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Prevalence and risk factors for primary open-angle glaucoma in a rural northeast China population: a population-based survey in Bin County, Harbin

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CLINICAL STUDY

Abstract

Purpose To estimate the prevalence and associated risk factors of primary open-angle glaucoma (POAG) in a rural population in northeast China.

Methods A population-based survey was conducted within Bin County, Harbin of northeast China. Glaucoma was diagnosed using International Society of Geographical and Epidemiological Ophthalmology criteria. All the subjects underwent a complete ophthalmic examination.

Results A total of 4956 (86.0%) of 5762 subjects aged 40 years or older were examined. The mean intraocular pressure (IOP) of right eyes was 14.0 (95% confidence interval (CI), 13.9 to 14.1) mm Hg. The prevalence of POAG was 0.71% (35/4956, 95% CI, 0.47 to 0.93). In these POAG subjects, 17 (48.6%) had elevated IOP >21 mm Hg in either eye, 3 (8.8%) participants had been treated by laser trabeculoplasty or trabeculectomy and were known to have POAG. Vision impairment to varying degrees was present in 20 subjects (58.8%) with 1 subject blind in both eyes and 8 subjects blind in one eye. On multivariate analysis, age, family history of glaucoma, systemic hypertension, and IOP were regarded as significant independent risk factors.

Conclusions POAG is a disease of serious consequence and of low diagnosis and treatment rates in rural northeast China. Age, family history of glaucoma, systemic hypertension, and IOP remain as significant independent risk factors for POAG.

Introduction

Glaucoma is the second most common cause of blindness as estimated from blindness certification,[1] and can be classified into primary open-angle glaucoma (POAG), primary angle-closure glaucoma (PACG), or can be secondary to other pathology.[2]

It has been estimated that there will be 79.6 million people with open-angle glaucoma (OAG) and angle-closure glaucoma (ACG) in 2020, and of these, 74% will have OAG. Given the large population and future growth in China, 11.7 million of those with OAG in 2020 will be Chinese.[3] Recently, surveys regarding glaucoma have been performed in Liwan[4] and Beijing.[5] However, the vast range of geographic, the climatic, and cultural differences present throughout China suggest that these factors may have an important role in estimating the prevalence of conditions like OAG. In particular, the diversity present and absence of data available in the northeast area of the world's most populous country imply that such a survey for this region would represent a worthwhile endeavor.

In this article, we report the prevalence of POAG, according to the definitions suggested

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by the International Society of Geographical and Epidemiological Ophthalmology (ISGEO),[2] and the possible associated risk factors in a rural population in the North of China.

Materials and methods

Study population

The study was conducted within the town of Changan in Bin County of Harbin, an area lying in northeast China. The township encompassed 156.8 km^2 and comprised 18 contiguous villages of approximately equal size. Each village was divided into 8–14 second-order villages. In total, Changan comprised 183 second-order villages. The total population of these villages was approximately 32 800 persons, according to the 2000 National Census Report of China. Of the residents, 48.88% were women, and for residents older than 40 years, women accounted for 56.23%.

Participants were selected using a random, stratified, cluster sampling process. All persons aged 40 years or older who had been a resident in the selected village for at least 6 months were eligible for inclusion. The 18 villages were numbered in clockwise order. From 18 villages, 12 were randomly enumerated by computer. Subsequently, 84 second-order villages within the 12 villages (109 second-order villages) were randomly enumerated, generating a total sample population of 5762 people.

Clinical examination

A single survey team conducted the entire study. Each team member was assigned specific tasks and received additional training in the study procedures as shown in Figure 1.

A trained health worker administered a standard questionnaire to collect details of demographic information, life style, general medical history, and ophthalmic history. Blood pressure, measurement of blood glucose, and detailed ophthalmic examinations were performed on all subjects.

Visual acuity (VA) was recorded using a 4-m Early Treatment Diabetic Retinopathy Study logarithm of minimum angle of resolution E chart (Precision Vision, Villa Park, IL, USA). An optometrist assessed the best-corrected VA (BCVA) by using the results of a handheld autorefraction (Topcon Corporation, Model RM-8000B, Tokyo, Japan) with necessary subjective refinement in those subjects with presenting VA of <6/12.

Slit lamp biomicroscopy was performed by two experienced glaucoma specialists to identify abnormalities of the anterior segment. Under topical anesthesia using 0.5% proparacaine, intraocular pressure

(IOP) was measured with a handheld Perkins applanation tonometer (HA-2, Kowa Xinghe, Japan) using 0.5% proparacaine and fluorescein staining of the tear film. The right eye was measured first and one reliable measurement was recorded for each eye. The instrument was calibrated before use on each day of testing.

Gonioscopy was performed on all subjects with a Goldmann-type one-mirror lens (Haag Streit, Bern, Switzerland) in dim ambient illumination with a shortened slit that does not fall on the pupil. Dynamic examination was performed after the static gonioscopy of four quadrants was completed. The angle was graded using the Scheie's system, and the peripheral iris contour, degree of trabecular meshwork pigmentation, peripheral anterior synechiae, and other angle abnormalities were recorded.

Stereoscopic evaluation of the optic nerve head was performed using a +78 diopter (D) lens by the same two specialists. Standard disc images for vertical cup-disc ratio (VCDR) from 0.1 to 1.0 in 0.1 increments were used in the grading process. The margins of the cup were defined by stereoscopic view as the point of maximum inflection of the vessels crossing the neuroretinal rim.[4] If the stereo view was not satisfactory, the pupil was dilated using 1% tropicamide (Mydriacyl; Alcon, Puurs, Belgium) plus 2.5% phenylephrine (Alcon), provided the participant did not have closed angles with raised IOP. The VCDR was measured and recorded. Presence of any notching, splinter hemorrhages, and peripapillary atrophy were documented. A high level of agreement ($\kappa = 0.86$) was present between the two ophthalmologists regarding the VCDR (0.7 or more).

A provisional diagnosis of suspected glaucoma was made when the subject had one or more of the following conditions: IOP $\geq$ 21 mm Hg in either eye; VCDR $\geq$ 0.7 in either eye or VCDR asymmetry $\geq$ 0.2; and focal thinning, notching, or a splinter hemorrhage.[6] All subjects were advised to get a static visual field test (THG-10-BA210-013 Octopus, Interzeag AG, Bern-Köniz, Switzerland) with G1 program and TOP strategy.

Diagnostic definitions

Cases of glaucoma were defined using the ISGEO criteria.[2] Glaucoma was classified in accordance with three levels of evidence.

Visual fields were judged acceptable for analysis if fixation losses <20%, false positives <33%, and false negatives <33% were present. After excluding the superior four points and the four points immediately adjacent to the blind spot, abnormal visual fields were defined when size was $\geq 18° \times 12°$ and depth was
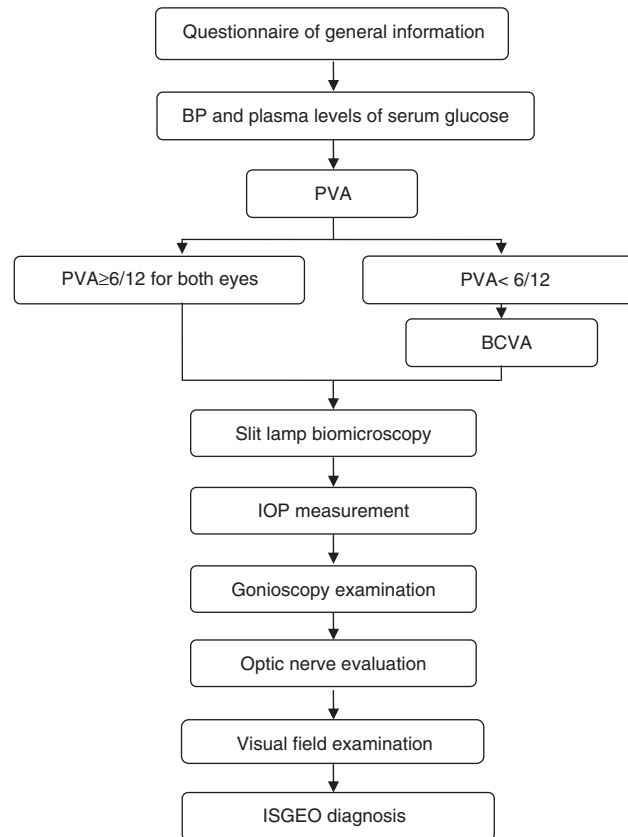
Figure 1 Participant flow chart in Bin glaucoma survey.

$\geq 10\,dB$.[7] When all visual field results were completed of the 226 subjects (452 eyes), 88.1% (398 eyes) were considered as producing reliable data.

Blindness was defined as the BCVA of <20/400 and/or visual field constriction of <10° from fixation in the better eye.

The division of cases of glaucoma into POAG and PACG was based on the gonioscopic finding of a broad angle. POAG was diagnosed if the criteria outlined above for categories 1–3 were met in one or both eyes, $\geq 90^\circ$ of posterior (usually pigmented) trabecular meshwork was visible on static gonioscopy, and no secondary cause for glaucoma was present.[2] Primary angle-closure suspect (PACS) was diagnosed based on trabecular meshwork was not seen for 270° or more on gonioscopy. Primary angle-closure (PAC) was PACS with evidence of peripheral anterior synechiae and/or elevated IOP without glaucomatous damage of the optic disc. PACG was PAC with evidence of glaucoma as defined.[2] Secondary glaucoma was diagnosed if the criteria for categories 1–3 were met and a secondary cause was evident.

We chose 12 potential risk factors for analysis. The two potential risk factors considered in the analysis were defined as follows:

Systemic hypertension: current use of systemic antihypertensive medications or a measured systolic blood pressure of 140 mm Hg or greater and/or a diastolic blood pressure of 90 mm Hg or greater.[8]

Diabetes mellitus: a nonfasting or postload serum glucose level of 200 mg/dl (11.1 mmol/l) or higher or the use of antidiabetic medication.[9]

Ethics

The study was approved by the Ethics Committee of the Second Affiliated Hospital, Harbin Medical University. Consent for participation was obtained from the head of each village before commencement of the survey, and written informed consent was obtained from all willing participants. The study was conducted in accordance with the Declaration of Helsinki.

Statistics

The database was established with Epidata3.0 (EpiData Association, Odense, Denmark). Statistical analysis was performed with SPSS 13.0 (SPSS Inc., Chicago, IL, USA) programs. Data are presented as prevalence and odds ratios (OR) with corresponding 95% confidence intervals (CIs). Age- and sex-specific prevalence of POAG and its

95% CIs were calculated. Univariate and multivariate logistic regression models were used to identify risk factors of POAG. The probable risk factors for POAG were analyzed by the univariate logistic regression. All risk factors associated with POAG on univariate analysis were modeled using multivariate logistic regression analysis. To find the best model, a forward elimination stepwise procedure was carried out in a way that the factor would be brought into the analysis if the corresponding *P*-value was <0.2. A value of *P*<0.05 was defined as statistically significant.

Results

A total of 5762 participants were considered eligible for this study (2544 men/44.2% and 3218 women/55.8%), and 4956 (2228 men and 2728 women) were examined in the clinic, therefore the response rate was 86.0%. Distribution of their age, sex, and educational level are shown in Table 1.

Tables 2 and 3 provide data on the IOP in right eyes and VCDR parameters for the population without glaucoma. Of the 4956 participants, IOP values were missing from 13 right eyes and 1 left eye. VCDR values were missing from 165 right and 153 left eyes. These data were absent as a result of media opacities, trauma, and inflammation or refusal to be examined (Table 4). In total, the optic discs of 4854 subjects were measured in at least in one eye. IOP declined with age in normal participants.

The distributions of IOP and VCDR parameters for glaucoma cases are shown in Table 5. VCDR values were missing from 1 right eye.

Table 6 summarizes the prevalence, age, and sex distribution of POAG.

Table 1 Characteristics of the subjects attending for clinical examination

	40–49	50–59	60–69	≥70	Total (%)
Man	612	688	539	389	2228 (44.96)
Woman	819	933	594	382	2728 (55.04)
Educational level					
University education	3	—	—	—	3 (0.06)
College education	3	7	6	1	17 (0.34)
High schooling	69	55	14	2	140 (2.82)
Middle schooling	409	225	88	11	733 (14.79)
Primary Schooling	708	748	590	81	2127 (42.92)
Illiterate	239	586	435	676	1936 (39.06)
Total for age (%)	1431 (28.87)	1621 (32.71)	1133 (22.86)	771 (15.56)	4956 (100.00)

Table 2 IOP in normal participants (right eyes)[a]

Age	Number	Median (mm Hg)	Mean (mm Hg) (95% CI)	97.5th Centile	99.5th Centile
40~	1429	15	14.8 (14.7–15.0)	21	25
50~	1601	14	14.3 (14.2–14.5)	21	25
60~	1098	13	13.4 (13.2–13.5)	20	25
≥70	719	12	12.5 (12.3–12.7)	20	25
Total	4847	14	14.0 (13.9–14.1)	21	25

Abbreviation: IOP, intraocular pressure.
[a]Defined as those with available vertical CDR data and excluding eyes with definitive glaucomatous field defect.

Table 3 VCDR and VCDR asymmetry in normal participants

	Number	Median	Mean (95% CI)	97.5th Centile	99.5th Centile
Right VCDR	4751	0.30	0.313 (0.311–0.315)	0.5	0.6
Left VCDR	4732	0.30	0.312 (0.310–0.314)	0.5	0.6
VCDR asymmetry[a]	4712	0.00	0.012 (0.011–0.013)	0.1	0.3

Abbreviation: VCDR, vertical cup-disc ratio.
[a]Absolute value of the difference in VCDR in two eyes.

The prevalence of POAG in any category within at least one eye was 0.71% (95% CI, 0.47 to 0.93). This prevalence increased with age in both women and men, and was similar in male (0.72%) and female (0.70%) POAG patients. Suspected glaucoma on the basis of optic disc exam alone was reported for 203 subjects (203/4854, 4.2%), 187 subjects (187/4854, 3.9%) were found to have peripapillary atrophy, and 8 subjects (8/35, 22.9%) were diagnosed POAG. Splinter hemorrhages were observed in 27 subjects (27/4854, 0.6%) and 4 subjects (4/35, 11.4%) were POAG. Diagnosis is as based on category 1 comprised 26 subjects (74.3%), 4 subjects (11.4%) based on category 2, and 5 subjects (14.3%) based on category 3. In all, 17 (48.6%) participants had elevated IOP of >21 mm Hg in either eye, and only 3 (8.6%) participants had been treated by laser trabeculoplasty or trabeculectomy. Varying degrees of vision impairment was observed in 21 (60.0%) of the subjects. The prevalence of bilateral blindness in the patients with glaucoma was 2.9% (1/35) and unilateral blindness was 22.9% (8/35). Table 7 shows the prevalence of POAG in selected population-based studies as resulting from the ISGEO criteria.

Table 4 The reason for missing data of IOP and VCDR (n = subjects)

	IOP	VCDR values
Media opacities	0	98
Trauma	9	21
Inflammation	1	42
Refusal to be examined	3	9

Table 5 IOP, VCDR and VCDR asymmetry in glaucoma cases

	IOP		VCDR		VCDR asymmetry[a]
	Right	Left	Right	Left	
Number	35	35	34	35	34
Median (mm Hg)	20	20	0.60	0.60	0.00
Mean (95% CI) (mm Hg)	20.17 (18.17–22.18)	19.17 (17.24–21.10)	0.64 (0.59–0.68)	0.58 (0.52–0.64)	0.10 (0.05–0.14)

[a]Absolute value of the difference in VCDR in two eyes.

Table 6 Prevalence, distribution of age and sex for POAG

Age	Case detection rates					
	Men		Women		Total	
	n (%)	95% CI	n (%)	95% CI	n (%)	95% CI
40 ~	0	—	0	—	0	—
50 ~	2 (0.29)	0.03 ~ 1.03	3 (0.32)	0.06 ~ 0.94	5 (0.31)	0.04 ~ 0.57
60 ~	6 (1.11)	0.22 ~ 1.97	7 (1.18)	0.31 ~ 2.03	13 (1.15)	0.52 ~ 1.75
≥70	8 (2.06)	0.64 ~ 3.41	9 (2.36)	0.82 ~ 3.82	17 (2.20)	1.15 ~ 3.19
Total	16 (0.72)	0.36 ~ 1.06	19 (0.70)	0.38 ~ 1.00	35 (0.71)	0.47 ~ 0.93

Table 7 Prevalence of POAG in selected population-based studies used ISGEO criteria

Author	Location	Setting	Age (years)	Prevalence, %
He et al[4]	Liwan, Guangzhou	Urban	≥50	1.8
Shen et al[42]	Singapore Malay	Urban	≥40	2.5
Casson et al[12]	Meiktila, Myanmar	Rural	≥40	2.0
Raychaudhuri et al[11]	Calcutta, West Bengal	Rural	≥50	3.0
Vijaya et al[6]	Chennai, South India	Rural	≥40	1.62
Rahman et al[13]	Dhaka, Bangladesh	Rural	≥35	2.5
Bourne et al[7]	Rom Klao, Thailand	Urban	≥50	2.3
Rotchford et al[43]	Temba, South Africa	Urban	≥40	2.9
Rotchford et al[44]	Zulu, South Africa	Rural	≥40	2.7
Present study	Bin, China	Rural	≥40	0.71

Abbreviation: ISGEO, International Society of Geographical and Epidemiologic Ophthalmology.

Table 8 Univariate logistic regression analysis of risk factors for POAG

Variable	ß	SE	Wald x^2	P	Adjusted OR (95% CI)
Sex	0.03	0.34	0.01	0.924	1.03 (0.53~2.01)
Age	1.10	0.20	30.17	<0.001	2.99 (2.02 ~ 4.42)
Educational level	1.24	0.33	13.94	<0.001	3.47 (1.81~6.66)
Family history	3.83	0.36	113.26	<0.001	45.97 (22.71~93.02)
Diabetes	1.84	0.46	16.29	<0.001	6.30 (2.58~15.40)
Systemic hypertension	1.01	0.34	8.90	0.003	2.75 (1.42~5.36)
Migraine	0.89	0.60	2.19	0.139	0.41 (0.13~1.34)
Blood type					
A and B	0.18	0.39	0.21	0.644	1.20 (0.56~2.56)
A and AB	0.21	0.61	0.12	0.733	0.81 (0.25~2.67)
A and O	0.47	0.36	1.73	0.188	0.63 (0.31~1.26)
Smoking	0.24	0.17	1.94	0.164	1.27 (0.91~1.79)
Alcohol	0.12	0.15	0.60	0.439	0.89 (0.66~1.20)
Intraocular pressure	3.00	0.34	76.43	<0.001	20.13 (10.27~39.45)

Table 9 Multivariate logistic regression analysis of risk factors for POAG

Variable	ß	SE	Wald x^2	P	Adjusted OR (95% CI)
Age	0.72	0.23	9.60	0.002	2.06 (1.31~3.26)
Family history	2.68	0.45	35.62	<0.001	14.58 (6.05~35.15)
Systemic hypertension	0.90	0.38	5.58	0.018	2.45 (1.17~5.16)
Intraocular pressure	2.00	0.40	24.79	<0.001	7.39 (3.36~16.24)

Univariate and multivariate logistic regression analyses of risk factors for POAG are shown in Tables 8 and 9. Age, educational level, family history of glaucoma, diabetes, systemic hypertension, and IOP were significant independent risk factors as derived from the univariate analysis. After multivariate analysis, age, family history of glaucoma, systemic hypertension, and IOP were identified as significant independent risk factors.

Discussion

This study, to our knowledge, is the first population-based study from northeast China to classify OAG based on the ISGEO criteria[2] and therefore can be compared with other studies that use the same criteria.

Of the 5762 people aged 40 years or older in this study, the participant rate was 86.01%. This response rate is reasonable for population-based surveys and similar to the studies of the Urban South Indian Study (80.2%),[10] West Bengal Study (83.1%),[11] and Mandalay Division (83.7%),[12] but higher than that of Dhaka (66%).[13] The high response rate suggests the data obtained are representative of the population.

The prevalence of POAG in our survey was 0.71% (95% CI, 0.47–0.93). When compared with that of studies conducted in other countries, the prevalence in northeast China was substantially lower than that of Bangladesh (2.1%),[13] Australia (3.0%),[14] Japan (3.6%),[15] and Singaporean Chinese (3.2%),[16] but slightly higher than Mongolia (0.5%).[17] Although no clear explanation exists for these differences, genetic, environmental, and/or methods used for detecting and defining POAG would seem to represent likely sources for these variations.

When considering regions inside China, however, the prevalence in our survey remained lower than Beijing (1.76%, 2004)[5] and urban Guangzhou (2.1%, 2006),[4] but higher than the Shunyi district of Beijing (0.29%, 2002).[18] One reason for this variation observed within China may be the differences in the ages of the study participants. In the Guangzhou survey, subjects were aged 50 years or older. As the prevalence of POAG shows an increasing trend with age, the younger age profile of our population could have resulted in an underestimation of its prevalence. In addition, Guangzhou is located 3430 km from our study area where climatic and ethnic conditions are very different. The inhabitants of northeast China belong to the Han nationality, Mongolian race and are of the north-Asia type, while in south China, the Malay type are mostly a transition group with origins from Far Eastern to South Asian. After analyzing the relationship between POAG prevalence and temperature, Weale[19] hypothesized that high temperatures can accelerate the onset, and increase the prevalence of POAG. While

conclusions generated from this study can be subject to ecologic fallacies, the prevalence of POAG in our study is in line with the concept that lower rates are associated with colder climates. As for the two surveys in Beijing, the glaucoma criteria adopted was different from ours and the mean IOP in normal participants in the 2004 Beijing investigation ($\sim$15–16 mm Hg) was higher than ours (14.0 mm Hg), which can lead to the differences reported in POAG prevalence.

In our study, some subjects who had media opacities and were not examined for disc assessment could also have had glaucoma. Additionally, we used strict criteria for defining POAG, which could have excluded a large group of possible POAG cases from the analyses. This approach potentially reduced the number of cases but led to fewer false positives. Therefore, for these reasons the overall estimate for POAG prevalence in our study may be underestimated.

Conversely, we classified glaucoma as POAG in the case of media opacity and IOP exceeding the 99.5th percentile or evidence with the history of previous glaucoma filtering surgery. In fact, subjects meetings this criteria were not necessarily POAG. Therefore, as based on this definition, our survey may have over-estimated POAG prevalence to some extent.

In our study, the prevalence of PACG, PAC and PACS were 1.57% (95% CI, 1.469–1.671), 1.33% (95% CI, 1.236–1.424), and 4.68% (95% CI, 4.541–4.819), respectively.[20] The ratio of the prevalence of PACG to POAG was in excess of 2 : 1. This high ratio in our study suggested that, some of the cases may have both mechanisms but be diagnoses as angle closure, thus reducing those who have only OAG.

Applanation tomometer as used in this study is a relatively accurate method for IOP measurement. In our study, we only present results from right eyes, and the mean IOP in our normal subjects was 14.0 (95% Cl, 13.9–14.1) mm Hg. This is broadly consistent with mean IOP in other population-based studies that had used the same criterion or same method for measuring IOP such as 14.1 mm Hg in Japan,[21] 13.5 mm Hg in China,[18] and 12.7 mm Hg in Mongolia.[17] These values are much lower than those reported in white populations.[14,22] Similarly, Lin et al[23] have concluded that the mean IOP values in elderly Chinese population were lower than in Cavcasians.

Most European and American studies have reported a positive association between age and IOP.[24–26] While in our study this relationship was not significant.[27] In contrast, Chinese,[18] Korean, and Japanese studies,[21,28–31] as well as a recent Australian study,[32] have reported a negative association. Like that of these latter studies, which indicate a negative relationship, our data showed that the mean IOP in non-glaucomatous eyes declined with age.

Results from several studies have shown that POAG prevalence of increases with age.[4,5,6,18] Our findings show a similar trend in that POAG was more prevalent among older subjects.

Some studies have shown a higher prevalence of POAG in men,[33] but others have shown no gender difference,[34] and the Blue Mountains Eye Study[35] reported a higher prevalence of glaucoma in women. In our study, we found no difference in prevalence between male and female subjects.

As based on the univariate and multivariate logistic regression analysis in our survey, we report that age, family history of glaucoma, systemic hypertension, and IOP remained as significant independent risk factors for POAG.

Old age had often been shown to be associated with increased risk of POAG, which is consistent with our findings.

Family history was found to be strong risk factor for POAG in this study as revealed from data derived both from history and ophthalmic examination. Among persons with less education, knowledge of glaucoma is low, so family history may be underestimated. The importance of this risk factor has also been highlighted in other studies.

IOP was another strong risk factor for POAG in our study. This finding is in agreement with virtually every study performed. However, only 17 (48.6%) participants with glaucoma in our survey had elevated IOP >21 mm Hg in either eye. Our results reinforce the opinion that POAG diagnosis cannot be based only on the level of IOP, but higher IOP represents an important risk factor for POAG. Accordingly, normal or low tension glaucoma should not be ignored.

The relationship between as the vascular system, in particular systemic hypertension, and POAG remains controversial. Conclusions resulting from data obtained in several population-based studies have failed to arrive at any consensus regarding the relationship between BP and OAG.[36–40] Our results suggest that systemic hypertension might be a possible risk factor for the development of POAG.

According to the BCVA, glaucoma was the second leading cause of visual impairment and blindness in our study.[41] The causes of glaucoma blindness in total 13 participants were PACG (11/13), POAG (1/13), and secondary to other pathology (1/13).[41] Poor medical treatment consciousness and poor medical treatment level in rural area, which resulted in that the subjects did not receive timely treatment or did not further consult with a doctor after treatment may explain in part our finding that high prevalence of PACG blindness. Among all 35 POAG patients in our study, the proportion of high tension glaucoma was 48.6%. Only three subjects (8.6%)

were known to have POAG and had been treated, whereas for the remainder (91.4%) the disease was diagnosed during the course of study. This low rate of diagnosis and low treatment rate are a matter of concern from a public health point of view. Some factors that can contribute to these unsatisfactory rates include the lack of facilities for comprehensive ophthalmic examination for the population, the widespread use of inappropriate eye examination techniques, and/or lower socioeconomic status and disease awareness. In such a situation, a silent disease like glaucoma especially POAG can go unnoticed.

Many changes have occurred in the field of glaucoma in recent years. These include modifications in the definition of the disease itself, new instruments for glaucoma diagnosis and monitoring, safer and more efficient medications, and laser treatments. These advances will positively influence the design of future glaucoma screening programs and should now permit such a program of diagnosis and treatment to be both feasible and cost effective. Collaboration among diverse specialists, including community health-care experts, glaucoma specialists, optometrists, and health economists will be integral in organizing and implementing an effective glaucoma screening strategy. Information and prevention campaigns to raise glaucoma awareness in high-risk populations could also have a positive impact on visual health and aid in identifying areas in need for future investigation.

In conclusion, POAG is a disease of low diagnosis and treatment rates in rural northeast China. The overall prevalence of POAG was 0.71% in this population. Age, family history of glaucoma, systemic hypertension, and IOP remained as significant independent risk factors for POAG in rural northeast China. The increase in prevalence with age is a cause of concern, as this segment of the Chinese population is expected to increase dramatically over the next few decades. These rates of prevalence must improve significantly, to reduce ocular morbidity, and minimize blindness because of glaucoma.

Summary

What was known before
- The prevalence of POAG in south China.

What this study adds
- The prevalence of POAG in northeast China.

Conflict of interest

The authors declare no conflict of interest.

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