WORLD VIEW

Prevalence of visual impairment, blindness, and cataract surgery in the Hong Kong elderly

John J Michon, Joseph Lau, Wing Shing Chan, Leon B Ellwein

Br J Ophthalmol 2002;**86**:133–139

Series editors:
W V Good and S Ruit

See end of article for authors' affiliations

Correspondence to:
Leon B Ellwein, PhD, National Eye Institute, 31 Center Drive, Bethesda, MD 20892–2510, USA

Accepted for publication 14 August 2001

Background: The prevalence of vision impairment, unilateral/bilateral blindness, and cataract surgery were estimated in a population based survey among the elderly in a suburban area of Hong Kong.
Methods: 15 public, private, and home ownership scheme housing estates in the Shatin area of Hong Kong were subjected to cluster sampling to randomly select a cross section of people 60 years of age or older. Visual acuity measurements and ocular examinations were conducted at a community site within each estate. The principal cause of reduced vision was identified for eyes with presenting visual acuity worse than 6/18.
Results: A total of 3441 subjects from an enumerated population of 4487 (76.7%) completed an eye examination. The prevalence of presenting visual acuity less than 6/18 in at least one eye was 41.3%; and 73.1% in those 80 years of age or older. Unilateral blindness (acuity <6/60) was found in 7.9% of subjects and bilateral blindness in 1.8%. Refractive error and cataract were, respectively, the main causes of vision impairment and blindness. Visual impairment with either eye <6/18 increased with advancing age and was more prevalent in males, the less educated, and those living in public housing estates. The prevalence of cataract surgery was 9.1% and was associated with advancing age and less education.
Conclusions: Blindness and visual disability were common in this socioeconomically advanced population, with most of it easily remedied. Because of a rapidly ageing population, healthcare planners in Hong Kong must prepare for an increasing burden of visual disability and blindness.

Hong Kong is a special administrative region of the People's Republic of China comprising 1095 square kilometres with a population in 1998 of 6.7 million people .[1] Per capita income ranks it among the highest in Asia. The healthcare system is a mixture of public and private service, and most indices of performance such as infant mortality are excellent. Life expectancy is 82.6 years for females and 77.2 years for males; 14.1% of the population is over the age of 60, with 6.5% over 70 and 1.8% over 80. Fully 18.5% of the Hong Kong population is expected to be 60 or over in 2014, and 3.3% 80 or over.[1]

Population based studies of vision impairment and cataract surgery in ethnic Chinese populations in two rural areas near Beijing and Guangzhou have been published.[2 3] The present study was conducted to obtain comparative data from Hong Kong using the same measurement protocol as in the two mainland China surveys.

The study was limited to people aged 60 years or older residing in Shatin, a densely populated suburban town in the New Territories area of Hong Kong comprising 69.4 square kilometres in area with a population of 583 000. Nearly all people reside in large housing estates consisting of multiple high rise apartment buildings. These buildings are referred to as blocks. Three types of housing estates cover 95% of all residential units in Shatin: public (government owned), private, and home ownership scheme (government subsidised, self purchased housing). The number of residents in a block generally ranges from 700 in private housing to 4000 in public housing. Shatin is comparable to Hong Kong with respect to age and household income: a 1996 census showed (for adults 60 years of age or older) a median age of 65.9 in Shatin and 66.0 in Hong Kong with a median monthly household income (all households) of HK$16 558 for Shatin versus HK$15 500 for Hong Kong generally.

METHODS

Sampling

The study sample was drawn from 15 of the largest housing estates within the district board area of Shatin: eight public, four private, and three home ownership scheme, with an estimated population of 176 200, 67 200, and 33 500, respectively.

Cluster sampling was used to select subjects from each of the 15 estates, where a cluster consisted of all residents of a block within the estate. Blocks within each estate were selected randomly. Sample size requirements were based on estimating with 95% confidence the prevalence of bilateral blindness (visual acuity less than 6/60 in both eyes) within an error bound of plus or minus 20%. The prevalence used for sample size calculation was 4.3%, which was based on preliminary results from the survey conducted in Shunyi County of northern China.[2] The sample size required with simple random sampling was 2137. Assuming a design effect of 1.75 because of cluster sampling and an examination response rate of 80%, a sample size of 4675 was required. With adults 60 years of age and older comprising an estimated 11% of the Shatin population, it was necessary to include approximately 42 500 residents in the survey—about 15% of the sampling frame population.

Stratification of the sampling frame by estate was used to ensure that a minimum of one block would be selected from each estate. The sample size was allocated across the 15 estate strata such that at least 15% of the population within a housing type was sampled (that is, one out of every seven blocks in each estate). Because of the relatively small proportion of the sampling frame population living in home ownership scheme housing, these estates were intentionally oversampled, by a factor of almost two (and beyond that necessitated by requiring that at least one block be selected from each estate). The two smallest private estates were similarly oversampled. Accordingly, eight blocks with an estimated population of 26 499 were randomly selected from 63 blocks in the eight public housing estates, 16 blocks with an estimated population of 12 867 were selected from the 90 blocks in the four private estates, and six blocks with an estimated population of 9691 were selected from among the 22 blocks in the three home ownership scheme estates.

Fieldwork

Survey fieldwork was carried out from February 1998 to July 1998 by a team headed by a study ophthalmologist with 20 years of clinical experience. The team included two ophthalmic technicians, four enumerators, and several community volunteers. Overall survey management was provided by project co-directors (JJM and JL). An international external technical advisory committee consisting of an ophthalmologist with experience in similar surveys, a data and project management expert, an expert in quality of life assessment, a staff member from the World Health Organization (WHO) prevention of blindness programme, and a health services research staff member from the National Eye Institute (LBE), was established to approve the study protocol and oversee implementation. The protocol, which was used in earlier surveys in Nepal[4] and in two rural areas of China,[2 3] was cleared by the WHO secretariat committee on research involving human subjects.

An official study introduction letter, endorsed by government authorities, was sent to all flats (individual apartments) in the selected blocks 1 week before the door to door enumeration. The study was also reported on in a community newspaper and posters were displayed in the selected blocks. Community support and mobilisation of subject participation were further obtained through the cooperation of local organisations—the Shatin District Board, estate residents' associations, and estate management companies.

Enumerators visited each flat up to five times. For every non-contact, a note was left giving the date of the next visit and a phone number for arranging an alternative visiting time. Households that refused to participate were revisited by an enumerator together with a local volunteer who was well known in the estate. Enumeration attempts were terminated once two in-person refusals were received.

The enumerator inquired about the total number of residents in the household and the name, sex, age, and education level of those eligible for the study: all adults 60 years of age or above who had been living in the estate for at least 6 months, including those who may have been temporarily absent. Eligible subjects were allowed to choose a preferred appointment time for the eye examination, and were given an appointment ticket with a map showing the location of the examination site.

Visual acuity testing and eye examinations were conducted in the community hall or the Shatin District representative's office at the selected estates. Home visit eye examinations were given to eligible residents who were immobile and to those who would otherwise not participate in the study. (The home visit team consisted of an ophthalmologist (JJM) and an ophthalmic technician.) Written consent from subjects was obtained after registration at the examination site, with the nature of the examination and participant rights explained by the registrar.

Distance visual acuity measurement was carried out by an ophthalmic assistant using an illuminated logMAR chart at 4 metres, and recorded as the smallest line read with one or no errors. Visual acuity was measured for each eye using the subject's usual distance correction (referred to as presenting visual acuity). Pinhole vision was measured in all eyes that failed to present with acuity of 6/18 or better. External eye, anterior segment, and fundus assessments were done by the team ophthalmologist using a slit lamp and direct and indirect ophthalmoscopy. Pupils were dilated in all cases with visual acuity <6/18 in either eye and in all people with cataract surgery. Intraocular pressure was measured by applanation tonometry for those cases suspected as having glaucoma based on optic disc characteristics. All eyes with presenting visual acuity less than 6/18 were assigned a principal cause of impairment by the examining ophthalmologist using a 20 item list. All subjects with an eye complaint and others where an eye abnormality was detected were referred to the Prince of Wales Hospital in Shatin. A total of 185 subjects were referred for treatment.

Subjects with visual acuity <6/60 in either eye and those who had been operated on for cataract were administered visual functioning and vision related quality of life questionnaires.[5 6] A sample of subjects with normal vision was also interviewed. (These questionnaires were the same as those used in the Nepal[7] and China[8 9] surveys.) Interviews were conducted while the subjects' eyes were being dilated, or after a brief examination for those with normal vision.

Quality assurance

Fieldwork was preceded by staff training and a pilot study in which subjects from one public and two private non-study blocks were examined. Interobserver comparison of pinhole visual acuity measurements between the ophthalmic technicians and one of the project co-directors (JJM) was carried out in 400 eyes during the pilot, 68 of which had pinhole visual acuity less than 6/18. With visual acuity categories defined as greater than 6/18, less than 6/18 to 6/60, less than 6/60 to 3/60, and less than 3/60, there was agreement in 384 (96.0%) of the 400 eyes (kappa = 0.86). Interobserver agreement between the study ophthalmologist and the project co-director (JJM) on the cause of impairment/blindness was assessed in 82 eyes with presenting visual acuity less than 6/18. Agreement on refractive error, posterior capsule opacity, corneal opacity, glaucoma, and age related macular degeneration as principal causes of impairment or blindness was 100%; agreement for cataract was 98% (kappa = 0.95).

Analysis

Subjects were placed in one of five mutually exclusive vision categories: (1) normal or near normal vision (NN), 6/18 or better in both eyes; (2) unilateral or bilateral visual impairment (VI), less than 6/18 to 6/60 in the worse eye, 6/60 or better in the better eye; (3) unilateral blindness (UB), less than 6/60 in the worse eye, 6/60 or better in the better eye; (4) moderate bilateral blindness (MB), less than 6/60 in the worse eye, less than 6/60 to 3/60 in the better eye; and (5) severe bilateral blindness (SB), less than 3/60 in both eyes. These categories for reporting bilateral vision status are more discriminating than the usual WHO classification, which uses only the better eye in defining (near) normal vision as $\geq$ 6/18, low vision as <6/18 to $\geq$3/60, and blindness as <3/60.

Study data were analysed using STATA,[10] statistical software that provides for adjustments of estimates and standard errors as required by the cluster and stratified sample design. Because estimation of variance and sampling errors was not possible within the eight public housing estates where only a single block (single sampling unit) was selected, pairs of similar strata were combined and treated as if each pair constituted a single, larger stratum. One home ownership estate with a single selected block was also paired. After this collapsing, 10 strata remained: four with public housing estates, four with private, and two with home ownership estates. Overestimation of sampling errors was expected from this collapsing of the original 15 strata into 10.

Prevalence of vision impairment and of blindness based on presenting and pinhole visual acuity were estimated. All estimates were weighted (adjusted) to account for the disproportionate sampling across estate strata, with weights proportional to the inverse of the selection probabilities in each stratum. Multiple logistic regression was used to investigate the association of impairment/blindness with age, sex, education, and housing type (a proxy for socioeconomic status).

Table 1 Characteristics of examined subjects by sex, age, education level, and housing*

	Male				Female			
	Age group (years)				Age group (years)			
	60–69	70–79	80+	All	60–69	70–79	80+	All
Education level:								
None	116	132	56	304 (22.1)	585	549	231	1365 (66.2)
Primary	314	267	63	644 (46.7)	298	153	46	497 (24.1)
Secondary or above	269	133	28	430 (31.2)	148	46	7	201 (9.7)
Housing type:								
Public	373	284	80	737 (53.5)	481	387	184	1052 (51.0)
Private	147	109	33	289 (21.0)	265	145	45	455 (22.1)
Home ownership	179	139	34	352 (25.5)	285	216	55	556 (27.0)
All	699 (50.7)	532 (38.6)	147 (10.7)	1378 (100)	1031 (50.0)	748 (36.3)	284 (13.8)	2063 (100)

*Data are given as number (%) of people.

Education was categorised as none for those with no formal schooling, primary for those with 1–6 years of schooling, and secondary or more for those with at least 7 years of schooling. Principal causes of visual impairment and blindness in individual eyes by presenting visual acuity and subject age were tabulated with adjustment for the disproportionate sampling. The prevalence of cataract surgery was calculated and its relation with age, sex, education, and housing type was examined by multiple logistic regression.

RESULTS

The study sample consisted of 30 clusters (eight public, 16 private, and six home ownership scheme blocks). A total of 12 958 households were identified, including 11 594 where it was possible to make person to person contact with someone within the household. A total of 4487 eligible subjects were enumerated and 3441 (76.7%) were examined, including 98 at their home. The examination response was 75.7% in public housing, 77.7% in private housing, and 77.8% in home ownership housing. The unexamined consisted of 873 refusers, 169 appointment no shows, and four people who were uncommunicative.

The examined and unexamined did not differ with regard to age (Pearson $\chi^2 = 0.95$, p>0.05) or housing type (Pearson $\chi^2 = 2.68$, p >0.05). Females were overrepresented in the examined sample (60.0%) compared with those unexamined (51.1%) (Pearson $\chi^2 = 24.67$, p=<0.001). Education information was obtained at the examination site and therefore was not available for comparison between the examined and unexamined.

Demographic characteristics of the examined subjects are displayed in Table 1. The mean age was 70.2 years in men and 70.6 years in women. Females were less educated than males.

Prevalence and causes of impairment

The prevalences of visual impairment, unilateral blindness, and bilateral blindness based on presenting and pinhole visual acuity, weighted for the disproportionate sampling across housing strata, are shown in Table 2. Seven subjects with missing visual acuity measurements were not included in the analysis. Using presenting visual acuity, 41.3% (95% CI: 38.5%–44.2%) of the population 60 years of age or older had at least one eye less than 6/18 (vision impaired or blind); 19.5% had vision less than 6/18 in both eyes (that is, better eye <6/18). The percentage of subjects with unilateral blindness was 7.9%, while 1.8% (95% CI: 1.2%–2.5%) were bilaterally

Table 2 Weighted prevalence of impaired vision and blindness based on presenting (pinhole) visual acuity by age, sex, education, and housing*

	Weighted prevalence percentage					
	Normal/near normal (NN) Presenting (pinhole)	Vision impairment (VI) Presenting (pinhole)	Unilateral blindness (UL) Presenting (pinhole)	Moderate bilateral blindness (MB) Presenting (pinhole)	Severe bilateral blindness (SB) Presenting (pinhole)	Examined‡ No (%)
Age (years):						
60–69	71.7 (77.6)	22.7 (17.9)	4.9 (4.2)	0.6 (0.3)	0.1 (0.0)	1729 (50.3)
70–79	52.0 (58.8)	38.0 (32.8)	8.3 (7.2)	1.0 (0.5)	0.7 (0.6)	1279 (37.2)
80+	26.9 (37.0)	48.0 (43.4)	18.4 (16.6)	3.4 (0.9)	3.2 (2.0)	426 (12.4)
Sex:						
Male	59.3 (66.4)	31.4 (25.3)	7.7 (7.5)	1.0 (0.5)	0.7 (0.4)	1377 (40.1)
Female	58.3 (64.9)	31.8 (27.6)	8.0 (6.5)	1.1 (0.5)	0.7 (0.5)	2057 (59.9)
Education:						
None	52.7 (60.1)	35.7 (30.9)	9.4 (7.9)	1.3 (0.6)	0.9 (0.5)	1663 (48.4)
Primary	61.4 (68.2)	30.4 (24.9)	6.7 (6.3)	0.9 (0.3)	0.6 (0.4)	1140 (33.2)
Secondary plus	70.8 (75.9)	22.3 (18.1)	5.8 (5.2)	0.7 (0.6)	0.3 (0.3)	631 (18.4)
Housing:						
Public	56.1 (63.5)	33.5 (28.3)	8.3 (7.2)	1.3 (0.5)	0.9 (0.5)	1782 (51.9)
Home ownership	61.2 (66.5)	30.5 (26.3)	6.8 (6.1)	0.7 (0.6)	0.7 (0.6)	908 (26.4)
Private	65.8 (71.6)	26.1 (21.3)	7.2 (6.6)	0.8 (0.4)	0.1 (0.1)	744 (21.7)
All	58.7 (65.5)	31.6 (26.7)	7.9 (6.9)	1.1 (0.5)	0.71 (0.46)	3434 (100.0)
95% CI†	55.8, 61.5 (63.5, 67.4)	29.6, 33.7 (25.0, 28.4)	6.4, 9.4 (5.9, 7.9)	0.65, 1.56 (0.20, 0.74)	0.31, 1.10 (0.19, 0.73)	
Design effect	2.65 (1.36)	1.48 (1.13)	2.43 (1.31)	1.50 (1.26)	1.73 (1.27)	

*Vision categories are defined by visual acuity of both the better and worse eyes, respectively. NN = ⩾6/18, ⩾6/18; VI = ⩾6/60, <6/18 to ⩾6/60; UL = ⩾6/60, <6/60; MB = <6/60 to ⩾3/60 <6/60; SB = <3/60, <3/60; †indicates 95% confidence interval; ‡seven of the 3441 people examined were excluded from the prevalence calculation because of missing visual acuity measurements.

Table 3 Demographic associations with presenting blindness and vision impairment

	Bilateral blindness†	Vision impairment/blindness†
	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Age (years):		
60–69	1.0	1.0
70–79	2.5 (0.8 to 8.2)	2.2*** (1.9 to 2.6)
80+	10.1** (2.6 to 38.5)	6.3*** (5.2 to 7.5)
Sex:		
Male	1.0	1.0
Female	0.9 (0.6 to 1.3)	0.8* (0.7 to 1.0)
Education:		
None	1.0	1.0
Primary	0.9 (0.4 to 2.1)	0.8* (0.7 to 0.9)
Secondary or above	0.9 (0.3 to 2.3)	0.6*** (0.5 to 0.7)
Housing:		
Public	1.0	1.0
Home ownership	0.8 (0.3 to 2.3)	0.9 (0.7 to 1.1)
Private	0.5 (0.2 to 1.2)	0.7* (0.6 to 1.0)
All:		

†Bilateral blindness: both eyes <6/60; vision impairment/blindness: either eye <6/18.
*p<0.05, **p<0.01, ***p<0.001.

blind (moderate and severe bilateral blindness combined). When pinhole visual acuity was used, the percentage of subjects with either visual impairment or blindness dropped from 41.3% to 34.5% (95% CI: 32.6%–36.5%). Bilateral blindness dropped from 1.8% to 0.93% (95% CI: 0.52%–1.33%).

The percentage of the population wearing glasses for distance correction was low: 28.2% among those with normal/near normal presenting vision, 21.0% among those with vision impairment, 31.0% among those with unilateral blindness, and 26.3% among those with bilateral blindness. Overall, 26.1% were wearing glasses.

Table 3 shows multiple logistic regression results for the association of bilateral blindness and visual impairment with subject age, sex, education, and housing type. Subjects in the 80+ age groups were found to have a higher likelihood of being bilaterally blind than those in the 60–69 age group. Sex, education, and housing type were not statistically significant. When the outcome variable was bilateral blindness, unilateral blindness and visual impairment combined, age, sex, education, and housing were all statistically significant. The two older age groups had a higher likelihood of having visual impairment/blindness than those 60–69 years of age. Females were less likely than males to be vision impaired or blind. People with higher education levels (both primary and secondary or above) had a lower likelihood of visual impairment or blindness than people with no education. Residents in private housing had a lower likelihood of being visually impaired/blind than residents in public housing. Those in home ownership scheme housing were not significantly different from those in public housing.

The principal causes of presenting unilateral or bilateral vision impairment, unilateral blindness, and moderate or severe bilateral blindness, weighted for the disproportionate sampling across housing strata, are shown in Table 4. People with bilateral impairment or blindness may have causes that differ between the two eyes. These cases are represented twice—once for each cause. Refractive error is the principal cause for people with vision impairment and cataract for those unilaterally or bilaterally blind.

Table 5 provides information on the principal causes of visual impairment or blindness in individual eyes by presenting visual acuity and subject age. Refractive error accounted for 51.0% of the eyes that were either impaired or blind, followed by cataract (28.1%), macular degeneration (7.6%), glaucoma (3.0%), corneal opacity (2.4%), retinal abnormalities (for example, retinal vein occlusion, diabetic retinopathy 2.4%), and myopic degeneration (1.6%). Refractive error and cataract together accounted for 79.1% of all impaired or blind eyes; these were eyes that could be treated by corrective lenses or surgery. Refractive error was found to be the most prevalent cause of impairment or blindness in eyes for people aged 60–69 (63.4%) and 70–79 (52.4%). Among those aged 80 or above, cataract (43.6%) was the dominant cause. In terms of

Table 4 Weighted percentage distribution of principal causes of presenting impairment and blindness in people

Principal cause*	Vision impairment (VI)	Unilateral blindness (UL)	Bilateral blindness (MB and SB)
Refractive error	68.9	16.2	0
Cataract	23.7	44.5	51.7
Macular degeneration	4.7	18.4	27.1
Glaucoma	2.1	7.3	7.7
Corneal opacity	2.1	5.3	9.2
Retinal abnormalities	1.5	9.2	4.0
High myopia	0.7	3.6	10.3
Others	0.4	4.3	2.5
Globe (absent/phthisical)	0	4.9	7.1
Optic atrophy	0.3	3.1	2.1
PCO/after cataract	0.9	1.7	0
Undetermined	0.7	1.3	0

*Cause in one or both eyes, thus percentage totals exceed 100%.

Table 5 Percentage distribution of principal causes of impaired/blind eyes by presenting visual acuity and age

Principal cause	Presenting visual acuity ≥6/60–<6/18	≥3/60–<6/60	<3/60	Subject age (years) 60–69	70–79	≥80	All (%)
Refractive error	61.6	10.0	2.9	63.4	52.4	32.0	51.0
Cataract	25.1	51.6	36.2	16.5	28.1	43.6	28.1
Macular degeneration	5.0	14.7	20.7	6.3	6.1	12.0	7.6
Glaucoma	2.2	4.6	7.5	2.8	3.5	2.4	3.0
Corneal opacity	1.6	5.3	5.9	3.6	1.8	1.6	2.4
Retinal abnormalities	1.6	2.8	7.5	2.8	2.6	1.7	2.4
High myopia	0.8	3.7	5.4	1.5	1.6	1.5	1.6
Others	0.3	1.9	4.2	1.0	0.8	0.9	0.9
Globe (absent/phthisical)	–	–	6.6	0.4	1.0	1.1	0.8
Optic atrophy	0.4	2.5	2.7	0.4	0.8	1.3	0.8
PCO/after cataract	0.8	0.9	0.4	0.8	0.6	1.0	0.7
Undetermined	0.6	2.1	–	0.4	0.7	0.9	0.7
All	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6 Never operated individuals with cataract blindness by age, sex, education, and housing type

	No examined†	No unilateral blind	No bilateral blind	Total blind	Prevalence‡	Adjusted OR (95% CI)§
Age (years)						
60–69	1729	19	3	22	1.3	1.0
70–79	1279	33	8	41	3.4	2.56* (1.18 to 5.53)
80+	426	28	13	41	10.8	8.37*** (4.32 to 16.23)
Sex						
Male	1377	27	11	38	3.2	1.0
Female	2057	53	13	66	3.3	0.82 (0.55 to 1.22)
Education						
None	1663	51	14	65	4.2	1.0
Primary	1140	24	7	31	2.8	0.83 (0.40 to 1.74)
≥ Secondary	631	5	3	8	1.3	0.48* (0.25 to 0.90)
Housing						
Public	1782	51	19	70	3.8	1.0
Home	908	16	2	18	2.0	0.59 (0.33 to 1.05)
Private	744	13	3	16	2.2	0.70 (0.40 to 1.21)
All	3434	80	24	104	3.3	

*p<0.05, **p<0.01, ***p<0.001. †Not including seven people with missing visual acuity measurements; ‡crude prevalence per 100 examined subjects; §adjusted odds ratio (95% confidence interval).

blindness (visual acuity <6/60), the principal causes were cataract (41.3%), followed by macular degeneration (18.7%), glaucoma (6.6%), corneal opacity (5.7%), refractive error (5.2%), retinal abnormalities (5.9%), myopic degeneration (4.8%), absent/phthisical globe (4.4%), and optic atrophy (2.6%). Considering only vision impairment less than blindness (<6/18 to ≥ 6/60), refractive error (61.6%) and cataract (25.1%) were the predominant causes.

Cataract blindness and surgery

Among the 23 study subjects with severe bilateral blindness, five (21.7%) had cataract diagnosed as the principal cause of blindness for both eyes, and another subject (4.3%) had cataract diagnosed as the principal cause in one eye only. Therefore, 26.0% of the severe bilaterally blind could have been improved by cataract surgery. Among the 35 with moderate bilateral blindness, 16 (45.7%) had cataract as the principal cause of blindness in both eyes and another five (14.3%) had cataract in one eye only, for a total of 60.0%. For both categories of bilateral blindness considered together, 46.6% (27/58) can be attributed to blinding unoperated cataract in at least one eye, representing a *weighted* prevalence of cataract blindness of 0.93% (95% CI: 0.57%–1.29%). For the 267 unilaterally blind, 102 (38.2%) had unoperated cataract diagnosed as the principal cause in the blind eye, representing a weighted unilateral blindness prevalence because of cataract of 3.11% (95% CI: 2.69%–3.54%). Together, 39.6% (129/325) of the unilateral and bilateral blind, with cataract as the principal cause of blindness in at least one eye, could potentially be helped by cataract surgery, representing a weighted prevalence of 4.04% (95% CI: 3.53–4.57).

The distribution of unilateral and bilateral blindness attributed to cataract for those never operated for cataract is shown in Table 6. (Of the 102 unilaterally blind from cataract, 22 had already been operated in the fellow eye; and of 27 bilaterally blind, three had. These 25 already operated unilateral or bilateral blind people are excluded from the tabulation of the 104 never operated people.)

Cataract blindness was associated with increasing age. Education at the secondary level or beyond was associated with a lower cataract blindness rate. Sex or housing had no significant association with cataract blindness.

A total of 310 people had already been operated on for cataract, 9.1% (95%CI: 8.2%–10.0%) (Table 7). Cataract surgery was associated with age, as expected. People with higher education levels were less likely to have had cataract surgery than people with no education. Sex or housing was not a statistically significant predictor of cataract surgery.

DISCUSSION

Vision impairment was common in this socioeconomically advanced population. Presenting visual acuity <6/18 in at least one eye was present in 41.3% of people and in 19.5% in both eyes. Blindness had a prevalence of 1.8%, associated only with advancing age. Public housing (lower income level), less

Table 7 Cataract surgery by age, sex, education, and housing

	No examined†	No cataract operated	Prevalence‡	Adjusted OR (95% CI)§
Age (years)				
60–69	1729	76	4.6	1.0
70–79	1279	137	10.7	2.33*** (1.71 to 3.17)
80+	426	96	22.2	5.22*** (2.95 to 9.26)
Sex				
Male	1377	96	6.9	1.0
Female	2057	213	10.6	1.22 (0.94 to 1.58)
Education				
None	1663	200	12.2	1.0
Primary	1140	77	6.5	0.62** (0.47 to 0.81)
⩾ Secondary	631	32	5.0	0.55** (0.37 to 0.80)
Housing				
Public	1782	159	9.0	1.0
Home	908	79	8.9	1.14 (0.76 to 1.72)
Private	744	71	9.5	1.28 (0.97 to 1.70)
All	3434	309¶	9.1	

*p<0.05, **p<0.01, ***p<0.001. †Not including seven people with missing visual acuity measurements; ‡crude prevalence per 100 examined subjects; §adjusted odds ratio (95% confidence interval); ¶does not include one 80+ year old illiterate female in public housing with missing visual acuity measurements.

education, and male sex were associated with visual impairment <6/18 in at least one eye. Refractive error was the principal cause of vision impairment, and cataract was the principal cause of blindness. Together, these two causes accounted for 79.1% of eyes with presenting acuity <6/18.

Unilateral or bilateral blindness because of unoperated cataract was associated with increasing age and less education. Those already operated on for cataract were also more likely to be elderly and less educated. The association of less education with a higher rate of both unoperated and already operated cataract subjects is suggestive of a higher incidence of cataract in this population, as is the case with older age. This finding is consistent with those from similar studies in Nepal and Shunyi county.[2 4] The reasons for this disparity are unclear, but differences in nutrition, smoking, and exposure to solar radiation are possible risk factors.[11] Reasons why those with blindness or impairment due to cataract had not sought surgery were not solicited, nor were reasons why those with refractive error were not wearing suitable corrective lenses. Hong Kong has a system of universal healthcare access, but long queues may deter some groups from registering for and completing cataract surgery.

In spite of a relatively large study sample, it was not large enough to estimate blindness prevalence within the intended error bound of plus or minus 20% with 95% confidence because the estimated 1.8% prevalence was actually half of the 4.3% used in calculating the desired sample size. Accordingly, the 1.2% to 2.5% confidence interval represents an error bound of plus or minus 35%, not the intended plus or minus 20%.

Because a predetermined number of blocks (apartment buildings) were randomly selected and fully enumerated, block size had no influence on the chance of any person being included. Although the stratified cluster sampling introduced design effects, these were taken into account in the calculation of confidence intervals for prevalence estimates and odds ratios. With weighting adjustments to compensate for disproportionate sampling across estate strata, estimates were representative of the Shatin sampling frame population. Because of some differences between the sampling frame population and Shatin as a whole, and because of incomplete enumeration and examination response as noted below, the distributions of age, sex, and education in the examined sample were not precisely in correspondence with the distributions for Shatin as a whole: the weighted sample was 40.4% male and 59.6% female compared to 44.6% male and 55.4% female for the Shatin population aged 60 or older. The weighted sample distribution was for 50.0% between 60 and 69 years of age and 50.0% for those aged 70 or older, compared to the corresponding percentages of 54.4% and 45.6% for Shatin. The weighted sample distribution for education was 50.3% with no education, 32.4% with primary education, and 17.3% with at least secondary education compared to the percentages of 40.3%, 41.9%, and 17.9% for Shatin residents aged 60 or older.

The study findings may be subject to biases because of the incomplete enumeration within the selected study sample. It was not possible to make contact with anyone in approximately 10% of apparently occupied flats, despite repeat visits at different times. The 4487 enumerated subjects were less than the 5396 expected on the assumption that 11% of the survey population would be ⩾60 years of age. (The 4487 corresponds to only 9.1% being ⩾ 60 years of age.)

The less than complete response to the examination was another source of potential bias. In an attempt to determine whether the visual acuity status of those not examined differed from those examined, refusers were asked to participate in a simplified visual acuity testing procedure. Using a modified chart with two sizes of optotypes at 1 metre, binocular visual acuity was categorised as ⩾6/18, <6/18 to ⩾6/60 to <6/18, or <6/60. Of the 873 refusers, 549 (62.9%) participated in the screening. Presenting visual acuity <6/60 (blindness) was found in 36 (6.6%) and visual impairment (<6/18 to ⩾6/60) in 385 (70.1%). Vision in this tested group of refusers was poorer than that among the examined population (Pearson $\chi^2 = 784.4$, $p<0.001$). Accordingly, the true level of vision impairment and blindness in the community may be greater than that estimated from the examined population.

Because perimetry was not included in the examination protocol, blindness associated with visual field defects was not identified. This study deficiency may have resulted in an underestimate of blindness caused by glaucoma or peripheral retinal disease.[12] In addition, subjects with moderate to dense cataract but impaired because of undetected retinal pathology may have been considered as being cataract impaired.

The 1.8% prevalence of blindness found in Shatin was lower than that in the two surveys in rural China.[2 3] Blindness prevalence among those 60 years of age or over was 4.3% in Shunyi county and 5.7% in Doumen county. Visual acuity <6/18 in at least one eye was 38% and 62%, respectively, compared with 41.3% in Shatin. Blindness was less of a problem in the urban Shatin area, but vision impairment was not significantly less, at least in comparison to Shunyi county. By comparison, in a population based survey in Melbourne, Australia,[13] presenting blindness among those ⩾60 years of age was 0.75%, and visual acuity <6/18 in the better eye was 2.7% in Melbourne, compared with the 19.5% found in Shatin.

In conclusion, healthcare planners should recognise the extent to which visual impairment, including blindness, is a problem within the elderly population of Shatin and most likely Hong Kong as a whole. Over two fifths of those 60 years and over had unilateral or bilateral visual disability, while nearly three quarters of those 80 years and over were in this category. According to our data, fully 390 000 people 60 or over were visually impaired, with 269 000 of these the result of refractive error and 92 400 the result of cataract. Fortunately, most of this impairment is easily remedied by simple refraction and provision of spectacles, and by cataract surgery. This survey highlights the need to target prevention of blindness programmes to an increasing number of elderly people, with a special emphasis on those with little or no education.

ACKNOWLEDGMENTS

The authors wish to thank Dr Mark Tso, former chairman of the Department of Ophthalmology and Visual Sciences, the Chinese University of Hong Kong, and the Shatin District Board for assistance in organising the research. Special thanks are given to Dr Bjorn Thylefors and Dr Dominique Negrel, World Health Organization, Dr G-P Pokharel, Foundation Eye Care Himalaya, Mr RD Thulasiraj, Aravind Eye Hospital, and Dr Astrid Fletcher, London School of Hygiene, who along with one of the authors (LBE), served on an external technical committee that provided advice regarding study design and data analysis. Edmond Ng and Mason Lau, Centre for Clinical Trials and Epidemiological Research, assisted with data collection and analysis.

This research was supported by the World Health Organization, National Institutes of Health Contract N01-EY-2103, and a grant from the Lions Club International Foundation.

Authors' affiliations

J J Michon*, Department of Ophthalmology and Visual Sciences, Chinese University of Hong Kong, Hong Kong
J Lau, W S Chan, Centre for Clinical Trials and Epidemiological Research, Chinese University of Hong Kong, Hong Kong
L B Ellwein, National Eye Institute, National Institutes of Health

*Current affiliation: Duke Eye Center, Durham, NC 27710, USA

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