Changing Views on Open-Angle Glaucoma: Definitions and Prevalences—The Rotterdam Study

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Purpose. To create a quantitative basis for diagnostic criteria for open-angle glaucoma (OAG), to propose an epidemiologic definition for OAG based on these, and to determine the prevalence of OAG in a general white population.

Methods. Of the 7983 subjects 55 years of age or older participating in the population-based Rotterdam Study, 6756 subjects participated in the ophthalmic part of this study (6281 subjects living independently and 475 in nursing homes). The criteria for the diagnosis of OAG were based on ophthalmoscopic and semiautomated Imagenet estimations of the optic disc such as vertical cup-to-disc ratio (VCDR), minimal width of neural rim, or asymmetry in VCDR between both eyes, and visual field testing with kinetic Goldmann perimetry. All criteria for the diagnosis of OAG were assessed in a masked way independently of each other.

Results. Mean VCDR on ophthalmoscopy was 0.3 and with Imagenet 0.49, and the 97.5th percentile for both was 0.7. The prevalence of glaucomatous visual field defects was 1.5%. Overall prevalence of definite OAG in the independently living subjects was 0.8% (95% confidence interval [CI] 0.6, 1.0; 50 cases). Prevalence of OAG in men was double that in women (odds ratio 2.1; 95% CI 1.2, 3.6). Different commonly used criteria for diagnosis of OAG resulted in prevalence figures ranging from 0.1% to 1.2%.

Conclusions. The overall prevalence of OAG in the present study was comparable to most population-based studies. However, prevalence figures differed by a factor of 12 when their criteria for OAG were applied to this population. A definition for definite OAG is proposed: a glaucomatous optic neuropathy in eyes with open angles in the absence of history or signs of secondary glaucoma characterized by glaucomatous changes based on the 97.5 percentile for this population together with glaucomatous visual field loss. In the absence of the latter or of a visual field test, it is proposed to speak of probable OAG based on the 99.5th or possible OAG based on the 97.5th percentiles of glaucomatous disc changes for a population under study. (*Invest Ophthalmol Vis Sci.* 2000;41:3309–3321)

Primary open-angle glaucoma (POAG) ranks third among causes of incurable visual impairment in the Western world.[1–3] Despite prevalence figures in white subjects ranging from 0.8% to 3.0%,[1,4–14] little is known about its etiology. This may be partly due to the lack of a worldwide epidemiologic definition of, or standard for diagnosis of, POAG[1–15] (Table 1). As a result many (epidemiologic) studies are difficult to compare, because of the different criteria and methods used for diagnosis, hampering meta-analyses and the search for risk factors.

It is nowadays generally accepted that POAG is an optic neuropathy characterized by cupping of the optic nerve head, with corresponding nerve fiber loss and visual field defects but that there is no consensus about cutoff points for normal disc measurements. An elevated intraocular pressure (IOP) is considered to be a risk factor for POAG, as well as the presence of a first-degree relative with glaucoma.[16] For the diagnosis POAG congenital forms of glaucoma have to be excluded, as well as secondary causes of glaucoma such as pseudoexfoliation.

The aim of the present study was to quantify in a masked way the prevalence of determinants of open-angle glaucoma (OAG) in a white population, to propose diagnostic criteria for OAG, and to study the influence of various diagnostic criteria for OAG on the prevalence of OAG. Because we did not specifically exclude pseudoexfoliation at baseline, we will further write about OAG instead of POAG.

Methods

Population

The present study was performed as the ophthalmic part of The Rotterdam Study, a prospective cohort study of all residents, 55 years of age and older.[17] Results of a prevalence study

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TABLE 1. Different Criteria for OAG

Baltimore Eye Survey[7]
Definite, probable, and uncertain classification. Best available from eight, sometimes not quantified, different disc criteria (CDR ≥ 0.8, or difference between OU ≥ 0.3 or 0.4). VF defect not explainable by other causes. No IOP criterion.
Barbados Eye Study[9]
VF, optic disc, and ophthalmic examination criteria. Seven combinations possible. Definite: At least on succession 2 abnormal VF together with 2 of 3 of following criteria: CDR ≥ 0.7, asymmetry ≥ 0.2, rim width ≤ 0.1, notching, disc hemorrhage. If not: suspect. IOP no criterion.
Beaver Dam Eye Study[8]
At least two of the following criteria: VF defect not explainable by other causes, CDR ≥ 0.8 or an asymmetry in CDR ≥ 0.2, IOP ≥ 22 mm Hg, or IOP-lowering treatment.
Blue Mountains Eye Study[11]
Glaucomatous VF defect not explainable by other causes, combined with VCDR ≥ 0.7, or asymmetry in VCDR between both eyes ≥ 0.3.
Egna-Neumarkt Study[13]
At least 2 of the following criteria with open angle: Glaucomatous VF defect, IOP ≥ 22 mm Hg and 1 of the following disc criteria: CDR ≥ 0.7, or asymmetry > 0.2, or difference in VCDR and HCDR > 0.2, or notching, or disc hemorrhage, or excavation reaching disc margin.
Framingham Study[25]
VF defect not explainable by other cases (only in selected part of the population), combined with VCDR ≥ 0.6, or asymmetry in VCDR between both eyes ≥ 0.2.
Melbourne Visual Impairment Project[14]
No strict criteria due to uncertainty of diagnostic criteria. Panel discussion with 6 ophthalmologists grading in none, possible, probable, or definite POAG. Criteria: past POAG history, IOP > 21 mm Hg, VF defect including enlarged blind spot, CDR ≥ 0.7, or asymmetry ≥ 0.3.
Ponza Glaucoma Study[12]
Glaucomatous VF defects and 1 of the following criteria: IOP > 20 mm Hg, CDR ≥ 0.5, or asymmetry ≥ 0.2. Suspect if questionable VF loss.
Rotterdam Study (2000 criteria)
If present in at least 1 eye with open angle and no history or sign of secondary glaucoma. No IOP criteria.
Definite OAG: GVFD combined with at least possible GON: VCDR ≥ 0.7, or asymmetry between both eyes ≥ 0.2, or a minimal rim width < 0.1.
Probable OAG: (1) GVFD without possible GON or (2) absence of GVFD or of any VF test with probable GON: VCDR ≥ 0.9, or asymmetry ≥ 0.3, or minimal rim width < 0.05.
Possible OAG: possible GON and no GVFD.

CDR, cup–disc ratio; GON, glaucomatous optic neuropathy; GVFD, glaucomatous visual field defect; HCDR, horizontal cup–disc ratio; IOP, intraocular pressure; OD, right eye; OS, left eye; OU, oculus uterque; POAG, primary open angle glaucoma; VCDR, vertical cup–disc ratio; VF, visual field.

in a subset of the examined population using different criteria for OAG have been published previously.[10] The study was performed according to the Declaration of Helsinki and was approved by the Medical Ethics Committee of the Erasmus University. Written informed consent was obtained from all participants. All residents were asked to participate in an extensive home interview, after which an appointment was made for a medical examination, including a complete ophthalmologic one.

Ophthalmologic Examination

The ophthalmologic examination (Table 2[18,19]) was performed by three ophthalmologic residents and two technicians. After perimetry, mydriatic drops were administered in both eyes, irrespective of the anterior chamber angle depth or history of glaucoma,[20] for lens and fundus examination, and photography. At the end of the first phase a miotic (Table 2) was administered in both eyes to counteract the mydriasis.

Optic Disc Measurements

Stereo transparencies from both eyes of all individuals were digitized and analyzed by two technicians with the semiautomated Topcon Image Analyzer (Imagenet), using the module for the retinal nerve fiber layer height. The system's hardware, its software modules, and reproducibility of measurements have been described previously.[21,22] For both ophthalmoscopy and Imagenet, the distribution of the measurements of the vertical cup-disc ratio (VCDR) and the asymmetry of the VCDR between both eyes together with their 97.5th and 99.5th percentiles were determined. The neural rim width was only determined with Imagenet and was defined as the proportion of the diameter of the rim section, measured at each of 36 equally spaced points on the optic disc border, in relation to the total optic disc diameter.

Proposed Definitions for Probable and Possible Glaucomatous Optic Neuropathies

Because cupping of the optic nerve head is the hallmark for glaucomatous optic neuropathy (GON), we chose to use this term. However, it does not imply that a person with GON definitely has glaucoma.

Probable GON was defined as the presence of at least one of the following characteristics: a VCDR, or asymmetry in VCDR between both eyes, or minimum width of the neural rim equal to or surpassing the 99.5th percentile of the population concerned. Possible GON was defined as the above and greater than or equal to the 97.5th but less than the 99.5th percentile of the population.

Visual Field Screening and Determination

The visual field (VF) screening during the first phase (Table 2) reduced examination time and the chance of rim artifacts. Three or more contiguously missed points on the screening test (≥4 when blind spot was included) were taken as evidence for a VF defect. In the case of a defective or unreliable VF test, VFs were retested with the same screening test in the second phase, about 2 weeks later. Subjects with a VF defect or unreliable test in the second phase of the study underwent kinetic Goldmann perimetry on both eyes, performed by a skilled perimetrist in the third phase, some weeks later. Also, in cases with a Goldmann VF defect gonioscopy was performed to exclude cases with narrow angles. All subjects with glaucomatous VF defects had normal open anterior chamber angles. VF testing was unreliable or impossible in the institutionalized subjects, mainly due to physical and mental disabilities.

All Goldmann VF charts were independently graded by six different graders (three senior ophthalmologists, two residents, one perimetrist) according to a special grading protocol. Graders were at first masked to all clinical data and optic disc appearances. Classification of the defects was solely based on the shape and localization of the defect. With regard to glaucomatous VF defects (GVFDs) special attention was put on a nasal step, paracentral defects, arcuate scotomas, central rests, remaining peripheral islands, and temporal nerve fiber bundle defects. For fields with inconsistent classifications (30%) a consensus was reached among the graders. The fundus and

TABLE 2. Ophthalmologic Examination and OAG Screening: The Rotterdam Study, 1990–1993

Examination Type/Method/Tool	Manufacturer/Method Reference/Specifications
Phase I	
Autorefraction	Topcon RMA 2000*
Best corrected visual acuity	Lighthouse Visual Acuity Chart (2nd edition)
Keratometry	Topcon OM-4 Ophthalmometer*
Slit-lamp examination	Topcon SL-3E slit-lamp*
Chamber angle slit-lamp estimation	Van Herick[18]
IOP measurement	Goldmann applanation tonometer[19],†
VF screening of both eyes separately	Modified 52-point supra threshold screening test central 24° radius (Humphrey VFA)‡
Mydriatic drops	Tropicamide 0.5% and phenylephrine 5%
Color transparencies macular area	35° field; TRC-50VT camera* in mydriasis
Stereo simultaneous color transparencies optic disc	20° field; TRC-SS2 camera* in mydriasis
Ophthalmoscopy	Direct and indirect (AusJena ophthalmoscope, Zeiss bonoscope) in mydriasis
Miotic drop	One drop of thymoxamine-hydrochloride 0.5%
Phase II	
Visual field screening	As in phase I in case of unreliable or defective VF
Phase III	
Visual field determination	In case of unreliable or defective VF in phase II: kinetic Goldmann perimetry†, experienced perimetrist
IOP measurement	Goldmann applanation tonometer[19],†
Gonioscopy (Shaffer)	Goldmann 3-mirror contact lens†

* Tokyo Optical Co, Tokyo, Japan.
† Haag Streit, Bern, Switzerland.
‡ Zeiss, Oberkochen, Germany.

optic disc transparencies were examined in a masked way for clues for retinal causes of VF defects and, if present, for the expected location of the VF defect. For exclusion of other nonglaucomatous causes of VF defects all other data available in The Rotterdam Study was used, including questionnaire data on and neurologic examination of all subjects, and (history) data from general practitioners including reports from all medical specialists who had treated the subject in the past.

Definition of Glaucomatous VF Defect

Glaucomatous VF defect (GVFD) was as defined as any Goldmann VF defect for which no other (neur)ophthalmologic cause could be found (see previous paragraph), thus excluding, for example, hemianopias and quadrantanopias.

Definitions for Definite, Probable, and Possible OAGs, Ocular Hypertension, and Elevated IOP

The following OAG definitions hold for a subject in whom in one or both eyes an open angle was present in the absence of a history or signs of angle closure or secondary glaucoma.

Definite OAG is the presence of a GVFD in combination with at least possible GON.

Probable OAG is either the presence of a GVFD in the absence of a GON or the absence of a GVFD with a probable GON.

Possible OAG is the presence of possible GON in the absence of either a GVFD or a VF test.

For logistic reasons subjects underwent a glucose tolerance test (GTT; by the cardiovascular research group) approximately 20 minutes before IOP measurement in the first testing phase. This GTT was carried out by giving an oral glucose load of 75 g in 200 ml of water and was performed on all nondiabetic subjects who had not had a gastrectomy.

The IOP was not used in the definition of OAG, neither was the use of IOP-lowering medication or the performance of an IOP-lowering (laser) operation in the absence of our criteria for OAG. Elevated IOP was defined as an IOP $>$ 21 mm Hg or an IOP $\leq$ 21 mm Hg with any form of IOP-lowering treatment. Ocular hypertension was defined as an IOP $>$ 21 mm Hg (or $\leq$21 mm Hg with any IOP-lowering treatment) in the absence of a GVFD or a GON. IOP values were adjusted for the IOP-lowering effect of the GTT.

Data Analysis

Although the distribution of IOP and VCDR was not completely gaussian we thought it sound to assume a normal distribution because of the large numbers in our study. Their 97.5th and 99.5th percentiles, also corrected for disc area quartiles and age strata, were parametrically calculated for each eye separately for the whole cohort, including the OAG cases. These percentiles were rounded up or down to the closest one decimal but for the minimum neural rim width (to two decimals), in an attempt to include all OAG cases. In analyses in which Imagenet data were combined with ophthalmoscopic data, the latter was only used when the Imagenet data were missing or unreliable (n = 84).

Prevalence figures of GVFDs; definite, probable, and possible OAGs; elevated IOP; and ocular hypertension were calculated by 5-year age categories and by gender. Prevalence figures of definite, probable, and possible OAGs were calculated using disc data obtained by ophthalmoscopy, by Imagenet and both. To estimate the influence of age and gender on these prevalence figures, logistic regression analysis was

TABLE 3. Response Figures of the Rotterdam Study, 1990–1993

Age Category, y	55–59	60–64	65–69	70–74	75–79	80+	Total
Independently living subjects							
Total eligibles	1480	1761	1737	1606	1286	1291	9161
Total examined	1172 (79.2)	1421 (80.7)	1327 (76.4)	1157 (72.0)	834 (64.9)	583 (45.2)	6494 (70.9)
Ophthalmologically examined	1162 (78.5)	1399 (79.4)	1278 (73.0)	1108 (69.0)	795 (61.8)	594 (41.8)	6281 (68.6)
Men	483 (75.1)	616 (79.1)	594 (75.7)	452 (69.5)	315 (63.0)	166 (44.0)	2626 (70.5)
Women	679 (81.0)	783 (79.5)	684 (70.8)	656 (68.6)	480 (61.1)	373 (40.8)	3655 (67.2)
Nursing homes							
Total eligibles	1	4	14	29	125	941	1114
Total examined	1 (100)	3 (75.0)	12 (85.7)	20 (69.0)	72 (57.6)	527 (56.0)	635 (57.0)
Ophthalmologically examined	0 (0.0)	1 (25.0)	8 (57.1)	12 (41.4)	60 (48.0)	394 (41.9)	475 (42.6)
Men	0 (0.0)	0 (0.0)	4 (50.0)	4 (50.0)	18 (48.6)	93 (54.7)	119 (53.1)
Women	0 (0.0)	1 (33.3)	4 (66.7)	8 (38.1)	42 (47.7)	301 (39.0)	356 (40.0)

Numbers in parentheses are percentages of the number of eligible subjects in each age category.

used. The odds ratio (OR) was used in these analyses as an approximation of the relative risk. Sensitivity, specificity, and predictive values of different cutoff points for VCDR for the presence of a GVFD and, thus, OAG were calculated.

All analyses were adjusted for age and gender when appropriate and were performed separately for the independently living subjects and for those living in nursing homes.

Finally, definitions of definite OAG used in other population-based studies (Table 1) were, as far as available and common to those in our study, applied to our data.

RESULTS

Population

Interview data were collected for 78% (n = 7983) of the eligible persons (n = 10,275; independently living subjects plus nursing home subjects). The overall response rate for the center visit was 69% (n = 7129). A total of 6756 subjects participated in the ophthalmic part of the study. Table 3 shows the response figures, focused on the ophthalmologic examinations. The availability of ophthalmologic data in nursing homes was limited.

TABLE 4. Distribution of Optic Disc Dimensions in Independently Living Subjects Determined by Imagenet and Ophthalmoscopy

	Imagenet (SE) n = 5619	Ophthalmoscopy (SE) n = 6199
Mean VCDR	0.49 (0.0018)	0.30 (0.0024)
Median asymmetry in VCDR	0.06	0.00
Mean minimal neural rim width	0.17 (0.001)	not assessed

	Percentage of Subjects	Percentage of Subjects
Disc dimension VCDR ≥		
0.4	76.7	43.2
0.5	55.0	19.6
0.6	26.5	9.0
0.7	5.1	4.0
0.8	0.4	1.6
0.9	0.0	0.7
Asymmetry in VCDR ≥		
0.2	7.5	5.8
0.3	1.3	1.6
0.4	0.1	0.6
Minimal neural rim width <		
0.25	80.5	Not assessed
0.20	58.2	
0.15	26.2	
0.10	4.1	
0.05	0.1	

See Table 1 for abbreviations.

Distribution of Optic Disc Dimensions

The distribution of the optic disc dimensions in the independently living subjects, determined by Imagenet and ophthalmoscopy, is shown in Table 4. The mean VCDR for ophthalmoscopy was 0.3, for Imagenet 0.49. Mean VCDR was significantly higher with Imagenet compared with ophthalmoscopy. Mean VCDR, its asymmetry between both eyes, and mean minimal rim width were not significantly different in independently living subjects and those in nursing homes (data not shown). The influences of disc area and age on those disc measures are given in Tables 5 and 6, respectively. The 97.5th percentile of the VCDR was similar for right and left eyes and differed 0.05 between the lowest and highest quartiles of disc area. Subjects 75 years of age or older had on ophthalmoscopy on average a 0.1 higher VCDR than those between 55 and 75 years of age. Table 7 shows the 97.5th and 99.5th percentiles for VCDR, asymmetry in VCDR, and minimal neural rim width together with the chosen cutoff points for criteria for GON, based on the findings in Tables 4, 5, and 6. The 97.5th percentile of the VCDR for both ophthalmoscopy and Imagenet was ≥ 0.7 (as it was in a different substudy on this population for the Heidelberg Retina Tomograph). The cutoff point for asymmetry in VCDR between both eyes was ≥ 0.2 for both ophthalmoscopy and Imagenet. The chosen cutoff points for definitions of GON derived from Table 7, thus were used for definitions of OAG in the Rotterdam Study (Table 1).

TABLE 5. Influence of Disc Area on 97.5th Percentile of VCDR Both Determined by Imagenet (n = 5619 Subjects)

Right Eyes		Left Eyes	
Disc Area (quartiles)	**VCDR**	**Disc Area (quartiles)**	**VCDR**
<2.11 mm^2	≥0.68	<2.07 mm^2	≥0.68
2.11–2.39 mm^2	≥0.71	2.07–2.36 mm^2	≥0.71
2.39–2.71 mm^2	≥0.73	2.36–2.68 mm^2	≥0.73
≥2.71 mm^2	≥0.76	≥2.68 mm^2	≥0.75
Overall	≥0.73	Overall	≥0.73

TABLE 6. Influence of Age on 97.5th Percentile of VCDR and VCDR Asymmetry between Both Eyes for Ophthalmoscopy and Imagenet Data

Age, y	VCDR OD Imagenet	VCDR OD Ophthalmoscopy	VCDR OS Imagenet	VCDR OS Ophthalmoscopy	Asymmetry Imagenet	Asymmetry Ophthalmoscopy
55–64	0.72	0.7	0.72	0.7	0.26	0.2
65–74	0.73	0.7	0.72	0.7	0.26	0.2
75–84	0.74	0.8	0.74	0.8	0.3	0.2
85+	0.77	0.8	0.74	0.8	0.31	0.2

See Table 1 for abbreviations. All data indicate greater than or equal to.

Prevalence of Glaucomatous VF Defects

The number of subjects with a GVFD is shown in Table 8. The odds for men to have a GVFD were twice higher than for women (OR 2.0; 95% CI 1.3, 3.1). GVFDs were present in 8.6% of all subjects with a VCDR ≥ 0.7. This prevalence increased to 38% in subjects with a VCDR ≥ 0.8 and to 60% in subjects with a VCDR ≥ 0.9.

Prevalence of Definite, Probable, and Possible OAGs

Table 9 shows the overall prevalence of definite, probable, and possible OAGs for the various age groups derived from combined Imagenet and ophthalmoscopic data. When Imagenet was not available or unreliable, ophthalmoscopic data were used. Tables 10 and 11 show the data derived when these techniques were separated. Between the cases in Tables 10 and 11 there was overlap but not complete concordance. Of the independently living subjects, 50 had definite OAG (0.8%; 95% CI 0.6, 1.0) with an OR of 2.1 (95% CI 1.2, 3.6) for men versus women. The risk estimates between OAG, age, and gender remained the same when the OAG cases defined with Imagenet or with ophthalmoscopy were analyzed separately or by pooling (see Tables 9 through 11).

In nursing homes no VFs were tested. In these subjects only probable or possible OAG could be diagnosed based on optic disc appearance. The prevalence of possible OAG was comparable with prevalence figures of possible OAG in the independently living subjects in the same age categories.

TABLE 7. Percentiles of Optic Disc Dimensions in Independently Living Subjects and Derived Cutoff Points Leading to Criteria for Probable and Possible Glaucomatous Optic Disc Neuropathy (GON)

	Imagenet *n* = 5619		Ophthalmoscopy *n* = 6199	
Percentiles	**97.5**	**99.5**	**97.5**	**99.5**
VCDR ≥	0.73	0.78	0.7	0.9
Chosen cutoff point ≥	**0.7**	**0.8**	**0.7**	**0.9**
Asymmetry in VCDR ≥	0.26	0.34	0.2	0.3
Chosen cutoff point ≥	**0.2**	**0.3**	**0.2**	**0.3**
Minimal neural rim width <	0.08	0.05	Not assessed	
Chosen cutoff point <	**0.1**	**0.05**		

Cutoff points derived from Tables 4, 5 & 6.

Probable GON defined as based on the 99.5th percentiles: A disc with a VCDR ≥ 0.9 with ophthalmoscopy or ≥ 0.8 for Imagenet, or an asymmetry in VCDR ≥ 0.3 between both eyes either on ophthalmoscopy or with Imagenet, or a minimal neural rim width < 0.05 on Imagenet.

Possible GON was defined as a VCDR ≥ 0.7, or an asymmetry ≥ 0.2 between both eyes either on ophthalmoscopy and Imagenet, or a minimal rim width < 0.1 with Imagenet.

IOP Distribution in this Population

Although IOP was not used for the diagnosis of OAG in this study, we will present our data on IOP here for comparison with other studies. Our IOP data were influenced by the GTT. The IOP-lowering effect of the GTT was studied by comparing the IOPs of subjects who had undergone a GTT with those of subjects who had not (those who refused and diabetic subjects). Subjects with a GTT had a significantly lower mean IOP (−1.13 mm Hg; 95% CI −1.41, −0.84) than subjects without GTT (similar in diabetic subgroup and refuser subgroup). Unadjusted for the effect of the GTT the mean IOP (subjects with IOP-lowering treatment were excluded) was 14.5 mm Hg (95% CI 14.46, 14.61). After correction for the IOP-lowering effect of the glucose solution, the mean IOP was 15.6 mm Hg (95% CI 15.48, 15.64). The cumulative distribution of IOP (adjusted for the GTT) is shown in Figure 1. There were no significant IOP differences between independently living subjects and subjects in nursing homes ($P = 0.185$, adjusted for age and gender), or between men and women, and there was no clinically significant change in IOP with increasing age.

The prevalence figures of elevated IOP (>21 mm Hg) are shown in Table 12 for the independently living subjects. The OR for men to have an IOP > 21 mm Hg compared with women was 1.35 (95% CI 1.10, 1.66). Ocular hypertension was present in 5.6% of participants and also was more prevalent in men than in women (OR 1.26; 95% CI 1.02, 1.56). Again, the prevalence of ocular hypertension in subjects in nursing homes was not significantly different from the prevalence in independently living subjects ($P = 0.48$, adjusted for age and gender).

Of the 50 diagnosed OAG cases (using the combined Imagenet and ophthalmoscopy data), 23 subjects (OR 46.0%; 95% CI 45.9, 46.1) were previously known to have OAG and received IOP-lowering treatment. Of the remaining 27 OAG cases, only three had an IOP > 21 mm Hg.

On the other hand, of the 242 independently living subjects with IOP-lowering treatment, only 13 (OR 8.7%; 95% CI

TABLE 8. Prevalence of GVFDs

Age, y	Men (%)	Women (%)	Total (%)
55–59	2/479 (0.4)	0/672 (0.0)	2/1151 (0.2)
60–64	5/609 (0.8)	4/773 (0.5)	9/1382 (0.7)
65–69	11/588 (1.9)	7/670 (1.0)	18/1258 (1.4)
70–74	13/442 (2.9)	11/643 (1.7)	24/1085 (2.2)
75–79	8/295 (2.7)	7/461 (1.5)	15/756 (2.0)
80+	10/152 (6.6)	9/338 (2.7)	19/490 (3.9)
Total	49/2565 (1.9) [SE = 0.27]	38/3557 (1.1) [SE = 0.17]	87/6122 (1.4) [SE = 0.15]

Numbers indicate subjects. Glaucomatous VF defect was defined as any Goldmann VF defect for which no other (neur)ophthalmologic cause could be found. Denominators in tables might vary because of missing or unreliable data.

Table 9. Prevalence of OAG: The Rotterdam Study, 1990–1993—Imagenet Data Combined with Ophthalmoscopic Data

Age, y	Men (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Women (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Total (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG
Independently living subjects															
55–59	483	1 (0.2)	1 (0.2)	7 (1.4)	72 (14.9)	679	0 (0)	0 (0)	10 (1.5)	94 (13.8)	1162	1 (0.1)	1 (0.1)	17 (1.4)	166 (14.2)
60–64	616	4 (0.6)	1 (0.2)	10 (1.6)	83 (13.5)	783	1 (0.1)	3 (0.4)	10 (1.3)	114 (14.6)	1399	5 (0.4)	4 (0.3)	20 (1.4)	197 (14.1)
65–69	594	5 (0.8)	6 (1.0)	6 (1.0)	98 (16.5)	684	6 (0.9)	1 (0.1)	17 (2.5)	105 (15.4)	1278	11 (0.9)	7 (0.5)	23 (1.8)	203 (15.9)
70–74	452	6 (1.3)	7 (1.5)	5 (1.1)	57 (12.6)	656	7 (1.1)	4 (0.6)	8 (1.2)	97 (14.8)	1108	13 (1.2)	11 (1.1)	13 (1.2)	154 (13.9)
75–79	315	6 (1.9)	2 (0.6)	11 (11.1)	51 (16.2)	480	3 (0.6)	4 (0.8)	16 (3.3)	70 (14.6)	795	9 (1.1)	6 (0.8)	27 (3.4)	121 (15.2)
80+	166	6 (3.6)	4 (2.4)	5 (3.0)	39 (23.5)	373	5 (1.3)	4 (1.1)	10 (2.7)	60 (16.1)	539	11 (2.0)	8 (1.5)	15 (2.8)	99 (18.4)
Total	2626	28 (1.1)	21 (0.8)	44 (1.7)	400 (15.2)	3655	22 (0.6)	16 (0.4)	71 (1.9)	540 (14.8)	6281	50 (0.8)	37 (0.6)	115 (1.8)	940 (15.0)
SEM		0.0020	0.0018	0.0025	0.0069		0.0013	0.0011	0.0022	0.0058		0.0011	0.0010	0.0017	0.0044
Dependently living subjects*															
55–59	0					0					0				
60–64	0					1					1				
65–69	4					4					8				
70–74	4				1 (25.0)	8				1 (12.5)	12				2 (16.7)
75–79	18				3 (16.7)	42			2 (4.8)	6 (14.3)	60			2 (3.3)	9 (15.0)
80+	93			4 (4.3)	21 (22.6)	301			18 (6.0)	42 (14.0)	394			22 (5.6)	63 (16.0)
Total	119			4 (3.4)	25 (21.0)	356			20 (5.6)	49 (13.8)	475			24 (5.1)	74 (15.6)
SEM		—	—	0.0165	0.0375	—	—	—	0.0122	0.0183		—	—	0.0100	0.0166

Relative risk estimates for definite OAG in independently living subjects: gender (men compared with women), adjusted for age (OR 1.99; 95% CI 1.13, 3.51) and age (per year increase), adjusted for gender (OR 1.09; 95% CI 1.05, 1.12).

* In nursing homes no VF testing was performed. Thus, only probable and possible OAGs could be diagnosed. Probable OAG GON, probable OAG based on probable GON; Probable OAG GVFD, probable OAG based on GVFD; Possible OAG, based on possible GON.

TABLE 10. Prevalence of OAG: The Rotterdam Study, 1990–1993—Ophthalmoscopic Disc Data Only

Age, y	Men (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Women (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Total (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG
Independently living subjects															
55–59	483	0 (0)	2 (0.4)	4 (0.8)	31 (6.4)	679	0 (0)	0 (0)	10 (1.5)	40 (5.9)	1162	0 (0)	2 (0.1)	14 (1.2)	71 (6.1)
60–64	616	3 (0.5)	2 (0.3)	10 (1.6)	41 (6.7)	783	1 (0.1)	3 (0.4)	7 (0.9)	58 (7.4)	1399	4 (0.3)	5 (0.4)	17 (1.2)	99 (7.1)
65–69	594	5 (0.8)	6 (1.0)	6 (1.0)	45 (7.6)	684	6 (0.9)	1 (0.1)	10 (1.5)	55 (8.0)	1278	11 (0.9)	7 (0.5)	16 (1.3)	100 (7.8)
70–74	452	9 (2.0)	4 (0.9)	10 (2.2)	19 (4.2)	656	8 (1.2)	3 (0.5)	10 (1.5)	53 (8.1)	1108	17 (1.5)	7 (0.6)	20 (1.8)	72 (6.5)
75–79	315	3 (1.0)	5 (1.6)	10 (3.2)	26 (8.3)	480	2 (0.4)	5 (1.0)	10 (2.1)	39 (8.1)	795	5 (0.6)	10 (1.3)	20 (2.5)	65 (8.2)
80+	166	6 (3.6)	4 (2.4)	2 (1.2)	22 (13.3)	373	4 (1.1)	5 (1.3)	7 (1.9)	33 (8.8)	539	10 (1.9)	9 (1.7)	9 (1.7)	55 (10.2)
Total	2626	26 (1.0)	23 (0.9)	42 (1.6)	184 (7.0)	3655	21 (0.6)	17 (0.5)	54 (1.5)	278 (7.6)	6281	47 (0.7)	40 (0.6)	96 (1.6)	462 (7.4)
SEM		0.0019	0.0018	0.0024	0.0050		0.0013	0.0011	0.0020	0.0044		0.0011	0.0010	0.0015	0.0033
Dependently living subjects*															
55–59	0					0					0				
60–64	0					1					1				
65–69	4					4					8				
70–74	4					8					12				
75–79	18				2 (11.1)	41			2 (4.9)	3 (7.3)	59			2 (3.4)	5 (8.5)
80+	93			6 (6.5)	7 (7.5)	297			13 (4.4)	22 (7.4)	390			19 (4.9)	29 (7.4)
Total	119			6 (5.0)	9 (7.6)	351			15 (4.3)	25 (7.1)	470			21 (4.5)	34 (7.2)
SEM		—	—	0.0201	0.0243		—	—	0.0108	0.0138		—	—	0.0095	0.0120

Relative risk estimates for definite OAG in independently living subjects: gender (men compared with women), adjusted for age: (OR 1.94; 95% CI 1.08, 3.47) and age (per year increase), adjusted for gender: (OR 1.09; 95% CI 1.05, 1.12).

* In nursing homes no VF testing was performed. Thus, only probable and possible OAGs could be diagnosed. See Tables 1 and 9 for definitions and abbreviations.

TABLE 11. Prevalence of OAG: The Rotterdam Study, 1990–1993—Imagenet Data Only

Age, y	Men (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Women (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG	Total (*n*)	Definite OAG	Probable OAG GVFD	Probable OAG GON	Possible OAG
Independently living subjects															
55–59	434	1 (0.2)	1 (0.2)	6 (1.4)	67 (15.4)	620	0 (0)	0 (0)	7 (1.1)	85 (13.7)	1054	1 (0.1)	1 (0.1)	13 (1.2)	152 (14.4)
60–64	563	4 (0.7)	1 (0.2)	8 (1.4)	80 (14.2)	722	0 (0)	4 (0.6)	6 (0.8)	108 (15.0)	1285	4 (0.3)	5 (0.4)	14 (1.1)	188 (14.6)
65–69	539	2 (0.4)	9 (1.7)	5 (0.9)	90 (16.7)	626	4 (0.6)	3 (0.5)	14 (2.2)	100 (16.0)	1165	6 (0.5)	12 (1.0)	19 (1.6)	190 (16.3)
70–74	399	3 (0.8)	10 (2.5)	0 (0)	55 (13.8)	592	4 (0.7)	7 (1.2)	7 (1.2)	93 (15.7)	991	7 (0.7)	17 (1.7)	7 (0.7)	148 (14.9)
75–79	252	4 (1.6)	4 (1.6)	6 (2.4)	44 (17.5)	399	3 (0.8)	4 (1.0)	15 (3.8)	64 (16.0)	651	7 (1.1)	8 (1.2)	21 (3.2)	108 (16.6)
80+	122	2 (1.6)	8 (6.6)	5 (4.1)	36 (29.5)	262	4 (1.5)	5 (1.9)	7 (2.7)	49 (18.7)	384	6 (1.6)	13 (3.4)	12 (3.1)	85 (22.1)
Total	2309	16 (0.7)	33 (1.4)	30 (1.3)	372 (16.1)	3221	15 (0.5)	23 (0.7)	56 (1.7)	499 (15.5)	5530	31 (0.6)	56 (1.0)	86 (1.6)	871 (15.8)
SEM		0.0017	0.0025	0.0024	0.0077		0.0012	0.0015	0.0023	0.0064		0.0010	0.0013	0.0017	0.0049
Dependently living subjects*															
55–59	0					0					0				
60–64	0					1					1				
65–69	4					2					6				
70–74	4				1 (25.0)	7				1 (14.3)	11				2 (18.1)
75–79	13				3 (23.1)	24				5 (20.8)	37				8 (21.6)
80+	57			1 (1.8)	17 (29.3)	169			8 (4.7)	33 (19.5)	226			9 (3.9)	50 (22.1)
Total	78			1 (1.3)	21 (26.9)	203			8 (3.9)	39 (19.2)	281			9 (3.2)	60 (21.4)
SEM		—	—	0.0128	0.0506		—	—	0.0137	0.0277		—	—	0.0105	0.0245

Relative risk estimates for definite OAG in independently living subjects: gender (men compared with women), adjusted for age: (OR 1.63; 95% CI 0.80, 3.32) and age (per year increase), adjusted for gender: (OR 1.09; 95% CI 1.04, 1.13).

* In nursing homes no VF testing was performed. Thus, only probable and possible OAGs could be diagnosed. See Tables 1 and 9 for definitions and abbreviations.

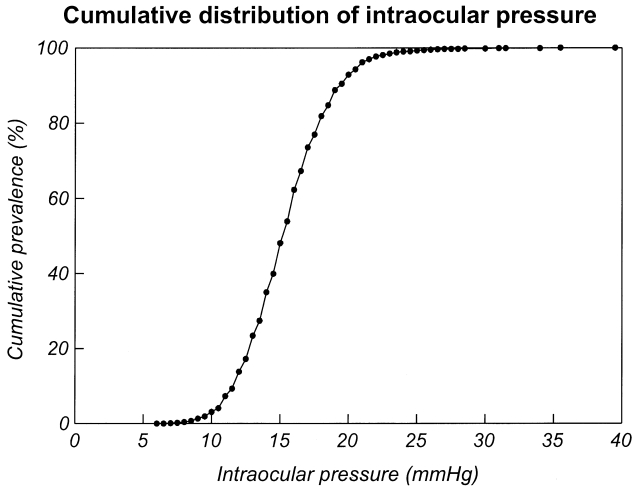

FIGURE 1. Cumulative distribution of the IOP adjusted for influence of a previously taken GTT in 5977 independently living subjects without IOP-lowering therapy. The 2.5th percentile corrected for the GTT was both for right and left eyes < 10 mm Hg, the 97.5th percentile > 22 mm Hg. Uncorrected for the GTT these were < 9 mm Hg and > 21 mm Hg.

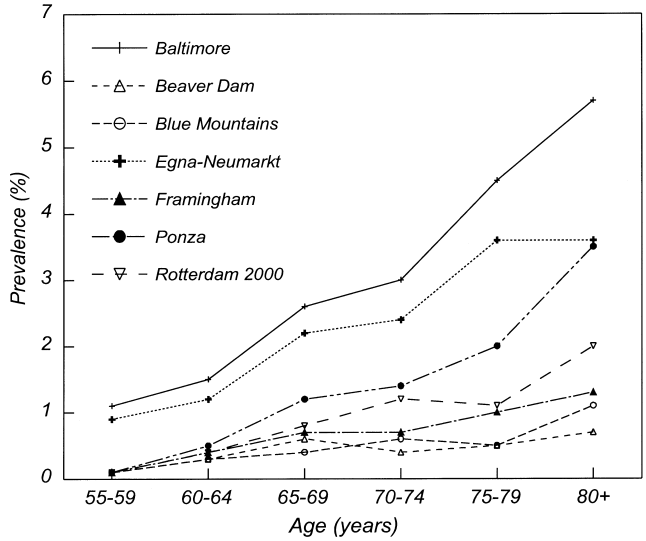

FIGURE 2. Variation in prevalence figures of OAG in the Rotterdam Study when different criteria for the definition of OAG, as used by other population-based studies, were applied to the Rotterdam data.

5.1, 12.2) had definite OAG when using only ophthalmoscopic data, and 23 (9.5%, 95% CI 5.8, 13.2) subjects had definite OAG using the combined Imagenet and ophthalmoscopy data. The sensitivity of elevated IOP for detection of OAG was calculated only in the newly diagnosed OAG cases (because the IOPs at the time of diagnosis of the known OAG cases were not available). The sensitivity was 11.1% (3 of 27 cases had an elevated IOP) and the specificity 98.0% (5827 of 5943 subjects had no definite OAG). The predictive value of an IOP > 21 mm Hg for the detection of OAG was only 2.5%; the predictive value of an IOP ≤ 21 mm Hg for its absence was 99.6%.

Figure 2 shows the variation in prevalence of OAG by age in our study, when OAG definitions from other large population-based studies were applied to our data. This resulted in prevalence figures varying between 0.1% and 1.4% in the youngest age-categories to prevalence figures between 0.9% and 5.9% in the oldest ones.

DISCUSSION

In this article we have given the rationale for the following proposal for an international definition of (primary) OAG in epidemiologic research: POAG is a disorder characterized by a GVFD, in combination with probable or possible GON based on cutoff points approximating the 99.5th and 97.5th percentiles, respectively, in that population in at least one eye of a subject with open chamber angle, and no history or sign of angle closure or secondary glaucoma. Thus, an algorithm may be created leading to the diagnosis of definite, probable, or possible POAG (see addendum). If other research groups use a similar approach, one is free to pool definite and probable OAG or not.

When looking at Table 1 and reference 15, it seems that we have not made much progress in defining glaucoma since Donders coined the term glaucoma simplex in 1861.[23] It, thus, seems like a risky enterprise to start defining criteria for POAG nearly 150 years later. On the other hand, it is

TABLE 12. Prevalence of Elevated IOP* and IOP-Lowering Treatment: The Rotterdam Study, 1990–1993

	Independently Living Subjects				Nursing Home Subjects			
	Elevated IOP		Ocular Hypertension		Elevated IOP		Ocular Hypertension	
Age, y	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)	Men (%)	Women (%)
55–59	12/478 (2.5)	25/673 (3.7)	10/478 (2.1)	22/673 (3.3)	—	—	—	—
60–64	38/609 (6.2)	22/777 (2.8)	28/609 (4.6)	15/777 (1.9)	—	0/1 (0.0)	—	0/1 (0.0)
65–69	44/582 (7.6)	33/681 (4.8)	30/582 (5.2)	21/681 (3.1)	0/4 (0.0)	0/1 (0.0)	0/4 (0.0)	0/1 (0.0)
70–74	34/446 (7.6)	36/651 (5.5)	20/446 (4.5)	24/651 (3.7)	0/4 (0.0)	0/8 (0.0)	0/4 (0.0)	0/8 (0.0)
75–79	25/315 (7.9)	40/476 (8.4)	17/315 (5.4)	29/476 (6.1)	0/16 (0.0)	5/36 (13.9)	0/16 (0.0)	2/36 (5.6)
80+	21/165 (12.7)	31/366 (8.5)	8/165 (4.8)	24/366 (6.6)	7/87 (8.0)	23/289 (8.0)	1/87 (1.1)	13/289 (4.5)
Total	174/2595 (6.7)	187/3624 (5.2)	113/2595 (4.4)	135/3624 (3.7)	7/111 (6.3)	28/335 (8.4)	1/111 (0.9)	15/335 (4.5)

Relative risk estimates for IOP and gender (men compared with women): Elevated IOP (OR 1.35; 95% CI 1.10, 1.66) and ocular hypertension (OR 1.26; 95% CI 1.02, 1.56).

Ocular hypertension defined as an IOP > 21 mm Hg at present (or any IOP-lowering treatment) in the absence of a GVFD or GON.

* Elevated IOP defined as any IOP > 21 mm Hg (or IOP-lowering treatment) irrespective of other signs of OAG or GON; this category includes all subjects with ocular hypertension.

clear also from Figure 2 that there is a need for valid comparisons between studies. Current variations in definition allow wide variations in prevalence data, as well as justification for treatment. In this study we define cutoff values for OAG determinants based on statistical grounds. This means that on arbitrary statistical grounds a division is made between normal and abnormal discs. We realize that this might be artificial and that some subjects may falsely be defined as healthy or abnormal. However, because of the large variation in OAG definitions in epidemiologic and/or clinical research, we think it is for the time being a good starting point to use such a definition for better comparison and pooling of study results. In due time further refinement of the definition may become possible when more incidence data become available. Using 97.5th or 99.5th percentiles to define abnormality does not mean that we used these criteria to define someone as being diseased. Only in combination with other signs we propose the term definite OAG. We felt that our database allowed for the definition of OAG on statistical grounds and that such an approach may become a starting point for future diagnostic fine-tuning. This may not be too far away because some large population-based studies are working on incidence data on POAG.

We did not fully exclude pseudoexfoliation as a cause of OAG during baseline examination and, thus, refer in this article to OAG instead of POAG. As no case of OAG in this cohort had pseudoexfoliation on follow-up clinical examination we feel that in practice we may assume that our data are valid as POAG data as did two studies that included pseudoexfoliation in the diagnosis of POAG.[11,13]

In this study we present prevalence figures for OAG combining GON data obtained by Imagenet and ophthalmoscopy. We think the Imagenet data are the more reliable data, especially for follow-up and risk-factor analyses. However, because the Imagenet module for the optic disc is not available any more, and neither is the simultaneous stereoscopic Topcon TRC-SS2 camera, also essential for this module, we also present prevalence figures based on only ophthalmoscopic optic disc data for comparison with other studies. We found in a substudy that Imagenet and the Heidelberg Retina Tomograph had much higher correlations for the estimation of the VCDR than ophthalmoscopy, showing that ophthalmoscopy is less reliable than these semiautomated apparatuses, even carried out by trained examiners. Still we felt that in daily practice ophthalmoscopy will be the method of choice during the coming years. Therefore, in choosing cutoff points for the VCDR and other disc measures we looked primarily at feasibility and tried to choose cutoff points that were also ophthalmoscopically assessable. Thus, to create as simple as possible a definition for OAG, based on glaucomatous VF loss and GON, we propose as a cutoff point for a statistically abnormal, and thus arbitrarily pathologic, possible GON a VCDR $\geq$ 0.7, asymmetry in VCDR between both eyes $\geq$ 0.2 or neuroretinal rim width $<$ 0.1 for data obtained by ophthalmoscopy. The latter was not assessed in this study by ophthalmoscopy but would probably be necessary in other studies to detect discs with local notching of the rim. From Tables 5 and 6 one may see that for the largest discs the cutoff for pathologic VCDR might have been chosen as $\geq$ 0.8, and the same holds for those 75 years of age and older. All these subdivisions make the definition more and more complicated and that is why we propose to keep as the cutoff point for a possible GON a VCDR $\geq$ 0.7. It should be borne in mind that this definition exists for the cohort studied and that for other cohorts and especially different races this type of definition might have different values.

Hitherto, some studies did not specify whether one used information on IOP or disc measures to grade VF defects as glaucomatous.[2,8,13] Two were masked in this respect[9,11] and one was not.[14] Similarly, before deciding whether a subject had OAG, all studies mentioned in Table 1 looked at the combined data of a case while we tried to do so by combining strictly defined determinants without subjective overall evaluation at the end. We believed that this would lead to less assessment bias. On the other hand, this resulted in small differences in prevalence of OAG when the Imagenet or ophthalmoscopy data were used.

Our overall prevalence of definite OAG of 0.8% (with combined use of Imagenet and ophthalmoscopic data; 0.7% when only using ophthalmoscopic data) and its rise with age are comparable with prevalence figures of the Framingham Study[24] (1.2%), of The Baltimore Eye Survey[7] (1.1%), and among the white subjects of the Barbados Eye Study[9] (0.8%). The Beaver Dam Eye Study and the Blue Mountains Eye Study, on the other hand, found a higher overall prevalence, 2.1%[8] and 3.0%,[11] respectively. The prevalence of definite plus probable OAG in the Rotterdam Study was 3.2% and this may explain the gap. Several more reasons for these differences exist. All studies mentioned in Table 1 but the Egna-Neumarkt and the Rotterdam Study used for final assignment to glaucoma diagnosis a review of all data by one or more principal investigators, glaucoma specialists, or ophthalmologists. In this study we combined the VF and optic disc data, and this led straightforward to one of three diagnostic categories (apart from normals) without additional influence on the final results. The discrepancy with the Beaver Dam Study could be explained by their wider criteria for POAG. Other sources for differences between studies include sampling and perimetry techniques, screening methods for glaucoma, subjective interpretation of examination data, diagnostic criteria, age distributions, and real geographic contrasts in prevalence due to differences in lifestyle or genetic drift.

The VF screening and grading procedure in our study resulted in a prevalence of 1.5% of GVFDs compatible with OAG. This is comparable with the findings of the Framingham Study (1.4%, screening in a subset only, enlargement of blind spot excluded)[25] but lower than that found in Australia (3.1%).[11] The Blue Mountains Eye Study used, after screening, Humphrey full threshold perimetry (C30-2), which is more sensitive than kinetic Goldmann perimetry,[26] especially in glaucoma where it might detect up to 21% more defects.[27] Full threshold automated perimetry is nowadays considered to be the gold standard for VF examination, but at baseline in 1990 we felt that especially in older subjects it may create more false-positive errors compared with Goldmann perimetry. This might be because of poor fixation that accounted for 9% of inadequate Humphrey fields versus 2% at the Goldmann perimeter.[27] Between threshold Humphrey perimetry and kinetic Goldmann perimetry there is 88% concordance when both tests appeared reliable.[27] Because the Humphrey algorithms also have changed in the meantime and because we now perform both Humphrey 30-2 and Goldmann perimetry in the follow-up study, a more valid comparison between both methods will be possible within

a year from now. It also has been shown that supra threshold perimetry identifies about two thirds of all cases identified by full-threshold perimetry.[28] Using this latter test our prevalence of definite OAG might have risen to approximately 1.4%. Even then there still would have been a twofold difference in prevalence by comparison with the Blue Mountains Eye Study. Given the variation in techniques and differences between various studies we believe that conclusions on geographic differences are for the time being not justifiable.

Our study differed from other large population-based studies with regard to the use of Imagenet to assess the optic nerve. Imagenet used strict criteria for defining the cup margins, based only on topographic data, thus reducing variation due to different observers. This makes it also particularly interesting for follow-up studies.[21] We found a higher mean VCDR on Imagenet measurements (0.49) compared with studies using other methods for examining the optic disc (mean VCDR 0.28,[5] 0.3[10] using ophthalmoscopy by several examiners, 0.36[8] and 0.43[11] by grading of photographs). As a result, the prevalence of an enlarged VCDR was also higher in our study than in other studies (VCDR $\geq$ 0.4: 76.7% compared with 27.1%[5] or 37.0%[8]). However, our prevalence of a VCDR $\geq$ 0.7 (5.1%) was only slightly different from the findings of the Blue Mountains Eye Study (5.0%), which examined stereo transparencies with a viewer.[11] Also, asymmetry in VCDR between both eyes was more prevalent in our study, compared with findings of other studies (4.6% asymmetry $\geq$ 0.2,[25] 0.7% asymmetry $\geq$ 0.3[11]).

The relation between OAG and gender is still controversial. In Framingham[5] and Barbados[9] a higher prevalence of POAG was found in men, which matched our finding. However, in the Blue Mountains Eye Study a (borderline significantly) higher OR of 1.55 for POAG was found for women,[11] and in Baltimore[7] and Beaver Dam[8] no difference was found. It might be that in younger subjects the association between OAG and gender is not yet present. It would seem possible that if the study cohort had a greater proportion of younger subjects the gender risk would disappear.

Our study did not show any correlation between age, gender, or IOP. This is in contrast to previously published results,[1,4,29] but is in agreement with others.[1,5,8] Our findings do agree with prevalence data on IOP and VCDR in nursing home inhabitants.[30] However, the response in the nursing homes was low, especially in the older subjects, increasing the risk of selection bias. This could explain our lower OAG prevalences compared with that study.[30] One could adjust the prevalence rates for probable and possible OAGs in the nursing homes by raising them by 25% similar to the lower response rates in these homes than in the independently living subjects.

In conclusion, the overall prevalence of definite OAG in the Rotterdam Study was 0.8%, which is comparable to findings of other population-based studies on whites. The OR for men to have OAG was higher than for women. There was a significant increase in prevalence of OAG with increasing age. The overall prevalence of OAG varied 12-fold with different criteria and screening algorithms. We hope that standardizing diagnostic procedures and our proposed definitions will improve future (epidemiologic) glaucoma research.

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Addendum: Decision tree for classifying Primary Open Angle Glaucoma

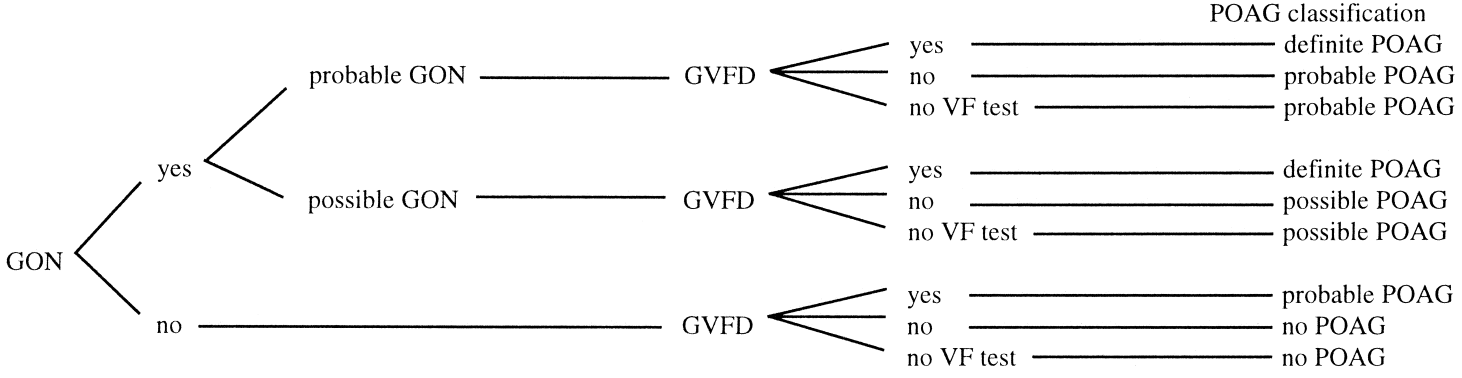
in subjects who have at least in one and the same eye an open anterior chamber angle and no history or signs of angle closure or secondary glaucoma

The diagnosis POAG depends on the presence or absence of a glaucomatous optic neuropathy (GON) and/or a glaucomatous visual field defect (GVFD). Because a GON usually appears earlier and is easier to assess than a GVFD, the decision tree starts with GON and afterwards includes presence or absence of a GVFD.

The diagnosis of GON is based on the 97.5th and 99.5th percentiles of the various disc measures in the population concerned.

Cut-off points for disk parameters in percentiles for the population of the Rotterdam Study	≥ 97.5th percentile	≥ 99.5th percentile	classification
Vertical cup-disk ratio (VCDR)	0.7		possible GON
		0.9	probable GON
Asymmetry in VCDR between both eyes	0.2		possible GON
		0.3	probable GON
Minimum neural rim width	0.1		possible GON
		0.05	probable GON

Definite POAG is the presence of a GVFD in combination with a probable or possible GON
Probable POAG is the presence of a GVFD in absence of a GON ór the presence of a probable GON in the absence of a GVFD or of any VF test.
Possible POAG is the presence of a possible GON in the absence of a GVFD.



Legends. GON: glaucomatous optic neuropathy. GVFD: glaucomatous visual field defect. See text for explanation