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Progression of Near Vision Loss and Incidence of Near Vision Impairment in an Adult Chinese Population

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Abstract

Purpose: To investigate the progression of near vision loss and the cumulative incidence of near vision impairment (NVI) 6 years after initial examination of an urban Chinese cohort.

Design: Population-based, prospective cohort study.

Participants: People aged 35 years examined at baseline in the Yuexiu District of Guangzhou, China.

Methods: Participants examined at baseline were invited for 2-year and 6-year follow-up examinations in 2010 and 2014, respectively. Examinations included noncycloplegic autorefractometry and binocular near visual acuity (NVA) with and without current near correction measured at 40cm using a logMAR ETDRS near vision tumbling E chart. Those with uncorrected binocular NVA (UCNVA) 20/40 underwent subjective refraction to obtain best-corrected binocular NVA (BCNVA).

Main Outcome Measures: Change in UCNVA between baseline and 2014 follow-up examinations and the 6-year cumulative incidence of vision impairment based on three definitions: NVA 20/40, 20/50 and 20/63.

Results: Among the 1817 baseline participants, 1595(87.8%) were reexamined in 2010 and 1427(78.5%) in 2014. Mean vision loss between baseline and the 2014 follow-up was 1.54 (± 1.74) lines of UCNVA. Vision loss was associated with age 80 years or older, less education and better baseline UCNVA. The 6-year cumulative incidence of uncorrected binocular NVI (UCNVI) across the three vision impairment definitions was 55.2% (95% confidence interval [CI]: 46.1%–64.3%), 51.3% (95% CI: 44.0%–58.7%) and 42.4% (95%CI: 35.5%–49.3%), respectively. With best-corrected binocular NVI (BCNVI), incidence was 6.89% (95%CI: 4.28%–9.50%), 5.17% (95%CI: 2.89%–7.44%) and 2.62% (95%CI: 1.11%–4.12%), respectively. A higher

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incidence of UCNVI was associated with worse baseline UNNVA for all three impairment definitions. Similarly, incidence of BCNVI was associated with worse baseline BCNVA, but also with older age and education at the primary level or less. Gender was not significant for either UCNVI or BCNVI.

Conclusions: Approximately half of those aged 35 years or older develop UCNVI in 6 years, the overwhelming majority of whom can be corrected with spectacles. Cost-effective strategies to provide spectacles to this at-risk population remains an issue requiring further study.

Keywords

near vision impairment; incidence; progression

Introduction

Uncorrected distance refractive error is the main cause of visual impairment and the second cause of blindness worldwide.¹ The public health significance of uncorrected refractive error has been recognized and is a priority in the Vision 2020 initiative.² Near vision impairment (NVI) has also been acknowledged by the World Health Organization (WHO) as an important aspect of visual function, but the related disease burden could not be directly estimated due to a lack of population-based data.¹ A recently published systematic review of population-based studies of visual impairment and blindness worldwide over the past 32 years identified 238 articles on distant vision impairment but found only 4 on NVI.³

NVI is a common presentation of presbyopia, an age-related and progressive condition that begins at around 30 years of age, with essentially everyone developing presbyopia and complete loss of accommodation by the age of 50–55 years.^{4–6} One recent estimate reported that nearly 108 million people worldwide suffered from impaired distance vision, whereas an even a larger 517 million from NVI.^{7, 8} Part of the reason that NVI is poorly represented in the literature is the perception that, compared with distance vision, it is a condition of less importance and urgency. Studies have shown, however, that NVI and presbyopia are associated with worsening quality of life in both developing and developed countries.^{9–11} NVI and presbyopia have been related to greater difficulty in daily activities, a higher risk of accidents, and cognitive decline, leading to lower self-esteem and higher levels of depression.^{12–14}

Among the limited studies on the prevalence of NVI, in a multi-country population-based study we reported a prevalence of 60% or higher for people aged 35 years and older, increasing to 90% for people aged above 70.¹⁵ This high prevalence had been validated in other studies of different ethnicities.^{16–18} To the best of our knowledge, longitudinal progression of near vision loss and the incidence of NVI have never been reported. With estimates that the number of people aged 65 years and older in China will double in the next 20–30 years, NVI data are in urgent need for the planning of cost-effective service delivery.

The aims of the present study are to report on the progression of near vision loss along with the incidence of near vision impairment, including the significance of age-, gender- and education-related risk factors in an urban Chinese population.

Methods

Study population

Participants were identified using random cluster sampling from adults aged ≥ 35 years in the urban upper-middle-income Yuexiu District of Guangzhou, China, during the latter part of 2008. Details of the recruitment and study methodology have been reported elsewhere.^{15, 19, 20} In brief, 2284 eligible persons were enumerated during door-to-door household visits, including name, gender and age; the study population for this article consists of the 1817 (79.6%) participants who attended baseline examinations. Subsequent attempts were made to re-contact all those who attended the baseline examination to participate in a follow-up study in 2010 and again in 2014. Follow-up examinations, using similar procedures, generally took place at the Zhongshan Ophthalmic Center (ZOC) in Guangzhou or in local community facilities or homes for individuals with mobility restrictions or limited free time. Those who did not attend follow-up examinations were categorized as deceased, refusing further examination, relocated out of the area or lost to contact based on information provided by household members or the local residents' committee.

The baseline protocol was approved by the World Health Organization Secretariat Committee on Research Involving Human Subjects and by the institutional review board at ZOC. Approval for the follow-up surveys was obtained from the responsible institutional review ethics committee. Written informed consent was received from all subjects and the study was conducted in accordance with the tenets of the Declaration of Helsinki.

Procedures

A brief questionnaire that included education background and detailed ophthalmic surgical history was administered by trained interviewers at baseline. At each follow-up participants were asked if they had undergone any kind of eye surgery, and the specific type, since the last examination.

Eye examinations were performed indoors under ambient lighting. Binocular near visual acuity (NVA) was measured at 40 cm using a LogMAR ETDRS near vision tumbling E chart (Precision Vision, La Salle, Illinois, USA). Distance was maintained by a 40 cm string attached to the chart at one end and placed against the outer canthus at the other end. Visual acuity was recorded as the smallest line read with 1 or no errors. Subjects with binocular uncorrected NVA (UCNVA) ≥ 20/40 were tested to obtain their binocular best-corrected NVA (BCNVA) with progressively higher spherical plus powers after correction of distance refractive error. Noncycloplegic auto-refraction (KR-8800; Topcon Corp) and distance visual acuity were also measured. Slit-lamp examination of the anterior segment and fundus examination using non-contact slit-lamp lens (90D, Volk Optical Inc.) was performed by an ophthalmologist. Follow-up examinations were performed by the same examiner as at baseline in a masked fashion without knowledge of baseline information.

Data Management and Analyses

Computerized data entry was carried out at baseline and at each follow-up. Data ranges, frequency distributions, and consistency among related measurements were checked with a series of data-cleaning programs.

Age was defined using age at baseline and categorized into 4 age groups: 35–49, 50–64, 65–79 and 80+. Education level was categorized into 3 groups: primary school, secondary completed, and high school. Multiple logistic regression was used to analyze the association of baseline age, gender, education and baseline UCNVA with follow-up examination response rates.

Vision loss between baseline and follow-up was defined by assigning each line on the ETDRS chart a number from 0 to 14, with the number increasing as NVA deteriorated. (When describing NVA outcomes, the equivalent Snellen visual acuity was used for a more straightforward presentation.) Accordingly, NVAs of 20/20, 20/25, 20/32 and 20/40 were represented by line numbers 0, 1, 2 and 3, respectively. NVA of 20/400 was represented by line number 13, with line 14 corresponding to NVA 20/500. Progression of vision loss was calculated as the NVA line number at follow-up minus the line number at baseline; thus, a positive line change indicated a worsening of vision between baseline and follow-up and a negative change indicated improvement of vision. An ordered multiple logistic regression model was used to investigate the association of baseline age, gender, education and baseline UCNVA with the change in lines of UCNVA.

The incidence of NVI was based on 3 different definitions of impairment: 20/40, 20/50, and 20/63. For each definition, incidence of binocular uncorrected NVI (UCNVI) and binocular best-corrected NVI (BCNVI) were calculated as the percentage of the at-risk population (those without impairment at baseline) who developed impairment during the time interval between baseline and follow-up. Multiple logistic regression was used to investigate the association of baseline age, gender, education and baseline UCNVA with the 6-year cumulative incidence of UCNVI and BCVNI.

Statistical analyses were performed using STATA Statistical Software: Release 12.0 (StataCorp LP, Collage Station, TX). P-values of 0.05 were considered statistically significant.

Results

Baseline examinations were available for 1817 (79.6%) of the 2284 enumerated eligible persons in 2008: mean age was 53.3 ± 13.0 years (range, 35–94) with 54.0% female. Table 1 shows the 2010 and 2014 follow-up status for the study population. Accordingly, 1595 (87.8%) of those examined at baseline were reexamined in 2010 and 1427 (78.5%) were reexamined in 2014, including 66 who were not examined at the 2010 follow-up.

Table 2 presents the 2010 and 2014 follow-up examination rates by baseline age, gender, education level and baseline UCNVA. (Because education level was missing for 88 (4.84%) of the baseline participants, and thus would be excluded from the multiple regression

modeling, they were assigned an education category based on that which was most common for their age group: those in age groups 35–49 and 50–64 were assigned high school, age group 65–79 was assigned secondary, and age group 80+ was assigned primary.) In multiple logistic regression, examination at both the 2010 and 2014 follow-up was associated with those in the 50–64 age cohort, and inversely associated with those of age 80+. Education at the primary level or less was positively associated with participation at the 2010 follow-up, and baseline UCNVA <20/63 was negatively associated with participation at the 2014 follow-up. The higher follow-up rates in females in both 2010 and 2014 were not at statistically significant levels. Direct comparison of participants who did and did not attend the follow-up examinations can be found at supplement Table 1.

Table 3 shows the change in lines of UCNVA between baseline and the 2014 follow-up. UCNVA remained unchanged, or even improved, in 1/4 of the population while decreasing in the rest. In an ordered multiple logistic regression model, progression of vision loss in the six-year interval was associated with 80+ years of age at baseline, less education, and baseline UCNVA >20/40.

Table 4 characterizes the study population at baseline and at each of the two follow-ups dichotomized as normal/near-normal vision (UCNVA >20/40) and impaired vision (UCNVA ≤20/40). One hundred forty-five (23.1%) of the 627 with normal/near-normal vision at baseline and examined at the 2010 follow-up progressed to vision impairment, while 46 (4.75%) of the 968 with vision impairment at baseline and examined at the 2010 follow-up regressed to normal/near-normal vision. Similarly, at the 2014 follow-up, 318 (55.2%) of the 576 with normal/near-normal vision at baseline progressed to vision impairment, and 12 (1.41%) of the 851 with vision impairment at baseline regressed to normal/near-normal vision.

Accordingly, considering progression and regression of vision impairment within the baseline to follow-up time intervals, the prevalence of UCNVA ≤20/40 increased from 60.7% at baseline to 66.9% for the 1,595 participants examined at the 2010 follow-up, while for the 1,427 participants examined at the 2014 follow-up, prevalence increased from 59.6% to 81.1%.

Table 5 presents the six-year cumulative incidence of UCNVA in the six-year interval between baseline and the 2014 follow-up based on the three definitions of increasing UCNVA: progression from NVA >20/40 to NVA ≤20/40, progression from NVA >20/50 to NVA ≤20/50, and progression from NVA >20/63 to NVA ≤20/63. As NVA at baseline deteriorated, the incidence of vision impairment increased for all three definitions: from 34.6% to 82.5% for the NVA ≤20/40 definition, from 20.3% to 90.3% for the NVA ≤20/50 definition and from 8.02% to 76.8% for the NVA ≤20/63 definition.

In multiple logistic regression modeling, the increase in incidence with deteriorating baseline UCNVA was highly significant for all three definitions of impairment (Table 5). The lower incidence among those in the 35–49 age group was not at a statistically significant level, compared to the reference 50–64 age group, nor was the relatively high incidence in the 65–79 and 80+ age groups, in part because of the relatively small number of participants

in these two older age categories. (The 50–64 age group, rather than 35–49, was used as the logistic regression reference because the incidence of BCNVI was zero in the 35–49 age group as shown in Table 6. Similarly, because the incidence of BCNVI was zero or essentially zero with the 20/63 and 20/50 NVI definitions, the baseline NVA reference was chosen to correspond with three lines of NVA between it and the NVI definition.) Increased incidence with lower educational level was generally not statistically significant, and the slightly higher incidence among males was not statistically significant.

Table 6 presents the six-year cumulative incidence of BCNVI based on the three definitions of vision impairment along with the association of age, gender, education and baseline BCNVA with incident BCNVI. The 6-year incidence of BCNVI increased as baseline BCNVA deteriorated using different NVA cutoffs: The incidence increased from 0.76% for BCNVA 20/20 to 18.4% for BCNVA 20/32 using the NVA 20/40 definition, from 0.19% for BCNVA 20/20 to 62.8% for BCNVA 20/40 using the NVA 20/50 definition, and from 0.0% for BCNVA 20/20 to 33.3% for BCNVA 20/50 using the NVA 20/63 definition. Older age and education at the primary level or less, but not gender, were found to be associated with a higher incidence of BCNVI.

Discussion

To the best of our knowledge, the present study is the first one to report on the incidence and longitudinal progression of NVI. NVA deteriorated over time in people aged 35 years and older with nearly half developing UCNVI in 6 years.

The prevalence of presbyopia and NVI was found to be relatively high in previous studies: The prevalence of presbyopia among people aged 40 years or older was 67.3% and 61.7% in rural China and Tanzania, respectively.^{21, 22} The prevalence for those aged 30 years or older was 54.7% in Brazil and 69.9% in India.^{23, 24} A recent study investigating the prevalence of both distant and near vision impairment reported that 80.3% of the examined subjects had NVI while 51.7% had presbyopia.¹⁷ Difference NVA measurement methods and different NVI definitions preclude direct comparisons of study findings. A multi-county population-based NVI prevalence study using the same protocol at each study site, and which included the baseline examinations in the present study, was published in 2012 and reported standardized age- and gender-adjusted prevalence for binocular NVI (20/40) ranging from 50.4% to 85.4% across the seven sites.¹⁵

We found that three-quarters of the study population underwent UCNVA deterioration in the 6-year time interval. Those aged 80 years or older were associated with significantly greater progression of vision loss, likely due to the onset of cataract, age-related macular degeneration and other age-related eye diseases. Those with less education were also at greater risk of UCNVA deterioration: possibly because people of lower educational level are likely to be of lower socio-economic status, and therefore, have less resources to care for their eyes.

The incidence of UCNVI depended on the visual acuity cut-point used to define impairment: As the definition of impairment increased from 20/40 to 20/63, the number at risk

increased while the incidence rate decreased. Unlike the progression of vision loss associated with older age and less education, the incidence of UCNVI for all three definitions was associated only with baseline UCNVA. Incidence steadily increased as the baseline visual acuity approached the cut-point for the vision impairment definition.

NVA improvement was also observed in a small subset of participants during the follow-up. General variability in NVA measurements, along with treatments such as cataract surgery, may be part of the reason. There were 112 participants who underwent cataract, glaucoma and other eye surgeries (in one or both eyes) during the 6-year follow-up. They were not excluded from the analysis of progression and incidence as it was unclear whether the surgery had any effect on post-surgery binocular NVA or the risk of worsening NVA. Another possibility for the NVA improvement might be the newly developed nucleus sclerosis of the lens that would cause myopic shift, however, we are not able to prove this as data on lens opacity were not collected in the current study.

The incidence of BCNVI increased dramatically with age, again because of the onset and worsening of age-related eye diseases. The observed higher incidence of BCNVI among participants with education at the primary level or less may also have been related to economic factors. The incidence of BCNVI did not differ between significantly males and females, consistent with findings of no apparent differences in prevalence.^{15, 25}

The incidence of presenting NVI can be found in supplement Table 2. A high incidence of presenting NVI across all three NVI definitions was, in large measure, due to the substantial reduction in those with near vision glasses between baseline and the 2014 follow-up: Among the 1,427 examined at the 2014 follow-up, 49.9% had glasses with a bifocal (distance and near) or near-only correction at baseline, while only 23.5% had similar glasses at the 2014 examination; this is in spite of the fact that near vision glasses were provided free of charge at baseline to participants with binocular NVA 20/63 that could be improved by 2 or more lines. Accordingly, the incidence of presenting NVI in the current study should not be considered as representative of the actual situation in the general population, but is reported as reference information.

China is the most populated country in the world and the only country with more than 180 million population aged 60 years or older (United Nations Department of Economics and Social Affairs, 2012). It is estimated that the proportion of the population 60 years or older will increase from 12.4% in 2010 to 28% in 2040.²⁶ According to the National Bureau of Statistics of China (NBSC, 2011), the life expectancy in China is 74.84 years and continues to grow. In this regard, China is facing a challenge larger than any other country in dealing with a rapidly aging society.²⁷ With an incidence of nearly 90% for UCNVI (20/40) among those aged 65 years or older, and an incidence of nearly 40% for BCNVI, the increasingly large size of the population with NVI in China represents a significant societal resource burden.

The dramatic decrease in vision impairment that can be achieved with best correction demonstrates that a substantial part of the NVI problem can be effectively addressed by dispensing appropriate spectacles. Previous studies have shown that a large proportion of

people with correctable NVI were under- or uncorrected, and it follows that greater efforts should address this for the period that their vision remains recoverable.^{6, 18, 28, 29} In addition, more research is needed to understand barriers to accessing eye care before interventions can be properly designed. It should be noted that good distance visual acuity does not necessarily predict good NVA, and we should deliver eye care for both.

Strengths of the study lie in its population-based design and the use of a standardized examination methodology at baseline and both follow-ups. Of participants examined at baseline, 12.2% were not part of the 2010 follow-up and 21.5% were not in the 2014 follow-up – reasons pertained to death, unable to re-contact, relocation, and refusal to participate. Those not in the follow-ups were generally older and with somewhat worse NVA at baseline. The extent to which this biases the study results is unknown. Incomplete classification of the cause of UCNVI was also a weakness. Nevertheless, based on the spherical plus power needed to reach BCNVA and the recording of lens opacity and abnormal fundus findings, we speculate that most UCNVI is attributable to presbyopia and that most BCNVI is attributable to cataract and age-related macular degeneration. The impact of NVA deterioration on quality of life was not addressed in this study and still needs further investigation.

In conclusion, for people aged 35 years or older NVA deteriorates over time with an increasing incidence of NVI. The challenge is to establish a system that delivers appropriate correction to those in need in an ageing China. Further research is also needed to provide detailed information on the causes underlying NVI and to shed light on potential prevention and treatment strategies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Glossary

NVI	near vision impairment
NVA	near visual acuity
UCNVA	uncorrected binocular NVA
BCNVA	best-corrected binocular NVA
UCNVI	uncorrected binocular NVI
BCNVI	best-corrected binocular NVI

WHO	World Health Organization
ZOC	Zhongshan Ophthalmic Center

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Table 1.

Follow-up status at 2010 and 2014 for participants examined at baseline.

2010 Status	2014 Status					
	Accepted	Refused	Can't Contact	Relocated	Deceased	ALL
Accepted	1,361 (74.9)	51 (2.81)	60 (3.30)	70 (3.85)	53 (2.92)	1,595 (87.8)
Refused	57 (3.14)	30 (1.65)	25 (1.38)	27 (1.49)	13 (0.72)	152 (8.37)
Can't Contact	9 (0.50)	4 (0.22)	4 (0.22)	30 (1.65)	4 (0.22)	51 (2.81)
Deceased	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	19 (1.05)	19 (1.05)
ALL	1,427 (78.5)	85 (4.68)	89 (4.90)	127 (6.99)	89 (4.90)	1817 (100.0)

Table 2.

Multiple logistic regression for 2010 and 2014 follow-up reexamination response in the baseline examined population.

	No. Examined at Baseline	Examined at 2010 Follow-Up		Examined at 2014 Follow-Up	
		No. (%)	O.R. (95% C.I.)	No. (%)	O.R. (95% C.I.)
Age At Baseline					
35–49	803	694 (86.4)	Reference	641 (79.8)	Reference
50–64	645	590 (91.5)	1.73 (1.18–2.53) ^{**}	560 (86.8)	1.73 (1.16–2.56) [*]
65–79	292	257 (88.0)	0.99 (0.63–1.57)	194 (66.4)	0.54 (0.33–0.89) [*]
80+	77	54 (70.1)	0.28 (0.14–0.59) ^{**}	32 (41.6)	0.19 (0.09–0.42) ^{**}
Gender					
Male	836	721 (86.2)	Reference	643 (76.9)	Reference
Female	981	874 (89.1)	1.27 (0.98–1.64)	784 (79.9)	1.26 (0.92–1.73)
Education					
<= Primary	228	208 (91.2)	2.58 (1.12–5.93) [*]	157 (68.9)	1.09 (0.61–1.94)
Secondary	399	355 (89.0)	1.21 (0.71–2.09)	317 (79.5)	0.99 (0.59–1.65)
>= High School	1,190	1,032 (86.7)	Reference	953 (80.1)	Reference
Near Uncorrected VA at Baseline					
> 20/40	709	627 (88.4)	Reference	576 (81.2)	Reference
<=20/40 – 20/63	780	691 (88.6)	0.88 (0.61–1.27)	629 (80.6)	1.08 (0.89–1.31)
< 20/63	328	277 (84.5)	0.62 (0.34–1.12)	222 (67.7)	0.62 (0.43–0.89) [*]
ALL	1,817	1,595 (87.8)	---	1,427 (78.5)	---

* Statistically significant at the P = 0.050 level.

** Statistically significant at the P = 0.010 level.

Table 3.

Change in lines of uncorrected near binocular vision in the six-year interval between baseline and the 2014 follow-up with odds ratios from an ordered multiple logistic regression model.

Age At Baseline	No. Examined at 2014 Follow-Up	Change in Lines of Visual Acuity (%)							Mean Line Change (S.D.)	Odds Ratio (95% C.I.)
		-2	-1	0	+1	+2	+3	+4	+5	
35-49	641	2.96	4.68	18.7	24.3	20.1	14.8	9.98	4.37	Reference
50-64	560	2.50	7.50	14.8	25.7	24.8	16.4	6.25	1.96	1.23 (0.94-1.61)
65-79	194	4.12	8.76	15.0	25.8	20.1	15.5	7.73	3.09	1.21 (0.84-1.75)
80+	32	3.13	6.31	16.6	25.0	21.9	15.6	12.5	9.38	2.18 (1.33-3.55)**
Gender										
Male	643	2.33	5.75	17.9	26.3	21.5	13.7	9.49	3.11	Reference
Female	784	3.44	6.76	15.6	24.0	22.3	17.1	7.27	3.57	0.97 (0.81-1.17)
Education										
<= Primary	157	3.82	8.28	10.8	18.5	27.4	20.4	6.37	4.46	1.79 (1.29-2.48)**
Secondary	317	1.89	5.68	12.6	27.4	24.9	15.1	7.89	4.42	1.29 (0.97-1.73)
>= High School	953	3.15	6.19	18.9	25.3	20.0	14.9	8.71	2.83	Reference
Near Uncorrected Visual Acuity										
> 20/40	576	0.69	3.30	17.2	21.5	21.4	18.2	11.8	5.90	Reference
<=20/40-20/63	629	1.91	6.36	13.8	28.3	24.6	16.7	6.52	1.75	0.56 (0.43-0.73)**
< 20/63	222	11.7	14.0	23.0	24.8	15.8	5.41	4.05	1.35	0.17 (0.13-0.22)**
ALL	1,427	2.94	6.31	16.6	25.0	21.9	15.6	8.27	3.36	---

** Statistically significant at the P = 0.010 level.

Table 4.

Change in uncorrected near binocular vision from baseline to the 2010 follow-up and from the 2010 follow-up to the 2014 follow-up with visual acuity 20/40 defined as impaired vision and >20/40 as normal/near-normal vision.

Baseline	2010 Follow-Up	2014 Follow-Up
Normal/Near-Normal 709 (39.0)	Normal/Near-Normal 482 (68.0)	Normal/Near-Normal 238 (49.4)
		Impaired ⁺ 184 (38.2)
		Lost to FU 60 (12.5)
	Impaired ⁺ 145 (20.5)	Normal/Near-Normal 10 (6.90)
		Impaired ⁺ 116 (80.0)
		Lost to FU 19 (13.1)
Impaired 1108 (61.0)	Lost to FU 82 (11.6)	Normal/Near-Normal 10 (12.2)
		Impaired ⁺ 18 (22.0)
		Lost to FU 54 (65.9)
	Normal/Near-Normal [§] 46 (4.15)	Normal/Near-Normal [§] 4 (8.70)
		Impaired 39 (84.8)
		Lost to FU 3 (6.52)
Impaired 1108 (61.0)	Impaired 922 (83.2)	Normal/Near-Normal [§] 6 (0.65)
		Impaired 764 (82.9)
		Lost to FU 152 (16.5)
	Lost to FU 140 (12.6)	Normal/Near-Normal [§] 2 (1.43)
		Impaired 36 (25.7)
		Lost to FU 102 (72.9)

⁺Progression from normal/near-normal vision to impairment.

[§]Regression from impairment to normal/near-normal vision.

Table 5.

Incidence of uncorrected near binocular vision impairment (defined as VA 20/40, VA 20/50, or VA 20/63) between baseline and the 2014 follow-up with multiple logistic regression odds ratios for age, gender, education, and baseline visual acuity covariates.

	Impairment defined as VA 20/40			Impairment defined as VA 20/50			Impairment defined as VA 20/63		
	No. At Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)	No. At Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)	No. At Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)
Age at Baseline									
35–49	429	48.5 (38.4–58.5)	0.73 (0.33–1.61)	502	40.2 (31.1–49.4)	0.76 (0.43–1.37)	555	27.7 (19.5–36.0)	0.91 (0.59–1.41)
50–64	123	72.4 (62.5–82.2)	Reference	212	69.8 (65.2–74.4)	Reference	359	57.1 (51.9–62.3)	Reference
65–79	24	87.5 (67.6–97.3) #	2.27 (0.58–8.84)	46	84.8 (74.8–94.8)	2.15 (0.82–5.68)	89	68.5 (59.1–78.0)	1.33 (0.80–2.21)
80+	0	---	---	2	100 (15.8–100) #	---	13	84.6 (54.5–98.1) #	1.79 (0.43–7.46)
Gender									
Male	248	56.5 (41.4–71.5)	Reference	344	55.2 (45.8–64.6)	Reference	467	44.3 (34.8–53.8)	Reference
Female	328	54.3 (48.4–60.2)	0.96 (0.60–1.55)	418	48.1 (40.9–55.3)	0.85 (0.67–1.08)	549	40.8 (35.5–46.1)	0.99 (0.76–1.27)
Education									
<= Primary	17	64.7 (0.38–0.86) #	0.82 (0.21–3.21)	32	78.1 (60.0–90.7) #	1.73 (0.53–5.68)	70	72.9 (64.0–81.7)	1.86 (0.99–3.49)
Secondary	114	71.9 (58.8–85.1)	2.14 (1.01–4.53) *	161	61.5 (54.8–68.2)	1.44 (0.81–2.55)	232	50.9 (41.3–60.4)	1.33 (0.75–2.35)
>= High School	445	50.6 (41.0–60.1)	Reference	569	46.9 (38.2–55.7)	Reference	714	36.7 (28.6–44.8)	Reference
Uncorrected VA at Baseline									
20/20	237	34.6 (28.0–41.2)	Reference	237	20.3 (15.4–25.1)	0.50 (0.34–0.75) **	237	8.02 (4.91–11.1)	0.16 (0.11–0.23) **
20/25	156	54.5 (43.7–65.2)	2.08 (1.37–3.15) **	156	35.3 (27.5–43.1)	Reference	156	19.2 (10.6–27.9)	0.42 (0.20–0.86) *
20/32	183	82.5 (77.9–87.2)	7.39 (5.05–10.8) **	183	65.6 (57.6–73.5)	3.06 (1.64–5.72) **	183	38.3 (30.7–45.8)	Reference
20/40	---	---	---	186	90.3 (87.5–93.1)	14.4 (8.79–23.5) **	186	62.9 (57.0–68.9)	2.67 (1.80–3.97) **
20/50	---	---	---	---	---	---	254	76.8 (70.7–82.8)	4.79 (2.68–8.58) **
ALL	576	55.2 (46.1–64.3)	---	762	51.3 (44.0–58.7)	---	1,016	42.4 (35.5–49.3)	---

Confidence interval calculated with exact binomial.

* Statistically significant at the P 0.050 level.

** Statistically significant at the P <= 0.010 level.

Table 6.

Incidence of best-corrected near binocular vision impairment (defined as VA 20/40, VA 20/50, or VA 20/63) between baseline and the 2014 follow-up with multiple logistic regression odds ratios for age, gender, education, and baseline visual acuity covariates.

	Impairment defined as VA 20/40			Impairment defined as VA 20/50			Impairment defined as VA 20/63		
	No. at Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)	No. at Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)	No. at Risk	Incidence % (95% C.I.)	O.R. (95% C.I.)
Age at Baseline									
35–49	640	0.16 (0.00–0.87) #	0.05 (0.01–0.36) **	640	0.00(0.00–0.57) #	---	641	0.00(0.00–0.57) #	---
50–64	548	5.47 (3.72–7.72) #	Reference	556	2.52(1.38–4.19) #	Reference	557	0.54(0.11–1.57) #	Reference
65–79	149	35.6 (27.9–43.8) #	5.05 (2.68–9.51) **	175	25.7(19.4–32.9) #	4.64 (2.22–9.71) **	189	12.7(8.31–18.3) #	5.99 (1.84–19.5) **
80+	13	69.2 (38.6–90.9) #	20.3 (3.30–124) **	22	59.1(36.4–79.3) #	14.8 (4.13–52.8) **	27	37.0(19.4–57.6) #	16.7 (2.54–110) **
Gender									
Male	619	6.62 (3.66–9.59)	Reference	634	4.42(2.58–6.25)	Reference	640	2.66(1.04–4.27)	Reference
Female	731	7.11 (4.20–10.0)	1.23 (0.60–2.51)	759	5.80(2.96–8.63)	1.21 (0.54–2.73)	774	2.58(1.09–4.07)	0.55 (0.31–0.96) *
Education									
<= Primary	114	33.3 (20.6–46.0)	4.57 (2.47–8.45) **	134	29.1(18.7–39.6)	5.13 (2.96–8.90) **	147	17.7(7.89–27.5)	5.39 (2.51–11.6) **
Secondary	301	9.63 (5.84–13.4)	2.87 (2.04–4.05) **	312	5.45(1.35–9.54)	2.29 (0.76–6.87)	315	1.27(0.35–3.22) #	0.98 (0.13–7.34)
>= High School	935	2.78 (1.82–4.05) #	Reference	947	1.69(0.97–2.73) #	Reference	952	0.74(0.30–1.51) #	Reference
Best Corrected VA at Baseline									
20/20	529	0.76(0.21–1.92) #	Reference	529	0.19(0.00–1.05) #	0.36 (0.03–3.86)	529	0.00(0.00–0.69) #	---
20/25	436	4.13 (1.09–7.16)	2.01 (0.38–10.7)	436	1.61(0.49–2.72)	Reference	436	0.46(0.00–1.65) #	0.29 (0.08–1.10)
20/32	385	18.4 (12.5–24.4)	6.38 (1.66–24.5) *	385	9.61(5.89–13.3)	3.33 (1.83–6.06) **	385	3.90(1.91–5.88)	Reference
20/40				43	62.8(41.2–84.4)	19.2 (8.73–42.0) **	43	30.2(11.4–49.1)	3.79 (1.81–7.90) **
20/50							21	33.3(6.57–60.1)	3.23 (1.14–9.16) *
ALL	1,350	6.89 (4.28–9.50)	---	1,393	5.17(2.89–7.44)	---	1,414	2.62(1.11–4.12)	---

Confidence interval calculated with exact binomial.

* Statistically significant at the P 0.050 level.

** Statistically significant at the P 0.010 level.