Asian American/Pacific Islander Paradox in Diabetic Retinopathy: Findings from the Behavioral Risk Factor Surveillance System, 2006–2008

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Objectives: To compare the self-reported prevalence of diabetic retinopathy (DR) between Asian Americans/Pacific Islanders (AAPIs) and Whites in the United States.

Methods: We analyzed data from 70,209 adults aged ≥18 years with diabetes derived from the 2006–2008 Behavioral Risk Factor Surveillance System (BRFSS), including 1,499 AAPIs and 68,710 White individuals.

Results: Compared with Whites with diabetes, AAPIs with diabetes had higher socioeconomic status, fewer risk factors (eg, smoking) and coexisting chronic diseases (eg, cardiovascular disease [CVD]). Diabetes duration and percentage of persons using insulin were similar between the 2 populations. However, AAPIs had a much higher prevalence of DR (27.6%) than Whites (18.2%) ($P<.001$). Comparing AAPIs to Whites, the age- and gender-adjusted odds ratio of DR was 1.97 (1.48–2.62). The adjusted odds ratio was 2.21 (1.63–3.00) after adjustment for sociodemographic (education and marital status), chronic conditions (CVD and smoking), severity of diabetes and diabetes care (age of diabetes onset, frequency of self-checking blood sugar, and frequency of dilated eye exam).

Conclusions: Despite their favorable socio- and health-related profiles, AAPIs had significantly higher prevalence of DR compared with Whites. (*Ethn Dis.* 2010;20:111–117)

Key Words: Diabetic Retinopathy, Prevalence, Racial Difference, Diabetes Care

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Introduction

Diabetes affects more than 23.6 million (7.8%) of the US population.[1] Each year more than 800,000 new cases of type 2 diabetes are diagnosed.[2] Diabetic retinopathy (DR), one of the most common complications of diabetes, is a significant cause of blindness and visual impairments.[3] About 12 million Asian Americans and Native Hawaiian/Pacific Islanders (AAPIs) live in the United States,[4] constituting 4.2% of the population and one of the nation's most rapidly growing ethnic groups.[5] Some studies suggest that AAPIs have higher risk of developing complications, such as end-stage renal disease, once they have diabetes.[6] Other complications, such as cardiovascular disease (CVD)[7] and lower extremity amputation,[8] were fewer in AAPIs compared with Whites. Relatively little information, however, is available on DR in AAPI populations in the United States. To fill this knowledge gap, we analyzed data on 70,209 adults aged ≥18 years from the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS), 2006–2008, to determine the prevalence of DR among 1,499 AAPIs with diabetes. We then compared this group's data with that of 68,710 US Whites with diabetes. We also attempted to explore the potential reasons contributing to the difference.

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Material and Methods

Data Source

The BRFSS is a population-based telephone survey of US adults aged ≥18 years in all 50 states, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. This ongoing surveillance collects state-specific data on preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases among non-institutionalized US adults.[9] Each year, in addition to the survey's core section, states are allowed to select optional modules with detailed health conditions to be included in the questionnaire. A diabetes module covers specific questions related to diabetes onset, care, and complications. Forty-nine states/territories used this module in 2006, 46 in 2007, and 49 in 2008. The data gathered during these years provides national estimates of DR. Variations in prevalence of DR were small across these 3 years. Pooling data from these 3 years not only covered all 50 states and Washington, DC, but also increased the sample size for AAPIs. The average response and cooperation rates were 51.8% and 73.9% respectively in the survey years from 2006 to 2008. The main language used in the survey was English, but Spanish and Chinese were also used in some states. In survey years 2006–2008, 98% of the interviews were administered in English among White persons and 94% among AAPI respondents.

Data Collection

Participants were asked, ''Have you been told by a doctor that you have

diabetes?'' If they answered yes, they were classified as self-reported diabetes. If they responded no, pre-diabetes, or diabetes during pregnancy, they were classified as non-diabetes and were excluded from our analysis. The BRFSS does not ask about diabetes type; therefore, in attempt to limit the study to respondents with type 2 diabetes, we excluded persons who had diabetes before age of 30 and were also using insulin. Among the respondents with diabetes, 9% met these criteria, which is consistent with current estimates that type 2 diabetes accounts for more than 90% of diabetes.[1] Diabetic retinopathy was ascertained by asking the respondents with self-reported diabetes, ''Has a doctor ever told you that diabetes has affected your eyes or that you had retinopathy?''

Persons with diabetes were also asked how old they were when told they had diabetes and whether they were taking insulin. Information related to diabetes care was obtained through asking the respondents: how often they (or a family member or friend) checked their blood sugar (glucose) level, and their feet for any sores or irritations; how often they had seen a doctor, nurse, or other health professional for diabetes in the 12 months preceding the survey; how often such health professionals checked their feet and hemoglobin A1C (a test that measures the average level of blood sugar over the past 3 months); when they last had an eye exam during which the pupils were dilated; and if they had ever taken a course or class on how to manage their diabetes.

Other information that we collected included: age (18–34, 35–44, 45–54, 55–64, and 65+ years), sex, educational level (<high school, high school graduate, or >high school); annual family income levels (<$25,000, $25,000–$50,000, and >$50,000); marital status (married or partner, divorced/separated/widow, never married); having health insurance; history of CVD (ie, stroke, coronary heart disease, or myocardial infarction); smoking status (current, former, or never); and body mass index (BMI <25, 25–29, ≥30 kg/m^2).

Data Analysis

Whites were used as a reference group. In our initial analysis, we separated Asian Americans and Native Hawaiian/Pacific Islanders as 2 subgroups, and they followed similar patterns of DR prevalence, compared with Whites. The number of Native Hawaiian/Pacific Islander respondents was small: just 270 persons over the 3 survey years. Hence, Asian Americans and Native Hawaiian/Pacific Islanders were combined into one group, which we abbreviated as AAPIs. Age-standardized prevalence of DR was calculated by direct method using age distribution of all persons with diabetes in 2006–2008 as the standard. The chi-square test was used to compare characteristics of AAPIs and Whites. Multivariate logistic regression was used to assess the association between race/ethnicity and outcome (ie, DR). In the basic model, we included age groups and sex in the analysis. Then we included various covariates in a hierarchical order, adding the following additional covariates in each model: (1) sociodemographic variables (education and marital status), (2) coexisting chronic disease and risk factors (CVD and smoking), and (3) severity of diabetes and diabetes care (eg, age of diabetes onset, frequency of self-checks for blood sugar levels, and frequency of dilated eye exam).

The SAS callable SUDAAN version 9.0 (Research Triangle Park, North Carolina) was used in the analysis to account for the complex design of the survey.

RESULTS

After excluding respondents whose data lacked information on DR (1.5%), our analysis included 70,209 persons with diabetes, among whom 1,499 were self-identified as AAPI and 68,710 as White. Characteristics of respondents with diabetes are presented in Table 1. Compared with Whites, AAPIs were younger, and had a higher proportion of males, more persons who were married, and more with education beyond high school. AAPIs also had lower prevalence of CVD, hypertension (2007 only), current smoking, and obesity. Table 2 shows diabetes-related characteristics including prevalence of DR, severity of diabetes, and diabetes care in AAPIs compared with Whites. AAPIs had a much higher crude prevalence of DR than Whites in each of the survey years (Figure 1). The three year combined data showed age-standardized prevalence of DR was significantly higher in AAPIs than in Whites ($P<0.001$) (Table 2). Diabetes occurred in AAPIs at a younger age than in Whites; however, duration of diabetes was similar between the 2 groups ($P=.53$). Percentage of persons who were using insulin, an indicator of diabetes severity, was similar between AAPIs and Whites ($P=.24$). Overall, AAPIs did not monitor their blood glucose levels and self-check their feet as often as Whites (all $P<.01$). However, they visited doctors for diabetes, and had A1C and feet checked by health professionals as often as Whites. For frequency of dilated eye exam, although more AAPIs had never had an eye examination (6.1%) compared with Whites (3.9%), more AAPIs had received an eye exam within the past year (75.6% vs. 70.6%). About half of all respondents had ever taken a course or class on self-management of diabetes (47.1% of AAPIs and 53.7% of Whites, respectively, $P=.05$).

For variables with significantly different distributions between AAPIs and Whites, we used univariate logistic analysis to examine their associations with DR. Older age (but not in the oldest group), male sex, lower education levels, nonmarried, history of CVD, current smoking, earlier onset of dia-

Table 1. Characteristics of adults with diabetes in Asian American/Pacific Islanders and Whites, using data from the Behavioral Risk Factor Surveillance System 2006–2008

	Asian/Pacific Islanders (*n*=1,499)			Whites (*n*=68,710)			
	%	UCI	LCI	%	UCI	LCI	*P*
Age groups, y							<.001
18–34	5.3	2.7	10.1	2.8	2.4	3.3	
35–44	17.0	12.7	22.5	7.7	7.1	8.2	
45–54	18.2	13.5	24.1	18.0	17.3	18.7	
55–64	26.5	21.2	32.4	27.3	26.6	28.0	
65+	33.1	27.4	39.3	44.2	43.5	45.0	
Sex							<.001
Male	65.8	59.7	71.4	52.8	52.0	53.6	
Female	34.2	28.6	40.3	47.2	46.4	48.0	
Education							<.001
<High school	7.5	5.1	11.1	11.8	11.3	12.4	
High school graduate	17.1	12.5	22.9	34.7	34.0	35.5	
>High school	75.4	69.3	80.6	53.4	52.6	54.2	
Family annual income ($)							.08
<25000	33.6	27.2	40.7	33.2	32.4	34.0	
25000 to <50000	23.7	18.5	29.9	30.1	29.3	30.9	
≥50000	42.6	36.2	49.4	36.7	35.8	37.6	
Marital status							<.001
Married	78.7	73.1	83.4	64.6	63.8	65.3	
Divorced, separated or widowed	12.7	9.4	16.9	27.6	27.0	28.3	
Never married	8.6	5.4	13.6	7.8	7.3	8.3	
Having medical insurance	91.5	86.2	94.9	93.1	92.6	93.5	.43
History of CVD	16.2	12.1	21.4	29.0	28.3	29.7	<.001
Hypertension*	55.1	43.9	65.9	68.6	67.5	69.7	<.001
Smoking status							<.001
Current	10.0	6.7	14.8	15.1	14.5	15.7	
Former	27.5	21.9	33.8	41.8	41.0	42.6	
Never	62.5	55.9	68.6	43.1	42.4	43.9	
Obesity status							<.001
Normal	38.5	32.3	45.1	14.6	14.1	15.2	
Overweight	37.3	31.0	44.1	33.0	32.2	33.8	
Obesity	24.2	19.5	29.6	52.3	51.5	53.2	

Note. UCI=Upper limit of 95% confidence interval; LCI=lower limit of 95% confidence interval; CVD=cardiovascular disease.
* Data available in 2007 only.

betes, more frequent self-check of blood sugar levels, and more frequent dilated eye exam were significantly, positively associated with DR (data not shown here). These variables were included step-by-step in the multivariate logistic models to examine the independent association between race/ethnicity (AAPI compared with White) and likelihood of DR (Table 3). Compared with Whites with diabetes, the age- and gender-adjusted odds ratio (AOR) associated with DR for AAPI was 1.97 (confidence interval 1.48–2.62). The AOR increased to 2.12 (1.59–2.83) when education and marital status were added into the model. Since fewer AAPIs had coexisting CVD and fewer AAPIs smoked than Whites, as expected, the AOR increased when these 2 covariates were included in the model (AOR=2.20, 1.64–2.94). Adjustment for age of diabetes onset, frequency of self-checked blood sugar levels, and frequency of dilated eye exam, either individually or in combination, had little influence on AOR. We performed an alternative analysis at the final step of logistic regression (model 4 in Table 3). We included diabetes duration instead of age of diabetes onset and included other covariates (eg, use of insulin, frequency of A1C check, and ever took a course/class in self -management of diabetes). The AORs were very similar to model 4 reported in Table 3.

DISCUSSION

Data from this large population-based national survey demonstrate an

Table 2. Diabetes-related characteristics of adults with diabetes in Asian American/Pacific Islanders and Whites, using data from the Behavioral Risk Factor Surveillance System 2006–2008

	Asian/Pacific Islanders			White Persons			
	%	UCI	LCI	%	UCI	LCI	*P* value
Prevalence of diabetic retinopathy							
Crude	27.6	22.2	33.0	18.2	17.6	18.8	<.001
Age–standardized*	29.2	23.3	35.0	18.2	17.7	18.8	<.001
Age of diabetes onset, y							<.001
<30	3.1	1.7	5.7	4.0	3.5	4.6	
30–39	22.7	17.4	29.1	11.7	11.1	12.3	
40–49	28.2	22.7	34.5	22.1	21.4	22.8	
50–59	21.8	17.3	27.1	28.7	28.0	29.4	
≥60	24.1	19.0	30.0	33.4	32.7	34.2	
Diabetes duration, y							.53
0–5	45.5	39.1	52.0	44.6	43.8	45.4	
6–10	16.4	12.4	21.4	17.0	16.5	17.6	
11–20	27.5	21.8	34.0	25.3	24.6	26.0	
>20	10.6	7.9	14.2	13.1	12.6	13.6	
Use of insulin	18.0	13.5	23.6	21.2	20.6	21.9	.24
Self-checked blood sugar, times per week							<.001
0	14.5	10.0	20.5	10.4	9.8	11.0	
1–6	37.7	31.7	44.1	27.4	26.6	28.1	
≥7	47.8	41.4	54.3	62.3	61.4	63.1	
Self-checked feet, times per week							<.001
0	27.4	21.8	33.8	11.6	11.0	12.2	
1–6	25.1	19.8	31.3	21.6	21.0	22.3	
≥7	47.5	41.0	54.1	66.8	66.0	67.6	
Doctor visit in the past 12 mo (times)							.96
0	12.5	8.2	18.4	11.8	11.2	12.3	
1–3	43.7	37.4	50.2	44.0	43.2	44.9	
≥4	43.8	37.5	50.3	44.2	43.4	45.0	
A1C checked in the past 12 mo (times)							.82
0	14.9	10.5	20.8	14.5	14.0	15.1	
1–3	56.2	49.6	62.6	54.8	53.9	55.6	
≥4	28.9	23.5	34.9	30.7	29.9	31.5	
Feet checked by physician in the past 12 mo (times)							.08
0	32.9	26.9	39.4	29.4	28.6	30.1	
1–3	47.2	40.7	53.8	44.7	43.9	45.5	
≥4	19.9	15.5	25.2	25.9	25.2	26.7	
Last time having an dilated eye exam							.02
Within 1 y	75.6	69.4	80.9	70.6	69.8	71.3	
More than 1 y ago	18.3	14.1	23.5	25.6	24.8	26.3	
Never	6.1	3.0	11.9	3.9	3.5	4.2	
Ever took a course/class on self-management of diabetes							.05
Yes	47.1	40.7	53.5	53.7	52.9	54.5	
No	52.9	46.5	59.3	46.3	45.5	47.1	

* Age standardized to all persons with diabetes in 2006–2008.

AAPI paradox in DR. Compared with Whites, AAPIs with diabetes had a more favorable socioeconomic status, as indicated by higher education beyond high school and higher income levels. They had fewer risk factors (smoking and obesity) and fewer coexisting conditions, such as hypertension and CVD. Although AAPIs had an earlier onset of diabetes than their White counterparts, diabetes duration in AAPIs was similar to that in Whites. The severity of diabetes, as measured by the use of insulin and frequency of self-checking glucose levels in AAPIs, was either similar to or less than severity among Whites, however, the prevalence of DR was significantly higher among AAPIs than Whites.

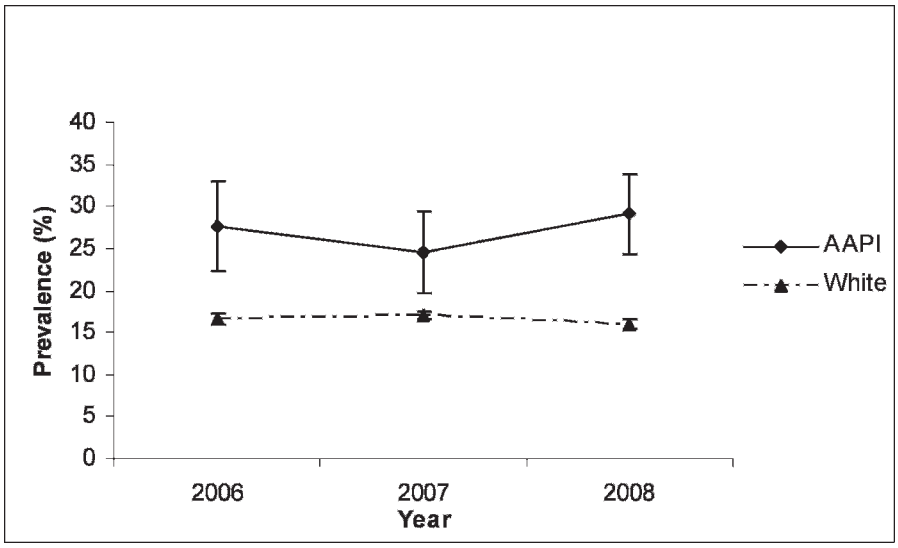

Fig 1. Self-reported crude prevalence of diabetic retinopathy in Asian American/ Pacific Islanders and Whites, using data from the Behavioral Risk Factor Surveillance System, 2006–2008

Studies comparing DR in Asians and other racial/ethnic groups have been conducted mostly in Europe, predominantly in the United Kingdom, and focus on the comparison between South Asians and White Europeans.[10–14] Studies in patient series have reported lower,[13] similar,[14] and higher[10–12] prevalence of DR among Asians. It had been well documented that South Asians in the UK had higher rates of type 2 diabetes, younger age at diabetes onset, and higher prevalence of glucose intolerance compared with the indigenous population.[15] South Asians in the UK had higher blood pressure, A1C, and total cholesterol,[12] as well as longer diabetes duration and more coexisting ischemic heart disease.[16] Unfavorable clinical profiles among these South Asians played a role in, but did not completely account for, the excess prevalence of DR.[10,12]

There were fewer reports on comparisons of DR among different ethnic groups in the United States.[17–19] McNeely and Boyko reported similar prevalence of DR in comparisons of Asian Americans and Whites, but higher in Pacific Islanders in the 2001 BRFSS.[17] It should be noted, however, that only 186 Asian Americans and 71 Pacific Islanders were represented in the analysis. Wong and colleagues also failed to find any difference in prevalence between Chinese Americans and Whites in the Multi-Ethnic Study of Atherosclerosis,[18] but this study is also limited by small sample size, representing just 101 Chinese and 153 White participants. Analyzing a patient series at San Francisco General Hospital, Lim and co-workers found no statistical difference in DR prevalence among White, Black, Hispanic, and Asian groups.[19] Based on their findings, the authors suggested that there is no need to focus future public health outreach and interventions for DR on particular groups by race or ethnicity.[19] Our findings, based on large national samples, do not support this view. In contrast to the previous reports in the United States, we observed an excess burden of diabetic retinopathy in Asian Americans with diabetes.

In the BRFSS, except in some states where Spanish was also used, English was the main language used in the survey. Although Chinese-version questionnaires have been used in California since 2004, the majority of BRFSS interviews among AAPIs were still conducted in English. Hence, the AAPI respondents in the BRFSS were mostly English speakers and more affluent persons, compared with AAPIs overall. Our data showed that AAPI respondents had higher education and income levels than Whites, and higher education level was associated with lower prevalence of DR. However, despite having higher socioeconomic status, AAPIs had a higher prevalence of DR.

Aside from data on duration of diabetes and use of insulin, we did not have direct measures of diabetes severity in this survey. More frequent blood sugar checks are required in persons with more severe diabetes, but more frequent self-checks of blood sugar may also be an indicator of better self-management of diabetes. AAPIs checked their blood sugar less frequently than Whites; higher frequency of blood sugar check was associated with a higher prevalence of DR in our analysis. Based on these findings and the observed similarity in diabetes duration, insulin use, frequency of doctor visits, and A1C

Table 3. Adjusted odds ratio and 95% confidence interval for the likelihood of diabetic retinopathy in Asian/Pacific Islanders vs Whites

Model	Covariates in the model	AOR (95% CI)
1	Age, sex	1.97 (1.48,2.62)
2	Age, sex, education, marital status	2.12 (1.59,2.83)
3	Age, sex, education, marital status, CVD, smoking	2.20 (1.64,2.94)
4	Age, sex, education, marital status, CVD, smoking, age of diabetes onset, self-check glucose, dilated eye exam	2.21 (1.63,3.00)

CI=confidence interval; CVD=cardiovascular disease.

check between AAPIs and Whites, it appears that AAPIs in general did not have more severe diabetes than Whites. This means that higher prevalence of DR in AAPIs was not attributed to a racial difference in diabetes severity.

In the current data, we found no indication of differential quality and access of diabetes care between AAPIs and Whites. Percent of persons who have health insurance, frequency of doctor visits, and A1C checks were similar between the 2 populations. There was only a small racial difference in the percentage of persons who had ever taken a course/class on self-management of diabetes (47.1% AAPIs vs. 53.7% Whites). Although more AAPIs never had a dilated eye exam (6.1%) than Whites (3.9%), more AAPIs (75.6%) had an exam within a year, compared with Whites (70.6%). A competing risk for mortality may be a potential contributor for racial disparities. Despite an often earlier onset of diabetes, lower rates of CVD among AAPIs with diabetes may confer longer survival relative to that of Whites and thus a greater opportunity for AAPIs to develop diabetes complications such as DR. However, our data showed that diabetes duration was very similar between AAPIs and Whites and in general, AAPIs were younger than Whites. A longitudinal study at Kaiser Permanente Medical Care Program in northern California found that the average age at death among diabetic cohort was similar between Asians (69.3 years) and Whites (72.0 years).[6] In that Kaiser cohort, Asian Americans had a lower incidence of myocardial infarction, stroke, congestive heart failure, and lower extremity amputation, but had a higher incidence of end-stage renal disease, compared with Whites with diabetes. Unfortunately, data on DR were not reported in their study.[6]

There are several limitations to our study. Information on DR was based on self-report, which may underestimate the prevalence. The prevalence of retinopathy among diabetics ≥40 years in the current study was 21.6%, which is much lower than reported in other studies (33.2% to 40.3%) in which retinopathy was diagnosed by fundus photography.[18,20] No clinical measurement data (eg, blood pressure, blood glucose) were obtained in our study. Hence, we were not able to evaluate the impact of these clinical measures on DR. Finally, we reported AAPIs in aggregate, which consists of various ethnic subgroups. There may be variations in DR among different subgroups.

Our results suggest that AAPIs with diabetes may be more susceptible to developing DR compared with their White counterparts.

Our results suggest that AAPIs with diabetes may be more susceptible to developing DR compared with their White counterparts. Efforts to prevent DR should thus be more aggressive among these populations. Assessment of DR risk among AAPIs should be implemented proactively at an early stage to prevent vision. Culturally sensitive health education, and management of diabetes and its coexisting risk factors that contribute to retinopathy, should be emphasized.[21] Our findings also highlight the need for further studies to determine whether unmeasured factors, including possible genetic origin, may contribute to the AAPI paradox in DR.[22]

DISCLAIMER

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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AUTHOR CONTRIBUTIONS

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Data analysis and interpretation: Li, Liao
Manuscript draft: Li, Liao, Fan, Zhang, Balluz
Statistical expertise: Li, Liao, Fan, Zhang, Balluz
Administrative, technical, or material assistance: Balluz
Supervision: Balluz