

A Two-Site, Population-Based Study of Barriers to Cataract Surgery in Rural China

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PURPOSE. China has among the lowest cataract surgical rates in Asia. This study was conducted to identify barriers to cataract surgery in rural China.

METHODS. All subjects having undergone cataract surgery and persons with presenting visual acuity $\leq 6/60$ (in Yangjiang) or $\leq 6/18$ (in Handan) in ≥ 1 eye due to nonsurgically treated cataract were identified in two population-based studies in southern (Yangjiang) and northern (Handan) China. The subjects were administered a questionnaire assessing attitudes in four areas constituting potential barriers to surgery: knowledge about cataract, perceptions of local surgical quality, transportation and cost, and available resources.

RESULTS. Interviews were completed on 71% to 86% of eligible subjects in both sites. Interviewed subjects did not differ significantly from nonrespondents with regard to age, sex, and presenting acuity in the better-seeing eye. A total of 214 (80.4%) nonsurgical and 131 (76.6%) surgical participants were interviewed, with a mean age of 71.8 ± 8.0 and 73.7 ± 7.4 years, respectively ($P > 0.1$). Among the nonsurgical subjects, 67.8% were blind (presenting vision, $\leq 6/60$) in ≥ 1 eye due to cataract, whereas among the surgical participants, 25.2% remained blind in the eye that had undergone surgical removal of the cataract. In a multivariate analysis adjusted for age, sex, and site, increased knowledge and higher estimates of the quality of surgery were associated with having had surgery, whereas cost and transportation scores were not.

CONCLUSIONS. Lack of knowledge about cataract and concerns about the quality of local services appear to be the principal barriers to cataract surgery in rural China. (*Invest Ophthalmol Vis Sci.* 2009;50:1069–1075) DOI:10.1167/iovs.08-2783

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China has among the lowest cataract surgical rates (CSRs) in Asia, at 446 cases per 1 million population per year.¹ This despite a pool of more than 23,000 ophthalmologists.² However, these doctors treat an average of only 24 cases of cataract per year, 15% of the rate that would be necessary to eliminate China's cataract backlog.¹ As a result of this shortfall, some 400,000 persons become blind in China each year from cataract,^{3,4} and nonsurgical cataract remains the leading cause of blindness.^{5–8}

China's low cataract surgical output results to some extent from limitations in supply. Only half of China's ophthalmologists perform surgery,⁹ and 80% of the country's eye doctors are located in urban areas.^{9,10} The Chinese Ministry of Health has estimated that 45% of China's 2400 county hospitals do not offer cataract surgical services,^{9,10} which means that many patients cannot obtain surgery near their homes. However, low demand for surgery appears to play an important role in limiting surgical output, due to barriers including cost,^{11,12} and patient concerns, often justified,^{13,14} about surgical quality.

Although nonsurgically treated cataract is the most important cause of blindness in the world's largest country, little is known about the relative impact of various potential barriers to care. Although China is undergoing a dramatic urbanization, some 70% of residents remain in rural areas,^{9,15} emphasizing the need to understand why rural populations there do not use cataract surgical services.

Yorston¹⁶ has suggested that four barriers are of particular importance in limiting access to cataract surgery worldwide: Lack of knowledge about cataract and its treatment, uncertainty over the quality of locally available services, transportation problems, and concerns over the cost of surgery. We created and validated a novel questionnaire, designed to assess respondents' views and attitudes in each of these four areas. The instrument was used in ongoing rural population-based studies in Handan, Hebei Province (in the North of China), and Yangjiang, Guangdong Province (in Southern China). Two groups were included at each site: subjects with visual disability in at least one eye due to nonsurgical cataract and those who had already undergone cataract surgery in one or both eyes.

The current report describes factors that differentiate rural Chinese persons who undergo cataract surgery from those who could benefit from cataract surgery but have not received services.

METHODS

The Handan Eye Study (HES) is a population-based study of eye disease prevalence and risk factors among persons aged ≥ 30 years in Yongnian County of Handan City, Hebei Province, in Northern China.⁸ A total of 6830 (90.4%) persons of the 7557 eligible were examined between February and December 2007. The Yangjiang Eye Study was a population-based study of eye disease conducted from October to December 2006, including 4589 subjects (83.0%) of an eligible sample of 5531 aged ≥ 50 years in Yangjiang County, a semirural area in Guangdong (Canton) Province, Southern China.

Participants from the population-based evaluations were enrolled in the present study in June 2007 if they had undergone cataract surgery in one or both eyes or had visual disability thought by the examiner to be due to nonsurgical cataract in at least one eye. The visual acuity criteria to define visual disability differed between the two sites: In Yangjiang, it was presenting visual acuity $\leq 6/60$ in either eye, whereas in Handan, it was presenting acuity $\leq 6/18$ in either eye. To correct this discrepancy, additional analyses were performed including only subjects in Handan who met the Yangjiang vision criterion.

Eligible subjects were contacted by study personnel and informed consent was sought for participation in the present study. Presenting visual acuity in each eye was obtained from the databases of the Handan and Yangjiang studies. The methods of vision measurement in both settings were standardized and are reported elsewhere.⁸ The protocol of the present study was approved by the Institutional Review Boards of the Zhongshan Ophthalmic Center (Guangzhou, China) and Tongren Hospital (Beijing, China). The principals of the Declaration of Helsinki were followed throughout.

Characteristics of Study Locales

In Yangjiang, there are two major service providers for cataract surgery, who performed approximately 2000 to 2500 surgeries annually between 2004 and 2007. These numbers may be supplemented by intermittent outreach teams from tertiary centers in the area, such as Zhongshan Eye Center. The bulk of operations are performed by using the small-incision sutureless approach, whereas approximately one third of surgeries were phacoemulsifications performed in one of the centers. There is no formal waiting list for cataract surgery in this area. In Handan, approximately 300 surgeries are performed annually, most with phacoemulsification, by a mix of local surgeons and those from Beijing.

In Yangjiang, the study was performed in Yangxi, a rural county located in western Guangdong Province, 241 km from the provincial capital of Guangzhou. The county population was 467,665 in the 2003 census and had an average per capita annual income of 3950 RMB (US\$564 at current rate of exchange),¹⁷ similar to that for rural households across all Guangdong (4054 RMB [US\$579] in 2004).¹⁸

In Handan, the survey was performed between October 2006 and October 2007 in Yongnian, a rural county with annual per capita income of 2751 RMB (US\$393) and adult illiteracy rate of 9.2% in 2000.¹⁹ These values may be compared with those of 2253 RMB (US\$321) and 11.9% for all of rural China at the time of the same 2000 census.¹⁹

Questionnaires

After informed consent was obtained, the interviews were performed in the subject's homes (Yangjiang) or in a village clinic (Handan) by trained study personnel in the local dialect of Chinese. In Yangjiang, a standard visual function questionnaire was administered. This instrument is described elsewhere in detail.²⁰ It assesses overall vision, visual perception, limitation in daily activities, peripheral vision, near vision, sensory adaptation, light-dark adaptation, visual search, color discrimination, glare disability, and depth perception and has been validated for use in Chinese.^{13,14}

The main Barriers Questionnaire consisted of a brief demographic section including age and sex (which was used to confirm subject identity and did not contribute to the scoring), and the following four segments:

1. A "knowledge" segment with 10 questions about the subject's awareness of cataract, its causes and treatments, and his or her own diagnosis. Subjects were also asked if they knew where cataract could be treated and whether such treatment is painful. Subjects were permitted to answer "Do not know" to any of these questions.
2. A "perception-of-quality" segment consisting of two related sets of five questions each. Participants indicating in the knowledge section that they were aware of a specific location where cataract surgery was performed ($136/437 = 31.1\%$ of those responding)

were asked to rate the following on a four-level scale from best to worst: likely visual outcome after surgery, perceived skill of surgeons, quality of instruments and facilities, quality of service, and physicians' willingness to explain procedures. Subjects were permitted to respond to any of the questions that they were "uncertain." Persons unaware of a specific cataract surgical facility were asked to respond to a corresponding set of questions on the basis of their perception of local general medical facilities.

3. A "transportation" segment consisting of the following four questions: What is the farthest you have ever been from home? What mode of transportation did you use to get there? What mode of transportation do you most commonly use? How difficult is it for you to get to the local medical clinic? Responses were based on a four-point scale.
4. A "cost-and-resources" segment consisting of 20 questions covering the following areas:
 - a. Willingness to pay anything and amount willing to pay for cataract surgery, assessed with a "bidding format" after a brief introduction meant to provide adequate context for the response. The methods used in assessing willingness to pay have been described elsewhere in detail.¹² Specifically, respondents were told that their willingness or unwillingness to pay for surgery would not affect the actual amount of any surgical fee.
 - b. Cost of surgery and availability of free surgery locally.
 - c. Willingness of family members or friends to accompany the respondent for surgery and the period during which they could be available.
 - d. Household income, respondent's education, and current employment, if any.
 - e. Size of the respondent's house and number of persons living there.
 - f. Availability of and coverage provided by health insurance.

Subjects were then asked if they would be willing to undergo surgery or not, and if they were unwilling, to choose from a list of reasons. Administration of the entire questionnaire required 20 to 40 minutes per subject. Interobserver reliability of the questionnaire was assessed by having two separate study personnel administer the form on separate occasions to a total of 20 subjects (10 with poor vision from cataract and 10 having had cataract surgery).

Scoring

Individual items in each section were scored from 0 (worst) to 3 (best), using the following approach.

Quantitative responses (e.g., farthest distance ever traveled from home, amount willing to pay for cataract surgery, household income) were sorted into quartiles, with a value of 3 being assigned to the highest quartile and 0 to the lowest, except in circumstances in which logic dictated the opposite order (e.g., cost of cataract surgery in a local facility, with a higher value receiving a lower score).

Nonquantitative questions that could be answered with ordinal responses (e.g., "Are doctors at [institution's name] facility skillful and well-trained?") were scored from 3 (e.g., "Yes very well-trained") to 0 (e.g., "Very poorly trained").

Questions that did not require a quantitative or ordinal response (e.g., "What causes cataract?") were also scored from 0 (worst) to 3 (best), with lower scores indicating poorer knowledge or greater barriers in the area of transportation or resources.

A mean score of 0 to 3 was computed for each of the four segments, and then these were normalized from 0 (worst) to 10 (best).

Statistical Methods

Frequency distributions and χ^2 analyses were conducted to assess demographic characteristics and visual acuity. Nonparametric tests were performed for knowledge, transportation, quality, and cost scores across a one-way classification (surgical versus nonsurgical, age or sex). Each of the four subscores, age, sex, and site (Yangjiang versus Handan) were considered as candidate risk factors in multivariate

TABLE 1. Demographic Characteristics and Visual Acuity

Variable	Nonsurgical						Surgical					
	Handan		Yangjiang		Total		Handan		Yangjiang		Total	
	Interview	No Interview	Interview	No Interview	Interview	No Interview	Interview	No Interview	Interview	No Interview	Interview	No Interview
Subject, n (%)	92 (7.4)	32 (2.6)	122 (86)	20 (1.4)	214 (80.4)	52 (19.6)	35 (7.1)	14 (2.9)	96 (7.9)	26 (2.1)	131 (76.6)	40 (23.4)
Mean age (SD), y	72.8 (6.6)	72.3 (6.8)	74.4 (8.0)	73.8 (6.2)	73.7 (7.4)	72.9 (6.6)	67.1 (9.2)	66.3 (9.2)	73.4 (7.0)	73.3 (11.4)	71.8 (8.0)	70.8 (11.1)
<i>P</i> , age*	0.40		0.33		0.24		0.35		0.36		0.34	
Male, n (%)	37 (40.2)	12 (37.5)	39 (32.0)	10 (50.0)	76 (35.5)	22 (42.3)	20 (57.1)	5 (35.7)	35 (36.5)	11 (42.3)	55 (42.0)	16 (40.0)
<i>P</i> , sex	0.78		0.12		0.36		0.18		0.59		0.82	
Presenting vision ≤ 6/18 (%)	3 (3.6)	0	2 (1.6)	0	5 (2.3)	0	22 (62.9)	6 (42.9)	45 (46.9)	15 (52.7)	67 (51.2)	21 (52.5)
6/60 (%) < Presenting vision < 6/18 (%)	64 (69.6)	24 (75)	0	0	64 (29.9)	24 (46.2)	4 (11.5)	4 (28.6)	27 (28.5)	4 (15.4)	31 (23.7)	8 (20)
Presenting vision ≤ 6/60 (%)	25 (27.2)	8 (25)	120 (98.4)	20 (10.0)	145 (67.8)	28 (53.8)	9 (25.7)	4 (28.6)	24 (25.0)	7 (26.9)	33 (25.2)	11 (27.5)
<i>P</i> , vision*	0.55		0.56		0.06		0.28		0.40		0.88	

These parameters did not differ significantly between subjects completing and not completing the interview, for those with or without previous surgery.
 * *P*, comparison between persons who did and did not complete interviews.

TABLE 2. Mean Scores for Nonsurgical and Surgical Participants in Yangjiang and Handan China

Category	Handan					Yangjiang					P Handan vs. Yangjiang					Total Handan and Yangjiang				
	K	Q	T	C	P	K	Q	T	C	P	K	Q	T	C	P	K	Q	T	C	
Nonsurgical	2.79 ± 2.62	2.34 ± 2.49	5.28 ± 3.23	3.11 ± 1.51	2.96 ± 2.64	2.77 ± 2.75	2.61 ± 3.50	3.37 ± 1.67	0.1	<0.001	0.37	0.2	<0.001	0.1	2.88 ± 2.63	2.59 ± 2.65	3.73 ± 3.63	3.27 ± 1.61		
Surgical	7.20 ± 1.83	6.44 ± 2.26	6.39 ± 1.46	4.92 ± 1.22	5.78 ± 2.76	5.78 ± 2.76	4.89 ± 3.06	4.58 ± 1.68	0.15	<0.001	0.001	0.22	<0.001	0.15	6.25 ± 2.58	6.00 ± 2.83	5.39 ± 2.72	4.70 ± 1.55		
P	<0.001	<0.001	0.0089	<0.001	<0.001	<0.001	0.001	<0.001	0.16	<0.001	0.28	0.28	<0.001	0.16	<0.001	<0.001	<0.001	<0.001		
Age																				
50-69 y	5.34 ± 2.93	4.45 ± 3.26	6.30 ± 2.41	4.54 ± 1.57	4.75 ± 2.71	4.20 ± 3.12	4.07 ± 3.41	4.68 ± 1.42	0.46	<0.001	0.11	0.35	<0.001	0.46	5.05 ± 2.82	4.31 ± 3.17	5.17 ± 3.14	4.61 ± 1.49		
>70 y	3.78 ± 3.14	3.47 ± 2.95	5.34 ± 2.89	3.29 ± 1.53	4.01 ± 3.11	4.03 ± 3.29	3.45 ± 3.53	3.67 ± 1.80	0.04	<0.001	0.35	0.13	<0.001	0.04	3.93 ± 3.12	3.83 ± 3.18	4.12 ± 3.43	3.53 ± 1.72		
P	<0.01	0.04	0.02	<0.001	0.06	0.31	0.12	<0.001	0.16	<0.001	0.28	0.28	<0.001	0.16	0.001	0.08	0.003	<0.001		
Sex																				
Male	3.88 ± 3.09	3.62 ± 3.09	4.62 ± 2.62	3.15 ± 1.53	4.32 ± 3.02	4.20 ± 3.30	4.62 ± 3.68	4.28 ± 1.81	<0.001	<0.001	0.25	0.15	0.49	<0.001	4.10 ± 3.05	3.91 ± 3.20	4.62 ± 3.17	3.70 ± 1.76		
Female	4.82 ± 3.17	4.02 ± 3.08	6.87 ± 2.42	4.37 ± 1.56	4.10 ± 3.05	4.00 ± 3.23	3.07 ± 3.30	3.80 ± 1.73	0.006	<0.001	0.05	0.43	<0.001	0.006	4.32 ± 3.10	4.00 ± 3.18	4.26 ± 3.52	3.91 ± 1.71		
P	0.03	0.23	<0.001	<0.001	0.36	0.34	0.001	0.02	0.16	<0.001	0.28	0.28	<0.001	0.16	0.22	0.41	0.17	0.11		

The subscales are as follows: knowledge about cataract (K), perception of surgical quality (Q), access to transportation (T), and cost barriers to surgery (C). All scores are given as the mean ± SD; higher scores indicate better outcome.

logistic regression models, with previous cataract surgery as the outcome. Subscores between the first and second administration by different interviewers for a single individual were compared using the intraclass correlation coefficient. All analyses were performed with commercial software (Statistical Analysis System, ver. 9.1.3; SAS Institute Inc., Cary, NC).

RESULTS

Interviews were successfully completed for 71% to 86% of eligible surgical and nonsurgical participants in both Yangjiang and Handan. Across both sites, a total of 214/266 (80.4%) subjects with visual disability from nonsurgical cataract in either eye, and 131/171 (76.6%) surgical subjects, responded to the questionnaire (Table 1). Interviewed subjects did not differ significantly from nonrespondents with regard to age, sex and presenting visual acuity in the better eye (Table 1). The mean age across the two sites of surgical and nonsurgical subjects undergoing interviews was 71.8 ± 8.0 and 73.7 ± 7.4 years, respectively, whereas 58% and 64.5%, respectively, were women (P > 0.1 for comparison of age and sex between surgical and nonsurgical subjects).

More than two thirds of nonsurgical subjects participating in the study had presenting visual acuity of ≤6/60 (legally blind according to the United States definition) in the better-seeing eye, whereas slightly more than half of surgical subjects had visual acuity of ≥6/18 in the surgical eye (Table 1). Vision in the surgical eye did not differ between subjects undergoing surgery in Yangjiang versus Handan (P > 0.1). Among all surgical subjects, 110 (65.9%) had undergone surgery in one eye only, and 57 (34.1%) had undergone bilateral surgery. (This information was unavailable for four subjects.)

The scores on the knowledge, quality, transportation, and cost segments of the questionnaire were each lower (worse) for nonsurgical than for surgical subjects at both the Handan and Yangjiang sites, with the exception of the transportation score at Handan (P = 0.07; Table 2). Participants aged 50 to 69 years had higher (better) unadjusted scores than did participants aged 70 years and above (P = 0.001), whereas sex was not associated with scores on any of the four segments of the Cataract Surgical Barriers questionnaire (Table 2). Scores were generally higher among participants in Handan than in those in Yangjiang (Table 2), with the mean total scores in Handan being 24.9 and 13.5, respectively, for surgical and nonsurgical participants, compared to 21.0 and 11.7 for Yangjiang.

Two logistic regression models with the outcome of having undergone cataract surgery were created, one including all subjects in the study, and the other including only those surgical subjects from Handan who met the more stringent visual criterion used in Yangjiang (presenting vision in at least one eye ≤ 6/60). The results were consistent across both models: a better score on the knowledge and quality segments of the questionnaire was significantly associated with having had cataract surgery, whereas age, sex, and the cost and transportation scores were not significantly associated with having had surgery (Table 3). In the model using the same visual criterion for surgical participants across both sites (i.e., visual acuity ≤ 6/60), location (Handan versus Yangjiang) was not associated with having had surgery, whereas the Yangjiang site was associated with higher odds of surgery when all subjects were included (Table 3).

In a final logistic regression model including the subjects' self-reported visual function, in addition to all the factors in the model in Table 3, better knowledge and quality subscores remained significantly predictive of having had cataract surgery (Table 4). Visual function was better in the patients who had undergone surgery, with the difference being significant when

TABLE 3. Multivariate Logistics Analysis of Factors Potentially Associated with Having Undergone Cataract Surgery in at Least One Eye versus Having Poor Vision Associated with Untreated Cataract

Variables	All Subjects Included		Only VA \leq 6/60 Included	
	OR (95% CI)	P	OR (95% CI)	P
Age (per year)	0.98 (0.95-1.01)	0.11	0.98 (0.95-1.02)	0.30
Female vs. male	1.14 (0.66-2.00)	0.6	0.93 (0.51-1.69)	0.81
Knowledge (per unit of score)	1.28 (1.13-1.46)	<0.001	1.22 (1.07-1.39)	0.0037
Quality (per unit of score)	1.25 (1.12-1.41)	<0.001	1.24 (1.19-1.40)	0.0003
Cost (per unit of score)	1.15 (0.94-1.41)	0.18	1.19 (0.95-1.47)	0.13
Transportation (per unit of score)	1.07 (0.98-1.17)	0.26	1.09 (0.99-1.120)	0.08
Site (Yangjiang vs Handan)	2.22 (1.21-4.08)	0.01	1.11 (0.55-2.25)	0.77

The column on the left includes all subjects, while the column on the right includes only those subjects in Handan meeting the more stringent vision criterion for recruitment (\leq 6/60 in at least one eye) utilized in Yangjiang. OR, odds ratio; CI, confidence interval.

only subjects in Handan who met the more stringent vision criterion used in Yangjiang were included (Table 4).

In interobserver testing on 10 subjects with and 10 without previous cataract surgery, selected according to the study criteria, the intraclass correlation coefficient values for the four subscale scores were: knowledge 0.78, quality 0.75, traffic 0.76, and cost 0.93. All these values are indicative of high reliability.

Among 214 persons who had poor vision due to nonsurgical cataract, 112 (52.3%) indicated that they would be willing to have surgery when asked: 58/122 (47.5%) in Yangjiang and 54/92 (58.7%) in Handan. The most common reasons given for being unwilling to undergo surgery across the two sites were: concerns about the cost of surgery ($n = 20$, 19.6%), being too old for surgery ($n = 16$, 15.9%), and inability of family members to take time off to accompany the patient to the hospital ($n = 6$, 5.6%).

DISCUSSION

Subjects with less knowledge about cataract and poor perceptions of local service quality were less likely to undergo cataract operations in this population-based assessment of potential barriers to surgery in rural China. This finding was consistent across the two sites we surveyed. Knowledge about cataract and its treatment has been identified as an important factor in determining access to cataract surgical services in rural China. A report from Guangdong indicates that more than 95% of persons undergoing surgery knew a person who had

already had the procedure.²¹ These findings argue for increased efforts to inform rural populations that cataract can be treated surgically. Previous studies²¹ suggest that word-of-mouth advertising and television may be particularly well suited for use in rural Asia.

Although it is widely believed that good surgical results are an important prerequisite to fostering demand for surgery in a population, our results are among the first to demonstrate that perceptions of local surgical quality differ significantly between surgical and nonsurgical community members. An important practical challenge is that population-based studies have frequently demonstrated that cataract surgical results in rural Asia are poor. For example, studies from Doumen¹³ and Shunyi¹⁴ counties in China found that 40% to >50% of participants were blind in the surgical eye after surgery. Although the results in the present study were somewhat better than those in the earlier reports, fully 26% (44/171) of surgical subjects across the two sites were blind in the surgical eye after surgery. The causes of blindness in 24 participants after cataract surgery in Yangjiang were as follows: refractive error ($n = 10$, including four with aphakia), posterior capsule opacity (PCO; $n = 4$), macular degeneration ($n = 3$), other retinal causes ($n = 2$), corneal opacity ($n = 1$), glaucoma ($n = 1$), nonglaucomatous optic atrophy ($n = 1$), retinal detachment ($n = 1$), and undetermined causes ($n = 1$). Thus, as much as 11/24 (46%: aphakia, PCO, corneal opacity, glaucoma, and retinal detachment) of poor postoperative vision could have been caused by surgical complications. Further clinical training might potentially improve the detection of comorbidities (the

TABLE 4. Multivariate Logistics Analysis of Factors Potentially Associated with Having Undergone Cataract Surgery in at Least One Eye versus Having Poor Vision Associated With Untreated Cataract

Variables	All Subjects Included		Only VA \leq 6/60 Included	
	OR (95% CI)	P	OR (95% CI)	P
Age (per year)	0.99 (0.96-1.03)	0.54	0.99 (0.96-1.03)	0.67
Female vs. male	1.26 (0.71-2.22)	0.43	1.06 (0.58-1.92)	0.86
Knowledge (per unit of score)	1.30 (1.14-1.48)	<0.0001	1.25 (1.10-1.43)	0.001
Quality (per unit of score)	1.23 (1.10-1.38)	0.0003	1.23 (1.10-1.39)	0.0005
Cost (per unit of score)	1.15 (0.94-1.41)	0.801	1.13 (0.91-1.40)	0.26
Transportation (per unit of score)	1.07 (0.97-1.17)	0.1715	1.09 (0.99-1.20)	0.0723
Site (Yangjiang vs. Handan)	2.70 (1.36-5.27)	0.0037	1.38 (0.68-2.83)	0.37
VF total	1.14 (0.99-1.302)	0.0669	1.17 (1.02-1.34)	0.0246

This model is the same as that in Table 3, except that self-reported visual function has been included (measured at the time of interview, that is, after surgery in patients having undergone surgery). The column on the left includes all subjects, while the column on the right includes only those subjects in Handan meeting the more stringent vision criterion for recruitment (\leq 6/60 in at least one eye) utilized in Yangjiang. VF, visual function.

cause of as much as $10/24 = 42\%$ of poor postoperative vision.)

Smaller, clinic-based studies of surgical results from individual programs²² have demonstrated that excellent visual outcomes can be achieved in rural China by local surgeons. The critical inputs appear to be modern equipment and thorough training, not only in surgery but also in appropriate preoperative screening and postoperative management.²²

Self-reported visual function was better among subjects who had undergone cataract surgery compared with those who had not. The visual function questionnaire was administered at the time of our cross-sectional study, and thus scores reflected postoperative visual function among surgical participants. It would have been valuable to have preoperative visual function scores for all subjects to determine whether a lack of self-perceived vision deficit was an important barrier to surgery. Unfortunately, the design of the study did not permit determining when perceived vision deficit influenced decisions about surgical treatment of cataract.

Our finding that the score on the cost and resources segment of the Barriers Questionnaire was not significantly associated with having obtained surgery in the multivariate model is consistent with previous studies demonstrating that some 80% of persons eligible for cataract surgery in rural China are willing to pay for operations, a mean amount of more than US\$55.¹² Cataract services are currently available in Yangjiang at a roughly comparable cost, whereas in Handan the prevailing price is approximately US\$200.

Xu et al.¹¹ have shown that reducing the cost of cataract surgery can lead to significant increase in uptake of services in rural China. The results of the present study suggest that, if surgery is available for a cost of 1 or 2 months' salary, the price of the operation may not present the most significant barrier to uptake of services in rural China. This is in contrast to the situation in East Africa, where Lewallen et al.²³ have reported that only 4% of patients eligible for cataract surgery are willing to pay anything for an operation. This finding may be generalized, but with caution, to other regions of China, where low-cost surgery may not be readily available.

The finding that transportation is not among the most significant barriers to access of cataract services may reflect the high population density and relatively well-developed transportation infrastructure in Eastern China,¹⁵ compared with that in other regions of the world such as Africa²⁴ and even other parts of Asia. Although some two thirds of the Chinese population dwells in these eastern regions, these findings may not be generalizable to the less densely settled western part of the country. Our failure to show a significant association between access to cataract surgery and the transportation subscore could also have been due to limitations of the instrument used to measure this factor.

The strengths of this study are its population-based design and relatively high recruitment rates among both surgical and nonsurgical subjects in two geographically disparate locations. Key results were consistent across both sites (Tables 2, 3).

The limitations of the study must also be acknowledged. In a cross-sectional study such as this, associations of cause and effect cannot be clearly delineated. We hypothesize that lack of knowledge about cataract and concerns over poor quality of locally available services have acted as barriers that have prevented some participants from seeking surgery. However, it is also possible that participants who have undergone cataract surgery have increased their knowledge of the disease and its treatment because they sought out and received care. Furthermore, their interactions with the medical establishment may have modified their attitudes about the quality of care provided by local surgeons. Only a prospective study could completely settle this question, but such a design would present significant

ethical difficulties. Although participants who did and did not complete the questionnaire did not differ significantly with regard to age, sex, and visual acuity, the possibility cannot be excluded that the four fifths of our sample who responded are not fully representative of the local population.

A final but important limitation is that different vision standards were used to recruit participants with cataract-associated visual disability in the two locations studied. Although the findings are consistent across the study sites, the use of different cutoffs limited our ability to make direct comparisons between the populations. This problem is to some extent reduced, in that we observed consistent results between models including all subjects at the two sites and those models which included only nonsurgical persons from Handan meeting the more rigorous Yangjiang vision standard of $\leq 6/60$.

Despite its limitations, this study provides some of the first population-based data available on barriers to cataract surgery in rural China. It is hoped that these results may help to inform programs designed to increase the current low uptake of cataract surgical services in this large population group and to stimulate further study of the impact of specific strategies.

References

1. China Disabled Person's Federation (CDPF). *Statistics Yearbook on the Undertakings of People with Disabilities in China*. Beijing: CDPF Information Center; 2005;3-99.
2. Ministry of Health (MOH). *Chinese Health Statistical Digest 2004*. Beijing: China Statistics Press; 2005;3-29.
3. Zhang S, Zou L, Gao Y, et al. Epidemiological survey: national epidemiological survey of blindness of blindness and low vision in China. *Chin Med J*. 1992;105:603-608.
4. Thylefors B, Negrel A-D, Pararajasegaram R, et al. Global data on blindness. *Bull World Health Organ*. 1995;73:115-121.
5. Xu L, Wang Y, Li Y, et al. Causes of blindness and visual impairment in urban and rural areas in Beijing: the Beijing Eye Study. *Ophthalmology*. 2006;113:1141.e1-e3.
6. Dunzhu S, Wang FS, Courtright P, et al. Blindness and eye diseases in Tibet: findings from a randomised, population based survey. *Br J Ophthalmol*. 2003;87:1443-1448.
7. Li S, Xu J, He M, Wu K, Munoz SR, Ellwein LB. A survey of blindness and cataract surgery in Doumen County. *China Ophthalmol*. 1999;106:1602-1608.
8. Liang YB, Friedman DS, Wong TY, et al. Prevalence and causes of low vision and blindness in a rural Chinese adult population: the Handan Eye Study. *Ophthalmology*. 2008;115(11):1965-1972.e1.
9. Lin Y. Comparative study on preventing avoidable blindness in China and in Nepal. *Chin Med J*. 2007;120:280-283.
10. Lin Y. Analysis on the status of departments of ophthalmology in general hospitals. *The Yearbook of Health in the People's Republic of China*. Beijing: People's Medical Publishing House; 2000: 150-151.
11. Xu J, Zhu S, Li S, Pizzarello L. Models for improving cataract surgical rates in southern China. *Br J Ophthalmol*. 2002;86:723-724.
12. 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.
13. He M, Xu J, Li S, et al. Visual acuity and quality of life in patients with cataract in Doumen County. *China Ophthalmol*. 1999;106: 1609-1615.
14. Zhao J, Sui R, Jia L, et al. Visual acuity and quality of life outcomes in patients with cataract in Shunyi County. *China Am J Ophthalmol*. 1998;126:515-523.
15. *China Statistics Year Book 2004*. Beijing: Bureau of Statistics. 2004:95-119.
16. Yorston D. High-volume surgery in developing countries. *Eye*. 2005;19:1083-1089.
17. *Statistical Yearbook of Yangjiang* (in Chinese). Beijing: China Statistics Press; 2004:335.

18. Bureau of Statistics of Guangdong Province. *2004 Income and Expenditure of Rural Residents in Guangdong* (in Chinese). Available at http://www.gdstats.gov.cn/tjsj/ncjmsz/ncjmxjszqk/t20050310_29338.htm. Accessed September 29, 2008.
19. <http://www.stats.gov.cn/tjsj/nds/renkoupucha/2000pucha/pucha.htm> (in Chinese). Accessed October 26, 2008.
20. Fletcher AE, Ellwein LB, Selvaraj S, Vijaykumar V, Rahmathullah R, Thulasiraj RD. Measurements of vision function and quality of life in patients with cataracts in southern India. *Arch Ophthalmol*. 1997;115:767-774.
21. Congdon N, Rao SK, Choi K, et al. Sources of patient knowledge and financing of cataract surgery in rural China: the Sanrao Study of Cataract Outcomes and Up-Take of Services (SCOUTS), Report 6. *Br J Ophthalmol*. 2008;92(5):604-608.
22. Lam DS, Congdon NG, Rao SK, et al. Visual outcomes and astigmatism after sutureless, manual cataract extraction in rural china: Study of Cataract Outcomes and Up-Take of Services (SCOUTS) in the Caring Is Hip Project, Report 1. *Arch Ophthalmol*. 2007;125:1539-1544.
23. Lewallen S, Geneau R, Mahande M, Msangi J, Nyaupumbwe S, Kitumba R. Willingness to pay for cataract surgery in two regions of Tanzania. *Br J Ophthalmol*. 2006;90:11-13.
24. Uthman OA, Uthman MB. Geography of Africa biomedical publications: An analysis of 1996-2005 PubMed papers. *Int J Health Geogr*. 2007;6:46.