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Prevalence, Awareness, and Risk Factors of Primary Open-Angle Glaucoma

Korea National Health and Nutrition Examination Survey 2008–2011

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Purpose: To investigate the prevalence, awareness, and risk factors for primary open-angle glaucoma (POAG) in the Korean population.

Design: The Korea National Health and Nutrition Examination Survey (KNHANES), a population-based cross-sectional study using a complex, stratified, multistage, probability-cluster survey.

Participants: A total of 13 831 participants 40 years of age or older were included from the KNHANES database for the years 2008 through 2011.

Methods: Glaucoma diagnosis was based on the International Society of Geographical and Epidemiological Ophthalmology criteria. The prevalence of POAG and the proportion of POAG patients previously informed of the disease were calculated using KNHANES sample weights. Ocular and systemic factors were compared between the POAG and control groups. Univariate and multivariate logistic regression analyses were used to evaluate the risk factors for POAG.

Main Outcome Measures: Weighted prevalence, awareness, and risk factors for POAG.

Results: The prevalence of POAG in the Korean population was 4.7% (95% confidence interval, 4.2–5.1): 5.5% in men and 3.9% in women, respectively, which increased with age ($P < 0.001$). The mean intraocular pressure (IOP) in POAG eyes was 15.0±0.4 mmHg, which was higher than that of the control group (14.0±0.1 mmHg; $P < 0.001$). Multivariate logistic regression analysis revealed that older age ($P < 0.001$), male gender ($P < 0.001$), higher IOP ($P < 0.001$), myopia ($P < 0.001$), hypertension ($P = 0.031$), and nonoverweight status ($P = 0.017$) were associated significantly with POAG in the Korean population. Among the 710 study participants diagnosed with POAG, only 8.0% were aware of the disease.

Conclusions: This was the first study to examine the prevalence, awareness, and risk factors of POAG in the Korean population using 4-year KNHANES data. Koreans with higher IOP, myopia, older age, male gender, hypertension, and nonoverweight status require more attention and support from the glaucoma screening and surveillance systems. *Ophthalmology 2016;■:1–10 © 2016 by the American Academy of Ophthalmology.*

*Supplemental material is available at www.aaojournal.org.

Glaucoma is the leading cause of irreversible visual impairment worldwide, affecting more than 70 million people, approximately 10% of whom are blind bilaterally.[1,2] It is expected that with longer life expectancy, the prevalence of glaucoma will increase along with its socioeconomic burden. Previous population-based studies have reported different glaucoma prevalences ranging from 0.5%[3] to 8.8%[4] according to ethnicity, the study design, and the definition of glaucoma. These studies also have reported primary open-angle glaucoma (POAG) to be the most common type among the various subcategories.[5–9]

Unlike Western countries, most Asian nations have reported higher POAG prevalences of intraocular pressure (IOP) of 21 mmHg or less.[7–18] Additionally, myopia (or longer axial length)[6,8,12,16,19,20] commonly has been reported as a significant risk factor for POAG among Asians. In white and black populations by contrast, the main risk factors are old age and high IOP[21,22]; myopia showed a positive association with POAG only in the Blue Mountains Eye Study.[23] These results suggest the possibility of race- or ethnicity-based differences in pathophysiologic features and among the factors associated with POAG. Nevertheless, no definitive risk factor difference has been found between

Asians and white or black persons.[24] Such inconclusive results could be attributed to the unstandardized study designs and limitations of previously conducted surveys. Therefore, a large population-based survey with systematic interviews and questionnaires as well as ophthalmic and various systemic evaluations that can represent an entire population is needed. A suitable database for such an investigation is the Korea National Health and Nutrition Examination Survey (KNHANES), a nationwide population-based sampling.

Recently, the Namil study, a population-based glaucoma prevalence survey, estimated the prevalence of POAG among Koreans 40 years of age or older as 3.5% (95% confidence interval [CI], 2.7%−4.3%).[7] It identified older age, higher IOP, and history of thyroid disease as risk factors for POAG.[25] However, the Namil study included only a rural population, and detailed investigation of systemic risk factors was difficult because of the limited data collected. Therefore, the purpose of the present study was to investigate the nationwide prevalence, awareness, and potential risk factors of POAG among the Korean population. To the best of our knowledge, this is the first study to report such data for the Korean population 40 years of age or older using a 4-year (2008−2011) KNHANES sample.

Methods

This study adhered to the tenets of the Declaration of Helsinki; written informed consent was obtained from all of the KNHANES participants. The survey protocol was approved by the Institutional Review Board of the Korea Center for Disease Control and Prevention. Because all of the KNHANES data are de-identified and opened to the public, the Institutional Review Board of the Seoul National University Hospital determined that this study was exempt from requiring their approval.

Study Design and Population

The KNHANES is an ongoing, population-based cross-sectional survey conducted in South Korea by the Korea Center for Disease Control and Prevention and the Korean Ministry of Health and Welfare. Initiated in 1998, it has been completed every year since 2007. The KNHANES uses a complex, stratified, multistage, probability-cluster survey with rolling sampling designs to analyze a representative, civilian, noninstitutionalized South Korean population. By means of this multistage sampling design (using strata, cluster, and weight), data from KNHANES may be considered to represent the entire population of Korea (Table 1, available at www.aaojournal.org). The detailed design of the KNHANES has been described previously.[26] The KNHANES IV (2008−2009) selected 4600 households across 200 enumeration districts annually, and KNHANES V (2010−2011) selected 3840 households across 192 enumeration districts annually using systematic sampling.[26] According to the Population and Housing Census data of Korea for 2008 through 2011, the mean size of each household was approximately 3 people. Therefore, approximately 69 people from 23 households and 60 people from 20 households are presumed to have been included per district in KNHANES IV and V, respectively. Within selected households, all family members older than 1 year were included as eligible subjects and were asked to participate in the survey. The response rates were 77.8%, 82.8%, 81.9%, and 80.4% in

2008, 2009, 2010, and 2011, respectively. The response rate of participants 40 years of age or older from 2008 through 2011 was approximately 76.7% on average, which was similar to the overall response rate. In the present study, eligible participants 40 years of age or older having a gradable fundus photograph and frequency doubling technology (FDT) perimetry test result for at least 1 eye were included. Participants with missing data or unreliable examination results were excluded.

Examination

The KNHANES consists of 3 parts: the health interview survey, the health examination survey including a comprehensive ophthalmologic examination, and the nutrition survey. The data from the first 2 surveys were used in this study. The health interview survey included standardized questionnaires on demographic variables, as well as current and past medical conditions, health-influencing behaviors (e.g., smoking, drinking, exercise, sun exposure), and socioeconomic status. The health examination survey included measurement of body height and weight, waist circumference, average systolic and diastolic blood pressures in a sitting position corrected by arm length, as well as blood tests (e.g., differential cell counts, hemoglobin, glucose, lipid profile, kidney function, liver enzyme, gamma-glutamyl transferase), routine urinalysis, pulmonary function tests, and an ophthalmologic examination.

The detailed ophthalmologic examination was conducted by ophthalmologists who had been trained periodically by the Korean Ophthalmological Society National Epidemiologic Survey Committee. It included measurement of visual acuity by Snellen chart, IOP by Goldmann applanation tonometry, spherical equivalent (SE) using automatic refractometry (KR-8800; Topcon, Tokyo, Japan), and slit-lamp biomicroscopy (Haag-Streit model BQ-900; Haag-Streit AG, Koeniz, Switzerland). The anterior chamber and angle assessment was performed using the Van Herick method, because gonioscopy was not included in the KNHANES. Participants 19 years of age or older underwent nonmydriatic fundus photography with a 45° field angle digital fundus camera (TRC-NW6S; Topcon) in a dark room. All of the participants underwent FDT perimetry with the screening program N30-1 (Humphrey Matrix FDT perimetry; Carl Zeiss Meditec, Inc., Dublin, CA) if they had elevated IOP of 22 mmHg or more or a glaucomatous optic disc appearance: (1) horizontal or vertical cup-to-disc (CD) ratio of 0.5 or more, (2) violation of the neuroretinal rim thickness order of inferior>superior>nasal>temporal rule, (3) presence of optic disc hemorrhage, or (4) presence of retinal nerve fiber layer (RNFL) defect.

Determination of Glaucoma Diagnosis

Two discrete glaucoma reading committees were established, each comprising glaucoma specialists from different institutes. A diagnosis was made based on the fundus photography and FDT perimetry findings, in accordance with the International Society of Geographical and Epidemiological Ophthalmology criteria.[27] The fundus photographs and FDT perimetries were evaluated twice, first as preliminary grading, and later as detailed grading. After the preliminary grading, the detailed grading was performed independently by another group of glaucoma specialists who were blind to the participants' other information. Any discrepancy between the preliminary and detailed gradings was adjudicated by a third group of glaucoma specialists (K.H.P., C.Y.K.). Preparatory to the glaucoma diagnosis, the subjects were categorized into POAG and nonglaucomatous groups, the latter serving as a control. The POAG group was defined as having an open angle using the Van Herick method (peripheral