Diabetic Retinopathy in African Americans With Type 1 Diabetes: The New Jersey 725

I. Methodology, Population, Frequency of Retinopathy, and Visual Impairment

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Objective: To determine the frequency and severity of diabetic retinopathy, as well as associated visual impairment, among African Americans with type 1 diabetes.

Methods: A total of 725 African Americans with type 1 diabetes were enrolled in the study (The New Jersey 725). Clinical evaluations included structured clinical interview, ocular examination, stereoscopic fundus photography, and blood pressure measurements. Severity of retinopathy was determined via masked grading of fundus photographs. Biological evaluations included blood and urine assays.

Results: Of the 725 patients, 463 (63.9%) presented with any diabetic retinopathy and 137 (18.9%) with proliferative diabetic retinopathy. The frequency and severity of retinopathy were both significantly associated with older age at examination. Visual impairment (visual acuity in the better eye ≤20/40) was present in 79 (11.0%) and legal blindness in 22 (3.1%) of the patients. Diabetic retinopathy was responsible for 90.9% of the blindness. Frequency of visual impairment was significantly associated with older age and female sex, and only weakly with lower education.

Conclusions: Diabetic retinopathy in African Americans with type 1 diabetes is common, being found in almost two thirds of the patients studied. Its frequency and severity increase with age. Visual impairment is common, increasing with age and duration of diabetes and is more frequent in women than in men.


DIABETIC retinopathy remains the leading cause of new cases of blindness among Americans aged 20 to 64 years. However, most studies of diabetic retinopathy have been conducted among predominantly white diabetic populations with little black representation. The only 2 clinical studies of diabetic retinopathy among African Americans with type 1 diabetes included only 58 patients and 11 patients, and did not use standardized examination protocols. In the Third National Health and Nutrition Examination Survey (NHANES III), a population-based study, African Americans were found to have higher rates of diabetic retinopathy than whites. However, persons participating in that survey were adults with type 2 diabetes. Thus, little is known about clinical aspects of diabetic retinopathy among African Americans with type 1 diabetes, particularly with regard to frequency and severity.

There is similarly little information about visual impairment associated with diabetes in African Americans with type 1 diabetes. The US Model Reporting Area Registry data for 1969-1970 indicated that the age-standardized rate of self-reported blindness from diabetic retinopathy alone for nonwhites (including Hispanics) was twice that for whites, and that nonwhite women were 3 times more likely to be blind from diabetes than either nonwhite men or white men or women. In the Baltimore Eye Survey, a population-based survey of causes of blindness and visual impairment in persons 40 years or older, there was a greater proportion of African Americans than of whites who were visually impaired from diabetic retinopathy. In that survey, visual impairment was significantly associated with age, African American race,
lower education, unemployment, and poor general health status.19 There are no studies to examine the association of socioeconomic factors with loss of vision in African Americans with type 1 diabetes. Since the prevalence of diabetes among African Americans is high, and its incidence increasing,20 diabetic retinopathy and associated visual impairment may represent a major public health problem in this population.
grading was performed by one of the graders. This consisted of a field-by-field, lesion-by-lesion, evaluation of each photographic set for each eye using the ETDRS adaptation of the modified Airlie House classification of diabetic retinopathy. Level 10 represents no retinopathy; level 15, questionable retinopathy; levels 20 to 53, nonproliferative retinopathy of increasing severity; and levels 61 to 85, proliferative retinopathy of increasing severity. Macular edema was considered present if any area of the retina within 1 disc diameter from the center of the macula was thickened or if there was a prior history of macular edema with evidence of focal laser photocoagulation treatment confirmed by the treating physician. Subsequently, a computer program was used to analyze the detailed gradings and to derive a general retinopathy level for each eye. Severity of diabetic retinopathy for the patient was determined from the grading of the worse eye. Eyes that could not be graded for retinopathy level because of opacities of the media, phthisis, or enucleation were initially classified as “cannot grade.” For such patients, review of all previous medical records was done subsequent to the visit. If the patient had had either previous panretinal photocoagulation for proliferative diabetic retinopathy, or pars plana vitrectomy for either diabetic tractional retinal detachment or vitreous hemorrhage secondary to proliferative diabetic retinopathy, the retinopathy level for that patient was classified as grade 85. Patients who had an ETDRS grading of 53 or less at the time of examination and had previously received laser photocoagulation for proliferative diabetic retinopathy, as documented by chart review, were classified as grade 61.

DEFINITIONS

The patients' current age was defined as the age at examination, the age at onset of diabetes was defined as the age at which the diagnosis was first recorded by a physician in the patient's chart, and the duration of diabetes was defined as the time between the two. Socioeconomic factors recorded included patients' level of education, marital and employment status, personal income (for those ≥18 years of age), and family income. To classify socioeconomic status, the Goldthorpe and Hope classification of occupations was performed to identify potential confounders. The dependent variable in this regression was the presence or absence of visual impairment. Estimates of the proportion of patients (number with retinopathy/number of patients) presenting with any diabetic retinopathy (ETDRS levels ≥20) and with proliferative diabetic retinopathy (ETDRS levels ≥61) are reported as a function of age at examination. Estimates of the proportion of patients with visual impairment in the better eye are reported as a function of age, duration of diabetes, and sex.

The strengths of the association between the frequency of the retinopathy and age, and between the frequency of visual impairment (visual acuity in the better eye ≥20/40) and age, duration of diabetes, sex, and socioeconomic factors were estimated and tested using logistic regression. For dichotomous variables, the odds ratio (OR) and 95% confidence interval (CI) for the predictor (present vs absent) are presented. For categorical variables, the Wald test was used and the OR for every level of the variable vs the “normal” category are shown. In addition, for each risk factor a P value for a test of the null hypothesis that the OR is 1.0 is reported.

Descriptive analyses, including cross tabulations, were performed to identify potential confounders for the relationship between visual impairment and socioeconomic factors. Multiple logistic regression was used to isolate the impact of specific risk factors by controlling for the effect of potential confounders. The dependent variable in this regression was the presence or absence of visual impairment. Independent variables were entered in a predetermined sequence, which allowed to identify the unique impact of each factor.

The purpose of this study was to examine the frequency and severity of diabetic retinopathy among a large geographically well-defined cohort of African Americans with type 1 diabetes. In this first article, I describe the methodology, patient characteristics, the frequency and severity of diabetic retinopathy as a function of age, and the frequency of visual impairment by age, sex, duration of diabetes, and relationship of visual impairment to so-
economic factors in 725 African Americans with type 1 diabetes (The New Jersey 725 study). Data regarding risk factors, including sex, for diabetic retinopathy in this cohort are presented in a companion article.21

RESULTS

DEMOGRAPHIC CHARACTERISTICS

Table 1 shows the demographic characteristics of the 725 patients. Ages were normally distributed and ranged from 3 to 80 years. Age at diagnosis of diabetes ranged from 6 months to 29 years. Of the 725 patients, 126 (17.4%) had been diagnosed between 1934 and 1975, 197 (27.2%) between 1975 and 1985, and 402 (55.4%) since 1985. There was a slight excess of women (58.3%). Among the 725 patients, 43.6% were classified as middle and 56.4% lower socioeconomic status. The average family income was $24 600 (range, $9000-$80 000). Most patients were urban dwellers (78.8%). Among eligible patients who did not participate, there were 64 men and 86 women. Their mean ± SD age was 30.5 ± 9.9 years and their mean age at diagnosis of diabetes 19.7 ± 7.8 years. There were no significant differences between participants and nonparticipants for age, sex, or age at onset of diabetes.

FREQUENCY AND SEVERITY OF DIABETIC RETINOPATHY

Frequency and severity of diabetic retinopathy in the worse eye by age at examination are shown in Figure 2.
VISUAL IMPAIRMENT

Relationship to Age, Duration of Diabetes, and Sex

Frequencies of either visual impairment (visual acuity in the better eye ≤20/40) or blindness (visual acuity in the better eye ≤20/200) are shown, by age at examination and sex, in Figure 3 in the 721 patients in whom visual acuity could be determined. Of the 721 patients, 642 (89.0%) had no visual impairment, 57 (7.9%) had minimal to moderate impairment, and 22 (3.1%) were legally blind. Frequency of visual impairment significantly increased with increasing age, from 7.6% in those younger than 18 years to 32.8% in those 45 years and older (OR, 1.06; 95% CI, 1.04-1.09). Legal blindness was first seen in 2.1% of patients aged 25 to 34 years, and increased to 14.8% of those 45 years and older (Figure 3).

Frequency of visual impairment was also strongly and positively associated with duration of diabetes (OR, 1.08; 95% CI, 1.05-1.10) (Figure 4). Legal blindness was present in 4.2% of patients with 15 to 19 years of diabetes and peaked to 17.1% in those with 22 to 24 years of diabetes. Among patients with 30 or more years of diabetes, 12 (31.6%) had some visual impairment in the better eye and 5 (13.2%) were legally blind.

Minimal to moderate visual impairment in the better eye was significantly more frequent in women than in men (10.2% vs 4.7%, respectively; \( \chi^2 = 6.55, P < .05 \)), but not legal blindness (3.1% vs 3.0% for women and men, respectively). Compared with men, women had a significantly higher frequency of visual impairment (7.7% vs 13.3%; OR, 1.83; 95% CI, 1.10-3.09) even after adjusting for age (OR, 1.90; 95% CI, 1.13-3.22) or duration of diabetes (OR, 1.72; 95% CI, 1.02-2.93).

Forty-nine (6.8%) of the 721 patients had visual impairment due solely or partly to diabetic retinopathy, including 29 (4.0%) with minimal to moderate impairment, and 20 (2.8%) who were legally blind. Significantly more women than men had minimal to moderate visual impairment due to diabetic retinopathy (23 women vs 6 men; \( \chi^2 = 17.65, P < .01 \)). For the whole cohort, diabetic retinopathy, either solely or partly, was responsible for 62.0% of visual impairment and 90.9% of legal blindness.

Thirty (4.2%) of the 721 patients had visual impairment due to other causes: one was legally blind from glaucoma, one from optic nerve sarcoidosis; 28 patients had minimal to moderate visual impairment from various causes including cataract (n = 6), glaucoma (n = 1), keratoconus (n = 1), multiple sclerosis (n = 1), other retinal disease (n = 5), and refractive error (n = 7). In 7 patients the cause of minimal to moderate impairment could not be determined (Table 2).

Relationship to Socioeconomic Factors

After adjusting for age, duration of diabetes, and sex, the frequency of visual impairment was inversely associ-
ated with the level of education (OR, 0.42; 95% CI, 0.21-0.86) and employment status (OR, 0.34; 95% CI, 0.15-0.78) (Table 3). Among unemployed patients 205 (59.1%) were disabled, and 52 (15.0%) were disabled due to vision problems. There was no significant association between visual impairment and socioeconomic status, family income, or marital status (Table 3).

To evaluate the relative contribution of the various risk factors to the frequency of visual impairment, models based on logistic regression were developed that included age, duration of diabetes, sex, education, socioeconomic status, marital status, employment status, and family income. Older age (OR, 1.06; 95% CI, 1.01-1.13) and female sex (OR, 2.38; 95% CI, 1.03-5.54) were found to be independently associated with a higher frequency of visual impairment. Higher education was weakly associated with a lower risk of visual impairment (OR, 0.44; 95% CI, 0.18-1.07) (data not shown).

In the present study, the frequency of any diabetic retinopathy in African Americans with type 1 diabetes was high (63.9%) and increased significantly with age, being present in 93.4% of those 45 years and older. Proliferative diabetic retinopathy was not seen before 20 years of age, but then increased steadily to be seen in 59.0% of patients 45 years and older. Visual impairment in the better eye was present in 11.0% of the patients and increased significantly with age up to 32.8% of those aged 45 years and older. The frequency of legal blindness was also high (3.1%). Legal blindness was first seen in young patients aged 20 to 29 years and increased to 14.8% of patients 45 years and older. Visual impairment in the better eye was significantly more frequent in older patients and in women than in men, but there was no sex difference for legal blindness. There was a trend for higher levels of educational attainment to be associated with a lower frequency of visual impairment.

Strengths of the study include the large (N = 725) geographically well-defined cohort, the wide range of ages and duration of diabetes, the fairly equal representation of both low and middle-high socioeconomic levels, and a distribution of levels of domicile and education comparable with those reported for African Americans in the eastern United States. Other strengths include that very few patients (4.3%) could not be located and the participation rate was high (82.9%). Further strengths include...
the use of a structured clinical interview as well as standardized protocols for the ocular examination and examination of all previous medical records. Also, photographic documentation included 7 stereoscopic fundus photographs and detailed grading by masked observers using the ETDRS scale.

In African American patients, the frequencies of either any (63.9%) or proliferative (18.9%) retinopathy were comparable to those reported in the population-based Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) for whites with type 1 diabetes (69% and 23%, respectively), but higher than those found in either the large European clinic-based EURODIAB IDDM Complications Study (46% and 10.6%, respectively) or in Denmark (48% and 13%, respectively). However, even higher rates of either any or proliferative diabetic retinopathy have been reported in the Pittsburgh Epidemiology of Diabetes Complications Study (87% and 19%, respectively). The frequency of diabetic retinopathy in African Americans with type 1 diabetes also increased with age, and proliferative retinopathy was not seen before 20 years of age, both findings that were reported among whites with type 1 diabetes. The association between frequency of retinopathy and age is likely to be related to duration of diabetes, a risk factor that is examined in the companion article. Although the frequency of proliferative retinopathy in African Americans aged 45 years and older (59.0%) was higher than the 45% reported in the WESDR, this difference was not statistically significant. In the small clinic-based study of Arkken et al., there was no significant difference in rates of progression of retinopathy between African Americans and whites with type 1 diabetes over the 4-year follow-up period, suggesting that severity of retinopathy may not be different between these two ethnic groups. In the NHANES III, non-Hispanic blacks were not a higher risk for retinopathy than non-Hispanic whites after adjusting for duration of diabetes, hemoglobin A₁c level, and treatment with insulin or oral agents.

In the present study, the frequency of any visual impairment in the better eye (11.0%) was higher (but not significantly so) than the 7.8% reported for whites in the population-based WESDR. African Americans aged 45 years and older also had a higher prevalence of legal blindness than whites of comparable age in the WESDR (14.8% vs 10.9%, respectively), although this again was not statistically significant, possibly because of issues of low statistical power. For the whole cohort, the frequency of legal blindness (3.1%) was comparable to that reported in the WESDR for whites (3.2%), but somewhat higher than frequencies reported in other white populations, i.e., 2.3% in the EURODIAB IDDM Complications Study, 1% in England, 3% in Denmark, and 2.4% in Iceland.

In African American patients with 30 or more years of diabetes, visual impairment in the better eye (31.6%) was higher than the 22% reported for whites in the WESDR. Legal blindness was encountered after a relatively short duration of diabetes (about 11 years) and was high (13.2%) in those with 30 or more years of diabetes. Compared with men, African American women had significantly more visual impairment in the better eye due solely or partly to diabetic retinopathy. In the WESDR, women 55 years or older also had higher rates of moderate to severe visual impairment than men. The frequency of legal blindness in the African American patients, however, was not significantly different between the sexes, a finding that differs from US blindness registry data that showed that nonwhite women were 3 times more likely to be blind from diabetes than either nonwhite men or white men or women. These registry data included older persons than those in the present study. Among whites, an increased risk of blindness due to diabetes has been reported for women in some, but not all, studies.

In this study, frequency of visual impairment was inversely associated with lower levels of education, a finding that has also been reported in relation to the incidence of visual loss in white women with type 1 diabetes and may be related to less use of health care services. Among African American patients, however, there was no association between education and having a regular ophthalmologist (data not shown). Unemployed African American patients also had a 70% higher risk of being visually impaired than those who were employed. It is of note that a substantial percentage (59.1%) of unemployed patients were disabled, although visual impairment (visual acuity in the better eye ≤20/40) was present in only 15.0% of the unemployed. When other confounding factors are added to the model, only lower educational level shows a weak association with higher frequency of visual impairment, suggesting that socioeconomic status itself may not be an important determinant of visual impairment in African Americans with type 1 diabetes.

The limitations of the present study include that patients were recruited from those hospitalized who may perhaps have a greater severity of diabetes and thus a higher frequency of retinopathy and blindness than nonhospitalized persons with diabetes. Among our patients, 92% had been hospitalized at the time of diagnosis of diabetes, while 8% had not. This is consistent with previous reports indicating that more than 90% of African Americans with type 1 diabetes are hospitalized at the time of diagnosis of the disease. Another limitation of this study is that the frequency of diabetic retinopathy, particularly that of proliferative retinopathy, may have been underestimated because of selective mortality. High mortality rates have been previously reported in this population. In the present study, 14.3% of the 1122 African Americans with type 1 diabetes identified by chart review were dead. Thus, patients who are at risk for retinopathy, particularly proliferative retinopathy, may also be at risk for death from diabetes or other causes and may thus have been excluded from the study. Another possible limitation is bias in patient selection. However, 95.7% of the patients who met study criteria were successfully located and 82.9% of eligible patients agreed to participate.

In summary, the data of the present study show that the frequencies of diabetic retinopathy and associated visual impairment in African Americans with type 1 diabetes are high (63.9% for any retinopathy, 18.9% for proliferative retinopathy, 11.0% for visual impairment, and
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REFERENCES


