Incident Open-Angle Glaucoma and Blood Pressure

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Background: The risk of open-angle glaucoma (OAG) may be related to low blood pressure (BP) relative to intraocular pressure (IOP), ie, to low perfusion pressure (PP). Alternatively, systemic hypertension may increase OAG risk.

Objective: To clarify these possible relationships by evaluating hypertension and PP (where PP = BP – IOP) as risk factors for incident OAG in a black population.

Design: Population-based cohort study (85% participation); simple random sample of residents of Barbados, West Indies, aged 40 years and older.

Participants: Two thousand nine hundred eighty-nine black participants at risk; 67 developed OAG after 4 years (2.2% incidence).

Main Outcome Measure: Adjusted relative risk (RR) of OAG from logistic regression analyses.

Results: The 4-year risk increased markedly with baseline IOP. With an IOP less than or equal to 17 mm Hg, incidence was 0.7%, increasing to 18.3% with IOP greater than 25 mm Hg, for a 25-fold increase in RR. However, OAG developed throughout the IOP range and two thirds of incident cases had baseline IOP less than 25 mm Hg. Baseline hypertension was associated with a halving of the RR of OAG (RR, 0.49; 95% confidence interval [CI], 0.29-0.85); the RR also tended to decrease as systolic BP increased ($P = .07$). Consistent with these findings, a lower baseline PP increased RR (systolic PP <101 mm Hg, 2.6 [95% CI, 1.3-4.9]; diastolic PP <55 mm Hg, 3.2 [95% CI, 1.6-6.6]; mean PP <42 mm Hg, 3.1 [95% CI, 1.6-6.0]).

Conclusions: As baseline IOP increased, the risk of OAG substantially increased. In contrast, persons with systemic hypertension at baseline had half the RR, suggesting that hypertension does not increase (and may decrease) the 4-year risk of OAG. Lower PP at baseline increased RR approximately 3-fold, a result consistent with the vascular hypothesis of OAG pathogenesis.

Arch Ophthalmol. 2002;120:954-959

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In the last 10 years, several large prevalence studies of open-angle glaucoma (OAG) have been conducted.[1-10] While they have confirmed the relationship of OAG to age, high intraocular pressure (IOP), family history, and African ancestry, no other major risk factors have been identified consistently. Vascular factors have been investigated,[11-19] with particular attention to blood pressure (BP) and perfusion pressure (PP), where PP = BP – IOP. According to the vascular hypothesis of OAG pathogenesis, a low BP relative to IOP could lead to low PP, thus impairing perfusion of the optic nerve and causing glaucomatous loss of the visual field. On the other hand, systemic hypertension may increase risk by damaging the small vessels of the optic disc; furthermore, BP and IOP levels are positively correlated[11,12,15-20] and a similar positive link between high BP and OAG might be expected. These conflicting scenarios regarding the possible effect of high or low BP levels on OAG risk have not been clarified. Elucidating this relationship is important to understand the factors affecting OAG development as well as having clinical implications given the high prevalence of hypertension and use of BP-lowering treatment among older adults.

One obstacle to clarifying the issue is the dearth of population-based cohort studies to measure incidence, ie, the risk of developing OAG in a given period. Such longitudinal studies allow the most valid inferences by recording BP at baseline before the onset of OAG, and following the cohort to identify incident cases that develop over time. The magnitude of the BP effect can be quantified by calculating relative risks (RR$), which compare the incidence of OAG at various BP levels.[21] Avail-

METHODS

The Barbados Eye Studies, funded by the National Eye Institute (Bethesda, Md), are investigating the prevalence, incidence, and risk factors for major causes of visual loss in a large, predominantly African-origin population. The baseline prevalence study, the BES, was based on a simple random sample of Barbadian-born citizens, aged 40 to 84 years, with 84% participation.[1] After 4 years, the surviving cohort members were invited for a follow-up visit as participants in BISED and 85% of the 4040 eligible participants were reexamined (N=3427: 3193 black; 139 mixed, 95 white/other).[22]

As detailed previously,[1,22] baseline and follow-up data were collected using standardized protocols, including ophthalmic and other measurements, tonometry, Humphrey automated perimetry (Zeiss-Humphrey Systems, Dublin, Calif), lens gradings, 30° color stereo fundus photography of the disc and macula, and an interview. A 10% systematic sample and persons with specific findings (best-corrected visual acuity <20/30, visual field defects, IOP >21 mm Hg, history of major eye diseases or diabetes, family history of glaucoma, and inability to have perimetry, fundus photographs, or lens gradings) were referred for a comprehensive ophthalmologic examination. The definition of OAG[1,22] required the presence of both visual field defects and optic disc damage after ophthalmologic exclusion of other possible causes. Intraocular pressure was not considered in this definition. Visual field defects were determined by specific criteria based on automated perimetric data.[1,22] Optic disc damage was ascertained by the study ophthalmologist and by masked photographic gradings at a reading center.

Three applanation tonometry measurements were recorded and IOP for a person was defined as the highest mean value in either eye. Blood pressure was measured twice with the Hawksley (Hawksley & Sons Ltd, Lancing, Sussex, England) random zero sphygmomanometer, following the Hypertension Detection and Follow-up protocol,[24] and the average was used in the analysis. Quality control was maintained by monitoring digit preference and conducting replicate measurements. Hypertension was defined as a systolic BP (SBP) greater than or equal to 140 mm Hg and/or a diastolic BP (DBP) greater than or equal to 90 mm Hg, and/or using BP-lowering treatment, following current guidelines.[25] Perfusion pressure was evaluated by systolic (SBP – IOP), diastolic (DBP – IOP), and mean PP (⅔ mean arterial pressure – IOP, where mean arterial pressure = DBP + ⅓ [SBP – DBP]). Blood pressure and PP were stratified by quartiles of the population distribution and also used as continuous variables. Associations were evaluated by logistic regression analyses, which controlled for age, sex, and other relevant IOP and BP variables. Results are reported as adjusted RR with 95% confidence intervals. Tests for trend used a 4-category variable denoting BP and PP quartiles in the logistic regression models. All analyses were performed with SAS software (SAS Institute, Cary, NC).

Table 1. Four-year Incidence of Open-Angle Glaucoma and RR by IOP at Baseline*

IOP at Baseline, mm Hg	Incidence		RR (95% CI)†
	n	%	
≤17	9/1313	0.7	1.0
>17-19	8/716	1.1	1.59 (0.61-4.16)
>19-21	15/559	2.7	3.97 (1.72-9.20)
>21-23	6/167	3.6	4.76 (1.64-13.83)
>23-25	7/102	6.9	10.50 (3.76-29.38)
>25	22/120	18.3	24.69 (10.55-57.79)

*RR indicates relative risk; IOP, intraocular pressure; and CI, confidence interval.
†Logistic regression adjusting for age, sex, hypertension, and IOP-lowering treatment.

able reports, however, are based on cross-sectional data from clinic-based or prevalence studies, which do not allow the determination of incidence or RR.

Recently, incidence rates of OAG were obtained by the Barbados Incidence Study of Eye Diseases (BISED), 1992-1997,[22,23] which reexamined the population-based cohort of the Barbados Eye Study (BES), 1988-1992.[1] To assess the potential role of BP, this report evaluates systemic hypertension and PP as risk factors for the 4-year incidence of OAG in black BISED participants while controlling for pertinent variables. Since persons of African descent have high prevalences of OAG and hypertension, this evaluation has important public health implications and makes associations easier to detect.

RESULTS

Of the 3193 black BISED participants, 2989 did not have OAG at baseline. After 4 years, 67 of these participants (2.2%) met the criteria for incident OAG.[22] Incidence was higher with age, in men, and in those with higher IOP.[22] The 67 incident cases, therefore, were older than the rest of the cohort (median age at baseline, 64 years vs 55 years), tended to have more males (49% vs 41%), and had higher IOP (median IOP at baseline, 21.3 mm Hg vs 17.7 mm Hg). At baseline, 10.4% of the incident cases reported IOP-lowering treatment vs 1.1% of the other cohort members.[22]

As presented in **Table 1**, the 4-year incidence increased from 0.7% with IOP less than or equal to 17 mm Hg to 3.6% at IOP 21 to 23 mm Hg, reaching 18.3% at IOP greater than 25 mm Hg. The adjusted RR confirms the strong association between IOP and the incidence of OAG. Compared with IOP less than or equal to 17 mm Hg, the 4-year risk of developing OAG was about 5 times higher, with IOP between 21 to 23 mm Hg, and about 25 times higher, with IOP greater than 25 mm Hg, after adjusting for age, sex, IOP-lowering treatment, and systemic hypertension status.

Systemic hypertension was frequent, affecting about 52% of black participants at baseline; about half of these participants with hypertension used BP-lowering medications. **Table 2** presents OAG incidence and adjusted RR for hypertension and BP-lowering treatment at baseline. Persons with hypertension had a statistically significant decreased risk of OAG ($P=.01$), with about half

Table 2. Four-Year Incidence of Open-Angle Glaucoma and Relative Risk by Hypertension and Blood Pressure Treatment at Baseline*

	Incidence No. (%)	RR (95% CI)†
Hypertension (SBP/DBP ≥140/90 mm Hg or treatment)		
No	34/1420 (2.4)	1.0
Yes	33/1526 (2.1)	0.49 (0.29-0.85)‡
BP-lowering medication		
No	49/2125 (2.3)	1.0
Yes	18/856 (2.1)	0.74 (0.41-1.33)

*RR indicates relative risk; CI, confidence interval; SBP, systolic BP; and DBP, diastolic BP.
†RRs for BP-lowering treatment or hypertension were adjusted for age, sex, IOP, and IOP-lowering treatment.
‡$P = .01$.

Table 3. Four-Year Incidence of Open-Angle Glaucoma and Relative Risk by Quartiles of Blood Pressure at Baseline*

BP Quartiles	Incidence No. (%)	RR (95% CI)†
SBP, mm Hg‡		
SBP < 119	16/725 (2.2)	1.0
119 ≤ SBP < 132	16/763 (2.1)	0.81 (0.38-1.72)
132 ≤SBP <148	14/723 (1.9)	0.63 (0.29-1.38)
SBP ≥ 148	21/775 (2.7)	0.51 (0.23-1.12)
DBP, mm Hg‡		
DBP < 73	17/736 (2.3)	1.0
73 ≤ DBP < 80	17/655 (2.6)	1.20 (0.58-2.48)
80 ≤ DBP < 88	12/779 (1.5)	0.60 (0.28-1.33)
DBP ≥ 88	21/816 (2.6)	0.94 (0.47-1.89)

*RR indicates relative risk; BP, blood pressure; CI, confidence interval; SBP, systolic BP; and DBP, diastolic BP.
†Adjusting for age, sex, intraocular pressure (IOP), and IOP- or BP-lowering treatment.
‡Test for trend: $P = .07$ for SBP; $P = .52$ for DBP.

the risk (RR, 0.49) of persons with lower BP. Users of BP-lowering treatment had about three fourths (RR, 0.74) the risk of nonusers but the RR was not statistically significant. Analyses of age-specific RR showed the same pattern, with decreased RR in every age group (data not shown).

Despite the almost 10-year older age of the OAG group, their baseline BP levels (median SBP and DBP, 133 mm Hg and 79 mm Hg, respectively) resembled those of the remaining cohort members (median SBP and DBP, 132 mm Hg and 80 mm Hg, respectively). **Table 3** presents results for SBP and DBP, stratified by quartiles of the distribution. The crude OAG incidence rates had no consistent pattern across SBP and DBP categories, possibly reflecting the relatively small size of these categories and their differences in age, sex, IOP, and treatment. After adjusting for these confounding variables, the RR tended to decrease as SBP increased (0.81 for SBP 119-132 mm Hg; 0.63 for SBP 132 to 148 mm Hg; 0.51 for SBP greater than or equal to 148 mm Hg). The test for trend was consistent with lower risks at higher SBP ($P = .07$); no trends were seen for DBP ($P = .52$).

Table 4. Relative Risk (RR) of Open-Angle Glaucoma by Blood Pressure and Treatment Categories at Baseline*

BP and Treatment Categories	Incidence No. (%)	RR (95% CI)†
SBP, mm Hg		
SBP < 140; no BP-lowering treatment	34/1504 (2.3)	1.0
SBP < 140; with BP-lowering treatment	7/373 (1.9)	0.7 (0.29-1.66)
SBP ≥ 140; no BP-lowering treatment	15/619 (2.4)	0.5 (0.26-1.03)
SBP ≥ 140; with BP-lowering treatment	11/483 (2.3)	0.5 (0.23-1.08)
DBP, mm Hg		
DBP < 90; no BP-lowering treatment	41/1785 (2.3)	1.0
DBP < 90; with BP-lowering treatment	10/535 (1.9)	0.5 (0.26-1.17)
DBP ≥ 90; no BP-lowering treatment	8/338 (2.4)	0.6 (0.26-1.43)
DBP ≥ 90; with BP-lowering treatment	8/321 (2.5)	0.9 (0.40-2.04)

*BP indicates blood pressure; CI, confidence interval; SBP, systolic BP; and DBP, diastolic BP.
†Adjusting for age, sex, IOP, and IOP-lowering treatment.

Table 4 presents comparisons of OAG incidence and RR with various combinations of BP and treatment status. Compared with persons without elevated BP, all RRs for elevated SBP and DBP were less than 1, denoting lower risks. For the subgroup with SBP greater than or equal to 140 mm Hg and no treatment, the RR was decreased to one half (RR, 0.5; $P = .06$); a similar result was found for the subgroup with treated but uncontrolled SBP (RR, 0.5; $P = .08$). Comparably low RRs were observed for treated and controlled DBP and for DBP of 90 mm Hg and no treatment (RR, 0.5 and 0.6, respectively).

As presented in **Table 5**, OAG incidence was highest with low PP. Persons with lower systolic PP (SPP), ie, lower than the first quartile (<101.3 mm Hg), had a significant, more than 2½-times increased RR of developing OAG (RR, 2.6). Persons with moderately low SPP (101.3-114.4 mm Hg) also tended to have an increased RR (RR, 1.5), whereas persons with moderately high SPP (114.4-129.8 mm Hg) had similar a RR (RR, 0.9) as those with higher SPP. A similar pattern was found for diastolic PP (DPP), where lower DPP (<55 mm Hg) more than tripled the RR of OAG (RR, 3.2). While lower mean PP (MPP) (<41.9 mm Hg) also tripled the RR (RR, 3.1), there was a nonsignificant decreased RR at moderately high MPP (RR, 0.4), a result based on 4 incident cases. All tests for trend were statistically significant (SPP, $P = .003$; DPP, $P < .001$; MPP, $P < .001$), confirming the negative association between PP and OAG risk. Stratifying the analyses by presence or absence of hypertension treatment was unrevealing owing to small sample size.

Separate analyses were conducted to evaluate associations in the subgroup of cases with higher tensions (IOP>21 mm Hg at follow-up; n=48). These analyses yielded similar results to those in Tables 2 through 5. The RRs for hypertension, SPP, and DPP were of similar magnitude (RR, 0.44, 2.49, and 2.74, respectively) and sta-

tistically significant ($P<.05$). Additional analyses using BP and PP as continuous rather than categorical variables did not materially alter the results.

COMMENT

As far as we know, BISED provides the first population-based, longitudinal data on OAG risk factors, based on a relatively sizable number of cases, and in a black population. The study measured the 4-year risk of OAG at various IOP levels (Table 1) and offered evidence that systemic hypertension decreases the RR (Table 2). Lower RRs were also apparent when considering the users of BP-lowering treatment (Table 2) and persons with higher SBP (Table 3). Consistent with these findings, low PP at baseline approximately tripled the RR of OAG, suggesting that low BP relative to IOP increases RR (Table 5). This finding is in accord with the vascular hypothesis of OAG pathogenesis, that a low PP would contribute to the development of visual field defects. The same results were found in the subgroup of persons with OAG and IOP greater than 21 mm Hg, suggesting that these results also apply to cases with higher IOP and are not limited to "normal-tension" OAG. These results suggest the involvement of vascular factors in OAG development, with a possible "protective" effect of hypertension in maintaining an adequate PP.

OAG AND BASELINE IOP

An important contribution of this study is to provide a population-based measurement of the 4-year risk of OAG at various IOP levels. Although OAG developed throughout the IOP range, risk increased steadily with increasing IOP (Table 1). While high IOP was a major risk factor, one fourth of new OAG arose in persons with baseline IOP in the 13 to 19 mm Hg range; about half developed with IOP less than or equal to 21 mm Hg, and two thirds developed with IOP less than or equal to 25 mm Hg. Still, the magnitude of the relative and attributable[22] risks associated with high IOP substantiate its major role in OAG development.

OAG AND BASELINE BP

A new finding from BISED is that hypertension seemed to halve the RR of OAG during 4 years of follow-up; similar results were suggested for higher SBP (Tables 2 and 3). These findings are consistent with the hypothesis that hypertension has a protective effect on early OAG development since it maintains an adequate PP for the optic nerve. A decrease in RR with higher DBP was not evident across the quartiles of the DBP distribution (Table 2); however, a decreased RR was suggested in persons with DBP of 90 mm Hg and no treatment (Table 3), which is consistent with the SBP results. Since our current report reflects risk at 4 years, further follow-up of the cohort will be valuable to detect any changes in the relationships of BP and OAG over time. For example, long-standing hypertension may damage the small vessels and eventually impair PP.

Another important result is that antihypertensive treatment did not increase OAG risk. Such a hypothesis was advanced several years ago, based on various reports that visual field loss had developed after treatment of systemic hypertension.[26] In BISED, the use of BP-lowering treatment tended to decrease, not increase, the risk of OAG development (Tables 2 and 4). These results are consistent with those of our Long Island case-control study, which found similar use of antihypertensives drugs among OAG cases, ocular hypertensive cases, and controls.[17]

Table 5. Four-Year Incidence of Open-Angle Glaucoma and Relative Risk by Perfusion Pressure at Baseline*

	Incidence No. (%)	RR (95% CI)†
SPP, mm Hg‡		
SPP < 101.3	24/740 (3.2)	2.6 (1.3-4.9)
101.3 ≤ SPP < 114.4	15/748 (2.0)	1.5 (0.7-3.1)
114.4 ≤ SPP < 129.8	11/743 (1.5)	0.9 (0.4-1.9)
SPP ≥ 129.8	17/745 (2.3)	1.0
DPP, mm Hg‡		
DPP < 55	33/729 (4.5)	3.2 (1.6-6.6)
55 ≤ DPP < 62.3	12/723 (1.7)	1.3 (0.6-3.1)
62.3 ≤DPP < 70.3	11/763 (1.4)	1.2 (0.5-2.7)
DPP ≥ 70.3	11/761 (1.4)	1.0
MPP, mm Hg‡		
MPP < 41.9	33/750 (4.4)	3.1 (1.6-6.0)
41.9 ≤ MPP < 47.7	16/739 (2.2)	1.5 (0.7-3.3)
47.7 ≤ MPP < 53.6	4/743 (0.5)	0.4 (0.1-1.1)
MPP ≥ 53.6	14/744 (1.9)	1.0

*RR indicates relative risk; PP, perfusion pressure; CI, confidence interval; SPP, systolic PP; DPP, diastolic PP; and MPP, mean PP.

†Adjusting for age, sex, intraocular pressure (IOP), and IOP- or blood pressure–lowering treatment.

‡Test for trend: $P = .003$ for SPP; $P<.001$ for DPP; $P<.001$ for MPP.

While BISED found that hypertension decreased RR, some studies have reported cross-sectional associations of OAG with high BP.[13,14,17-19] In the Rotterdam and Egna-Neumarkt prevalence studies, significantly ($P<.05$) more hypertension was found in persons with high-tension OAG, but not in normal-tension OAG.[18,19] Similarly, cases with high-tension OAG in the Long Island study had higher DBP than controls[17]; however, after controlling for IOP, an independent association of OAG with high BP/hypertension was not confirmed, thus casting doubts on the role of high BP itself as a risk factor. In other case-control studies of high-tension OAG that included black participants, one study found uncontrolled systolic hypertension to be a major risk factor,[13] a result not verified in BISED (Table 3). In another study, DBP was positively related to OAG, but SBP tended to have a negative relationship[14]; the latter outcome is similar to BISED findings. This variability in results is not surprising since the relationship of BP and OAG is complex and may be affected by many factors, such as IOP and BP levels; extent of vascular damage; duration of hypertension and OAG; use of BP- and IOP-lowering medications; inclusion of IOP in the OAG definitions; hypertension definitions; selection; and other biases. As such, cross-sectional studies may yield different results depending on the distribution of these variables in their populations and the degree to which analyses adjust for contributory factors.

If high BP were positively associated with OAG, this relationship would be easier to detect in black populations, which have an increased prevalence of systemic hy-

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pertension and OAG. However, our baseline evaluations of the Barbados cohort, based on 302 black participants with prevalent OAG, found no significant associations with SBP, DBP, or hypertension.[16] In the Baltimore Eye Survey, which included white and black participants, age- and race-adjusted results suggested a small association of higher SBP and prevalent OAG but results were not statistically significant.[15] While there was no overall association with hypertension, younger persons (<60 years old) with OAG tended to have less hypertension than controls, which was similar to our BISED results; the reverse trend was only seen in persons 80 years and older. Possibly, this trend for a protective effect of hypertension at younger ages reflects the inclusion of persons with early, recently developed OAG, who may be more comparable with the BISED incident cases than the elderly cases with longer disease duration. No age trends were evident in the BISED incidence data. Based on BISED results, systemic hypertension does not increase (and in fact decreases) the RR and is unlikely to explain the high OAG frequency in persons of African descent.

OAG AND PP

A strong relationship was found between lower PP and OAG risk (Table 5). These BISED results were similar to our previous BES findings, among which persons with low BP/IOP differences or low BP/IOP ratios were up to 5.5 times more likely to have OAG than others.[16] In 1983, we also reported that Framingham Eye Study participants with field defects had significantly low BP/IOP ratios; persons with definite defects had lower ratios than those with suspect defects or no defects.[11] Low PP was also an OAG risk factor in the Baltimore and Egna-Neumarkt prevalence studies, the Long Island case-control study, and the Barbados Family Study, further confirming these findings.[15,17,19,27] One issue in interpreting these results is that a low PP could be explained by high IOP alone.[17] However, the analyses controlled for IOP and found a significantly low RR for hypertension. Our results indicate strong independent effects of high IOP and low BP, which are not explained by the contribution of the other. An additional issue to consider is that PP can be affected by BP- and IOP-lowering treatment, and few analyses have accounted for these effects. Our longitudinal results, which adjusted for confounding factors, help to clarify these issues by supporting the role of low PP in the development of early OAG. From our analyses, the risk attributable to low PP in the multivariate model[28] was about 30% to 40% (28% for SPP, 32% for MPP, and 41% for DPP), meaning that this factor could explain a substantial portion of the OAG risk in the cohort. Possibly, persons with OAG may have a loss of the usual balance between BP and IOP; in fact, an impairment of vascular autoregulation mechanisms has been postulated in these patients, with considerable clinical and experimental evidence to this effect.[26,29-32] The RRs for high IOP are of considerable magnitude (Table 1) and the attributable risks are also high[22]; it is likely that both mechanical and vascular factors play a role.

A major strength is the BISED cohort design, based on a population-based, nationwide random sample with high participation. Cohort studies are the only types of epidemiologic studies to directly measure risk and the strongest type of design to detect causal relationships.[21] While losses to follow-up may lead to biased estimates of risk in cohort studies, BISED achieved a high (85%) participation, with losses being mainly due to death. Aside from the older age and lower education of nonparticipants, no significant differences in demographics or major diagnoses were noted in participation rates; additionally, no differences in incidence estimates were observed after adjusting for nonparticipation.[22] In sum, a good representation of the original cohort was achieved, thus decreasing the possibility of nonparticipation biases.

While our 67 new cases represent the largest number of population-based incident OAG cases reported as far as we know, this number may not allow the detection of modest effects and estimates based on subgroups may have high variability. These sample size issues can lead to difficulties in interpreting the results of nonsignificant statistical tests. As such, examination of consistent trends in the data may be more revealing than relying on statistical significance alone.

Because this study was based on an Afro-Caribbean population with high OAG risk, questions can be raised as to the general applicability of BISED findings. Current concepts concerning racial differences in disease support environmentally related explanations (including gene-environment interactions) rather than genetic explanations alone.[33] Investigations in populations at high risk thus offer a special opportunity to advance knowledge on causation.[23] If a disease is more frequent in a population, the determining factors should be more common as well, thus making associations easier to detect. These underlying associations should generally apply to the disease across ethnic groups since similar etiologic mechanisms would pertain.[23] In fact, no major ethnic/racial differences in OAG risk factors have been reported,[34] supporting the general relevance of our results.

This 4-year longitudinal study confirms the strong influence of high IOP on the incidence of OAG. It is important to note, however, that two thirds of cases arose

with IOP less than 25 mm Hg at baseline, emphasizing the limitations of IOP as a predictor of risk. In addition to IOP, results support the involvement of vascular factors in the risk of early OAG, with systemic hypertension having a protective effect by presumably maintaining perfusion. Systemic hypertension at baseline approximately halved the RR and, consistent with this finding, low PP approximately tripled the RR. There was no evidence to support the hypothesis that antihypertensive treatment increases OAG risk.

Further follow-up of the cohort will provide estimates of 9-year risk of OAG as well as evaluations of possible changes in BP and IOP relationships over time. This and future reports may assist our understanding of the mechanisms leading to OAG development, with a view toward preventive interventions to lower risk.

Submitted for publication May 31, 2001; final revision received September 25, 2001; accepted October 26, 2001.

This study was supported by grants EYO7625 and EYO7617 from the National Eye Institute, Bethesda, Md.

We thank the Barbados Eye Studies participants and the Ministry of Health, Barbados, West Indies, for their role in the study.

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