Reducing Racial/Ethnic Disparities in Diabetes: The Coached Care (R2D2C2) Project

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BACKGROUND: Despite numerous efforts to change healthcare delivery, the profile of disparities in diabetes care and outcomes has not changed substantially over the past decade.

OBJECTIVE: To understand potential contributors to disparities in diabetes care and glycemic control.

DESIGN: Cross sectional analysis.

SSETTING: Seven outpatient clinics affiliated with an academic medical center.

PATIENTS: Adult patients with type 2 diabetes who were Mexican American, Vietnamese American or non-Hispanic white (n=1,484).

MEASUREMENTS: Glycemic control was measured as hemoglobin A1c (HbA1c) level. Patient, provider and system characteristics included demographic characteristics; access to care; quality of process of care including clinical inertia; quality of interpersonal care; illness burden; mastery (diabetes management confidence, passivity); and adherence to treatment.

RESULTS: Unadjusted HbA1c values were significantly higher for Mexican American patients (n=782) (mean= 8.3 % [SD:2.1]) compared with non-Hispanic whites (n= 389) (mean=7.1 % [SD:1.4]). There were no significant differences in HbA1c values between Vietnamese American and non-Hispanic white patients. There were no statistically significant group differences in glycemic control after adjustment for multiple measures of access, and quality of process and interpersonal care. Disease management mastery and adherence to treatment were related to glycemic control for all patients, independent of race/ethnicity.

LIMITATIONS: Generalizability to other minorities or to patients with poorer access to care may be limited.

CONCLUSIONS: The complex interplay among patient, physician and system characteristics contributed to disparities in HbA1c between Mexican American and non-Hispanic white patients. In contrast, Vietnamese American patients achieved HbA1c levels comparable to non-Hispanic whites and adjustment for numerous characteristics failed to identify confounders that could have masked disparities in this subgroup. Disease management mastery appeared to be an important contributor to glycemic control for all patient subgroups.

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INTRODUCTION

Despite comparable quality of the process of care[1–3] and many efforts to change features of the healthcare delivery system,[4–7] disparities in the outcomes of care for type 2 diabetes persist and have not changed substantially over the past 10 years.[8–13] Empirically tested hypotheses offered to explain the persistence of racial/ethnic disparities have included a broad spectrum of variables, from societal characteristics (e.g. limited access to healthcare services and resources[10,14–16]), characteristics of the healthcare system (e.g. continuity of care,[17] access to specialists,[18] availability of interpreters[19]), characteristics and behaviors of healthcare providers (e.g. quality of technical and interpersonal care,[20–27] clinical 'inertia'[28]), to characteristics and behaviors of patients (e.g. illness burden,[29] competing demands,[30] adherence to treatment,[31–34] health habits,[35,36] social environment,[37] health literacy,[38,39] and disease management mastery[40–42]). Differences in these areas have been observed to contribute alone, or in combination, to disparities in glycemic control.

To date, there have been few empirical studies of disparities in chronic disease that have attempted to test this broad spectrum of variables simultaneously in community-based settings serving multiple racial/ethnic groups. We conducted the study in community-based clinics serving large numbers of Mexican American and Vietnamese American patients who had comparable, low socioeconomic status, as well as non-Hispanic white patients of higher socioeconomic status as a reference group. We present here the results from analyses of the cross-sectional phase of our study, Reducing Racial Disparities in Diabetes Using Coached Care (R2D2C2), in which we identified the key target variables for reducing disparities in glycemic control.

METHODS

Setting

The study was conducted at seven geographically and ethnically diverse clinics affiliated with an academic health system. A diabetes registry of all adult patients with type 2 diabetes was used to identify patients who had at least one encounter with a family medicine, internal medicine or endocrinology provider within the 12 months ending June 30, 2007 (*n*=3,894). These registry patients had a mean age of 58.9 [SD=13.5], 43.2 % were male, 27.0 % were non-Hispanic white, 41.2 % were Mexican American, 13.4 % were Asian and 18.5 % were of other ethnic origin. The primary insurance for 43.2 % of patients was listed as Medicare, for 21.4 % as Medicaid, for 19.2 % as commercial and for the remainder (16.2 %) as uninsured.

Design

This initial cross-sectional analysis of the R2D2C2 study was aimed at identifying major contributors to disparities in glycemic control among three racial/ethnic groups sampled from the diabetes registry.

Derivation of Analytic Patient Sample

Using the diabetes registry population, we identified study participants who met the following criteria: 1) were Vietnamese American, Mexican American or non-Hispanic white; 2) were 18 years of age or older; and 3) had type 2 diabetes, as indicated by any of: HbA1c≥6.5 %, a fasting glucose >126 mg/dl, a 2 h glucose tolerance test value >200 mg/dl or random glucose >200 mg/dl, were under active treatment with oral antihyperglycemic agents or insulin, or had ICD-9, DRG or CPT codes for diabetes or diabetes-related complications. We excluded patients: 1) aged 80 and above; 2) with dementia or other serious mental health problems; 3) with cancer or other serious medical problems; and 4) who could not speak English, Spanish or Vietnamese American. We approached the 1,971 eligible patients (50.6 % of the 3,894 registry patients) as they presented for their regularly scheduled diabetes appointments. Of these, 1,484 (75.3 %) consented to participate and completed a baseline survey. Sociodemographic characteristics of study patients were comparable to registry patients (data not shown).

Data Collection

Upon enrollment, study patients completed the R2D2C2 baseline survey. Laboratory, administrative and medical records data were abstracted for relevant study measures.

Study Measures

Glycemic control was measured as HbA1c levels using the D-10 Hemoglobin Testing System (Bio-Rad Laboratories, Hercules, CA). We used mean HbA1c values rather than thresholds to assess disparities between racial/ethnic groups.

We generated a set of measures with conceptually and empirically supported relationships to disparities in glycemic control.[11,15,43,44] These variables permitted us to test empirically the conceptual framework describing health disparities diagrammed in Fig. 1 below.

With few exceptions, we relied on previously tested measures of study variables, and where possible, used multiple data sources for each measure. These measures included barriers to care (e.g. access to care, insurance status, job flexibility, transportation[45]), features of the health care system (e.g. presence and quality of interpreter services,[19] continuity of care,[46] access to specialists, access to nurse educators/dietitians), provider characteristics and behaviors (e.g. regimen intensification,[47] quality of technical and interpersonal care[26,27,48,49]) and patient characteristics and behaviors (including demographic profile, e.g. age, gender, race/ethnicity; illness burden, including the Total Illness Burden Index,[50] depression,[51] physical function,[52,53] and diabetes burden[42]; health habits[54]; perceived social support for diabetes management[55]; and disease management mastery, including passivity,[40] and disease management confidence[41,42,56,57]).

Technical quality of care for diabetes was measured as annual performance of HbA1c, lipids, blood pressure, foot and eye exams and annual testing for microalbuminuria.[26,48] Measures of regimen type and intensification were abstracted from medical records and included classes of oral antihyperglycemic agents, proportion of patients on insulin, proportions of patients for whom a new oral agent had been added, the class of oral agent had been changed or the dose increased in the prior year, and the proportion of patients for whom insulin had been initiated in the prior year. We also created a composite measure of the proportion of patients with any regimen intensification in the prior year. Interpersonal care measures included: physician–patient communication,[49] participatory decision-making style,[58,59] trust in physician,[60,61] and communication regarding cost related medication non-adherence.[62] A composite measure of barriers to regimen adherence was adapted for diabetes from previously existing adherence measures.[62–65]

Statistical Analysis

We used SPSS v. 20.0 (IBM Corp., Armonk, New York) for all analyses. Univariate and distributional analysis included measure of central tendency, kurtosis and skew. All derived multi-item measures were tested for reliability using Cronbach's alpha, and standard error of measurement was computed. Construct validity for derived multi-item scales was assessed using confirmatory principal components and varimax rotated factor analyses. Comparisons of ethnic differences in the reliability coefficients of derived variables were performed using Feldt's W statistic (data not shown).[66]

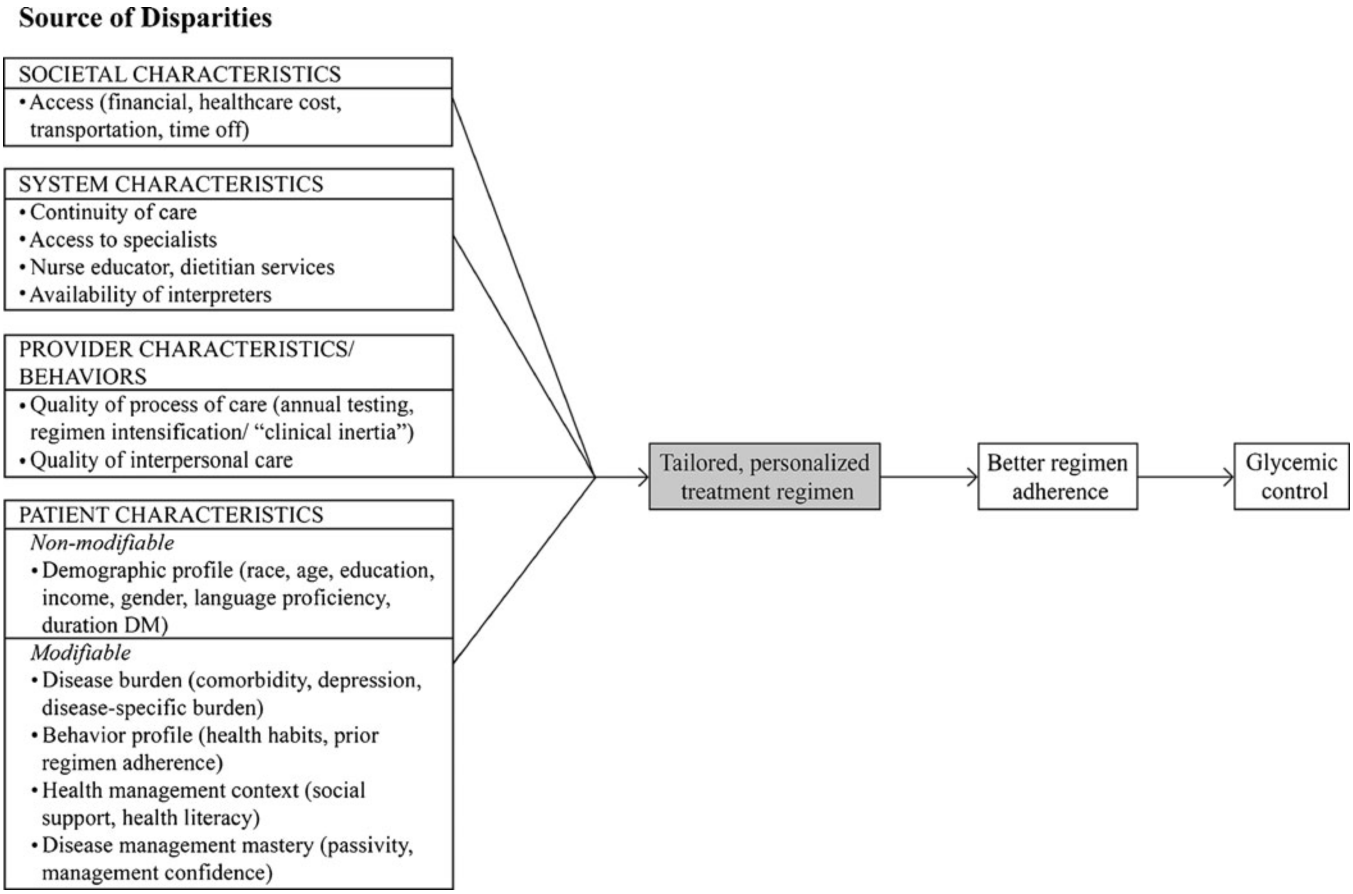

Figure 1. Comprehensive conceptual framework for evaluating diabetes disparities.

Differences between racial/ethnic groups on quality-of-care, and all patient-reported measures were tested with separate linear regression models for continuous variables and logistic regression models for categorical variables declaring non-Hispanic white patients as the reference group. To account for multiple comparisons, group differences with p values$\leq$0.001 were reported as statistically significant.[67]

We conducted analyses testing the relative contributions to glycemic control of constructs diagrammed in Fig. 1 and listed in Tables 1, 2, 3, and 4, using the residual direct effect (RDE) method of disparities measurement described elsewhere.[68] We sequentially entered groups of variables representing the same construct as blocks in a linear regression model. To create a parsimonious model, we then eliminated blocks of variables where none of the measures in the block was statistically significantly related to glycemic control. Constructs listed within each box were measured using more than one multi-item measure (see Methods above). Models were tested for multi-collinearity at the entry of each block of variables, and residuals were examined for normality. We were not able to estimate whether individual patients received an optimally tailored regimen (shaded box, Fig. 1).

RESULTS

Characteristics of the Study Sample. Compared to the non-Hispanic whites, Mexican American patients were younger, less well-educated, more were female, and very few were born in the US (see Table 1). Roughly three-fourths of Mexican American patients reported annual household incomes less than $20,000.

Compared to the non-Hispanic whites, Vietnamese American study patients were older, less well-educated, more were female, and very few were US born. Vietnamese American patients reported the lowest annual household income of the three racial/ethnic groups with less than 10 % reporting income greater than $20,000. Roughly one-fourth of Mexican American and Vietnamese American patients reported proficiency in English, compared to roughly 90 % of non-Hispanic white patients.

Mexican American patients had had diabetes roughly 1 year longer than non-Hispanic whites. Unadjusted HbA1c values were significantly higher for Mexican American patients compared to non-Hispanic whites (mean=8.3 % [SD 2.1] vs. 7.1 %, [SD 1.4], p<0.001). There were no statistically significant differences in unadjusted HbA1c between non-Hispanic white and Vietnamese American patients.

Table 1. Characteristics of Study Sample by Race/Ethnic Group (*n*=1,484)[†]

	Non-Hispanic White (*n*=389)	**Mexican American (*n*=782)**	**Vietnamese American (*n*=313)**
Demographics			
Age (years)	60.6 (10.7)	55.5 (10.8)[*]	67.3 (10.0)[*]
Education level (years)	14.6 (2.4)	6.9 (4.4)[*]	10.2 (4.1)[*]
Female gender (%)	44.5	67.0[*]	60.1[*]
Born in U.S. (%)	75.6	14.3[*]	8.6[*]
Household income (%)			
< $20,000	28.2	75.2[*]	92.8[*]
$20,000–59,999	20.0	20.5[*]	4.6[*]
≥ $60,000	51.8	4.4[*]	2.5[*]
English proficiency (%)[‡]	89.4 (17.6)	22.0 (30.2)[*]	24.2 (18.2)[*]
Diabetes			
Duration of diabetes (years)	8.8 (7.3)	9.7 (7.4)[*]	9.3 (7.5)
Hemoglobin A1c (%)[§]	7.1 (1.4)	8.3 (2.1)[*]	6.9 (1.1)

[*] *p ≤0.001*

[†] *Measures were derived from Reducing Racial Disparities in Diabetes Coached Care (R2D2C2) Patient Survey except as noted for HbA1c; table entries are means with standard deviations in parentheses or percents as noted. Racial/ethnic group comparisons conducted using linear regression for continuous variables and logistic regression for categorical variables*

[‡] *Self-assessed proficiency in spoken and written English "very good" or better*

[§] *Hemoglobin A1c values were abstracted from participants' medical records at participating UC Irvine Medical Center clinics, taking the most recent value prior to the date the patient completed the R2D2C2 Survey*

Racial/Ethnic Differences in Access to Care, Continuity and Availability of Care. More than one-third of Mexican American patients were uninsured, compared to very small proportions of non-Hispanic white patients (see Table 2). The majority (95 %) of Vietnamese American patients were insured through Medicare or a combination of Medicare and Medicaid; more than 41 % of non-Hispanic white patients had commercial insurance or were insured through Medicare (41 %). Mexican American patients reported more difficulty accessing care in every category of barriers to access compared to non-Hispanic whites. With the exception of language barriers, Vietnamese American patients reported comparable access to non-Hispanic whites.

Although most study patients reported having a usual source of care for their diabetes, more than 10 % fewer Mexican American patients compared to non-Hispanic whites reported a regular source of diabetes care (see Table 2). Vietnamese American patients reported comparable or somewhat better continuity of care compared to non-Hispanic whites. Fewer Mexican American patients reported having seen an endocrinologist, ophthalmologist or cardiologist in the prior year compared to non-Hispanic whites. Fewer Vietnamese American patients reported having seen a dietitian; however, roughly twice as many reported having seen a nurse educator in the prior year compared to non-Hispanic whites.

Table 2. Differences in Access to Care and Availability of Services (System Characteristics) by Racial/Ethnic Group (*n*=1,484)[†]

	Non-Hispanic White (*n*=389)	**Mexican American (*n*=782)**	**Vietnamese American (*n*=313)**
Access to care			
Health insurance type, % in each category[‡]			
Uninsured	3.1	36.2[*]	0.6
Commercial	41.4	6.4[*]	4.5[*]
Medicare	41.4	16.4[*]	57.4[*]
Medicaid	12.1	30.4[*]	25.8[*]
Medicare + Medicaid combined	2.1	10.6[*]	11.6[*]
Barriers to access to care			
Overall (composite score)[§]	10.6 (14.2)	25.4 (23.2)[*]	9.0 (17.3)
Due to cost	15.7 (28.4)	42.7 (39.6)[*]	10.3 (24.9)
Due to lack of insurance	20.0 (29.0)	36.0 (40.5)[*]	9.2 (23.5)[*]
Due to geographic inaccessibility	11.9 (23.0)	26.7 (31.7)[*]	11.9 (22.8)
Due to lack of transportation	8.2 (22.1)	21.6 (32.8)[*]	10.2 (22.8)
Due to language barriers	1.1 (9.2)	8.6 (22.4)[*]	6.3 (20.9)[*]
Due to work inflexibility	6.8 (18.9)	17.1 (28.2)[*]	5.5 (18.8)
System characteristics			
Continuity of care			
% with a usual source of care for diabetes	93.4	80.0[*]	91.6
% treated by current physician ≥5 years	25.2	10.3[*]	53.2[*]
Availability of services			
% saw endocrinologist	52.1	14.5[*]	56.8
% saw ophthalmologist	79.6	63.3[*]	86.9
% saw cardiologist	35.9	19.8[*]	37.3
% saw dietitian	27.1	26.2	13.5[*]
% saw nurse educator	19.6	14.3	41.1[*]

[*] *p ≤0.001*

[†] *Measures were derived from Reducing Racial Disparities in Diabetes Coached Care (R2D2C2) Patient Survey except as noted for HbA1c; table entries are means with standard deviations in parentheses or percents as noted. Racial/ethnic group comparisons conducted using linear regression for continuous variables and logistic regression for categorical variables*

[‡] *Insurance type abstracted from administrative data*

[§] *Patient rating of difficulty accessing care due to six specific barriers adapted from the Medical Expenditure Panel Survey on a 5-point Likert scale from "a major problem" to "not a problem at all"; transformed to range from 0 to 100 with higher values indicating greater difficulty accessing care*

Racial/Ethnic Differences in Performance of Processes of Care. Although fewer Vietnamese American patients had an annual test for kidney functioning and fewer Mexican American patients had an annual dilated eye exam compared to non-Hispanic whites, there were no statistically significant differences in the performance of all five recommended processes of care measures for either group compared to non-Hispanic whites (see Table 3).

Significantly more Mexican American patients were taking two or more classes of oral agents compared to non-Hispanic whites (59.0 % vs. 42.9 %, $p<0.001$). There

Table 3. Differences in Quality of the Process of Diabetes Care by Racial/Ethnic Group (N=1,484)[†]

	Non-Hispanic White (n=389)	Mexican American (n=782)	Vietnamese American (n=313)
Technical process quality of care [‡]			
% Annual HbA1c test	95.4	98.4	99.1
% Annual LDL test	93.5	96.4	97.4[*]
% Annual urinalysis for microalbumin	74.6	83.0[*]	69.2[*]
% Annual foot exam	98.1	99.1	100.0[*]
% Annual eye exam	67.3	49.4[*]	72.7
% All five process measures documented as completed[§]	49.7	41.6	53.3
Medication regimen[‖]			
Classes of oral antihyperglycemic agents prescribed			
% on zero oral agents	17.6	9.4[*]	12.9
% on one class of oral agent	39.6	31.6	46.9
% on 2 or more classes of oral agents	42.9	59.0[*]	40.3
Currently taking insulin (%)	28.1	31.1	16.9
New oral agent added in past year (%)	31.9	38.1	31.3
Class of oral agent changed in past year (%)	6.4	4.0	18.5[*]
Daily dosage of oral agent increased in past year (%)	35.1	45.1[*]	25.9
Insulin initiated in the past year (%)	8.3	10.6	2.9
Any regimen intensification noted in medical record in past year (%)	54.4	64.5[*]	48.1
Interpersonal quality of care[¶]			
Quality of physician communication[**]	78.7 (23.3)	71.9 (25.6)[*]	75.5 (21.0)
Trust in physician[††]	87.6 (18.4)	85.4 (20.5)	90.5 (13.2)
Difficulty communicating with physician due to language (%)[‡‡]	6.4	26.2[*]	11.5
Participatory decision making style[a]	68.0 (23.5)	73.0 (21.6)	65.6 (20.7)
Discussed costs of medication with physician (%)[b]	32.7	45.7[*]	23.2

[*] *$p \leq 0.001$*

[†] *Table entries are means with standard deviations in parentheses or percents, as noted; Racial/ethnic group comparisons conducted using linear regression for continuous variables and logistic regression for categorical variables*

[‡] *Measures collected from medical record abstraction; table entries are percent performance of each indicator over the one-year period preceding completion of the R2D2C2 patient survey; diabetes process quality measures based on NCQA-recommended indicators*[26]

[§] *Proportion of patients achieving all five process indicators; data entries are averaged within race/ethnic groups*

[‖] *Measures collected from medical record abstraction; table entries are percent of patients for which each indicator was noted in the medical record over the one-year period preceding completion of the R2D2C2 patient survey*

[¶] *All interpersonal quality measures derive from reducing Racial Disparities in Diabetes Coached Care (R2D2C2) Project Patient Survey; measures have been transformed from original scoring to range from 0 to 100, with high scores indicating better quality*

[**] *Patient ratings of the quality of physician's communication on five items, each rated on 5-point Likert scales ranging from "excellent" to "poor"*

[††] *Patient ratings of trust in physician's care on five items, each rated on 5-point Likert scale from "never" to "always"*

[‡‡] *Proportion of patients who indicated having difficulty speaking with or understanding the doctor or nurse because they spoke different languages "sometimes", "often" or "always"*

[a] *Patient reports of quality of physician's participatory decision-making style on nine items, each rated on 5-point Likert scales ranging from "all of the time" to "none of the time"*

[b] *Proportion of patients who responded "Yes" to either "Did you talk to your doctor about the cost of medications?" or "Did your doctor switch your medication to a less expensive one?"*

were no statistically significant differences between Mexican American and non-Hispanic white patients in the proportion of patients currently on insulin. More Vietnamese American patients had had the class of oral agents changed in the prior year compared to non-Hispanic whites. More Mexican American patients had had any intensification of diabetes regimen noted in the previous year compared to non-Hispanic whites; there were no statistically significant differences between Vietnamese American and non-Hispanic white patients.

Mexican American patients reported poorer quality of physician communication and more difficulty communicating with physicians due to language barriers than non-Hispanic whites. However, they reported more participatory decision-making styles of their physicians and more frequently discussed costs of medications with their physicians compared to non-Hispanic whites. The quality of interpersonal care was comparable for Vietnamese American and non-Hispanic white patients.

Racial/Ethnic Differences in Patient Complexity, Health Habits, Social Support, Non-Adherence and Disease Management Mastery. Mexican American patients had comparable general burden of illness compared to non-Hispanic whites, but reported greater depressive symptoms and greater burden specific to diabetes and its management (see Table 4). Compared to non-Hispanic white patients, Vietnamese American patients had more depressive symptoms, and poorer physical function, but reported comparable burden from diabetes and its management.

Non-Hispanic whites reported poorer health habits compared to either other group, including less frequent exercise, less healthy diet, and more smoking. Non-Hispanic white patients reported more social support for disease management compared to either other patient group, with Vietnamese American patients reporting the least support. More Mexican American patients reported non-adherence to treatment regimens for any reason and specifically due to costs of medications while Vietnamese

Table 4. Differences in Illness Burden/Patient Complexity, Health Habits, Social Support, Medication Nonadherence and Disease Management Mastery by Racial/Ethnic Group (*N*=1,484)[†]

	Non-Hispanic White (*n*=389)	Mexican American (*n*=782)	Vietnamese American (*n*=313)
Illness burden/patient complexity			
Total illness burden Index (mean (SD))[‡]	5.3 (3.5)	5.0 (3.5)	5.8 (3.7)
Depressive symptoms (mean (SD))[§]	11.1 (8.1)	13.1 (8.2)[*]	15.1 (7.6)[*]
Physical Functioning (mean (SD))[‖]	65.5 (30.7)	67.5 (29.1)	58.2 (27.8)[*]
Diabetes burden (mean (SD))[¶]	32.2 (26.1)	46.3 (29.8)[*]	28.0 (22.9)
Health habits			
Moderate to vigorous exercise for 20 min, 3+ times/week (%)[**]	39.5	55.5[*]	54.0[*]
Healthy diet (mean (SD))[††]	72.2 (18.8)	76.8 (18.2)[*]	84.2 (11.7)[*]
Currently smokes (%)	12.8	8.6	3.7[*]
Perceived social support[‡‡]	61.5 (31.6)	42.6 (32.2)[*]	32.3 (22.2)[*]
Medication nonadherence[a]			
Reported nonadherence for any reason (%)	55.2	70.4[*]	56.3
Reported nonadherence due to cost (%)	33.2	55.0[*]	25.8
Disease management mastery			
Provider-dependent health care orientation (mean (SD))[b]	40.6 (16.1)	57.3 (16.2)[*]	51.5 (12.4)[*]
Management confidence (mean (SD))[c]	52.2 (22.3)	58.9 (24.7)[*]	72.9 (16.2)[*]

[*] *$p \leq 0.001$*

[†] *Measures derive from reducing Racial Disparities in Diabetes Coached Care (R2D2C2) Project Patient Survey; table entries are means with standard deviations (SD) in parentheses or percents, as noted. Unless otherwise noted, measures have been transformed from original scoring to range from 0 to 100. Racial/ethnic group comparisons conducted using linear regression for continuous variables and logistic regression for categorical variables*

[‡] *Total Illness Burden Index, a measure of the presence and severity of comorbid conditions. Scores range from 0 to 16 with higher scores indicating greater comorbidity.*[50]

[§] *Abbreviated Center for Epidemiology Studies Depression Scale (CES-D).*[51]

[‖] *The ten-item Physical Functioning Scale (PFI-10) of the Medical Outcomes Study Short Form 36 (SF-36)*[52]

[¶] *The eight-item Diabetes Burden Scale assessing the patient's perceptions of the burdens related to health, social life, lifestyle and finances that impact the patient and his or her family as a result of having diabetes*[42]

[**] *Derived from patient reports of the number of times engaging in activities that increase breathing and heart rate in an average week*

[††] *Summary measure of patient-reported dietary behaviors including the frequency with which specific foods high in sugar, salt and fat were eaten; higher scores represent healthier eating behaviors*

[‡‡] *The seven-item Perceived Support Scale*[55]

[a] *The proportion of patients reporting deviations from their prescribed medication regimens on 13 items assessing nonadherence due to cost or other reasons*[63,64]

[b] *Provider-Dependent Health Care Orientation scale, measuring patient passivity; higher scores indicate greater passivity*[40]

[c] *Seven-item Management Confidence scale, measuring the patient's level of confidence in his or her ability to succeed in specific diabetes management behaviors; higher scores indicate greater confidence*[41]

American patients reported comparable non-adherence compared to non-Hispanic whites. Both Mexican American and Vietnamese American patients were more passive compared to non-Hispanic whites. Vietnamese American patients reported greater disease management confidence compared to non-Hispanic white patients (mean=72.9 [SD 16.2] vs. 52.2 [SD 22.3], $p<0.001$).

Modeling Disparities. All variables listed in Tables 1, 2, 3, and 4 were included in the original model. For the parsimonious model described above (see Statistical Analysis), all system characteristics, as well as patients' health habits and social support failed to reach statistical significance and were eliminated from the final model. We compared the adjusted HbA1c values for Mexican American and Vietnamese American patients to those for non-Hispanic whites after the addition of each set of retained variables (Fig. 2). Unadjusted HbA1c values for Mexican American patients were 1.2 % higher ($p<0.001$) and 0.2 % lower (a non-significant difference), for Vietnamese American patients compared to non-Hispanic whites, with race/ethnicity alone accounting for 11 % of the variance in HbA1c (Model 1). The addition of demographic characteristics, including gender, age at study enrollment, duration of diabetes, education, annual household income and whether the patient was born in the U.S., reduced the adjusted mean difference in HbA1c between Mexican American patients compared to non-Hispanic whites to 0.6 % (Model 2) and significantly increased the explained variance in HbA1c (R^2=0.11 to 0.20, $p<0.001$).

Access to care (Model 3), including insurance status and type, and perceived barriers to access also significantly increased the variance explained in HbA1c (R^2=0.20 to 0.22, $p<0.001$) and reduced the estimate of the disparity between Mexican American and non-Hispanic white patients to 0.4 %. The quality of the process of care (Model 4, including annual testing for control and complications, medication regimen and regimen intensification) increased the explained variance in HbA1c (R^2=0.22 to 0.31, $p<0.001$) and reduced the estimate of the disparity between Mexican American and non-Hispanic white patients to 0.3 %, a non-significant difference. The quality of interpersonal care (Model 5, including participatory decision-making style, trust in physician, etc.), contributed significantly to the explained variance in glycemic control (p= 0.04) but did not further reduce the estimated disparity between non-Hispanic white and Mexican American patients. Overall burden from disease (Model 6) did not contribute to the variance explained by the model.

Disease management mastery (Model 7) contributed significantly to the explained variance in glycemic control ($p<0.001$) and produced estimates of the disparity in HbA1c between Mexican American and Vietnamese American patients similar to the estimated disparity between Mexican Americans and non-Hispanic whites (greater only by 0.4 % and 0.2 % respectively). The inclusion of

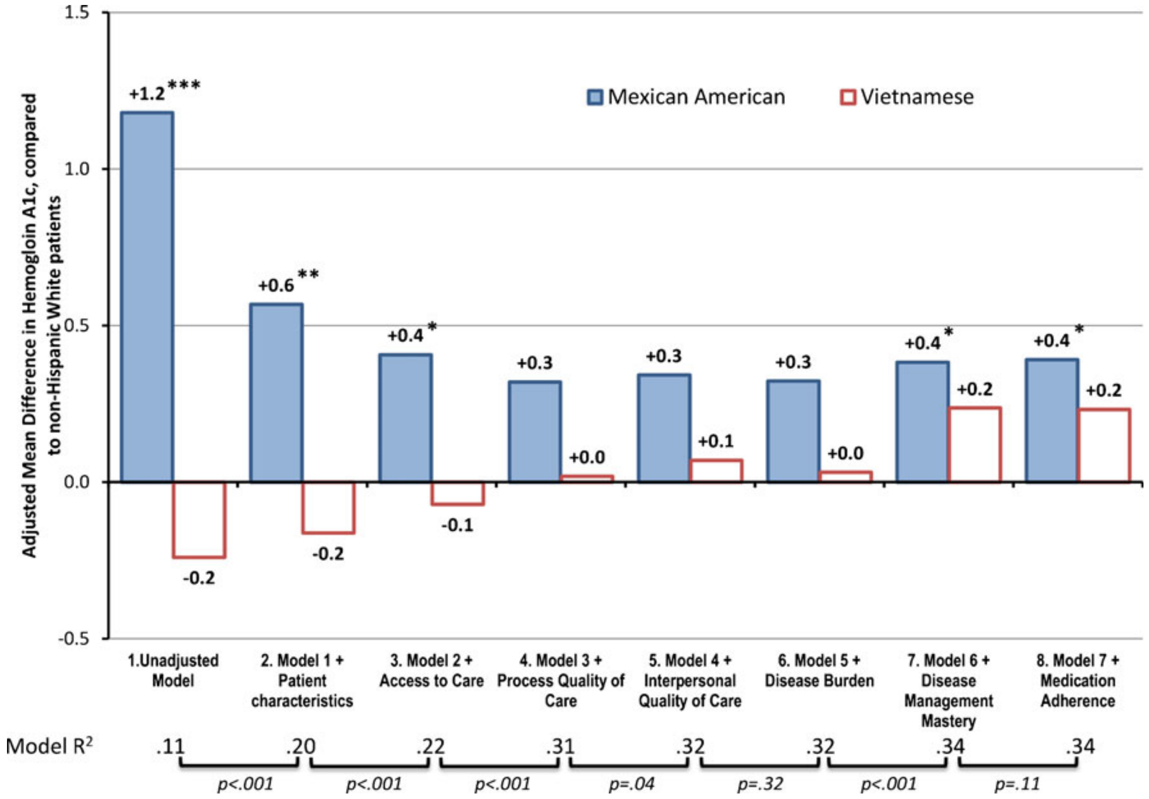

Figure 2. Results of sequential regression models assessing contributions of patient characteristics, access to care, quality of care and medication adherence to glycemic control. ***$p<0.05$, **$p<0.01$, ***$p<0.001$. Model 1: Race/ethnicity only. Model 2: Model 1 and gender; age; duration of diabetes; born in the U.S.; education level; income (< \$20–\$40 k, \$40–\$60 k, > \$60 k). Model 3: Model 2 and insurance status (uninsured, Medicaid, Medicare vs. commercial); barriers to access. Model 4: Model 3 and regimen intensification, all five processes of care, number of diabetes medications, currently on insulin. Model 5: Model 4 and physician–patient language discordance; physician–patient communication; participatory decision-making style; trust in physician. Model 6: Model 5 and Total Illness Burden Index; SF-36 physical function index; depression symptomology; diabetes burden scale. Model 7: Model 6 and management confidence; passive orientation toward health care. Model 8: Model 7 and adherence to treatment scale.**

medication adherence (Model 8) did not improve the fit of the model.

DISCUSSION

Despite considerable evidence documenting disparities in diabetes care and outcomes and formidable efforts to reduce those disparities,[11] diabetes outcomes remain suboptimal among poor and underserved minority patients.[8,12,13] This study attempted to identify the major contributors to disparities in glycemic control for low income patients in two racial/ethnic groups seen in community based clinics.

Recognizing that disparities in health and healthcare are the result of a complex interplay among multiple variables representing all levels of the healthcare environment, we assessed the unique contribution of variables representing the spectrum of previously hypothesized contributors from societal to patient characteristics. We used multiple data sources, including patient surveys, medical record abstraction, administrative data, etc. to represent the broad array of individual constructs that have been previously demonstrated to contribute to disparities in diabetes care and outcomes. We were therefore able to minimize bias associated with methods effects resulting from the use of a single data source for all study variables.

We found that Mexican American patients had clinically and statistically significantly poorer unadjusted glycemic control compared to non-Hispanic white study patients. Beyond race/ethnicity, the independent contribution of demographic characteristics, including age, gender, education, income, nativity and English proficiency, reduced the estimate of disparities in glycemic control between Mexican American and non-Hispanic white patients by roughly half, almost doubling the explained variation in glycemic control. Of note, despite income, education and proportion of US born roughly comparable to Mexican American patients, Vietnamese American patients had comparable HbA1c levels to non-Hispanic white patients. Adjustment for numerous variables previously linked with disparities in diabetes care and outcomes failed to identify confounders that could have masked differences between Vietnamese American and non-Hispanic white patients in our study.

Study findings could not be explained solely by differential access, to care for Mexican American patients. After adjustment for all study measures of differential access, including patient-reported barriers to access to care, significant disparities in HbA1c remained. Similarly, although we observed poorer continuity of care and more limited availability of specialty care and services in Mexican American patients, these variables did not explain significant between-group variation in glycemic control.

Other studies have observed poorer quality of the process of care for Hispanic vs. non-Hispanic whites with diabetes, even after adjustment for demographic characteristics and health insurance.[8] In our study, when differences in quality of care, including greater regimen intensification for Mexican American patients were taken into account, the observed disparities in glycemic control among the groups compared were no longer statistically significant.

One of the most striking findings from this study was the contribution of greater disease management mastery to glycemic control independent of racial/ethnic group, and after adjustment for access to care, quality of care and disease burden. We and others have shown that physicians' participatory decision-making style, and effective patient participation in treatment decisions are associated with improvements in health outcomes for chronic diseases[69–72] including diabetes,[73,74] and in adherence to treatment.[74] In previous research, a positive association between a sense of mastery over disease management and adherence to treatment has been noted.[29,75] Effectively participating in care may be associated with treatment regimens more closely tailored to patients' circumstances, and consequently to greater commitment to treatment decisions, more effective adherence and better outcomes of care. Longitudinal observational studies are needed to evaluate these relationships.

These findings point to some potentially mutable elements of physician–patient communication as a mechanism for enhancing patients' disease management mastery and improved health outcomes. We are now testing an intervention in these disadvantaged groups to enhance patients' disease management mastery, to improve their ability to participate in tailoring treatment regimens they can effectively implement, and thereby improve glycemic control.

Study Limitations

Our study has a number of limitations. First, although we included non-Hispanic whites as a comparison group, our setting did not allow us to represent other racial/ethnic groups in which diabetes is prevalent (e.g. African Americans). Our findings may not generalize to other racial/ethnic groups. Second, we are studying patients who have regular access to healthcare, despite financial and other barriers. Our findings may therefore underestimate the contribution of barriers to access to glycemic control. Finally, data from this study are cross-sectional and cannot be used to test causal relationships among variables. An ongoing longitudinal cohort from this study will allow us to test hypotheses regarding the relative contributions of access, system, physician and patient characteristics to diabetes disparities among our patient samples.

CONCLUSIONS

Results from this study suggest that no simple explanation, such as adequate access to healthcare or quality of care, may be sufficient to explain disparities in glycemic control. Effective interpersonal care along with a sense of disease management mastery appear to make important contributions to glycemic control for all patients, after careful adjustment for other variables that contribute to disparities in care and outcomes. Finally, the complex interplay among patient, physician and system characteristics that contribute to disparities in one racial/ethnic group may not similarly disadvantage another group. Balancing the need to construct generalizable interventions to reduce disparities and the need to tailor their content to address relevant barriers within each racial/ethnic group is a necessary next step.

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