



## Predictors of Glycemic Control in a Multiethnic Public Clinic Population

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**Abstract:** To assess correlates of glycemic control in a multiethnic federally qualified health center population. Deidentified data from a federally qualified health center were examined for patients in diabetes treatment. New variables were created to assess illness burden. Bivariate testing was done to assess treatment compliance by language group. Multinomial regression models assessed three outcomes: uncontrolled, controlled and well controlled glycated hemoglobin (Hba1c). The conceptual framework for this study was Andersen's Health Care Utilization Model. The sample was 1,581 patients. The average was 56. Eighty Five percent of the patients had well controlled or controlled Hba1c. Mandarin speakers were the most likely to have Hba1c controlled despite having the highest average age. Immigrant English speakers had worse glycemic control than their monolingual counterparts. All Asian subgroups had better glycemic control than Hispanics and African Americans. In the final model, the correlates of glycemic control were illness burden, time spent with a provider and health promoting activities. English speaking Hispanics and African Americans continue to have worse glycemic control regardless of having access to care.

**Keywords:** Glycemic Control, Mandarin speakers, glycated hemoglobin.

### Introduction

According to the American Diabetic Association, high glycemic values put an individual at risk for cardiovascular disease, blindness, amputations, and renal failure [1]. Moreover, diabetes is the leading cause of all these conditions in the United States. Glycated hemoglobin, also known as Hba1c, is a blood test that measures average blood sugar over the previous two to three months [2]. A Glycated hemoglobin of seven is equivalent a glucose monitor reading of 125 [3]. There is international consensus that Hba1c is a good barometer of diabetes control [2]. In 1996, the

Framingham Heart Study reported that Hba1c values could consistently identify blood sugar control in individuals regardless of diabetes status [4]. Glycated hemoglobin has been validated across ethnicities and for the purpose of this paper, the Chinese [5].

Although diabetes is a growing problem, it is a larger burden for ethnic and racial minorities [6]. Hispanics and African-Americans are at greater diabetes risk than their white counterparts [7-10]. This is also true for South Asian immigrants [11-13]. The

Sacramento Area Latino Study on Aging also (SALSA) and the -- Mediators of Atherosclerosis in South Asians Living in America (MASALA) studies reported that poverty, low education levels and sedentary lifestyles contribute to prediabetes and diabetes [13-14]. The SALSA study found that third generation Mexican Americans were more than twice as likely to have diabetes compared to their immigrant counterparts. However, this increased risk was attenuated after adjusting for socioeconomic variables.

Another multiethnic study evaluated diabetes as a risk factor for atherosclerosis. The MESA or Multiethnic Study of Atherosclerosis included Chinese, Mexican, and African American individuals. Researchers found that an Hba1c greater than seven predicted progression of coronary artery calcium, which increases the risk of cardiovascular events [15].

Ethnic and racial subgroups face higher risk of diabetes and barriers to care. Ethnic minorities may have a primary language other than English. This is called limited English proficiency (LEP). Minorities with LEP, as well as other low income populations, are more likely to have low literacy skills. This may be a barrier to medical care [16]. Language skills affect communication with providers [17-18]. LEP is also a barrier to employment and employer-sponsored health insurance. Before the Affordable Care Act (ACA), commercial insurance was typically provided by an employer.

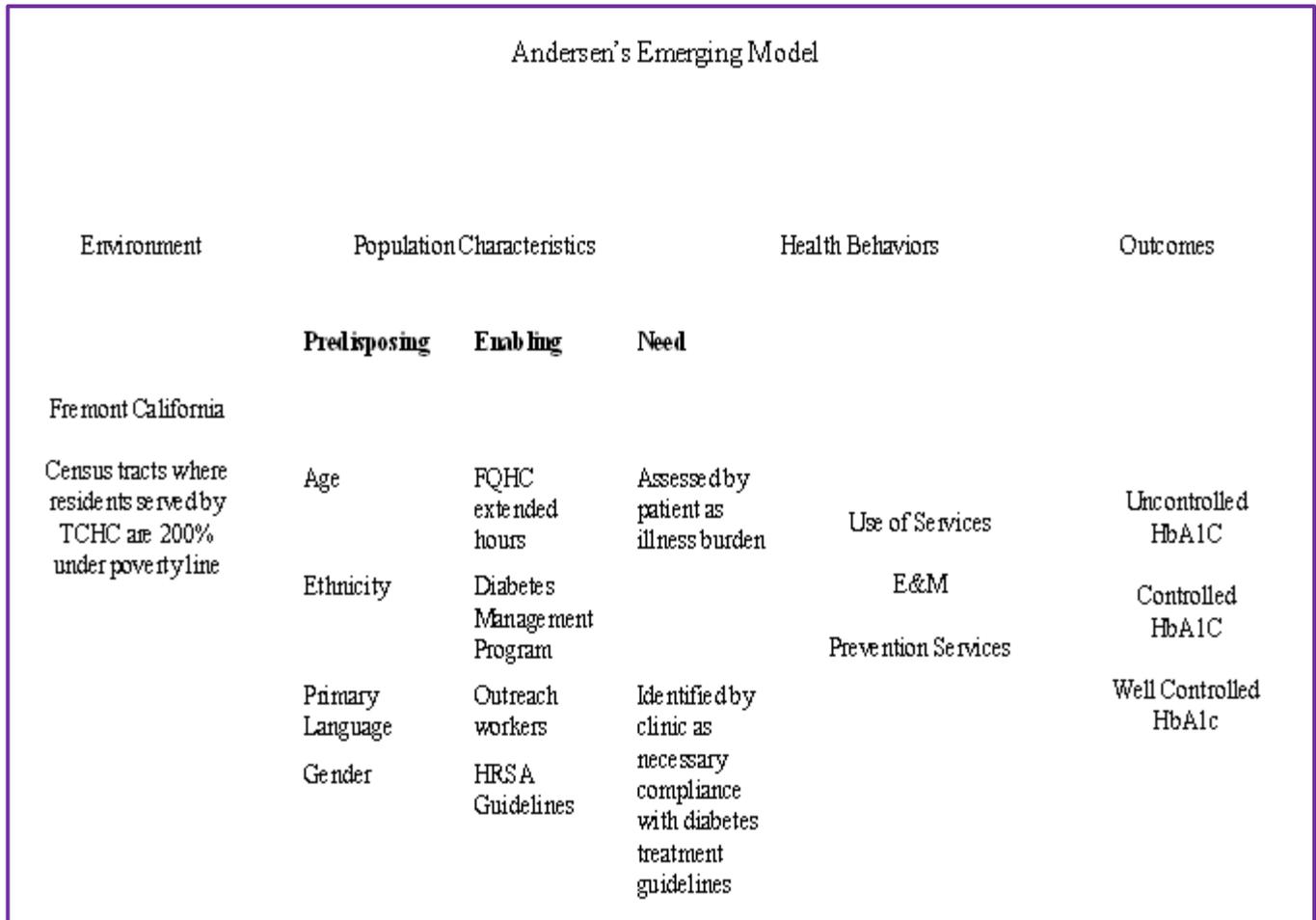
The Affordable Care Act (ACA) expanded Medicaid and created insurance exchanges but these benefits did not change access to care for many California residents. Immigrants with fewer than five years of residence and undocumented individuals do not qualify for either the Medicaid expansion or the insurance exchanges created by the ACA [19-20]. Historically, federally qualified health centers have served both the under and uninsured. Some studies document that

federally qualified health centers have been more effective in managing poor populations than their private provider counterparts [21].

This federally qualified health center is in Alameda County, which has the highest emergency room (ER) utilization rate in the San Francisco Bay area. According to the Centers for Disease Control, 9.1% of the population reported having diabetes [22]. The rate of diabetes related emergency room visits per 10,000 exceeds the California rate, 212.6 and 188.4, respectively. Only twelve percent of ER visits in 2012 resulted in a hospital admission. In other words, Alameda County residents use the emergency room for primary care [23] African American and Hispanic groups have the highest number of diabetes hospitalizations [24].

This federally qualified Health Center (FQHC) provided care for over 20,000 patients in 2013. Of these, nine percent were diabetic. The health center provides services in nineteen languages. The clinic has expanded hours, culturally trained outreach workers and a diabetes management program Electronic medical record (EMR) data are used to identify a patient with at least two visits for diabetes. This identification triggers program initiatives that range from mailed reminders for less complicated patients and in clinic diabetes education for more complex members. Encounters for exercise and other counseling are recorded in the EMR [25].

The conceptual framework for this study was Andersen's Health Care Utilization Model [26] Following the Andersen model, predisposing factors include demographic data. Enabling factors included the universal availability of disease management and provider face time. Need variables were comorbidities and multimorbidities where the latter was operationalized as the number of disease classifications. Figure 1 outlines the model.



**Figure 1. Conceptual Model 1**

**Methods**

**Data**

Data identifying members in treatment for diabetes in 2013 were extracted from the clinic’s electronic medical record (EMR). Lab data were retrieved from files used to report compliance with quality guidelines to the Health Services Resources Administration (HRSA). All data were deidentified and given a new patient number, which was used to link EMR and lab data.

**Sample**

The original files contained data for 2,020 patients. Pregnant women and pediatric cases were removed. Patients who did not

have their glycated hemoglobin (Hba1c) assessed in 2013 were excluded. Patients were then assessed for primary care visits reporting an evaluation and management (E&M) visit. Patients who had an Hba1c test but had no record documenting an E&M visit were also removed from the sample. Finally, patients in language groups with fewer than 100 patients were omitted from the final sample.

**Study Design**

This study was a cross-sectional study with three potential outcomes based on the patient’s last Hba1c results for 2013. This is consistent with the Health Resources and Services Administration guideline [30]. The outcome variable was assessed according to lab results. Hba1c results less than or equal to seven were labeled well-controlled. Results

between eight and nine were put into the controlled category. Patients with Hba1c results equal to or greater than ten were considered to be uncontrolled.

### ***Independent Variables***

#### ***Predisposing Factors***

Independent variables included primary language, which had seven levels with the reference group being white English speakers who were not Asian or Hispanic origin. The Hindi speaking group was combined with the Punjabi language group. Similarly, Chinese and Mandarin speakers were collapsed into one language group. Other demographic variables were gender and age. For the former, women were the reference group. Age was treated as a continuous variable.

#### ***Enabling Factors***

Number of minutes spent with a provider in 2013 was also a variable used to measure illness burden. This was quantified according to the 2013 Current Procedure Terminology (CPT) codes, which provide a minute value for all E&M visits [31]. Count of diagnoses was labeled comorbidities and classifications across ICD9 category were label multimorbidities. The final variable in this category was number of visits.

#### ***Need Factors***

Variables addressing illness burden included unique count of clinic visits, diagnoses, and count of diagnoses categories based on the International Classification version 9 taxonomy [32].

Patient motivation was assessed by examining additional prevention services. These included compliance with foot and eye exams as well as lab tests for low density lipoprotein (LDL) and kidney function.

### ***Statistical Analysis***

Descriptive statistics were summarized. In order to run categorical bivariate tests examining the effect of patient group on compliance with diabetes management guidelines, each group was compared against all other groupings. For example, in order to determine if there was an association between Asian English speakers and having an eye exam, a Pearson chi square was run after creating a binary variable that represented whether a patient belonged to the Asian English speaking group. Binary variables were created for each patient group for a total of six groups.

Multivariate analyses was done using the mlogit command in STATA version 13. Three multinomial models were run. The first was limited to demographic variables. The second model kept the demographic variables and added clinical variables – minutes spent with a provider, comorbidities and multimorbidities. The final model added compliance with the other diabetes guidelines. These were eye exams, foot exams, tests for low density lipoprotein (LDL), and tests to determine kidney damage. Post estimation tests examined predicted probabilities of having a glycated hemoglobin test by language group.

### ***Human Subjects Protection***

This study was approved by the biomedical internal review board reviewers at Tulane University.

### ***Results***

In the original sample, members with diabetes (2,020) represented nine percent of all patients seeking care at the health center in 2013. This is consistent with statistics from the American Diabetes Association in 2010 [1]. Pregnant women and children were removed leaving 2,003 unique patients. Of these, 1,900 (95%) had at least one glycated hemoglobin lab in 2013. Patients belonging to a language

or language ethnicity race grouping of more than 100 ( $n = 1,628$ ) were retained. The final sample cut removed patients who had and Hba1c but had not had a primary care office visit from the evaluation and management chapter of the American Medical Association's Current Procedure Terminology (CPT) [32]. The final sample size was 1,581. The sample derivation can be seen in Figure 1.

The largest language group was English speakers of Asian origin followed by monolingual Spanish speakers. Across language groups, African Americans were more likely to be women (67%). Two groups had more men than women. These were white English speakers (55%) and English speakers of Asian origin (51%). The group most likely to have controlled Hba1c was the Chinese and Mandarin (95%) speaking group. The lowest control was the English Hispanic origin speakers (74%) followed by African-Americans (79%). On average, the Hindi and Punjabi group had the most comorbidities (14.63). The Chinese and Mandarin group had the lowest average comorbidities. Their

average comorbidities were less than ten. These results are (see table 1).

Compliance with diabetes treatment guidelines was evaluated from electronic medical record and lab result data. Mandarin speakers were the group most likely to have foot exams ( $p < 0.0001$ ). At 10%, African-Americans had the lowest compliance with eye exams ( $p < 0.05$ ). The Hindi and Punjabi and Mandarin speakers were less likely to have kidney function testing. African-Americans had the lowest compliance with LDL testing followed by white English speakers. The latter was highly significant. Table 2 summarizes these results. Three multinomial logit models were run to examine variables associated with glycemic control. The base outcome was controlled diabetes. Unlike linear regression where the coefficients need to be different from zero to be significant, in a multinomial logit the base outcome is assumed to be one.



**Figure 2. Sample Derivation**

**Table 1. Sample Characteristics**

	n	% Male	Age	Diagnoses	Multimordibidities	Provider Time	Controlled Hba1c Values		
							<7	8 - 9	<=9
<b>Language Groupings</b>									
<b>English Asian Origin</b>	380	51%	58.04 (10.43)	13.80 (9.67)	6.03 (3.65)	29.34 (20.17)	58%	31%	89%
<b>Spanish</b>	342	41%	55.54 (11.29)	13.45 (9.64)	5.99 (3.64)	28.22 (16.31)	52%	31%	82%
<b>English White</b>	266	55%	55.09 (9.68)	13.57 (9.24)	6.06 (3.58)	30.28 (20.40)	52%	31%	83%
<b>English Hispanic Origin</b>	192	49%	50.32 (11.56)	12.95 (9.17)	5.82 (3.55)	29.43 (19.69)	48%	26%	74%
<b>Hindi &amp; Punjabi</b>	188	43%	60.00 (8.20)	14.63 (9.66)	6.29 (3.58)	25.43 (13.44)	60%	30%	89%
<b>African American</b>	110	33%	54.87 (9.45)	11.76 (9.06)	5.49 (3.34)	25.77 (13.93)	52%	27%	79%
<b>Mandarin</b>	103	45%	61.83 (7.83)	9.79 (6.34)	4.84 (2.55)	23.83 (15.20)	52%	43%	95%
<b>Grand Total</b>	1581	46%	56.32 (10.62)	13.28 (9.42)	5.92 (3.54)	28.19 (18.03)	54%	31%	85%

**Table 2. Compliance with Diabetes Treatment Guidelines by Group**

Group	n	Foot Exam	Eye Exam	Kidney Testing	LDL
<b>English Asian Origin</b>	380	66.05%	22.11%	79.74%**	81.84%**
<b>Spanish</b>	342	66.37%	21.05%	80.12%**	81.58%**
<b>English White</b>	266	65.04%	16.54%	65.41%**	66.54%***
<b>English Hispanic Origin</b>	192	69.79%	17.71%	64.58%**	66.67%**
<b>Hindi and Punjabi</b>	188	73.40%	23.40%	77.13%	78.72%
<b>English African-American</b>	110	70.91%	10.00%**	60.91%**	62.73%**
<b>Chinese and Mandarin</b>	103	85.44%***	19.42%	75.73%	75.73%**

Therefore, a confidence interval that includes one, is not different from the base outcome or not statistically significant.

Because the base outcome is 1, a relative risk ratio (RRR) under 1 is subtracted from 1. For example, if the model RRR for men is 20 and women are the comparison group, men are 80 less likely than woman to have the outcome of interest. According to Bruin from the UCLA

Statistical Lab, if the RRR is less than 1 the outcome is more likely to be in the referent group [33].

**Table 3. Multinomial Regression Results**

Group	Model 1				Model 2				Model 3			
	Uncontrolled		Well-Controlled		Uncontrolled		Well-Controlled		Uncontrolled		Well-Controlled	
	RRR	95CI	RRR	95& CI	RRR	95& CI	RRR	95& CI	RRR	95& CI	RRR	95& CI
English Asian Origin	0.67	(0.41, 1.08)	0.86	(0.60, 1.23)	0.66	(0.41, 1.06)	0.82	(0.57, 1.18)	0.72	(0.44, 1.17)	0.79	(0.55, 1.14)
Spanish	1.05	(0.67, 1.65)	0.96	(0.66, 1.39)	1.05	(0.66, 1.65)	0.94	(0.65, 1.37)	1.16	(0.73, 1.84)	0.9	(0.62, 1.31)
English Hispanic Origin	1.39	(0.85, 2.28)	0.91	(0.58, 1.41)	1.38	(0.84, 2.27)	0.89	(0.57, 1.39)	1.43	(0.87, 2.36)	0.89	(0.57, 1.39)
Hindi & Punjabi	0.66	(0.37, 1.20)	0.80	(0.52, 1.23)	0.66	(0.36, 1.20)	0.74	(0.48, 1.14)	0.73	(0.4, 1.34)	0.72	(0.46, 1.11)
African American	1.23	(0.68, 2.24)	0.85	(0.50, 1.42)	1.23	(0.67, 2.24)	0.83	(0.49, 1.41)	1.25	(0.68, 2.29)	0.83	(0.49, 1.41)
Chinese & Mandarin	0.37	(0.14, 0.99)	1.31	(0.80, 2.13)	0.36*	(0.14, 0.98)	1.28	(0.78, 2.11)	0.43	(0.16, 1.15)	1.23	(0.74, 2.03)
Male	0.85	(0.63, 1.13)	0.83	(0.66, 1.04)	0.84	(0.63, 1.13)	0.83	(0.66, 1.04)	0.84	(0.62, 1.12)	0.82	(0.66, 1.04)
Age	0.96***	(0.95, 0.98)	1.00	(0.99, 1.02)	0.97***	(0.95, 0.98)	1.00	(0.99, 1.02)	0.97***	(0.95, 0.98)	1.00	(0.99, 1.02)
Diagnoses					1.04	(0.96, 1.12)	1.13***	(1.06, 1.20)	1.02	(0.94, 1.11)	1.13***	(1.06, 1.20)
Provider Time					1.00	(0.99, 1.01)	0.99*	(0.98, 1.00)	1.00	(0.99, 1.01)	0.99*	(0.98, 1.00)
ICD9 Groups					0.88	(0.71, 1.08)	0.70***	(0.59, 0.82)	0.93	(0.75, 1.15)	0.69***	(0.58, 0.82)
Foot Exam									0.72*	(0.52, 0.99)	1.02	(0.79, 1.32)
Kidney Function									0.57**	(0.42, 0.79)	1.34*	(1.01, 1.77)

## Model 1

### *Controlled*

In Model 1, the reference group for language group is White English speakers. For the first language category, the relative risk ratio (RRR) for comparing uncontrolled Asian English speakers to controlled White English speakers is 1- .67 or 23%. This means that Asian English speakers are 23% less likely to be uncontrolled than their white English speaking counterparts when holding all other variables constant. Monolingual Spanish speakers were 5% more likely to be uncontrolled while English speaking Hispanics were 39% more likely to be uncontrolled than their white English speaking counterparts. Mandarin speakers 63% less likely to be uncontrolled. No group was statistically different than the base outcome. That is, although the range of Hba1c control differed, it was not statistically different from the white English speakers.

The RRR comparing males to females for controlled Hba1c relative to the uncontrolled level given that the other variables in the model are held constant is 15%. In other words, men are 18% less likely to have uncontrolled Hba1c relative to women in the white English speaking base outcome. Age was highly significant (p. <0.0001). As a patient becomes a year older, the RRR for uncontrolled patients is 4% less relative to the controlled Hba1c counterparts given the other variables in the model are held constant.

### *Well controlled*

In model one in the well- controlled category, no variables were statistically different than their reference groups. However, the Mandarin speakers were 31% more likely to have well controlled Hba1c compared to white English speakers in the reference group. The Hindi and Punjabi

speakers were 40% less likely to have their Hba1c controlled.

## Model 2

### *Uncontrolled*

English speaking Hispanics were 39% less likely to have glycemic control followed by African Americans who were 23% less likely to have glycemic control compared to the white English speaking reference group. Mandarin speakers were 63% less likely to have uncontrolled Hba1c values and this was statistically significant at  $p < 0.05$  ((0.14, 0.98).

Again, age was statistically significant at  $p < 0.0001$  (0.95, 0.98). The RRR for age was .97. Each additional year of life decreased the probability of having uncontrolled Hba1c by 3%. Men were 16% less likely to have uncontrolled Hba1c compared to their female counterparts.

Each additional diagnosis increased the probability of having uncontrolled Hba1c by 4%. Time spent with provider had no effect on the model – the RRR was 1.00. Patients with more multimorbidities were 12% less likely to have uncontrolled Hba1c values.

### *Well controlled*

Mandarin speakers were 28% more likely to have well controlled glycemic values compared to their white English speaking counterparts in the reference group. Conversely, Hindi and Punjabi speakers were 16% less likely to have well-controlled Hba1c values. Men were 17% less likely to have well-controlled Hba1c values compared to females in the reference group. Age had a RRR of 1 meaning it was the same as the reference group.

In model 2, each additional disease increased well controlled Hba1c by 13% and decreased for each additional mulitmorbidty by 30% relative to the referent group. Both

these variables were highly significant ( $p < 0.0001$ ) Provider time becomes significant at  $p < 0.05$  (0.98, 1.00).

### Model 3

#### *Uncontrolled*

In the final model, prevention measures were added. English speaking Hispanics were 43% more likely to have uncontrolled Hba1c; African-Americans were 25% more likely to have uncontrolled Hba1c values compared to the white English speaking reference group. The RRR for men remained relatively unchanged with 16% being less likely to have uncontrolled Hba1c values compared to their female counterparts and age too remained highly statistically significant with the same RRR as Model 2.

Each additional diagnosis increased uncontrolled Hba1c by 2%. Multimorbidities decreased uncontrolled Hba1c by 7% and provider time was no different than the reference group with a RRR of 1.

Having a foot exam decreased uncontrolled Hba1c by 27% ( $p < 0.05$ ) and having a test for kidney function decreased uncontrolled Hba1c by 43% ( $p < 0.01$ ).

#### *Well controlled*

The most notable change in model 3 involves the prevention variables. Having a foot exam increased well controlled Hba1c by 2%. More importantly, the RRR for having kidney testing was 1.34. This means patients who had kidney testing were 34% more likely to have well-controlled glycated hemoglobin.

### Discussion

With regard to language and ethnicity, these findings reiterate previous research documenting that later generation ethnic groups have worse health outcomes. Still,

English speaking Asians did far better than English speaking Hispanics. Men tend to have worse health outcomes and in this study, they are sometimes in better control than their female counterparts. The difference between comorbidities and multimorbidities is that here comorbidities was any disease other than diabetes, this could have been acne. Multimorbidity describes a situation where a patient has multiple conditions affecting different body systems. It makes sense that patients with multimorbidities are more likely to be controlled rather than well controlled. The fact that age did not have a negative impact on Hba1c control may be associated with the sample being limited to community dwelling individuals. Also, it is documented that older, retired people, have more time to seek medical care and in ethnic communities, they may have more social support.

The finding that health promoting activities, such as compliance with other diabetes guidelines, are associated with glycemic control is an indication that adverse diabetes events, such as amputations, can be mitigated -- even in populations living below the poverty level.

#### Limitations

Data for this study were limited to lab results and primary care visits. Hospitalizations would have given a more clear evidence of disease burden but were available only for patients enrolled in Medi-Cal data captured in surveys, such as marital status, which is known to affect health, was not available.

Language use was a proxy for ethnicity. However, among English speakers, language was concatenated with race and Hispanic status. There were no Afro-Latinos in the sample. With regard to the Asian groups, the Census bureau's definition for Asian includes groups as diverse as people from Afghanistan to Japan so the Asian-English speaking group,

in future studies, may be better evaluated by Asian subgroup when this is possible. FQHC is located in a food desert but FQHC does do nutrition outreach. Patient nutritional data information may help reveal the disparity between all Asian groups versus Hispanics and African Americans.

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