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Prevalence and Outcomes of Cataract Surgery in Rural China:

The China Nine-Province Survey

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Abstract

Purpose: To investigate the prevalence and visual acuity (VA) outcomes of cataract surgery in rural populations throughout China.

Design: Population-based, cross-sectional study.

Participants: Forty-five thousand seven hundred forty-seven adults 50 years of age and older.

Methods: Geographically defined cluster sampling was used in randomly selecting a cross-section of residents from a representative rural county within each of 9 provinces in mainland China. Participants underwent VA measurements, refraction, and a slit-lamp examination at local examination sites; those with previous cataract surgery were queried as to the year and type of surgical facility. Surgical procedure and evidence of surgery complications were noted during the examination. The principal cause of visual impairment was identified for eyes with VA of 20/40 or worse.

Main Outcome Measures: Cataract surgery procedure, presenting and best-corrected distance VA, and causes of visual impairment.

Results: Of 50 395 enumerated eligible persons, 45 747 (90.8%) were examined and tested for VA. The overall prevalence of cataract surgery was 2.09%. Surgical coverage among those with VA worse than 20/200 in both eyes because of cataract was 35.7%. Unoperated cataract was associated with older age, female gender, lack of education, and geographic area (province).

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Access to affordable cataract surgery should be a priority in prevention of blindness throughout rural China with an increased emphasis on postsurgical visual acuity outcomes.

Among the 1174 cataract-operated eyes, 31.1% had presenting VA of 20/32 or better, 15.4% had presenting VA of 20/40 to 20/63, 30.0% had presenting VA worse than 20/63 to 20/200, and 23.5% had presenting VA worse than 20/200. With best correction, the percentages were 57.6%, 6.2%, 18.5%, and 17.7%, respectively. Posterior capsule opacification, refractive error, and retinal disorders were the main causes in cataract-operated eyes with VA worse than 20/63.

Conclusions: Two thirds of those with bilateral visual impairment or blindness because of cataract remain in need of sight-restoring surgery. Posterior capsule opacification and refractive error, both readily amenable to treatment, were common in cataract-operated eyes. Sustained government efforts to provide access to affordable modern cataract surgery with a greater emphasis on postoperative follow-up and the quality of VA outcomes are needed.

Cataract blindness is a high-priority public health topic in China, as evidenced by the establishment of the SightFirst China Action program in 1997¹ and the Ministry of Health's new 3-year One Million Cataract Program. In addressing the need for a representative, up-to-date characterization of the nature and magnitude of visual impairment and blindness, particularly among those 50 years of age and older living in the rural areas of mainland China, the Ministry commissioned a national China Nine-Province Survey. This survey significantly expanded the geographic scope and representativeness of previous data from surveys in the Shunyi district of Beijing municipality,² Doumen county in southern Guangdong province,³ the Haidian and Daxing districts of Beijing,⁴ the Kunming prefecture in southwest Yunnan province,⁵ and Yongnian county in Handan in northern Hebei province.⁶

The 9 provinces were distributed across 3 regions representative of the different levels of socioeconomic development within the 4 municipalities and 27 provinces of mainland China. In collaboration with local health authorities, a rural county within each province was identified as the study area. The east coast region was represented by Shunyi district in Beijing municipality, Qidong county in Jiangsu province, and Yangxi county in Guangdong province. The inland middle area was represented by Shuangcheng county in Heilongjiang province, Jian county in Jiangxi province, and Longrao county in Hebei province. Changji county in Xinjiang province, Yongchuan county in Chongqing municipality, and Luxi county in Yunnan province represented the western region. As reflected in 2002 census data on consumption for rural households, ranging from 1525 yuan (\$223) in Xinjiang to 4390 yuan (\$643) in Beijing, the selected study provinces were socioeconomically diverse.⁷

The surveys were implemented by local teams with oversight and technical supervision by the Chinese Ophthalmological Society through a specially established committee of study directors from each of the nine provinces and chaired by the Chinese Ophthalmological Society president (JZ). The China Nine-Province Survey teams are identified in an online-only appendix (Appendix appears in the March 2010 issue⁸ [Zhao J, Ellwein LB, Cui H, et al. Prevalence of Vision Impairment in Older Adults in Rural China: The China Nine-Province Survey. *Ophthalmology* 2010;117: 409–16; available at <http://aaojournal.org>]).⁸

A companion article reports on the prevalence of visual impairment in each of the 9 study areas.⁸ The present article describes the prevalence of cataract surgery, surgical coverage among those visually impaired or blind as a result of cataract, risk factors for unoperated

cataract, visual acuity (VA) outcomes after cataract surgery, and causes of poor outcomes in cataract-operated eyes.

Patients and Methods

The surveys were carried out in a randomly selected sample of individuals. Major urban areas within the county were excluded. The study sampling frame for each county was constructed using geographically defined clusters based on village register census data. Field work was carried out over a 6- to 8-month period, beginning in October 2006. Listing of households with the names of residents 50 years of age and older were obtained from the village registers, followed by door-to-door visits conducted by the enumeration team. Those 50 years of age and older were enumerated by name, gender, age, education (using graduation levels), and spectacle usage. Participants were examined at local community facilities according to a prescheduled date established at the time of enumeration. Written informed consent using a scripted consent form was obtained at the time of examination, which included VA measurements, refraction, and a basic eye examination.

Distance VA, with spectacles if the participant had them at presentation, was measured using a retroilluminated logarithm of the minimum angle of resolution tumbling E chart. Those with VA of 20/40 or worse in one or both eyes were autorefracted, and best-corrected visual acuity (BCVA) was determined. Those with cataract surgery were queried as to the year and type of surgical facility for each operated eye. Ophthalmic examination of the eyelid, globe, pupillary reflex, and lens was carried out by a study ophthalmologist. Pupils of eyes with BCVA of 20/40 or worse were dilated for direct ophthalmoscopy and slit-lamp examination. Intraocular pressure measurement by applanation tonometry was performed on an optional basis, primarily for glaucoma suspects with optic disc abnormalities. The type of cataract surgery, posterior capsule status, and signs of surgical complications were noted in the examination of cataract-operated eyes.

A principal cause of visual impairment or blindness for eyes with VA of 20/40 or worse at presentation was determined by the examining ophthalmologist's clinical judgment using a 14-item list (refractive error, amblyopia, cataract, posterior capsule opacification, corneal opacity or scar, phthisical or disorganized or absent globe, glaucoma, other optic atrophy, macular degeneration, diabetic retinopathy, retinal detachment, other retinal or choroidal changes, other cause, undetermined cause). Refractive error was assigned as the cause for eyes that improved to 20/32 or better with refractive correction, or with pinhole vision when subjective refraction was not possible because of age or disability. Cataract was assigned when lens opacity was commensurate with visual impairment and no other abnormality could account for the decrease in visual acuity. Except for explanations and discussion during the introduction of the clinical protocol to each survey team, no attempt was made to delineate explicitly definitions and criteria for establishing each of the principal diagnoses, as was done in the more comprehensive Beijing and Handan eye studies.^{4,6}

Participants with VA of 20/40 or worse in the better eye correctable with refraction were provided with a prescription for spectacles. Treatment for minor ophthalmic problems was provided, free of charge, at the time of examination. Those with VA worse than 20/200

because of cataract were referred for surgery. Others requiring further management were given an explanation of the problem and referred to the hospital or clinic nearest their home.

Human subject research approval of the protocol was cleared by the World Health Organization Secretariat Committee on Research Involving Human Subjects. The Peking Union Medical College Hospital Committee on Ethics on Research approved implementation of the survey protocol in China. The study adhered to the tenets of the Declaration of Helsinki. Further details regarding the sampling plan, enumeration of subjects, visual acuity measurement, and the eye examination are available in the companion article.⁸

Data Management and Analysis

The prevalence of cataract surgery in the study population was calculated by age, gender, education, and province. The total burden of cataract-related visual impairment and blindness (VA <20/200) was calculated as the sum of (1) the number of persons who already had undergone surgery and who were presumed to have been bilaterally impaired or blind when first operated on for cataract, and (2) the number of unoperated persons who were bilaterally impaired or blind because of cataract in one or both eyes. Because preoperative vision status was not available, already-operated persons were presumed to have been bilaterally impaired or blind at the time the first eye was operated on if both eyes were operated on, or if only one eye was operated on and the unoperated fellow eye was visually impaired or blind. Surgical coverage among the cataract impaired or blind population was calculated as the ratio of the already-operated visually impaired or blind to the unoperated visually impaired or blind plus the already-operated visually impaired or blind (i.e., the already-operated visually impaired or blind divided by the total cataract impairment or blindness burden). To the extent that not all cataract-operated eyes were impaired or blind when operated on, as presumed, the actual surgical coverage rate is somewhat less than that calculated.

Multiple logistic regression was used to investigate the association of age, gender, education, and geographic location (province) with already-operated cataract visual impairment or blindness, unoperated cataract visual impairment or blindness, and surgical coverage. Geographic location (province) was included explicitly as a regression variable to account for regional variation in the delivery of eye care.

Presenting VA and BCVA in cataract-operated eyes was tabulated by age, gender, education, and province. Visual acuity was categorized as: normal vision, 20/32 or better; mild visual impairment, 20/40 to 20/63; moderate visual impairment, worse than 20/63 to 20/200; severe visual impairment, worse than 20/200 to 20/400; and blindness, worse than 20/400. The association of age, gender, education, intraocular lens (IOL) status, year of surgery, and province with presenting VA and BCVA of 20/63 or better (considered a reasonably good vision outcome) in cataract-operated eyes was investigated with logistic regression. Principal causes of impairment or blindness in eyes with VA worse than 20/63 were tabulated by province and with BCVA for all provinces taken together. gender, education, intraocular lens (IOL) status, year of surgery, and province with presenting VA and BCVA of 20/63 or better (considered a reasonably good vision outcome) in cataract-operated eyes was investigated

with logistic regression. Principal causes of impairment or blindness in eyes with VA worse than 20/63 were tabulated by province and with BCVA for all provinces taken together.

Statistical analyses were performed using Stata/SE Statistical Software, release 9.0 (Stata Corp., College Station, TX). Confidence intervals (CIs) and *P* values (considered significant at the *P* 0.05 level) were calculated with adjustment for clustering effects and stratification associated with the sampling design.

Results

The study population consisted of 50 395 enumerated persons 50 years of age and older, of whom 45 747 (90.8%) were examined. Across all 9 provinces, 954 persons (1174 eyes) were operated on for cataract, representing a cataract surgery prevalence of 2.09% (95% CI, 1.90%–2.27%) and ranging from 0.97% (95% CI, 0.58%–1.36%) in Heilongjiang to 4.27% (95% CI, 3.35%–5.19%) in Yunnan (Table 1). Cataract surgery was associated with older age, female gender, and province. The level of education was not significant. Compared with Beijing (the regression reference province), the prevalence of cataract surgery was low in Jiangshu, Heilongjiang, Jiangxi, and Chongqing provinces and was high in Yunnan province.

Of the 954 cataract-operated participants, 628 were presumed to have had severe visual impairment or blindness (VA <20/200) in both eyes at the time of initial surgery (Table 2). An additional 1131 participants were severely impaired or blind because of unoperated cataract. Thus, the total burden of cataract-related visual impairment or blindness included 1759 (3.83%) of the study participants. Surgical coverage within this cohort of operated and unoperated participants was 35.7%, ranging from 24.4% in Heilongjiang to 62.2% Beijing. (Surgical coverage among those with VA <20/400 [blindness] was 43.1%, ranging from 32.0% in Heilongjiang to 72.4% in Beijing.)

Cataract-operated visual impairment or blindness because of cataract was associated with older age and female gender, and in comparison with Beijing, was high in Yunnan province and low in Jiangshu, Heilongjiang, and Chongqing provinces (Table 3). Un-operated cataract impairment or blindness also was associated with older age and female gender, inversely associated with education at primary and secondary levels, and in comparison with Beijing, was high in Guangdong, Heilongjiang, Jiangxi, Hebei, Chongqing, and Yunnan provinces. Surgical coverage was low among those 80 years of age or older, was high among those with education at or above the secondary level, and compared with Beijing, was low in all provinces except Xinjiang.

An IOL was present in 78.4% of the 1174 cataract-operated eyes, ranging from 55.6% in Jiangxi province to 96.9% in Yunnan province (Table 4). Cataract surgery was primarily extracapsular cataract extraction (70%) or phacoemulsification (19%) for IOL implantation, and either extracapsular cataract extraction (56%) or ICCE (42%) for aphakic eyes. As shown, 43.4% were operated on during the interval between 2004 and the time of the survey (late 2006 or early 2007), with 26.2% before 2000. Essentially, all of the cataract surgeries in Yunnan province were in recent years, with 91% being combined extracapsular cataract

extraction and IOL implantation procedures. with 91% being combined extracapsular cataract extraction and IOL implantation procedures.

Of the 954 cataract-operated participants, 220 were operated in both eyes: 139 were pseudophakic in both eyes, 53 were aphakic in both eyes, and 28 were pseudophakic in one eye and aphakic in the fellow eye. For the 734 with unilateral cataract surgery, 615 were pseudophakic and 119 were aphakic (including 4 with undetermined lens status). Seven (0.90%) of the 782 pseudophakics were wearing glasses for distance correction at the time of the examination, along with 23 (13.4%) of the 172 aphakics.

Presenting VA and BCVA for the 1174 cataract-operated eyes by age, gender, education, IOL status, year of surgery, and province are shown in Table 5. Overall, a reasonably good vision outcome (VA 20/63) was found in 46.5% of eyes with presenting vision and in 63.8% with best correction. Multiple logistic regression was used to investigate whether the differences in the percentage of eyes with good outcomes were statistically significant with covariate adjustments. The relatively small percentage with VA of 20/63 or better in the 80 years of age and older group was significant with both presenting VA ($P = 0.002$) and BCVA ($P = 0.003$). The percentages with VA of 20/63 or better was significantly lower in females than in males based on BCVA ($P = 0.044$), but not with presenting vision ($P = 0.083$). Those with primary or secondary education were more likely to have VA of 20/63 or better compared with those with no education ($P = 0.027$ and $P = 0.053$, respectively). In eyes with IOL implantation, the high percentage with VA of 20/63 or better was highly significant with both presenting VA and BCVA ($P < 0.001$). Finally, the small percentages with VA of 20/63 or better in Guangdong province was significant (compared with Beijing, the reference province) with both presenting VA and BCVA ($P = 0.017$ and $P = 0.010$, respectively), whereas the relatively high percentages in Yunnan was highly significant with BCVA ($P < 0.001$), but not with presenting VA ($P = 0.083$). Year of surgery was not significant with either presenting VA or BCVA, in part because of its correlation with IOL status. (In the period up to and including 1999, 43% of cataract surgery was with an IOL, compared with 95% in the period from 2004 onward.)

Table 6 identifies the principal cause of impairment for the 628 cataract-operated eyes with VA worse than 20/63. Overall, posterior capsule opacification (PCO) was the most common cause, accounting for 25.0% of eyes, and ranging from 7.9% in Xinjiang to 50.0% in Heilongjiang. Refractive error also was common, accounting for 18.3% of eyes and ranging from 4.0% in Jiangshu to 70.3% in Yunnan. Retinal disorders (13.5%) were the third most common cause of impairment and were particularly prevalent in Xinjiang. With BCVA, the number of cataract-operated eyes with VA worse than 20/63 was reduced to 425, removing the 115 eyes with refractive error as the principal cause and another 88 eyes that improved to 20/63 or better with refractive correction (Table 6). Posterior capsule opacification remained as the most common cause of impairment, accounting for 30.4% of impaired eyes with BCVA, followed by retinal disorders (17.2%) and other causes (13.7%).

For the 181 cataract-operated eyes presenting with mild visual impairment (range, 20/40–20/63), the principal cause was refractive error (55.8%), followed by PCO (27.6%). Retinal (4.4%) or other causes were uncommon (data not shown).

Discussion

A major strength of the Nine-Province Survey is that it was conducted in reasonably large and randomly selected population-based samples representative of rural areas throughout China. The high examination response rate also was important in minimizing bias from participant selfselection, as was the use of the identical clinical protocol at each study site, which allowed for straightforward and direct comparisons of data across study sites.

As shown in Table 3, the elderly and those with little or no education were particularly affected by severe visual impairment or blindness because of unoperated cataract. Surgical coverage of cataract-related severe visual impairment or blindness was also low in these subgroups. Cataract surgical coverage among females was not significantly different than that in males, but females were found to be at greater overall risk of cataract-related severe impairment or blindness, as reflected in a greater total burden (operated plus unoperated cases), as shown in Table 2. Unoperated cataract impairment or blindness was comparatively high in Heilongjiang, Chongqing, and Yunnan provinces, with correspondingly low surgical coverage rates. Despite the high prevalence of cataract surgery in Yunnan, unoperated cataract remains a problem there because of the comparatively high prevalence of visual impairment and blindness.⁸

Visual acuity outcomes in cataract-operated eyes were influenced to a large extent by whether the surgery included an IOL, but also varied on the basis of age, gender, education level, and province. The low percentage of good outcomes in those 80 years of age and older, for both presenting VA and BCVA, was a reflection of a higher risk of ocular comorbidities among the very elderly. The relatively poor outcomes in females were the result of more cases with PCO, retinal disorders (particularly macular degeneration), and to a lesser extent, optic atrophy and glaucoma. Although education was not a significant predictor of good vision when measured with best correction, those with higher levels of education were more likely to have better presenting vision because of less uncorrected refractive error. Those with little education may have been under the impression that corrective spectacles were unnecessary and also may have been less able to afford refractive correction. Visual acuity outcomes were not markedly different across the 9 provinces except in Guangdong, where they were relatively poor, and in Yunnan, where they were extraordinarily good. As explained by the survey director, Luxi county was the recipient of a recent nongovernmental agency-sponsored cataract surgery initiative with priority given to cases with a high likelihood of full vision restoration: those without dense lens opacities and a media and fundus examination adequate to rule out any coexisting abnormalities. There was no obvious explanation for the comparatively poor cataract surgery outcomes in Guangdong province.

Refractive error and PCO were the principal causes in nearly all (83.4%) cataract-operated eyes with mild visual impairment (20/40 to 20/63) at presentation. In eyes with moderate or severe visual impairment or blindness (VA <20/63), PCO was the most common cause, accounting for one fourth of such eyes. Although PCO can be treated readily with an yttrium-aluminum-garnet laser capsulotomy, it may not be readily available in all rural settings. Further, patients may attribute loss of vision to a failure of cataract surgery, and

thus may be hesitant to seek the necessary follow-up examination. Uncorrected refractive error (18.3%) was the second most common cause in cataract-operated eyes with VA worse than 20/63, with only 13.4% of aphakics and less than 1% of pseudophakics wearing a refractive correction. The importance of an IOL of the appropriate power is underscored by the fact that an IOL was present in more than three fourths of those with uncorrected refractive error. This is illustrated in Yunnan where the already exceptional VA outcomes could have been even better if greater attention had been given to biometric measurements in the determination of appropriate IOL power: refractive error was the principal cause in 70% of eyes with VA worse than 20/63. Retinal disorders (13.5%) were the third most common cause of VA worse than 20/63 in cataract-operated eyes. Because these pathologic features may have coexisted at the time of cataract surgery, a rigorous preoperative examination to determine whether the patient is visually impaired or blind as a result of cataract, rather than being impaired or blind with cataract, is needed to help screen out cases in which cataract surgery is unlikely to improve vision. Again, Yunnan is an example where, through careful preoperative screening, essentially none of the postoperative visual impairment was the result of causes other than refractive error and PCO.

Table 7 repeats data from Beijing, Guangdong, and Yun nan for comparison with data from previous surveys in these 3 provinces. As shown, the prevalence of cataract surgery in the current Shunyi survey (2.75%) was significantly higher than that in the earlier Shunyi survey (1.72%) conducted in (Differences were defined as significant when the estimate from the earlier survey did not fall within the 95% confidence interval for the current survey.) Similarly, cataract surgical coverage in the current Shunyi survey (62.2%) compares favorably with the lower coverage (47.8%) reported in the 1996 survey.² The 2 Shunyi surveys were conducted in the same geographical area; thus, these findings provide reasonable evidence of a sustained and successful effort in addressing visual impairment or blindness resulting from cataract in Shunyi.

In Guangdong province, the prevalence of cataract surgery in Yangxi county was higher than that in the 1997 survey conducted in Doumen county.³ This does not hold for cataract surgical coverage, however, which does not seem to be significantly different between the 2 surveys.

For Yunnan province, the prevalence of cataract surgery in Luxi county, which was higher than that in any other province, with three fourths of it occurring since 2004, does not seem to be significantly higher than that in the recent survey in Kunming.⁵ The comparatively low cataract surgical coverage in Luxi county, however, was significantly below that reported in the Kunming survey. Because the emphasis on cataract surgery in Luxi county is a recent phenomenon, it is not particularly surprising that cataract surgery coverage remains relatively low. It is also likely that differences in access and affordability of eye care in rural Luxi versus that in urban Kunming account for some of this discrepancy.

Current findings suggest a general improvement in VA outcomes over that reported in the previous studies. Presenting VA of 20/63 or better was found in 55.6% of cataract-operated eyes in the current Shunyi survey versus the much lower 25.0% in the 1996 Shunyi survey, and with a similar improvement using corrected vision.⁹ In Yangxi, the comparatively low

percentage of persons with good vision at presentation (31.2%) was still marginally higher than the 23.7% reported in the 1997 Doumen survey, but essentially no different with best-corrected vision.¹⁰ Finally, the particularly good vision outcomes in Luxi county easily exceed those in the Kunming survey.⁵

Although trends in both cataract surgery volume and outcomes seem to be heading in a positive direction, comparisons with population-based studies of adults 50 years of age or older based on a similar clinical protocol in Rajasthan (India),¹¹ Sivaganga (India),¹² Tirunelveli (India),¹³ Gujarat (India),¹⁴ and São Paulo (Brazil)¹⁵ are not as favorable. Cataract surgery prevalence, which ranged from 0.97% to 4.27% across the 9 provinces, is much lower than the 11.8% to 17.6% range reported from the 4 surveys in India and the 6.28% prevalence from the survey in São Paulo. Similarly, except for Beijing (62.2%) and Xinjiang (57.6%), surgical coverage among the cataract impaired or blind is less than the 56.5% to 77.5% range in India and the 89.7% in São Paulo. The highest cataract surgery prevalence (17.6%) and coverage (72.2%) was in the Gujarat survey, conducted in 2007 during a period when cataract surgery services were on a rapid increase. The other 3 surveys in India were earlier, conducted between 1999 and 2000. The Brazil survey took place during 2004 and 2005, after a 1999 government initiative that greatly expanded subsidized access to cataract surgery.

In Yunnan (67.3%), and to a lesser extent Beijing (55.6%), the percentage of cataract-operated eyes with VA of 20/63 or better at presentation is comparable with the 60.3% in Sivaganga,¹² the 64.0% in Tirunelveli,¹³ and the 69.3% in São Paulo.¹⁵ With regard to BCVA, the percentage with 20/63 vision or better at presentation in Yunnan, 91.2%, compares favorably with the 86.9% in Sivaganga, the 83.1% in Tirunelveli, and the 79.5% in São Paulo; the best-corrected outcomes in Beijing (68.3%) are less favorable. In the Los Angeles Latino Eye Study,¹⁶ the only major population-based study in the United States to report on postoperative visual impairment in cataract-operated individuals, 74.7% of cataract-operated eyes had VA of 20/63 or better at presentation and 81.3% of cataract-operated eyes had BCVA of 20/63 or better at presentation, similar to that in Yunnan. Again, across all of the studies, the percentage differences in outcomes with presenting VA versus those with BCVA highlight the issue of uncorrected refractive error after cataract surgery.

It is apparent from the findings in this survey that recent efforts by the Ministry of Health to increase cataract surgical volume, particularly among the poor in rural China, are critically needed. In conjunction with the new 3-year One Million Cataract Program, the Ministry is working closely with the China Disabled Persons' Federation to develop cost-effective models for cataract surgery outreach among the rural underserved. The China Disabled Persons' Federation is organizationally under the State Council and, with its extensive network of community volunteers throughout the countryside, is an important resource in combating cataract blindness in China.

Survey findings also are clear in underscoring the need for greater attention in ensuring good cataract surgery outcomes, including more thorough case screening and periodic postsurgical follow-up. The findings from Luxi county demonstrate the feasibility of rapidly increasing the volume of modern-day cataract surgery while ensuring exceptionally good VA

outcomes. (At the same time, the low cataract surgical coverage in Luxi county indicates that cataract blindness control is just now beginning and that continuing efforts are needed to reach the remaining large number of persons with cataract visual impairment or blindness.)

The lack of appropriate refractive spectacles for a large proportion of cataract patients clearly is a problem, in China and elsewhere. Although refractive error is treated easily with spectacles, patients may not receive the necessary correction for a number of reasons, including a perception that sharp vision is not needed, no postoperative follow-up examination, and the cost of spectacles. It again is important to emphasize that the need for refractive correction would be minimized if greater attention was given to ensuring that IOLs were of an appropriate power. Similarly, it is apparent that increased attention should be given to the development of PCO subsequent to cataract surgery and the postoperative follow-up necessary to identify those in need of treatment.

Although health care in rural China is available in county and local township hospitals and clinics throughout each province, affordability across the patient populations varies widely.⁷ Increased access to affordable cataract surgery along with greater emphasis on good visual acuity outcomes is needed to enhance the effectiveness of prevention of blindness efforts among older adults in rural China.

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Table 1.

Cataract Surgery by Age, Gender, Education, and Province

	<u>Examined</u>	<u>Cataract-Operated Persons</u>		
	<i>No. (%)</i>	<i>No.</i>	<i>% Prevalence (95% Confidence Interval)</i>	<i>Adjusted Odds Ratio</i>
Age (yrs)				
50–59	21 670 (47.4)	109	0.50 (0.41–0.60)	Reference
60–69	13 345 (29.2)	265	1.99 (1.67–2.30)	3.99 (3.12–5.10) [†]
70–79	8351 (18.3)	436	5.22 (4.61–5.83)	10.2 (8.10–12.8) [†]
80+	2381 (5.2)	144	6.05 (5.00–7.09)	11.7 (9.01–15.2) [†]
Gender				
Male	20 947 (45.8)	391	1.87 (1.65–2.09)	Reference
Female	24 800 (54.2)	563	2.27 (2.05–2.49)	1.28 (1.12–1.46) [†]
Education				
None	13 796 (30.2)	485	3.52 (3.08–3.96)	Reference
<Primary	7307 (16.0)	128	1.75 (1.41–2.09)	0.83 (0.68–1.02)
Primary	16 252 (35.5)	231	1.42 (1.21–1.64)	0.87 (0.71–1.07)
Secondary	8392 (18.3)	110	1.31 (1.04–1.58)	0.99 (0.75–1.31)
Province				
Beijing	5118 (11.2)	141	2.75 (2.30–3.21)	Reference
Jiangshu	5141 (11.2)	75	1.46 (1.15–1.76)	0.47 (0.36–0.62) [†]
Guangdong	4589 (10.0)	141	3.07 (2.45–3.70)	0.96 (0.72–1.28)
Heilongjiang	5047 (11.0)	49	0.97 (0.58–1.36)	0.45 (0.29–0.68) [†]
Jiangxi	5010(11.0)	83	1.66 (1.28–2.03)	0.56 (0.41–0.76) [†]
Hebei	5051 (11.0)	90	1.78 (1.45–2.12)	0.77 (0.59–1.01)
Xinjiang	5250 (11.5)	81	1.54 (1.17–1.91)	0.82 (0.61–1.10)
Chongqing	5390 (11.8)	74	1.37 (0.89–1.86)	0.51 (0.33–0.78) [†]
Yunnan	5151 (11.3)	220	4.27 (3.35–5.19)	1.41 (1.02–1.95) [*]
All	45 747 (100.0)	954	2.09 (1.90–2.27)	

* *P* 0.05.[†] *P* 0.01.

Table 2.

Operated and Unoperated Persons with Cataract-Related Severe Visual Impairment or Blindness (<20/200) by Age, Gender, Education, and Province

	No Examined	Cataract-Operated Persons				Unoperated		Surgical Coverage (%)
		<i>All Operated</i>		<i>Presumed Severe Visual Impairment or Blindness*</i>		<i>Cataract Severe Visual Impairment or Blindness*</i>		
		No	<i>Prevalence[†]</i>	No.	<i>Prevalence[†]</i>	No.	<i>Prevalence[†]</i>	
Age (yrs)								
50–59	21 670	109	0.50	53	0.24	53	0.24	50.0
60–69	13 345	265	1.99	162	1.21	129	0.97	55.7
70–79	8351	436	5.22	298	3.57	527	6.31	36.1
80+	2381	144	6.05	115	4.83	422	17.7	21.4
Gender								
Male	20 947	391	1.87	245	1.17	408	1.95	37.5
Female	24 800	563	2.27	383	1.54	723	2.92	34.6
Education								
None	13 796	485	3.52	326	2.36	770	5.58	29.7
<Primary	7307	128	1.75	90	1.23	151	2.07	37.3
Primary	16 252	231	1.42	147	0.90	170	1.05	46.4
Secondary	8392	110	1.31	65	0.77	40	0.48	61.9
Province								
Beijing	5118	141	2.75	84	1.64	51	1.00	62.2
Jiangshu	5141	75	1.46	41	0.80	67	1.30	38.0
Guangdong	4589	141	3.07	110	2.40	132	2.88	45.5
Heilongjiang	5047	49	0.97	32	0.63	99	1.96	24.4
Jiangxi	5010	83	1.66	62	1.24	130	2.59	32.3
Hebei	5051	90	1.78	51	1.01	73	1.45	41.1
Xinjiang	5250	81	1.54	53	1.01	39	0.74	57.6
Chongqing	5390	74	1.37	48	0.89	127	2.36	27.4
Yunnan	5151	220	4.27	147	2.85	413	8.02	26.3
All	45747	954	2.09	628	1.37	1131	2.47	35.7

* Visual acuity <20/200 in both eyes.

[†] Prevalence per 100 examined participants.

Table 3.

Association of Age, Gender, Education, and Province with Cataract-Related Severe Visual Impairment or Blindness (<20/200)

	Cataract-Operated Severely Impaired or Blind	Unoperated Cataract Severely Impaired or Blind	Surgical Coverage
Age (yrs)			
50–59	Reference	Reference	Reference
60–69	5.13 (3.64–7.23) [†]	3.80 (2.56–5.62) [†]	1.47 (0.90–2.41)
70–79	14.8 (10.8–22.2) [†]	24.4 (16.8–35.3) [†]	0.75 (0.49–1.15)
80+	20.1 (14.5–28.0) [†]	77.5 (51.8–116.0) [†]	0.37 (0.24–0.57) [†]
Gender			
Male	Reference	Reference	Reference
Female	1.42 (1.22–1.65) [†]	1.59 (1.40–1.80) [†]	0.93 (0.77–1.14)
Education			
None	Reference	Reference	Reference
<Primary	0.94 (0.73–1.22)	0.90 (0.67–1.21)	1.10 (0.80–1.51)
Primary	1.01 (0.79–1.28)	0.80 (0.64–1.00) [*]	1.34 (0.94–1.92)
>Secondary	1.13 (0.79–1.62)	0.65 (0.45–0.92) [*]	2.14 (1.35–3.39) [†]
Province			
Beijing	Reference	Reference	Reference
Jiangshu	0.42 (0.29–0.61) [†]	0.93 (0.60–1.43)	0.45 (0.26–0.79) [†]
Guangdong	1.24 (0.88–1.74)	2.02 (1.40–2.92) [†]	0.58 (0.38–0.90) [*]
Heilongjiang	0.50 (0.31–0.80) [†]	2.80 (1.92–4.09) [†]	0.17 (0.10–0.29) [†]
Jiangxi	0.75 (0.52–1.09)	2.17 (1.49–3.16) [†]	0.38 (0.23–0.60) [†]
Hebei	0.72 (0.52–1.01)	1.80 (1.16–2.79) [†]	0.42 (0.24–0.73) [†]
Xinjiang	0.98 (0.68–1.41)	1.36 (0.92–2.02)	0.76 (0.45–1.27)
Chongqing	0.58 (0.36–0.96) [*]	2.38 (1.65–3.43) [†]	0.26 (0.14–0.48) [†]
Yunnan	1.65 (1.11–2.46) [*]	7.15 (4.48–11.4) [†]	0.31 (0.20–0.48) [†]

Data are given as adjusted odds ratios (95% confidence interval) obtained by multiple logistic regression.

^{*} $P < 0.05$.

[†] $P < 0.01$.

Table 4.

Number (%) of Cataract-Operated Eyes within Each Province by Intraocular Lens Status and Year of Surgery

Province	All Operated Eyes	Intraocular Lens Status		Year of Surgery		
		Without	With	1999	2000–2003	2004
Beijing	189 (16.1)	20(10.6)	169 (89.4)	55 (29.1)	60 (31.8)	74 (39.2)
Jiangshu	89 (7.6)	27 (30.3)	62 (69.7)	34 (38.2)	26 (29.2)	29 (32.6)
Guangdong	189 (16.1)	44 (23.3)	145 (76.6)	65 (34.4)	26 (29.2)	55 (29.1)
Heilongjiang	62 (5.3)	18 (29.0)	44(71.0)	23 (37.1)	13 (21.0)	26 (41.9)
Jiangxi	99 (8.4)	44 (44.4)	55 (55.6)	35 (35.4)	23 (23.2)	41 (41.4)
Hebei	111 (9.5)	38 (34.2)	73 (65.8)	28 (25.2)	37 (33.3)	46 (41.4)
Xinjiang	113 (9.6)	28 (24.8)	85 (75.2)	34 (30.1)	46 (40.7)	33 (29.2)
Chongqing	96 (8.2)	27 (28.1)	69 (71.9)	30 (31.3)	25 (26.0)	41 (42.7)
Yunnan	226 (19.3)	7(3.1)	219 (96.9)	4 (1.8)	58 (25.7)	164 (72.6)
All	1174 (100.0)	253 (21.6)	921 (78.4)	308 (26.2)	357 (30.4)	509 (43.4)

Table 5.

Presenting and Best-Corrected Visual Acuity of Cataract-Operated Eyes by Age, Gender, Education, Intraocular Lens Status, Year of Surgery, and Province

	Number (%) of Eyes	Percentage by Presenting Visual Acuity			Percentage by Best-Corrected Visual Acuity				
		20/32	20/40–20/63	<20/63–20/200	<20/200	20/32	20/40–20/63	<20/63–20/200	<20/200
Age (yrs)									
50–59	145 (12.4)	31.0	19.3	26.2	23.5	58.6	9.7	13.1	18.6
60–69	335 (28.5)	31.9	17.6	30.2	20.3	63.6	4.8	18.2	13.4
70–79	519 (44.2)	36.2	13.9	28.1	21.8	60.3	5.0	17.9	16.8
80+	175 (14.9)	14.3	12.6	38.3	34.9	37.1	9.7	25.1	28.0
Gender									
Male	479 (40.8)	37.4	15.5	26.9	20.3	65.8	5.0	13.6	15.7
Female	695 (59.2)	26.8	15.4	30.0	23.5	51.9	7.1	21.9	19.1
Education									
None	563 (48.0)	35.0	10.5	32.3	22.2	61.3	5.2	16.7	16.9
<Primary	160(13.6)	18.8	21.9	30.0	29.4	43.8	12.5	21.3	22.5
Primary	302 (25.7)	30.6	17.8	27.3	24.3	56.3	5.9	19.7	18.1
Secondary	149 (12.7)	30.6	22.5	26.5	20.4	61.2	4.1	19.7	15.0
IOL status									
Without	253 (21.6)	4.4	2.8	24.5	68.4	21.7	5.9	27.3	45.1
IOL									
With IOL	921 (78.4)	38.4	18.9	31.5	11.2	67.4	6.3	16.1	10.2
Year of surgery									
1999	308 (26.2)	14.0	10.1	28.3	47.7	36.4	5.8	23.1	34.7
2000–2003	357 (30.4)	30.3	16.8	32.2	20.7	55.5	8.1	20.2	16.3
2004	509 (43.4)	42.0	17.7	29.5	10.8	71.9	5.1	14.5	8.5
Province									
Beijing	189 (16.1)	30.2	25.4	24.9	19.6	61.4	6.9	13.8	18.0
Jiangshu	89 (7.6)	24.7	19.1	23.6	32.6	48.3	7.9	16.9	27.0
Guangdong	189 (16.1)	9.0	22.2	39.7	29.1	34.9	10.1	31.8	23.3
Heilongjiang	62 (5.3)	30.7	4.8	37.1	27.4	46.8	3.2	24.2	25.8
Jiangxi	99 (8.4)	10.1	16.2	30.3	43.4	45.5	8.1	18.2	28.3
Hebei	111 (9.5)	22.5	18.9	28.8	29.7	52.3	6.3	25.2	16.2
Xinjiang	113 (9.6)	34.5	9.7	33.6	22.1	55.8	6.2	23.0	15.0
Chongqing	96 (8.2)	34.4	14.6	26.0	25.0	56.3	6.3	20.8	16.7
Yunnan	226 (19.3)	63.3	4.0	27.0	5.8	89.4	1.8	4.0	4.9
All	1174 (100.0)	31.1	15.4	30.0	23.5	57.6	16.2	18.5	17.7

IOL = intraocular lens.

Table 6.
Principal Cause of Presenting and Best-Corrected Visual Acuity <20/63 in Cataract-Operated Eyes

Principal Cause	Presenting Visual Acuity										Best-corrected Visual Acuity All
	Beijing	Jiangsu	Guangdong	Heilongjiang	Jiangxi	Hebei	Xinjiang	Chongqing	Yunnan	All	
PCO	20 (23.8)	7 (14.0)	31 (23.9)	20 (50.0)	17 (23.3)	32 (49.2)	5 (7.9)	11 (22.5)	14 (18.9)	157 (25.0)	129 (30.4)
Refractive error *	12 (14.3)	2 (4.0)	7 (5.4)	3 (7.5)	16 (21.9)	8 (12.3)	7 (11.1)	8 (16.3)	52 (70.3)	115 (18.3)	0 (0.0)
Retinal disorders	9 (10.7)	14 (28.0)	15 (11.5)	5 (12.5)	5 (6.8)	2 (3.1)	28 (44.4)	7 (14.3)	0 (0.0)	85 (13.5)	73 (17.2)
AMD	0 (0.0)	7 (14.0)	11 (8.5)	3 (7.5)	4 (5.5)	1 (1.5)	21 (33.3)	4 (8.2)	0 (0.0)	51 (8.1)	42 (9.9)
Diabetic retinopathy	1 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (4.1)	0 (0.0)	3 (0.48)	3 (0.71)
Retinal detachment	1 (1.2)	0 (0.0)	1 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	3 (4.8)	1 (2.0)	0 (0.0)	6 (0.96)	6 (1.4)
Other retinal	7 (8.3)	7 (14.0)	3 (2.3)	2 (5.0)	1 (1.4)	1 (1.5)	4 (6.4)	0 (0.0)	0 (0.0)	25 (4.0)	22 (5.2)
Optic atrophy	7 (8.3)	1 (2.0)	11 (8.5)	0 (0.0)	7 (9.6)	5 (7.7)	1 (1.6)	2 (4.1)	2 (2.7)	36 (5.7)	32 (7.5)
Glaucoma	7 (8.3)	6 (12.0)	6 (4.6)	2 (5.0)	2 (2.7)	2 (3.1)	4 (6.4)	0 (0.0)	1 (1.4)	30 (4.8)	29 (6.8)
Corneal opacity/scar	6 (7.1)	0 (0.0)	3 (2.3)	4 (10.0)	1 (1.4)	2 (3.1)	2 (3.2)	5 (10.2)	2 (2.7)	25 (4.0)	24 (5.7)
High myopia	2 (2.4)	4 (8.0)	0 (0.0)	1 (2.5)	5 (6.9)	0 (0.0)	3 (4.8)	7 (14.3)	0 (0.0)	22 (3.5)	20 (4.7)
Amblyopia	0 (0.0)	2 (4.0)	14 (17.8)	0 (0.0)	0 (0.0)	1 (1.5)	2 (3.2)	0 (0.0)	0 (0.0)	19 (3.0)	11 (2.6)
Disorganized globe	1 (1.2)	0 (0.0)	2 (1.5)	0 (0.0)	1 (1.4)	1 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.80)	5 (1.2)
Other cause	7 (8.3)	11 (22.0)	18 (13.9)	0 (0.0)	8 (11.0)	9 (13.9)	10 (15.9)	8 (16.3)	3 (4.1)	74 (11.8)	58 (13.7)
Undetermined	13 (15.5)	3 (6.0)	23 (17.7)	5 (12.5)	11 (15.1)	3 (4.6)	1 (1.6)	1 (2.0)	0 (0.0)	60 (9.6)	44 (10.4)
ALL (any cause)	84 (100)	50 (100)	130 (100)	40 (100)	73 (100)	65 (100)	63 (100)	49 (100)	74 (100)	628 (100)	425 (100)

AMD = age-related macular degeneration; PCO = posterior capsule opacification.

Data are presented as no. (%) of eyes.

* Includes only those improving to 20/32 with subjective refraction.

Table 7.

Prevalence of Cataract Surgery, Surgical Coverage, and Visual Acuity Outcomes among Those 50 Years of Age in Surveys across China

	<u>Cataract Surgery Prevalence</u>	<u>Surgical Coverage Percentage</u>	<u>Visual Acuity 20/63</u>	
	<i>Prevalence</i>	<i>Percentage</i>	<i>Presenting Vision</i>	<i>Best-Corrected Vision</i>
Beijing municipality				
Shunyi County (1996) ^{2,9}	1.72	47.8	25.0	36.2 *
Shunyi District (current)	2.75 (2.30–3.21)	62.2 (53.5–71.0)	55.6 (48.0–63.1)	68.3 (61.2–75.3)
Guangdong Province				
Doumen County (1997) ^{3,10}	2.06	40.3	23.7	42.1
Yangxi County (current)	3.07 (2.45–3.70)	45.5 (39.1–50.7)	31.2 (22.3–39.5)	45.0 (37.3–51.1)
Yunnan Province				
Kunming (2006) ⁵	3.52	46.4	45.0	—
Luxi County (current)	4.27 (3.35–5.19)	26.3 (22.4–30.1)	67.3 (54.5–80.0)	91.2 (86.5–95.8)

Data are presented as percentage (95% confidence interval).

* Represents pin-hole vision.