Health Psychology

The Role of Acculturation in the Accuracy of Type 2 Diabetes Risk Perception: National Health and Nutrition Examination Survey 2011–2016

Ashley M. Splain and Tasneem Khambaty

Online First Publication, September 23, 2024. https://dx.doi.org/10.1037/hea0001402

Health Psychology

ISSN: 0278-6133
https://doi.org/10.1037/hea0001402

The Role of Acculturation in the Accuracy of Type 2 Diabetes Risk Perception: National Health and Nutrition Examination Survey 2011–2016

Ashley M. Splain and Tasneem Khambaty
Department of Psychology, University of Maryland, Baltimore County

Objective: High rates of undiagnosed Type 2 diabetes mellitus (T2DM) necessitate additional efforts to increase risk awareness, particularly among marginalized and immigrant populations. We examined the association of acculturation with the likelihood of accurate perception of T2DM risk in a large nationally representative sample of adults at risk for T2DM. ***Method:*** Participants were 5,034 adults, *M* (*SD*) age: 53 (23) years, 48% female. Acculturation was operationalized as length of time in the United States, and whether participants predominantly spoke English or their native language at home. Adults were considered to have accurate risk perception if they (a) met American Diabetes Criteria for prediabetes, and (b) self-reported their risk. ***Results:*** Less than half of the sample (33%) accurately perceived their T2DM risk. Logistic regression models adjusting for age, race, sex, education, insurance status, smoking, alcohol use, waist circumference, and family history of T2DM revealed that adults living in the United States up to 15 years were 1.35–2.33 times ($ps < .04$) as likely to inaccurately perceive their risk for T2DM compared to adults living in the United States >15 years and United States-born adults. Adults with lower versus higher English proficiency had a 41% ($p = .03$) increased likelihood of misperceiving their T2DM risk. ***Conclusions:*** Findings suggest that acculturation plays an important role in shaping T2DM risk perceptions among both nonimmigrant and immigrant populations. Increased cognizance of acculturation status (e.g., by healthcare providers) may be warranted to promote early T2DM risk detection and prevention at the population level.

Public Significance Statement
In the context of alarming rates of undiagnosed Type 2 diabetes mellitus (T2DM) and consequently, the need for early detection and accurate risk awareness, our study demonstrated that adults living in the United States up to 15 years were 1.35–2.33 times as likely to inaccurately perceive their T2DM risk compared to adults living in the United States >15 years and United States-born adults. Our findings emphasize the important role of acculturation in shaping T2DM risk perceptions among both nonimmigrant and immigrant populations and support health care providers taking into account varying levels of acculturation when communicating about T2DM risk.

Keywords: acculturation, risk perception, Type 2 diabetes, health beliefs, health disparities

Supplemental materials: https://doi.org/10.1037/hea0001402.supp

Despite increasing prevention and management efforts, Type 2 diabetes mellitus (T2DM) remains a public healthcare crisis—currently impacting 34.1 million adults in the United States. The prevalence of T2DM in racial/ethnic minorities as well as immigrants to the United States is particularly high, with T2DM prevalence among immigrants at 15.7% compared to 12.8% among those born in the United States (Guadamuz et al., 2020). The Centers for Disease Control and Prevention (2022) currently places rates of diagnosed T2DM across race/ethnic groups as follows: American Indians/Alaskan Natives: 14.5%, non-Hispanic Blacks: 12.1%, Hispanic/Latinos: 11.8%, Asian Americans: 9.5%, and non-Hispanic Whites: 7.4%. Even more alarming is the rate of undiagnosed T2DM where the condition remains undetected and untreated for a range of time after the initial onset of disease. Rates of undiagnosed T2DM currently range from 23.3% to 34.5% (Cowie, 2019), with higher rates, perhaps not surprisingly, observed among minority and immigrant communities. Data from the National Health and Nutrition Examination Survey (NHANES) indicate that foreign-born residents of the United

John M. Ruiz served as action editor.
Tasneem Khambaty https://orcid.org/0000-0003-0504-0805
We have no conflicts of interest to disclose.
Ashley M. Splain served as lead for data curation, formal analysis, resources, software, visualization, and writing–original draft. Tasneem Khambaty contributed equally to project administration and served in a supporting role for supervision, visualization, and writing–original draft. Ashley M. Splain and Tasneem Khambaty contributed equally to conceptualization, writing–review and editing, and methodology.
Correspondence concerning this article should be addressed to Tasneem Khambaty, Department of Psychology, University of Maryland, Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, United States. Email: khambaty@umbc.edu

States have 1.5 times higher odds of undiagnosed T2DM compared to those born in the United States (Hsueh et al., 2020). Undiagnosed T2DM is particularly detrimental to one's health given the increased risk for debilitating comorbidities and complications including retinopathy, neuropathy, nephropathy, ischemic heart disease, and atherosclerotic cerebrovascular disease. In fact, studies suggest that micro and macrovascular complications may arise 5–6 years before diagnosis (Harris et al., 1992; Ogurtsova et al., 2022). Findings from the Data Center for Strategic Research T2DM cohort revealed that 35% of individuals with undiagnosed T2DM had complications at the time of diagnosis (Gedebjerg et al., 2018). It is likely that this rate of undiagnosed T2DM and resulting complications is further exacerbated among groups with limited access to healthcare (Ogurtsova et al., 2022). To prevent these serious sequelae of undiagnosed T2DM and improve the quality of life of millions of adults in the United States, early detection and treatment are critical.

For earlier detection and treatment efforts to succeed, however, accurate awareness and understanding of one's risk for developing T2DM (i.e., accurate risk perception) is necessary. Risk perception refers to an individual's judgment of his or her likelihood of a health condition (Ferrer & Klein, 2015). Theories such as the health belief model support the idea that understanding one's risk for a disease is a necessary first step for the prevention and management of an illness (Becker, 1974). Individuals who accurately understand their risk are more likely to seek diagnostic information and engage in medical treatment (Janz & Becker, 1984). Not surprisingly, sizable literature has examined risk perception related to prediabetes and diabetes in various populations, mainly focusing on sociodemographic correlates that may help increase awareness and prevention efforts. Investigators have been particularly interested in understanding the role of risk perception among populations with high prevalence of T2DM such as racial and ethnic minorities and rural populations in the United States (Chopra & Chopra, 2017; Fukuoka & Oh, 2022). Generally speaking, individuals with a family history of T2DM, who are overweight or obese, or who are female commonly report a more accurate perception of T2DM risk (Khan et al., 2022; Wilkie et al., 2017). Some research has been conducted with regard to race/ethnicity and immigrant status, but the findings are mixed. Data from NHANES indicate that Mexican American, Asian, and other/multiracial groups generally showed better perception of T2DM risk compared to White Americans (Hsueh et al., 2019; Wilkie et al., 2017). However, other studies have found that African Americans and Hispanic Americans were significantly less likely to perceive themselves as being at risk for developing either diabetes or prediabetes compared to non-Hispanic Whites (Joiner et al., 2022). The only study of foreign-born individuals who immigrated to the United States found that immigrant status was associated with a lower perception of T2DM risk, over and above the effect of race/ethnicity (Hsueh et al., 2019). It remains unclear at this time how awareness and understanding of T2DM risk can be bolstered at the population level to promote early detection and treatment, which would help exponentially lower the $327 billion in T2DM-health care costs the United States spends annually (Centers for Disease Control and Prevention, 2022).

With minority and immigrant populations at especially high risk for undiagnosed T2DM, and literature presenting mixed findings between race-ethnicity and risk perception, acculturation may be one relevant construct of interest. Acculturation was first defined by anthropologists in the late 19th century as "phenomena which result when groups of individuals having different cultures come into continuous first-hand contact, with subsequent changes in the original cultural patterns of either or both groups" (Redfield et al., 1936). This definition underscores changes in both immigrants and nonimmigrants as a function of close contact, with both influencing one another's cultures, particularly in the context of global communication, and travel (Rudmin, 2003). The field of Psychology, often interested in individual experiences of acculturation, has recently focused on the role of acculturation in elucidating health disparities and related health outcomes due to its broad impact on a variety of biopsychosocial factors (Abraido-Lanza et al., 2006). In the context of T2DM risk perception for example, it is reasonable to hypothesize that acculturation (more time spent in the United States, and English proficiency) influences risk perception through better communication and engagement with the healthcare system, greater social capital and interactions with peers and neighbors, and increased engagement with American media and exposure to American ideals for health behaviors (Concha et al., 2013; Khan et al., 2022; Layne et al., 2023; Misra et al., 2021; Rodriguez-Alcalá et al., 2019).

Two of the most common approaches to measuring acculturation are (a) time spent in the United States and (b) the level of English spoken at home (Celenk & Van de Vijver, 2011). These proxy variables have been linked to changes in attitudes and behaviors that are outcomes of acculturation (Chesla et al., 2016; Diaz et al., 2012; Hubert et al., 2005; Jonnalagadda & Diwan, 2005; Steele et al., 2020), and are also commonly examined in relation to health outcomes (Moran et al., 2007; Pachipala et al., 2022; Yoshida & Fonseca, 2021). Indeed, prior literature has indicated that the incidence of T2DM and other cardiometabolic diseases increases as individuals spend more time in the United States, due to weight gain, a more sedentary lifestyle, and the American diet (Mainous et al., 2008; Venkatesh et al., 2017). However, longer time in the United States is also associated with better access to healthcare and increased healthcare utilization (Gorman et al., 2010; Jonnalagadda & Diwan, 2005), leading to better detection and treatment of disease.

While separate literatures have examined (a) risk perception related to prediabetes and diabetes, and (b) the role of acculturation in T2DM incidence, prevalence, and control, it remains unknown whether acculturation influences the perception of an individual's risk for T2DM. Having a better understanding of this association may be critical to improving screening and early intervention among at-risk populations, including those immigrating to the United States. Therefore, the objective of our study is to examine the independent association of acculturation with the likelihood of accurate risk perception among adults at risk for T2DM in a large representative sample of adults living in the United States.

Method

Sample and Procedure

The NHANES public use data files from 2011 to 2016 were examined. The NHANES continuous annual surveys, conducted by the National Center for Health Statistics and the Centers for Disease Control and Prevention, assess the health and nutritional status of a nationally representative sample of the civilian, noninstitutionalized U.S. population. A description of the survey design—a stratified, multistage, probability sample—is available online (https://www.cdc.gov/nchs/nhanes.htm). Low-income individuals, adolescents, older adults, and African and Mexican Americans were oversampled.

Participants first completed an interview in their homes. Additional interviews and examinations, including the diabetes laboratory and anthropomorphic measurements, were conducted in mobile examination centers after the home interview.

In total, 30,951 individuals participated in NHANES 2011–2016. Our analytic sample consisted of any individuals considered at risk for T2DM based on the American Diabetes Association criteria: fasting glucose (100–125 mg/dl), oral glucose tolerance tests (140–199 mg/dl), or Hemoglobin (Hb) A1c (5.7–6.4). Individual cases were excluded for missing sample weights and covariates. Our final sample consisted of 5,034 participants, of whom 1,615 participants self-reported immigrating to the United States.

Measures

T2DM Risk Perception

NHANES personnel conducted fasting plasma glucose, HbA1c, and oral glucose tolerance tests for all individuals 12 years and older who had been fasting for at least 9 hr. Individuals who were excluded from oral glucose tolerance testing included those with hemophilia and chemotherapy safety exclusions, women currently pregnant, those taking insulin, oral or injectable medications for diabetes, those self-reporting bariatric surgery, such as total or partial gastrectomy; and those fasting less than 9 hr, refusing phlebotomy or not drinking the entire Trutol™ solution within the allotted time. HbA1c data were analyzed using the Tosoh G8 HPLC SOP. Individuals considered at risk for T2DM were then classified as having accurate risk perception if they answered "yes" to the following question. "{Do you/Does SP} feel {you/he/she} could be at risk for diabetes or prediabetes?" Individuals who answered "no" to the previous question were considered to have inaccurate risk perception. This single-item measure has been widely applied in prior research to assess T2DM risk perception (Brown et al., 2017; Fukuoka & Oh, 2022; Joiner et al., 2022; Kim et al., 2007; Mainous et al., 2008).

Immigrant Status

Individuals who indicated if they were born in 50 United States states or Washington, DC were categorized as United States born. Individuals who reported that they were born in another country were categorized as foreign-born.

Acculturation

Acculturation was based on the following two measures: (a) the amount of time of English versus one's native language was spoken at home and (b) the amount of time spent in the United States. Both of these measures were included in order to capture multiple aspects of the acculturation experience and to determine whether time in the United States and exposure to American culture over time versus greater adaption to an aspect of American culture in the form of language converge in the relationship with T2DM risk perception.

Time in the United States. Individuals who were not born in the United States were asked how many years they had spent in the United States after immigration. In both the full analytic sample and the immigrant-only sample, 5-year intervals of time after immigration were examined, such that individuals were classified into five categories: living in the United States for $\leq$5, $>$5 to $\leq$10, $>$10 to $\leq$15, $>$15 years, or born in the United States (Iglesias-Rios et al., 2015).

Language Usage. Individuals were asked whether they spoke English or their native language predominantly at home. Individuals who reported speaking English $\geq$50% of the time, including those who reported speaking English and their native language equal amounts at home, were categorized as having high acculturation. Those who spoke their native language at least $>$50% of the time at home were categorized as having low acculturation. Based on prior analysis of language as a measure of acculturation, language was only examined among immigrants rather than among the full data set (Celenk & Van de Vijver, 2011).

Sociodemographic Variables

The following sociodemographic variables were included in analytic models: age (years), sex (0 = *female*; 1 = *male*), race (0 = *non-Hispanic White*, 1 = *Hispanic/Latino*, 2 = *non-Hispanic Black*, 3 = *non-Hispanic Asian*, 4 = *other race*) and education (less than ninth grade, ninth to 11th grade, high school diploma or general education diploma, some college or associate degree, and college graduate or above). The initial three categories were collapsed to create a three-level variable (0 $\leq$ *high school*, 1 = *some college*, and 2 = *college graduate or above*).

Clinical Variables

The following clinical variables were also included in analytic models due to their relevance to a T2DM diagnosis: current health insurance status (0 = *no*; 1 = *yes*), smoking status (0 = *never/former*, 1 = *current*), alcohol use (0 = *former/never*, 1 = *current*), waist circumference (measured in cm), and family history of T2DM (0 = *no*; 1 = *yes*). Waist circumference was measured to the nearest 0.1 cm at the end of normal expiration using a steel measuring tape which was placed at the high point of the iliac crest while the participant was in a standing position. Health insurance, smoking status, and alcohol use were assessed using self-report questionnaires collected during at-home interviews. Family history of T2DM was assessed by asking individuals if any of their biological relatives were ever told by a health professional that they had T2DM.

Statistical Analysis

We first examined nativity as our primary independent variable to understand the overall differences between immigrant and nonimmigrant status on T2DM risk perception (N = 5,034). Next, we conducted a series of logistic regression analyses in which time in the United States was analyzed as the independent variable (reference group: born in the United States), in conjunction with the following sociodemographic and clinical covariates: age, sex, education, race/ethnicity, smoking status, alcohol, and waist circumference. Model 2 further included: family history of T2DM and insurance status. This type of theory-based hierarchical covariate adjustment is helpful in evaluating the contribution of these two predictors above and beyond other sociodemographic and clinical covariates, as both demonstrate strong correlations with the likelihood of receiving a diagnosis of T2DM (Lewis, 2007). The reference group for the time in the United States was changed to obtain all estimated comparisons between time categories.

Third, analyses were conducted in a subsample of individuals who reported immigrating to the United States (N = 1,615). Here, both acculturation based on time in the United States (15+ years as the referent) and language use (English use $\geq$50% of the time

vs. native language >50% of the time) were examined as independent variables in separate models. Similar to the models utilizing the full sample, the first model included sociodemographic and clinical covariates, while the second model further included potentially confounding variables. All estimates from the logistic regression models were weighted using NHANES examination sample weights, which account for the complex survey design, survey nonresponse, and post-stratification, thereby yielding estimates representative of the U.S. civilian, noninstitutionalized population. SAS statistical software (Version 9.3) was used for all analyses.

Results

Participant Descriptive Statistics

Table 1 presents descriptive statistics for all demographic and clinical variables according to the accuracy of risk perception. In the full sample of adults at risk for T2DM ($N = 5,034$), the average age of participants was 53 years ($SD = 23.41$) and roughly half (48%) were female. Race and ethnicity were representative of the United States at the time of the assessment given the NHANES sample design. Roughly 40% of the sample had a high school degree and 30% received some college education. Approximately 80% were born in the United States. In line with the passing of the Affordable Care Act in 2008, 84% of participants reported having current health insurance. More than half of the participants reported having consumed alcohol at some point in their lifetime (67%) and 20% reported being current smokers. The average waist circumference for both males and females was above the cutoff for obesity (males: 104.33 cm; females: 101.56 cm), and 40% reported having a family history of T2DM. NHANES data from 1999 to 2004 indicated that 32.5% of adults had a family history of T2DM (Valdez et al., 2007), while 2009–2014 data indicated a prevalence of 36.70% (Moonesinghe et al., 2018). Our prevalence rate from 2011 to 2016

Table 1
Sociodemographic Characteristics (N = 5,034)

Variable	Full sample	Perception of T2DM risk[a]		
		Accurate perception ($N = 1,683$)	Inaccurate perception ($N = 3,351$)	p
Age, *M* (*SD*)	52.99 (23.41)	51.13 (39.02)	53.94 (29.09)	<.001
Gender				<.001
Male	2,583 (51%)	749 (29%)	1,834 (71%)	
Female	2,451 (48%)	956 (39%)	1,495 (61%)	
Race				.32
Non-Hispanic White	3,287 (65%)	1,118 (34%)	2,169 (66%)	
Non-Hispanic Black	719 (12%)	266 (37%)	452 (63%)	
Hispanic/Latino	608 (14%)	207 (34%)	401 (66%)	
Non-Hispanic Asian	269 (5%)	83 (31%)	186 (69%)	
Other race	143 (3%)	53 (37%)	90 (63%)	
Education				.02
High school	1,967 (39%)	610 (31%)	1,357 (69%)	
Some college	1,573 (31%)	566 (36%)	1,007 (64%)	
College	1,493 (30%)	537 (36%)	956 (64%)	
Insurance status				.13
Yes	4,245 (84%)	1,486 (35%)	2,759 (65%)	
No	788 (16%)	244 (31%)	543 (69%)	
Smoking				.41
Former/never	1,270 (27%)	(33%)	(67%)	
Current	1,024 (20%)	(36%)	(64%)	
Alcohol				.15
Former/never	879 (15%)	(37%)	(63%)	
Current	3,076 (67%)	(34%)	(66%)	
Waist circumference (cm)	102.99 (26.96)	107.73 (39.02)	100.53 (29.80)	<.001
Male	104.33 (30.51)	108.67 (53.21)	102.55 (32.64)	<.001
Female	101.56 (33.35)	107.00 (45.41)	98.05 (39.73)	<.001
Family history of T2DM				<.001
Yes	1,990 (40%)	1,114 (56%)	856 (43%)	
No	3,044 (60%)	1,578 (19%)	2,466 (81%)	
Immigrant status				<.001
Born in the United States	3,419 (68%)	1,197 (35%)	2,222 (65%)	
Foreign born	1,615 (32%)	452 (28%)	1,163 (72%)	
Time in the United States, years				<.001
≤5	91 (2%)	18 (20%)	73 (80%)	
>5 to ≤10	96 (2%)	25 (26%)	71 (74%)	
>10 to ≤15	159 (3%)	37 (23%)	122 (77%)	
>15	586 (12%)	182 (31%)	404 (69%)	
Born in the United States	4,102 (81%)	1,436 (35%)	2,666 (65%)	

Note. T2DM = Type 2 diabetes mellitus.
[a] Participants were considered to have accurate risk perception if they (a) met American Diabetes Criteria for prediabetes, and (b) self-reported being at risk for T2DM.

NHANES data (40%) is likely skewed higher due to our sample being limited to those at risk for T2DM but remains in line with the increase in rates of T2DM over the last decade. Overall, about one-third (32%) of our sample participants reported that they were born outside of the United States. Of these individuals, 12% were living in the United States for >15 years, 3% were living in the United States for >10 to ≤15 years, 2% were living in the United States for >5 to ≤10 years, and 2% were living in the United States for ≤5 years. Among the 1,615 participants who endorsed being immigrants to the United States, approximately two-thirds (63%) of immigrants were living in the United States for >15 years, 17% for >10 to ≤15 years, 10% for >5 to ≤10 years, and 10% for ≤5 years. In this subsample, 64% endorsed speaking English ≥50% of the time at home.

Sociodemographic and Clinical Factors by Accuracy of Risk Perception

As seen in Table 1, approximately two-thirds of the full sample (67%) inaccurately perceived their risk for developing T2DM. These individuals tended to be older than those who accurately reported their T2DM risk (M_{age}: 54 vs. 51 years, $p < .001$), and were more likely to be men (71%) than women (61%; $p < .001$). Across race/ethnicity, inaccurate risk perception was highest among non-Hispanic Asians (69%), followed by non-Hispanic Whites (66%), Hispanic/Latinos (66%), non-Hispanic Blacks (63%), and finally, multiracial respondents (63%); however, these differences were not statistically significant ($p = .32$). Education levels appeared to be a good indicator of accuracy of risk perception: inaccurate risk perception was highest among those with a high school education or less (69%) and lowest among those with a college degree or higher (64%; $p = .02$). Additionally, individuals that reported being born in the United States (35%) versus outside the United States (28%) were more likely ($p < .001$) to have an accurate T2DM risk perception. Clinically, among both men and women, individuals who accurately versus inaccurately perceived their T2DM risk had higher waist circumferences (men: 108.67 vs. 102.55 cm, $p < .001$; women: 107.00 vs. 98.05 cm, $p < .001$) and were more likely to have a family history of T2DM (56% vs. 43%).

Table 2 presents sociodemographic and clinical characteristics of the subsample of participants who reported immigrating to the United States, according to the accuracy of risk perception. A large proportion of immigrants (72%) inaccurately perceived their risk for developing T2DM. Similar to the full sample, rates of inaccurate risk perception were greater for men (75% vs. 69% women, $p < .001$), those with a lower waist circumference ($p < .001$), and those without a family history of T2DM ($p < .001$). Indicative of the consistent predictive utility of education, immigrants with lower levels of education were more likely to inaccurately perceive their risk for T2DM (74% among those with a high school education or less vs. 67% among those with a college degree or higher, $p = .02$).

Immigration Status and T2DM Risk Perception

Foreign-born individuals were 1.48 (95% confidence interval [CI] [1.13–1.94]) times as likely to inaccurately perceive their T2DM risk compared to those born in the United States (see Table S1 in the online supplemental materials). In this model, higher age (odds ratio, $OR = 1.02$, 95% CI [1.01, 1.02]), male gender, ($OR = 1.92$, 95% CI [1.60, 2.29]), high school or lower education ($OR = 1.39$, 95% CI [1.17, 1.65]), and lower waist circumference ($OR = 0.97$, 95% CI [0.96, 0.98]) were all associated with increased odds of inaccurate risk perception. When further adjusting for insurance status and family history of T2DM (Model 2), foreign-born individuals remained at high risk ($OR =$ 1.32, 95% CI [0.97, 1.80]) of inaccurately perceiving their T2DM risk, but the *OR* fell just short of significance.

Time in the United States and T2DM Risk Perception

Evaluating time in the United States among the full sample, and adjusting for demographic (age, sex, education, and race/ethnicity) and clinical (smoking status, alcohol, and waist circumference) factors (Model 1; Table 3), individuals living in the United States ≤5 years were 2.72 (95% CI [1.40, 5.27]) times as likely to inaccurately perceive their T2DM risk compared to those born in the United States and 2.17 (95% CI [1.16, 4.04]) times as likely than those living in the United States >15 years. Individuals living in the United States for >5 to ≤10 years had 1.70 (95% CI [1.16, 2.48]) times the odds of inaccurately perceiving T2DM risk compared to United States-born individuals, and 1.35 times the odds of inaccurate risk perception compared to those living in the United States >15 years, although this *OR* fell slightly below significance level (95% CI [0.98, 1.87]). Even adults living in the United States >10 to ≤15 years had increased odds of inaccurate risk perception by 2.12 (95% CI [1.39, 3.21]) times compared to those United States born, and by 1.69 (95% CI [1.18, 2.41]) times compared to those in those living in the United States >15 years. In these models, higher age ($OR = 1.02$, 95% CI [1.01, 1.02]), male gender, ($OR =$ 1.92, 95% CI [1.60, 2.29]), high school or lower education ($OR =$ 1.39, 95% CI [1.17, 1.65]), and lower waist circumference ($OR =$ 0.97, 95% CI [0.97, 0.98]) were all associated with increased odds of inaccurate risk perception. Individuals identifying as Hispanic/Latino ($OR = 0.75$, 95% CI [0.59, 0.95]) and non-Hispanic Asian ($OR = 0.56$, 95% CI [0.40, 0.79]) were more likely to accurately perceive their T2DM risk compared to non-Hispanic Whites. When further adjusting for insurance status and family history of T2DM (Model 2), individuals living in the United States ≤5 and >10 to ≤15 years remained more likely to inaccurately perceive their T2DM risk compared to those born in the United States ($OR =$ 2.33, 95% CI [1.09, 4.99]; $OR = 1.92$, 95% CI [1.19, 3.09]) and those living in the United States >15 years ($OR = 2.04$, 95% CI [1.03, 4.07], $OR = 1.68$, 95% CI [1.12, 2.51]). However, the *OR*s for those living in the United States >5 to ≤10 years fell short of significance (compared to United States-born adults: $OR = 1.44$, 95% CI [0.94, 2.23]; compared to adults >15 years: $OR = 1.27$, 95% CI [0.88, 1.82]), likely due to the small sample size in this category. In these models, having a family history of T2DM was linked to participants being 80% more likely to accurately perceive their T2DM risk ($OR = 0.20$, 95% CI [0.20, 0.24]), while current insurance status did not appear to be associated ($OR = 1.20$, 95% CI [0.94, 1.55]). In Model 2, non-Hispanic Asians ($OR = 0.60$, 95% CI [0.43, 0.0.85]), but not Hispanic/Latino groups were more likely to accurately perceive their T2DM risk ($OR = 0.60$, 95% CI [0.43, 0.0.85]) compared to non-Hispanic Whites.

When examining time in the United States in the immigrant sample (Table 4), we observed a similar pattern of results as the full

Table 2
Sociodemographic Characteristics of the Immigrant Subsample (N = 1,615)

Variable	Full sample	Perception of T2DM risk[a]		
		Accurate perception (N = 451)	Inaccurate perception (N = 1,164)	p
Age, *M* (*SD*)	48.53 (24.11)	47.74 (32.15)	48.84 (27.73)	.23
Gender				<.001
Male	872 (54%)	218 (25%)	654 (75%)	
Female	759 (46%)	235 (31%)	523 (69%)	
Race				.32
Non-Hispanic White	242 (15%)	48 (20%)	194 (80%)	
Non-Hispanic Black	109 (7%)	29 (27%)	80 (73%)	
Hispanic/Latino	825 (51%)	239 (29%)	586 (71%)	
Non-Hispanic Asian	411 (25%)	119 (29%)	292 (71%)	
Other race	27 (2%)	10 (37%)	17 (63%)	
Education				.02
High school	834 (52%)	217 (26%)	617 (74%)	
Some college	325 (20%)	85 (26%)	240 (74%)	
College	455 (28%)	150 (33%)	305 (67%)	
Insurance status				.12
Yes	1,097 (68%)	340 (31%)	757 (69%)	
No	518 (32%)	114 (22%)	404 (78%)	
Smoking				.40
Former/never	349 (22%)	(26%)	(74%)	
Current	190 (13%%)	(20%)	(80%)	
Alcohol				.15
Former/never	222 (12%)	(31%)	(69%)	
Current	829 (57%)	(28%)	(72%)	
Waist circumference (cm)	97.93 (19.29)	101.45 (27.73)	96.56 (22.51)	<.001
Male	99.72 (26.93)	103.34 (45.82)	98.52 (30.54)	<.001
Female	95.84 (24.11)	99.72 (37.78)	94.06 (25.72)	<.001
Family history of T2DM				<.001
Yes	569 (35%)	290 (51%)	279 (49%)	
No	1,046 (65%)	167 (16%)	879 (84%)	
Time in the United States, years				<.001
≤5	148 (10%)	30 (20%)	118 (80%)	
>5 to ≤10	164 (10%)	43 (26%)	121 (74%)	
>10 to ≤15	242 (17%)	56 (23%)	186 (77%)	
>15	1,061 (63%)	329 (31%)	732 (69%)	
Language usage				<.001
Speaking native language >50% time	1,039 (64%)	260 (25%)	779 (75%)	
Speaking English ≥50% of time	576 (36%)	184 (32%)	392 (68%)	

Note. T2DM = Type 2 diabetes mellitus.
[a] Participants were considered to have accurate risk perception if they (a) met American Diabetes Criteria for prediabetes, and (b) self-reported being at risk for T2DM.

sample. Specifically, individuals living in the United States ≤5 years and >10 to ≤15 years had 2.11 times and 1.67 times the odds of inaccurately perceiving their risk for T2DM, respectively, compared to immigrants living in the United States >15 years (≤5 years: *OR* = 2.11, 95% CI [1.07, 4.13]; >10 to ≤15 years: *OR* = 1.67, 95% CI [1.12, 2.48]). The *OR* for those in the United States >5 to ≤10 years was similarly elevated but fell just short of significance (*OR* = 1.41, 95% CI [1.00, 1.99]). Older age (*OR* = 1.01, 95% CI [1.01, 1.02]), male gender (*OR* = 1.72, 95% CI [1.23, 2.39]), high school or lower education (*OR* = 1.97, 95% CI [1.38, 2.82]), and lower waist circumference (*OR* = 0.96, 95% CI [0.95, 0.98]) remained factors that increased the odds of inaccurate risk perception among immigrants. Again, Hispanic/Latino (*OR* = 0.40, 95% CI [0.19, 0.84]) and non-Hispanic Asian (*OR* = 0.36, 95% CI [0.16, 0.79]) groups were more likely to accurately perceive their risk for T2DM compared to non-Hispanic Whites. Further adjustment for family T2DM history and insurance status did not modify this pattern of results except that the *OR* for the ≤5 years category fell short of significance, despite a similar magnitude of effect (*OR* = 1.86, 95% CI [0.91, 3.81]); again, smaller cell sizes may have contributed to underpowered analyses; roughly 10% of the sample was in the ≤5 years category. Among immigrants, both T2DM family history (*OR* = 0.19, 95% CI [0.14, 0.26]) and insurance status (*OR* = 1.54 95% CI [1.04, 2.29]) were significant predictors of T2DM risk perception. In this sample, differences between either Hispanic/Latino (*OR* = 0.39, 95% CI [0.18, 0.87]) or non-Hispanic Asian (*OR* = 0.37, 95% CI [0.16, 0.87]) groups and non-Hispanic Whites on T2DM risk perception remained significant after further adjustment.

Language Usage and T2DM Risk Perception

When considering acculturation based on the use of one's native versus English language at home (Table 5), immigrants primarily speaking their native language had 54% (95% CI [1.11, 2.14]) increased odds of inaccurate risk perception. Male gender (*OR* =

Table 3
Logistic Regression Models Depicting Odds of Inaccurate T2DM Risk Perception According to Time Spent in the United States (N = 5,034)

Variable	Model 1[a]		Model 2[b]	
	OR	95% CI	*OR*	95% CI
Time in the United States				
Born in the United States	Reference	Reference	Reference	Reference
≤5	2.72	[1.40, 5.27]*	2.33	[1.09, 4.99]*
>5 to ≤10	1.70	[1.16, 2.48]*	1.44	[0.94, 2.23]
>10 to ≤15	2.12	[1.39, 3.21]*	1.92	[1.19, 3.09]*
>15	1.26	[0.95, 1.65]	1.14	[0.83, 1.56]
Age	1.01	[1.01, 1.02]*	1.01	[1.01, 1.20]*
Gender				
Male	1.92	[1.60, 2.29]*	1.69	[1.39, 2.07]*
Race				
Non-Hispanic White	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.90	[0.76, 1.08]	1.06	[0.89, 1.25]
Hispanic/Latino	0.75	[0.59, 0.95]*	0.84	[0.65, 1.07]
Non-Hispanic Asian	0.56	[0.40, 0.79]*	0.60	[0.43, 0.85]*
Other race	0.90	[0.52, 1.56]	1.02	[0.57, 1.81]
Education				
High school	1.39	[1.17, 1.65]*	1.43	[1.18, 1.74]*
Some college	1.23	[0.99, 1.51]	1.21	[0.96, 1.53]
College or higher	Reference	Reference	Reference	Reference
Smoking				
Current	0.87	[0.63, 1.19]	0.87	[0.62, 1.23]
Alcohol				
Current	1.18	[0.95, 1.48]	1.19	[0.95, 1.50]
Waist circumference (cm)	0.97	[0.96, 0.98]*	0.97	[0.97, 0.98]*
Insurance status				
No			1.20	[0.94, 1.55]
Family history of T2DM				
Yes			0.20	[0.20, 0.24]*

Note. T2DM = Type 2 diabetes mellitus; CI = confidence interval.
[a] Model 1 adjusts for age, gender, self-identified race, education, smoking status, alcohol use, and waist circumference. [b] Model 2 adjusts for all covariates in Model 1, and additionally for insurance status and family history of T2DM.
* $p < .05$.

1.66, 95% CI [1.18, 2.35]), high school or lower education, (*OR* = 1.76, 95% CI [1.23, 2.52]), and lower waist circumference (*OR* = 0.96, 95% CI [0.95, 0.97]) were associated with increased odds of inaccurate risk perception. When further adjusting for insurance status and T2DM family history, native language use versus use of English at home remained strongly associated with a 41% increased odds of inaccurate risk perception (*OR* = 1.41, 95% CI [1.04, 1.92]), although having a family history of T2DM was a buffer against poor risk perception (*OR* = 0.19, 95% CI [0.14, 0.26]). Not having current insurance increased the odds of inaccurate perception by 58% among our immigrant sample (*OR* = 1.58, 95% CI [1.07, 2.35]). Consistent with the results for time in the United States, Hispanic/Latino (*OR* = 0.35, 95% CI [0.16, 0.78]) and non-Hispanic Asian (*OR* = 0.36, 95% CI [0.15, 0.83]) groups remained more likely to accurately perceive their risk for T2DM compared to non-Hispanic Whites after further adjustment.

Discussion

In this nationally representative sample, foreign-born individuals were 1.32 (95% CI [0.97, 1.80]) times as likely to inaccurately perceive their T2DM risk compared to those born in the United States. Adults living in the United States up to 15 years were 1.35–2.33 times as likely to inaccurately perceive their risk for T2DM compared to adults living in the United States >15 years and United States-born adults even after adjusting for key sociodemographic and clinical factors associated with risk perception. Adults who immigrated to the United States were similarly 1.29–1.86 times as likely to misperceive their T2DM risk in their first 15 years after immigration compared to those living in the United States for 15 or more years. In these models, adjustment for family history of T2DM and insurance status attenuated the magnitude of these effects, indicating the strong influence of these factors on risk perception. With regard to acculturation based on language use, adults speaking a native language at home ≥50% of the time had a 41% increased likelihood of misperceiving their T2DM risk compared to immigrants who reported predominantly speaking English at home. With strong implications for public health and disease prevention, our analyses revealed that among the immigrant, but not the full sample, insurance status was a strong contributor to risk perception, with individuals without current health insurance being 58% more likely to misperceive their T2DM risk than those with current health insurance. Findings related to race/ethnicity indicated that both Asian and Hispanic communities, who are known to be at high T2DM risk, consistently demonstrated better T2DM risk perception compared to non-Hispanic Whites. Of note, this pattern emerged in

Table 4
Logistic Regression Models Depicting Odds of Inaccurate T2DM Risk Perception According to Time Spent in the United States in the Immigrant Subsample (N = 1,615)

	Model 1[a]		Model 2[b]	
Variable	*OR*	95% CI	*OR*	95% CI
Time in the United States, years				
>15	Reference	Reference	Reference	Reference
≤5	2.11	[1.07, 4.13]*	1.86	[0.91, 3.81]
>5 to ≤10	1.41	[1.00, 1.99]	1.29	[0.86, 1.92]
>10 to ≤15	1.67	[1.12, 2.48]*	1.57	[1.03, 2.42]*
Age	1.01	[1.01, 1.02]*	1.01	[1.00, 1.02]
Gender				
Male	1.72	[1.23, 2.39]*	1.56	[1.10, 2.22]*
Race				
Non-Hispanic White	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.50	[0.19, 1.31]	0.53	[0.20, 1.42]
Hispanic/Latino	0.40	[0.19, 0.84]*	0.39	[0.18, 0.86]*
Non-Hispanic Asian	0.36	[0.16, 0.79]*	0.37	[0.16, 0.87]*
Other race	0.30	[0.07, 1.31]	0.32	[0.08, 1.35]
Education				
High school	1.97	[1.38, 2.82]*	1.70	[1.15, 2.50]*
Some college	1.65	[0.98, 2.71]	1.44	[0.86, 2.41]
College or higher	Reference	Reference	Reference	Reference
Smoking				
Current	1.33	[0.78, 2.24]	1.45	[0.80, 2.65]
Alcohol				
Current	1.13	[0.82, 1.57]	1.11	[0.76, 1.62]
Waist circumference (cm)	0.96	[0.95, 0.98]*	0.96	[0.95, 0.98]*
Insurance status				
No			1.54	[1.04, 2.29]*
Family history of T2DM				
Yes			0.19	[0.14, 0.26]*

Note. T2DM = Type 2 diabetes mellitus; CI = confidence interval.
[a] Model 1 adjusts for age, gender, self-identified race, education, smoking status, alcohol use, and waist circumference. [b] Model 2 adjusts for all covariates in Model 1, and additionally adjusts for insurance status and family history of T2DM.
* $p < .05$.

models separately considering either proxy measure of acculturation—time in the United States, or language proficiency. Overall, examining acculturation based on (a) time spent in the United States and (b) frequency of English spoken at home yielded converging evidence that adults in lower versus higher acculturation categories were more likely to have low awareness of their T2DM risk. To our knowledge, this study represents the first attempt to combine separate literatures on (a) acculturation, and (b) risk perception in T2DM to begin to answer the question: How do individuals with higher or lower levels of acculturation perceive their risk for T2DM?

One prior study examined the associations of immigrant status and race/ethnicity with T2DM risk perception among adults in the United States without T2DM. Hsueh et al. (2019) found that foreign-born individuals are less likely than United States-born individuals to accurately perceive their T2DM risk. By examining immigration in a more nuanced manner, our study extends these findings to show that in the first 15 years after immigration, adults continue to show low awareness of T2DM risk. While studies specifically investigating T2DM risk perception are scarce, our findings are also consistent with literature that has examined acculturation and perceived risk for other chronic diseases and related health behaviors. In the case of smoking risk and cessation, a study surveying Bosnian refugees living in central Pennsylvania showed that greater acculturation as measured by a seven-item scale, was associated with a better perception of the risk of heart attack and lung cancer for smokers (Helweg-Larsen & Stancioff, 2008). In another study recruiting 615 Latino and non-Latino White smokers, acculturation based on English proficiency was linked to higher awareness of the risks of continuing smoking, and of the benefits of smoking cessation (Bock et al., 2005). However, another study found a contradicting pattern of results in that individuals with less acculturation were less likely to underestimate their 10-year risk of cardiovascular disease (Diaz et al., 2012). These variable findings are possible given the variability in the measurement of acculturation across studies, along with different sample characteristics such as ethnicity and country of origin.

In addition to acculturation, higher age, male gender, high school, or lower education, lower waist circumference, and a family history of T2DM were robust contributors to risk perception in the current study. Of notable interest, a high school or lower level of education was associated with a 39% increased likelihood of inaccurate risk perception in the full sample, and an alarming 97% increased likelihood in the immigrant sample. Consistent with these findings, prior literature has indicated that the accuracy of risk perception increases as adults earn a college degree (Chopra & Chopra, 2017; Mainous et al., 2019). Conversely, having a family history, and a higher waist circumference were associated with a higher likelihood of accurate perception of risk across all measures of acculturation and both within the full and immigrant samples. It is possible that these

Table 5

Logistic Regression Models Depicting Odds of Inaccurate T2DM Risk Perception According to Language Use in the Immigrant Subsample (N = 1,615)

Variable	Model 1[a]		Model 2[b]	
	OR	95% CI	*OR*	95% CI
Language usage				
Speaking native language > 50% time	1.54	[1.11, 2.14]*	1.41	[1.04, 1.92]*
Age	1.01	[0.98, 1.01]	1.00	[0.99, 1.02]
Gender				
Male	1.66	[1.18, 2.35]*	1.51	[1.04, 2.20]*
Race				
Non-Hispanic White	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.50	[0.20, 1.29]	0.54	[0.21, 1.40]
Hispanic/Latino	0.35	[0.17, 0.75]*	0.35	[0.16, 0.78]*
Non-Hispanic Asian	0.34	[0.15, 0.75]*	0.36	[0.15, 0.83]*
Other race	0.27	[0.06, 1.18]	0.30	[0.07, 1.29]
Education				
High school	1.76	[1.23, 2.52]*	1.55	[1.04, 2.31]*
Some college	1.60	[0.97, 2.63]	1.40	[0.84, 2.34]
College or higher	Reference	Reference	Reference	Reference
Smoking				
Current	1.33	[0.77, 2.30]	1.46	[0.80, 2.68]
Alcohol				
Current	1.13	[0.81, 1.59]	1.12	[0.76, 1.65]
Waist circumference (cm)	0.96	[0.95, 0.97]*	0.96	[0.95, 0.98]*
Insurance status				
No			1.58	[1.07, 2.35]*
Family history of T2DM				
Yes			0.19	[0.14, 0.26]*

Note. T2DM = Type 2 diabetes mellitus; CI = confidence interval.
[a] Model 1 adjusts for age, gender, self-identified race, education, smoking status, alcohol use, and waist circumference. [b] Model 2 adjusts for all covariates in Model 1, and additionally adjusts for insurance status and family history of T2DM.
* $p < .05$.

factors serve as visual reminders of health, thereby increasing awareness of one's risk for diabetes. These findings are in line with prior studies showing that a family history of diabetes, a higher body mass index, along with having additional health concerns, or worse self-rated health are linked to a more accurate perception of T2DM risk (Khan et al., 2022; Misra et al., 2021).

Multiple psychosocial and behavioral factors may mediate the perception of T2DM risk observed in the current report based on acculturation status. Above and beyond education (for which we controlled in our analyses), higher levels of acculturation are likely to influence factors such as health literacy, which in turn impact awareness and perception of risk for chronic diseases such as T2DM. For instance, higher levels of acculturation were associated with better numeracy skills and diabetes education among Spanish speakers (Miller De Rutté & Barrie, 2022). Adoption of English primarily for communication may also increase the ease of communication about health (e.g., with the health care system). In turn, diabetes-related, or overall health-related knowledge increases awareness of risk (Chopra & Chopra, 2017; Khan et al., 2022; Misra et al., 2021). Second, higher acculturation and greater health literacy may also lead to greater efficacy in managing one's health (Pérez, 2015; Sagong & Yoon, 2021). Studies show that lower acculturation is linked to greater fear, and display of an external locus of control with regard to health, constructs often associated with low-risk perception (Edelman et al., 2009). Thus, it is possible that greater time spent in the United States, and greater English proficiency improve self-efficacy and awareness of disease risk. Finally, higher acculturation in the form of more time spent in the United States may also lead individuals who were not born in the United States to accumulate more social capital (Concha et al., 2013; Rodriguez-Alcalá et al., 2019), including more positive and trusting neighborhood relationships, which have been shown to be associated with increased knowledge and perception of disease risk (Layne et al., 2023). At the same time, more time spent in the United States often exposes individuals to American ideals for health behaviors through mass media, television, and other outlets. The foci of these outlets on diet trends and leisure exercise may provide greater awareness of health and understanding of disease prevention. Together, acculturation may work to increase the accuracy of disease risk perception through these sociocultural factors.

Among the study's strengths are a large nationally representative sample of adults living in the United States with a good representation of individuals who immigrated to the United States. With regard to T2DM risk perception, we were able to combine biomedical data on T2DM risk with survey data on perceptions of health to better assess the accuracy of risk perception. With regard to acculturation, we were able to examine two distinct measurements (i.e., time spent in the United States, and language proficiency), to understand whether these distinct assessments converge on risk perception. However, the limitations of the study also warrant discussion. First, NHANES data did not allow for more in-depth assessments of acculturation based on cultural values or behaviors. Our acculturation measures are good proxies, but cannot perfectly capture a complex process such as

acculturation. For instance, language usage may be limited as a proxy for acculturation for the small number of foreign-born individuals immigrating from another English-speaking country. Our dichotomous operationalization of acculturation (high vs. low) is also somewhat crude, and future studies are needed to examine language proficiency in a more nuanced manner across and within immigrant groups. Second, limitations in the data collected prohibited the examination of potential mediators such as health literacy, or a more in-depth analysis of health care access and utilization. Finally, as only cross-sectional data were available, we were unable to examine the influence of acculturation on risk perception over time or the link between risk perception and future prevention of disease. Future studies should apply longitudinal models to understand these important linkages, moving toward a consensus for measuring acculturation to allow for comparisons across studies. Given the diversity among and between minority groups at higher risk for T2DM, there is also a critical need to understand nuances in both acculturation and risk perception among different immigrant groups and race–ethnicities to gain a better understanding of how perceptions around T2DM risk may develop, change, and influence prevention and management, and develop targeted interventions to improve risk perception in high-risk populations.

In conclusion, our findings suggest that acculturation plays an important role in shaping T2DM risk perceptions among both nonimmigrant and immigrant populations. Based on our and other similar findings, implications for clinical practice are worth considering. First, public health efforts are needed to improve risk communication in the area of T2DM (Joiner et al., 2022). Efforts to directly increase individuals' awareness of their current risk status are an important aspect of health promotion that encourages the adoption of healthy behaviors. Incorporating acculturation may help to better focus these efforts to increase risk communication and risk detection—via tools such as the American Diabetes Association's Diabetes Risk Test (Lindstrom & Tuomilehto, 2003)—especially among minority and immigrant groups. Thus, screening and preventive services can increase applicability to target populations. Finally, acculturation is a factor that requires additional attention by providers in health care settings, such that communication around health promotion and disease prevention takes into account varying levels of acculturation. An increased overall cognizance of acculturation status is warranted to bolster awareness and understanding of T2DM risk at the population level and to promote early detection and prevention efforts.

Resumen

Objetivo: Las altas tasas de diabetes tipo 2 (T2DM, por sus siglas en inglés) no diagnosticadas requieren esfuerzos adicionales para aumentar la conciencia sobre los riesgos, particularmente entre las poblaciones marginadas e inmigrantes. Examinamos la asociación de la aculturación con la probabilidad de una percepción precisa del riesgo de T2DM en una gran muestra representativa a nivel nacional de adultos con riesgo de T2DM. ***Métodos:*** Los participantes fueron 5,034 adultos (edad media (DE): 53 (23) años, 48% mujeres). La aculturación se puso en práctica como el tiempo en los EE. UU. y si los participantes hablaban predominantemente inglés o su lengua materna en casa. Se consideró que los adultos tenían una percepción precisa del riesgo si (a) cumplían con los criterios estadounidenses de diabetes para la prediabetes y (b) informaban ellos mismos su riesgo. ***Resultados:*** Menos de la mitad de la muestra (33%) percibió con precisión su riesgo de T2DM. Los modelos de regresión logística que ajustaban por edad, raza, sexo, educación, estado de seguro, tabaquismo, consumo de alcohol, circunferencia de la cintura y antecedentes familiares de T2DM revelaron que los adultos que vivieron en los EE. UU. hasta los 15 años tenían entre 1.35 a 2.33 veces ($ps < .04$) la probabilidad de percibir de manera inexacta su riesgo de T2DM en comparación con los adultos que viven en los EE. UU. >15 años y los adultos nacidos en los EE. UU. Los adultos con un dominio del inglés más bajo versus más alto tenían 41% ($p = .03$) mayor probabilidad de percibir erróneamente su riesgo de T2DM. ***Conclusiones:*** Los hallazgos sugieren que la aculturación juega un papel importante en la configuración de las percepciones de riesgo de T2DM entre las poblaciones inmigrantes y no inmigrantes. Puede estar justificado un mayor conocimiento del estado de aculturación (p. ej., por parte de los proveedores de atención médica) para promover la detección temprana del riesgo de T2DM y la prevención a nivel de la población.

References

Abraido-Lanza, A. F., Armbrister, A. N., Florez, K. R., & Aguirre, A. N. (2006). Toward a theory-driven model of acculturation in public health research. *American Journal of Public Health*, *96*(8), 1342–1346. https://doi.org/10.2105/AJPH.2005.064980

Becker, M. H. (1974). The health belief model and personal health behavior. *Health Education Monographs*, *2*(4), 324–473. https://doi.org/10.1177/109019817400200401

Bock, B. C., Niaura, R. S., Neighbors, C. J., Carmona-Barros, R., & Azam, M. (2005). Differences between Latino and non-Latino White smokers in cognitive and behavioral characteristics relevant to smoking cessation. *Addictive Behaviors*, *30*(4), 711–724. https://doi.org/10.1016/j.addbeh.2004.08.017

Brown, S. D., Grijalva, C. S., & Ferrara, A. (2017). Leveraging EHRs for patient engagement: Perspectives on tailored program outreach. *The American Journal of Managed Care*, *23*(7), Article e223. https://pubmed.ncbi.nlm.nih.gov/28850790/

Celenk, O., & Van de Vijver, F. J. R. (2011). Assessment of acculturation: Issues and overview of measures. *Online Readings in Psychology and Culture*, *8*(1), 2–16. https://doi.org/10.9707/2307-0919.1105

Centers for Disease Control and Prevention. (2022). *National diabetes statistics report*. Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services.

Chesla, C. A., Chun, K. M., Kwong, Y., Gay, C. L., Chi, H. L., Gu, Y., Hernandez, L., Huang, P., Strycker, L. A., & Ma, J. (2016). Cultural adaptation of the group lifestyle balance program for Chinese Americans. *The Diabetes Educator*, *42*(6), 686–696. https://doi.org/10.1177/0145721716666679

Chopra, I., & Chopra, A. (2017). Risk perception for diabetes in Appalachian women. *Women & Health*, *57*(5), 534–550. https://doi.org/10.1080/03630242.2016.1176100

Concha, M., Sanchez, M., Rosa, M. D. L., & Villar, M. E. (2013). A longitudinal study of social capital and acculturation-related stress among recent Latino immigrants in South Florida. *Hispanic Journal of Behavioral Sciences*, *35*(4), 469–485. https://doi.org/10.1177/0739986313499005

Cowie, C. C. (2019). Diabetes diagnosis and control: Missed opportunities to improve health: The 2018 Kelly West Award Lecture. *Diabetes Care*, *42*(6), 994–1004. https://doi.org/10.2337/dci18-0047

Diaz, V. A., Mainous, A. G., Williamson, D., Johnson, S. P., & Knoll, M. E. (2012). Cardiovascular and diabetes risk perception in a Hispanic community sample. *Ethnicity & Disease*, *22*(1), 5–11. https://pubmed.ncbi.nlm.nih.gov/22774302/

Edelman, D., Christian, A., & Mosca, L. (2009). Association of acculturation status with beliefs, barriers, and perceptions related to cardiovascular disease prevention among racial and ethnic minorities. *Journal of Transcultural Nursing*, *20*(3), 278–285. https://doi.org/10.1177/1043659609334852

Ferrer, R., & Klein, W. M. (2015). Risk perceptions and health behavior. *Current Opinion in Psychology*, *5*, 85–89. https://doi.org/10.1016/j.copsyc.2015.03.012

Fukuoka, Y., & Oh, Y. J. (2022). Perceived risk of heart attack and type 2 diabetes in Hispanic Adults with overweight and obesity. *Journal of Cardiovascular Nursing*, *37*(6), E197–E205. https://doi.org/10.1097/JCN.0000000000000866

Gedebjerg, A., Peter Almdal, T., Berencsi, K., Rugby, J., Steen Nielsen, J., Witte, D. R., Friborg, S., Brandslund, I., Vaag, A., Beck-Nielsen, H., Toft Sorensen, H., & Wernich Thomsen, R. (2018). Prevalence of micro- and macrovascular diabetes complications at time of type 2 diabetes diagnosis and associated clinical characteristics: A cross-sectional baseline study of 6958 patients in the Danish DD2 cohort. *Journal of Diabetes and its Complications*, *32*(1), 34–40. https://doi.org/10.1016/j.jdiacomp.2017.09.010

Gorman, B. K., Ghazal Read, J., & Krueger, P. M. (2010). Gender, acculturation, and health among Mexican Americans. *Journal of Health and Social Behavior*, *51*(4), 440–457. https://doi.org/10.1177/0022146510386792

Guadamuz, J. S., Durazo-Arvizu, R. A., Daviglus, M. L., Perreira, K. M., Calip, G. S., Nutescu, E. A., Gallo, L. C., & Castaneda, S. F. (2020). Immigration status and disparities in the treatment of cardiovascular disease risk factors in the hispanic community health study/study of Latinos (Visit 2, 2014–2017). *American Journal of Public Health*, *110*(9), 1397–1404. https://doi.org/10.2105/AJPH.2020.305745

Harris, M. I., Klein, R., Welborn, T. A., & Knuiman, M. W. (1992). Onset of NIDDM occurs at least 4–7 yr before clinical diagnosis. *Diabetes Care*, *15*(7), 815–819. https://doi.org/10.2337/diacare.15.7.815

Helweg-Larsen, M., & Stancioff, L. M. (2008). Acculturation matters: risk perceptions of smoking among Bosnian refugees living in the United States. *Journal of Immigrant and Minority Health*, *10*(5), 423–428. https://doi.org/10.1007/s10903-007-9107-1

Hsueh, L., Peña, J. M., Hirsh, A. T., De Groot, M., & Stewart, J. C. (2019). Diabetes risk perception among immigrant and racial/ethnic minority adults in the United States. *The Diabetes Educator*, *45*(6), 642–651. https://doi.org/10.1177/0145721719873640

Hsueh, L., Wu, W., Hirsh, A. T., de Groot, M., Mather, K. J., & Stewart, J. C. (2020). Undiagnosed diabetes among immigrant and racial/ethnic minority adults in the United States: National Health and Nutrition Examination Survey 2011–2018. *Annals of Epidemiology*, *51*, 14–19. https://doi.org/10.1016/j.annepidem.2020.07.009

Hubert, H. B., Snider, J., & Winkleby, M. A. (2005). Health status, health behaviors, and acculturation factors associated with overweight and obesity in Latinos from a community and agricultural labor camp survey. *Preventive Medicine*, *40*(6), 642–651. https://doi.org/10.1016/j.ypmed.2004.09.001

Iglesias-Rios, L., Bromberg, J. E., Moser, R. P., & Augustson, E. M. (2015). Food insecurity, cigarette smoking, and acculturation among Latinos: Data from NHANES 1999–2008. *Journal of Immigrant and Minority Health*, *17*(2), 349–357. https://doi.org/10.1007/s10903-013-9957-7

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly*, *11*(1), 1–47. https://doi.org/10.1177/109019818401100101

Joiner, K. L., Adams, M. P., Lee, K. A., Piatt, G., & Davis, M. A. (2022). Perceived risk for diabetes among US adults with undiagnosed prediabetes. *Preventive Medicine*, *160*, Article 107089. https://doi.org/10.1016/j.ypmed.2022.107089

Jonnalagadda, S. S., & Diwan, S. (2005). Health behaviors, chronic disease prevalence and self-rated health of Older Asian Indian immigrants in the U.S. *Journal of Immigrant Health*, *7*(2), 75–83. https://doi.org/10.1007/s10903-005-2640-x

Khan, R. K., Misra, R., Shawley-Brzoska, S., & Wen, S. (2022). Predictors of diabetes risk perception among college students. *Journal of American College Health*, *70*(6), 1803–1809. https://doi.org/10.1080/07448481.2020.1825222

Kim, C., McEwen, L. N., Piette, J. D., Goewey, J., Ferrara, A., & Walker, E. A. (2007). Risk perception for diabetes among women with histories of gestational diabetes mellitus. *Diabetes Care*, *30*(9), 2281–2286. https://doi.org/10.2337/dc07-0618

Layne, T. M., Agarwal, P., Rapkin, B. D., Jandorf, L. H., & Bickell, N. A. (2023). Cancer beliefs and screening behaviors: The impact of neighborhood and other social determinants of health. *Frontiers in Oncology*, *13*, Article 1072259. https://doi.org/10.3389/fonc.2023.1072259

Lewis, M. (2007, February). *Stepwise versus hierarchical regression: pros and cons* [Paper presentation]. Proceedings of the Annual Meeting of the Southwest Educational Research Association, San Antonio.

Lindstrom, J., & Tuomilehto, J. (2003). The diabetes risk score: A practical tool to predict type 2 diabetes risk. *Diabetes Care*, *26*(3), 725–731. https://doi.org/10.2337/diacare.26.3.725

Mainous, A. G., Diaz, V. A., & Geesey, M. E. (2008). Acculturation and healthy lifestyle among Latinos with diabetes. *The Annals of Family Medicine*, *6*(2), 131–137. https://doi.org/10.1370/afm.814

Mainous, A. G., Mansoor, H., Rahmanian, K. P., & Carek, P. J. (2019). Perception of risk of developing diabetes among patients with undiagnosed prediabetes: The impact of health care provider advice. *Clinical Diabetes*, *37*(3), 221–226. https://doi.org/10.2337/cd18-0050

Miller De Rutté, A. M., & Barrie, A. (2022). A review exploring acculturation and type 2 diabetes in Spanish-speaking populations. *Hispanic Health Care International*, *20*(2), 133–146. https://doi.org/10.1177/15404153211037022

Misra, R., Farjo, S., McGinnis Elavsky, M. A., Kuhn, S., & Morton-McSwain, C. (2021). Diabetes knowledge, behaviors, and perception, of risk in rural West Virginia counties. *Journal of Appalachian Health*, *3*(3), 51–67. https://doi.org/10.13023/jah.0303.05

Moonesinghe, R., Beckles, G. L. A., Liu, T., & Khoury, M. J. (2018). The contribution of family history to the burden of diagnosed diabetes, undiagnosed diabetes, and prediabetes in the United States: Analysis of the National Health and Nutrition Examination Survey, 2009–2014. *Genetics in Medicine*, *20*(10), 1159–1166. https://doi.org/10.1038/gim.2017.238

Moran, A., Diez Roux, A. V., Jackson, S. A., Kramer, H., Manolio, T. A., Shrager, S., & Shea, S. (2007). Acculturation is associated with hypertension in a multiethnic sample. *American Journal of Hypertension*, *20*(4), 354–363. https://doi.org/10.1016/j.amjhyper.2006.09.025

Ogurtsova, K., Guariguata, L., Barengo, N. C., Ruiz, P. L., Sacre, J. W., Karuranga, S., Sun, H., Boyko, E. J., & Magliano, D. J. (2022). IDF Diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. *Diabetes Research and Clinical Practice*, *183*, Article 109118. https://doi.org/10.1016/j.diabres.2021.109118

Pachipala, K., Shankar, V., Rezler, Z., Vittal, R., Ali, S. H., Srinivasan, M. S., Palaniappan, L., Yang, E., Juul, F., & Elfassy, T. (2022). Acculturation and associations with ultra-processed food consumption among Asian Americans: NHANES, 2011–2018. *The Journal of Nutrition*, *152*(7), 1747–1754. https://doi.org/10.1093/jn/nxac082

Pérez, A. (2015). Acculturation, health literacy, and illness perceptions of hypertension among Hispanic adults. *Journal of Transcultural Nursing*, *26*(4), 386–394. https://doi.org/10.1177/1043659614524785

Redfield, R., Linton, R., & Herskovits, M. J. (1936). Memorandum for the study of acculturation. *American Anthropologist*, *38*(1), 149–152. https://doi.org/10.1525/aa.1936.38.1.02a00330

Rodriguez-Alcalá, M. E., Qin, H., & Jeanetta, S. (2019). The role of acculturation and social capital in access to health care: A meta-study on Hispanics in the US. *Journal of Community Health*, *44*(6), 1224–1252. https://doi.org/10.1007/s10900-019-00692-z

Rudmin, F. W. (2003). Critical history of the acculturation psychology of assimilation, separation, integration, and marginalization. *Review of General Psychology*, *7*(1), 3–37. https://doi.org/10.1037/1089-2680.7.1.3

Sagong, H., & Yoon, J. Y. (2021). Pathways among frailty, health literacy, acculturation, and social support of middle-aged and older Korean immigrants in the USA. *International Journal of Environmental Research and Public Health*, *18*(3), Article 1245. https://doi.org/10.3390/ijerph18031245

Steele, E. M., Khandpur, N., Sun, Q., & Monteiro, C. A. (2020). The impact of acculturation to the US environment on the dietary share of ultra-processed foods among US adults. *Preventive Medicine*, *141*, Article 106261. https://doi.org/10.1016/j.ypmed.2020.106261

Valdez, R., Yoon, P. W., Liu, T., & Khoury, M. J. (2007). Family history and prevalence of diabetes in the U.S. Population: The 6-year results from the Nation Health and Nutrition Examination Survey (1999–2004). *Diabetes Care*, *30*(10), 2517–2522. https://doi.org/10.2337/dc07-0720

Venkatesh, S., Conner, T., Song, W. O., Olson, B. H., & Weatherspoon, L. J. (2017). The relationship between dietary acculturation and type 2 diabetes risk among Asian Indians in the U.S. *Journal of Immigrant and Minority Health*, *19*(2), 294–301. https://doi.org/10.1007/s10903-016-0482-3

Wilkie, S. K., Bleser, W. K., Miranda, P. Y., & BeLue, R. (2017). Role of depressive symptoms in mediating socioeconomic disparities in diabetes risk misperception. *American Journal of Health Behavior*, *41*(3), 348–357. https://doi.org/10.5993/AJHB.41.3.14

Yoshida, Y., & Fonseca, V. A. (2021). Diabetes control in Asian Americans—Disparities and the role of acculturation. *Primary Care Diabetes*, *15*(1), 187–190. https://doi.org/10.1016/j.pcd.2020.01.010

Received July 14, 2023
Revision received January 16, 2024
Accepted April 21, 2024 ■