Diabetes Screening and Monitoring Among Older Mexican-Origin Populations in the U.S.

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OBJECTIVE

The purpose of the study is to examine diabetes screening and monitoring among Latino individuals as compared with non-Latino White individuals and to better understand how we can use neighborhood data to address diabetes care inequities.

RESEARCH DESIGN AND METHODS

This is a retrospective observational study linked with neighborhood-level Latino subgroup data obtained from the American Community Survey. We used generalized estimating equation negative binomial and logistic regression models adjusted for patient-level covariates to compare annual rates of glycated hemoglobin (HbA_{1c}) monitoring for those with diabetes and odds of HbA_{1c} screening for those without diabetes by ethnicity and among Latinos living in neighborhoods with low (0.0–22.0%), medium (22.0–55.7%), and high (55.7–98.0%) population percent of Mexican origin.

RESULTS

Latino individuals with diabetes had 18% higher rates of HbA_{1c} testing than non-Latino White individuals with diabetes (adjusted rate ratio [aRR] 1.18 [95% CI 1.07–1.29]), and Latinos without diabetes had 25% higher odds of screening (adjusted odds ratio 1.25 [95% CI 1.15–1.36]) than non-Latino White individuals without diabetes. In the analyses in which neighborhood-level percent Mexican population was the main independent variable, all Latinos without diabetes had higher odds of HbA_{1c} screening compared with non-Latino White individuals, yet only those living in low percent Mexican-origin neighborhoods had increased monitoring rates (aRR 1.31 [95% CI 1.15–1.49]).

CONCLUSIONS

These findings reveal novel variation in health care utilization according to Latino subgroup neighborhood characteristics and could inform the delivery of diabetes care for a growing and increasingly diverse Latino patient population. Clinicians and researchers whose work focuses on diabetes care should take steps to improve equity in diabetes and prevent inequity in treatment.

The Latino population has grown considerably in the U.S. in recent decades, comprising an estimated 18.5% of the population in 2019 (1). This diverse demographic varies greatly in the factors that impact their health outcomes (2). There are

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demonstrated differences in the magnitude and significance of associations between cardiovascular disease risk factors among Latino subgroups (3). Additionally, long-standing survey-based evidence has found that Latino subgroups of Mexican and Puerto Rican origin are more likely to be diagnosed with diabetes compared with those of Cuban origin in the U.S. (4,5). Data from the American Diabetes Association in 2018 state that Mexican-origin individuals (13.8%) have a higher diabetes rate than Puerto Ricans (12%) and Cuban-origin individuals (9%) (6). These data also show that the prevalence of both diagnosed and undiagnosed diabetes is nearly twice as high among Latino individuals than among non-Latino White individuals (7). Moreover, differences in diabetes outcomes among Latino subgroups have been demonstrated numerous times (8). Existing evidence suggests that in the Latino population, a 0.5% increase in glycated hemoglobin (HbA_{1c}) is associated with a 10.5% greater risk of diabetes-related vascular complications (7). This contributes to a higher risk of developing complications associated with diabetes in Latinos when compared with their non-Latino White counterparts (9).

However, it is unclear whether individuals in all Latino subgroups, especially Mexican-origin individuals who face diabetes inequity, receive large-scale equitable primary care for diabetes and whether this contributes to differences in diabetes outcomes. Specifically, it is uncertain if Mexican-origin individuals are equitably screened for diabetes and/or their diagnosis monitored with regular HbA_{1c} tests. In the past, due to data limitations, research approaches combined Latino populations into a singular group. With a growing and increasingly heterogeneous Latino population in the U.S., it is imperative to better understand the variation in care across Latino subgroups (10). To address this gap, we analyzed electronic health record (EHR) data from a multistate sample of patients at community health centers (CHCs) linked with neighborhood-level Latino subgroup data. The prevalence of diabetes in CHC patients is higher than that of the general population, thereby making CHCs a setting where diabetes care is imperative (11).

Our objective was to assess the differences in the odds of diabetes screening and the rates of diabetes monitoring between Latino individuals, stratified by the percent population of Mexican origin in their neighborhood, and non-Latino White individuals. Previous research shows that there is higher diabetes screening and monitoring utilization by Latinos when compared with non-Latinos (12). We wanted to explore this further, and therefore, we hypothesize that Latinos with and without diabetes have a higher utilization of HbA_{1c} screening and monitoring regardless of the percentage of the population in their neighborhood of Mexican origin compared with non-Latino Whites with and without diabetes, respectively.

Diabetes screening and monitoring can both be performed by conducting the HbA_{1c} tests. The former is recommended by providers to identify prediabetes or diabetes in individuals without diabetes. Diabetes monitoring, in contrast, is conducted in individuals with diabetes to provide a snapshot of their average blood glucose level over the past 2 to 3 months and to develop a treatment plan for diabetes. The risk of developing diabetes complications is higher with elevated levels of blood glucose (13). Diabetes screening of asymptomatic cases may lead to early detection, diagnosis, and treatment, with the focus on improving health outcomes (14).

RESEARCH DESIGN AND METHODS

Study Data and Population

This is a retrospective observational study, and we used OCHIN (not an acronym; formerly Oregon Community Health Information Network until more states joined) data from the Accelerating Data Value across a National Community Health Center Network (ADVANCE) Clinical Research Network (CRN), linked with neighborhood-level Latino subgroup data. ADVANCE is a member of PCORnet, and the ADVANCE CRN contains EHR data from CHCs across the U.S. and has been successfully used to study vulnerable populations and health disparities (15,16). Our data set included 105,257 older adults and data from 17 states (Alaska, California, Florida, Georgia, Oregon, Indiana, Massachusetts, Minnesota, Montana, Nevada, New Mexico, North Carolina, Ohio, Texas, Utah, Washington, and Wisconsin), including 497 unique clinics within 92 health systems across the nation, thereby making it generalizable to the CHC population across the U.S. (11). The population in this study included adults aged ≥50 years who had at least one ambulatory visit within the study period and who had census tract-level geocoded addresses available in the EHR (2012–2017). This cohort was limited to include an older population seeking services within CHCs. Older adults in general having equitable access to and utilization of recommended preventive care is a priority of the Centers for Disease Control and Prevention (17,18) and Healthy People 2020 (19).

Outcomes

The outcome variables were: *1*) annual rates of HbA_{1c} monitoring test within the study period among individuals with diabetes; and *2*) ever having HbA_{1c} screening within the study period among people without diabetes. As per the recommendation of the American Diabetes Association, HbA_{1c} testing should be done twice a year minimum for individuals living with diabetes who are meeting treatment goals and more frequently for those individuals with diabetes not meeting the goals (20).

Independent Variable

Our main independent variable was self-reported ethnicity documented in the EHR (Latino/non-Latino White). We use the terms Latino and non-Latino Whites because they are more often preferred among our study population; the actual ethnicity variable collected is Hispanic and non-Hispanic. In the analyses that further evaluated Latino subgroup, the main independent variable was the percent Mexican origin in each census tract obtained from the American Community Survey 2012–2016 estimates. Neighborhood subgroup has been used similarly in other work evaluating health care utilization (21). We focused on neighborhood percent Mexican origin because evidence shows that Latinos with Mexican heritage are more likely to be affected by diabetes than others (22), and Mexican-origin Latinos represent a large and a persistently growing population in the U.S. (23). We calculated categories of percent Mexican origin in the neighborhood using the Jenks natural breaks method, which creates natural groupings from within the data to minimize within-group variance and maximize

variance between the groups (24). The percent Mexican-origin variable included four categories: *1*) non-Latino White; *2*) Latinos living in a neighborhood with low percent Mexican origin (0–22.0%); *3*) Latinos living in a neighborhood with medium percent Mexican origin (22.0–55.7%); and *4*) Latinos living in a neighborhood with high percent Mexican origin (55.7–98.0%).

Covariates

We adjusted for patient-level characteristics, including patient preferred language (English/Spanish), age in years at first visit (50–54, 55–59, 60–64, 65–70, and ≥70), sex (male/female), insurance type (never insured, some private insurance, some public insurance, or a combination of private and public insurance), ambulatory visits per year (<1, 1–2, 3–4, 5–9, ≥10), BMI (never overweight/obese, sometimes overweight/obese, or always overweight/obese), and income as percent of the U.S. federal poverty level (always ≥138%, above and below 138%, always <138%, or never documented). We also included a diagnosis of atherosclerotic cardiovascular disease, as diabetes is found to be a risk factor in people with accentuated cardiovascular risk profile (25), and individuals having this diagnosis may seek more care than those who do not.

Statistical Analysis

We conducted descriptive analyses to examine characteristics of the sample overall and by ethnicity groups. χ^2 tests were used to compare differences in patient characteristics between ethnicity groups. Next, we report unadjusted rates/prevalence of HbA_{1c} tests stratified by diabetes status. For the analyses restricted to the sample of individuals with diabetes, we conducted generalized estimating equation (GEE) negative binomial regression to model HbA_{1c} testing rates as a function of ethnicity adjusted for the above-listed covariates. Furthermore, we fitted models with a compound symmetry correlation structure and empirical sandwich variance estimator to obtain adjusted rate ratios (aRRs) and their corresponding 95% CIs, accounting for clustering of individuals within CHCs. For the analyses restricted to the sample of individuals without diabetes, we conducted logistic regression, also clustered by clinic, to obtain adjusted odds ratios (aORs) of ever receiving HbA_{1c} screening in the study period.

For both GEE negative binomial and logistic regression approaches, we considered two models. Model 1 included ethnicity (non-Latino White vs. Latino) as the main independent variable. Model 2 included the categorical neighborhood percent Mexican origin as the main independent variable. All statistical tests were two-sided, and type I error was set at 5%. We conducted all analyses using R and Stata software. This study was approved by the Oregon Health & Science University Institutional Review Board (study number 19022).

RESULTS

The study population comprised 105,257 adults aged ≥50 years with at least one ambulatory visit within the study period and who had at least one address available in the EHR. The number of people missing address data was 57,050 when all other criteria of inclusion/exclusion were already applied. Patient characteristics are shown in Table 1. The majority of the individuals were non-Latino Whites (72.3%), female (56.0%), and first visited a CHC at 55–59 years (38.0%) or 60–64 years of age (37.8%). Most individuals had some public health insurance (61.0%), and two-thirds of individuals were overweight (BMI >25.0 kg/m^2) at every clinic visit (66.9%). Nearly half of the individuals had a self-reported income <138% of the federal poverty level at every clinic visit (44.7%). More than one-fourth of individuals had a diabetes diagnosis (26.4%), out of which 98.02% had type 2 diabetes, 1.51% had type 1 diabetes (in 0.47% cases, the type was not specified), and half of the population had never received an HbA_{1c} test (49.7%). When comparing Latino with non-Latino White patients, we observed that Latinos had double the prevalence of diagnosed diabetes compared with Whites (42.8% vs. 20.1%; $P < 0.001$). All other variables also differed statistically between Latino and non-Latino White patients ($P < 0.001$ for all). Supplementary Table 1 shows patient characteristics stratified by categorical neighborhood percent Mexican origin.

Supplementary Figure 1 shows unadjusted rates of HbA_{1c} monitoring among those individuals with diabetes by categorical neighborhood percent Mexican origin. Non-Latino White patients had 1.33 tests/year; Latinos living in neighborhoods with low percent Mexican origin had 1.86 tests/year; Latinos living in neighborhoods with medium percent Mexican origin had 1.71 tests/year; and Latinos living in neighborhoods with high percent Mexican origin had 1.66 tests/year.

Supplementary Figure 2 shows unadjusted prevalence of HbA_{1c} screening among those individuals without diabetes by categorical neighborhood percent Mexican origin. Non-Latino Whites had an HbA_{1c} screening prevalence of 13.9%, Latinos living in a neighborhood with low percent Mexican origin had an unadjusted prevalence of 44.4%, Latinos living in a neighborhood with medium percent Mexican origin had a prevalence of HbA_{1c} testing of 45.7%, and Latinos living in a neighborhood with high percent Mexican origin had a 39.0% HbA_{1c} testing prevalence.

Table 2 shows results from the regression models. In the analyses that considered Latinos as a single group, Latino individuals with diabetes had 18% higher rates of HbA_{1c} testing than non-Latino White individuals with diabetes (aRR 1.18 [95% CI 1.07–1.29]). Latino individuals without diabetes had 25% greater odds of screening than did their non-Latino White counterparts (aOR 1.25 [95% CI 1.15–1.36]).

When we evaluated the category of neighborhood percent Mexican origin compared with non-Latino White individuals with diabetes, Latino individuals with diabetes living in a neighborhood with low percent Mexican origin had a 31% higher rate of receiving HbA_{1c} monitoring (aRR 1.31 [95% CI 1.15–1.49]) compared with non-Latino White individuals. However, those living in neighborhoods with medium or high percent Mexican origin had similar monitoring rates compared with non-Latino White individuals. Among those without diabetes, all Latino individuals had increased odds of HbA_{1c} screening compared with non-Latino White individuals (Table 2).

CONCLUSIONS

This article is unique in its consideration of Latino subgroups' use of basic primary care services by older adults at high risk for diabetes and its complications. As the Latino population grows in

Table 1—Characteristics of patients

	Overall (*N* = 105,257)	Non-Latino White (*N* = 76,048)	Latino (*N* = 29,209)	*P* value
Language				NA
English	81,946 (77.9)	76,048 (100)	5,898 (20.2)	
Spanish	23,311 (22.2)	0 (0)	23,311 (79.8)	
Age at first visit (years)				<0.001
50–54	6,140 (5.8)	4,924 (6.5)	1,216 (4.2)	
55–59	39,974 (38.0)	29,361 (38.6)	10,613 (36.3)	
60–64	39,737 (37.8)	28,248 (37.2)	11,489 (39.3)	
65–69	18,066 (17.2)	12,740 (16.8)	5,326 (18.2)	
≥70	1,340 (1.3)	775 (1.0)	565 (1.9)	
Sex				<0.001
Female	58,895 (56.0)	41,620 (54.7)	17,275 (59.1)	
Male	46,362 (44.1)	34,428 (45.3)	11,934 (40.9)	
Insurance type				<0.001
Never insured	16,131 (15.3)	12,505 (16.4)	3,626 (12.4)	
Some private insurance	15,693 (14.9)	13,770 (18.1)	1,923 (6.6)	
Some private and public insurance	9,225 (8.8)	7,198 (9.5)	2,027 (6.9)	
Some public insurance	64,208 (61.0)	42,575 (56.0)	21,633 (74.1)	
Average visits per year				<0.001
<1	25,231 (24.0)	19,986 (26.3)	5,245 (18.0)	
1 to 2	36,464 (34.6)	27,224 (35.8)	9,240 (31.6)	
3 to 4	20,784 (19.8)	13,874 (18.2)	6,910 (23.7)	
5–9	17,315 (16.5)	10,958 (14.4)	6,357 (21.8)	
≥10	5,463 (5.2)	4,006 (5.3)	1,457 (5.0)	
Overweight BMI (>25.0 kg/m^2)				<0.001
Never overweight/obese	17,666 (16.8)	14,946 (19.7)	2,720 (9.3)	
Sometimes overweight/obese	17,223 (16.4)	12,894 (17.0)	4,329 (14.8)	
Always overweight/obese	70,368 (66.9)	48,208 (63.4)	22,160 (75.9)	
Percent of U.S. federal poverty level				<0.001
Always ≥138	14,328 (13.6)	12,796 (16.8)	1,532 (5.2)	
Above and below 138	10,922 (10.4)	8,335 (11.0)	2,587 (8.9)	
Always <138	47,023 (44.7)	29,395 (38.7)	17,628 (60.4)	
Never documented	32,984 (31.4)	25,522 (33.6)	7,462 (25.6)	
Diabetes diagnosis				<0.001
Yes	27,792 (26.4)	15,294 (20.1)	12,498 (42.8)	
HbA_{1c} test ever				<0.001
Yes	52,939 (50.3)	31,439 (41.3)	21,500 (73.6)	
Heart disease diagnosis				<0.001
Yes	11,337 (10.8)	8,967 (11.8)	2,370 (8.1)	

Data are *N* (%) unless otherwise indicated. *P* values were determined from χ^2 tests. NA, not applicable.

size and heterogeneity in the U.S., it is imperative to better understand subgroups' differences in utilization and outcomes (9). We focused on diabetes screening and monitoring among Latinos because of the widespread impact and unequitable burden of this condition's diagnosis and management in this population (7). Overall, the Latino individuals (with or without diabetes) in our CHC study sample received more diabetes screening and monitoring tests compared with non-Latino White adults.

Even though literature suggests that Latinos tend to have worse health outcomes compared with their non-Latino White counterparts, results from our study suggest that poor outcomes are not due to less frequent HbA_{1c} screening/monitoring tests. It is plausible that Latino individuals in our study sample could have prediabetes or higher HbA_{1c} values compared with their non-Latino White counterparts, leading them to get tested more frequently, but again, they did not receive less of this particular diabetes service, and we did not measure this in our study. In fact, a previous study has demonstrated that Latinos have greater diabetes screening when compared with non-Latino White individuals (12).

Specifically, in our study, we found that Latinos with diabetes from neighborhoods with low percent Mexican-origin populations had higher monitoring rates compared with the non-Latino Whites with diabetes. These Latino patients may "stand out" more within these provider settings because of greater perceived barriers or risk factors, leading to more diagnostic tests as compared with non-Latino White individuals with diabetes. Latinos in low Mexican-origin neighborhoods may also seek out this care more or experience fewer actual barriers to these tests, raising these rates. Alternately, Latino individuals with diabetes possibly have

Table 2—Adjusted rate ratios of HbA_{1c} monitoring and adjusted odds ratios of HbA_{1c} screening

	Monitoring among those with diabetes (*N* = 27,792), RR (95% CI)	Screening among those without diabetes (*N* = 77,465), OR (95% CI)
Model 1: Ethnicity as main independent variable		
Ethnicity		
Non-Latino White	Reference	Reference
Latino	**1.18 (1.07–1.29)**	**1.25 (1.15–1.36)**
Model 2: Percent Mexican origin in neighborhood as main independent variable		
Ethnicity		
Non-Latino White	Reference	Reference
Low percent Mexican origin (0.0–22.0)	**1.31 (1.15–1.49)**	**1.27 (1.16–1.38)**
Medium percent Mexican origin (22.0–55.7)	1.06 (0.97–1.16)	**1.26 (1.13–1.39)**
High percent Mexican origin (55.7–98.0)	1.03 (0.88–1.21)	**1.15 (1.02–1.29)**

All models adjusted for language, age at first visit, sex, insurance type, visits per year, BMI, income as percent of the federal poverty level, and atherosclerotic cardiovascular disease diagnosis. For patients with diabetes, negative binomial GEE models were used. For patients without diabetes, logistic GEE models were conducted. Boldface text indicates statistical significance.

higher HbA_{1c} values compared with their non-Latino White counterparts (26), which prioritizes them for more frequent testing as per the standard testing guidelines. Ultimately, from our data, the reason for these higher rates is uncertain, and further research can prioritize understanding the level of glucose control in neighborhoods by Latino subgroup, which may help clarify the etiology of higher testing rates.

Clinicians and researchers who are looking to improve equity in diabetes care should focus further attention on care steps subsequent to HbA_{1c} testing. Clinicians should be aware that any inequity in their Latino/Mexican-origin patients may be less likely to stem from too few HbA_{1c} tests and should make sure tests are appropriately followed up and other features of diabetes care receive adequate attention. As above, researchers can participate in improving diabetes care equity by conducting more research around ethnic subgroups, especially focusing on levels of glucose control by subgroup and neighborhood. Further, understanding neighborhood level associations with diabetes control and care may provide insight into how to mitigate diabetes impacts across populations and would further help in formulating health policies around diabetes care equity.

In lieu of the patient-level Latino subgroup information, we used community subgroup information as our independent variable. It is, however, uncertain what this information represents—the likelihood of the individual status or a neighborhood effect. Previous research used community-level information as a proxy for individual-level information to examine the association between racial/ethnic composition and neighborhood satisfaction (27). This study found that for Latinos specifically, higher levels of satisfaction in integrated neighborhoods is attributed to socioeconomic conditions and fewer social problems than in predominantly minority communities (27). The inference made from this study is that there is a balance between socioeconomic status and issues related to race by individuals in their residential preferences (27). Based on the aforementioned findings and the subgroup information that we used in our study, it is evident that further work is needed to understand the representation of proxy measures like individual subgroup status or neighborhood effects around the Latino population research work.

Limitations

The cohort comprises only older adults ≥50 years, thereby narrowing the scope of the study to only a certain age group. Diabetes is more prevalent in the age group represented in our study sample; however, we acknowledge that the results may have been different if younger adults had also been included in our study population. Additionally, we did not have subgroup information for all possible Latino subgroups and for all ethnicities (e.g., Asian subgroups); therefore, we could not calculate a full neighborhood ethnicity percentage. Furthermore, the data are also solely from CHCs, so results may not be generalizable to the entire country. However, the prevalence of diabetes in CHC patients is higher than that of the general population, thereby making CHC a setting where diabetes care is imperative (11). Lastly, further work is needed to understand the use of proxy measures like individual subgroup status or neighborhood effects for Latino population research work. Once we understand these proxy measures more fully, further research can focus on the diabetes care received in these Latino subpopulation–specific ethnic enclaves. Despite our inclusion of numerous factors associated with diabetes care (listed in the *Research Design and Methods* section) not seen in many studies, we could not include some other possible confounders as they are unavailable in our data set, like diabetes education, nutrition counseling, and mental health conditions.

Many of the ∼500 clinics included within our data set likely have quality improvement initiatives related to diabetes screening and monitoring; however, reporting on all of them is outside the scope of work of our study aside from accounting for clustering by clinic, which we did in our modeling.

Conclusion

Our study found that, among adults ≥50 years going to CHCs, Latinos with or without diabetes had a higher utilization of HbA_{1c} screening/monitoring regardless of neighborhood percent Mexican origin, compared with non-Latino Whites with or without diabetes. Furthermore, Latino individuals with diabetes in neighborhoods

with low percent Mexican origin had higher monitoring rates than their non-Latino White counterparts. Clinicians and researchers whose work focuses on diabetes care should take steps to improve equity in diabetes and prevent inequity in treatment. Clinicians can take appropriate care steps after HbA_{1c} testing and ensure tests are followed up. Further, researchers can participate in diabetes care equity by conducting research around ethnic subgroups and understanding neighborhood level associations with diabetes control and care.

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Author Contributions. R.D. conceived the design, drafted the manuscript, and critically revised the manuscript for content. J.H. conceived the design, drafted portions of the manuscript, and critically reviewed and edited the manuscript. J.A.L. and M.M. conceived the design, performed analyses, drafted portions of the manuscript, and critically reviewed and edited the manuscript. B.A., D.E.-H., C.E.V.G., S.G., K.C.-B., J.K., and A.B. contributed to the interpretation of the findings and critically reviewed and edited the manuscript. J.H. is the guarantor of this work and, as such, had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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