Prevalence of Lens Opacities in Adult Chinese Americans: The Chinese American Eye Study (CHES)

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See the appendix for the members of the Chinese American Eye Study Group

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Purpose. We determined the age- and sex-specific prevalence of posterior subcapsular (PSC), nuclear, cortical, and mixed lens opacities in a population-based sample of Chinese-American adults.

Methods. A population-based sample of Chinese-Americans 50 years and older, from 10 census tracts in Monterey Park, CA, USA, underwent a detailed interview and a comprehensive clinical examination that included assessment of different types of lens opacities by the slit-lamp–based Lens Opacities Classification System II (LOCS II). All lens changes (including pseudophakia/aphakia), PSC, nuclear, and/or cortical opacities, were evaluated and graded.

Results. Of the 5782 eligible subjects, 4582 (79.2%) Chinese Americans aged 50 years and older completed a comprehensive eye examination. Of the participants with LOCS II grading (n = 4234/4582, 92%), 3.0% had PSC opacities, 38.1% had nuclear opacities, and 23.4% had cortical opacities. The prevalence of all lens changes was 48.0% for all age groups and was higher by 10-year increasing age groups ($P < 0.0001$). The prevalence of visual impairment in the better-seeing eye with cortical only, nuclear only, PSC only, and mixed opacities was 3.9%, 5.0%, 14.3%, and 9.4%, respectively. A total of 454 (9.9%) individuals had undergone cataract extraction in at least one eye.

Conclusions. Chinese Americans have a high prevalence of visual impairment associated with lens opacities, and a high prevalence of nuclear opacities. Public health policies and programs designed to improve cataract detection and treatment could help reduce the burden of visual impairment in Chinese Americans.

Keywords: prevalence of lens opacities, epidemiology, adult Chinese American, population-based

Cataract is the most common cause of visual impairment (VI) and blindness in the United States as well as in the world.[1–3] It is estimated that cataracts affect nearly 22 million Americans age 40 and older; and by age 65, more than half of all Americans have been diagnosed with cataracts.[4] Furthermore, the direct medical costs for cataract treatment in the United States are high, reaching approximately $6.8 billion per year.[5–7]

The burden of eye disease in the United States has been well characterized with respect to cataracts for non-Hispanic whites and Hispanics,[8–20] but little is known about the prevalence of lens opacities (LOP) in Asian Americans.[21] Data from the United States Census Bureau shows that between 2000 and 2010, the Asian population grew 43.3%, resulting in a total of 14.7 million Asian Americans in the United States (4.8% of the total population), with Chinese Americans being one of the largest growing segment of the population.[22,23] The burden of LOP in adults of Chinese ancestry in the United States is not known with respect to characteristic of opacity type or demographics of individuals in the population. Thus, it is important to have current data specific to various segments of the diverse United States population. This information can provide data for eliminating correctable visual impairment and reducing vision loss in Chinese Americans.

The Chinese American Eye Study (CHES), to our knowledge, is the first comprehensive study of Chinese Americans (living in the United States), and the largest study of aging (50+ years old) individuals of Chinese ancestry in the world, designed to evaluate the prevalence of eye disease, specifically the age- and sex-specific prevalence and severity of three types of age-related LOP: posterior subcapsular (PSC), nuclear, and cortical opacities, in persons of Chinese ancestry aged 50 years and older. We also evaluated the effect of LOP on VI.

Methods

Study Cohort

The CHES population included in this analysis consists of self-identified Chinese Americans, 50 years or older, residing in 10 census tracts of the City of Monterey Park, CA, USA, at the time of recruitment (February 2010 to October 2013). Details of the study design, sampling plan, and baseline data have been reported previously.[24] In brief, a door-to-door census of all dwelling units within the 10 census tracts in the City of Monterey Park was completed. All eligible residents were

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informed of the study objectives, and invited to complete a questionnaire and a clinical examination at the Local Eye Examination Center (LEEC). Interviews and clinical examinations were conducted after informed consent was completed. Institutional review board/ethics committee approval was obtained from the University of Southern California Health Sciences Institutional Review Board. All study procedures adhered to the principles outlined in the Declaration of Helsinki for research involving human subjects.

Clinical Examination

Data from the clinical examination included presenting (included existing refraction correction, if any) and best-corrected (best subjective refraction) distance visual acuity (VA) testing using Standard Early Treatment Diabetic Retinopathy Study protocols. Visual impairment in the better eye was defined as a best-corrected VA (BCVA) of 20/40 or worse in the better-seeing eye. Visual impairment in the worse eye was defined as a BCVA of 20/40 or worse in the worse-seeing eye.

Lens Examination Protocol

The lens was examined at the slit-lamp under maximum dilation with tropicamide 1% and phenylephrine 2.5%. The Lens Opacities Classification System II (LOCS II) was used to categorize opacities into 5 nuclear (N0, NI, NII, NIII, NIV), 5 PSC (P0, PI, PII, PIII, PIV), and 6 cortical (C0, Ctr, CI, CII, CIII, CIV) grades of increasing severity, according to photographic standards.[25] If one eye had undergone cataract surgery or was not gradable, the other eye was used to classify the type of opacity for that participant. Lens opacities were considered to be present if participants had lens opacity with LOCS II grade of ≥ 2 in one or both eyes. If grading was not possible, the reasons for not grading any regions in one or both eyes were recorded.

Definition of LOP

All lens changes included participants who presented, in either eye, with: (1) any gradable PSC, nuclear, or cortical lens opacity (LOCS II grade ≥ 2), (2) a lens opacity that was too advanced to grade, or (3) had undergone unilateral or bilateral cataract surgery.

Any PSC, any nuclear, or any cortical lens opacity was defined as a gradable opacity (LOCS II grade ≥ 2) of that type in either eye. Each participant was categorized as having one or more types of lens opacity. Any participant who had more than one type of lens opacity (LOCS II ≥ 2) was included in the category for each type of lens opacity present in either eye. Participants with bilateral cataract extraction were excluded from this group. Thus, participants with unilateral cataract extraction were included in this definition if the contralateral eye had gradable lens opacity.

Single and mixed types of LOP were defined as the presence of one or more types of opacity in the same individual. Participants were considered to have a single opacity (categorized as PSC only, nuclear only, or cortical only) if that was the only type present in both eyes. Participants were categorized as having mixed opacities if more than one type was present. All 4 categories (PSC only, nuclear only, cortical only, and mixed) were mutually exclusive. The prevalence of single and mixed types of LOP was based on participants with gradable LOCS II findings for each type of opacity. For this definition, if a participant had unilateral cataract extraction, the LOCS II grading from the contralateral phakic eye was used to define the lens opacity in that person.

Statistical Analyses

The frequency of each lens opacity type among all graded participants within each age- and sex-specific group was used to determine the sex- and age-specific prevalence for each opacity type (all lens changes, any lens opacity, and single and mixed opacities). Chi-square analyses were used to evaluate the presence of statistically significant differences in age- (by decades) and sex-specific frequencies by opacity type. The 2010 United States Asian population was used to calculate the age-adjusted prevalence rates for each study.[23] Further, to assess potential selection bias in excluding participants without LOCS II grading, we evaluated demographic differences between those with and without LOCS II grading (e.g., participants with cataract extraction or with missing LOCS II grading). In addition, the reproducibility of LOCS II grading between 2 examiners was evaluated throughout the data collection period by having each of the graders perform independent replicate grading on 50 participants every 6 months. Reproducibility was measured by proportionally weighted Kappa (κ) statistics for agreement. All analyses were conducted assuming a 0.05 significance level, using SAS (Version 9.2; SAS Institute, Inc., Cary, NC, USA).

Results

Participants

Of the 5782 eligible participants, 4582 completed a clinical examination at the LEEC corresponding to a participation rate of 79.2% (Fig. 1). Of the 4582 participants, 63% were female, 76% were married and the mean age was 61 years (SD $\pm$ 9 years).

Compared to Chinese living in the United States (50 years and older), CHES participants were more likely to be female (63% vs. 52% in the United States),[26] less likely to have 12 or more years of education (67% vs. 77% in the United States), and were similar in age (47% were 50–59 years in CHES compared to 44% for the United States).

Eligible participants who chose to participate compared to nonparticipants of the CHES clinical eye examination were similar in age (mean age of 61 vs. 63 years), were more likely to have an education of 12 years or more (67% vs. 58%), and less likely to be current smokers (7% vs. 12%). Participants and nonparticipants were similar with respect to marital status, income, health and vision insurance, history of diabetes, history of cataract and macular degeneration.

Of the participants completing the clinical examination (4582), 303 (6.6%) had undergone bilateral cataract extractions, 42 (0.9%) had missing LOCS II grading in both eyes, and 4234 (92.4%) participants had LOCS II grading in at least one eye (Fig. 1). Participants with missing LOCS II grading were mainly those who had cataracts that could not be graded due to poor pupillary dilation or those who refused to allow pupillary dilation. Intergrader agreement between LOCS II graders was moderate to good for all opacity types (PSC opacities, weighted κ [95% confidence interval (CI)] = 0.94 [0.71–1.0]; nuclear opacities, weighted $\kappa = 1.0$; cortical opacities, weighted $\kappa =$ 0.86 [0.72–1.00]).

Age- and Sex-Specific Prevalence of All Lens Changes

The prevalence of all lens changes in the CHES population was 48.0% before age-standardization (Table 1) and the prevalence of all lens changes was considerably higher in each successive 10-year age group ($P < 0.0001$). The prevalence was more than 3.7-fold higher in the $\geq$80 and older age group (95.6%) than in

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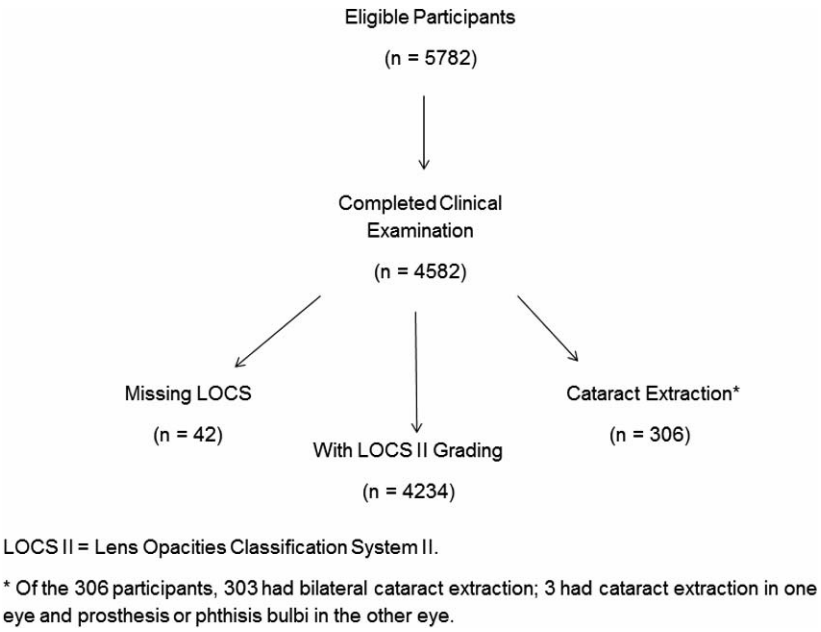


Figure 1. Participation flow chart and completeness of lens examination data for the Chinese American Eye Study.

the 50 to 59 age group (25.7%); the prevalence of all lens changes was higher in females (51.4%) than males (47.3%; $P = 0.001$), after adjusting for age.

Age- and Sex-Specific Prevalence and Severity of Any LOP

The overall prevalence of any PSC, nuclear, and cortical opacities before age-standardization was 2.4%, 34.2%, and 21.0%, respectively. The prevalence of any type of lens opacity (any PSC, any nuclear, and any cortical was higher among older age groups (all $P < 0.0001$; Table 2). After adjustment for age, Chinese-American females were more likely to have cortical opacities than Chinese-American males (25.1% vs. 20.7%, $P = 0.001$); however, there were no significant differences in the prevalence of any nuclear and PSC opacities by sex, after adjusting for age ($P = 0.43$). The severity of lens opacification by type is presented in Table 3; most of the participants (93.5%) had mild or moderate (LOCS II grade 1 and 2) nuclear opalescence; whereas only 8.2% of participants had the most advanced grades (LOCS II grade $\geq$3) of cortical opacification and only 0.9% had advanced grades of PSC (LOCS II grade $\geq$ 3). Among Chinese Americans 70 years and older, 2.3%, 20.2%, and 23.7% had advanced PSC, nuclear, and cortical opacification, respectively (data not shown).

Age- and Sex-Specific Prevalence of Single and Mixed Opacities

The most prevalent single and mixed types of opacities were nuclear only (21.9%) and mixed opacities (12.5%), followed by cortical only (9.1%) and PSC only (0.2%; Table 4). The age-specific prevalence of mixed opacities was 3.9% in the 50 to 59 age group and 40.5% in the 80 and older participants ($P < 0.0001$). Similarly, the age-specific prevalence of nuclear only opacities was 14.2% in the 50 to 59 age group and 41.1% in the 80 and older participants ($P < 0.0001$). In contrast, the prevalence of cortical only opacity was higher from age groups 50 to 79 years old (prevalence, 6.6% to 13.7%, respectively) then decreased in participants 80 years and older (prevalence, 10.1%). Prevalence of cortical only opacities was higher in females (10.5%) than in males (7.5%), after adjusting for age ($P = 0.001$). There were no significant sex-related differences in prevalence of nuclear only, PSC only, or mixed opacities after adjusting for age ($P = 0.84$, $P = 0.78$, and $P = 0.32$, respectively).

Prevalence of Cataract Surgery

Of the 4582 participants who completed a clinical examination, 454 (9.9%) had cataract extraction in at least one eye; 148 (3.2%) had LOCS II grading in the eye without surgery, and 303 (6.6%) had bilateral cataract extraction; 3 had cataract

Table 1. Age- and Sex-Specific Prevalence of All Lens Changes in the CHES ($n = 4540$)

Age Groups, y	Males, % (95% CI)	Females, % (95% CI)	Total, % (95% CI)
50–59	24.2 (21.0, 27.3)	26.5 (24.2, 28.7)	25.7 (23.9, 27.6)
60–69	52.0 (47.9, 56.0)	58.8 (55.7, 62.0)	56.2 (53.7, 58.7)
70–79	83.3 (78.6, 88.1)	90.0 (86.6, 93.3)	87.1 (84.3, 89.9)
≥80	95.4 (91.8, 99.0)	95.8 (92.8, 98.9)	95.6 (93.3, 98.0)
Total	47.9 (45.5, 50.3)	48.0 (46.1, 49.8)	48.0 (46.5, 49.4)
Age adjusted*	47.3 (44.9–49.7)	51.4 (49.6–53.2)	49.8 (48.3– 51.3)

All lens changes included persons who presented with any of the following categories in either eye: (1) any gradable posterior subcapsular, nuclear, or cortical lens opacity (LOCS II grade $\geq$ 2); (2) an opacity too advanced to grade; or (3) undergone unilateral or bilateral cataract surgery.

* United States 2010 Asian population was used as the standard population to calculate the age-adjusted prevalence rates.[23]

Table 2. Age- and Sex-Specific Prevalence of LOP of Any Type in the CHES

Opacity Type	Age Group, y	Males, *n* (%), *N* = 1554	Females, *n* (%), *N* = 2680	Total, *n* (%), *N* = 4234
Any PSC	50–59	5 (0.7)	16 (1.1)	21 (1.0)
	60–69	15 (2.6)	20 (2.2)	35 (2.4)
	70–79	12 (6.0)	12 (4.9)	24 (5.4)
	≥80	13 (15.9)	7 (9.2)	20 (12.7)
	Total	45 (2.9)	55 (2.1)	100 (2.4)
	Age adjusted*	3.3	2.7	3.0
	% (95% CI)	(2.4, 4.2)	(2.1, 3.3)	(2.5, 3.5)
Any nuclear	50–59	124 (17.7)	259 (17.9)	383 (17.8)
	60–69	231 (40.6)	398 (43.5)	629 (42.4)
	70–79	138 (68.7)	169 (69.0)	307 (68.8)
	≥80	68 (82.9)	61 (80.3)	129 (81.6)
	Total	561 (36.1)	887 (33.1)	1448 (34.2)
	Age adjusted*	37.6	38.4	38.1
	% (95% CI)	(35.2, 40.0)	(36.6, 40.2)	(36.6, 39.6)
Any cortical†	50–59	65 (9.3)	157 (10.9)	222 (10.3)
	60–69	123(21.6)	267 (29.2)	390 (26.3)
	70–79	78 (38.8)	124 (50.6)	202 (45.3)
	≥80	41 (50.0)	33 (43.4)	74 (46.8)
	Total	307 (19.8)	581 (21.7)	888 (21.0)
	Age adjusted*	20.7	25.1	23.4
	% (95% CI)	(18.7, 22.7)	(23.5, 26.7)	(22.1, 24.7)

Any type of opacity was defined as the presence in at least one eye of any gradable PSC, nuclear, or cortical LOP (LOCS II grade ≥ 2). Participants with more than one type of opacity could be included in more than one category. Percentages are based on age groups. Age was statistically significantly associated with each opacity type ($P < 0.0001$).

* United States 2010 Asian population was used as the standard population to calculate the age-adjusted prevalence rates for each opacity type.[23]

† Females were more likely to have cortical opacities ($P = 0.001$). No sex-related differences were present for any other type of opacity ($P > 0.1$).

extraction in one eye and prosthesis or phthisis bulbi in the other eye. The prevalence of bilateral pseudophakia in our cohort was 6.4% ($n = 293$); of those, 99.4% had a posterior chamber IOL, and 0.6% had an anterior chamber IOL. The prevalence of pseudophakia in either eye (unilateral and bilateral) ranged from 1.7% in the 50 to 59 year age group to 60.3% in the 80 year and older participants ($P < 0.0001$; Fig. 2). There was no significant difference in the prevalence of pseudophakia between female (9.7%) and male (10.1%) participants ($P = 0.72$). The prevalence of bilateral aphakia (prosthesis or phthisis bulbi were not included) in our cohort was 0.2% ($n = 10$). There was no significant difference in the sex-specific prevalence of aphakia (female 0.14%, male 0.36%, $P = 0.12$).

Prevalence of Visual Impairment and LOP

The prevalence of VI in the worse-seeing eye of participants with cortical only, nuclear only, PSC only, and mixed opacities was 12.2%, 14.2%, 28.6%, and 23.7%, respectively. The prevalence of VI in the better-seeing eye of participants with cortical only, nuclear only, PSC only, and mixed opacities was 3.9%, 5.0%, 14.3%, and 9.4%, respectively. The presence of VI (attributed to lens opacity) was more common in individuals with PSC only opacities and mixed opacities (Fig. 3); approximately 9.4% of participants with mixed opacities were visually impaired in the better eye. In addition, if one considers monocular VI, 23.7% of all participants with mixed opacities were visually impaired.

Table 3. Prevalence of Any Cortical, Posterior Subcapsular, or Nuclear Lens Opacity by Level of Severity (LOCS II Grade)

	Participants, *n* (%)		
LOCS II Grade*	Any PSC Opacity	Any Nuclear Opacity	Any Cortical Opacity
0	3774 (94.0)	71 (1.7)	2190 (54.5)
Trace	–	–	444 (11.1)
1	141 (3.5)	2715 (64.1)	495 (12.3)
2	64 (1.6)	1244 (29.4)	559 (13.9)
3	36 (0.9)	168 (4.0)	227 (5.7)
4	–	36 (0.9)	102 (2.5)

* LOCS II grading of the most advanced level in either eye. The *n* for all types of opacities is not the same since the LOCS II grade for a specific type of opacity was missing in some participants. Prevalence was defined as LOCS II grade ≥ 2 for any type of lens opacity.

Discussion

To our knowledge, CHES is the first population-based study of eye disease among persons 50 years and older of Chinese ancestry in the United States to examine the age- and sex specific prevalence and burden of LOP in the fastest growing ethnic group (Chinese) of Asian Americans in the United States population.[23] In this study, we found a high prevalence (almost 50%) of LOP in Chinese Americans, with nuclear opacities being the most common type. The prevalence of lens changes among all participants was almost 4-fold higher in those 80 years and older (95.6%) compared to those 50 to 59 years old (25.7%). The prevalence of lens changes also was higher in females (51.4%) compared to males (47.3%), after controlling for age; a pattern also observed with cortical opacities but not with nuclear opacities.

Visual Impairment and Cataract Surgery Prevalence

Visual impairment was found more frequently among PSC and mixed opacities than other types of LOP. Although PSC opacities are less common in CHES, their presence may be more visually significant than cortical and nuclear. The Handan Eye study also found PSC and mixed opacities associated with

Table 4. Age- and Sex-Specific Prevalence of Single and Mixed Types of LOP in the Chinese-American Eye Study

Opacity Type	Age Group, y	Males, *n* (%)	Females, *n* (%)	Total, *n* (%)
PSC only	50–59	2 (0.3)	4 (0.3)	6 (0.3)
	60–69	0	1 (0.1)	1 (0.1)
	70–79	0	0	0
	≥80	0	0	0
	Total	2 (0.1)	5 (0.2)	7 (0.2)
	Age adjusted*	0.14	0.17	0.17
	% (95% CI)	(0.0, 0.33)	(0.01, 0.33)	(0.0, 0.29)
Nuclear only	50–59	95 (13.5)	209 (14.5)	304 (14.2)
	60–69	154 (27.1)	248 (27.1)	402 (27.1)
	70–79	76 (37.8)	80 (32.7)	156 (35.0)
	≥80	30 (36.6)	35 (46.1)	65 (41.1)
	Total	355 (22.8)	572 (21.3)	927 (21.9)
	Age adjusted*	23.1	23.6	23.4
	% (95% CI)	(21.0, 25.2)	(22.0, 25.2)	(22.1, 24.7)
Cortical only	50–59	35 (5.0)	106 (7.3)	141 (6.6)
	60–69	50 (8.8)	118 (12.9)	168 (11.3)
	70–79	23 (11.4)	38 (15.5)	61 (13.7)
	≥80	8 (9.8)	8 (10.5)	16 (10.1)
	Total	116 (7.5)	270 (10.1)	386 (9.1)
	Age adjusted*	7.5	10.5	9.4
	% (95% CI)	(6.2, 8.8)	(9.3, 11.7)	(8.5, 10.3)
Mixed type	50–59	30 (4.3)	54 (3.7)	84 (3.9)
	60–69	78 (13.7)	153 (16.7)	231 (15.6)
	70–79	62 (30.9)	90 (36.7)	152 (34.1)
	≥80	38 (46.3)	26 (34.2)	64 (40.5)
	Total	208 (13.4)	323 (12.1)	531 (12.5)
	Age adjusted*	14.5	15.1	15.0
	% (95% CI)	(12.7, 16.3)	(13.7, 16.5)	(13.9, 16.1)

The "only" type of opacity included those participants who had only that type of opacity present (LOCS II grade ≥ 2). Mixed type indicates more than one type was present. These four categories are mutually exclusive.

* United States 2010 Asian population was used as the standard population to calculate the age-adjusted prevalence rates for each opacity type.[23]

VI in non-US Chinese, where the Los Angeles Latino Eye Study (LALES) reported mixed and nuclear opacities more frequently associated with VI in Latinos.

Prevalence of any cataract extraction in CHES was higher (9.9%) than reported by other non-Hispanic whites (6.8%) in the Beaver Dam Eye Study, Latinos (3.9%) in LALES, and in Afro-Caribbeans (2.8%) in the Barbados Eye study; however, the prevalence of cataract extraction was lower in CHES compared to other non-US Chinese groups (Tanjong Pagar Survey, 11.1%; Shih-Pai Study, 12.9%). An exception to this pattern was the Handan Eye Study where the LOP extraction frequency was only 0.8%, which may be explained by the rural adult Chinese population. Differences observed in the prevalence of cataract extraction may be explained by variation in the prevalence of LOP by population, or differences in access to or use of cataract surgery.

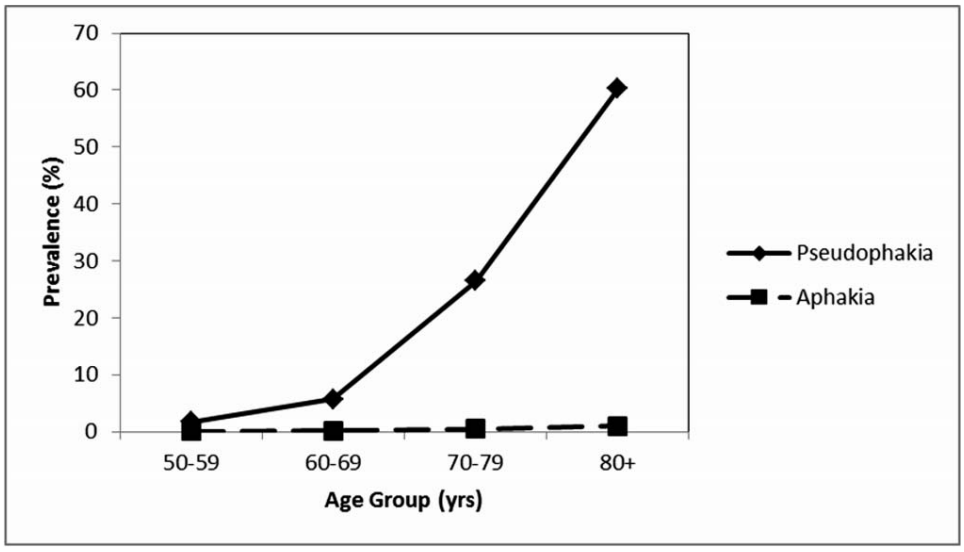
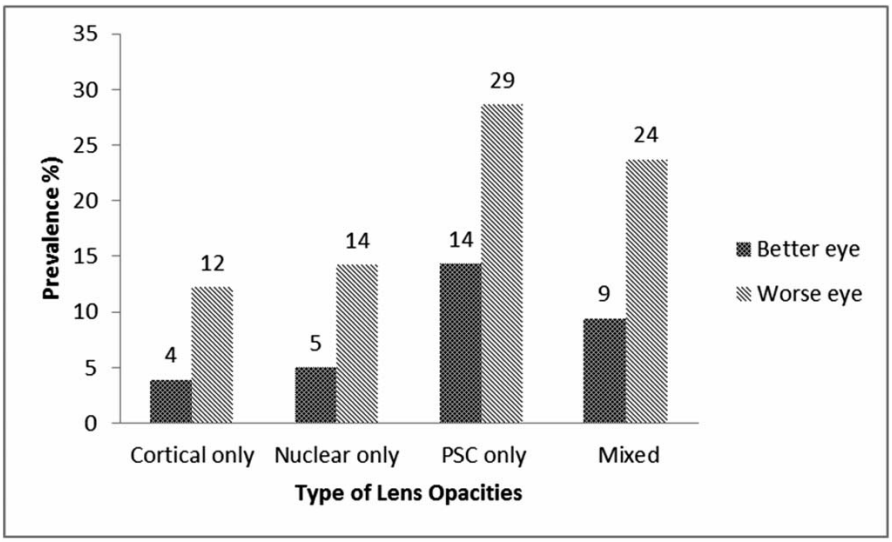


Figure 2. Age-specific prevalence of pseudophakia and aphakia in at least one eye in the Chinese American Eye Study.



PSC = posterior subcapsular. The primary cause of visual impairment was attributed to lens opacity.

FIGURE 3. Prevalence of visual impairment (BCVA of 20/40 or worse) associated with single and mixed types of opacities in the Chinese American Eye Study.

Comparison Across Chinese Studies

A detailed comparison of our data with other Chinese studies is not possible due to differences in age distribution and methodology used for classifying LOP (CHES used the LOCS II grading system where other studies used the LOCS III grading system). However, when evaluating the age-adjusted prevalence of LOP, our data suggested that Chinese Americans in CHES have a higher prevalence of age-adjusted nuclear opacities (38.1%) than observed in Chinese from the Handan Eye Study[27] (12.2%), but lower than reported in the Beijing Eye Study[28] (71.5%) and in the Tanjong Pagar Study[29] (45.9%). Participants in the CHES also have a lower prevalence of cortical opacities (23.4%) compared to Chinese in the Handan Eye Study (33.7%) and the Tanjong Pagar Study (44.9%), but higher than in the Beijing Eye Study (15.3%). Prevalence of PSC opacities was low across all Chinese populations (CHES 3.0%, Handan Eye Study 3.0%, Beijing Eye Study 6.3%, and Tanjong Pagar Study 14.1%) compared to the other two opacities (cortical and nuclear).

Differences observed in the prevalence of opacities may be influenced by differences in study protocols and grading procedures, but also due to differences in lifestyle or environmental exposures. For example, some studies[27,28,30] have reported smoking, history of myopia and use of hormone replacement therapy were associated with nuclear opacities, while myopia, higher fasting glucose, and history of diabetes were associated with PSC, and higher systolic blood pressure, history of cigarette smoking, and diabetes were associated with cortical opacities. Analytic models to explore determinants of LOP in CHES are currently in process.

Comparison Across Non-Chinese Studies

Compared to Latinos in the LALES (based on the same grading methodology, the LOCS II grading system), Chinese Americans had a higher age-adjusted prevalence of nuclear opacities[14] (18.5% in LALES vs. 38.1% in CHES) but similar prevalence of cortical opacities (23.5% in LALES vs. 23.4% in CHES), except in those participants who were 80 years and older where Latinos had higher prevalence of cortical opacities than Chinese Americans (60.2% in LALES vs. 46.8% in CHES). Chinese Americans in CHES also had lower age-adjusted prevalence of PSC opacities (6.2% in LALES vs. 3.0% in CHES).

Although direct comparison is not possible with non-Hispanic whites due to different methods of lens grading (photographic grading system), the Beaver Dam Eye Study (BDES)[31] and in the Blue Mountain Eye Study (BMES)[32] data suggests that CHES participants have a higher prevalence of nuclear opacities (17.8% to 81% in CHES vs. 6.6% to 57% in BDES, and 3.9% to 48.5% in BMES; ages 55 to 84 years), a lower prevalence of PSC (1.0% to 12.7% in CHES vs. 4.3% to 14.3% in BDES and 3.8% to 11.7% in BMES, ages 55 to 84 years), and similar prevalence of cortical opacities (10.3% to 46.8% in CHES vs. 10.9% to 42.4% in BDES and 13.1% to 46.7% in BMES, ages 55 to 84 years). However, compared to African Caribbean in the Barbados Eye Study,[33] using the same method of lens grading (LOCS II), CHES has a lower age-adjusted prevalence of PSC (3.0% vs. 5.1%), and cortical (23.4% vs. 42.3%), but higher prevalence of nuclear opacities (38.1% vs. 23.1%).

A major strength of this study is the inclusion of population-based data, using a large number of adults ($N = 4582$), high participation rate (79%), and use of standardized protocols and the same ophthalmologists for grading lens opacification (LOCS II grading system) throughout the study. To ensure consistency of grading, a regular evaluation of intergrader agreement of LOCS II grading was performed with a second ophthalmologist masked to the initial results. Moderate to excellent agreement (0.60–0.80) between ophthalmologists ($\kappa = 0.79$) was achieved throughout the course of the study. Thus, grading of LOP was consistent among ophthalmologists.

A potential limitation of this study is that the prevalence of nuclear opacities compared to cortical opacities may be underestimated because nuclear opacity may be more likely to lead to cataract surgery than other types of opacities (e.g., cortical). However, a subanalysis after including and excluding cases of unilateral cataract surgery revealed no difference in the prevalence of any PSC opacities (2.4% vs. 2.1%), any nuclear opacities (34.2% vs. 32.8%), or any cortical LOP (21.0% vs. 20.0%) present. The exclusion of a small number of participants who did not undergo pupil dilation because of narrow angles or diagnosis of angle-closure glaucoma could

have resulted in a slight underestimate of the true cataract prevalence, since these participants are more likely to have cataract. Another potential limitation is not including the LOCS III grading for direct comparison of our data with other Chinese population studies.

The CHES cohort is composed mostly of Mandarin-speaking immigrants, 68.7% of whom are from mainland China. While there are small differences in demographic characteristics between the Chinese Americans persons included in this study and those in the United States, we believe these data are likely to provide an accurate representation of LOP prevalence in Chinese American individuals. However, caution is warranted when extrapolating these estimates to Chinese populations of different geographic or genetic heritage as differences in these characteristics may contribute to differences in the burden of LOP. Age- and sex-specific or standardized estimates should be used to compare prevalence differences across Chinese populations.

Conclusions

The CHES provides the first precise estimates of the overall, age- and sex-specific prevalence of LOP for adults of Chinese ancestry in the United States 50 years of age and older.

These data suggested that Chinese Americans in CHES have a high prevalence of VI associated with LOP, and specifically a high prevalence of nuclear opacities, especially among adults age 60 years and older. The potential environmental, lifestyle, and genetic factors that may contribute to the observed differences in the prevalence of LOP in Chinese Americans compared to Chinese in Asia or other racial/ethnic groups in the United States need further evaluation.

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Appendix

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