation (odds ratio, 3.58; 95% CI, 2.43-5.28; $P<.001$). Of the 74 individuals with DED, 63 (85.1%) had a tear film BUT of 10 seconds or less, 29 (39.2%) had a fluorescein score of at least 1, and 40 (54.1%) had MGD (19 with grade 1, 17 with grade 2, and 4 with grade 3). Of the 65 participants who had not been diagnosed as having DED, 56 (86.2%) had a tear film BUT of 10 seconds or less, 21 (32.3%) had a fluorescein score of at least 1, and 32 (49.2%) had MGD (17 with grade 1, 14 with grade 2, and 1 with grade 3). Regarding MGD severity, there was no significant difference between participants with vs without DED (linear-by-linear association χ^2 test, $P=.36$). With the increasing severity of MGD, the tear film BUT tended to decrease, although the difference was not significant (mean [SD] BUT: 4.73 [2.90] seconds for grade 0 MGD [$n=67$ (48.2%)], 4.33 [2.88] seconds for grade 1 MGD [$n=36$ (25.9%)], 3.71 [2.15] seconds for grade 2 MGD [$n=31$ (22.3%)], and 3.20 [0.90] seconds for grade 3 MGD [$n=5$ (3.6%)]; $F=1.329$; $P=.27$, Welch analysis of variance).

Of all the dry eye signs, only the Schirmer test score was shown to have a significant association with positive dry eye symptoms, although the test also had a low sensitivity that only 35.8% of participants had both a Schirmer test score of 5 mm or less and positive dry eye symptoms (Table 3). Receiver operating characteristic curve analysis revealed that a Schirmer test with a cutoff value of 5 mm has a predictive value, although the accuracy is limited (area under the receiver operating characteristic curve for DED, 0.580; $P=.001$) (**Figure**). In logistic regression analysis, female sex, urban region, and low Schirmer test score were found to be associated with DED (**Table 4**).

COMMENT

To our knowledge, this is the first community-based study to investigate the prevalence of DED in Korea. Korea has a fairly homogeneous population of Asian ethnicity because there has been no mass migration in history, and, thus, is considered to be an optimal country for the evaluation of DED prevalence in an Asian population.

Although many researchers have reported the DED prevalence in various countries,^{2,3,6-15} a direct comparison between such studies is difficult because of differing diagnostic criteria, study populations, dry eye symp-

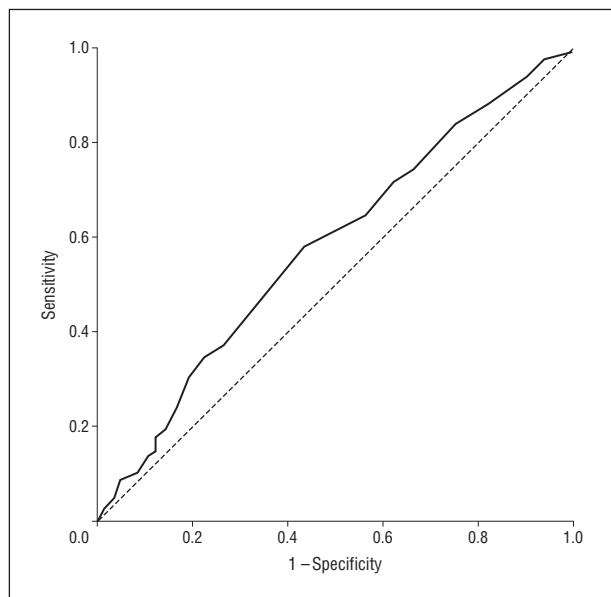


Figure. Receiver operating characteristic curve based on different Schirmer test thresholds. Area under the curve, 0.580; $P = .001$.

Table 4. Logistic Regression Analysis of Factors Potentially Associated With Dry Eye Symptoms

| Factor | Odds Ratio (95% CI) | P Value |
|---------------------|-------------------------------|--------------------|
| Sex: female/male | 1.64 (1.15-2.33) | .006 ^a |
| Region: urban/rural | 1.94 (1.35-2.80) | <.001 ^a |
| Age, y | | .42 |
| ≥85/65 | 1.93 (0.83-4.47) | .12 |
| 80-84/65-69 | 1.14 (0.58-2.25) | .70 |
| 75-79/65-69 | 1.32 (0.80-2.16) | .28 |
| 70-74/65-69 | 0.94 (0.61-1.44) | .76 |
| Schirmer test score | 0.97 (0.94-0.99) ^b | .009 ^a |

Abbreviation: CI, confidence interval.

^a $P < .05$.

^b An increase in the Schirmer test score of 1 mm leads to a 0.97-fold decreased risk of having dry eye symptoms.

tom questionnaires, and objective tests.^{2,4,7} The Salisbury Eye Evaluation Study, which used a validated 6-item questionnaire, demonstrated that 14.6% of participants reported 1 or more of the 6 dry eye symptoms often or all the time.¹⁸ Schaumberg et al^{10,12} defined DED as the presence of clinically diagnosed DED or having severe symptoms (dryness and irritation) often or constantly and reported a prevalence of 7.8% in US women and 4.3% in US men. Other studies^{8,14} based on a self-administered questionnaire reported a prevalence of 28.7% (the Canadian Dry Eye Epidemiology Study) and 15.3% to 16.6% (the Blue Mountains Eye study). In Asia, previous studies^{2,3,7,9,11,15,16,19} that used symptom questionnaires revealed a prevalence of 21.0% to 73.5%.

In the present study, we defined DED as the presence of 1 or more dry eye symptoms included in the 6-item questionnaire occurring often or all the time (Table 1); this definition was based on current trends wherein emphasis is placed on symptom assessment in the prevalence study of DED.^{8,21} This emphasis is because (1) there is no gold standard among dry eye tests and DEQs have

been reported to have substantial repeatability,^{4,22} (2) dry eye tests have been shown to have poor correlation with dry eye symptoms,^{4,17,18,22} and (3) the treatment goal for DED is to relieve patients' symptoms.²¹ Recent population-based studies^{6-9,16,18,21,23} have also defined DED as the presence of frequent dry eye symptoms.

In the present study, dry eye symptoms were common in participants 65 years or older, with a sex-, age-, and region-adjusted prevalence of 33.2%. The high prevalence might, in part, be because this study included only an elderly population. Previous studies^{6,10,12,17} have demonstrated that the DED prevalence increases with age, although some studies^{8,18} have found no such correlation. However, in the present study, no significant difference was noted in stratified age groups, presumably because this study included only participants 65 years or older with a limited age distribution.

As summarized in **Table 5**, the DED prevalence in Asian populations is higher than that in white populations.¹⁰ A study¹⁰ conducted in the United States reported that Asian women were more likely to have severe DED symptoms than were white women, indicating ethnic differences in the prevalence of dry eye symptoms. The high DED prevalence of 33.2% in the present study is similar to the prevalence of 33.7% in elderly Chinese (≥65 years old) in Taiwan⁹ and considerably higher than that of 14.4% in elderly Americans.¹⁸ Uchino et al¹⁵ reported that the prevalence of DED in elderly Japanese (>60 years old) was 73.5%, suggesting that DED is highly prevalent in northeast Asia.

In the present study, female sex was associated with an increased prevalence of DED. Many previous studies have reported similar sex differences in DED prevalence,^{2,3,6,9,17} suggesting that sex hormones affect ocular surface conditions through their effects on lacrimal glands, meibomian glands, conjunctival goblet cell density, and ocular surface sensitivity.^{2,9} Individuals in urban regions were also more likely to have DED than were those in rural regions, which agrees with the findings of a recent study by Jie et al.³ Although the exact cause of this difference is unclear, the factors that contribute to the difference are assumed to include air pollution, workplace environment, and lifestyle in urban regions.³ Further studies are needed to elucidate the exact mechanism.

The lack of association between signs and symptoms of DED in the present study corresponds well with previous studies.^{4,17,18,22} It is conceivably due to (1) inconsistency and lack of repeatability of dry eye tests in common use, (2) the heterogenic nature of DED and variable disease process, and (3) differences in the sensation of a dry eye symptom and cognitive response to the DEQ.⁴ Among the dry eye tests performed, only a low Schirmer test score was shown to be associated with dry eye symptoms, and a cutoff value of 5 mm had a predictive value, although limited, for DED (Table 3 and Figure). However, the present results also show that the Schirmer test has low sensitivity, as only 35.8% of participants (63 of 176) with a Schirmer test score of 5 mm or less had positive dry eye symptoms (Table 3). The low sensitivity was also demonstrated in previous studies,^{17,21} in which the use of topical anesthetics was suggested to be the cause. However, anesthetics were never used in the present study,

Table 5. Prevalence of DED Reported in Previous Population-Based Studies

| Source | Country | Participants, No. | Age, y | Diagnostic Criteria | Prevalence, % |
|--------------------------------------|-----------------------|----------------------|--------|--|---------------|
| Moss et al, ⁶ 2000 | United States | 3722 | 48-91 | Self-reported history of DED | 14.4 |
| Schaumborg et al, ¹⁰ 2003 | United States (women) | 39 876 | 45-84 | Clinically diagnosed DED or severe symptoms | 7.8 |
| Schaumborg et al, ¹² 2009 | United States (men) | 25 444 | ≥50 | Clinically diagnosed DED or severe symptoms | 4.3 |
| Chia et al, ⁸ 2003 | Australia | 1174 | ≥50 | Symptoms (≥3 symptoms) | 15.3 |
| | | | | (≥1 moderate to severe symptoms) | 16.6 |
| Viso et al, ¹³ 2009 | Spain | 654 | ≥40 | Presence of symptoms and ≥1 sign | 11.0 |
| Lee et al, ⁷ 2002 | Indonesia | 1058 | ≥21 | Symptoms (6 questions) | 27.5 |
| Lin et al, ⁹ 2003 | Taiwan | 1361 | ≥65 | Symptoms (8 questions) | 33.7 |
| Lekhanont et al, ² 2006 | Thailand | 550 | ≥40 | Symptoms (6 questions) | 34.0 |
| Uchino et al, ¹¹ 2008 | Japan | 3549 | 22-60 | Clinically diagnosed DED | 13.0 |
| | | | | Severe dry eye symptoms | 32.3 |
| Uchino et al, ¹⁵ 2006 | Japan | 113 | >40 | Japanese Dry Eye Diagnostic Criteria ¹⁵ | 73.5 |
| Lu et al, ¹⁶ 2008 | China (Tibet) | 1840 | ≥40 | Symptoms (6 questions) | 52.4 |
| Jie et al, ³ 2009 | China (Beijing) | 1957 | ≥40 | Symptoms (6 questions) | 21.0 |

Abbreviation: DED, dry eye disease.

suggesting the presence of other causes, including the aforementioned factors that contributed to the discrepancy between dry eye signs and symptoms. Therefore, the Schirmer test may not be appropriate as a screening test for DED because it might be useful for aqueous-deficient dry eye but might not be predictive of a symptom-based dry eye definition. These findings agree well with those of a previous study concerning the Chinese population in Taiwan.²¹ A low Schirmer test score is significantly associated with dry eye symptoms in elderly Chinese and Korean populations,²¹ whereas no such correlation has been found in elderly white populations.^{17,18} This finding, along with the differences in prevalence, suggests differences in the distribution of causes of DED and susceptibility to the disease between Asian and white populations.²¹

Meanwhile, the results that approximately 50% of the participants had MGD suggests that MGD may be prevalent in Korea, which is in accord with the reports of other Asian countries.^{2,15,21} Although an association between MGD and dry eye symptoms was not found, the results suggest that MGD may cause tear film instability and worsen the ocular surface disease, and thus more attention should be given to the disease.

The present study has a few limitations. First, the severity of DED was never considered in the analyses. Investigation of more specifically graded variables—that is, dividing the “often or all the time” of the DEQ into “often” and “constantly” could yield more detailed data on the association of dry eye signs and symptoms. Second, the few patients and the higher DED prevalence in the group that underwent secondary evaluation reduced the statistical power of logistic regression analysis and, thus, could limit generalization of the study results. Although measures to avoid selection bias were used, patients with dry eye symptoms might have more incentive to visit Seoul National University Bundang Hospital and received secondary evaluation. However, that did not affect the evaluation of DED prevalence because it was determined at the initial field visit. Third, the DEQ may also be reflective of other ocular surface diseases, including MGD, allergic conjunctivitis, and chronic infectious

conjunctivitis, and, thus, are not specific for DED and carry a risk of overestimating the DED prevalence. Fourth, some dry eye symptoms might not be covered by the DEQ. For example, tear film instability symptoms, including improvement in vision with blinking, were not included in the questionnaire, which possibly had an effect on the result that tear film BUT and MGD were not associated with DED. Therefore, development of the diagnostic criteria for DED that reflects the dry eye symptoms more specifically is required.

In conclusion, to our knowledge, this is the first study reporting the prevalence of DED in Korea. Dry eye disease is a common condition, with an estimated prevalence of 33.2% in elderly Koreans. Women and urban dwellers are more likely to experience dry eye symptoms. A low Schirmer test score was associated with frequent dry eye symptoms, although its diagnostic value as a single test was limited. Given the high prevalence and effect on quality of life, further studies are required to better understand the disease.

Submitted for Publication: June 4, 2010; final revision received September 17, 2010; accepted September 28, 2010.

Correspondence: Ki Woong Kim, MD, PhD, Department of Neuropsychiatry, Seoul National University Bundang Hospital, 166 Gumiro, Bundanggu, Seongnam-si, Gyeonggi-do 463-707, Korea (kwkimmd@snu.ac.kr).

Author Contributions: Drs Han and Hyon contributed equally to this article. All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Financial Disclosure: None reported.

Funding/Support: This study was supported by research grant 07-2008-0270 from the Ministry for Health, Welfare, and Family Affairs, Republic of Korea, and by grant A092077 from the Korean Health Technology Research and Development Project, Ministry for Health, Welfare, and Family Affairs, Republic of Korea.

Additional Contributions: Eun Ryung Han, MD, assisted with acquisition of data and clinical examination.

REFERENCES

1. Moss SE, Klein R, Klein BE. Long-term incidence of dry eye in an older population. *Optom Vis Sci*. 2008;85(8):668-674.
2. Lekhanont K, Rojanaporn D, Chuck RS, Vongthongsri A. Prevalence of dry eye in Bangkok, Thailand. *Cornea*. 2006;25(10):1162-1167.
3. Jie Y, Xu L, Wu YY, Jonas JB. Prevalence of dry eye among adult Chinese in the Beijing Eye Study. *Eye (Lond)*. 2009;23(3):688-693.
4. The epidemiology of dry eye disease: report of the Epidemiology Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf*. 2007;5(2):93-107.
5. Tong L, Waduthantri S, Wong TY, et al. Impact of symptomatic dry eye on vision-related daily activities: the Singapore Malay Eye Study. *Eye (Lond)*. 2010;24(9):1486-1491.
6. Moss SE, Klein R, Klein BE. Prevalence of and risk factors for dry eye syndrome. *Arch Ophthalmol*. 2000;118(9):1264-1268.
7. Lee AJ, Lee J, Saw SM, et al. Prevalence and risk factors associated with dry eye symptoms: a population based study in Indonesia. *Br J Ophthalmol*. 2002;86(12):1347-1351.
8. Chia EM, Mitchell P, Rochtchina E, Lee AJ, Maroun R, Wang JJ. Prevalence and associations of dry eye syndrome in an older population: the Blue Mountains Eye Study. *Clin Experiment Ophthalmol*. 2003;31(3):229-232.
9. Lin PY, Tsai SY, Cheng CY, Liu JH, Chou P, Hsu WM. Prevalence of dry eye among an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Ophthalmology*. 2003;110(6):1096-1101.
10. Schaumberg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. *Am J Ophthalmol*. 2003;136(2):318-326.
11. Uchino M, Schaumberg DA, Dogru M, et al. Prevalence of dry eye disease among Japanese visual display terminal users. *Ophthalmology*. 2008;115(11):1982-1988.
12. Schaumberg DA, Dana R, Buring JE, Sullivan DA. Prevalence of dry eye disease among US men: estimates from the Physicians' Health Studies. *Arch Ophthalmol*. 2009;127(6):763-768.
13. Viso E, Rodriguez-Ares MT, Gude F. Prevalence of and associated factors for dry eye in a Spanish adult population (the Salnes Eye Study). *Ophthalmic Epidemiol*. 2009;16(1):15-21.
14. Caffery BE, Richter D, Simpson T, Fonn D, Doughty M, Gordon K. CANDEES: the Canadian Dry Eye Epidemiology Study. *Adv Exp Med Biol*. 1998;438:805-806.
15. Uchino M, Dogru M, Yagi Y, et al. The features of dry eye disease in a Japanese elderly population. *Optom Vis Sci*. 2006;83(11):797-802.
16. Lu P, Chen X, Liu X, et al. Dry eye syndrome in elderly Tibetans at high altitude: a population-based study in China. *Cornea*. 2008;27(5):545-551.
17. McCarty CA, Bansal AK, Livingston PM, Stanislavsky YL, Taylor HR. The epidemiology of dry eye in Melbourne, Australia. *Ophthalmology*. 1998;105(6):1114-1119.
18. Schein OD, Muñoz B, Tielsch JM, Bandeen-Roche K, West S. Prevalence of dry eye among the elderly. *Am J Ophthalmol*. 1997;124(6):723-728.
19. Shimmura S, Shimazaki J, Tsubota K. Results of a population-based questionnaire on the symptoms and lifestyles associated with dry eye. *Cornea*. 1999;18(4):408-411.
20. Foulks GN, Bron AJ. Meibomian gland dysfunction: a clinical scheme for description, diagnosis, classification, and grading. *Ocul Surf*. 2003;1(3):107-126.
21. Lin PY, Cheng CY, Hsu WM, et al. Association between symptoms and signs of dry eye among an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Invest Ophthalmol Vis Sci*. 2005;46(5):1593-1598.
22. Nichols KK, Nichols JJ, Mitchell GL. The lack of association between signs and symptoms in patients with dry eye disease. *Cornea*. 2004;23(8):762-770.
23. Manaviat MR, Rashidi M, Afkhami-Ardekani M, Shoja MR. Prevalence of dry eye syndrome and diabetic retinopathy in type 2 diabetic patients. *BMC Ophthalmol*. 2008;8:10.

Visit www.archophthalmol.com. As an individual subscriber you can use the Citation Manager. You can download article citations in the Medlars format compatible with import into personal bibliographic management software such as EndNote, Reference Manager, or ProCite.