Racial Differences in the Relationship Between Blood Pressure and Risk of Retinopathy Among Individuals With NIDDM

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OBJECTIVE— To assess whether the prevalence of retinopathy differs between blacks and whites with diabetes and to examine differences between blacks and whites in the relationship between risk factors for and prevalence of retinopathy. Population data suggest diabetic retinopathy is either more prevalent or more severe in blacks than in whites.

RESEARCH DESIGN AND METHODS— We analyzed data from a screening study for retinopathy among patients with diabetes, conducted in Maryland from 1986-1990.

RESULTS— After adjusting for age, duration of diabetes, type of treatment for diabetes, and presence or absence of high blood pressure, black men with NIDDM were ~23% more likely to have retinopathy than other race-sex groups (not statistically significant). We also found a different relationship between systolic blood pressure and retinopathy prevalence in blacks than in whites among individuals with NIDDM. Among blacks, the risk increased as systolic blood pressure increased, even within the normal range, and reached statistical significance at >150 mmHg. Among whites, the risk was increased only among those with high systolic blood pressure (>140 mmHg) and did not reach statistical significance.

CONCLUSIONS— Our data are consistent with the hypothesis that differences exist between blacks and whites in risk of diabetic retinopathy, and that the effect of blood pressure on risk of retinopathy differs between blacks and whites.

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NIDDM, NON-INSULIN-DEPENDENT DIABETES MELLITUS; BP, BLOOD PRESSURE; DVIP, DIABETES VISUAL IMPAIRMENT PROJECT; sBP, SYSTOLIC BLOOD PRESSURE; dBP, DIASTOLIC BLOOD PRESSURE; OR, ODDS RATIO; CI, CONFIDENCE INTERVAL; ESRD, END-STAGE RENAL DISEASE; R-R, RELATIVE RISK.

Retinopathy is a common complication of diabetes mellitus in both blacks and whites and is a major cause of blindness in the U.S.; ~10% of new cases of blindness are related to diabetes. Although evidence suggests diabetic retinopathy is either more prevalent or more severe in blacks than in whites (1), no published reports directly compare the incidence or prevalence of retinopathy between black and white Americans with diabetes (2). Studies conducted in the U.S. comparing the prevalence of diabetic retinopathy among Hispanics with non-Hispanic whites have yielded conflicting results (3,4).

Less is known about differences among racial or ethnic groups in risk factors for development and/or progression of retinopathy. Studies of American Indian and predominantly white diabetic populations have shown risk factors for development and/or progression of retinopathy include longer duration of diabetes, the presence of other microvascular complications of diabetes, hyperglycemia (or lack of control of diabetes), and high BP (5–7). Hamman et al. (4) found no differences between Hispanics and non-Hispanic whites in the impact of known risk factors on risk of retinopathy. Identification of racial differences in risk and in risk factors may assist in developing screening programs that are more effective at identifying individuals at higher risk of developing diabetic retinopathy.

To address questions about racial differences in diabetic retinopathy, we analyzed data from a screening study for retinopathy among individuals with diabetes, which was conducted in Maryland from 1986–1990. We assessed differences between blacks and whites in the prevalence of retinopathy among individuals with NIDDM, after taking into account differences in the distribution of age, duration of diabetes, type of treatment for diabetes, and high BP. We also examined differences between blacks and

whites in the association between these risk factors and the prevalence of retinopathy.

RESEARCH DESIGN AND METHODS

— The Maryland DVIP was designed to increase awareness of the prevention and control of diabetic eye disease among people with diabetes and their health-care providers. DVIP targeted those who were at increased risk of having undiagnosed diabetic eye disease; specifically, those who had not had a dilated eye exam for at least 1 yr were recruited into DVIP. The project's services focused on two geographic areas with high diabetes-related morbidity and mortality: Baltimore City and Somerset County; clinics also were held in other areas throughout Maryland. The screening sessions were conducted at facilities that provide health care to patients with diabetes. Selection of sites was based on population density and factors related to access to care (e.g., number of ophthalmologists, socioeconomic status). The goal was not to recruit everyone with diabetes, but to examine as many high-risk individulas as possible within the budgetary constraints. From 1986–1990, 2,357 persons ≥18 yr of age with diabetes participated (638 white men, 258 black men, 890 white women, 528 black women, plus 43 individuals of other races).

Screening visit

Screening sites were set up at local facilities so participants could visit sites convenient to them. During these visits, demographic data (age, sex, race), healthcare information (type of medical insurance, regular physician and ophthalmologist, time since last ophthalmologic exam), and medical background (duration of diabetes, type of diabetes, type of treatment for diabetes, BP, visual acuity, ophthalmic pressure, current smoking practice, degree of retinopathy, history of hypertension) were collected. Classification of diabetes was based on the clinical history provided by the participant: age at onset of diabetes (<40 yr or ≥40 yr), type of treatment (with or without insulin), and the presence or absence of ketoacidosis at onset. BP was measured after at least 5 min of rest with the participant in a sitting position. Retinal photographs allowed us to assess the degree of retinopathy. The importance of diabetic control and regular visits to an ophthalmologist in the prevention and control of retinopathy were emphasized.

Table 1—*Description of diagnostic categories used to classify retinal photographs*

CATEGORY	DESCRIPTION
NO DIABETIC RETINOPATHY	NONE OF THE ABNORMALITIES LISTED BELOW
BACKGROUND DIABETIC RETINOPATHY	SCATTERED MICROANEURYSMS AND/OR SMALL BLOT INTRARETINAL HEMORRHAGES
PREPROLIFERATIVE DIABETIC RETINOPATHY	PRESENCE OF ANY OF THE FOLLOWING: COTTON WOOL SPOTS, INTRARETINAL MICROVASCULAR ABNORMALITIES, VENOUS LOOPS, OR VENOUS BEADING
PROLIFERATIVE DIABETIC RETINOPATHY	PRESENCE OF RETINAL OR OPTIC DISC NEOVASCULARIZATION. SEVERITY ESTABLISHED WITH CRITERIA DEVELOPED BY THE DIABETIC RETINOPATHY STUDY GROUP. PRESENCE OF ≥3 RISK FACTORS FOR SEVERE VISUAL LOSS ESTABLISHED THAT THE EYE WAS AT HIGH RISK FOR VISUAL LOSS (17).

Evaluation of retinopathy

Retinal photographs were obtained with a nonmydriatic camera (Canon CR3–45NM fundus camera, which is a nonstereoscopic 45° fixed angle camera; Canon, Tokyo). One photograph was taken for each eye, centering between the disc and the macula. The 35-mm Kodachrome film for the slides (Eastman Kodak, Rochester, NY) was processed in a routine fashion. An ophthalmologist (Dr. Sherman) examined the photographs to determine if retinopathy was present, and, if so, to assess its severity (Table 1). He did not examine the participants, so his rating of the degree of retinopathy was not affected by knowledge of other clinical characteristics of the participant, eliminating one potential source of bias.

Use of a nonmydriatic camera had several advantages: *1*) it was far faster than a conventional ophthalmologic fundus examination; 2) it did not require the presence of an ophthalmologist; 3) it did not require pupillary dilatation with the accompanying blurred vision for several hours; and 4) it was less expensive and more mobile than conventional seven-field photography. One disadvantage was that the entire retina was not seen, so changes in the more peripheral parts of the retina may not have been detected; Klein et al. (8) estimated that 8–15% of diabetic retinopathy may be missed by a nonmydriatic camera. A second disadvantage was that the photographs were not of sufficient quality to detect the more subtle changes of diabetic retinopathy such as intraretinal microvascular abnormalities. In comparing the rating of retinopathy (into four diagnostic categories) using a nonmydriatic camera versus a standard fundus camera, Klein et al. (8) found exact agreement in 82% of the photographs; 13% of the photographs taken using the nonmydriatic camera could not be graded. For the nonmydriatic camera, interrater agreement was 85%, and intrarater agreement was 81%. In a British study including both Indians and Europeans, agreement between photographic assessment of retinopathy (using a nonmydriatic camera) and ophthalmoscopy by an ophthalmologist was 72% and did not differ between racial groups (9). A study of 138 DVIP participants showed 93% agreement between findings using our method and a subsequent ophthalmological examina-

tion (10). We may have missed some cases of retinopathy within our study group, but such misclassification is unlikely to differ between blacks and whites or by risk-factor status (e.g., high vs. normal BP). Such nondifferential misclassification could minimize the differences between groups or bias the estimate of R-R toward 1.0. In addition, because recognizing preproliferative retinopathy is sometimes difficult with a single photograph taken with a nonmydriatic camera, we may have underrated the severity of retinopathy.

Analytical sample

For these analyses, 468 blacks and 960 whites with NIDDM who were ≥40 yr of age and for whom retinopathy status was known for at least one eye were used. Participants of other races numbered too few to be analyzed separately. An additional 11 individuals who were missing information on BP, duration of diabetes, or type of treatment for diabetes, were excluded from the multivariate analyses.

Statistical analysis

Each person was included only once in these analyses; the more severe retinopathy rating was used. To assess differences between races and sexes in the prevalence of diabetic retinopathy, adjusted for the effects of risk factors, we used multiple logistic regression (11). To examine racial differences in the impact of each risk factor on risk of diabetic retinopathy, we analyzed the two races separately because this approach makes no assumptions about the homogeneity of risk for specific risk factors between races.

Age was collected as a continuous variable and was included in the regression models as such. Duration of diabetes was collected as a categorical variable (0–4, 5–9, 10–14, and ≥15 yr). It was included in the regression models as a trichotomous variable (<5 yr, 5–9 yr, and ≥10 yr duration) because preliminary analyses suggested this categorization best described the relationship between retinopathy and duration of diabetes, and the assumption of a log-linear relationship was valid.

BP was used in two ways: *1*) to assess whether the apparent race-sex difference in the prevalence of retinopathy could be explained by differences in the prevalence of risk factors, we categorized BP into high (sBP > 140 mmHg or dBP > 90 mmHg) and normal; *2*) to examine possible racial differences in the impact of risk factors on the prevalence of retinopathy, we divided sBP into five categories, roughly quintiles (≤120, 121–130, 131–140, 141–150, and >150 mmHg).

Table 2—*Distribution of retinopathy among DVIP participants with NIDDM, stratified by race, sex, and age*

		Retinopathy status in worse eye (%)			
	n	None	Background	Preproliferative	Proliferative
White men					
40–64 yr	201	70.6	18.9	10.4	0.0
≥65 yr	186	78.0	14.5	5.9	1.6
Age-adjusted		73.7	17.1	8.6	0.7
Black men					
40–64 yr	105	61.9	19.0	17.1	1.9
≥65 yr	55	78.2	9.1	12.7	0.0
Age-adjusted		68.6	15.0	15.3	1.1
White women					
40–64 yr	302	72.2	20.5	6.0	1.3
≥65 yr	271	66.4	27.7	4.4	1.5
Age-adjusted		69.8	23.5	5.3	1.4
Black women					
40–64 yr	233	74.7	13.7	10.3	1.3
≥65 yr	75	64.0	25.3	9.3	1.3
Age-adjusted		70.3	18.5	9.9	1.3

RESULTS

Occurrence of retinopathy

Of the 1,428 individuals with NIDDM who had an adequate retinal photograph for at least one eye, 71% had no retinopathy, 19% had background retinopathy, 8% had preproliferative retinopathy, and 1% had proliferative retinopathy. For 227 individuals (14% of those ≥40 yr), no retinopathy data were available, either because of blindness or inability to focus or because the presence of cataracts, small pupils, or camera error made the quality of photographs inadequate for rating. The proportion of unavailable photographs varied little by race—13% of whites and 15% of blacks (not statistically significant).

Middle-aged black men had the highest prevalence of retinopathy (38%), as shown in Table 2. This excess was especially evident in preproliferative retinopathy, in which the prevalence in black men was 17% compared with 6–10% in the other race-sex strata. Older women also had a higher prevalence of retinopathy (34% for whites, 36% for blacks), but the excess was in background retinopathy (25–28% in older women vs. 9–15% in older men). After adjustment for age, the prevalence of retinopathy among race-sex groups was no different. The age-adjusted prevalences of retinopathy were 26% for white men, 31% for black men, and 30% for both white and black women.

Table 3—*Distribution of potential risk factors for retinopathy among DVIP participants ≥40 yr of age with NIDDM and retinopathy data, stratified by race and sex*

	White men	Black men	White women	Black women
n	387	160	573	308
High BP (%)*				
Yes	41.8	40.3	40.9	46.6
No	58.2	59.7	59.1	53.4
Median BP (mmHg [range])				
sBP	138 (90–230)	136 (102–198)	138 (92–230)	140 (94–226)
dBP	82 (60–136)	84 (52–112)	80 (50–110)	84 (58–114)
History of hypertension (%)				
Yes	39.8	51.3	56.7	64.9
No	60.2	48.7	43.3	35.1
Treatment (%)				
No drugs	25.3	14.4	19.9	17.5
Oral agent	56.3	58.1	53.4	52.0
Insulin	18.3	27.5	26.7	30.5
Duration of diabetes (%)				
0–4 yr	42.6	43.7	37.0	45.9
5–9 yr	22.2	27.5	23.3	28.0
10–14 yr	14.0	15.0	19.6	13.4
≥15 yr	21.1	13.7	20.0	12.7
Age at exam (%)				
40–64 yr	51.9	65.6	48.1	75.6
≥65 yr	48.1	34.4	47.3	24.4
Median age at exam (yr [range])	64 (40–89)	60.5 (40–83)	64 (40–87)	59 (40–86)
Current smoker (%)				
Yes	18.6	36.9	13.3	19.2
No	81.4	63.1	86.7	80.8

*sBP >140 mmHg or dBP >90 mmHg.

Distribution of risk factors for retinopathy

The apparent excess of more severe retinopathy among black men could not be explained by a higher prevalence of known risk factors for retinopathy (Table 3). The prevalence of high BP was about the same for all race-sex groups. Women more often reported a history of hypertension than men, and blacks more often reported a history of hypertension than their same sex among whites. Blacks more often were being treated for diabetes with medication than whites. The reported duration of diabetes was shorter in blacks than in whites, and blacks tended to be younger than whites at the time of examination. The distribution of a potential risk factor, current cigarette smoking, differed significantly across race-sex groups: 37% of black men were current smokers, twice that of other groups. The lower prevalences of treatment with insulin and history of hypertension are consistent with the observed lower prevalence of retinopathy among white men.

Distribution of health-care variables

Almost all participants had a regular physician (97% of whites and 96% of blacks), but only 45% of whites and 30% of blacks had a regular ophthalmologist, perhaps reflecting our ascertainment strategy. In addition, 45% of blacks and 33% of whites had never had an ophthalmological examination; 15% of whites and 8% of blacks had had an examination within the past year. We found a significant difference in the type of medical insurance between blacks and whites: 77% of whites had some form of private insurance, 17% were covered by Medicare or Medicaid, and 6% had no insurance; 57% of blacks had some form of private medical insurance, 28% were covered only by Medicare or Medicaid, and 15% had no insurance. Among blacks, type of medical insurance did not differ between men and women; among whites, however, women were significantly less likely to have private insurance and more likely to have no insurance or to be covered only by Medicare or Medicaid than were men.

Black-white differences in the prevalence of retinopathy

No statistically significant differences were found in the prevalence of retinopathy among the race-sex groups. Black men were more likely to have retinopathy than white men (OR = 1.23, 95% CI, 0.80–1.91), after adjustment for age at time of exam, type of treatment for diabetes, duration of diabetes, and presence or absence of high BP. Women with NIDDM did not have a higher prevalence of retinopathy than white men (OR = 1.07, 95% CI, 0.79–1.46 for white women; OR = 0.91, 95% CI, 0.62–1.32 for black women).

Disease characteristics and racial differences in risk factors

For both races, individuals with longer duration of diabetes (5–9 yr, OR = 1.88; ≥10 yr, OR = 3.54) or high BP (OR = 1.48) were significantly more likely to have retinopathy (data not shown). Age was inversely related to the prevalence of retinopathy (for 10-yr interval, OR = 0.82). Treatment with oral agents alone (OR = 2.09) or with insulin (OR = 4.66) also was significantly associated with increased prevalence of retinopathy when compared with individuals who were not receiving drug treatment for diabetes. Current smoking was not a risk factor for retinopathy, and its inclusion in the model did not alter the relationship of race and sex with retinopathy. Except for BP, the association of retinopathy with its risk factors varied little by race (Table 4).

After controlling for the effects of other risk factors, a different relationship was observed between BP and retinopathy in blacks than in whites. In blacks, the OR increased as sBP increased, even within the normal range. Further modeling of the effect of BP on prevalence of retinopathy (data not shown) showed that among blacks the effect was linear and statistically significant. In whites the risk was increased in those with elevated sBP (>140 mmHg) but not at lower levels of BP. The effect of sBP was linear, but not statistically significant. In addition, for a given sBP, the OR for retinopathy was higher in blacks than in whites. Inclusion of health-care variables did not alter the pattern of results (data not shown).

Such a pattern might be observed if the distribution of BP within each category differed between blacks and whites. The means in each sBP category differed by <1 mmHg between races, so such an explanation is unlikely. We also were concerned that differential treatment for hypertension may be producing these results. Although information on BP medication was not available for many of the participants, we had data on whether they had been previously diagnosed as having hypertension. We used this as a surrogate measure for treatment (agreement >90%, κ-statistic >80% for blacks and whites) and analyzed the subgroup that had had no history of hypertension. The pattern of results for this subgroup was similar to that observed in the total group; the association between prevalence of retinopathy and sBP was stronger among blacks than whites. Therefore, differential treatment for hypertension is an unlikely explanation for these results. These findings support the idea that BP, as usually measured, may have a greater impact on risk of diabetic retinopathy in blacks with NIDDM than in whites with NIDDM.

CONCLUSIONS — Diabetes mellitus is more prevalent in black adults than in white adults; data from the 1976–1980 National Health and Nutrition Examination Survey revealed that the age-standardized prevalence of diabetes in black men and women 20–74 yr of age was ~50% higher than in their same-sex

Table 4—*Results from multiple logistic regression analyses showing dose-response effect associated with sBP among individuals with NIDDM*

	Blacks (n = 465)*	Whites (n = 952)†
	OR (95% CI)	OR (95% CI)
Age (10 yr)	0.75 (0.59–0.95)	0.85 (0.72–1.00)
Sex		
Male	1.00 (Reference)	1.00 (Reference)
Female	0.72 (0.47–1.11)	1.05 (0.77–1.44)
Duration of diabetes (yr)		
<5	1.00 (Reference)	1.00 (Reference)
5–9	1.77 (1.34–2.33)	1.92 (1.59–2.31)
≥10	3.13 (1.81–5.41)	3.67 (2.53–5.34)
Treatment for diabetes		
No drugs	1.00 (Reference)	1.00 (Reference)
Oral agent only	1.85 (0.90–3.82)	2.22 (1.39–3.55)
Insulin	3.88 (1.81–8.35)	5.13 (3.08–8.54)
sBP (mmHg)		
≤120	1.00 (Reference)	1.00 (Reference)
121–130	1.37 (0.61–3.07)	1.18 (0.70–2.00)
131–140	1.65 (0.76–3.58)	0.93 (0.56–1.54)
141–150	2.15 (0.92–5.00)	1.32 (0.77–2.27)
>150	2.92 (1.39–6.15)	1.39 (0.84–2.31)

These results are stratified by race.
*137 with retinopathy, 328 without retinopathy.
†273 with retinopathy, 679 without retinopathy.

white counterparts (12). Based on these data alone, we would expect blacks to be overrepresented among patients with diabetic complications. Evidence from data on another diabetic complication, ESRD, indicates that racial differences in risk of developing diabetes cannot fully account for the much higher incidence of ESRD in the black population compared with whites (13).

Little information is available to evaluate possible differences between American blacks and whites in either the occurrence of retinopathy or the rate of progression of retinopathy in individuals with diabetes (2). Data on blindness secondary to diabetic retinopathy in the general population suggest the prevalence of the more severe forms of diabetic retinopathy may be higher in black Americans than in white Americans; the age-standardized prevalence rates were 14/100,000 in blacks and 6/100,000 in whites (1). Retinopathy eventually occurs in most patients with diabetes mellitus (13). A racial difference in the prevalence of retinopathy may be the result of a difference in risk of developing retinopathy or in age at onset, perhaps attributable to differences in the distribution of recognized risk factors for diabetic retinopathy, such as high BP.

In our study of a diabetic population screened for retinopathy, we observed only small racial differences in the prevalence of retinopathy; the prevalence of retinopathy was ~23% higher in black men than in white men, whereas the prevalence in black women and white women was about the same, and was not different from that in white men. This difference could not be explained by differences in the distribution of age at exam, duration of diabetes, type of treatment for diabetes, or the presence of high BP.

The importance of BP or hypertension as a risk factor may differ between blacks and whites. The diurnal pattern of BP in normotensive and borderline hypertensive persons has been found to differ between blacks and whites. Blacks showed less of a decline in BP during sleep than whites (14–16). Therefore, the risk associated with a specific BP level may be higher in blacks than in whites, because a higher average daily BP would be maintained. Our data are consistent with that hypothesis. The OR associated with a specific level of sBP was higher in blacks than in whites with NIDDM.

The DVIP study was designed to be a screening program for diabetic eye disease, not a research study; therefore, measurements may be less precise than those collected in a well-designed research project. The diagnosis of retinopathy in our study was based on a screening protocol using fundus photographs from a nonmydriatic fundus camera, not a diagnostic exam. As a result, we probably missed some cases of retinopathy (8). In addition, DVIP targeted individuals who had not had a recent ophthalmological examination. Although these factors might affect the validity of actual estimates of prevalence of diabetic retinopathy, comparison of risks in blacks with risks in whites still is valid if the two groups are comparable.

In our analyses we adjusted for differences in the distributions of use of medical care and all known risk factors for retinopathy that may have affected comparison of rates in blacks and in whites, except glycemic control, on which we have no information. Therefore, we cannot exclude the possibility that group differences in glycemic control account for the increased prevalence of retinopathy among black men. Glycemic control also might affect the difference in the association of sBP with retinopathy between blacks and whites.

A cross-sectional study cannot establish a temporal relationship between disease and a risk factor; a variable measured after diagnosis actually may be an additional outcome of the disease process, not a cause of the disease. With prevalent cases of a condition, determining whether identified risk factors really are associated with survival, or reflect a causal association, is difficult. For example, we found an inverse relationship between age and prevalence of retinopathy among certain subgroups. This probably reflects co- morbidity of diabetic complications, so older patients with retinopathy are underrepresented in our screening group because of decreased survival or more rigorous medical care.

No observational study is perfect, but even imperfect studies can shed light on potentially important issues. This study provides no information on actual prevalence of retinopathy among patients with diabetes, but it does suggest black-white differences in the association of BP and retinopathy among people with NIDDM. Because of the relatively small number of individuals with more advanced retinopathy, we could only examine differences related to retinopathy as a whole; issues related to severity could not be examined. These racial differences in the association between retinopathy and BP need to be studied in a cohort followed prospectively, so prevalence-incidence bias may be avoided and differences in progression of retinopathy, in addition to risk of developing retinopathy, can be studied. If such differences do exist, then more highly targeted interventions may be needed.

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References

1. Kahn HA, Hiller R: Blindness caused by diabetic retinopathy. *Am J Ophthalmol* 78:58–67, 1974
2. Rabb MF, Gagliano DA, Sweeney HE: Diabetic retinopathy in blacks. *Diabetes Care* (Suppl. 4) 13:1202–206, 1990
3. Hafffner SM, Fong D, Stern MP, Pugh JA, Hazuda HP, Patterson JK, van Heuven WAJ, Klein R: Diabetic retinopathy in Mexican Americans and non-Hispanic whites. *Diabetes* 37:878–84, 1988
4. Hamman RF, Mayer EJ, Moo-Young GA, Hildebrandt W, Marshall JA, Baxter J: Prevalence and risk factors of diabetic retinopathy in non- Hispanic whites and Hispanics with NIDDM. *Diabetes* 38: 231–37, 1989
5. Nelson RG, Wolfe JA, Horton MP, Pettitt DJ, Bennett PH, Knowler WC: Proliferative retinopathy in NIDDM: incidence and risk factors in Pima Indians. *Diabetes* 38:435–40, 1989
6. Jerneld B, Algvere P: Relationship of duration and onset of diabetes to prevalence of diabetic retinopathy. *Am J Ophthalmol* 102:431–37, 1986
7. Knowler WC, Bennett PH, Ballantine EJ: Increased incidence of retinopathy in diabetics with elevated blood pressure: a six-year follow-up study in Pima Indians. *N Engl J Med* 302:645–50, 1980
8. Klein R, Klein BEK, Neider MW, Hubbard LD, Meuer SM, Brothers RJ: Diabetic retinopathy as detected using ophthalmoscopy, a nonmydriatic camera and a standard fundus camera. *Ophthalmology* 92:485–91, 1985
9. Mohan R, Kohner EM, Aldington SJ, Nijhar I, Mohan V, Mather HM: Evaluation of a non-mydriatic camera in Indian and European diabetic patients. *Br J Ophthalmol* 72:841–45, 1988
10. Saudek S, Feldman S, Sherman S, Georgopoulos A: The use of a non-mydriatic camera in detecting previously undiagnosed diabetic eye disease. *Diabetes* (Suppl. 1) 37:93A, 1988
11. Breslow NE, Day, NE: The analysis of case-control studies. In *Statistical Methods in Cancer Research*. Vol. 1. Lyon, International Agency for Research on Cancer, 1980
12. Harris MI: Noninsulin dependent diabetes mellitus in black and white Americans. *Diabetes Metab Rev* 6:71–90, 1990
13. Cowie CC, Port FK, Wolfe RA, Savage PJ, Moll PP, Hawthorne VM: Disparities in incidence of diabetic end-stage renal disease according to race and type of diabetes. *N Engl J Med* 321:1074–79, 1989
14. Harshfield GA, Dupaul LM, Albert BS, Christman JV, Willey ES, Murphy JK, Somes GW: Aerobic fitness and the diurnal rhythm of blood pressure in adolescents. *Hypertension* 15:810–14, 1990
15. Harshfield GA, Hwang C, Grim, CE: Circadian variation of blood pressure in blacks: influence of age, gender and activity. *J Human Hypertens* 4:43–47
16. Murphy MB, Nelson KS, Elliott WJ: Racial differences in diurnal blood pressure profile (Abstract). *Am J Hypertens* 1 (Suppl. A): 55A, 1988
17. Diabetic Retinopathy Study Research Group: Four risk factors for severe visual loss in diabetic retinopathy: the third report from the diabetic retinopathy study. *Arch Ophthalmol* 97:654–55, 1979