ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/24263830

Rationale, Design, Methodology, and Baseline Data of a Population-Based Study in Rural China: The Handan Eye Study

Article *in* Ophthalmic epidemiology · July 2009

Impact Factor: 1.15 · DOI: 10.1080/09286580902738159 · Source: PubMed

CITATIONS
47

READS
34

11 authors, including:

Yuan Bo Liang
Wenzhou Medical College
82 PUBLICATIONS **673** CITATIONS
SEE PROFILE

T-Y Wong
Singapore National Eye Centre
1,423 PUBLICATIONS **39,247** CITATIONS
SEE PROFILE

Xiao Hui Yang
North China University of Water Conservancy…
59 PUBLICATIONS **676** CITATIONS
SEE PROFILE

Siyan Zhan
Peking University Health Science Center
118 PUBLICATIONS **1,033** CITATIONS
SEE PROFILE

Available from: Yuan Bo Liang
Retrieved on: 12 May 2016

Ophthalmic Epidemiology, 16:115–127
ISSN: 0928-6586 print / 1744-5086 online
Copyright © 2009 Informa Healthcare USA, Inc.
DOI: 10.1080/09286580902738159

informa
healthcare

Rationale, Design, Methodology, and Baseline Data of a Population-Based Study in Rural China: The Handan Eye Study

Yuan Bo Liang,[1,2] David S. Friedman,[3,4] Tien Yin Wong,[5,6] Feng Hua Wang,[1] Xin Rong Duan,[1] Xiao Hui Yang,[1] Qiang Zhou,[1] Qiushan Tao,[7] Si Yan Zhan,[7] Lan Ping Sun,[2] Ning Li Wang,[1] and **the Handan Eye Study Group**

[1] *Beijing Tongren Eye Center, Capital Medical University, Beijing Ophthalmology & Visual Science Key Lab, Beijing, China*
[2] *Handan Eye Hospital, Hebei Province, China*
[3] *Wilmer Eye Institute, The Johns Hopkins University, Baltimore, Maryland, USA*
[4] *Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA*
[5] *Centre for Eye Research Australia, University of Melbourne, Melbourne, Australia*
[6] *Singapore Eye Research Institute, National University of Singapore, Singapore*
[7] *School of Public Health, Peking University, Beijing, China*

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

ABSTRACT

***Purpose*: To describe the rationale, design, methodology and baseline characteristics of the Handan Eye Study (HES), a population-based study to determine the prevalence and impact of visual impairment and major ocular diseases in Chinese adults living in a rural region north China. *Methods*: Population-based, cross-sectional study. 6830 Han people aged 30 years and older from 13 villages of Yongnian County, Handan city, Hebei province, China were recruited. The interviews covered demographic, behavioral, and ocular risk factors as well as health-related and vision-related quality of life. Ocular examination included measurement of visual acuity (VA), intraocular pressure, anterior and posterior segment examinations, visual field testing, and anterior segment, fundus and optic disc photography/imaging. Physical examination included measurement of height and weight, blood pressure, electrocardiogram, fasting blood glucose, lipid levels, urea nitrogen and creatinine as well as tests of physical function including walking speed. *Results*: Of the 7557 individuals eligible for the Handan Eye Study (HES), 6830 (90.4%) subjects participated the study. The majority of participants were female (53.6%), the average (± standard deviation) age was 52.3 (± 12.3) years, and 100% were self-identified Han people. In contrast to the non-participants, those who participated were more likely to be female, elderly, married, and had more years of education ($P < 0.05$). *Conclusion*: The HES successfully examined over 90% of eligible Han Chinese adults aged 30 and older from a rural region of north China. Results from the HES will provide key information about the prevalence, risk factors, impact, and trends of ocular disease in rural regions of China.**

INTRODUCTION

Data from population-based eye studies conducted in different countries, such as from the United States,[1–6] Australia,[7–10] Western Europe,[11–15] Singapore,[16–23] and Japan[24–28] have been used to guide public health policy and plan preventive strategies.[29–34] China is the most populous country in the world. Although there have been several population-based surveys conducted in China,[35–52] these have primarily been conducted in cities or nearby areas. For example, the Beijing Eye Study (BES) examined 4439 participants of 5324 individuals in 7 defined communities in Beijing in 2001, with a follow-up study in 2006. The BES has reported important data on the prevalence of and risk factors for eye diseases in this urban and peri-urban population and those living near the city.[45,53–60]

Received 8 December 2008; accepted 26 December 2008.
Keywords: Chinese, design, eye disease, methodology, population-based study
Correspondence to:
Dr. Ning li Wang
Beijing Tongren Eye Center
PLS FIX.Beijing Tongren Hospital
Capital Medical University
Beijing, China
No. 1 Dong Jiao Min Xiang
Dongcheng District
Beijing, 100730 China
email: wningli@trhos.com

Copyright © 2009 Informa Healthcare
Not for Sale or Commercial Distribution
Unauthorized users cannot download, display, view and print a single copy for personal use.
RIGHTSLINK

Figure 1. The location of the Handan Eye Study.

The majority of the Chinese (64%) live far from large cities like Beijing, however,[61] the prevalence of blindness and visual impairment, the specific causes of vision loss, the risk factors for these conditions, and the accessibility and barriers for eye care are largely unknown for these individuals.[62]

The Handan Eye Study (HES) was designed to determine the prevalence and impact of eye diseases among rural populations in China. Yongnian County, Handan, located in the south part of Hebei province (about 500 kilometers south of Beijing, Figure 1) has demographic characteristics similar to other rural Chinese locations according to the 2000 National Census (Table 1).[63] There are three hospitals which provide eyecare (including about 350 cataract surgeries per year). The cataract surgical rate in the region is similar to other parts of China.[64]

The objective of this article is to summarize the study design and procedures, to describe the strategies used to maximize participation in this study, and to present the baseline characteristics of this cohort.

METHODS

Study design

The HES is a population-based cohort study funded by the China Ministry of Science & Technology, China Ministry of Health, and Handan City Bureau of Science & Technology. It was designed to examine the prevalence and impact of eye disease in non-institutionalized, community dwelling persons aged 30 years or older in Yongnian County, Handan City, to determine both modifiable and non-modifiable risk factors that may be associated with ocular diseases and to understand the barriers to use of eye care services in this region. Ethics Committee approval was obtained from the Beijing Tongren Hospital review board, and written informed consent was obtained from all subjects, those who can not read or write were asked to stamp with right forefinger.[65]

Specific aims

The HES had 5 specific aims: (1) to determine the age-specific prevalence of blindness, visual impairment, and ocular disease among the rural population 30 years or older living in Yongnian County; (2) to determine the primary causes of blindness and visual impairment; (3) to identify risk factors for the presence of these conditions; (4) to determine the impact of blindness, visual impairment, and the presence of ocular disease and some systemic medical conditions on self-reported visual impairment and health-related quality of life; and (5) to evaluate utilization of eye care service in the countryside.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

Table 1. Demographic Characteristics of Yongnian Inhabitants Comparing with National Rural and Urban Residents in the Fifth National Census 2000

Characteristics	Yongnian County	Rural areas	Urban areas
Population	828, 897	783, 841, 243	458, 770, 983
Yearly Income(¥)*	2751	2253	6280
Gender (%)			
Male	50.62	51.67	51.28
Female	49.38	48.33	48.72
Age (%)			
0–9	14.48	14.09	10.62
10–19	24.32	19.19	17.01
20–29	15.84	15.61	19.58
30–39	15.96	18.14	20.54
40–49	12.83	12.95	14.22
50–59	8.18	9.10	8.36
60–69	4.94	6.30	5.91
70–79	2.78	3.58	2.94
80+	0.66	1.04	0.83
Marital (%)†			
Single	26.10	18.77	22.59
Married	67.97	74.06	72.02
Divorced	0.42	0.69	1.25
Widow/widower	5.50	6.49	4.14
Education (%)‡			
Illiteracy	7.98	9.56	4.71
Half-illiteracy	1.34	2.30	0.95
Primary	37.10	46.00	25.03
Middle School	46.20	35.89	37.57
High School	6.09	5.73	22.42
College and above	1.29	0.53	9.32
Minority (%)	0.07	10.29	5.36

* 1¥ equal to 0.135 United States Dollar.
†Among those age 15 year and over.
Among those age 6 years and over. "Illiteracy" was defined as the disability to read any Chinese word; "Half-illiteracy" was present if the person could understand some of Chinese words, but could not get any useful information from the reading.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

Organizational structure

The organizers of the HES invited international epidemiologists to collaborate in the design of the study and in the preparation of all study procedures so that results could be standardized and comparable to the Singapore Malay Eye Study,[21,23] and the Blue Mountains Eye Study.[66] A hospital-based clinic was established in Yongnian County because it is centrally located in the study area. All research activities were managed by an Executive Group on a day-to-day basis, which reported the Steering Committee. To gain local support, the research team engaged representatives of Handan City as well as the Yongnian local government.

Sample size considerations

The sample size was targeted to achieve an adequate precision around estimates of prevalence and to allow for risk factor analyses to be carried out. As the prevalence of the main diseases in this cross-sectional baseline survey were estimated to be 2% or higher.[36,41,53,55,62,67–70] The present study can achieve a precision of 0.005 (d), considering a design effect of 1.5, with a sample of 4517.

$$n = \frac{z^2_{1-\alpha/2}P(1-P)}{d^2} \times \text{deff} = 4517$$

Assuming a response rate of 90% (which had been achieved in previous studies in China,[41,71,72], 5019 subjects would need to recruited to achieve the target study size. However, because one of the study aims was to develop a cohort for long-term follow-up, the target population included younger individuals with a low prevalence of ocular disease (those 30 to 49 years of age). We therefore increased the sample size by 2500 to include this younger group.

Some villages were randomly selected to have all persons 30 to 49 years of age included while others only had persons 50 years of age and over examined. Each village maintained an official list of persons living in the area and this was used as the sampling frame after updating the list in consultation with the local village leaders. Since we expected that 10% of the names on the registrations lists would be incorrect, we set our total sample at 8354 subjects.

RIGHTSLINK

Recruitment procedure1

A total of 13 villages were randomly selected using a clustered sampling technique with probabilities proportionate to the size of the population in each cluster. villages were There was door-to-door screening of 8653 names listed in the selected census, and 7557 persons were confirmed as eligible. We contacted the leaders of the target villages, and explained the importance of the HES. We also used local media such as television and radio to publicize the study. Depending on the village selected, individuals had to be either 30 or 50 years of age or older, and to be resident at least 6 months in the target village to be eligible.

A letter was sent to each potential subject's home address inviting him/her to participate in the study.

At least three days before, a visit to the potential subject's home was made by local organizers (usually the head of village and/or village doctors) and the nature of the study was explained in detail by recruitment staff (one ophthalmologist and two assistants). The subject was invited for an eye examination, and travel to the clinic was scheduled. All conversations conducted by HES staff were carried out in the local dialect. If the residents were unwilling to visit the clinic after three home visits, a slightly abbreviated examination conducted in the village (as opposed to the central study clinic) was offered. For those who did not attend the village examination, a brief home examination was offered.

Persons who had moved from the given home address, had not lived in the village in the past 6 months, were deceased or terminally ill (life expectancy less than 3 months, decided by the village doctors), or had severe mental disease were ineligible.

Operational strategies

Subjects could be examined in one of three locations: a central clinic in the county hospital, a temporary clinic in the targeted villages, or at the participant's home. Free transportation was provided to the central clinic, and more devices were available there than that in the village examination sites. The home visit consisted of visual acuity testing and evaluation of the fundus with a direct ophthalmoscope without pupil dilation.

In order to overcome language barriers and trust issues, all interviewers and coordinators were employed from local hospital or medical schools. To obtain fasting blood samples, the collection team arrived in the village early in the morning and blood centrifugation was done on site with samples stored in an icebox prior to transfer to the hospital refrigerator.

All the examinations were provided for free, and a senior ophthalmologist explained the results of the evaluations to the participants. We provided free cataract surgery to those with vision loss due to cataract and referred participants to the Handan Eye Hospital and Yongnian County Hospital (with a 30% reduction in fees) who had other findings in need of care.

Central clinic examination

1. Registration: The subject's name, demographic details and written informed consent were obtained. We used an identity card (ID) card or Chinese household "hukou" book to confirm that participants were indeed residents of the village. For those who did not bring their ID cards or had missing photos from the "hukou" book, we took a head photograph of these participants and re-confirmed their eligibility with three to five villagers who were not involved in the recruitment work.
2. Questionnaires: Subjects were interviewed by trained staff about demographic information, quality of life (EuroQol-5D, VF/QoL),[71,73,74] and cognitive status (the MiniMental State Examination, MMSE)[75] as well as medical conditions, family history of eye diseases, and barriers for seeking eye care. (Appendix III)
3. Physical Examination: Height, weight, waist-hip circumference, pulse rate, and blood pressure were measured according to a standardized protocol by certified nurses.[23]
4. Autorefraction and Visual Acuity (VA): Presenting VA, wearing present correction if spectacles were brought by the subject to the clinic, was tested monocularly (right followed by left eye) and binocularly using a Logarithmic VA Chart (Precision Vision, La Salle, IL, USA) at a distance of 4 meters. The contralateral eye was occluded with an eye patch for monocular measurements. Those who could not read any letters at 4 meters were asked to move closer to the chart and were tested at one meter allowing for the measurement of acuities as low as 1/40 (0.025). Subjective refraction was performed on all subjects with vision worse than 1.0 (less than 20/20) in either eye using a trial frame placed and adjusted on the participant's face. Auto refractor-Keratometer (with KR8800,Topcon,Tokyo,Japan) readings were used as the starting point and refinement of sphere, cylinder and cylinder axis were performed until the best corrected VA (BCVA) was obtained by a trained optometrist.
5. Intraocular Pressure (IOP): IOP was measured by Kowa applanation tonométer HA-2 (Kowa Company Ltd. Tokyo, Japan) in cooperative participants. When IOP could not be obtained with the Perkins tonometer, it was measured using Schiotz tonometer and digital palpation.[76]
6. Optic Disc Imaging: The optic disc was imaged with the Heidelberg Retina Tomography (HRT II, Heidelberg Engineering, Heidelberg, Germany) after cylinder lens correction was determined (to place in the machine) without pupil dilation. When the image quality was poor (standard deviation of more than 30 μm), a repeat image was obtained after pupil dilation.
7. Retinal Nerve Fiber Layer (RNFL) Imaging. The RNFL was imaged using the Zeiss GDx VCC system (Zeiss Company, Dublin, CA, USA) on 1 in 10 study subjects and on all glaucoma suspects. In addition, the Stratus Optical Coherence Tomography 3 (OCT3) device (Carl Zeiss, Jena, Germany) was used to measure the RNFL thickness using the fast RNFL thickness protocol after pupil dilatation.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

8. Visual Field Testing: The visual field (VF) was tested using the Humphrey Visual Field Analyzer 750i (Carl Zeiss, Jena, Germany) using the Swedish interactive threshold algorithm fast program 24-2 on 1 in 10 participants who attended the central clinic, and on all glaucoma suspects. Those with abnormal or borderline results using the glaucoma hemifield test and those with unreliable tests were given a second visual field test after 20 minutes rest. And all those who had a history of glaucoma, ocular hypertensives (IOP > 21 mmHg) and those with cup:disc ratio(CDR) greater than 0.6., having a history of glaucoma, were invited to repeat the VF test on a separate day during August 2007 to October 2007.
9. Slit Lamp Examination: The anterior and posterior segments were examined at the slit lamp.
10. Gonioscopy: Gonioscopy was performed on 1 in 10 subjects as well as all who were found to have limbal anterior chamber depth (LACD) less than or equal to 40% of limbal corneal thickness by a single clinician who had undergone standardization with a modified scheme introduced by Foster and colleagues[77] using a Magnaview lens (Ocular Instruments, Bellevue, Washington, USA) and a 4-mirror Sussman lens (Ocular Instruments, Bellevue, Washington, USA) for indentation when needed.
11. Anterior Segment Optical Coherence Tomography: The anterior segment was imaged using the Visante anterior segment OCT (Carl Zeiss, Jena, Germany) on all subjects examined at the central clinic.
12. Ocular Biometry: Axial length, anterior chamber depth and lens thickness were measured using a 10 MHz A/B-mode ultrasound device (Cine Scan, Quantel Medical, Clermont-Ferrand, France). Standard deviation of anterior chamber depth measurement <0.13 mm was required to accept the measurement. Corneal thickness was measure using an ultrasound pachymetry (UP1000, NIDEK, Inc. Tokyo, Japan).
13. Lens Grading: The Lens Opacification Classification System III (LOCS III) was used to grade the degree of lenticular opacity with slit lamp microscopy after pupil dilation by reference to the standard photos.[78]
14. Fundus Photography: Digital images of the macula and optic nerve were obtained. Using the TOPCON TRC-NW6S/7S (TOPCON Corporation, Tokyo, Japan), a non-mydriatic retinal camera system, stereoscopic photographs of Early Treatment of Diabetic Retinopathy Study (ETDRS) Standard Field 1 (centered on the disc), a non-stereoscopic photograph of Standard Field 2 (centered on the fovea), Standard Field 3 (centered so that the fovea was included) and Standard Fields 4 and 5 (centered on the super and inferior quadrants) were obtained.[79] Digital color stereoscopic photographs of optic nerve head were obtained with the Canon CR-DGi (Canon, Tokyo, Japan) non-mydriatic retinal camera by rotating the camera 5 degrees between images.
15. Other Measurements of Physical Function: Electrocardiogram was obtained on all who attended the central clinic. Ankle-brachial index, toe-brachial index, and pulse wave velocity were measured with a Colin BP-203RPE II (VP-1000) (Colin, Komaki, Japan). Physical mobility testing was also measured according to protocol.[80,81]
16. Blood Collection: Every subject who agreed to participate in the study was requested to fast for at least 8 hours prior to blood drawing, and this was facilitated by collecting blood in the villages between 7:00 and 9:00 a.m. Sterile vacuum tubes with and without ethylenediaminetetraacetic acid (EDTA) were used, and centrifugation was done in the village soon after blood collection. Blood cells were stored in 3 one-millimeter vials for frozen storage as a DNA bank. One sample of serum was used for biochemical analysis and the others were stored in –70° environment for possible later epidemiological molecular studies. Serum was analyzed for (a) lipids: total cholesterol, total triglycerides, low density lipoprotein (LDL) cholesterol, and high density lipoprotein (HDL) cholesterol, (b) serum creatinine, (c) blood urea nitrogen, and (d) fasting glucose in the laboratory of Handan Central Hospital (the quality control in the laboratory was certified and monitored yearly by Ministry of Health, China).
17. Urine Collection: Urine was collected at the same time of blood drawing into a clean plastic cup and brought back to the laboratory of Handan Central Hospital for analysis.

Village clinical examination (abbreviated exam)

For those subjects who did not present for a complete examination at the central clinic we offered an abbreviated exam carried out in the local village. This examination included:

1. Registration and ID confirmation
2. VA test, autorefraction and subjective refraction
3. Questionnaires
4. Anterior segment exam with a slit lamp
5. ankle-brachial index/toe-brachial index (ABI /TBI)
6. Blood pressure, height, weight, waist-hip ratio
7. IOP assessment
8. Gonioscopy
9. Dilated examination and photography (field 1 and field 2) of the fundus.

All these examinations were the same as those conducted in the central clinic.

Home examination

An abbreviated examination was conducted on participants who were unable or refused to have an examination in the village. Presenting VA was assessed using a 4 meter logMAR VA chart. Anterior segment examination was carried out using a portable hand-held slit lamp (Kowa SL 15, KOWA Company Ltd. Tokyo, Japan). The fundus was examined using a direct

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

ophthalmoscope without pupil dilation. The cause of visual impairment was determined by the examining ophthalmologist on the basis of this limited exam. In cases where VA testing was difficult due to patient cooperation, the examining ophthalmologist determined whether or not the vision was decreased or normal, and if decreased, those felt to have vision worse than 20/400 were considered to be blind.

At the end of the examination, a senior ophthalmologist reviewed the results of all procedures and provided a diagnosis and recommendation to all participants. A report was given to participants who required referral and follow up investigations.

Primary outcome measures (Appendix IV)

World Health Organization definitions were used for blindness (VA worse than 20/400 in the better seeing eye) and visual impairment (VA worse than 20/60 in the better seeing eye).[65] Causes of visual impairment and blindness were determined by two ophthalmologists based on the clinical examination and reported history. For cases where two ophthalmologists disagreed, a third senior ophthalmologist adjudicated the decision.

Cataract was defined based on the LOCS III grade[78,82] in four major groups: nuclear opalescence (NO), nuclear color (NC), cortical (C), and posterior subcapsular (P). Definitions of cataracts were based on similar criteria published by other groups using the LOCS III system.[19] Any cataract was defined as the presence, in at least one eye, of significant nuclear, cortical, or posterior subcapsular cataract, as defined above.

Graders of retinal photographs were trained and certified at the Retinal Vascular Imaging Centre, University of Melbourne, Melbourne, Australia. Age-related macular degeneration (AMD) was graded using the Wisconsin AMD classification system.[2]

Diabetic retinopathy (DR) was defined as retinopathy in persons with diabetes mellitus (fasting plasma glucose of 7.0 mmol/L or higher) or a history of diabetes on medication. DR was graded based using the protocol developed for the Multi-Ethnic Study of Atherosclerosis.[83] DR was present if any characteristic lesions were seen as defined by the ETDRS severity scale.[84] For each eye, a retinopathy severity score was assigned as follows according to a scale modified from the Airlie House Classification System.[85]

Definite glaucoma was defined according to the consensus panel recommendations of the Association of International Glaucoma Societies.[86,87] Those not meeting the definition of definite glaucoma who have suspicious appearing optic nerve features will be categorized as probable glaucoma based on the consensus of three glaucoma specialists reviewing all relevant information of history, VF and stereo photographs of the optic nerve.

Statistical analysis and quality control

Statistical analysis will be performed using standard statistical software (SAS9.1.3). Prevalence estimates for all outcomes (visual impairment, cataract. etc.) will be performed in age- and gender-stratified groups. As our study population was selected in two age groups (30–49 and 50+ years), age-adjusted prevalence will be calculated using direct adjustment to the Chinese population from the 2000 China census. Differences in prevalence between age groups and gender will be analyzed using chi-square test. For risk factor analysis (e.g., hypertension and cataract), we will compare frequency of the risk factor (e.g., hypertension) in people with and without the outcome of interest (e.g., cataract) use chi-square tests. We will perform multiple logistic regressions to control for effects of age, gender, and other potential confounders. For continuous traits, t-tests, analysis of variance (ANOVA), analysis of covariance (ANCOVA), and linear regressions models will be used. In addition, both person-specific and eye-specific analyses will be conducted; the later using generalized estimating equation (GEE) models.

Quality control procedures were implemented throughout the study. Data quality was supervised by an epidemiologist (SYZ), and two senior ophthalmologists (XRD,XHY) who worked and lived at the field site. The clinicians and ophthalmologists performing visual acuity testing, IOP measurement, LOCS III grading, cup-to-disc ratio (CDR) estimation, LACD estimation, and anterior chamber angle were certified by specialist before the study started. Consistency between the three clinicians performing visual acuity testing, two ophthalmologists performing IOP measurement, LOCS III grading, CDR estimation, LACD estimation, and anterior chamber angle were compared during a pilot study and was reassessed at the intermediate stage of the study (February 2007).

Paired ophthalmologists or clinicians examined the same subjects and results of 30 cases were recorded for each item to insure consistency and lack of drift. For the reliability, we did analysis with intraclass correlation co-efficiency (ICC) for continuous variables and Kappa value for categorical variables. The ICC was 0.68 for IOP, and other ICCs were above 0.75 for VA, A-scan, CDR assessment, LACD, and LOCSIII grading. The kappa value for peripheral anterior synechiae (PAS) in dynamic gonioscopy was 0.84 and above. In March 2007, we repeated the reliability tests, all ICCs were above 0.950.

RESULTS

Recruitment and baseline characteristics

During the period from October 2006 to October 2007, a total of 6830 participants were recruited and completed an eye examination (Figure 2). Participants numbering 7,557 were eligible for HES and 6,830 took part in the study (90.4% response rate). Of all the subjects, 5,909 (86.5%) were examined in the central clinic, 807 (11.8%) in a temporary study site at the village, and 114 (1.7%) at home.

All participants were self-identified Han people, although 10 persons (0.1%) reported that either a parent or grandparent was one of the Chinese minorities. Of the non-participants, 142 subjects (19.5%) declined to participate, 137 subjects (18.8%) agreed but did not present after 3 to 6 appointments were made and were therefore considered refusals, and 448 subjects (61.6%) were temporally outside of Yongnian County. Comparing those who participated in any examination, those who did not participate were more likely to be male,

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

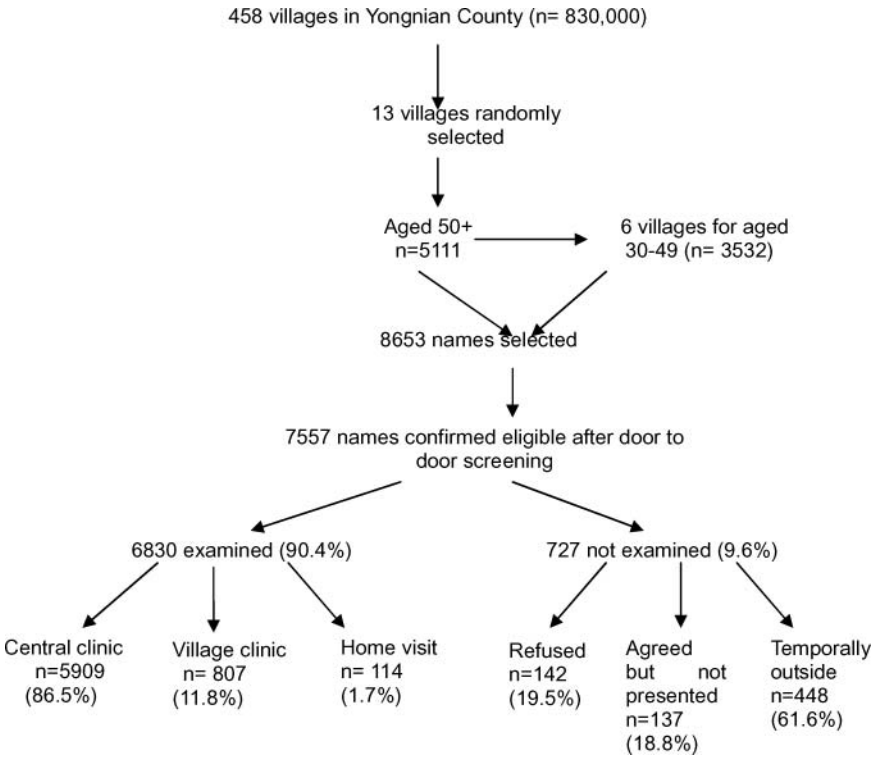

Figure 2. Flowchart for ascertainment of the Handan Eye Study cohort. Five thousand and nine hundred nine persons completed an eye examination in central clinic. Eight hundred and seven persons completed an abbreviated eye examination in village clinic, one hundred and fourteen completed visual acuity test in home.

younger, not married, and to have fewer years of education (Table 2).

Table 3 summarizes the demographic, socioeconomic, and clinical characteristics of the 6830 participants who completed an eye examination. The majority of the participants were female (53.7%), the average (± standard deviation [SD]) age was 52.3 (±12.3) years, 97% had completed middle school or lower, 90.2% were married, 40% had an annual income of less than 3500 ¥ (which is close to the average income for mainland China 2005), 5.4% had some form of medical insurance, and the mean score of self-reported quality of life (using the EQ5D) was 73.1 (100 = excellent, 0 = worst). Nearly 20% had been diagnosed previously with hypertension, 2.0% with diabetes, 2.6% with a cerebrovascular accident, and 5.0% stated they had been diagnosed with heart disease.

Comparing those who participated and came to the central clinic to those who were examined in the village, those attending the village exams were more likely to be male, older, have fewer years of formal education , have better self-reported health, and higher incomes ($p < 0.05$) (Table 3). A slightly higher prevalence of self-reported hypertension, diabetes, or heart disease was found in those examined in the central clinic ($p < 0.05$).

There was a statistically significant difference in the crude prevalence rate of presenting blindness and low vision depending on where the examinations took place (Table 4). The prevalence of blindness was 0.4 % among those examined in hospital clinic, 1.3% at the village clinics, and 8.8% at home ($p < 0.001$ adjusted for age and sex). For low vision, the prevalence was 4.7% at the central clinic, 7.3% at the village clinics, and 23.9% at home ($p < 0.001$ adjusted for age and sex).

DISCUSSION

The HES was designed to provide population-based data on the frequency and risk factors of visual impairment and the major sight-threatening eye diseases in a rural population from north China. Data from the HES will provide insight into issues regarding barriers to prevention and treatment of the most common eye diseases in the Chinese countryside.

Key features of the study design and methodology of the HES deserve further discussion. With respect to the sampling frame, we employed probabilities proportionate to the size of the population to select the cluster, regarding one natural village as one cluster in order to improve logistics and increase participation and follow-up.[88] We selected 13 clusters for subjects aged 50 years and over, providing complete evaluations for all persons of this age living in each cluster. For those aged 30 to 49 years group, only 6 of the 13 villages were randomly selected so that all subjects meeting age requirements in these villages were also examined.

Because the HES used the same protocols as other investigators,[23,66] there is the potential for data pooling to investigate racial/ethnic and inter-country differences. The HES also intends to compare eye disease prevalence rates between

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

Table 2. Demographic Characteristics for Participants and Nonparticipants in the Handan Eye Study

	Nonparticipants(%) (n = 727)	Participants (%) (n = 6830)	*P* *
Gender			
Male	53.2	46.3	<0.001
(Mean±SD)	49.9 ± 14.7	52.3 ± 12.1	<0.001
Age			
30–39	32.2	18.1	<0.001
40–49	18.7	19.5	
50–59	25.0	36.5	
60–69	9.9	16.4	
70–79	11.6	8.7	
80+	2.6	1.1	
Geographic location			
Plain	89.4	90.0	0.631
Hills	10.6	10.0	
Marital status			
Married	88.0	90.4	0.040
Education			
Illiteracy†	15.9	11.6	
Half-illiteracy (<1year) ‡	4.7	4.4	0.653
Primary school (1–5 years)	40.2	49.9	<0.001
Middle school (6–8 years)	36.4	31.2	0.001
High school or above (9– 11years)	2.7	2.9	0.031

SD: standard deviation.
Chi-square test for categorical variables: gender, age groups, geographic condition, and marital status: student's test for continuous variables: age. and logistic regression analysis for the correlation between education level and response to participate adjusted by age and gender.
†"illiteracy" was defined as the disability to read any Chinese word.
‡"Half-illiteracy" was present if the person could understand some of Chinese words, but could not get any useful information from the reading.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

urban and rural areas in China and therefore followed classification schemes used in the BES. Many of the testing protocols of the HES were not performed in BES. These include HRT, posterior segment OCT, GDx_VCC, digital sequential optic nerve photos, A-scan, wavefront scanning of the cornea, ABI, TBI and electrocardiogram, and tests of physical function. All of these examinations used standardized protocols, and grading of images also following international standards. This will once again allow for comparative analyses across populations.

Strengths and limitations

As noted above, the examinations were standardized and reproducible with a strong emphasis on quality control. In addition, the HES enrolled younger study subjects (persons 30 to 39 years of age) in order to both offer insight into the vision problems faced by this group, and to develop a cohort for longitudinal study of changes over time. The HES focused exclusively on a rural population, one that has not been well studied previously. Prospective evaluation of this cohort will offer insight into how urbanization and industrialization are affecting eye health in these regions of China. Finally, the HES studied a large number of individuals and achieved a high response rate (over 90% examined).

Important limitations remain in the HES. First, those presenting to the central clinic setting had lower rates of visual impairment than those seen in the villages or at home. Although 78.2% of eligible subjects nearly completed all the examinations, those recruited in the village were more likely to suffer from visual impairment, and less likely to have a history of hypertension, diabetes, and heart disease. They also had a higher score of self-rated health status. Therefore, we may potentially overestimate the rate of vascular related eye disease since this will be derived from fundus photos on those attending the central clinic.

Second, there could be a selection bias as a result of excluding residents who worked outside the county for 6 months (6.8%, 585 of 8,653 target population), as most of these persons were healthy and young, and therefore likely had normal vision. This could have led to a slight overestimation of the prevalence of blindness and low vision in the youngest persons studied.

Third, many of the questionnaires used in this study were originally developed for use in Western populations where life conditions and cultures are different from those in rural regions of developing countries. Responses to those questionnaires may not fully capture the experience or rural residents of China. Finally, since healthcare services are limited in rural China, self-reported medical illness may be inaccurate or under representative of the true prevalence of disease.

In summary, the HES is the largest comprehensive prevalence survey of eye diseases carried out in a rural population in China. Village-based examination was an important operational strategy to overcome problems with participation when using only a central clinic. Those seen in the villages had a higher prevalence of blindness and low vision. The HES will provide data on the

RIGHTSLINK

Table 3. Comparison of Characteristics of the Population Examined at the Central Clinic and in Village Clinics or at Home in the Handan Eye Study

Characteristics	N	%	Central Clinic (%)	Village or Home (%)	P‖
Landform					
Plains	6145	90	90.2	88.8	0.205
Hills	685	10	9.8	11.2	
Age					
30–39	1238	18.1	17.3	23.7	<0.001
40–49	1329	19.5	20.4	13.6	
50–59	2471	36.2	37.8	26	
60–69	1119	16.4	16.8	13.6	
70–79	597	8.7	7.2	18.5	
80+	76	1.1	0.6	4.7	
Gender					
Male	3166	46.4	45.2	54	<0.001
Female	3664	53.6	54.8	46	
Educational					
Illiteracy*	786	11.5	11	15	0.004
Half-illiteracy†	300	4.4	4.4	4.3	
Primary school	3389	49.6	50.5	45.6	
middle school	2121	31	30.9	32.9	
high school	199	2.9	3	2.3	
college	2	0.03	0.03	0	
Marital status					
Single	96	1.4	1.3	2.1	<0.001
Married	6163	90.2	91.2	85, 8	
Divorced	16	0.2	0.2	0.4	
Widow/widower	541	7.9	7.3	11.8	
Medical insurance	371	5.4	5.5	5.1	0.018
Individual income level yearly					
< 3500 ¥	2679	39.2	51.6	34.3	<0.001
< 5000 ¥	1481	21.7	27.9	24.7	
< 9000 ¥	543	7.9	9.5	15.9	
> 9000 ¥	667	9.8	11.1	25.1	
Self reported health score§	73 ± 18		72 ± 19	81 ± 9	<0.001
History of hypertension	1336	19.60%	21.1	18	0.048
History of diabetes	140	2%	2.3	1.2	0.044
History of stroke	177	2.60%	2.6	3.4	0.204
History of heart disease	344	5.00%	5.7	3.8	0.033

* "Illiteracy" was defined as the disability to read any Chinese word.
†"Half-illiteracy" was present if the person could understand some of Chinese words, but could not get any useful information from the reading.
‡1 ¥ equal to 0.135 United States Dollar
§100= excellent, 0 = worst
‖Chi-square test for categorical variables, student's test for continuous variables.

Table 4. Crude Prevalence Rate of Presenting Visual Impairment in Three Examination Sites

		Presenting Visual Acuity n (%)			*P*∗
Examination Site	*N*	<0.05	>=0.05 but <0.3	>=0.3	
Hospital-based central clinic	5890	21(0.4)	276(4.7)	5593(95.0)	<0.001
Village clinic	795	10(1.3)	58(7.3)	727(91.4)	
Home	114	10(8.8)	27(23.9)	77(67.3)	
Total†	6799	41(0.6)	361(5.3)	6397(94.1)	

* Kruskal Wallis nonparametric test
†Presenting visual acuity was available in 6799 persons.

eye health of those dwelling in rural area of China and on the impact that eye disease has on these persons. The longitudinal follow up of this cohort will allow us to identify changes that occur with aging and urbanization of the Chinese population.

DECLARATION OF to INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

ACKNOWLEDGMENTS

This study was supported by National Basic Research Program of China (973 Program), Grant 2007CB512201 from the Ministry of Science and Technology of the People's Republic of China, the Program of Health Policy for blindness prevention from Ministry of Health the People's Republic of China, Partially founded by the Key Technologies R&D Program.No.2006-10903 from Bureau of Science and Technology of Handan City, Hebei Province, China. With additional supports from Beijing Tongren Hospital and key discipline fund of Bureau of Health, Handan city, Hebei Province, China.

REFERENCES

1. Klein R, Klein BE, Lee KE, et al. Changes in visual acuity in a population over a 10-year period : The Beaver Dam Eye Study. *Ophthalmology*. 2001;108(10):1757–1766.
2. Klein R, Klein BE, Linton KL. Prevalence of age-related maculopathy. The Beaver Dam Eye Study. *Ophthalmology*. 1992;99(6):933–943.
3. Rahmani B, Tielsch JM, Katz J, et al. The cause-specific prevalence of visual impairment in an urban population. The Baltimore Eye Survey. *Ophthalmology.* 1996;103(11):1721–1726.
4. Munoz B, West SK, Rubin GS, et al. Causes of blindness and visual impairment in a population of older Americans: The Salisbury Eye Evaluation Study. *Arch Ophthalmol.* 2000;118(6):819–825.
5. McGuinness R. The Framingham Eye Study. *Am J Ophthalmol*. 1978;86(6):852–853.
6. Varma R, Paz SH, Azen SP, et al. The Los Angeles Latino Eye Study: Design, methods, and baseline data. *Ophthalmology.* 2004;111(6):1121–1131.
7. Mitchell P, Wang JJ, Smith W, Leeder SR. Smoking and the 5-year incidence of age-related maculopathy: The Blue Mountains Eye Study. *Arch Ophthalmol.* 2002;120(10):1357–1363.
8. Mitchell P, Wang JJ, Foran S, Smith W. Five-year incidence of agerelated maculopathy lesions: The Blue Mountains Eye Study. *Ophthalmology.* 2002;109(6):1092–1097. yes
9. Mitchell P, Smith W, Attebo K, Wang JJ. Prevalence of age-related maculopathy in Australia. The Blue Mountains Eye Study. *Ophthalmology.* 1995;102(10):1450–1460.
10. Livingston PM, Carson CA, Stanislavsky YL, et al. Methods for a population-based study of eye disease: The Melbourne Visual Impairment Project. *Ophthalmic Epidemiol.* 1994;1(3):139–148.
11. Vingerling JR, Hofman A, Grobbee DE, de Jong PT. Age-related macular degeneration and smoking. The Rotterdam Study. *Arch Ophthalmol*. 1996;114(10):1193–1196.
12. Andersen K, Launer LJ, Ott A, et al. Do nonsteroidal anti-inflammatory drugs decrease the risk for Alzheimer's disease? The Rotterdam Study. *Neurology.* 1995;45(8):1441–1445.
13. Vingerling JR, Dielemans I, Hofman A, et al. The prevalence of age-related maculopathy in The Rotterdam Study. *Ophthalmology.* 1995;102(2):205–210.
14. Buch H, Vinding T, la Cour M, et al. Risk factors for age-related maculopathy in a 14year follow-up study: the Copenhagen City Eye Study. *Acta Ophthalmol Scand*. 2005;83(4):409–418.
15. Buch H, Nielsen NV, Vinding T, et al. 14-year incidence, progression, and visual morbidity of age-related maculopathy: The Copenhagen City Eye Study. *Ophthalmology*. 2005;112(5):787–798.
16. Foster PJ, Oen FT, Machin D, et al. The prevalence of glaucoma in Chinese residents of Singapore: A cross-sectional population survey of the Tanjong Pagar district. *Arch Ophthalmol*. 2000;118(8):1105–1111.
17. Wong TY, Foster PJ, Hee J, et al. Prevalence and risk factors for refractive errors in adult Chinese in Singapore. *Invest Ophthalmol Vis Sci*. 2000;41(9):2486–2494.
18. Wong TY, Foster PJ, Ng TP, et al. Variations in ocular biometry in an adult Chinese population in Singapore: The Tanjong Pagar Survey. *Invest Ophthalmol Vis Sci*. 2001;42(1):73–80.
19. Seah SK, Wong TY, Foster PJ, et al. Prevalence of lens opacity in Chinese residents of Singapore: The Tanjong Pagar Survey. *Ophthalmology*. 2002;109(11):2058–2064.
20. Saw SM, Wong TY, Ting S, et al. The relationship between anterior chamber depth and the presence of diabetes in the Tanjong Pagar Survey. *Am J Ophthalmol.* 2007;144(2):325–326.
21. Lamoreux EL, Chong E, Wang JJ, et al. Visual impairment, causes of vision loss, and falls: The Singapore Malay Eye Study. *Invest Ophthalmol Vis Sci.* 2008;49(2):528–533.
22. Su DH, Wong TY, Wong WL, et al. Diabetes, hyperglycemia, and central corneal thickness The Singapore Malay Eye Study. *Ophthalmology.* 2007.
23. Foong AW, Saw SM, Loo JL, et al. Rationale and methodology for a population-based study of eye diseases in Malay people: The Singapore Malay Eye Study (SiMES). *Ophthalmic Epidemiol*. 2007;14(1):25–35.
24. Yamamoto T, Iwase A, Araie M, et al. The Tajimi Study report 2: Prevalence of primary angle closure and secondary glaucoma in a Japanese population. *Ophthalmology.* 2005;112(10):1661–1669.
25. Tomidokoro A, Araie M, Iwase A. Corneal thickness and relating factors in a population-based study in Japan: The Tajimi Study. *Am J Ophthalmol.* 2007;144(1):152–154.
26. Iwase A, Suzuki Y, Araie M, et al. The prevalence of primary open-angle glaucoma in Japanese: The Tajimi Study. *Ophthalmology*. 2004;111(9):1641–1648.
27. Miyazaki M, Kubota T, Kubo M, et al. The prevalence of pseudoexfoliation syndrome in a Japanese population: The Hisayama Study. *J Glaucoma*. 2005;14(6):482–484.
28. Hosoki R, Hisayama T, Takayanagi I. Some characterization of the responses to substance P and other tachykinins in rabbit iris sphincter muscle. *Jpn J Pharmacol.* 1985;37(2):159–165.
29. Congdon N, O'Colmain B, Klaver CC, et al. Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol*. 2004;122(4):477–485.
30. Congdon N, Vingerling JR, Klein BE, et al. Prevalence of cataract and pseudophakia/aphakia among adults in the United States. *Arch Ophthalmol*. 2004;122(4):487–494.
31. Friedman DS, O'Colmain BJ, Munoz B, et al. Prevalence of age-related macular degeneration in the United States. *Arch Ophthalmol*. 2004;122(4):564–572.
32. Friedman DS, Wolfs RC, O'Colmain BJ, et al. Prevalence of open-angle glaucoma among adults in the United States. *Arch Ophthalmol*. 2004;122(4):532–538.
33. Kempen JH, Mitchell P, Lee KE, et al. The prevalence of refractive errors among adults in the United States, Western Europe, and Australia. *Arch Ophthalmol.* 2004;122(4):495–505.
34. Kempen JH, O'Colmain BJ, Leske MC, et al. The prevalence of diabetic retinopathy among adults in the United States. *Arch Ophthalmol*. 2004;122(4):552–563.
35. He M, Foster PJ, Ge J, et al. Gonioscopy in adult Chinese: The Liwan Eye Study. *Invest Ophthalmol Vis Sci*. 2006;47(11):4772–4779.
36. He M, Foster PJ, Ge J, et al. Prevalence and clinical characteristics of glaucoma in adult Chinese: A population-based study in Liwan District, Guangzhou. *Invest Ophthalmol Vis Sci.* 2006;47(7):2782–2788.
37. He M, Foster PJ, Johnson GJ, Khaw PT. Angle-closure glaucoma in East Asian and European people. Different diseases? *Eye.* 2006;20(1):3–12.
38. He M, Zeng J, Liu Y, et al. Refractive error and visual impairment in urban children in southern China. *Invest Ophthalmol Vis Sci.* 2004;45(3):793–799.
39. Hu C, Zhao J, Pizzarello LD, et al. Cataract free zone and primary health care approach to prevention of blindness in Shunyi county of Beijing. *Chin Med J (Engl.)* 1996;109(7):561–565.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

40. Hu TS, Zhen Q, Sperduto RD, et al. Age-related cataract in the Tibet Eye Study. *Arch Ophthalmol*. 1989;107(5):666–669.
41. Li S, Xu J, He M, et al. A survey of blindness and cataract surgery in Doumen County, China. *Ophthalmology.* 1999;106(8):1602–1608.
42. Li X. Incidence and epidemiological characteristics of rhegmatogenous retinal detachment in Beijing, China. *Ophthalmology*. 2003;110(12):2413–2417.
43. Negrel AD, Maul E, Pokharel GP, et al. Refractive Error Study in Children: Sampling and measurement methods for a multi-country survey. *Am J Ophthalmol*. 2000;129(4):421–426.
44. Wu M, Yip JL, Kuper H. Rapid Assessment of Avoidable Blindness in Kunming, China. Ophthalmology. 2008;115(6):969–974.
45. Xu L, Wang Y, Li Y, et al. Causes of blindness and visual impairment in urban and rural areas in Beijing: The Beijing Eye Study. *Ophthalmology.* 2006;113(7):1134 e1–e11.
46. Zhao J, Jia L, Sui R, Ellwein LB. Prevalence of blindness and cataract surgery in Shunyi County, China. *Am J Ophthalmol*. 1998;126(4):506–514.
47. Zhao J, Mao J, Luo R, et al. The progression of refractive error in school-age children: Shunyi district, China. *Am J Ophthalmol*. 2002;134(5):735–743.
48. Zhao J, Mao J, Luo R, et al. Accuracy of noncycloplegic autorefraction in school-age children in China. *Optom Vis Sci*. 2004;81(1):49–55.
49. Zhao J, Sui R, Jia L. [Prevalence of cataract and surgical coverage among adults aged 50 or above in Shunyi District of Beijing, China]. *Zhonghua Yan Ke Za Zhi*. 2001;37(1):3–8.
50. Zhao JL. [An epidemiological survey of primary angle-closure glaucoma (PACG) in Tibet]. *Zhonghua Yan Ke Za Zhi*. 1990;26(1):47–50. [in Chinese]
51. Zou H, Zhang X, Xu X, et al. Epidemiology survey of rhegmatogenous retinal detachment in Beixinjing District, Shanghai, China. *Retina*. 2002;22(3):294–299.
52. Zou HD ZX, Xu Xun, et al. Prevalence study of age related macular degeneration in Caojiadu blocks, Shanghai. *Zhonghua Yan Ke Za Zhi*. 2005;41(1):15–19. [in Chinese]
53. Li Y, Xu L, Jonas JB, et al. Prevalence of age-related maculopathy in the adult population in China: The Beijing Eye Study. *Am J Ophthalmol*. 2006;142(5):788–793.
54. Xu L, Chen JH, Li JJ, et al. [The prevalence and its screening methods of primary open angle glaucoma in defined population-based study of rural and urban in Beijing]. *Zhonghua Yan Ke Za Zhi*. 2004;40(11):726–732.[in Chinese]
55. Xu L, Li J, Cui T, et al. Refractive error in urban and rural adult Chinese in Beijing. *Ophthalmology*. 2005;112(10):1676–1683.
56. Xu L, Li J, Wang Y, Jonas JB. Anthropomorphic differences between angle-closure and open-angle glaucoma: The Beijing Eye Study. *Acta Ophthalmol Scand*. 2007;85(8):914–915.
57. Xu L, Li J, Zheng Y, et al. Intraocular pressure in Northern China in an urban and rural population: The Beijing Eye Study. *Am J Ophthalmol*. 2005;140(5):913–915.
58. Xu L, Li Y, Wang S, et al. Characteristics of highly myopic eyes: The Beijing Eye Study. *Ophthalmology.* 2007;114(1):121–126.
59. Xu L, Wang Y, Jonas JB. Incidence of nonarteritic anterior ischemic optic neuropathy in adult Chinese: the Beijing Eye Study. *Eur J Ophthalmol*. 2007;17(3):459–460.
60. You Q, Xu L, Jonas JB. Prevalence and associations of epiretinal membranes in adult Chinese: the Beijing eye study. Eye. 2008;22(7):874–879.
61. National Bureau of Statistics P. R. China. Major Figures of the 2000 Population Census. No 1. available at :http://www.cpirc.org.cn/en/e5cendata1.htm. Beijing. accessed: Dec.17, 2007.
62. Zhou Q, Friedman DS, Lu H, et al. The epidemiology of age-related eye diseases in Mainland China. *Ophthalmic Epidemiol.* 2007;14(6):399–407.
63. China Population & Development Research Center. The annual report of Chinese citizen income 2006. available at:http://www.cpirc.org.cn/tjsj/tjsj_cy_detail.asp?id=7938. Accessed: March 2, 2007.
64. Foster A. Cataract and "Vision 2020-The Right To Sight" Initiative. *Br J Ophthalmol*. 2001;85(6):635–637.
65. Liang YB, Friedman DS, Wong TY, et al. Prevalence and causes of low vision and blindness in a rural Chinese adult population: The Handan Eye Study. *Ophthalmology*. 2008;115:1965–1972.
66. Attebo K, Mitchell P, Smith W. Visual acuity and the causes of visual loss in Australia. The Blue Mountains Eye Study. *Ophthalmology.* 1996;103(3):357–364.
67. Hu C, Zhao JL, Liu XL. The epidemiological study of the blindness and low vision in Shunyi County of Beijing. Chin J Ophthalmol. 1988;24:322–326 [in Chinese].
68. Hu Z ZJ, Dong FT, et al. An epidemiologic study of fundus diseases in Shunyi County, Beijing. *Chin J Ocul Fundus Dis*. 1988;4(4):193–196.
69. Wong TY, Loon SC, Saw SM. The epidemiology of age related eye diseases in Asia. *Br J Ophthalmol*. 2006;90(4):506–511.
70. Xu L, Cui T, Yang H, et al. Prevalence of visual impairment among adults in China: The Beijing Eye Study. *Am J Ophthalmol*. 2006;141(3):591–593.
71. Zhao J, Sui R, Jia L, et al. Visual acuity and quality of life outcomes in patients with cataract in Shunyi County, China. *Am J Ophthalmol*. 1998;126(4):515–523.
72. Zhao J, Sui R, Jia L, Ellwein LB. [Prevalence of glaucoma and normal intraocular pressure among adults aged 50 years or above in Shunyi county of Beijing]. *Zhonghua Yan Ke Za Zhi*. 2002;38(6):335–339. [in Chinese]
73. Espallargues M, Czoski-Murray CJ, Bansback NJ, et al. The impact of age-related macular degeneration on health status utility values. *Invest Ophthalmol Vis Sci*. 2005;46(11):4016–4023.
74. Langelaan M, de Boer MR, van Nispen RM, et al. Impact of visual impairment on quality of life: a comparison with quality of life in the general population and with other chronic conditions. *Ophthalmic Epidemiol*. 2007;14(3):119–126.
75. West SK, Friedman D, Munoz B, et al. A randomized trial of visual impairment interventions for nursing home residents: Study design, baseline characteristics and visual loss. *Ophthalmic Epidemiol*. 2003;10(3):193–209.
76. SH, Specht K, et al. Transpalpebral tonometry: reliability and comparison with Goldmann applanation tonometry and palpation in healthy volunteers. *Br J Ophthalmol*. 2005;89(3):280–283.
77. Foster PJ, Devereux JG, Alsbirk PH, et al. Detection of gonioscopically occludable angles and primary angle closure glaucoma by estimation of limbal chamber depth in Asians: Modified grading scheme. *Br J Ophthalmol*. 2000;84(2):186–192.
78. Foster PJ, Wong TY, Machin D, et al. Risk factors for nuclear, cortical and posterior subcapsular cataracts in the Chinese population of Singapore: The Tanjong Pagar Survey. *Br J Ophthalmol.* 2003;87(9):1112–1120.
79. Diabetic Retinopathy Study Coordinating Center. *Diabetic Retinopathy Study: Manual of Operations*. Baltimore:: Diabetic Retinopathy Study Coordinating Center, 1972.
80. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49(2):M85–M94.
81. Friedman DS, Freeman E, Munoz B, et al. Glaucoma and mobility performance: The Salisbury Eye Evaluation Project. *Ophthalmology.* 2007;114(12):2232–2237.
82. Chylack LT, Jr., Wolfe JK, Singer DM, et al. The Lens Opacities Classification System III. The Longitudinal Study of Cataract Study Group. *Arch Ophthalmol*. 1993;111(6):831–836.
83. Wong TY, Klein R, Islam FM, et al. Diabetic retinopathy in a multi-ethnic cohort in the United States. *Am J Ophthalmol*. 2006;141(3):446–455.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK

84. Grading diabetic retinopathy from stereoscopic color fundus photographs—An extension of the modified Airlie House classification. ETDRS report number 10. Early Treatment Diabetic Retinopathy Study Research Group. *Ophthalmology.* 1991;98(5 Suppl):786–806.

85. Diabetic retinopathy study. Report Number 6. Design, methods, and baseline results. Report Number 7. A modification of the Airlie House classification of diabetic retinopathy. Prepared by the Diabetic Retinopathy. *Invest Ophthalmol Vis Sci.* 1981;21(1 Pt 2):1–226.

86. Foster P, He M, Liebmann J. Epidemiology, classification and mechanism. In: Weinreb R, Friedman D, editors, *Angle Closure and Angle Closure Glaucoma.* Kugler Publications, The Hague, The Netherlands. 2006.

87. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. *Br J Ophthalmol.* 2002;86(2):238–242.

88. Peters TJ, Eachus JI. Achieving equal probability of selection under various random sampling strategies. *Paediatr Perinat Epidemiol.* 1995;9(2):219–224.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

APPENDIX I: THE HAND AN EYE STUDY GROUP

Investigators

Ningli Wang, M.D., Ph.D.
David S. Friedman, M.D., Ph.D.
Tien Yin Wong, M.D., Ph.D.
Siyan Zhan, Ph.D.
Lanping Sun, M.D.
Yuanbo Liang, M.D., Ph.D.
Jie Jin Wang, M. Med., Ph.D.
Fenghua Wang, M.D.
Xinrong Duan, M.D.
Xiaohui Yang, M.D., Ph.D.
Qiang Zhou, M.D.
Qiushan Tao, Ph.D.
Wen Huang, M.D.
Jiangping Wen, M.D.
Jinggang Yang, M.D., Ph.D.

Project Manager

Yuanbo Liang, M.D., Ph.D.

Assistant project managers

Fenghua Wang, M.D.
Xinrong Duan, M.D.
Xiaohui Yang, M.D., Ph.D.
Qiang Zhou, M.D.
Qiushan Tao, M.P.H., Ph.D.

External Advisory Board Members

Jialiang Zhao, M.D.
Mingguang He, M.D., M.P.H., Ph.D.
Guanglu Wang, M.D.
Liang Xu, M.D.
Youqin Jiang, M.D.

APPENDIX II: STUDY COLLABORATORS

Ministry of Health, Beijing, China
World Health Organization Collaborating Center on Blindness Prevention, Beijing
Beijing Tongren Hospital, Capital Medical University, China
Government of Handan City, Hebei Province, China
Bureau of Health, Handan, Hebei Province, China
Bureau of Health, Yongnian County, Hebei Province, China
The First hHospital, Yongnian County, Hebei Province, China
Wilmer Eye Institute,
The Johns Hopkins University, Baltimore, Maryland, USA
Centre for Eye Research, Australia, University of Melbourne, Melbourne, Australia

APPENDIX III: QUESTIONNAIRE ADMINISTERED IN THE HANDAN EYE STUDY

Questionnaire Administered in the Handan Eye Study

	Questions
General information	Gender, age, villages
Socio-economical information	Job, household income, education, marital, ethnicity, medical insurance, religion beliefs, house
Quality of Life	EuroQol-5D, VF/QoL
Mental status	Mini-mental state examination(MMSE)
General health	History of high blood pressure, heart diseases, stroke, hyperlipidemia, diabetes, thyroid disease, kidney disease, migraine, Intermittent claudication, fractures, and other systemic diseases
Medications usage	History of using vitamin, aspirin, hormone or any other type of medications taken exceeding 30 days
Ocular diseases awareness and history	Awareness and history of glaucoma, cataract, age-related macular degeneration, diabetic retinopathy, history of ocular trauma, pyterygium, and other surgical history of eye disease
Eye care referral system	Eye complaints, willingness to seek eye service, the pathway for referral eye care system
Daily life (behavior)	History of tobacco, alcohol, and garlic usage, fruit and green vegetable eating, outdoor activity, nap or sleeping custom, the intensity of exercises, mobile usage
Refractive error	Near work load, awareness and barrier of correction
Family history	Number of family members having glaucoma, cataract, retinal pigmentosa, age-related macular degeneration, myopia, strabismus, nystagmus

RIGHTSLINK

APPENDIX IV: PRIMARY OUTCOME MEASUREMENT IN THE HANDAN EYE STUDY

Primary outcome measurement in the Handan Eye Study

Primary endpoint	Reference to	Definition	Method
Visual impairment	WHO definition	**Blindness:** 1)Presenting VA <20/400; or 2)best corrected VA<20/400 **Low vision:** 1) Presenting VA <20/6 and ≥20/400 or 2)Best corrected VA<20/6 and ≥20/400	Both presenting VA and best corrected VA were used
Cataract	LOCSIII grading system	**Any cataract:** Nuclear Opacity or Nuclear Color>4 or Cortical opacity >2 or Posterior subcapsular opacity>2 in at least one eye	With examination of slit lamp reference to standard grading photos.
Age-related macular degeneration(AMD)	Wisconsin classification system	1) **Early AMD:** soft indistinct or reticular drusen, hard or soft distinct 2) **Late AMD:** Presence of exudative AMD or geographic atrophy	Based on one macular-centered photo
Diabetic retinopathy(DR)	Based on the lesions defined by ETDRS	1) **Diabetes Mellitus**: fasting plasma glucose≥7.0 mmHg or A history of diabetes on medication. 2) **No DR**: levels 10 through 13 3) any DR: levels 14 through 80 4) **Minimal nonproliferative diabetic retinopathy (NPDR)**: levels 14 to 20 5) **Mild-moderate NPDR:** levels 31 to 41 6) **Severe NPDR to proliferative retinopathy:** levels 51 to 80	With 5 standard field photos, stereo-macular photos were not available
Glaucoma	by ISGEO	**Category 1:** 1) Cup: disc ratio (CDR) ≥ 97.5th percentile for the normal population, CDR asymmetry between the two eyes ≥ 97.5th percentile for the normal population, or a neuroretinal rim width reduced to ≤ 0.1 CDR (between 11 to 1 o'clock or 5 to 7 o'clock); 2) a definite visual field defect consistent with glaucoma **Category 2:** 1) CDR or CDR asymmetry≥99.5th percentile for the normal population;2) No other explanation for CDR findings **Category 3:** if not possible to examine the optic disc.1) VA < 3/60 and the IOP > 99.5th percentile, 2) VA < 3/60 and the eye shows evidence of glaucoma filtering surgery, or medical records were available confirming glaucomatous visual morbidity.	Based on sequential optic nerve photos, visual field, IOP, history of medication or filtery surgery
Probable glaucoma:		Defined based on consensus of three glaucoma specialists reviewing all relevant information of history, VF and stereo photographs of ONH	
Classification of glaucoma	Recommended by AIGS	**Primary angle closure suspects (PACs)**: ITC≥180 degree of anterior angle **Primary angle closure (PAC)**: 1) ITC>= 180 degree 2) PAS or IOP>21mmHg; 2) no glaucomatous optic nerve damage. **Acute angle closure (AAC):** 1) History of previous acute attack of symptomatic elevation of IOP;2) Signs of iris whorling (distortion of the radially orientated iris fibers), "glaucomfleken" lens opacities, or excessive pigment deposition on the trabecular surface. **Primary angle closure glaucoma (PACG):** PLS FIX. PAC together with evidence of glaucoma, as defined above. **Primary open angle glaucoma (POAG)**:1) Optic nerve damage meeting any of the four categories of evidence above;2) Not have evidence of angle closure on gonioscopy;3) No identifiable secondary cause.	

WHO: World Health Organization.
ETDRS: Early Treatment of Diabetic Retinopathy Study.
ISGEO: International Society of Geographic and Epidemiological Ophthalmology.
AIGS: Association of International Glaucoma Societies.
ITC: Iris Trabecular Contact; IOP: Intraocular Pressure; PAS: Peripheral Anterior Synechiae.

Ophthalmic Epidemiol Downloaded from informahealthcare.com by JHU John Hopkins University on 06/03/10
For personal use only.

RIGHTSLINK