# Presbyopia and Near-Vision Impairment in Rural Northern China

*Qing Lu,*[1] *Wei He,*[1] *Gudlavalleti V. S. Murthy,*[2] *Xiangdong He,*[1] *Nathan Congdon,*[3] *Lirong Zhang,*[1] *Ling Li,*[1] *and Jian Yang*[1]

**Purpose.** Presbyopia limits activities of daily living, but population-based data from rural China are scarce.

**Methods.** A population-based, cross-sectional study was conducted in 2009 among all persons aged 40+ years in a rural area near Shenyang, China. Distance and near VA were measured using logMAR E charts. Individuals with pinhole-corrected distance vision ≥20/63 underwent detailed eye examination and near refraction.

**Results.** A total of 1008 (91.5%) respondents were examined (mean age, 58.4 ± 10.7 years for men, 56.8 ± 9.89 years for women). Women and older subjects were more likely to participate. The prevalence of functional presbyopia (near vision <20/50 [N8] improved by ≥1 line with correction) was 67.3% (95% confidence interval [CI], 64.30%–70.09%), increasing from 27.6% at 40 to 49 years of age to 81.8% at 60 to 69 years. Multivariate analysis showed that older age ($P < 0.001$), but not gender or education, was significantly associated with a higher risk of presbyopia. Self-reported presbyopic spectacle correction coverage was 51.5%. In multivariate logistic regression models, worse presenting near vision ($P = 0.013$) and higher required spherical equivalent power ($P < 0.001$) were associated with having correction, while age, gender, education, and distance vision were unassociated. Major barriers reported by persons without near correction included poor quality of available glasses (33.1%) and lack of awareness of the condition and its treatment (28.8%).

**Conclusions.** Presbyopia is highly prevalent in rural China, and nearly half of affected persons have no access to correction. Interventions should focus on education and improvement in the quality of refractive services. (*Invest Ophthalmol Vis Sci.* 2011;52:2300–2305) DOI:10.1167/iovs.10-6569

Recently, the World Health Organization (WHO) presented data on the global magnitude of refractive errors.[1] WHO acknowledged that presbyopia is an important problem affecting quality of life in middle age and beyond, but could not provide reliable estimates of the magnitude of the problem, because of a lack of scientifically valid population-based data.[1] Based on population projections and available evidence from prevalence studies, it has been estimated that there were 1.04 billion people globally with presbyopia in 2005, of whom 517 million (49.7%) did not have corrective spectacles.[2] Because of the large number of people with near vision impairment caused by uncorrected or undercorrected presbyopia and the negative effect on visual function, presbyopia is increasingly recognized as a problem of public health importance.

Functional presbyopia is defined as adding an optical correction to the presenting distance refractive correction, to achieve a near visual acuity (VA) criterion (≥1 line of acuity improvement or J1 print, N8 print, 20/50).[3–5] Several population-based studies of presbyopia have been undertaken in developed and developing countries.[3–13]

The prevalence of functional presbyopia among those aged 40 years and older varied from 43.8% in Timor-Leste to 72.3% in Brazil.[3,4] In addition to variation in the prevalence rates of presbyopia, there is a wide variation in usage of presbyopic spectacles between economically developed and developing countries. More than 85% of those aged 40 years and above in Australia[6] and 96% of those aged 30 years and above in Finland[7] were using spectacles to correct presbyopia, compared with 39% in Brazil,[3] 30% in India,[9] 26% in Timor Leste,[4] 17% in Zanzibar,[13] and 7% in Tanzania.[5] It is unknown whether these differences in rates of use of presbyopic spectacles are due in part to variation in the severity of near-vision impairment between populations.

With a population of 1.34 billion (2009), of whom 39.6% are 40 years of age and older,[14] China has an urgent need for data on near-vision impairment caused by uncorrected presbyopia, to plan for appropriate refractive services in China. The authors are unaware of any published data on the prevalence of presbyopia in rural China. The present study was undertaken to assist in planning for need-based refractive services in rural areas of one county in China.

## Material and Methods

Shenyang is the capital of Liaoning province, China, and has a population of 7.09 million, 64% residing in urban areas and 36% in rural zones. In Liaoning, 94.9% of the population have at least a primary education, and 17.5% are college-educated.[15]

Data were collected during a 2-month period (June and July 2009) in rural villages of Yuhong District, Shenyang City, China. Yuhong is one of 14 districts and counties of Shenyang. Among its population of 76,000, 65% dwell in rural areas composed of 103 villages. Individuals 40 years of age and older residing continuously for ≥6 months in the randomly selected villages were eligible. Ethical approval was obtained from ethics committees at the London School of Hygiene and Tropical Medicine and the Shenyang He Eye Hospital in China. Written informed consent was obtained from participants before the examination, and the tenets of the Declaration of Helsinki were adhered to throughout.

From the [1]Shenyang He Eye Hospital, Shenyang, China; the [2]International Centre for Eye Health, London School of Hygiene and Tropical Medicine, London, United Kingdom; the [3]Zhongshan Ophthalmic Center, State Key Laboratory of Ophthalmology and Preventive Ophthalmology Unit, Sun Yat Sen University, Guangdong, Peoples Republic of China.

Supported by funds from Christoffel Blindenmission, Bensheim, Germany.

Submitted for publication September 14, 2010; revised October 14, 2010; accepted October 23, 2010.

Disclosure: **Q. Lu**, None; **W. He**, None; **G.V.S. Murthy**, None; **X. He**, None; **N. Congdon**, None; **L. Zhang**, None; **L. Li**, None; **J. Yang**, None

Corresponding author: Wei He, Shenyang He Eye Hospital, No.128 North Huanghe Street, Shenyang, China 110034; hewei0111@163.com.

## Sampling Procedure and Participants

Clusters of approximately equal population size were defined geographically by using census data. Cluster random sampling according to the principle of population proportionate to size was used. An anticipated prevalence of 43.8% was based on previous studies.[2] An allowable error bound of 10% with 95% confidence levels and 80% response rate and a design effect of 2.0 were used to calculate the requisite sample size of 922. To provide for accurate estimates for different age groups, the proportion of the population in 10-year age brackets was calculated, and the sample size adjusted upward to 1200. A total of 15 study clusters of approximately 80 persons, each 40 years of age or older, were selected from 103 villages in the sampling frame to ensure a study sample of this size. Subjects with pinhole-corrected distance VA <20/63 in both eyes were excluded from the analysis, as were those in whom vision could not be recorded or who had visually significant ocular disease. They were excluded to avoid overestimating presbyopia by including persons with poor vision due to other underlying causes.

## Enumeration and Examination Procedures

Door-to-door visits were conducted by trained enumerators at all households within the sample frame in rural Yuhong District in Shenyang to identify all those 40 years of age and older. Sociodemographic information on the eligible 40+ population was also recorded by trained interviewers. All eligible subjects were then offered a complete eye examination. Presenting distance VA (with spectacles if worn) was measured by two trained ophthalmic assistants with a logMAR E chart (Low Vision Resource Center, Hong Kong, Peoples Republic of China) as the smallest line with at least four of the five optotypes read correctly, at a distance of 4 m in an adequately illuminated room at the local health center of each village. Pinhole vision (with spectacles if worn) was recorded for each eye separately, using the same procedure.

Information on habitual wear of near-vision spectacles was collected before the near-vision examination. Presenting and uncorrected near VA were measured for those participants whose pinhole-corrected distance VA was ≥20/63 in either eye, using a logMAR near-vision E chart (Low Vision Resource Center) at a distance of 40 cm indoors. A standard lamp provided constant illumination. The distance of 40 cm from the eyes was maintained with a string of 40 cm length attached to the top of the chart at one end, with the other end placed against the forehead and held taught. VA was measured and recorded as the smallest line with at least four of the five optotypes read correctly. Testing always included the 20/20 line.

## Near-Vision Correction

All subjects with presenting near VA <20/50 underwent near-vision measurement without distance-vision correction and with progressively higher plus sphere power in both eyes simultaneously, until a binocular VA ≥20/50 (N8) was obtained. The spherical diopter correction was recorded along with the corresponding corrected near VA. Correction of astigmatism was not undertaken in assessing corrected near vision. Subjects wearing spectacles providing near vision >20/50 (N8) had the power of currently worn spectacles recorded and did not undergo further correction of near vision.

## Ocular Examination and Definitions

After near-vision correction, a slit-lamp and an ophthalmoscope were used to examine the cornea, lens, and fundus, without dilation of the pupil, of those with near vision <20/40 and/or distance vision <20/20, to exclude visually significant ocular disease, such as cataract and retinal disease.

Presbyopia was defined as binocular near vision <N8 (20/50) at 40 cm with presenting distance refractive correction and improvement of near vision by at least 1 line with near correction. This definition, often referred to as functional presbyopia, has been used in earlier studies.[4,5]

We have followed the definitions of near vision impairment (NVI; provided by the International Agency for Prevention of Blindness (IAPB) Refractive Error Program Committee[16]), which have recently also been used by WHO.

Mild NVI: presenting binocular near vision <20/40 to 20/63.

Moderate NVI: presenting binocular near vision <20/63 to 20/200

Severe NVI: presenting binocular near vision <20/200 to 20/400

Near vision blindness: presenting binocular near vision <20/400

Presbyopia correction coverage (PCC) was calculated in the following manner: PCC (%) = 100 × (*n* with presbyopia need met)/([*n* with presbyopia need met] + [*n* with presbyopia need unmet]). The "met need" was defined as including those persons with functional presbyopia and had spectacles that allowed near vision to improve to ≥20/50 (N8) or by at least one line. Unmet need was defined as including those with near vision <20/50 (N8) due to functional presbyopia who did not have near-vision corrective spectacles or whose spectacles did not improve vision.

## Statistical Methods

All data were analyzed (SPSS for Windows version 16.0; SPSS Inc, Chicago, IL). 95% Confidence intervals (CIs) and *P*-values (significant at the $P < 0.05$ level) were calculated for the prevalence estimates. Separate multivariate models were created for potential predictors of having presbyopia and wearing presbyopic correction.

# Results

Among the 1200 initially screened, 98 (8.2%) were excluded by protocol on the basis of best corrected distance vision <20/63; 58.2% of these were women and 41.8% were men. Among the 1102 enumerated eligible subjects, 94 (7.8%) refused or were not available for examination. (Fig. 1) Men were less likely to take part ($P < 0.001$), but participants and nonparticipants did not differ significantly by age ($P = 0.59$; Table 1). Among 1008 subjects taking part in the survey, the mean age was 58.4 ± 10.7 years, and 59.9% (604/1008) were women.

Among 1008 examined subjects, the prevalence of functional presbyopia was 67.3%, increasing from 27.6% among persons less than 50 years old to 80.2% among those 50 to 59 years old, and remaining roughly stable thereafter (test for trend, $P < 0.001$; Table 2). In multivariate logistic modeling, the odds of presbyopia increased by 1.09 (95% CI, 1.06–1.11) for each year's increase in age, whereas gender and education were unassociated with presbyopia risk.

Among examined subjects, 21.9% (221) had normal near vision (≥20/40), while 42.8% (431) had mild NVI (<20/40–20/63), 34.2% (345) had moderate NVI (<20/63–20/200), and 1.1% (11) had severe NVI (<20/200; Table 3). No respondent was categorized as blind on the basis of near vision. Subjects aged 50+ years had a significantly lower prevalence of normal near vision (10.3%) compared with participants aged 40 to 49 years (60.2%, $P < 0.001$). The prevalence of presenting severe NVI was significantly higher among those with less education than in those educated at least to junior high school level ($P = 0.016$). There was no difference in NVI prevalence by gender (Table 3).

The mean add needed to improve vision to ≥20/50 (N8) was +2.11 ± 0.96 D. This value increased with age ($P < 0.001$), but did not vary by gender. Junior high school education and higher was associated with less severe functional presbyopia than was found in those with primary education and lower ($P = 0.041$).

Among persons with presbyopia responding to the question (666/678 = 98.2%), 343 (51.5%) indicated that they had spectacles, while 323 (48.5%) did not. Presbyopia coverage was

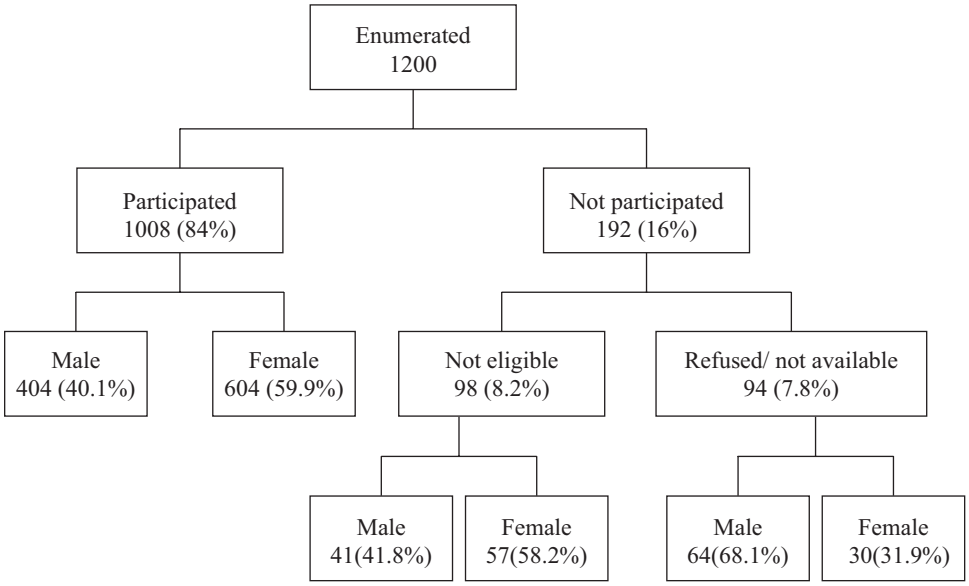


**FIGURE 1.** Flow chart showing the disposition of those enumerated for the survey.

lowest among persons aged 40 (25.0%) to 49 years and increased with age, peaking at 60 to 69 years, declining thereafter among persons 70 years of age and older (48.5; $P < 0.001$). Presbyopia coverage also increased among those with worse presenting near ($P < 0.001$) and distance ($P = 0.024$) vision, and those requiring stronger adds to achieve near vision of 20/50 ($P < 0.001$; Table 4). Neither gender nor education was significantly associated with having presbyopic needs met (Table 4). In multivariate logistic regression models, worse presenting near vision ($P = 0.013$) and greater required spherical equivalent power to correct presbyopia ($P < 0.001$) were associated with having correction, whereas no association was observed for gender, education, and distance vision. Age was also no longer associated with wear of corrective spectacles in the multivariate model (Table 5).

Among 323 respondents who needed presbyopic correction but did not have it, the commonest barriers reported were poor quality of available reading glasses ($n = 107$; 33.1%), perception that vision was normal ($n = 59$; 18.3%), and lack of awareness that presbyopia could be corrected ($n = 34$; 10.5%). Lack of money to purchase glasses ($n = 4$; 1.2%) and not knowing where to find services ($n = 7$, 2.2%) were not reported as significant barriers to using glasses.

## DISCUSSION

Functional presbyopia and associated near vision impairment were common in this rural Chinese population. Functional presbyopia affected some two thirds (67.3%) of persons 40 years of age and older, with prevalence peaking in the 50s and 60s. In other population-based studies of presbyopia in which a similar definition was used, the prevalence of functional presbyopia among subjects 40 years of age and older ranged from 43.8% in Timor-Leste[4] to 58.9% in Tanzania,[5] lower than we observed. Although we did not collect data on refractive error at distance, the reported prevalence of hyperopia among rural-dwelling northern Chinese 35 years of age and older has been reported as 15.9% in Handan,[17] higher than the rate of 4.78% among similar-aged persons in Tanzania.[5] It is possible that the excess of hyperopia explains the higher prevalence of functional presbyopia in China. It is interesting to note that the prevalence of functional presbyopia in those 40 to 49 years old (27.6%, mean power = +1.47 D) was lower in this study than in Tanzania and Timor Leste (50.4% in Tanzania,[5] 43.5% in Timor-Leste[4]). The recent Beijing Eye Study reported that 19.6% Chinese 40 years of age and older had mild myopia (−0.5 to < −1 D), and that this was more prevalent in younger subjects.[18] Thus, the low prevalence of presbyopia in Chinese persons aged 40 to 49 years may in part reflect a high prevalence of uncorrected mild myopia. The rapid rise thereafter may reflect both the loss of accommodation with age and the lower prevalence of myopia among older persons. Unfortunately, we did not collect data on distance vision in the present study, and thus cannot confirm this hypothesis.

Consistent with the population-based studies in India[9,12] and Nigeria,[19] no association was observed between presbyopia and education— unlike in Tanzania, where a higher prevalence of presbyopia was observed among more highly edu-

**TABLE 1.** Characteristics of Participants and Nonparticipants in a Study of Presbyopia in Rural Northern China

| Variables | Examined *n* (%) | Not Examined *n* (%) | Total *n* (%) | *P* |
|---|---|---|---|---|
| Age group, y | | | | 0.59 |
| 40–49 | 246 (90.1) | 27 (9.9) | 273 (24.8) | |
| 50–59 | 349 (93.3) | 25 (6.7) | 374 (33.9) | |
| 60–69 | 280 (92.7) | 22 (7.3) | 302 (27.4) | |
| 70+ | 133 (86.9) | 20 (13.1) | 153 (13.9) | |
| Gender | | | | <0.001 |
| Male | 404 (86.3) | 64 (13.7) | 468 (42.5) | |
| Female | 604 (95.3) | 30 (4.7) | 634 (57.5) | |
| Total | 1008 (91.5) | 94 (8.5) | 1102 (100) | |

**TABLE 2.** Prevalence of Functional Presbyopia in the Examined Population by Gender, Age, and Education

| Characteristic | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | Presbyopic (%) | 95% CI | Presbyopic (%) | 95% CI | Presbyopic (%) | 95% CI |
| Age, y* | | | | | | |
| 40–49 | 30/95 (31.6) | 23.1–41.5 | 38/151 (25.2) | 18.9–32.7 | 68/246 (27.6) | 22.4–33.5 |
| 50–59 | 92/120 (76.7) | 68.3–83.4 | 188/229 (82.1) | 76.6–86.6 | 280/349 (80.2) | 75.7–84.1 |
| 60–69 | 108/129 (83.7) | 76.3–89.2 | 121/151 (80.1) | 73.0–85.8 | 229/280 (81.8) | 76.8–85.9 |
| 70+ | 42/60 (70.0) | 57.4–80.2 | 59/73 (80.8) | 70.2–88.3 | 101/133 (75.9) | 68.0–82.5 |
| Total | 272/404 (67.3) | 62.6–71.7 | 406/604 (67.2) | 63.4–70.8 | 678/1008 (67.3) | 64.3–70.1 |
| Education† | | | | | | |
| No education | 50/70 (71.4) | 59.9–80.7 | 74 (71.8) | 62.5–79.7 | 124 (71.7) | 64.5–77.9 |
| Primary school | 74/107 (69.2) | 59.9–77.1 | 125 (70.6) | 63.5–76.9 | 199 (70.1) | 64.5–75.1 |
| Junior high school or higher | 148/207 (65.2) | 58.8–71.1 | 207 (63.9) | 58.5–68.9 | 355 (64.4) | 60.3–68.3 |

* Test for trend, $P < 0.001$.
† Test for trend, $P = 0.72$.

cated subjects.[5] Our study did not observe any gender differences in presbyopia prevalence, unlike studies in India,[9,12] Nigeria,[19] and Tanzania,[5] which found higher rates among women. Further work is needed to elucidate the reasons for these differences between societies in the gender distribution of presbyopia.

More than half of persons with presbyopia in this population reported having spectacles capable of improving their near vision, a presbyopia correction coverage (PCC) rate that significantly exceeded the range of 17.6% to 26.2% reported in other developing countries, including Timor-Leste, India, Kenya, and Tanzania.[4,5,9,10,12,13] Nevertheless, the half of presbyopic persons without spectacles remains far in excess of the 5% to 15% of similar-aged persons without near correction in developed countries such as Australia[6] and Finland.[7] Although the prevalence of undercorrected presbyopia was particularly high among younger persons in this setting, this trend disappeared with adjustment for the severity of presbyopia, suggesting that the lower rate of wear among younger persons is due to less visual need.

The principle barrier to accessing presbyopic correction reported by subjects in this setting was poor spectacle quality. This report is consistent with data from elsewhere in rural China, indicating that some 50% of children wearing glasses have powers that are incorrect by 1.0 D or more, 17% by ≥2 D.[20] Concerns over accuracy and quality of glasses ranked first among several groups of children asked about their requirements for spectacles in a recent focus group study conducted in rural Guangdong.[21] In many parts of the world, cost is an important barrier to purchase of presbyopic glasses.[4,9] That cost barriers were not thought to be important in this setting is consistent with other studies in rural China that have found that cost is not a significant impediment to acceptance of vision services such as cataract surgery,[22,23] distance spectacles,[24] and diabetic eye care.[25] An additional third of subjects (28.8%) without near correction reported a lack of knowledge about their condition and/or its correctability. This evidence of a knowledge barrier to vision services in rural China is also consistent with reports from the region indicating that lack of awareness limits access to cataract surgery,[23] refractive services,[21] and diabetic eye examinations.[25]

The results of the present study have practical implications for planners of blindness prevention programs. Among China's population of 1.34 billion people, more than a third (530 million; 39.6%) are 40 years of age an older, more than 60% of whom reside in rural areas.[26] The estimated life expectancy in China is 73 years.[27] Thus, a person developing functional presbyopia at the age of 50 years will spend nearly a third of his or her life with the condition. Based on our data, as many as 222 million adults in rural China are affected by functional presbyopia, among whom 149 million may be without near vision correction. Our results suggest that efforts to remediate this problem should focus on improving the quality of available

**TABLE 3.** Prevalence of Near Vision Impairment in the Examined Population by Gender, Age, and Education

| | Presenting Binocular Near Visual Acuity | | | | | |
|---|---|---|---|---|---|---|
| | ≥20/40 *n* (%) | <20/40–20/63 *n* (%) | <20/63–20/200 *n* (%) | <20/200 *n* (%) | Total *n* (%) | *P** |
| Age group, y | | | | | | <0.001 |
| 40–49 | 148 (60.2) | 82 (33.3) | 16 (6.5) | 0 (0) | 246 (100) | |
| 50–59 | 36 (10.3) | 171 (49.0) | 138 (39.5) | 4 (1.1) | 349 (100) | |
| 60–69 | 25 (8.9) | 117 (41.8) | 137 (48.9) | 1 (0.4) | 280 (100) | |
| 70+ | 12 (9.0) | 61 (45.9) | 54 (40.6) | 6 (4.5) | 133 (100) | |
| Gender | | | | | | 0.92 |
| Male | 90 (22.3) | 168 (41.6) | 142 (35.1) | 4 (1.0) | 404 (100) | |
| Female | 131 (21.7) | 263 (43.5) | 203 (33.6) | 7 (1.2) | 604 (100) | |
| Total | 221 (21.9) | 431 (42.76) | 345 (34.23) | 11 (1.09) | 1008 (100) | |
| Education | | | | | | 0.016 |
| None | 25 (14.5) | 79 (45.7) | 66 (38.2) | 3 (1.7) | 173 (100) | |
| Primary school | 54 (19.0) | 116 (40.8) | 111 (39.1) | 3 (1.1) | 284 (100) | |
| Junior high school or higher | 142 (25.8) | 236 (42.8) | 168 (30.5) | 5 (0.9) | 551 (100) | |

* $\chi^2$ test.

**TABLE 4.** Presbyopia Spectacle Coverage Rate by Clinical and Sociodemographic Variables

| Variables | Total *n* | Met Need (*n*) | Unmet Need (*n*) | Spectacle Coverage (%) | *P** |
|---|---|---|---|---|---|
| Age, y | | | | | <0.001 |
| 40–49 | 68 | 17 | 51 | 25.0 | |
| 50–59 | 276 | 140 | 136 | 50.7 | |
| 60–69 | 233 | 138 | 85 | 61.9 | |
| 70+ | 99 | 48 | 51 | 48.5 | |
| Total† | 666 | 343 | 323 | 51.5 | |
| Gender | | | | | 0.18 |
| Male | 260 | 125 | 135 | 48.1 | |
| Female | 406 | 218 | 188 | 53.7 | |
| Education | | | | | 0.99 |
| No education | 118 | 61 | 57 | 51.7 | |
| Primary school | 198 | 106 | 92 | 53.5 | |
| Junior high school or higher | 350 | 176 | 174 | 50.3 | |
| Presenting binocular near vision | | | | | <0.001 |
| <20/50–20/63 | 317 | 127 | 190 | 40.1 | |
| <20/63–20/200 | 335 | 207 | 128 | 61.8 | |
| <20/200 | 14 | 9 | 5 | 64.3 | |
| Spherical equivalent power to correct presbyopia‡ | | | | | <0.001 |
| ≤+1.00 D | 119 | 30 | 89 | 25.2 | |
| >+1.00 to +2.00 D | 302 | 150 | 152 | 49.7 | |
| >+2.00 to +3.00 D | 146 | 91 | 55 | 62.3 | |
| >+3.00 D | 98 | 72 | 26 | 73.5 | |
| Presenting distance vision | | | | | 0.024 |
| ≥20/40 | 526 | 259 | 267 | 49.2 | |
| <20/40 | 140 | 84 | 56 | 60.0 | |

* $\chi^2$ test.
† 12 cases missing.
‡ 13 cases missing.

near vision correction in rural areas and educational efforts directed at conveying the benefits of presbyopic correction.

There were some limitations to the present study. The lower response rate among men (79.4%) compared with that of women (87.4%) is a potential source of bias. The proportion of people aged 40 to 49 among respondents was 24.2%, less than people aged 50 (37.6%) to 59 and 60 (27.8%) to 69. In the Chinese population at large, the 40 to 49 age group is the largest. This distribution most likely reflects the phenomenon of rural to urban migration, widespread in China among persons of working age, and is representative of the current situation in many parts of rural China.

We relied on self-report from subjects and family members about the use of presbyopic spectacles. As this could not be confirmed by other means, we cannot exclude the possibility that attribution of spectacle use was inaccurate in some cases. Our use of the cutoff of 20/50 (N8) to define functional presbyopia as suggested by the WHO and IAPB did not allow us to estimate the prevalence of milder degrees of near vision disability. It is not known whether such milder presbyopia may be of greater significance in China due to the more complex writing system in use. Although only a basic ocular examination without dilation of the pupil was performed, since persons whose distance vision could not be corrected with refraction to at least 20/63 in at least one eye were excluded, we do not expect that undiagnosed eye disease would have been likely to greatly affect our prevalence estimates for presbyopia. Finally, we did not perform distance refraction on our subjects and are thus unable to assess the impact of refractive error on presbyopia, potentially an important factor, due to the high prevalence of adult myopia.[17]

Despite its limitations, this report provides previously unavailable data on the prevalence of presbyopia and rates of access to near vision correction in rural China. This information, together with our findings on the main barriers to care, may be of practical use to program planners seeking to create strategies to remediate this widespread problem.

## *Acknowledgments*

The authors thank Tianhua Wang, Cunrong Han, Hongjiao Gao, Baohong Wang, Ying Peng, Junwen Hu, Lijian Guo, Jing Liao from She-

**TABLE 5.** Multivariate Model of Determinants of Presbyopia Spectacle Coverage among 665 Persons Needing Near-Vision Correction

| Characteristic | OR | 95% CI | *P* |
|---|---|---|---|
| Age, per year | 1.008 | 0.988–1.028 | 0.447 |
| Gender | 1.239 | 0.891–1.722 | 0.203 |
| Education | 1.094 | 0.882–1.358 | 0.413 |
| Presenting binocular near vision | **0.038** | **0.003–0.499** | **0.013** |
| Spherical equivalent power to correct presbyopia | **1.005** | **1.003–1.007** | **<0.001** |
| Presenting distance vision | 0.622 | 0.304–1.271 | 0.193 |

Data in bold are statistically significant. OR, odds ratio.

nyang He Eye Hospital for their kind support and hard work in the field work and data input.

## *References*


1. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bull World Health Org.* 2008;86:63–70.
2. Holden BA, Fricke TR, Ho SM, et al. Global vision impairment due to uncorrected presbyopia. *Arch Ophthalmol.* 2008;126:1731–1739.
3. Duarte WR, Barros AJD, Dias-da-Costa JS, Cattan JM. Prevalence of near vision deficiency and related factors: a population-based study in Brazil (in Portuguese). *Cad Saude Publica.* 2003;19:551–559.
4. Ramke J, du Toit R, Palagyi A, Brian G, Naduvilath T. Correction of refractive error and presbyopia in Timor-Leste. *Br J Ophthalmol.* 2007;91:860–866.
5. Burke AG, Patel I, Munoz B, et al. Population-based study of presbyopia in rural Tanzania. *Ophthalmology.* 2006;113:723–727.
6. Taylor HR, Livingston PM, Stanislavsky YL, McCarty CA. Visual impairment in Australia: distance visual acuity, near vision, and visual field findings of the Melbourne Visual Impairment Project. *Am J Ophthalmol.* 1997;123:328–337.
7. Laitinen A, Koskinen S, Harkanen T, Reunanen A, Laatikainen L, Aromaa A. A nationwide population-based survey on visual acuity, near vision, and self reported visual function in the adult population in Finland. *Ophthalmology.* 2005;112:2227–2237.
8. Patel I, Munoz B, Burke AG, et al. Impact of presbyopia on quality of life in a rural African setting. *Ophthalmology.* 2006;113:728–734.
9. Nirmalan PK, Krishnaiah S, Shamanna BR, Rao GN, Thomas R. A population based assessment of presbyopia in the state of Andhra Pradesh, south India: the Andhra Pradesh Eye Disease Study. *Invest Ophthalmol Vis Sci.* 2006;47:2324–2328.
10. Sherwin JC, Keeffe JE, Kuper H, Islam FM, Muller A, Mathenge W. Functional presbyopia in a rural Kenyan population: the unmet presbyopic need. *Clin Exp Ophthalmol.* 2008;36(3):245–251.
11. Varma R, Ying-Lai M, Klein R, Azen S. Prevalence and risk indicators of visual impairment and blindness in Latinos: the Los Angeles Latino Eye Study. *Ophthalmology* 2004;111(6):1132–1140.
12. Maramamula S, Keefe J, Rao GN. Uncorrected refractive errors, presbyopia and spectacle coverage: results from a rapid assessment of refractive errors survey. *Ophthalmic Epidemiol.* 2009;16:269–274.
13. Laviers HR, Omar F, Jecha H, Kassim G, Gilbert C. Presbyopic spectacle coverage, willingness to pay for near correction and the impact of correcting uncorrected presbyopia in adults in Zanzibar, East Africa. *Invest Ophthalmol Vis Sci.* 2010;51:1234–1241.
14. U.S. Census Bureau International Data Base. Population pyramid China 2009.http://www.census.gov/ipc/www/idb. Accessed March 20, 2010.
15. Shenyang Bureau of Statistics (2008; web site in Chinese). http://www.sysinet.gov.cn/assembly/action/browsePage.do?channelID=1110786720304&contentID=1227145808310. Accessed April 16, 2010.
16. Holden B, Fricke T, Naidoo K, et al. Strategy for the Elimination of Vision Impairment from Uncorrected Refractive Error. Meeting of the Refractive Error Program Committee and IAPB Board of Trustees. Chittagong, Bangladesh, February 2008.
17. Liang YB, Wong TY, Sun LP, et al. Refractive errors in a rural Chinese adult population: The Handan Eye Study. *Ophthalmology.* 2009;116:2119–2127.
18. Xu L, Li J, Cui T, et al. Refractive error in urban and rural adult Chinese in Beijing. *Ophthalmology.* 2005;112:1676–1683.
19. Chiroma R. Prevalence of presbyopia and the impact of uncorrected presbyopia on the quality of life in rural Gwagwalada, Abuja Nigeria. Msc, Dissertation submitted to London School of Hygiene and Tropical Medicine, 2008.
20. Zhang MZ, Lv H, Gao Y, et al. Visual morbidity due to inaccurate spectacles among school-children in rural China: the See Well to Learn Well Project. Report 1. *Invest Ophthalmol Vis Sci.* 2009;50:2011–2017.
21. Li L, Lam J, Lu Y, et al. Attitudes of students, parents and teachers toward glasses use in rural China. *Arch Ophthalmol.* 2010;128:750–765.
22. He M, Chan V, Baruwa E, Gilbert D, Frick KD, Congdon N. Willingness to pay for cataract surgery in rural Southern China. *Ophthalmology.* 2007;114:411–416.
23. Yin Q, Hu A, Liang Y, et al. A two-site, population-based study of barriers to cataract surgery in rural China. *Invest Ophthalmol Vis Sci.* 2009;50:1069–1075.
24. Li LP, Song Y, Liu XJ, et al. Spectacle uptake among secondary school students with visually-significant refractive error in rural China: The Xichang Pediatric Refractive Error Study (X-PRES). Report 5. *Invest Ophthalmol Vis Sci.* 2008;49:2895–2902.
25. Wang D, Ding X, He M, et al. Use of eye care services among diabetic patients in urban and rural China. *Ophthalmology.* 2010;117:1755–1762.
26. Dong ZH, Chen ZG. The current situation of development of agriculture and approaches in China. China Human Rights Yearbook (2000–2005). 2002;977–979.
27. Ministry of Health. Life expectancy (web site in Chinese). http://www.moh.gov.cn/publicfiles/business/htmlfiles/zwgkzt/ptjty/digest2009/T5/sheet005.htm. Accessed March 21, 2010.