Beyond Race Disparities: Accounting for Socioeconomic Status in Diabetes Self-Care

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Introduction: Among patients with type 2 diabetes, racial disparities are prevalent across a variety of outcomes; however, inconsistent disparities in determinants of outcomes warrants exploring the impact of other, related factors. This study sought to examine whether disparities in health literacy, numeracy, self-care behaviors, and HbA1c persisted between non-Hispanic blacks and non-Hispanic whites after applying a robust adjustment for socioeconomic status (SES).

Methods: From 2016 to 2018, adult patients with type 2 diabetes (N=444) were recruited from primary care clinics. Participants self-reported demographics; indicators of SES (i.e., income, education, health insurance, housing status, and financial strain); subjective health literacy and numeracy; and self-care behaviors. Participants also completed an HbA1c test. In 2018, differences were examined between non-Hispanic blacks and non-Hispanic whites in health literacy, numeracy, self-care, and HbA1c, first unadjusted and then adjusted using propensity score weighting.

Results: In unadjusted analyses, compared with non-Hispanic whites, non-Hispanic blacks had lower health literacy ($p=0.039$) and numeracy ($p<0.001$); less medication adherence ($p=0.009$); use of information for dietary decisions ($p=0.013$); and problem eating behaviors ($p<0.001$; i.e., non-Hispanic blacks reported fewer problems); and higher HbA1c levels ($p=0.005$). After adjusting for all SES indicators, only the reverse disparity in problem eating behaviors ($p=0.016$) and the disparity in HbA1c ($p=0.011$) remained.

Conclusions: Findings highlight the importance of considering SES when examining disparities in health-related skills and behaviors. Moving beyond education and income to inclusion of more comprehensive markers of SES can improve understanding of how SES may contribute to disparities and the ability to appropriately target factors leading to inequality.
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INTRODUCTION

Approximately 10% of U.S. adults have diabetes[1] which can lead to heart disease, stroke, and amputations.[1] Costs of complications are substantial[2] and forecasted to more than double in the next decade.[3] Consistent performance of self-care behaviors can improve HbA1c and prevent complications.[4,5] Non-Hispanic blacks/African Americans (NHBs) with type 2 diabetes (T2D) have more complications,[6,7] more emergency room visits,[7] and worse HbA1c levels[8–10] as compared with non-Hispanic whites (NHWs). However, evidence is mixed as to whether NHBs have worse self-care. Rather, racial disparities in self-care behaviors tend to vary by sample and behavior.[11,12] In addition, health literacy

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and numeracy are important determinants of diabetes outcomes and are often worse among NHBs.[13−15]

Race is a construct used to group individuals, but more genetic variation exists within racial categories than between.[16,17] Rather than attributing differences between individuals to a racial category, it may be more informative to examine factors for which race may act as a proxy.[18] Social and economic conditions vary considerably between races, and gaps have persisted for decades[19]; in the U.S., NHBs have significantly less education and lower income than NHWs, and are twice as likely to live in poverty.[19] Research examining the role of SES in racial disparities in diabetes self-care and health-related skills is limited.[11] Looking beyond race to understand factors that contribute to diabetes disparities can identify appropriate strategies for reducing disparities. Therefore, this study seeks to examine differences in health literacy, numeracy, self-care behaviors, and HbA1c between NHBs and NHWs after adjustment for multiple SES indicators.

METHODS

Study Sample

This research was conducted as part of an RCT[20]; for the present analyses, baseline data were used from participants who self-reported NHW or NHB race. Data were collected between 2016 and 2018 from English-speaking adults diagnosed with T2D, prescribed at least one T2D medication, and receiving primary care at Vanderbilt University Medical Center or federally qualified health centers. Patients were excluded if they had an HbA1c <6.8% as the most recent value within 12 months. The Vanderbilt University IRB approved all study procedures.

Measures

Participants self-reported age, gender, race, diabetes duration, number of prescribed diabetes medications, insulin status, and SES (education, annual income, housing status, insurance status, and financial strain using the Tool for Assessing Patients' Stressors [TAPS]).[21] The full 20-item TAPS scale asks about experiences of stressors (yes/no) in the last 12 months; for the current study, the four items relevant to low SES were included (i.e., not enough money for food, rent or mortgage, or clothes; difficulty paying for health-related expenses; stressful jobs/unemployment; and lack of affordable local transportation). Participants also completed validated measures of health literacy,[22] numeracy,[23] and self-care behaviors. Healthy diet was assessed with two separate subscales that assess "use of information for dietary decisions" and "problem eating behavior."[24,25] The study assessed physical activity by calculating total MET minutes/week via the International Physical Activity Questionnaire,[26,27] medication adherence with the Adherence to Refills and Medications Scale for Diabetes,[28] self-monitoring of blood glucose with the Summary of Diabetes Self-Care Activities blood glucose testing subscale,[29] and smoking status using Behavioral Risk Factor Surveillance System items.[30] HbA1c was collected via venipuncture or point-of-care by patients' clinic or using a mail-in HbA1c kit[31,32] provided and analyzed by CoreMedica Laboratories (Lee's Summit, MO).

Statistical Analysis

Data were analyzed in 2018. Differences in covariates and outcomes between NHB and NHW participants were compared using unweighted and weighted samples. The R package Survey, version 3.33-2, was used for the weighted cohort analysis. Propensity score weights were calculated from a logistic model of race by SES indicators (income, education, housing status, insurance status, financial strain) as well as covariates, which could confound effects of interest (age, gender, clinic site [Vanderbilt University Medical Center versus federally qualified health center], diabetes duration, number of prescribed diabetes medications, insulin use, and HbA1c test type). To allow nonlinear associations with race, restricted cubic splines were fit for income, age, and diabetes duration. To allow for covariates with missing values, multiple imputation was used with the predictive mean in the R package MICE, version 2.46.0.[33] Each participant's propensity score weight equaled one over the predicted probability of being NHB or NHW based on his/her covariates.

The unweighted differences appear as they exist without covariate adjustment. The weighted differences appear as they would exist in an adjusted cohort where NHBs and NHWs both had covariate distributions resembling the unweighted sample as a whole (i.e., holding SES and covariates constant). Table 1 shows the covariate balance achieved in the weighted cohort between NHBs and NHWs. Table 2 shows differences in outcomes before and after weighting.

RESULTS

The sample (N=444) was nearly half (45%) NHB. In unweighted analyses (Table 2), there was no difference between NHBs and NHWs in MET minutes/week, self-monitoring of blood glucose, or smoking; however, compared with NHWs, NHBs had lower health literacy and numeracy, less medication adherence and use of information for dietary decisions, and fewer problem eating behaviors (such that NHBs reported fewer problems). In addition, NHBs had higher HbA1c values relative to NHWs. In weighted analyses, racial differences were attenuated for all outcomes, and only the problem eating behaviors reverse disparity and HbA1c disparity remained significant.

DISCUSSION

Among a diverse sample of adults diagnosed with T2D, racial disparities in determinants of diabetes outcomes present in unadjusted analyses largely disappeared after balancing the sample on multiple dimensions of SES. HbA1c, although attenuated, remained near 0.5% higher among NHBs relative to NHWs. This suggests additional factors (e.g., racial discrimination in health care)[34,35] may contribute to the HbA1c disparity. The reverse

Table 1. Unadjusted and Adjusted Differences in Participant Characteristics by Race

Characteristics[a]	Unweighted sample			Weighted sample[b]		
	NHW,M ± SD or n (%) (n=242)	NHB,M ± SD or n (%) (n=202)	p-value	NHW,M ± SD or n (%) (n[c]=433)	NHB,M ± SD or n (%) (n[c]=450)	p-value
Age, years[d]	56.7 ± 9.0	55.5 ± 10.1	0.306	56.2 ± 9.3	56.4± 9.5	0.881
Sex, male	134 (55)	70 (35)	**<0.001***	206 (48)	213 (47)	0.954
Education, years			0.063			0.991
<HS degree	21 (9)	23 (12)		43 (10)	42 (10)	
HS degree or equivalent	68 (28)	72 (37)		137 (32)	140 (32)	
>HS degree	151 (63)	102 (52)		250 (58)	258 (59)	
Annual household income, US$[d]			**<0.001***			0.955
<10,000	33 (14)	48 (27)		77 (19)	75 (19)	
10,000−24,999	59 (26)	55 (31)		112 (28)	120 (30)	
25,000−54,999	54 (24)	55 (31)		112 (28)	101 (25)	
≥55,000	82 (36)	22 (12)		105 (26)	104 (26)	
Housing status, homeless or unstable	30 (12)	21 (10)	0.534	50 (12)	52 (12)	0.997
Insurance status			**0.021***			0.992
Private	131 (55)	95 (48)		221 (52)	229 (51)	
Public only	50 (21)	65 (32)		109 (26)	113 (25)	
Uninsured	59 (25)	40 (20)		98 (23)	105 (24)	
Financial strain (TAPS-4)	1.1 ± 1.2	1.4 ± 1.3	**0.002****	1.2 ± 1.2	1.2 ± 1.2	0.753
Clinic, VUMC patient	154 (64)	102 (50)	**0.005****	257 (59)	263 (58)	0.849
Diabetes duration, years[d]	10.7 ± 7.7	11.3 ± 8.1	0.447	11.0 ± 8.1	11.4 ± 8.3	0.694
Number of prescribed diabetes medications	2.2 ± 0.9	1.9 ± 0.8	**0.002****	2.1 ± 0.8	2.1 ± 0.8	0.898
Insulin status, taking insulin	120 (50)	100 (50)	0.986	214 (50)	226 (50)	0.888
HbA1c test type			0.972			0.944
Venipuncture	171 (72)	141 (72)		312 (73)	327 (75)	
Mail-in kit	51 (21)	42 (22)		88 (21)	84 (19)	
Point-of-care	16 (7)	12 (6)		26 (6)	28 (6)	

Note: Boldface indicates statistical significance (*p<0.05, **p<0.01, ***p<0.001).
[a]There was 10.6% missingness in income, less than 5% missingness in HbA1c test type, insurance status, education and housing status, and less than 2% missingness in the remaining variables. Missingness rates (not shown) were similar between NHWs and NHBs in the weighted cohort.
[b]Cohort was constructed via propensity score weighting to be balanced on covariates.
[c]Sum of weights in the constructed cohort; the propensity model scales the distribution of each group to match the distribution of the sample as a whole across all variables included in the model.
[d]Models fit age, income, and diabetes duration with restricted cubic splines using five knots.
HS, high school; NHB, non-Hispanic black; NHW, non-Hispanic white; TAPS, Tool for Assessing Patients' Stressors; VUMC, Vanderbilt University Medical Center.

disparity in problem eating could be due to cultural differences in the perception of eating behaviors as problematic,[36,37] leading to differential interpretation of scale items; however, more research is needed.

This study highlights the importance of considering SES when examining disparities in determinants of diabetes outcomes. In past studies reporting worse self-care and health-related skills among NHBs,[11,13,14] SES may have been a key omitted variable driving those disparities. In a recent systematic review on racial disparities in T2D self-management, only nine of 25 studies adjusted for even a single marker of SES.[11] Seven of the nine studies reported that a racial disparity persisted in at least

one behavior, but almost all included only income and/or education in their SES adjustment. SES is a multidimensional construct, and use of these more traditional indicators limits understanding of its role[38,39] (e.g., years of education does not consider other types of training; income often fails to capture financial strain).[39]

Limitations
Limitations include use of self-reported measures that are vulnerable to social desirability and memory biases. In addition, findings were based on cross-sectional research, limiting causal inferences. Relevant confounding variables were selected, but inclusion of other/additional confounders could

Table 2. Unadjusted and Adjusted Differences in Outcomes by Race (N=444)

Outcomes[a]	Unweighted sample			Weighted sample[b]		
	NHW,M ± SD or n (%)(n=242)	NHB,M ± SD or n (%)(n = 202)	p-value	NHW,M ± SD or n (%)(n[c] = 433)	NHB,M ± SD or n (%)(n[c] = 450)	p-value
Health literacy (BHLS)	13.33 ± 2.49	12.99 ± 2.45	**0.039***	13.31 ± 2.50	13.05 ± 2.43	0.327
Numeracy (SNS-3)	4.66 ± 1.32	4.22 ± 1.17	**<0.001*****	4.51 ± 1.37	4.42 ± 1.21	0.520
Healthy diet (PDQ)						
Use of information for dietary decisions	3.14 ± 1.64	2.77 ± 1.65	**0.013***	3.09 ± 1.67	2.85 ± 1.65	0.170
Problem eating behaviors	3.53 ± 1.06	3.19 ± 1.11	**<0.001*****	3.48 ± 1.07	3.19 ± 1.12	**0.016***
Physical activity (IPAQ)	2,238.4 ± 2,800.3	2,298.6 ± 2,879.9	0.778	2,264.2 ± 2,844.5	2,252.2 ± 2,714.9	0.966
Medication adherence (ARMS-D)	40.42 ± 3.36	39.47 ± 3.84	**0.009****	40.12 ± 3.47	39.55 ± 3.98	0.179
Self-monitoring of blood glucose (SDSCA)	3.50 ± 2.88	3.77 ± 2.76	0.371	3.41 ± 2.91	3.96 ± 2.72	0.065
Smoking status (current smoker)	46 (19)	52 (26)	0.095	95 (22)	114 (26)	0.458
HbA1c (%)	8.31 ± 1.63	8.86 ± 1.97	**0.005****	8.33 ± 1.68	8.82 ± 1.88	**0.011***

Note: Boldface indicates statistical significance (*$p<0.05$, **$p<0.01$, ***$p<0.001$). Possible score range: BHLS (3−15); SNS-3 (1−5); PDQ subscales (1−6); ARMS-D (11−44; items reverse-scored, so higher scores indicate greater adherence); SDSCA (1−7).
[a]There was less than 5% missingness in IPAQ scores and HbA1c, and less than 2% missingness in the remaining variables. Missingness rates (not shown) were similar between NHWs and NHBs in the weighted cohort.
[b]Cohort was constructed via propensity score weighting to be balanced on covariates.
[c]Sum of weights in the constructed cohort.
ARMS-D, Adherence to Refills and Medication Scale for Diabetes; BHLS, Brief Health Literacy Screen; IPAQ, International Physical Activity Questionnaire; NHB, non-Hispanic black; NHW, non-Hispanic white; PDQ, Personal Diabetes Questionnaire; SDSCA, Summary of Diabetes Self-Care Activities; SNS, Subjective Numeracy Scale.

affect results. Lastly, recruiting from clinics in a single county in Tennessee and self-selection bias may limit generalizability of the findings.

CONCLUSIONS

Many initiatives focus on eliminating racial disparities in health; the role of socioeconomic factors should be fully considered in these efforts to advance health equity. Specifically, multidimensional assessments of SES are needed to advance efforts to eliminate disparities. Because race is a social construct representing different meanings in different samples and over time,[18,40] targeting upstream social determinants of health, which have remained consistently and markedly different between races, may be more effective in reducing health disparities.[41]

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