Prevalence of Age-related Maculopathy in the Adult Population in China: The Beijing Eye Study

YIBIN LI, MD, LIANG XU, MD, JOST B. JONAS, MD, HUA YANG, YINGNAN MA, MD, AND JIANJUN LI, MD

- OBJECTIVE: To evaluate the prevalence of age-related maculopathy (ARM) in adult Chinese living in rural or urban regions of mainland China.
- METHODS: The study included 4439 subjects (aged 40 or more years) out of 5324 subjects invited to participate (response rate 83.4%). It was held in rural and urban regions of Greater Beijing. The participants underwent a detailed ophthalmic examination including fundus photography. All fundus photographs were graded by the Wisconsin Age-Related Maculopathy Grading System.
- RESULTS: Fundus photographs were available for 4376 (98.6%) subjects. Early ARM was present in 122 (1.4%) of 8655 (95% confidence interval [CI] 1.16% to 1.66%) eyes or 63 (1.4%) of 4376 (95% CI 1.09% to 1.79%) subjects, late ARM in 12 (0.14%) of 8655 (95% CI 0.06% to 0.22%) eyes or seven (0.2%) of 4376 (95% CI 0.04% to 0.28%) subjects, and exudative ARM as part of late ARM in seven (0.1%) of 8655 (95% CI 0.02% to 0.14%) eyes or six (0.1%) of 4376 (95% CI 0.03% to 0.25%) subjects. The prevalence of early ARM, late ARM, and exudative ARM, respectively, increased from 0.61%, 0.07%, and 0.07% in the 40-to-44-year age group, to 1.66%, 0.26%, and 0.26% in the 55-to-59-year group, and to 2.99%, 0.90%, and 0.60% in the group aged 75 years and older. ARM was causative for visual impairment (best-corrected visual acuity in the better eye, <20/60 and ≥20/400) or blindness (visual acuity <20/400) in one subject (0.023%).

- CONCLUSIONS: Visual impairment due to ARM was relatively uncommon in the adult Chinese population in rural and urban regions. (Am J Ophthalmol 2006;142: 788–793. © 2006 by Elsevier Inc. All rights reserved.)

PREVIOUS POPULATION-BASED STUDIES HAVE shown that macular diseases, particularly age-related maculopathy (ARM), are the most common causes for visual impairment in the elderly white populations of western countries.1–24 It is in contrast to African-American and Indian societies, for which ARM has relatively rarely been detected as major cause for visual impairment.25–28 For Chinese, frequency of ARM was examined mainly in Taiwan and Singapore.29–36 Because population-based data of the prevalence of ARM for Chinese living in mainland China have mostly not been available yet, and because prevalence estimates by racial or ethnic group are important to gain understanding of the underlying reasons for different patterns of early and late stages of the disease, it was the purpose of the present study to examine the prevalence of ARM in adult Chinese living in a rural habitat or in a suburb of Greater Beijing in China.

METHODS

THE BEIJING EYE STUDY, A POPULATION-BASED PREVALENCE study in Northern China, was carried out in seven communities, three of which were located in a rural region and four of which were located in an urban region of Greater Beijing. The Medical Ethics Committee of the Beijing Tongren Hospital had approved the study protocol, and all participants gave informed consent. All people residing in the communities were officially registered by name, gender, and age at the local mayor's office. This register was used to identify the study sample. According to this registration, all homes were visited. The eligibility criteria for the study, including an age of 40 or more years, was confirmed by door-to-door enrollment. The door-to-
door visitation included all houses in the communities. The registration list of the inhabitants served to provide an overview of who is residing in each of the houses. Participation in the study was supported by the mayors of the communities. The study has been described in detail previously.37–40

At the time of the survey, in the year 2001, there were a total of 5324 individuals aged 40 years or older residing in the seven communities. In total, 4439 individuals (2505 women) participated in the eye examination, an overall response rate of 83.4%. The study was divided into the rural part (1918 [43.8%] subjects; 3814 eyes) and the urban part (2460 [56.2%] subjects; 4910 eyes).

All examinations were carried out in the communities, either in schoolhouses or in community houses. After obtaining informed consent, visual acuity was measured as uncorrected visual acuity (Snellen charts) in a distance of 5 m, and as near vision in a distance 25 to 30 cm using Jaeger charts, uncorrected and then corrected with an addition for near vision. Automatic refractometry (Auto Refractometer AR-610; Nidek, Tokyo, Japan) was performed if uncorrected visual acuity was lower than 1.0. The values obtained by automatic refractometry were verified and refined by subjective refractometry. Intraocular pressure was measured with a noncontact pneumotonometer (CT-60 computerized tonometer; Topcon, Tokyo, Japan) by an experienced technician as described in detail previously. Slit-lamp examination was performed by an ophthalmologist who had passed his ophthalmic training residency. The pupil was dilated with tropicamide until the size, area, and type. The predominant drusen size was graded with one of the following categories: none, less than 63 μm in diameter, between 63 and 125 μm in diameter, between 126 and 175 μm in diameter, between 175 and 250 μm, and 250 μm or more in diameter. The area covered by drusen was estimated by using the area of circles with a projected diameter on the fundus of 63 μm, 125 μm, 175 μm, 250 μm, and 500 μm, respectively. The ratio of the estimated affected area to the total area of the grid was calculated to obtain the percentage of area covered by drusen. We graded the maximum drusen type, addressing the most severe drusen type present as none, hard distinct drusen (<125 μm), intermediate soft distinct drusen (63 μm to 125 μm), large soft distinct drusen (>125 μm), and large soft indistinct semisolid drusen (>125 μm).

In gauging abnormalities of the retinal pigment epithelium, we considered two aspects: increased pigmentation and depigmentation. Increased retinal pigment epithelium pigmentation was graded as absent, questionable, total area of hyperpigmentation occupying an area of a circle with a diameter of less than 63 μm, between 63 and 125 μm in diameter, and more than 125 μm in diameter. Retinal pigment epithelial depigmentation was graded as absent, questionable, total area of retinal pigment epithelium depigmentation occupying a circle with a diameter of less than 125 μm, and more than 125 μm.

Five types of late age-related macular degeneration (AMD) lesions were considered: geographic atrophy, retinal pigment epithelium detachment, detachment of sensory retina, subretinal hemorrhage, and subretinal disciform scar. Exudative AMD was considered present if any of the following lesions were present: retinal pigment epithelium detachment, detachment of sensory retina, subretinal hemorrhage, or subretinal disciform scar. Late AMD was present if there were signs of exudative AMD or pure geographic atrophy. Early AMD was present if late AMD was absent, and there were signs of soft indistinct or any drusen (except hard indistinct drusen) combined with retinal pigment epithelium changes in the macular area.

For the assessment of ARM, the Wisconsin Age-Related Maculopathy Grading System was used.41 In the first step, a measurement scale was prepared by using three circular fields that were centered around the fovea. The first field with a diameter of 1 mm outlined the fovea centralis. The second field with a diameter of 3 mm covered the parafovea, and the field with a diameter of 6 mm included the perifoveal area. For drusen, three features were considered: size, area, and type. The predominant drusen size was graded with one of the following categories: none, less than 63 μm in diameter, between 63 and 125 μm in diameter, between 126 and 175 μm in diameter, between 175 and 250 μm, and 250 μm or more in diameter. The area covered by drusen was estimated by using the area of circles with a projected diameter on the fundus of 63 μm, 125 μm, 175 μm, 250 μm, and 500 μm, respectively. The ratio of the estimated affected area to the total area of the grid was calculated to obtain the percentage of area covered by drusen. We graded the maximum drusen type, addressing the most severe drusen type present as none, hard distinct drusen (<125 μm), intermediate soft distinct drusen (63 μm to 125 μm), large soft distinct drusen (>125 μm), and large soft indistinct semisolid drusen (>125 μm).

RESULTS

OF THE 4439 SUBJECTS INCLUDED IN THE STUDY, FUNDUS photographs with sufficient quality for examination were available for 8655 eyes of 4376 participants (98.6% of the original sample). The mean age was 56.1 ± 10.5 years, ranging from 40 to 101 years, and the mean refractive error was −0.37 ± 2.21 diopters, ranging from −20.13 diopters to +7.50 diopters. For 63 subjects (1.4%), fundus photographs could not be examined. The main reasons for not having photographs taken were inability dilate the pupil and marked lens opacity. Participants not included in the analysis because the photographs were not available or were of insufficient quality to grade drusen characteristics were significantly older (66.4 ± 11.1 years vs 56.1 ± 10.5 years; P < .001; 95% confidence interval [CI] 9.10 to 11.89), were significantly more myopic (−1.24 ± 3.5 diopters vs −0.37 ± 2.21 diopters; P < .001; 95% CI −1.26 to −0.58), had lower best-corrected visual acuity (0.58 ± 0.37 vs 0.91 ± 0.21; P < .001; 95% CI −0.36 to 0.31), and more marked nuclear cataract (P < .001; 95% CI 0.07 to 0.19). Both groups did not vary significantly in
The area covered by geographic atrophy measured between outer macular field in 8.6%. The main location of the irregular pigmentation of the retinal pigment epithelium was in the second macular field. The area covered by the neovascular ARM measured between 0.5 mm and 1 mm in two eyes (29%), and between 1 mm and 3 mm in five eyes (71%). It was located in the central macular field in five eyes (71%), and extended into the second macular field in two eyes (29%).

When we defined early ARM as absence of late ARM in addition to the presence of soft indistinct drusen or any drusen (except hard indistinct) combined with retinal pigment epithelium changes in the macular area, early ARM was detected in 122 (1.4%) of 8655 (95% CI 1.16% to 1.66%) eyes or 63 (1.4%) of 4313 (95% CI 1.09% to 1.79%) subjects.

When we defined exudative ARM as pigment epithelial detachment, detachment of sensory retina, subretinal hemorrhage, or subretinal disciform scar, the frequency of exudative ARM was seven (0.1%) of 8655 (95% CI 0.02% to 0.14%) eyes or six (0.1%) of 4376 (95% CI 0.03% to 0.25%) subjects.

When we defined late ARM as pigment epithelial detachment, detachment of sensory retina, subretinal hemorrhage, subretinal disciform scar, or geographic atrophy, its prevalence was 12 (0.14%) of 8655 (95% CI 0.06% to 0.22%) eyes or seven (0.2%) of 4376 (95% CI 0.04% to 0.28%) subjects. All stages of ARM were highly significantly associated with age (Tables 1 and 2).

Of all subjects with visual impairment defined as best-corrected visual acuity in the better eye of <20/60 and ≥20/400 (World Health Organization definition), ARM caused the visual loss in one (2.0%) of 49 subjects with visual impairment, or one (0.023%) out 4376 subjects overall included in the study. Of all subjects with blindness defined as visual acuity of <20/400 in the better eye (World Health Organization definition), ARM caused the visual loss in one (8%) of 13 subjects with blindness, or one (0.023%) out 4376 subjects overall included in the study.

DISCUSSION

The results of the Beijing Eye Study suggest that ARM is relatively rarely found in adult Chinese living in the Greater Beijing area. In the present study, 0.02% of the study population showed exudative ARM, defined as detachment of the retinal pigment epithelium or sensory retina, subretinal hemorrhage, or subretinal disciform scar, as a reason for visual impairment or blindness. The frequency of exudative ARM was seven (0.1%) of 8655 eyes or six (0.1%) of 4376 subjects. These prevalence
estimates of exudative ARM are relatively low compared with the frequency figures of AMD reported for white populations in western countries. To cite some examples, in the Baltimore Eye Survey,6 the second most common cause of visual impairment was AMD in 14.2% of the impaired eyes. AMD was more frequent among Caucasians than among African-Americans. In the Australian Blue Mountains Study,13 AMD was the most frequent cause of bilateral blindness in 13 (76%) of 17 subjects, and it was the most common cause of moderate to severe bilateral visual impairment in persons aged 70 or more years. In a recent study on the causes and prevalence of visual impairment among adults in the United States,21 the leading cause of blindness among Caucasians was AMD (54.4% of the cases), whereas among African-Americans, cataract and glaucoma accounted for more than 60% of blindness. In a study by Munoz and associates14 of a population-based sample of Hispanic individuals aged 50 or more years in Arizona, the overall prevalence of late AMD was 0.5%. The prevalence increased from 0.1% in the 50-to-59-year age group to 4.3% in the group aged 80 years and older. In the Rotterdam Study of 6775 subjects aged 55 years or older,8 for people younger than 75 years, myopic degeneration and optic neuropathy were the most important causes of impaired vision. For persons aged 75 years or older, AMD was the major cause of the increased prevalence of blindness.

The estimates of AMD in the present study on mainland Chinese in the Greater Beijing area were lower than estimates from the Chinese population group examined in the Taiwanese Shih-Pai Eye Study,33 in which AMD was the third most common cause of visual impairment accounting for 10.4% of the cases. The prevalence estimates of AMD in the present study were also markedly lower than the figures from a previous study carried out in Shanghai on 1023 subjects older than 50 years,36 where 15.5% of the included population had AMD.

### TABLE 1. Frequency of Age-Related Maculopathy in the Beijing Eye Study*

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Eyes</th>
<th>Percentage of Population</th>
<th>Frequency of Early ARM</th>
<th>Frequency of Late ARM</th>
<th>Frequency of Exudative ARM</th>
</tr>
</thead>
<tbody>
<tr>
<td>40–44</td>
<td>1463</td>
<td>16.9%</td>
<td>0.61% (0.21% to 1.02%)</td>
<td>0.07% (–0.07% to 0.20%)</td>
<td>0.07% (–0.07% to 0.20%)</td>
</tr>
<tr>
<td>45–49</td>
<td>1415</td>
<td>16.3%</td>
<td>0.85% (0.37% to 1.33%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50–54</td>
<td>1184</td>
<td>13.7%</td>
<td>1.44% (0.76% to 2.11%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>55–59</td>
<td>1145</td>
<td>13.2%</td>
<td>1.66% (0.92% to 2.40%)</td>
<td>0.26% (–0.03% to 0.56%)</td>
<td>0.26% (–0.03% to 0.56%)</td>
</tr>
<tr>
<td>60–64</td>
<td>1437</td>
<td>16.6%</td>
<td>1.25% (0.88% to 1.83%)</td>
<td>0.21% (–0.03% to 0.45%)</td>
<td>0</td>
</tr>
<tr>
<td>65–69</td>
<td>1085</td>
<td>12.5%</td>
<td>1.84% (1.04% to 2.64%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>70–74</td>
<td>591</td>
<td>6.8%</td>
<td>2.88% (1.53% to 4.23%)</td>
<td>0.34% (–0.13% to 0.81%)</td>
<td>0.17% (–0.16% to 0.50%)</td>
</tr>
<tr>
<td>75+</td>
<td>334</td>
<td>3.9%</td>
<td>2.99% (1.16% to 4.83%)</td>
<td>0.90% (–0.12% to 1.92%)</td>
<td>0.60% (–0.23% to 1.43%)</td>
</tr>
</tbody>
</table>

**ARM** = age-related maculopathy.

*Data are given as percentage and the 95% confidence intervals in parentheses.

### TABLE 2. Frequency of Age-Related Maculopathy in the Beijing Eye Study*

<table>
<thead>
<tr>
<th>Age</th>
<th>Subjects</th>
<th>Percentage of Population</th>
<th>Frequency of Early ARM</th>
<th>Frequency of Late ARM</th>
<th>Frequency of Exudative ARM</th>
</tr>
</thead>
<tbody>
<tr>
<td>40–44</td>
<td>733</td>
<td>16.8%</td>
<td>0.55% (0.01% to 1.08%)</td>
<td>0.14% (–0.13% to 0.40%)</td>
<td>0.14% (–0.13% to 0.40%)</td>
</tr>
<tr>
<td>45–49</td>
<td>710</td>
<td>16.2%</td>
<td>0.99% (0.26% to 1.71%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50–54</td>
<td>595</td>
<td>13.6%</td>
<td>1.18% (0.31% to 2.05%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>55–59</td>
<td>576</td>
<td>13.2%</td>
<td>1.56% (0.55% to 2.58%)</td>
<td>0.52% (–0.07% to 1.11%)</td>
<td>0.52% (–0.07% to 1.11%)</td>
</tr>
<tr>
<td>60–64</td>
<td>726</td>
<td>16.6%</td>
<td>1.24% (0.43% to 2.05%)</td>
<td>0.14% (–0.13% to 0.41%)</td>
<td>0</td>
</tr>
<tr>
<td>65–69</td>
<td>554</td>
<td>12.7%</td>
<td>2.17% (0.85% to 3.38%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>70–74</td>
<td>302</td>
<td>6.9%</td>
<td>2.98% (1.05% to 4.91%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>75+</td>
<td>180</td>
<td>4.1%</td>
<td>3.33% (0.69% to 5.98%)</td>
<td>1.11% (–0.43% to 2.66%)</td>
<td>1.11% (–0.43% to 2.66%)</td>
</tr>
</tbody>
</table>

**ARM** = age-related maculopathy.

*Data are given as percentage and 95% confidence intervals in parentheses. Only one randomly selected eye per subject was taken for statistical analysis.
and 19 (1.9%) of 1023 subjects had exudative AMD. Correspondingly, the prevalence rates of AMD in the age groups of 50 to 59, 60 to 69, 70 to 79, and more than 80 with 5.7%, 13.5%, 20.2%, and 23.5%, respectively, were considerably higher than in the Beijing Eye Study (Tables 1 and 2). There may be several reasons for the discrepancies between the two studies. One of the reasons may be differences in the definitions of AMD used in the investigations. In the Shanghai Study, the Chinese Ophthalmologic Society definition of AMD was applied in which AMD means any maculopathy as detected by ophthalmoscopy, such as any drusen, pigmentary irregularities of the retinal pigment epithelium, and detachment of sensory retina, whereas the Beijing Eye Study used the Wisconsin definition and grading system. Other reasons may be different inclusion criteria with a higher age in the Shanghai Study, ethnic differences between the populations living in Northern vs Southern China, climate differences and accompanying differences in food between the North vs South of China, and differences in environmental parameters.

A limiting factor of the present study is that subjects for whom a dense cataract was considered to be the reason for the visual impairment might additionally have had AMD. It may have artificially reduced the prevalence figures for AMD in the present study. Considering that the proportion of cataract blindness in the present study population (0.11%) was higher than the proportion of cataract blindness in the Taiwanese study (no cataract blindness),31 may give further importance to this possible limitation of the Beijing Eye Study. In the study from Shanghai, no data on cataract blindness were presented.36 In another epidemiologic survey carried out in another block in the Shanghai Study, the prevalence of cataract blindness in the years 1994, 1997, and 2000 were 1.51%, 1.09%, and 0.71%, respectively. In 2000, cataract accounted for 17% of all causes for blindness, and the prevalence of cataract blindness was 0.12%, a figure similar to the figure in the Beijing Eye Study.42

In agreement with the present Beijing Eye study, another population-based study in Taiwan revealed similarly low prevalence estimates of AMD in the Chinese population.44 All studies on Chinese population groups, such as the Shih-Pai Eye Study,33 the Singaporean Tanjong Pagar Survey,32 and other investigations,30,35 agree on lower prevalence estimates of AMD in Chinese than in western population groups.

In conclusion, visual impairment due to ARM was relatively uncommon in the adult Chinese population in rural and urban regions of Greater Beijing. Early AMD and late AMD are markedly less prevalent in Chinese population groups than in western populations. Future studies may reveal differences in the associated factors with the development of AMD and search for causes for the interethnic variations in the prevalence of AMD as reason for visual impairment.

REFERENCES

15. Buch H, Vinding T, Nielsen NV. Prevalence and causes of visual impairment according to World Health Organization and United States criteria in an aged, urban Scandinavian


Biosketch

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