Nine-Year Changes in Intraocular Pressure

*The Barbados Eye Studies*

Sun-Yuh Wu, MA; Barbara Nemesure, PhD; Anselm Hennis, FRCP(UK), PhD; M. Cristina Leske, MD, MPH; for the Barbados Eye Studies Group

**Objective:** To describe temporal changes in intraocular pressure (IOP) and associated risk factors after 9 years of follow-up in a population of African descent.

**Methods:** Changes in IOP were evaluated in 2298 participants without glaucoma or IOP-lowering treatment at baseline. Risk factor analyses used a multiple regression approach with mixed effects, which accounted for intereye correlation.

**Results:** The mean 9-year change in IOP was small, with relatively large dispersion (mean±SD, 0.4±4.0 mm Hg). Only 6.5% of persons with IOP of 21 mm Hg or less at baseline had elevated IOP greater than 21 mm Hg after 9 years. Mean IOP increases were largest in persons aged 50 to 59 years at baseline (mean±SD, 0.9±4.3 mm Hg), whereas IOP decreased in persons 70 years or older (mean±SD, −0.6±4.2 mm Hg). In multivariate analyses, IOP changes were positively associated with male sex, hypertension, diabetes history, and higher systolic and diastolic blood pressure at baseline, as well as with increases in blood pressure throughout 9 years (P<.05).

**Conclusions:** After long-term follow-up, minimal changes in IOP were observed in this African-origin population. The consistent relationships of hypertension and diabetes to IOP, a major glaucoma risk factor, underscore the public health importance of controlling these systemic conditions in black populations, where glaucoma incidence is high.

Arch Ophthalmol. 2006;124:1631-1636

---

LEVATED INTRAOCULAR PRESSURE (IOP) is a major risk factor for open-angle glaucoma (OAG), an ocular disease that most frequently affects persons of African ancestry. Information on the natural history of IOP in black populations is thus highly relevant to understand related disparities in OAG risk. The role of IOP as a modifiable risk factor in these populations was confirmed by recent data showing that topical ocular hypotensive therapy effectively delays or prevents the onset of OAG in African Americans with ocular hypertension. Nevertheless, most individuals with high IOP will not develop OAG, suggesting different etiologic mechanisms for each condition.

Although considerable cross-sectional data exist on the distribution and risk factors for elevated IOP, long-term longitudinal data are limited, particularly for persons of African ancestry. We previously reported on the longitudinal changes in IOP during a 4-year interval among the black participants of the Barbados Eye Studies. The current report aims to investigate temporal changes in IOP and prognostic factors for such changes during a 9-year period. Results are based on the African-origin participants of the Barbados Eye Studies without a glaucoma diagnosis or treatment at baseline.

**METHODS**

As described in previous reports, the Barbados Eye Studies are population-based epidemiologic investigations on the prevalence, incidence, and risk factors for major eye diseases in the predominantly black population of Barbados, West Indies. An initial cohort of 4631 participants, 40 to 84 years old, completed examinations at the study site, representing 84% of a randomly selected national sample. Self-reported ancestry was 93% of African origin, as found in the country’s population. After the baseline prevalence study (1988-1992), the surviving cohort members were reexamined to obtain data on incidence at 4 years (Barbados Incidence Study of Eye Diseases 1 [BISED I], 1992-1997) and 9 years (BISED II, 1997-2003). The BISED II participants (n=2793, 81% of the eligible survivors) had similar distributions of self-reported ancestry (2612 of African origin), were younger,
and were less likely to have hypertension at baseline than surviving nonparticipants and those who had died. The latter group included more men and reported more diabetes history.\textsuperscript{2,3} Compared with the participants, nonparticipants also had higher baseline IOP (mean±SD, 18.1±4.6 vs 19.4±5.7 mm Hg) and glycated hemoglobin levels (GHb) (mean±SD, 7.5%±2.1% vs 8.0%±2.7%).

The standardized study protocols\textsuperscript{3,6} included a detailed interview and various anthropometric and ocular measurements: 2 blood pressure (BP) readings with a Hawksley random-zero sphygmomanometer, Humphrey automated perimetry (Carl Zeiss Meditec Inc, Dublin, Calif), Lens Opacities Classification System II\textsuperscript{21} lens gradings at the slitlamp, and stereo fundus photography. The GHb assays by means of affinity chromatography of venous whole blood\textsuperscript{24} using Glyc-Allin GHb kits (Isolab, Akron, Ohio) were available for 3754 participants (81%) (GHb measurement began after the study had started). A subsample of consecutive participants in BISED II had pachymetry (5 measurements of central corneal thickness in each eye using a KMI ultrasonic RK3000 pachymeter; KMI Surgical, Paoli, Pa).\textsuperscript{35} Comprehensive dilated ophthalmologic examinations were conducted on a systematic 10% sample and on participants with specified positive findings (eg, ocular disease or diabetes history, IOP > 21 mm Hg, or best-corrected visual acuity < 20/30 in either eye). The study was approved by the institutional review boards of Stony Brook University, the University of the West Indies, and the Johns Hopkins University (Baltimore, Md) and was funded by the National Eye Institute.

The IOP data were based on the mean of 3 Goldman application tonometry measurements at each visit. Definite OAG was classified by the presence of both visual field defects and optic disc damage in at least 1 eye, after the exclusion of other possible causes by the study ophthalmologists.\textsuperscript{2,3} The IOP was not considered in this definition. Hypertension was defined as a mean systolic BP (SBP) of 140 mm Hg or higher and/or a diastolic BP (DBP) of 90 mm Hg or higher and/or a history of antihypertensive treatment.

Change in IOP was defined as the difference between the 9-year IOP and the baseline IOP. Analyses in this report excluded persons with glaucoma or those receiving IOP-lowering treatment at baseline. Descriptive data on IOP changes were person based, using data in the worse eye (the eye with a more positive IOP difference) of an individual. Person-based IOP changes were initially examined according to various factors; adjusted mean changes were estimated using general linear regression models that controlled for age, sex, and baseline IOP. Potential risk factors evaluated included baseline status of hypertension (or BP or antihypertensive medication), diabetes history (or GHb level), pulse rate, body mass index (calculated as weight in kilograms divided by the square of height in meters), corneal thickness, smoking, and alcohol use. Changes in BP from baseline to the 9-year follow-up visit were also investigated. To examine associations with IOP change using IOP measurements from both eyes of a participant, further analyses were based on multiple regression models with mixed effects (SAS procedure PROC MIXED with the REPEATED statement),\textsuperscript{36} which accounted for the correlation between eyes.

Table 1. Baseline Characteristics of the 2298 Study Participants

<table>
<thead>
<tr>
<th>Baseline Characteristic</th>
<th>Mean ± SD (Median)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>55.1 ± 10.5 (54.0)</td>
</tr>
<tr>
<td>Male, %</td>
<td>38.9</td>
</tr>
<tr>
<td>IOP, mm Hg</td>
<td>17.5 ± 3.3 (17.3)</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>133.2 ± 21.5 (130.0)</td>
</tr>
<tr>
<td>DBP, mm Hg</td>
<td>80.9 ± 11.6 (80.0)</td>
</tr>
<tr>
<td>Hypertension, %†</td>
<td>48.6</td>
</tr>
<tr>
<td>Diabetes history, %</td>
<td>14.4</td>
</tr>
</tbody>
</table>

Abbreviations: DBP, diastolic blood pressure; IOP, intraocular pressure; SBP, systolic blood pressure.

*Data are presented as mean ± SD (median) unless otherwise indicated. †SBP/DBP of 140/90 mm Hg or higher and/or a history of antihypertensive medication.

Of the 2612 BISED II participants of African descent, 2537 (97%) had IOP data from both the baseline and 9-year follow-up visits. This report included data on 2298 participants, after excluding 239 persons who had glaucoma (OAG, suspected glaucoma, or other types of glaucoma) or were receiving IOP-lowering treatment at baseline. The mean ± SD age of this study population was 55.1 ± 10.5 years at baseline, and 39% were male (Table 1). The distribution of other baseline characteristics, such as IOP, SBP and DBP, and diabetes history, is also presented in Table 1.

Table 2 presents adjusted mean person-based IOP changes. After 9 years of follow-up, the adjusted mean increase in IOP was only 0.4 mm Hg (median, 0.0 mm Hg), with a relatively large variation (SD, 4.0 mm Hg). Men had a larger increase (mean±SD, 0.7±4.1 mm Hg; median, 0.3 mm Hg) than women (mean±SD, 0.2±3.9; median, 0.0 mm Hg) (P=.003). Only 6.5% of persons with an IOP of 21 mm Hg or lower at baseline had an elevated IOP of more than 21 mm Hg after 9 years. Of this population without glaucoma or receiving IOP treatment at baseline, 3.8% had subsequent IOP-lowering treatment and 2.7% developed OAG after 9 years. Change in IOP was higher (P=.03; t test) in incident OAG cases (mean±SD, 2.2±6.6 mm Hg; median, 1.3 mm Hg) than among those who did not develop OAG (mean±SD, 0.4±3.9; median, 0.0 mm Hg).

The Figure presents the baseline and 9-year distribution of IOP by age group. The mean changes were small, and there were no apparent linear IOP differences with advancing age. A larger increase in IOP was observed in persons 50 to 59 years of age at baseline (mean±SD, 0.9±4.3 mm Hg; median, 0.7 mm Hg), and a decrease in IOP was seen in persons 70 years or older (mean±SD, 0.6±4.2; median, −0.7 mm Hg). After excluding incident cases of OAG or those receiving IOP-lowering treatment during the 9-year period, the age-associated distribution of IOP changes remained similar, with the overall mean±SD being 0.4±3.7 mm Hg (median, 0.0 mm Hg). It was 0.5±3.4 mm Hg (median, 0.0 mm Hg) for persons 40 to 49 years, 0.7±3.8 mm Hg (median, 0.7 mm Hg) for those 50 to 59 years, 0.1±3.6 mm Hg (median, 0.0 mm Hg) for those 60 to 69 years, and −0.6±5.2 mm Hg (median, −0.7 mm Hg) for those 70 years or older.
continuous variables. Thus, the IOP increased by 0.17 mm Hg at follow-up ($P < .001$) for every 10–mm Hg increase in SBP at baseline; additionally, the IOP increased by 0.23 mm Hg ($P < .001$) for every 10–mm Hg increase in within-person SBP between baseline and the 9-year visit. The corresponding estimated changes in IOP with DBP were either not significant or marginally significant ($P = .07$), respectively. Persons receiving antihypertensive medications had higher IOP increases. The GHb level and corneal thickness were evaluated in their respective subsamples (as categorical or continuous variables), with no significant associations found. Other variables examined (eg, pulse, smoking, and alcohol consumption) also were not significantly related to IOP change. Additional mixed-model analyses using eye-based rather than person-based IOP data indicated that hypertension ($P = .01$) and diabetes history ($P = .02$) were statistically significantly associated with IOP change, after adjustment for baseline IOP, age, and sex.

The final mixed model simultaneously included all significant variables, and results are presented in Table 3. Baseline IOP was negatively associated with IOP change ($P < .001$). Compared with persons 40 to 49 years of age at baseline, persons 50 to 59 years of age had larger increases in IOP ($P = .003$), whereas those 70 years or older tended to have larger IOP decreases ($P = .06$). The nonlinear relationship was further verified in a separate model, resulting in significant associations with age, as well as with age squared. The IOP increases were also associated with male sex, hypertension, and diabetes history. When GHb values were substituted for diabetes history, no significant associations with GHb values were found.

In separate models that considered SBP or DBP rather than hypertension, the 9-year changes in IOP were related to higher SBP or DBP at baseline and 9-year in-

<table>
<thead>
<tr>
<th>Baseline Characteristic</th>
<th>No. of Participants</th>
<th>Adjusted IOP Change, Mean ± SE, mm Hg*</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>894</td>
<td>0.52 ± 0.12</td>
<td>.04</td>
</tr>
<tr>
<td>Female</td>
<td>1404</td>
<td>0.21 ± 0.10</td>
<td></td>
</tr>
<tr>
<td>Hypertension†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1181</td>
<td>0.22 ± 0.12</td>
<td>.01</td>
</tr>
<tr>
<td>Yes</td>
<td>1116</td>
<td>0.49 ± 0.11</td>
<td></td>
</tr>
<tr>
<td>Antihypertensive medication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1680</td>
<td>0.25 ± 0.10</td>
<td>.02</td>
</tr>
<tr>
<td>Yes</td>
<td>617</td>
<td>0.66 ± 0.15</td>
<td></td>
</tr>
<tr>
<td>Diabetes history</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1960</td>
<td>0.31 ± 0.09</td>
<td>.10</td>
</tr>
<tr>
<td>Yes</td>
<td>331</td>
<td>0.67 ± 0.20</td>
<td></td>
</tr>
</tbody>
</table>

*Adjusted for age, sex, and baseline IOP.
†Systolic/diastolic blood pressure of 140/90 mm Hg or higher and/or a history of antihypertensive treatment.
COMMENT

To our knowledge, this is the first report on the natural history of IOP changes after long-term follow-up in an African-origin population. Although IOP remained relatively unchanged between baseline and 9-year follow-up, the relationship between IOP and age was not linear. A mild decrease in IOP was seen in persons 70 years or older, with a mild increase observed at younger ages. Additionally, baseline IOP was inversely associated with IOP change, whereas male sex, hypertension, and diabetes were positively related to changes in IOP.

The mean ± SD IOP change throughout 9 years was only 0.4 ± 4.0 mm Hg, a finding consistent with the Beaver Dam Eye Study (BDES), where the mean ± SD change was 0.0 ± 3.2 mm Hg throughout 5 years. In our previous 4-year report, IOP increased by 2.5 ± 3.9 mm Hg during this period, on average, with larger mean changes seen in the older age groups. The age effects observed at 4 and 9 years thus appear to differ and may indicate that IOP is affected by both short-term and long-term influences. Further examination of possible cohort effects found no clear pattern for each age group when comparing younger and older birth cohorts. Although the 9-year change could result from the naturally occurring long-term mortality in the population, one additional likely explanation for the 4-year and 9-year differences (and the lower IOP in the oldest age group) is selective mortality. Persons with hypertension and diabetes have higher IOP as well as increased mortality risks. Selective mortality from this source could thus result in selective losses of individuals with higher IOP. In fact, compared with participants in the 4-year follow-up, the nonparticipants at the 9-year visit were more frequently affected with hypertension (48% vs 62%) and diabetes (14% vs 23%) at baseline and were therefore more likely to have higher IOP after 9 years. Longitudinal changes in IOP thus result from the complex interplay of systemic and other factors.

Table 3. Nine-Year Change in IOP and Related Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Estimate (SE)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP at baseline</td>
<td>-0.58 (0.02)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age at baseline, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>0.49 (0.16)</td>
<td>.003</td>
</tr>
<tr>
<td>60-69</td>
<td>0.19 (0.18)</td>
<td>.03</td>
</tr>
<tr>
<td>≥70</td>
<td>-0.43 (0.23)</td>
<td>.06</td>
</tr>
<tr>
<td>Male</td>
<td>0.28 (0.14)</td>
<td>.04</td>
</tr>
<tr>
<td>Diabetes history</td>
<td>0.41 (0.19)</td>
<td>.03</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.33 (0.14)</td>
<td>.02</td>
</tr>
<tr>
<td>Model with SBP*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP per 10–mm Hg increase</td>
<td>0.19 (0.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Change in SBP per 10–mm Hg increase</td>
<td>0.22 (0.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Baseline antihypertensive medications</td>
<td>0.38 (0.18)</td>
<td>.04</td>
</tr>
<tr>
<td>Model with DBP**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBP per 10–mm Hg increase</td>
<td>0.16 (0.07)</td>
<td>.03</td>
</tr>
<tr>
<td>Change in DBP per 10–mm Hg increase</td>
<td>0.15 (0.06)</td>
<td>.01</td>
</tr>
<tr>
<td>Baseline antihypertensive medications</td>
<td>0.45 (0.18)</td>
<td>.02</td>
</tr>
</tbody>
</table>

Abbreviations: DBP, diastolic blood pressure; IOP, intraocular pressure; SBP, systolic blood pressure.

CREASES IN SBP OR DBP. The use of antihypertensive medications at baseline, an indicator of hypertension, was also a significant variable in these models. No interactions between age and the significant factors were noted. No other variables evaluated were associated with IOP change. Results remained similar in additional analyses that excluded persons receiving IOP-lowering treatment or developing OAG during 9-year follow-up. The possible impact of diurnal or seasonal variation on the regression models for IOP change was evaluated by assessing the effects of timing variations (eg, morning of the baseline visit and evening follow-up or vice versa) or seasonal variations (eg, warmer months at baseline vs cooler months at follow-up) on IOP measurements. No significant effects were found (data not shown).

The positive association between IOP and hypertension, particularly with elevated SBP, has been well documented in many cross-sectional studies, but fewer studies have reported significant correlations between IOP and DBP. Results from the current 9-year follow-up are consistent with our previously reported positive associations of 4-year IOP change with both SBP and DBP. In the Baltimore Longitudinal Study of Aging and 2 large Japanese studies, IOP change was positively correlated with a change in SBP but not in DBP. In contrast, in the predominantly European-derived population of the BDES, a 10–mm Hg increase in SBP (or DBP) was associated with an approximately 0.2–mm Hg (or 0.4–mm Hg) increase in IOP throughout 5 years of follow-up. We found similar results after 9 years in our African-origin population. The IOP changed between 0.14 and 0.45 mm Hg in persons with hypertension or higher SBP or DBP (per 10 mm Hg higher) at

AGE

Several cross-sectional studies showed increases in IOP with age, whereas others found negative associations. The few longitudinal studies available also yielded inconsistent results. The Baltimore Longitudinal Study of Aging reported a weak negative association between IOP change and age among middle-aged white men, and a 10-year study among Japanese aircraft personnel found similar results. In contrast, a longitudinal study of a large Japanese population revealed significant IOP increases with age, as did our 4-year follow-up investigation. The nonlinear relationship between IOP change and age from the present 9-year report was also found in the cross-sectional analyses of IOP and blood pressure from the BDES. Although selective mortality may partially explain the lower IOP in our oldest age group, the correlation between aging and reduction in the aqueous flow is a likely explanation.

BLOOD PRESSURE

The positive association between IOP and hypertension, particularly with elevated SBP, has been well documented in many cross-sectional studies, but fewer studies have reported significant correlations between IOP and DBP. Results from the current 9-year follow-up are consistent with our previously reported positive associations of 4-year IOP change with both SBP and DBP. In the Baltimore Longitudinal Study of Aging and 2 large Japanese studies, IOP change was positively correlated with a change in SBP but not in DBP. In contrast, in the predominantly European-derived population of the BDES, a 10–mm Hg increase in SBP (or DBP) was associated with an approximately 0.2–mm Hg (or 0.4–mm Hg) increase in IOP throughout 5 years of follow-up. We found similar results after 9 years in our African-origin population. The IOP changed between 0.14 and 0.45 mm Hg in persons with hypertension or higher SBP or DBP (per 10 mm Hg higher) at
baseline, in persons with increases in SBP and DBP (per 10–mm Hg increase), or in those receiving antihypertension treatment at baseline. The increase in IOP among persons using antihypertensive medications is likely a marker for elevated blood pressure requiring treatment. A similar rebound effect was suggested by the BDES in that persons using antihypertensive agents at baseline had increased BP and increased IOP at the 5-year follow-up. The significant relationship between IOP and BP, even after controlling for antihypertension treatment, appears to support the hypothesis that increased BP leads to increased production of aqueous humor through ciliary artery pressure.

**DIABETES**

Although some cross-sectional studies reported an association between elevated IOP and diabetes, high GHb levels, others did not. Our current results are consistent with the longitudinal BDES data and our 4-year findings, indicating a higher IOP change in persons with a diabetes history. The GHb value alone was significantly related to 4-year but not to 9-year increases in IOP, possibly because of the smaller sample size at 9 years and the lower GHb values of participants than nonparticipants. Although genetic factors and/or diabetes-related autonomic dysfunction may underlie the relationship between diabetes and IOP, further investigations are needed to confirm such an association.

**OTHER FACTORS**

Several longitudinal studies, including this investigation, have reported a negative association between baseline IOP and subsequent change in IOP, a relationship possibly explained by regression to the mean. In addition, 2 large longitudinal Japanese studies reported positive relationships of body mass index to IOP change. Although we found a positive link between elevated IOP and body mass index at baseline, the association did not persist in the 4- or 9-year follow-up. Sex was not significantly associated with IOP change in the BDES or 4-year BES data, whereas men had higher IOP increases than women at 9 years. Any positive relationships between female sex and IOP increases may be obscured by selective losses to follow-up in women, since women with hypertension at baseline were more likely to be nonparticipants than men (data not shown).

On the other hand, the link between male sex and long-term IOP change may partially explain the higher likelihood of glaucoma in men than in women, as suggested by our study and others. Although several studies, mainly in white populations, reported a positive correlation between central corneal thickness and IOP, no such relationships were found in our cross-sectional data and the current longitudinal evaluation.

In searching for possible risk factors, a low percentage of the variation in IOP, approximately 10% or less, can be explained by variables (similar to those evaluated in the current report) included in the regression models of various cross-sectional studies. These results suggest that other unknown determinants influence IOP.

**STRENGTHS AND WEAKNESSES**

Major strengths of our study are the population-based design, the standardized protocol, and good participation. However, the results can be affected by losses to follow-up inherent to longitudinal studies, especially among older populations. Since hypertension and diabetes increase the risk of death or nonparticipation, the impact of these conditions on IOP change is likely to be underestimated. These systemic conditions and IOP have been related consistently in our cross-sectional data and in the 4-year and 9-year longitudinal evaluations. Interestingly, despite this consistency, these systemic variables have not been uniformly associated with the prevalence of OAG. Furthermore, systemic hypertension at baseline cut the 4-year risk of OAG in half, a result in concert with the strong association with low perfusion pressure in our study population. As discussed previously, such findings support the role of low perfusion pressure in OAG development and suggest that the disease mechanisms for glaucoma and ocular hypertension are not the same; additional investigations are still needed to clarify these differences.

In conclusion, after 9 years of follow-up, the natural history of IOP in this population revealed minimal IOP changes. Since IOP is a major risk factor, variables that affect IOP are of particular importance to black populations, given their high prevalence and incidence of OAG. In this regard, the positive associations of IOP with hypertension and diabetes, which are especially frequent in these populations, have substantive public health relevance.

**Submitted for Publication:** March 10, 2006; final revision received May 16, 2006; accepted June 16, 2006.

**Correspondence:** Suh-Yuh Wu, MA, Department of Preventive Medicine, Stony Brook University, HSC L3086, Stony Brook, NY 11794-8036 (swu@notes.cc.sunysb.edu).

**Author Contributions:** Ms Wu had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**The Barbados Eye Studies Group:** Principal Investigator: M. Cristina Leske, MD, MPH. Coordinating Center: Stony Brook University, Stony Brook, NY: M. C. Leske, MD, MPH; Barbara Nemesure, PhD; Suh-Yuh Wu, MA; Leslie Hyman, PhD; Xiaowei Li, PhD; Lixin Jiang, MS; Ling Yang, MS; Kasihuri Sarma, BA; Karen Kelleher, BA, and Melinda Santoro, MS. Data Collection Center: Ministry of Health, Bridgetown, Barbados, West Indies: Anthea M. S. Connell, FRCOphth (deceased); Anselm Hennis, FRCOphth (UK), PhD; Ann Bannister, MBBS, MRCOphth; Muthu A. Thangaraj, MB, BS, DO; Coreen Barrow, Patricia Basdeo, Kim Bayley, and Anthanne
Financial Disclosure: None reported.

Funding/Support: This study was supported by grants EY07625, EY07617, and EY014921 from the National Eye Institute, Bethesda, Md.

Acknowledgments: We thank the BES participants and the Ministry of Health, Barbados, West Indies, for their role in the study.

REFERENCES