PATIENT-CENTERED COMMUNICATION

Use of Antihyperglycemic Medications Among US People with Limited English Proficiency

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ABSTRACT

BACKGROUND: Language barriers can impact pharmaceutical disease management leading to potential health disparities among limited English proficiency (LEP) people with diabetes mellitus (DM) in the United States (US).

OBJECTIVE: To assess the use of antihyperglycemic medications and estimate their impact on glycemic control by LEP status.

DESIGN: Cross-sectional design. We compared the classes of prescribed antihyperglycemic medications and their impact on glycemic control between English-speaking and LEP participants (i.e., Spanish-speaking or needing interpretation services) with DM applying generalized linear models and adjusting for sociodemographic variables.

PARTICIPANTS: Data from the US National Health and Nutrition Examination Survey (NHANES 2003–2018).

MAIN MEASURES: Selected language for interview or interpreter request (main exposure). Outcomes include prescribed antihyperglycemic medications and glycemic control (HBA1c).

KEY RESULTS: Data for 4666 participants with DM were analyzed. Antihyperglycemic medications were similarly used by LEP and English-speaking people with DM, except for insulin, which was less frequently used by LEP people. Despite similar medications, LEP people using biguanides and TZDs were less likely to reach glycemic target levels (adjusted odds ratios ranging 1.7 to 3.3) compared to English-speaking people with DM.

CONCLUSIONS: Our findings indicate that the differences in DM outcomes among LEP people are likely attributed to factors other than medication prescription. These might include cultural beliefs, dietary adjustments, and communication barriers in healthcare. Enhanced patient education, acknowledgment of cultural practices, and improved language services could potentially mitigate these disparities.

Frank Müller and Harland Holman shared first authorship.

Prior Presentation The results of this study have been presented as a poster at the 83rd Scientific Session American Diabetes Association, San Diego, June 23–26, 2023.

Received April 16, 2024
Accepted January 10, 2025
Published online January 28, 2025

KEY WORDS: limited English proficiency; migrants; medication adherence; HbA1c; diabetes mellitus; NHANES

J Gen Intern Med 40(8):1803–10
DOI: 10.1007/s11606-025-09385-x

INTRODUCTION

The latest census reports that 22% of United States (US) residents speak a language other than English at home and approximately 20% of these residents reported speaking English “not well” or “not at all”.[1] People with LEP often experience challenges accessing and navigating the healthcare system and are more prone to unfavorable outcomes of chronic conditions and medical errors compared to English-speaking people.[2,3] This also applies to the management of diabetes mellitus (DM): people with LEP are more likely to have undiagnosed DM,[4] and struggle more often to maintain blood glucose levels within target range[5–7] and cardiovascular health goals compared to English-speaking people.[8] The reason for these findings is complex: language discordance may impede DM self-management,[9,10] provider’s lack of cultural competency in DM care, e.g., lacking awareness on dietary habits,[11] or religious and cultural beliefs.[12] Migrant patients also have expressed anxiety about encounters with native English-speaking providers, despite the availability of language interpretation services.[13]

Furthermore, previous studies have highlighted variations in medication prescribing patterns for DM by race and ethnicity[14] and other studies have suggested that people from racial and ethnic minority groups are likely to experience decreased initiation of newer antihyperglycemic medications and technologies with high effectiveness and cardiovascular benefits for patients with DM.[15–17] In addition to socioeconomic factors, differences in medication access might be attributed to language discordance and limited opportunities for effective counseling on medication regimens. Indeed, adequate comprehension of medication dosing, timing, and side effects is required to minimize the incidence of DM complications, including life-threatening hyperglycemia.[18] Healthcare providers might prioritize medications with simple regimens to minimize these risks. To date, the relationship between LEP and the pharmacologic management of DM has not been assessed in a representative sample of the US population. Therefore, this study used data from the National Health and Nutrition Examination Survey (NHANES) to evaluate the use of antihyperglycemic medications and estimate their impact on glycemic control by LEP status.

METHODS

Study Design

The NHANES is designed to enroll and assess a representative sample of approximately 5000 participants/year of the US civilian non-institutionalized population. Participants are selected using a multistage area probability sampling approach[19] with certain racial and ethnic groups being deliberately oversampled to enhance validity. Data were derived from computer-assisted interviews, physical exams, and laboratory tests. For this study, we used data from eight NHANES cycles (2003–2004, 2005–2006, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018).

Study Subjects

We used data for non-pregnant adults (aged 18 or older) with diagnosed DM (i.e., answered "yes" to the question "Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?"; $n = 5467$). Participants were excluded from the analysis if they were solely using insulin or received their DM diagnosis before the age of 18 as both aspects are predominately prevalent among patients with type 1 DM ($n = 797$). We further excluded four participants who solely used less commonly prescribed medications (amylin analog or alpha glucosidase).

Main Exposure

In NHANES, participants selected the language of the interview (English or Spanish) or requested an interpreter to complete the interviews. We categorized the main exposure for this study as (a) interview completed in English (i.e., English-speaking), (b) interview completed in Spanish (i.e., LEP-Spanish), or (c) interview completed with an interpreter (i.e., LEP-interpreter).

Outcome

Here, the outcomes of interest were classes of antihyperglycemic medication and glycemic control. The use of prescribed medications was assessed during the NHANES household interview. Participants who responded "yes" to the question "In the past 30 days, have you used or taken medication for which a prescription is needed?" were asked to show the interviewer the medication container of all the products used or verbally report the name of the medication(s). Antihyperglycemic medications were categorized into biguanides (i.e., metformin), insulin secretagogues (i.e., sulfonylurea, meglitinide), thiazolidinediones (TZDs), antidiabetic combinations (two or more classes of antidiabetic medications), and a group with newer medications including glucagon-like peptide 1 agonists (GLP1), dipeptidyl peptidase 4 inhibitors (DDP4), and sodium-glucose cotransporter-2 inhibitors (SGLT2). A final group included any of the beforementioned medication(s) plus insulin. The categorization followed the therapeutic drug classes provided by NHANES, with insulin secretagogues and newer antidiabetic drugs being combined into respective groups due to small sample sizes.

Glycemic control was evaluated using HbA1c that reflects average blood glucose levels for the preceding 90 days. The threshold for above-target glycemic levels was defined as HbA1c > 7% (> 53 mmol/mol) as defined in the current guidelines from American Diabetes Association.[20]

Study Covariates

Additional covariates included participants' survey reported age (years), sex (male/female), educational attainment (high school degree or less/higher than high school degree), ratio of family income to federal poverty guidelines (< 1/1 + / missing), health insurance coverage (any type of healthcare plan; yes/no), time since DM diagnosis (years), number of healthcare visits in the past 12 months ($\leq 1/> 1$), number of prescribed antihyperglycemic medications (range 0–5), and body mass index (BMI, measured by study personnel as part of the NHANES physical exam and categorized into non-obese (< 30 kg/m^2), obese ($\geq$ 30 kg/m^2) or missing).

Statistical Analysis

First, we used descriptive statistics to characterize the study sample by LEP status, including relative and absolute frequencies, mean, and standard error of mean (SEM). Differences between LEP status were assessed using analysis of variance for continuous variables and design-corrected Rao-Scott x^2 test for categorical variables. The crude prevalence of antihyperglycemic medication use was estimated for each LEP group. Separate logistic regression models were then used to estimate the adjusted prevalence of each medication use by LEP status. Multivariable logistic regression was also used to estimate the odds of above-target glycemic levels by LEP status, stratified by antihyperglycemic medication use.

All analyses were adjusted for the NHANES complex sampling design (clustering, stratification, data release cycle, and NHANES examination weights). Data analyses were conducted with SAS® version 9.4 (SAS Institute, Inc., Cary, NC). The significance level was set, a priori, at $p < 0.05$.

Research Ethics

NHANES received approval through the National Center for Health Statistics Research Ethics Review Board.[21] All participants provided written informed consent prior to enrollment. The Michigan State University Institutional Review Board deemed the analysis of the publicly available deidentified NHANES data as non-human subject research.

RESULTS

This study included 4666 participants with self-reported physician-diagnosed probable type 2 DM (age of diagnosis ≥ 18 years; not solely using insulin). Most participants completed the NHANES interview in English (90.0%), whereas 7.0% of the participants completed the interview in Spanish and 3.0% requested an interpreter. Comparing the three groups (Table 1), age, antihyperglycemic medication use (yes/no), education, health insurance, healthcare visits, income to poverty ratio, BMI, and HbA1c levels were statistically different. For example, LEP-Spanish (85.8%) and LEP-interpreter (81.3%) participants more commonly held a high school degree or less as their highest level of educational attainment compared to English-speaking participants (46.5%). Also, LEP-Spanish (36.8%) and LEP-interpreter (19.5%) participants were more likely to lack health insurance coverage than English-speaking participants (8.0%).

Figure 1 presents the crude prevalence of antihyperglycemic medication use by LEP status among participants who used at least one medication in the past 30 days. The use of biguanides, secretagogues, antihyperglycemic combinations, or newer medications (GLP1 agonists, DDP4 inhibitors, or SGLT2 inhibitors), with or without insulin, did not differ by LEP status (all $p > 0.05$). The use of TZDs was different across the three groups ($p = 0.03$), being less commonly used by LEP-Spanish participants with DM.

When adjusting for potentially confounding variables, the association between LEP-Spanish and the use of any antihyperglycemic medication was attenuated towards the null (odds ratio (OR) = 1.0; 95% CI = 0.8, 1.4), whereas participants in the LEP-interpreter group were more likely to use antihyperglycemic medications compared to English-speaking participants (OR = 1.8; 95% CI = 1.1, 2.9), with income and health insurance status explaining the changes from the unadjusted estimates (Table 2, panel A). Among participants reporting to have taken antihyperglycemic medications in the past 30 days, LEP status was not associated with medication use without insulin (Table 2, panel B). On the other hand, medication use with insulin was less common among LEP-Spanish (OR = 0.6; 95% CI = 0.4, 0.9) and LEP-interpreter participants (OR = 0.5; 95% CI = 0.3, 1.0) compared to English-speaking participants, but these differences were not statistically significant for LEP-interpreter participants ($p = 0.07$).

Table 1 Selected Characteristics of the Study Population. Data Are for the US NHANES, 2003–2018

LEP status	**English-speaking ($n = 3801$)**	**LEP-Spanish ($n = 665$)**	**LEP-interpreter ($n = 200$)**	
Characteristics	Mean (SEM) or unweighted n (weighted %)			p-value*
Age, years	60.8 (0.3)	56.1 (0.7)	63.3 (1.2)	< 0.001
Time since DM diagnosis, years	9.6 (0.2)	9.4 (0.4)	8.8 (0.6)	0.46
Prescription antihyperglycemic medications†				
Not using	767 (20.3%)	159 (26.6%)	32 (15.0%)	0.004
Mean number if using	1.7 (0.02)	1.6 (0.04)	1.5 (0.06)	0.10
Female sex	1839 (49.4%)	340 (52.3%)	100 (55.9%)	0.13
High school degree or less	2003 (46.5%)	591 (85.8%)	160 (81.3%)	< 0.001
Do not have health insurance coverage	340 (8.0%)	205 (36.9%)	46 (19.5%)	< 0.001
Annual healthcare visits > 1	3489 (92.0%)	544 (78.0%)	178 (90.2%)	< 0.001
Family income to poverty ratio				< 0.001
< 1	653 (12.3%)	264 (39.2%)	104 (53.3%)	
≥ 1	2815 (80.1%)	285 (45.5%)	67 (35.1%)	
Missing	333 (7.6%)	116 (15.3%)	29 (11.6%)	
HbA1c				< 0.001
≤ 7%	2105 (57.4%)	296 (44.0%)	88 (46.9%)	
> 7%	1516 (39.1%)	347 (53.0%)	98 (46.9%)	
Missing	180 (3.5%)	22 (3.0%)	14 (6.2%)	
BMI				< 0.001
< 30 kg/m^2	1525 (35.5%)	322 (48.4%)	142 (69.5%)	
≥ 30 kg/m^2	2187 (62.5%)	325 (49.3%)	55 (26.8%)	
Missing	89 (2.0%)	18 (2.3%)	3 (3.7%)	

*p-values are based on analysis of variance for continuous variables and design-corrected Rao-Scott x^2 test for categorical variables

†Prescription antihyperglycemic medication use was defined as taking biguanides, insulin secretagogues, TZDs, antihyperglycemic combinations, GLP1 agonists, DDP4 inhibitors, or SGLT2 inhibitors in the 30 days prior to NHANES assessment, with or without insulin

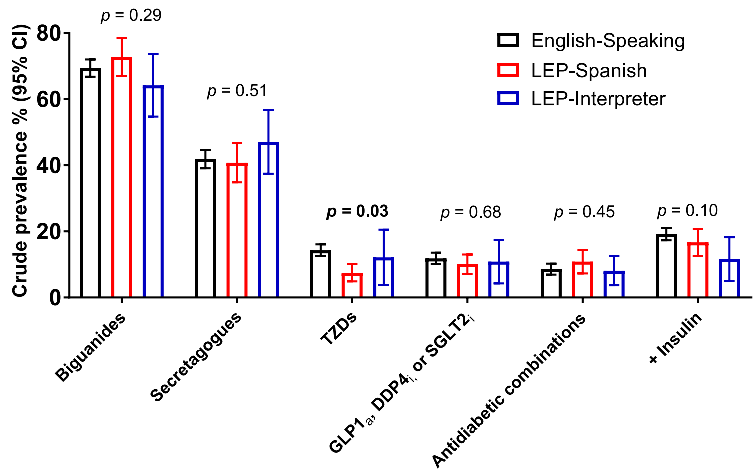

Figure 1 Use of antihyperglycemic medications by LEP status among participants who used at least one medication in the past 30 days ($n = 3708$). Data are for the US NHANES, 2003–2018.

We then ran a logistic regression model to estimate the association between above-target glycemic HbA1c (> 7%) and LEP status, adjusting for potential confounding variables and medication use. Overall, favorable HbA1c targets control were less often reached by LEP-Spanish and LEP-interpreter participants compared to English-speaking participants (Table 3). To further evaluate these differences, we ran stratified analysis by type of medication. In fully adjusted models, LEP people using biguanides showed higher odds of elevated HbA1c (LEP Spanish OR = 1.8; 95% CI = 1.2, 2.5 and LEP interpreter OR = 1.9; 95% CI = 1.1, 3.1) compared to English-Speaking participants. Among TZD users, this association was significant only for Spanish-speaking LEP people (OR = 3.5; 95% CI = 1.7, 7.2), while among insulin secretagogue users, it was significant only for interpreter-LEP people (OR = 2.0; 95% CI = 1.04, 3.8). No significant associations were observed among participants using newer medications or antidiabetic combinations.

DISCUSSION

Our study on self-reported medication use in NHANES data from 2003 to 2018 has two main findings: First, antidiabetic medication does not significantly differ between English-speaking and LEP (both Spanish-speaking or other LEP using an interpreter) people with DM whereas the prevalence of insulin use was lower among LEP-Spanish people compared to English-speaking people. Second, despite widely similar treatment regimes in LEP and English-speaking people, LEP people were less likely to reach glycemic target levels compared to English-speaking people. The differences in glycemic control by LEP status were attenuated when using newer medications or antidiabetic combinations.

While there is a growing body of evidence suggesting that DM outcomes in language-diverse people are worse compared to English speakers,[5–7,22] this study suggests that these differences are unlikely due to differences in the prescription of antihyperglycemic medications. Our findings point to systemic barriers in healthcare delivery, including structural obstacles to accessing care, provider-level factors such as medication inertia, and challenges in providing culturally appropriate care.[23] Furthermore, DM management require lifestyle adjustments, including diet, exercise, reduction of alcohol use, and smoking cessation as well as stress management.[24–27] Research has highlighted how health system barriers and limited access to appropriate resources can affect medication use patterns and lifestyle modifications among migrant populations with DM.[7,28]

Achieving diet and drug adherence also requires effective and empathetic communication strategies between providers and their patients, despite language discordance. The utilization of professional interpreters in the provision of DM care to LEP populations has been associated with improved glycemic control.[29] However, studies with LEP patients in hospital settings have confirmed that relevant information or treatment considerations are often provided sparsely, e.g., by underutilization of teach-back methods or information not provided in the primary spoken language.[30] Providers often find the utilization of interpreters time-consuming and feel uncomfortable relying on them,[31] leading to underutilization and "getting-by" with untrained ad hoc interpreters[32,33] resulting in suboptimal care.

Providing DM care in patients' native languages has also been shown to improve outcomes,[34] but multilingual healthcare providers in the US and other Western countries are sparse[35,36] and most US medical schools do not offer language courses in which future provider could acquire language competencies in another language than English.[37]

Besides physicians, pharmacists play a crucial role in improving medication adherence and reducing adverse effects by providing essential education on prescribed medication.[38–40] However, language discordance makes it less likely that LEP people receive this education, and several studies have underscored the lack of interpretation capacities in pharmacies.[41–44]

Table 2 Association Between LEP Status and Antihyperglycemic Medication Use. Data Are for the US NHANES, 2003–2018

LEP status	English-speaking	LEP-Spanish	LEP-interpreter
	Odds ratios of use (95% CI)		
Panel A: All participants ($n=4666$)			
Any antihyperglycemic medication			
Model1[a]	1 (reference)	**0.7 (0.5, 0.9)**	1.4 (0.9, 2.2)
Model 2[b]	1 (reference)	**0.8 (0.6, 0.9)**	1.4 (0.9, 2.2)
Model 3[c]	1 (reference)	1.0 (0.8, 1.4)	**1.8 (1.1, 2.9)**
Panel B: Participants who used any antihyperglycemic medication in the past 30 days ($n=3708$)			
Biguanides			
Model 1[a]	1 (reference)	1.1 (0.8, 1.5)	0.7 (0.5, 1.1)
Model 2[b]	1 (reference)	1.0 (0.7, 1.4)	0.8 (0.5, 1.2)
Model 4[d]	1 (reference)	1.1 (0.8, 1.6)	0.7 (0.5, 1.2)
Insulin secretagogues			
Model 1[a]	1 (reference)	1.0 (0.8, 1.3)	1.3 (0.9, 1.9)
Model 2[b]	1 (reference)	1.1 (0.8, 1.5)	1.3 (0.9, 1.8)
Model 4[d]	1 (reference)	1.1 (0.8, 1.6)	1.2 (0.8, 1.9)
TZDs			
Model 1[a]	1 (reference)	**0.6 (0.4, 0.9)**	0.9 (0.4, 2.0)
Model 2[b]	1 (reference)	**0.6 (0.4, 0.9)**	1.0 (0.4, 2.1)
Model 4[d]	1 (reference)	0.6 (0.4, 1.0)	1.2 (0.5, 3.1)
Newer medications			
Model 1[a]	1 (reference)	0.8 (0.6, 1.1)	0.8 (0.4, 1.5)
Model 2[b]	1 (reference)	0.8 (0.5, 1.1)	0.8 (0.5, 1.6)
Model 4[d]	1 (reference)	0.8 (0.5, 1.2)	1.0 (0.4, 2.3)
Antidiabetic combination			
Model 1[a]	1 (reference)	1.3 (0.8, 2.1)	1.0 (0.5, 1.8)
Model 2[b]	1 (reference)	1.3 (0.8, 2.1)	1.0 (0.6, 1.9)
Model 4[d]	1 (reference)	1.2 (0.8, 1.9)	1.0 (0.5, 1.9)
+Insulin			
Model 1[a]	1 (reference)	0.8 (0.6, 1.1)	0.5 (0.3, 1.0)
Model 2[b]	1 (reference)	0.8 (0.6, 1.1)	0.5 (0.3, 1.0)
Model 4[d]	1 (reference)	**0.6 (0.4, 0.9)**	0.5 (0.3, 1.0)

[a]Logistic regression models are adjusted for NHANES survey design including NHANES data cycle

[b]Logistic regression models are additionally adjusted for participant's age (years) and sex (male, female)

[c]Logistic regression models are additionally adjusted for time since diabetes diagnosis (years), education attainment (high school or less, > high school), income to poverty ratio (< 1, 1+, missing), health insurance coverage (yes, no), number of healthcare visits in the past 12 months, BMI (< 30 kg/m^2, 30 + kg/m^2, missing), and HbA1c ≤ 7%, > 7%, missing)

[d]Logistic regression models are additionally adjusted for the number of antihyperglycemic medications used

Table 3 Association Between Above Target HbA1c (i.e., HbA1c > 7%) and LEP Status, Stratified by Prescription Antihyperglycemic Medication Use. Data Are for the US NHANES, 2003–2018

LEP status	English-speaking	LEP-Spanish	LEP-interpreter
	Odds ratios of above-target HbA1c (95% CI)		
Participants who used any antihyperglycemic medication ($n=3708$)			
Model 1[a]	1 (reference)	1.8 (1.4, 2.3)	1.5 (0.9, 2.4)
Model 2[b]	1 (reference)	1.7 (1.3, 2.2)	1.6 (1.02, 2.6)
Model 3[c]	1 (reference)	1.6 (1.2, 2.1)	1.8 (1.1, 2.8)
Participants who used biguanides ($n=2510$)			
Model 1[a]	1 (reference)	2.0 (1.4, 2.6)	1.5 (0.9, 2.4)
Model 2[b]	1 (reference)	1.9 (1.4, 2.5)	1.6 (1.01, 2.6)
Model 4[d]	1 (reference)	1.8 (1.2, 2.5)	1.9 (1.1, 3.1)
Participants who used insulin secretagogues ($n=1623$)			
Model 1[a]	1 (reference)	2.0 (1.3, 2.9)	1.7 (0.8, 3.5)
Model 2[b]	1 (reference)	1.7 (1.1, 2.6)	1.9 (1.0, 3.6)
Model 4[d]	1 (reference)	1.4 (0.9, 2.1)	2.0 (1.04, 3.8)
Participants who used TZDs ($n=474$)			
Model 1[a]	1 (reference)	3.2 (1.6, 6.6)	2.1 (0.4, 12.0)
Model 2[b]	1 (reference)	3.3 (1.7, 6.6)	2.1 (0.4, 12.9)
Model 4[d]	1 (reference)	3.5 (1.7, 7.2)	3.3 (0.9, 12.4)
Participants who used newer medications ($n=386$)			
Model 1[a]	1 (reference)	1.4 (0.7, 3.2)	1.4 (0.4, 5.2)
Model 2[b]	1 (reference)	1.4 (0.6, 3.2)	1.3 (0.4, 4.7)
Model 4[d]	1 (reference)	1.1 (0.4, 2.6)	1.1 (0.3, 3.5)
Participants who used antidiabetic combination ($n=333$)			
Model 1[a]	1 (reference)	0.9 (0.4, 1.8)	1.1 (0.3, 3.8)
Model 2[b]	1 (reference)	0.9 (0.4, 2.1)	1.2 (0.3, 4.4)
Model 4[d]	1 (reference)	1.0 (0.4, 2.5)	1.3 (0.3, 5.5)
Participants who used any antihyperglycemic medication and insulin ($n=673$)			
Model 1[a]	1 (reference)	2.1 (1.1, 4.1)	3.5 (0.4, 29.2)
Model 2[b]	1 (reference)	1.9 (1.0, 3.8)	3.2 (0.4, 24.6)
Model 4[d]	1 (reference)	1.8 (0.8, 3.7)	3.3 (0.4, 25.0)

[a]Logistic regression models are adjusted for NHANES survey design including NHANES data cycle

[b]Logistic regression models are additionally adjusted for age (years) and sex (male, female)

[c]Logistic regression models are additionally adjusted for time since diabetes diagnosis (years), education attainment (high school or less, > high school), income to poverty ratio (< 1, 1+, missing), health insurance coverage (yes, no), number of healthcare visits in the past 12 months, BMI (< 30 kg/m^2, 30 + kg/m^2, missing), antihyperglycemic medication (biguanides, insulin secretagogues, TZDs, newer medications, and antidiabetic combination), the number of antihyperglycemic medication used, and insulin use (yes, no)

[d]Logistic regression models are additionally adjusted for time since diabetes diagnosis (years), education attainment (high school or less, > high school), income to poverty ratio (< 1, 1+, missing), health insurance coverage (yes, no), number of healthcare visits in the past 12 months, BMI (< 30 kg/m^2, 30 + kg/m^2, missing), the number of antihyperglycemic medication used, and insulin use (yes, no; except when specified as the outcome)

Some LEP and immigrant populations might perceive DM not as a medical condition but as a moral shortcoming. These beliefs can obstruct lifestyle changes as well as disease self-management and healthcare providers who lack knowledge about cultural beliefs and practices may impede effective glycemic control. A study of DM perceptions among Chinese Americans found that the diagnosis was perceived as a punishment for actions performed in a past life.[45] Traditional Chinese medicine focuses on the body's harmony and its environment rather than a scientific and biomedical disease perception[46,47] and thus may contribute to delayed treatment for the rather asymptomatic DM condition. Adopting Western medical treatments may cause emotional stress for patients and reluctance in drug adherence due to the incongruence with their cultural belief system. Another study has shown that Spanish-dominant and bilingual Latinos were significantly more likely than their English-dominant counterparts to believe that diet, exercise, and weight would have only a little or no impact on their health.[48] These illustrative examples, mainly based on qualitative and ethnographic studies,[49] demonstrate possible cultural perspectives without indicating how common such beliefs may be. While these studies cannot be generalized across diverse immigrant populations, they should remind providers to remain attentive to individual cultural contexts in diabetes care.

Besides cultural perceptions of DM, new migrants to the US, including those with DM, face challenges in retaining the diet that they were used to in their countries of origin.[50] Contributing factors that make migrants switch to a Western diet ("dietary acculturation") and thus more unfavorable for glycemic control[51] include language barriers, limited financial resources, lack of mobility, and unavailability of suitable grocery stores ("food deserts").[52] Additionally, as migrants are often underinsured,[53,54] glucose monitoring as part of their DM management can be challenging and thus impeding glycemic control.[55]

Our study comes with several limitations. While we excluded participants who received DM diagnosis before the age of 18 and participants who solely use insulin, we cannot ascertain the type of DM. This study is based on NHANES data spanning from 2003 to 2018 and may not represent recent changes in DM trends among LEP populations, e.g., recent FDA approvals or warnings related to antihyperglycemic medications. The NHANES program was suspended in 2020 due to the COVID-19 pandemic, and the NHANES 2019–2020 data are not nationally representative, and no other data has been released since the pandemic. Furthermore, we used a pragmatic way to define LEP through interpretation service utilization for the respective NHANES interviews and thus cannot provide information on the proficiency level of the English language or provide stratified analyses on different language subgroups other than Spanish. Additionally, we were not able to assess if NHANES participants had access to language-concordant providers. While a strength of our study is the use of a large representative sample, NHANES is unlikely to have captured the large number of seasonal migrant workers in the US.

Despite these limitations, specific treatment formats in respective languages that focus on enhancing DM self-management and lifestyle changes, while actively considering cultural beliefs and practices, could lead to better DM outcomes among people with LEP.

Acknowledgements: *Not applicable*

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Funding *Open Access funding enabled and organized by Projekt DEAL. FM received funding as Peter C. and Pat Cook Endowed Clinical Research Fellow.*

Data Availability *All data analyzed for this manuscript are publicly available through the NHANES Study website (https://www.cdc.gov/nchs/nhanes/).*

Declarations:

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

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