

Five-Year Incidence and Postoperative Visual Outcome of Cataract Surgery in Urban Southern China: The Liwan Eye Study

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PURPOSE. To determine the 5-year incidence and visual outcome of cataract surgery in an adult urban Chinese population.

METHODS. A comprehensive eye examination was performed at baseline and 5 years later on subjects participating in a population-based study. Incident cataract surgery was defined as having undergone surgery in either eye during the 5-year period. Postoperative visual impairment (PVI) was defined as visual acuity (VA) <6/18 based on both presenting VA (PVA) and best corrected VA (BCVA) in the operated eye.

RESULTS. Among the 1405 baseline participants, 75% (924) of survivors were seen at the 5-year follow-up visit. Forty-four returning participants (62 eyes) had undergone incident cataract surgery, an incidence of 4.84% (95% confidence interval [CI] = [3.53, 6.44]). Detailed medical and surgical records were available for 54/62 (87.1%) eyes, and of these, 5/54 (24.1%) had an immediate preoperative visual acuity ≤6/120. All recorded surgeries were performed at tertiary-level hospitals with phacoemulsification and foldable intraocular lens implantation. Those undergoing cataract surgery were more educated ($P < 0.05$) and had poorer baseline PVA in the worse-seeing eye ($P < 0.001$) than 54 persons with baseline PVA <6/18 due to cataract who had not had surgery. Among the 62 operated eyes, 22.6% (14/62) had PVI based on PVA and 9.6% (6/62) based on BCVA.

CONCLUSIONS. Despite somewhat lower incidence, outcomes of cataract surgery in urban southern China are comparable with developed countries and better than for rural China. In urban China, emphasis should be on improving access to surgery. (*Invest Ophthalmol Vis Sci.* 2012;53:7936-7942) DOI: 10.1167/iops.12-10903

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Unoperated cataract remains the leading cause of blindness globally and is particularly common in developing countries such as China.¹⁻⁴ Cataract surgery is the only effective method to restore vision for those affected, but the provision of high-quality cataract surgery remains a challenge in many parts of the world.^{5,6} China has recently made great strides in improving health care coverage: The establishment of the basic social medical insurance system (BSMIS) in urban areas in 1998 and the new rural cooperative medical insurance system (RCMIS) in rural areas beginning in 2003 have resulted in an insurance coverage rate of over 95% across the nation.⁷⁻¹⁰ In light of the resulting improved ability to pay for medical care, strategies to improve surgical uptake may need to be revised if cost is no longer the major barrier to cataract surgery among the insured. However, very few population-based studies have assessed the incidence of cataract surgery after the establishment of BSMIS/RCMIS.⁸ Furthermore, the cataract surgical rate seems to vary greatly across different regions in China,^{4,11} but there is a lack of data to document the indications/visual threshold for operations. Population data on the visual threshold for cataract surgery may provide insights into the practice pattern and causes of regional variation in health care utilization.

The purpose of the present study is to assess the incidence and predictors of cataract surgery in a prospective, population-based study in urban southern China. We also document the distribution of preoperative visual acuity among persons undergoing incident cataract surgery in this population.

METHODS

The Liwan Eye Study is a population-based study carried out in one of the 10 urban administrative districts of Guangzhou, Southern China. The Liwan District was chosen for the survey because of its relatively stable population and representative demographic and socioeconomic characteristics.¹² Subjects were identified by cluster random sampling, and those aged ≥50 years who had been resident in the selected study clusters for >6 months were considered eligible. Eligible subjects were invited for a comprehensive eye examination in a temporary research clinic established in the community. A detailed questionnaire was administered to collect information regarding income, education, and other socioeconomic data.

Ethical approval for the study was obtained from the Zhongshan University Ethics Review Board, and the Research Governance Committee of Moorfields Eye Hospital, London. The study was conducted in accordance with the tenets of the World Medical Association's Declaration of Helsinki. Written informed consent was obtained from all subjects.

The baseline eye examination was performed between September 2003 and February 2004, and has been described elsewhere in detail.¹³

A 5-year follow-up examination was conducted in November 2009, and followed the same protocol. Presenting visual acuity (PVA) was measured with an Early Treatment Diabetic Retinopathy Study (ETDRS) visual chart using habitual refractive correction, if worn. Subjects with PVA <6/12 in either eye underwent noncycloplegic autorefractometry and assessment of best-corrected visual acuity (BCVA) in each eye. Examination of the anterior and posterior segment was carried out using a slit lamp (SL-8Z; Topcon, Tokyo, Japan, with D1x digital image system; Nikon, Tokyo, Japan) and +78-diopter (D) lens at 16× magnification by an experienced ophthalmologist (M.H.) before and after dilation of the pupil. For pseudophakic patients, information regarding date of cataract surgery and name of hospital was obtained from the patient by questionnaire. If the PVA was ≤20/63, the principal cause of impairment was assigned by the examining ophthalmologist using a 15-item checklist.

Incident cataract surgery was defined as the absence of the native crystalline lens in either eye at the follow-up examination, if the lens was present at baseline. For those with incident cataract surgery during the 5-year follow-up, we obtained detailed medical information (i.e., preoperative visual acuity [POVA], type of cataract surgery, model of intraocular lens, any intra- and postoperative complications, and cost of hospitalization and use of insurance) from the hospital where the surgery was carried out.

Statistical Analysis

All statistical analyses were performed with data analysis and statistical software (Stata version 11.0; StataCorp, College Station, TX). Chi-square tests were used to compare differences between subjects participating and not participating in follow-up examinations in terms of age, sex, education, income, baseline VA, and the presence of hypertension and diabetes mellitus. Logistic regression models were used to study the association of potential explanatory variables with incident cataract surgery, comparing those with cataract surgery and those having baseline PVA <6/18 in at least one eye and not having undergone incident cataract surgery. A *P* value < 0.05 indicated statistical significance.

RESULTS

Of the 1405 subjects participating in the baseline examination, 173 (12.3%) died by November 2009 and 308 (25.0% of survivors) did not return for reexamination (Fig.). Of nonparticipants in the follow-up examination, 64 (20.8%) moved away from the study area; 132 (42.9%) refused the examination; and 112 (36.3%) could not be contacted. The 924 participants in the 5-year follow-up (75% of survivors, 65.8% of baseline subjects) were younger (mean age, 63.4 ± 9.0 vs. 66.4 ± 10.6 years, *P* < 0.001); more likely to have hypertension (43.9% vs. 32.2%, *P* = 0.001); and diabetes (11.4% vs. 6.64%, *P* = 0.032); had poorer baseline VA (for the better-seeing eye, *P* < 0.001; for the worse-seeing eye, *P* < 0.001) than the 308 nonparticipants; whereas the sex distribution (female: 57.4% vs. 59.4, *P* = 0.527), education, income, and proportion having undergone cataract surgery prior to the baseline examination (4.6% vs. 3.57%, *P* = 0.466) were similar between these groups (Table 1).

A total of 44 subjects (62 eyes; [4.84%, 95% CI = 3.53, 6.44]) among 910 persons without prior binocular cataract surgery at baseline underwent incident cataract surgery. All surgeries had been performed at tertiary-level hospitals. The type of surgical procedure according to operative records was phacoemulsification combined with a foldable intraocular lens implantation in 100% of cases. The average cost of surgery was 6990 ± 790 RMB (USD 1030 ± 116 at 2009 exchange rates). Of the 866 patients without incident cataract surgery, 36 subjects (4.2%) had been operated already in one (22, 2.5%) or both (14, 1.6%)

eyes at the time of the baseline examination and 830 (95.8%) had never been operated. The incidence of cataract surgery increased from 1.45% among subjects aged 50 to 59 years to 14% for those ≥75 years (*P* < 0.001). Among women, the incidence was 5.17%, while for men it was 4.38% (*P* = 0.6, Table 2).

In logistic regression models, patients having incident cataract surgery were more educated (*P* < 0.05) and had worse PVA in the worse-seeing eye (*P* < 0.001) than 54 subjects with baseline PVA <6/18 due to cataract (Table 3). There were no significant differences in terms of sex, income, insurance status, or presence of hypertension or diabetes between subjects with and without incident cataract surgery.

Detailed medical and surgical records were available for 54/62 (87.1%) eyes. Of these, 13/54 eyes (24.1%) had a POVA <6/120. POVA from ≥6/120 to <6/60 was present in eight eyes (14.8%); ≥6/60 to <6/18 in 28 eyes (51.9%); and ≥6/18 in 5 eyes (9.3%) (Table 4). A total of 11/35 (32.4%) of patients were unilaterally blind, and three patients (8.8%) were bilaterally blind immediately prior to surgery. No evidence of surgical aphakia, posterior capsular rupture, or significant corneal edema was encountered on review of operative and perioperative records.

At the five-year follow up examination in 2009, postoperative PVA ≥6/18 was present in 48 eyes (48/62, 77.4%); ≥6/60 ~ <6/18 in nine eyes (14.5%); and ≤6/60 in five eyes (8.06%, Table 5). The main causes of postoperative PVA ≤6/18 was refractive error (6/14, 42.8%). This was followed by age-related macular dystrophy, diabetic retinopathy (two cases); unidentified retinal disease (two cases); myopic retinopathy (one case); and posterior capsular opacity (one case). Among 6 eyes with postoperative PVA of 6/18, three improved to 6/16 and three to 6/9.

DISCUSSION

Our study documents the 5-year incidence of cataract surgery in an adult population living in Liwan district, Guangzhou City, one of the major metropolitan cities in China. The 5-year incidence in this cohort (4.8%) is slightly lower than that reported in industrialized countries such as the United States (5.2%) and Australia (5.2%), but higher than that in Beijing (2%).¹⁴⁻¹⁶ The high incidence rate in our cohort likely reflects improved health care access due to national health care reform occurring in urban China during the time of this study: insurance rates increased from 29.7% in 2003 to 87.9% in 2008 and 95.7% in 2011.¹⁰ During this period, the average share of inpatient costs reimbursed by insurance in China grew from 14.4% in 2003 to 46.9% in 2011.¹⁰

The incidence of cataract surgery in our cohort was twice that previously reported in Beijing.¹⁶ This may be attributable to the fact that our cohort was entirely urban, while the Beijing Eye Study included not only urban subjects, but also a rural cohort, for whom health care reform was implemented later.¹⁰ Also, our study was completed more recently than the Beijing Eye Study (2009 vs. 2006). In view of the trend for rapidly rising uptake of insurance during this period, a modest time difference could explain much lower rate of access to surgery in Beijing. While it is encouraging to find incident rates of cataract surgery in the Liwan study which approach those in the developed world, it should be borne in mind that 21.6% of our study sample still had sight-threatening cataract.¹⁷ Based on these data, there are more than 30,000 persons blind and 581,000 with low vision due to unoperated cataract in Guangzhou alone.¹⁷ Eliminating the backlog of cataract blindness remains a formidable challenge in urban China. With widespread health insurance having somewhat ameliorated

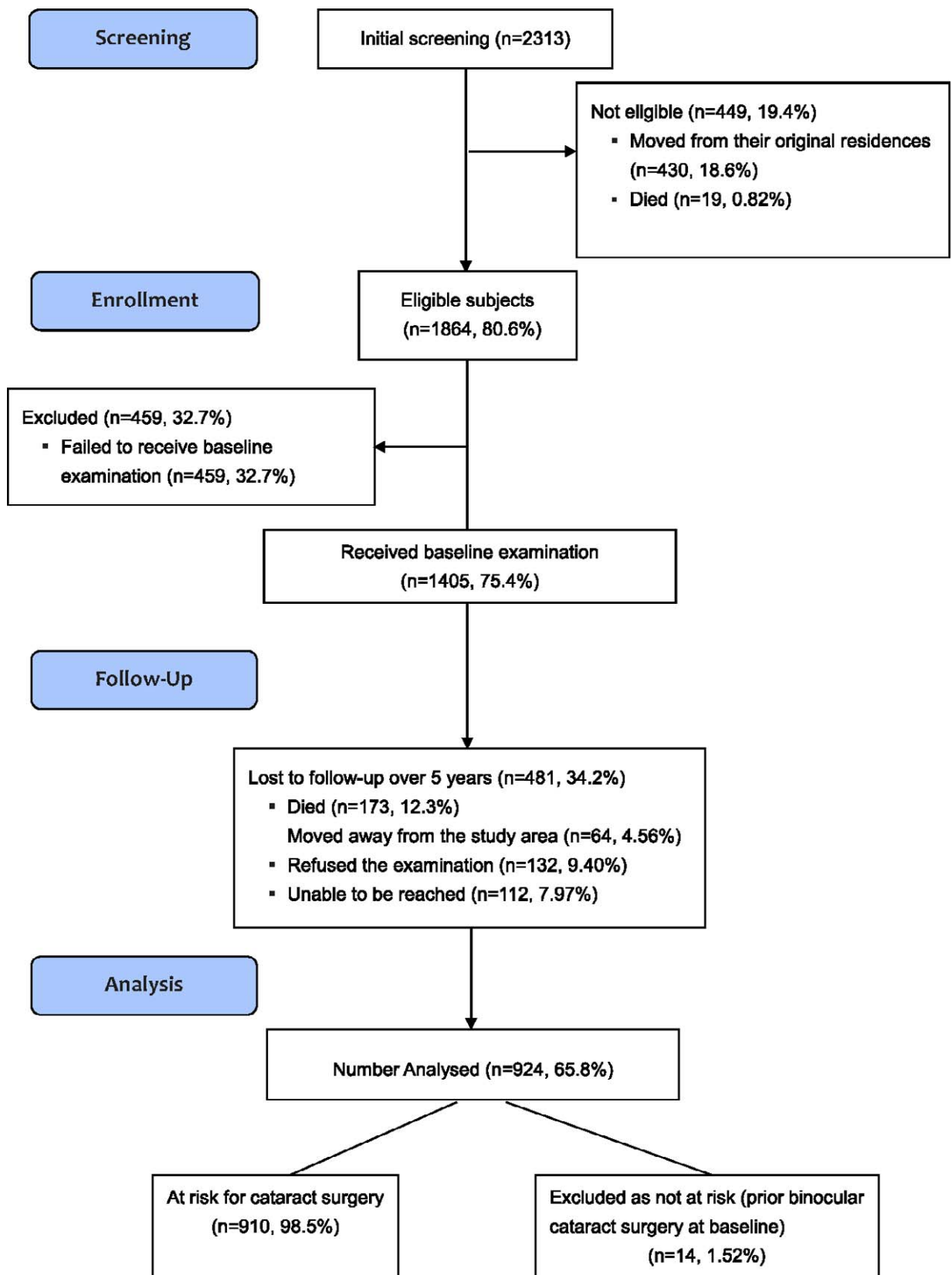


FIGURE. Enrollment of subjects into the study.

TABLE 1. Baseline Characteristics of Participants who Did and Did Not Return for Follow-Up Examination

	Participants Not Examined at Follow-Up <i>n</i> = 308 (25.0%)	Participants Examined <i>n</i> = 924 (75.0%)	<i>P</i> Value
Age			
50 to 54 y	62 (20.1)	206 (22.3)	<0.001
55 to 64 y	66 (21.4)	273 (29.6)	
65 to 74 y	101 (32.8)	340 (36.8)	
+75 y	79 (25.7)	105 (11.4)	
Sex			
Male	125 (40.6)	394 (42.6)	0.527
Female	183 (59.4)	530 (57.4)	
Education			
High school or above	34 (15.5)	160 (17.7)	0.653
Primary or secondary school	142 (64.6)	555 (61.5)	
None	44 (20.0)	188 (20.8)	
Income			
≥3000	162 (73.6)	474 (73.0)	0.053
1000 to 3000	31 (14.1)	124 (19.1)	
<1000	27 (12.3)	51 (7.86)	
Hypertension			
No	164 (67.8)	507 (56.1)	0.001
Yes	78 (32.2)	397 (43.9)	
Diabetes			
No	225 (93.4)	802 (88.6)	0.032
Yes	16 (6.64)	103 (11.4)	
Baseline PVA (better-seeing eye)			
≥6/12	219 (71.0)	759 (82.2)	<0.001
≥6/18 to 6/12	21 (6.82)	41 (4.44)	
≥6/120 to 6/18	66 (21.4)	121 (13.1)	
<6/120	2 (0.65)	2 (0.22)	
Baseline PVA (worse-seeing eye)			
≥6/12	177 (57.5)	642 (69.6)	0.001
≥6/18 to 6/12	15 (4.87)	41 (4.44)	
≥6/120 to 6/18	100 (32.5)	195 (21.1)	
<6/120	16 (5.19)	45 (4.88)	
BCVA (better-seeing eye)			
≥6/12	263 (85.4)	876 (94.9)	<0.001
≥6/18 to 6/12	17 (5.52)	20 (2.17)	
≥6/120 to 6/18	27 (8.77)	25 (2.71)	
<6/120	1 (0.32)	2 (0.22)	
BCVA (worse-seeing eye)			
≥6/12	227 (73.7)	779 (84.4)	<0.001
≥6/18 to 6/12	23 (7.47)	37 (4.01)	
≥6/120 to 6/18	41 (13.3)	69 (7.48)	
<6/120	17 (5.52)	38 (4.12)	
Prior cataract surgery			
Yes	11 (3.57)	42 (4.6)	0.466
No	297 (96.4)	882 (95.4)	

financial barriers to cataract surgery, it would appear that outreach and educational efforts to further stimulate demand for surgery may be needed. With surgical fees at some urban facilities exceeding USD1000, ample cost recovery for such efforts could be available.

The distribution of immediate POVA shows that 14.3% the subjects operated for cataract in our study were blind (POVA <3/60 in the better-seeing eye). This proportion is lower than has been reported for low-income regions (39%), and similar to middle-high income regions such as the Americas (17%) and

Europe (19%).^{18–20} This likely reflects the fact that cataract surgical access is relatively good in wealthy urban areas of China compared with the country as a whole. While the national cataract surgical rate has increased only from 480 in 2004²¹ to 772 in 2009,²² recent estimated figures for Beijing, Shanghai, and Guangzhou were 2629, 2356, and 1750, respectively, in 2011.²³ This remains well behind most parts of the developed world. The fact that >60% of surgeries were performed on eyes with more modest degrees of visual impairment (>6/60 in both eyes) reflects an increasing

TABLE 2. Five-Year Incidence of Cataract Surgery by Age and Sex

Surgery	All Persons		Male		Female	
	<i>N</i>	<i>n</i> (%)	<i>N</i>	<i>n</i> (%)	<i>N</i>	<i>n</i> (%)
Unilateral surgery						
50 to 54 y	205	3 (1.45)	78	1 (1.28)	127	2 (1.57)
55 to 64 y	269	1 (0.37)	120	0	149	1 (0.67)
65 to 74 y	336	13 (3.87)	144	5 (3.47)	192	8 (4.17)
+75 y	100	9 (9.00)	46	6 (13.0)	54	3 (5.56)
Incidence						
[95% CI]	910	26 (2.86 [1.87, 4.16])	388	12 (3.09 [1.61, 5.34])	522	14 (2.68 [1.47, 4.46])
Bilateral surgery						
50 to 54 y	205	0	78	0	127	0
55 to 64 y	269	2 (0.74)	120	2 (1.67)	149	0
65 to 74 y	336	11 (3.27)	144	1 (0.69)	192	10 (5.21)
+75 y	100	5 (5.00)	46	2 (4.35)	54	3 (5.56)
Incidence						
[95% CI]	910	18 (1.98 [1.18, 3.11])	388	5 (1.29 [0.42, 2.98])	522	13 (2.49 [1.33, 4.22])
Any cataract surgery						
50 to 54 y	205	3 (1.45)	78	1 (1.28)	127	2 (1.57)
55 to 64 y	269	3 (0.64)	120	2 (1.67)	149	1 (0.67)
65 to 74 y	336	24 (7.14)	144	6 (4.17)	192	18 (9.38)
+75 y	100	14 (14.0)	46	8 (17.4)	54	6 (11.1)
Incidence						
[95% CI]	910	44 (4.84 [3.53, 6.44])	388	17 (4.38 [2.57, 6.92])	522	27 (5.17 [3.44, 7.44])

N, number at risk; *n*, number of subjects.

TABLE 3. Factors Associated with Incident Cataract Surgery

	Subjects with Incident Cataract Surgery	Subjects with BCVA <6/18 Due to Cataract in 2003 in Either Eye without Incident Cataract Surgery	Univariate Logistic Regression (OR [95% CI])	Age and Sex Adjusted Logistic Regression (OR [95% CI])	Multivariate Logistic Regression (OR [95% CI])
Total number (%)	44 (44.9)	54 (55.1)			
Age					
Mean ± SD	70.5 ± 7.61	70.3 ± 8.6	1.00 (0.96, 1.05)	1.01 (0.96, 1.06)	0.96 (0.86, 1.07)
Sex					
Female, <i>n</i> (%)	27 (61.4)	38 (70.4)	0.67 (0.29, 1.55)	0.65 (0.27, 1.54)	0.78 (0.11, 5.42)
Education					
Never received education, <i>n</i> (%)	13 (33.3)	27 (50.0)	0.50 (0.21, 1.17)	0.50 (0.19, 1.31)	0.13 (0.02, 0.76)*
Income					
<1000, <i>n</i> (%)	26 (92.9)	27 (81.8)	2.89 (0.53, 15.6)	4.62 (0.72, 29.8)	7.64 (0.59, 98.9)
Insurance					
No insurance, <i>n</i> (%)	1 (2.70)	3 (6.00)	0.44 (0.04, 4.36)	0.45 (0.04, 4.58)	
Hypertension					
Yes, <i>n</i> (%)	21 (52.5)	28 (51.9)	1.02 (0.45, 2.33)	1.08 (0.47, 2.48)	1.44 (0.33, 6.26)
Diabetes					
Yes, <i>n</i> (%)	9 (22.5)	8 (15.1)	1.63 (0.57, 4.70)	1.72 (0.59, 5.03)	1.90 (0.25, 14.7)
Baseline PVA (better-seeing eye; LogMAR)					
Mean ± SD	0.92 ± 0.59	1.34 ± 0.81	0.43 (0.23, 0.80)*	0.41 (0.22, 0.78)*	
Baseline PVA (worse-seeing eye; LogMAR)					
Mean ± SD	1.63 ± 1.06	2.53 ± 0.94	0.42 (0.27, 0.66)†	0.40 (0.25, 0.64)†	0.20 (0.09, 0.47)†

LogMAR, log minimum angle of resolution.

* $P < 0.05$.

† $P < 0.001$.

TABLE 4. Distribution of Immediate Preoperative VA among Those Who Underwent Cataract Surgery

Category	PVA		Number of Cases (%)
	Better Eye	Worse Eye	
Near normal	≥6/18	≥6/18	2 (5.7)
Visually impaired	≥6/60	<6/18 ~ ≥6/60	19 (54.3)
Unilateral blindness	≥6/60	<6/60	11 (31.4)
Moderate blindness	<6/60 ~ ≥3/60	<6/60	0 (0)
Severe blindness	<3/60	<3/60	3 (8.6)
Total			35 (100.0)

TABLE 5. Distribution of Postoperative VA in the 5-Year Follow-Up Examination

Postoperative PVA	Postoperative BCVA				Total
	≥6/12	≥6/18 ~ <6/12	≥6/60 ~ <6/18	<6/120	
≥6/12	37	0	0	0	37 (59.7)
≥6/18 ~ <6/12	10	1	0	0	11 (17.7)
≥6/60 ~ <6/18	3	3	3	0	9 (14.5)
<6/60	0	2	2	1	5 (8.06)
Total	50 (80.6)	6 (9.68)	5 (8.06)	1 (1.61)	62 (100.0)

demand for better levels of vision, which will pose new challenges to the healthcare system.

In this urban population with high health insurance coverage rates, it appears that cost was no longer a major barrier to cataract surgery. Incident cataract surgery was significantly associated with lower education and poorer baseline PVA, but not with sex, income, education, and the presence of health insurance.

In view of the relatively good access to cataract surgery in this cohort, and the fact these patients overwhelmingly received phacoemulsification surgery at tertiary centers, it is not surprising that 77.4% had a postoperative PVA ≥6/18. These results compare favorably not only with previous population-based studies from China,^{2-4,16} but are also similar to outcomes achieved in developed regions such as Hong Kong,²⁴ Los Angeles,²⁵ and Singapore²⁶ (59.6%–74.6%). These outcomes suggest that increasing access to surgery, rather than further improvement in surgical quality, may remain the principal barrier to alleviating the burden of cataract blindness in coastal urban China.

Strengths of our study include its population-based design, and access to detailed preoperative and perioperative medical data for a large majority of patients. Among its limitations is the fact that information regarding the participants' knowledge of cataract and cataract surgery and awareness of local eye care services was not obtained. These factors may have influenced the uptake of cataract surgery in ways we are unable to measure. Another limitation is that the study population is only representative of permanent residents, and does not reflect the 3 million migrant residents of Guangzhou, who frequently suffer from low income and the lack of health insurance. It should also be noted that participation in the follow-up study was only 75% among survivors, and those taking part differed from nonparticipants in several potentially important ways. These results likely reflect the best case scenario in an advanced coastal urban setting, and may be applied to other populations only with care.

In conclusion, our study shows that the incidence of cataract surgery and distribution of visual outcomes in urban southern China are not very far behind those in developed countries, though there remains a large backlog of unoperated cataract, reflecting the need for further improved access to

cataract surgical services. Uncorrected refractive error is the leading cause of PVI, highlighting the need for better postoperative refractive care. Our findings have important public health implications for the 690 million residents of urban China, a large and rapidly growing population.

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