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HEMOGLOBIN A1C, BLOOD PRESSURE, AND LDL-CHOLESTEROL CONTROL AMONG HISPANIC/LATINO ADULTS WITH DIABETES: RESULTS FROM THE HISPANIC COMMUNITY HEALTH STUDY/STUDY OF LATINOS (HCHS/SOL)

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Abstract

Objective—To determine the prevalence of Hispanic/Latino adults with diabetes who meet target hemoglobin A1c, blood pressure (BP), and low-density-lipoprotein cholesterol (LDL-C) recommendations, and angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blocker (ARB) and statin medication use by heritage and sociodemographic and diabetes-related characteristics.

Methods—Data were cross-sectional, collected between 2008 and 2011, and included adults age 18 to 74 years who reported a physician diagnosis of diabetes in the Hispanic Community Health Study/Study of Latinos (N = 2,148). Chi-square tests compared the prevalence of hemoglobin A1c, BP, and LDL-C targets and ACE/ARB and statin use across participant characteristics. Predictive margins regression was used to determine the prevalence adjusted for sociodemographic characteristics.

Results—The overall prevalence of A1c <7.0% (53 mmol/mol), BP <130/80 mm Hg, and LDL-C <100 mg/dL was 43.0, 48.7, and 36.6%, respectively, with 8.4% meeting all three targets. Younger adults aged 18 to 39 years with diabetes were less likely to have A1c <7.0% (53 mmol/mol) or LDL-C <100 mg/dL compared to those aged 65 to 74 years; younger adults were more likely to have BP <130/80 mm Hg ($P<.05$ for all). Individuals of Mexican heritage were

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DISCLOSURE

The authors have no multiplicity of interest to disclose.

significantly less likely to have A1c <7.0% (53 mmol/mol) compared to those with Cuban heritage, but they were more likely to have BP <130/80 mm Hg compared to those with Dominican, Cuban, or Puerto Rican heritage ($P<.05$ for all); there was no difference in LDL-C by heritage. Overall, 38.2% of adults with diabetes were taking a statin, and 50.5% were taking ACE/ARB medications.

Conclusion—Hemoglobin A1c, BP, and LDL-C control are suboptimal among Hispanic/Latinos with diabetes living in the U.S. With 8.4% meeting all three recommendations, substantial opportunity exists to improve diabetes control in this population.

INTRODUCTION

The prevalence of diabetes in the U.S. has increased substantially over the past several decades, from 9.8% in 1988–1994 to 12.4% in 2011–2012; among Mexican Americans, the prevalence increased at a similar rate, from 17.5 to 20.5% (1). Data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) indicate that the current prevalence of diabetes among Hispanics/Latinos is 16.9% (2). This increasing prevalence of diabetes may predict future increases in morbidity, mortality, and economic costs, primarily due to complications from diabetes. However, it is well established that reductions in hemoglobin A1c (A1c) and/or blood pressure (BP) significantly reduce microvascular complications (3). In addition, BP and lipid control both substantially reduce cardiovascular disease (CVD), the major cause of death for individuals with diabetes (3). Based on this research, the American Diabetes Association (ADA) in 2011 recommended that most adults with diabetes achieve an A1c <7.0% (53 mmol/mol), BP <130/80 mm Hg, and LDL cholesterol (LDL-C) <100 mg/dL (i.e., known as the “ABCs” for diabetes control) (4). Statins were recommended for those with overt CVD or those older than 40 years with other CVD risk factors and for those with high LDL-C levels (4). Adults with diabetes and hypertension were recommended to have pharmacologic therapy that includes either an angiotensin-converting enzyme (ACE) inhibitor or an angiotensin receptor blocker (ARB) (4).

The National Diabetes Education Program was initiated in 1997 to disseminate evidence-based information on diabetes management, including the importance of meeting the ABCs (5). Despite improvements in achieving the ABCs, control remains suboptimal among U.S. adults and particularly among Hispanics/Latinos (6). Previous research from the 2007–2010 National Health and Nutrition Examination Survey showed that just over half of adults with diabetes had A1c <7.0% (53 mmol/mol) (52.5%), a BP <130/80 mm Hg (51.1%), an LDL-C <100 mg/dL (56.2%), or were taking a statin (51.4%) (6). Mexican Americans were significantly less likely to meet A1c and LDL-C targets compared to non-Hispanic whites and were significantly less likely to meet A1c targets compared to non-Hispanic blacks. The prevalence of having A1c ≥8.0% (64 mmol/mol) (29.3%) or BP ≥140/90 mm Hg (32.1%) was high for Hispanics/Latinos. In another study, Hispanics/Latinos with diabetes were shown to have a higher prevalence of end-stage renal disease compared to their non-Hispanic white counterparts, but the prevalence of CVD and visual impairment have been shown to be lower in Hispanics/Latinos with diabetes compared to non-Hispanic whites (7). Although the prevalence of diabetes-related complications has decreased over the past 2

decades, the public health burden of the disease persists, since the prevalence and cost of diabetes has significantly increased over the same time period (8).

The ABC targets have been studied in nationally representative samples, but no study as large as HCHS/SOL has examined ABC control in Hispanics/Latinos from diverse backgrounds living in the U.S. The purpose of this analysis was to assess ABC target control and ACE/ARB and statin use among a representative sample of Hispanic/Latino communities participating in the HCHS/SOL and to assess ABC target control and ACE/ARB and statin use by sociodemographic and diabetes-related characteristics.

METHODS

The HCHS/SOL is a probability sample and community-based cohort study of 16,415 self-identified Hispanic/Latino persons aged 18 to 74 years from randomly selected households in four U.S. field centers (Chicago, IL; Miami, FL; Bronx, NY; San Diego, CA). Baseline data were collected between 2008 and 2011. Sample design and cohort selection have been described previously (9). The household level response rate was 33.5%. Of the individuals who were screened, selected, and met eligibility criteria, 41.7% were enrolled; a nonresponse adjustment was used and is described under ‘Statistical Analysis’ below.

Study Participants

Participants were adults aged 18 to 74 years who self-reported a physician diagnosis of diabetes (N = 2,148). Sociodemographic characteristics and medical history of participants were obtained through an interviewer-administered questionnaire (www.csc.unc.edu/hchs). Participants were asked to report which of the following best describes their Hispanic/Latino heritage: Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, or more than one heritage. Participants self-reported sociodemographic characteristics (age, sex, education, income, marital status, place of birth [the U.S. or its territories vs. elsewhere], and preferred language of interview); health insurance status; number of physician visits and access to health care within the past year; time since diagnosis of diabetes; family history of diabetes; physician diagnosis of hypertension or elevated cholesterol; smoking status (current, former, or never); current medication profile (including antihyperglycemic, antihypertensive and lipid-lowering medications). Participants were asked to bring their medications to the examination to assess use of ACE inhibitors, ARBs and statins, in addition to other medications.

Macrovascular/Microvascular Disease and CVD Risk Factors

Macrovascular and microvascular diseases were considered common complications for persons with diabetes and included history of coronary heart disease (CHD), stroke, peripheral artery disease, or kidney disease. Participants self-reported any history of CHD, including angina, and any history of stroke. Peripheral artery disease (PAD) was determined by the ankle-brachial index among participants aged ≥45 years, with a value of ≤0.90 indicating PAD; ankle and arm BPs were taken using standardized Doppler procedures (10). Kidney disease was defined as having an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m² or the presence of albuminuria. The Chronic Kidney Disease Epidemiology

Collaboration equation was used to estimate eGFR from serum creatinine based on age, sex, and race (11). Albuminuria was defined as having a urine albumin to creatinine ratio ≥ 30 mg/g (12).

CVD risk factors in persons with diabetes included hypertension (self-report, self-report of medication, or BP $\geq 130/80$ mm Hg), high cholesterol (self-report, self-report of medication, or LDL-C ≥ 100 mg/dL), or obesity (body mass index [BMI] ≥ 30 kg/m²). Height and weight were measured to determine BMI (kg/m²). Waist circumference of ≥ 88 centimeters for women and ≥ 102 centimeters for men was considered high risk for CVD (13). Body fat percentage was measured using bio-impedance with the Tanita Body Composition Analyzer, TBP-300A. Participants were categorized as healthy weight, overweight, or obese based on their body fat percentage, age, and sex (14). Details on measured BP and LDL-C are stated below.

Main Outcomes

Targets for A1c, BP, and LDL-C measures were based on the ADA 2011 Standards of Care for most persons with diabetes (A1c $<7.0\%$ [53 mmol/mol], BP $<130/80$ mm Hg, LDL <100 mg/dL) (4), which aligns with the baseline data collection years of the HCHS/SOL. In addition, the ADA recommended less stringent A1c, BP, and LDL-C cut-points (A1c $<8.0\%$ [64 mmol/mol], BP $<140/90$ mm Hg, and LDL <130 mg/dL) for some individuals, including those with limited life expectancy, history of severe hypoglycemia, CVD risk factors, complications, or long-standing diabetes. Standard fasting blood samples were taken during the examination and processed at the Collaborative Studies Clinical Laboratory at the University of Minnesota Medical Center, Fairview, which performed all HCHS/SOL laboratory assays (15). All blood samples were aliquoted and centrifuged at the field center before being stored and shipped to the Clinical Laboratory; aliquots of serum were stored at -70°C (16). LDL-C was calculated for those fasting properly (8 to <24 hours) and who had triglycerides ≥ 400 mg/dL ($n = 95$ excluded) using the following formula (17):

$$(\text{LDL}-\text{C}) = [\text{total cholesterol}] - [\text{HDL cholesterol}] - [\text{triglycerides}/5].$$

BP was measured three times and averaged using standard epidemiologic procedures after the participant rested quietly for 5 minutes.

Statistical Analysis

We determined the overall prevalence (percent, standard error) of meeting A1c, BP, and LDL-C targets and use of ACE/ARB medications and statins and the prevalence by sociodemographic characteristics and diabetes-related factors. Chi-square tests were used to compare the prevalence of ABC targets by heritage and sociodemographic and diabetes-related characteristics. Predictive margins regression was used to determine the prevalence of ABC targets and ACE/ARB and statin use adjusted for (1) age and sex, (2) sociodemographic characteristics (education, income, heritage, place of birth, health insurance, preferred language, years in U.S., and field center), and (3) duration of diabetes, CVD risk factors (hypertension, high cholesterol, or obesity), and diabetes medication use. Predictive margins regression yields adjusted estimates of prevalence while controlling for

different covariate distributions (i.e., age, sex) in order to compare outcomes (i.e., the ABCs) by heritage.

To assess the extent to which A1c treatment goals are being individualized, we determined the prevalence of meeting several A1c cut-points stratified by age and the presence of macrovascular/microvascular disease (history of CHD, or stroke, or kidney disease, or peripheral artery disease) and/or CVD risk factors (hypertension, high cholesterol, or obesity). All statistical analyses used sample weights, clustering, and stratification to account for the HCHS/SOL sampling design using SUDAAN (SUDAAN User's Manual, Release 9.2, 2008; Research Triangle Institute, Durham, NC). The HCHS/SOL sampling weights are a product of a base weight (reciprocal of the probability of selection) and three adjustments: (1) nonresponse adjustments made relative to the sampling frame, which included characteristics for age, sex, and socio-economic status, (2) trimming to handle extreme values, and (3) calibration of weights to the 2010 U.S. Census according to age, sex, and Hispanic background (9).

RESULTS

Characteristics of Study Population

The majority of adults with self-reported diabetes were aged 40 to 74 years (87.2%) and were women (52.9%) (Supplemental Table 1). The largest Hispanic/Latino heritage group was Mexican (35.3%), followed by Puerto Rican (23.1%) and Cuban (20.1%). About two-thirds had a high school education or less, 56.9% had a household income of \$20,000, and half were married or living with a partner. Eighty-seven percent were born outside the U.S. or U.S. territories. Spanish was the preferred language for most participants (82.5%). About one-third did not have health insurance. Ten percent had not seen a doctor in the past year, and 13.7% reported needing health care in the past year but being unable to receive care.

Forty-three percent had a duration of diabetes of <5 years, and most were taking oral medications only (58.8%). A family history of diabetes was reported by 65.5% of participants. The prevalence of hypertension and high cholesterol was around 70% for each condition. Macro- and microvascular diseases were prevalent: 18.9% had a history of CHD, 5.1% had a history of stroke, 34.4% had kidney disease, and 10.9% had PAD. Almost one-fifth of participants were current smokers. Based on BMI, one-third were overweight, and 55.6% were obese.

Prevalence of ABC Targets and ACE/ARB and Statin Use by Sociodemographic Characteristics and Diabetes-Related Factors

A1c—Overall, the prevalence of A1c <7.0% (53 mmol/mol) was 43.0% among Hispanic/Latino adults with diabetes (Table 1, Fig. 1). The prevalence of A1c <7.0% (53 mmol/mol) increased with age; 35.3% of adults age 18 to 39 years had A1c <7.0% (53 mmol/mol), compared to 49.0% of adults age 65 to 74 years ($P = .023$). Among heritage groups, the prevalence of A1c <7.0% (53 mmol/mol) was highest among individuals of Cuban heritage (vs. Mexican heritage; $P = .021$). Participants who were living in the U.S. for a shorter duration (< 10 years) were more likely to have A1c <7.0% (53 mmol/mol) than those living

in the U.S. for 11 to 30 years ($P<.05$). Participants who had seen a doctor in the past year or reported no barriers to health care access were more likely to have A1c $<7.0\%$ (53 mmol/mol). The prevalence of having A1c $<7.0\%$ (53 mmol/mol) was higher for those with shorter duration of diabetes and significantly lower for those using both insulin and oral medications ($P<.001$ for all) (Table 2). Participants with hypertension were more likely to have A1c $<7.0\%$, and those with kidney disease were less likely to meet the target compared to those without these conditions. Prevalence estimates for other A1c cut-points are found in Supplemental Table 2.

BP and ACE/ARB Use—Overall, the prevalence of BP $<130/80$ mm Hg was 48.7% among Hispanic/Latino adults with diabetes (Table 1, Figure 1). The prevalence of BP $<130/80$ mm Hg was higher for younger adults (72.1% age 18 to 39 years vs. 31.9% age 65 to 74 years; $P<.001$). Participants of Mexican heritage were more likely to have BP $<130/80$ mm Hg compared to those of Dominican, Cuban, or Puerto Rican heritages ($P<.001$ for all). Participants with a household income $>\$75,000$ (vs. $\leq \$20,000$) were more likely to have BP $<130/80$ mm Hg ($P=.002$). Those who did not have health insurance were more likely to achieve BP $<130/80$ mm Hg ($P<.001$). Participants with shorter duration of diabetes (<5 years) were more likely to achieve a BP $<130/80$ mm Hg compared to those with duration ≥ 10 years ($P<.05$ for all) (Table 2). Those with self-reported hypertension, kidney disease, and PAD were less likely to have BP $<130/80$ mm Hg than those reporting no disease ($P<.05$ for all). Overall, 50.5% of adults with diabetes and 75.9% of those with diabetes and self-reported hypertension were taking ACE inhibitors or ARBs. Prevalence estimates for other BP cut-points are found in Supplemental Table 3.

LDL-C and Statin Use—Overall, the prevalence of LDL-C <100 mg/dL was 36.6% among Hispanic/Latino adults with diabetes (Table 1, Fig. 1). Participants age 65 to 74 years were more likely to have LDL-C <100 mg/dL (43.7%) compared to those age 18 to 64 years (34.4%; $P=.011$). Participants who lived in the U.S. for a shorter duration were less likely to have LDL-C <100 mg/dL (≤ 10 years vs. >30 years; $P=.007$). Those with health insurance were more likely to have LDL-C <100 mg/dL ($P<.001$) than those without. Participants reporting a greater number of physician visits more often had LDL-C <100 mg/dL. Adults taking insulin or oral medications were more likely to have LDL-C <100 mg/dL compared to those taking neither medication, and those with a history of hypertension were more likely to have LDL-C <100 mg/dL than those with no history ($P<.003$ for both) (Table 2).

Overall, the prevalence of statin use was 38.2% (Table 1, Fig. 1). Statin use increased with age: 15.1% of those aged 18 to 39 years reported statin use compared to 54.9% age 65 to 74 years ($P<.001$). Among those with diabetes and self-reported high cholesterol, 52.8% were taking a statin (Table 2). Prevalence estimates for other LDL-C cut-points are found in Supplemental Table 4.

All Three ABC Targets—Overall, 8.4% of adults had A1c $<7.0\%$ (53 mmol/mol), BP $<130/80$ mm Hg, and LDL-C <100 mg/dL (Fig. 1, Supplemental Table 5). There was no difference in prevalence of meeting the three targets by age, sex, or Hispanic/Latino heritage.

Adjusted Prevalence of ABC Targets, ACE/ARB Use, and Statin Use

The adjusted prevalence of A1c <7.0% (53 mmol/mol), BP <130/80 mm Hg, and LDL-C <100 mg/dL was similar after controlling for age, sex, sociodemographics, duration of diabetes, CVD risk factors, and diabetes medication use (Supplemental Table 5). In addition, the adjusted prevalence for use of ACE/ARB medications or statins was similar to the unadjusted prevalence. The relationship between unadjusted and adjusted prevalence estimates was similar by heritage for all outcomes.

A1c Target by Age, Macro- and Microvascular Disease, and CVD Risk Factors

To assess the extent to which A1c treatment goals are being individualized, the prevalence of A1c <6.5% (48 mmol/mol), <7.0% (53 mmol/mol), or <8.0% (64 mmol/mol) was determined by age and the presence of macro-/microvascular disease and/or CVD risk factors (Table 3). About one-fifth (20.7%) of adults with diabetes aged 18 to 44 years with macro-/microvascular disease and 37.6% with CVD risk factors had A1c <7.0% (53 mmol/mol); estimates were higher for those aged 65 to 74 years (45.2% and 48.6%, respectively). Just over half (55.3%) of adults aged 45 to 64 years and 72.7% aged 65 to 74 years with both macro-/microvascular disease and CVD risk factors had A1c <8.0% (64 mmol/mol). A lower proportion of younger adults with macro-microvascular disease and/or CVD risk factors had A1c <8.0% (64 mmol/mol) compared to those aged 45 years.

DISCUSSION

Overall, A1c, BP, and LDL-C control among Hispanic/Latino adults was suboptimal, with only 43, 49, and 37% having A1c <7.0% (53 mmol/mol), BP <130/80 mm Hg, and LDL-C <100 mg/dL, respectively. Only 8.4% achieved all three goals (A1c <7.0% [53 mmol/mol], BP <130/80 mm Hg, and LDL-C <100 mg/dL). Half (50.5%) of Hispanic/Latino adults with diabetes and 75.9% with diabetes and hypertension were using ACE inhibitors or ARBs. Statin use was low overall (38.2%) and only slightly higher for those with a history of CHD (55.2%).

ABC control differed to some degree by Hispanic/Latino heritage and duration of living in the U.S. Individuals of Cuban heritage were significantly more likely to have A1c <7.0% (53 mmol/mol) or <8.0% (64 mmol/mol) compared to those of Mexican heritage. For BP, individuals of Mexican heritage were more likely to achieve BP <130/80 mm Hg compared to those of Dominican, Cuban, or Puerto Rican heritages with a similar pattern for prevalence of BP <140/90 mm Hg. In addition, Hispanic/Latino adults who had lived in the U.S. for a shorter duration of time were more likely to have A1c <7.0% (53 mmol/mol) but less likely to have LDL-C <100 mg/dL. The reasons for these differences by heritage and duration of U.S. residency are unclear; after adjusting for sociodemographic characteristics, CVD risk factors, duration of diabetes, and diabetes medication use, the differences by heritage remained.

In a previous study utilizing the 2007–2010 National Health and Nutrition Examination Survey (NHANES), the proportions of adults with diabetes in the general U.S. population who achieved A1c <7.0% (53 mmol/mol) (43.0%) or LDL-C <100 mg/dL (56.2%) were

higher compared to Hispanic/Latinos with diabetes in the HCHS/SOL (43.0 and 36.6%, respectively) (6). In addition, non-Hispanic whites in NHANES had higher A1c and LDL-C control compared to Hispanics/Latinos in the HCHS/SOL (A1c <7.0%, 52.9% vs. 43.0%; LDL-C <100 mg/dL, 62.1% vs. 36.6%, respectively). Further, in older NHANES studies, similar results that compared A1c control by race/ethnicity showed greater control among non-Hispanic whites versus Hispanics, with Mexican Americans being the predominant Hispanic heritage (18–20). In the 2001–2004 Action for Health in Diabetes (Look AHEAD) study, a randomized controlled trial among overweight and obese adults with type 2 diabetes, more whites achieved A1c <7.0% compared to Hispanic/Latinos in the HCHS/SOL (49.2% vs. 43.0%), and a similar proportion achieved LDL-C <100 mg/dL (38.9% in Look AHEAD vs. 36.6% in HCHS/SOL) (21). This difference in A1c control may partially be due to the younger age distribution of the Hispanic/Latino population and the fact that younger adults tend to have worse A1c control (6). In addition, far fewer Hispanic/Latinos in the HCHS/SOL were taking a statin (38.2% vs. 51.4% in the NHANES total U.S. population with diabetes), although a larger proportion of older Hispanic/Latino adults in the HCHS/SOL were taking statins (54.9% among those age 65 to 74 years). However, only a little over half of those with diabetes and high cholesterol or a history of CHD—adults who are likely indicated for treatment—were taking a statin. Nevertheless, the disparity in A1c and LDL-C control among young Hispanics/Latinos is particularly concerning, since younger adults with diabetes have much to gain from risk factor control given their longer life expectancy and higher risk of developing complications over time. Given the large number of young Hispanics/Latinos in the U.S. population, targeting younger adults of Hispanic/Latino heritage could have significant population-level effects on the reduction of future complications and CVD risk factors. Finally, BP control (<130/80 mm Hg) was only slightly higher among non-Hispanic whites in NHANES 2007–2010 (53.2%) and whites in Look AHEAD 2001–2004 (51.7%) compared to Hispanic/Latino adults in the HCHS/SOL (48.7%).

As recommended by the ADA, A1c targets should be individualized based on several patient factors, including age, CVD risk factors, complications, and previous hypoglycemic or hyperglycemic events. In general, younger patients with few CVD risk factors should strive to achieve more stringent targets to prevent future complications, while older adults—who have less to gain from years of tight control—may consider less stringent targets (22). A1c control (A1c <7.0% [53 mmol/mol]) was suboptimal for young adults aged 18 to 44 years with macro-/microvascular diseases (20.7%) or CVD risk factors (37.6%). Thus, the majority of young adults with these diseases and CVD risk factors are not achieving an A1c <7.0% (53 mmol/mol), which presents a large public health opportunity to educate physicians and patients on the importance of good A1c control to prevent further complications.

Suboptimal diabetes control based on the ADA ABC targets may be due to several factors. First, target levels may be biologically unattainable due to the severity of the disease or lack of motivation due to fatigue of controlling the disease. Results indicated that A1c and BP control were more prevalent among participants with a more recent diagnosis. In addition, we found that only 22% of young adults with CVD risk factors and complications were able to meet an A1c target of <7.0% (53 mmol/mol). This finding may also be attributed to

higher medication costs and health expenses, which impact adherence to treatment goals for those with diabetes and chronic conditions. Second, lack of self-management skills may prevent meeting ABC targets. Diabetes is a challenging and complex disease to control and requires collaboration from patients, physicians, and educators; this type of management is not easy for all persons, especially those with limited resources, including health insurance. Not surprisingly, we found that a greater number of visits to a physician in the past year was associated with better A1c and LDL-C control. These findings highlight the importance of addressing the disparity in diabetes control by targeting Hispanics/Latinos with low socioeconomic status or other barriers to health care access. Third, the ABC goals may need to be reconsidered based on recommendations for more individualized diabetes care. Nevertheless, there is much room for improvement, especially among younger adults. Finally, the difference in prevalence of ABC targets by heritage is unclear. The underlying mechanisms should be investigated further in these groups, especially considering that the difference persisted after adjusting for sociodemographic characteristics and severity of disease.

A strength of this study was the use of a large and diverse sample that included several Hispanic/Latino heritage groups. The use of data on multiple clinical outcomes ascertained using standardized procedures also allowed for better characterization of diabetes control. This report assessed diabetes control for adults who self-reported diabetes and thus should be aware of the treatment goals. However, for some stratified estimates, standard errors were high, making definitive conclusions difficult; these estimates are noted in the table footnotes. Although the HCHS/SOL is a large representative study of the communities surveyed, estimates cannot be generalized to the entire U.S. Hispanic/Latino population.

CONCLUSION

The results of this study show that A1c, BP, and LDL-C control is suboptimal among this sample of Hispanics/Latinos with diabetes living in four U.S. communities. The greatest potential for reducing complications may be in collectively controlling for A1c, BP, and LDL-C; only 8.4% of participants met all three ABC control targets. Access to care, education, self-management skills, therapeutic adherence, and underlying physiologic mechanisms all play important roles in determining diabetes control. Future research and public health efforts should focus on improving control among young Hispanic/Latino adults, who have much to gain from long-term control. As the Hispanic/Latino population continues to grow and age, the economic and medical burden of future complications from poorly controlled diabetes will further burden an already aging U.S. population. Thus, there is an urgent need to improve diabetes management and control in order to provide persons with diabetes a longer and healthier life and reduce the public health burden of disease.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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This study was approved by the Institutional Review Boards at the data coordinating center and at each field center, where all subjects gave written consent.

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Abbreviations

A1c	hemoglobin A1c
ABC	hemoglobin A1c, blood pressure, low-density-lipoprotein cholesterol
ACE	angiotensin-converting enzyme
ADA	American Diabetes Association
ARB	angiotensin receptor blocker
BMI	body mass index
BP	blood pressure
CHD	coronary heart disease
CVD	cardiovascular disease
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
LDL-C	low-density lipoprotein cholesterol
NHANES	National Health and Nutrition Examination Survey
PAD	peripheral artery disease

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Fig. 1. The prevalence of hemoglobin A1c, blood pressure (BP), and low-density-lipoprotein cholesterol (LDL-C) control and medication use by (A) age and (B) Hispanic/Latino heritage among Hispanic/Latino adults with diabetes in the Hispanic Community Health Study/Study of Latinos, 2008–2011. *ACE* = angiotensin-converting enzyme; *ARB* = angiotensin receptor blocker.

Prevalence of ABC Control and Medication Use by Demographic Factors Among Hispanic/Latino Adults With Diabetes in the HCHS/SOL, 2008–2011

Table 1

	A1c <7.0% (53 mmol/mol) n = 2,121	BP <130/80 mm Hg n = 2,143	ACE inhibitor and/or ARB medication n = 2,099	LDL-C <100 mg/dL n = 2,048	Statin use n = 2,099
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
Total	43.0 (1.43)	48.7 (1.59)	50.5 (1.80)	36.6 (1.65)	38.2 (1.67)
Age (years)					
18–39 (Ref)	35.3 (4.81)	72.1 (4.63)	23.3 (5.07)	34.4 (5.74)	15.1 (4.59)
40–59	40.9 (1.86)	55.1 (2.02) ^c	46.0 (2.26) ^c	33.5 (2.27)	34.3 (2.19) ^b
60–74	47.8 (2.43) ^a	33.8 (2.30) ^c	64.1 (2.44) ^c	40.8 (2.43)	49.8 (2.47) ^c
65–74	49.0 (3.15) ^a	31.9 (3.04) ^c	66.5 (3.20) ^c	43.7 (3.29) ^a	54.9 (3.28) ^c
Sex					
Male (Ref)	41.9 (2.46)	46.0 (2.37)	48.0 (2.61)	38.0 (2.68)	38.8 (2.38)
Female	44.0 (2.11)	51.0 (2.05)	52.6 (2.43)	35.4 (2.27)	37.6 (2.42)
Hispanic/Latino heritage					
Mexican (Ref)	41.6 (2.71)	58.9 (2.67)	42.7 (2.85)	38.3 (3.23)	33.1 (2.58)
Dominican	40.9 (4.42)	31.3 (4.66) ^c	49.6 (4.85)	36.0 (5.17)	36.9 (4.41)
Central American	33.6 (4.96)	53.7 (5.39)	44.3 (5.22)	39.4 (5.67)	31.0 (5.37)
Cuban	51.9 (3.37) ^a	40.9 (3.82) ^c	55.9 (4.07) ^b	29.3 (3.72)	37.6 (3.47)
Puerto Rican	43.7 (2.45)	44.1 (3.02) ^c	59.3 (2.88) ^c	38.4 (2.96)	46.9 (2.93) ^c
South American	41.4 (7.08)	48.3 (7.47)	60.6 (6.66) ^a	28.3 (6.12)	42.9 (7.48)
Highest grade level					
Elementary (Ref)	47.3 (3.41)	43.0 (3.39)	50.6 (3.19)	39.3 (3.63)	40.6 (3.69)
Middle school	40.8 (3.57)	44.2 (3.84)	49.5 (3.68)	36.6 (3.44)	40.1 (3.71)
High school	42.2 (2.66)	51.5 (2.52) ^a	50.3 (3.53)	35.3 (2.77)	38.0 (3.44)
Trade school	45.4 (4.96)	42.3 (4.59)	53.1 (4.94)	32.8 (4.68)	36.0 (4.70)
College	40.1 (3.64)	56.7 (3.63) ^b	48.2 (3.79)	38.8 (4.15)	36.9 (3.57)
Household income					
\$20,000 (Ref)	46.3 (1.90)	44.4 (2.24)	52.5 (2.16)	37.1 (2.13)	38.1 (2.08)

	A1c <7.0% (53 mmol/mol) n = 2,121	BP <130/80 mm Hg n = 2,143	ACE inhibitor and/or ARB medication n = 2,099	LDL-C <100 mg/dL n = 2,048	Statin use n = 2,099
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
\$20,001–\$40,000	36.9 (3.06) ^a	55.9 (3.47) ^b	46.0 (3.60)	36.9 (3.78)	36.0 (3.46)
\$40,001–\$75,000	42.3 (5.25)	47.6 (5.28)	52.9 (5.49)	36.5 (5.96)	40.9 (5.30)
>\$75,000	44.6 (9.26)	74.0 (6.70) ^c	49.0 (9.65)	50.8 (10.07)	53.6 (9.40)
Marital status					
Single (Ref)	42.2 (3.00)	44.9 (3.64)	45.9 (3.49)	34.4 (3.53)	34.7 (3.42)
Married or living with a partner	42.4 (2.17)	51.2 (2.21)	50.8 (2.40)	37.9 (2.43)	37.6 (2.18)
Separated, divorced, or widow(er)	44.8 (2.88)	47.1 (3.27)	53.4 (3.14)	36.6 (3.37)	41.9 (3.22)
U.S. born					
No (Ref)	43.5 (1.55)	47.4 (1.71)	52.0 (1.95)	37.3 (1.72)	38.9 (1.85)
Yes	40.4 (4.24)	56.1 (4.26)	40.9 (4.02)	32.5 (4.50)	33.0 (3.75)
Number of years living in U.S. or territories (among all)					
10 (Ref)	50.9 (3.56)	51.9 (3.57)	46.2 (4.01)	29.8 (4.02)	24.5 (3.15)
11–20	38.5 (3.40) ^a	53.4 (3.63)	41.1 (3.70)	37.0 (3.64)	27.0 (2.77)
21–30	39.7 (3.52) ^a	48.1 (4.05)	44.9 (3.81)	34.2 (3.54)	36.9 (3.36) ^b
>30	43.9 (2.73)	44.7 (2.43)	60.8 (2.65) ^b	41.4 (2.54) ^b	51.1 (2.77) ^c
Preferred language					
Spanish (Ref)	43.2 (1.67)	47.8 (1.78)	51.8 (1.98)	36.3 (1.83)	38.4 (1.91)
English	42.2 (3.80)	52.7 (3.70)	43.9 (3.61)	38.0 (4.12)	37.1 (3.37)
Health insurance					
No (Ref)	40.6 (2.83)	56.6 (2.81)	37.4 (2.71)	26.9 (2.84)	22.0 (2.41)
Yes	44.3 (1.86)	45.4 (1.89) ^c	56.6 (2.27) ^c	41.4 (2.03) ^c	45.6 (2.20) ^c
Number of times saw physician in past 12 months					
0 (Ref)	30.6 (5.15)	47.1 (6.16)	22.8 (5.30)	20.5 (5.42)	7.8 (3.48)
1–2	53.7 (5.26) ^b	54.7 (5.22)	34.5 (4.32)	35.0 (5.89)	28.7 (4.98) ^c
3–5	46.3 (3.57) ^a	54.2 (3.65)	55.9 (3.57) ^c	39.6 (3.62) ^b	43.2 (3.35) ^c

	A1c <7.0% (53 mmol/mol) n = 2,121	BP <130/80 mm Hg n = 2,143	ACE inhibitor and/or ARB medication n = 2,099	LDL-C <100 mg/dL n = 2,048	Statin use n = 2,099
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
6–10	31.6 (3.78)	48.2 (4.79)	67.1 (4.49) ^c	42.3 (6.28) ^b	48.2 (4.66) ^c
>10	49.6 (4.57) ^b	48.5 (4.16)	55.5 (4.58)	43.5 (4.47) ^b	47.1 (3.98) ^c
Needed health care but could not get it, past 12 months					
Yes (Ref)	33.0 (5.30)	46.0 (5.08)	40.5 (4.74)	32.1 (5.25)	22.0 (4.24)
No	45.2 (2.11) ^a	51.8 (2.16)	52.4 (2.35) [*]	39.1 (2.39)	41.2 (2.15) ^c
Smoking Status					
Never (Ref)	44.2 (2.13)	46.8 (2.22)	51.2 (2.45) ^b	37.1 (2.43)	37.6 (2.31)
Former	42.7 (3.17)	46.0 (2.81)	55.7 (2.82) ^c	39.7 (2.88)	43.2 (2.75) ^a
Current	40.3 (3.45)	77.9 (2.80)	40.4 (3.77)	31.4 (4.09)	31.9 (3.92)

Abbreviations: A1c = hemoglobin A1c; ABC = hemoglobin A1c, blood pressure, low-density-lipoprotein cholesterol; ACE = angiotensin-converting enzyme; ARB = angiotensin-receptor blocker; BP = blood pressure; HCHS/SOL = Hispanic Community Health Study/Study of Latinos; LDL-C = low-density-lipoprotein cholesterol; Ref = reference group.

^a $P < .05$ vs. Ref.

^b $P < .01$ vs. Ref.

^c $P < .001$ vs. Ref.

Prevalence of ABC Control and Medication Use by Diabetes-Related CVD Risk Factors and Complications Among Hispanic/Latino Adults With Diabetes in the HCHS/SOL, 2008–2011

Table 2

	A1c <7.0% (53 mmol/mol) n = 2,121	BP <130/80 mm Hg n = 2,143	ACE inhibitor and/or ARB medication n = 2,099	LDL-C <100 mg/dL n = 2,048	Statin use n = 2,099
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
Duration of diabetes					
<5 years (Ref)	53.3 (2.48)	54.0 (2.44)	42.9 (2.78)	33.8 (2.79)	29.7 (2.57)
5–<10 years	47.7 (3.23)	52.9 (3.08)	55.3 (2.95) ^b	40.1 (3.09)	40.1 (3.23) ^a
10–<15 years	28.9 (3.26) ^c	40.2 (3.91) ^b	60.8 (3.71) ^c	34.1 (3.94)	44.2 (3.95) ^b
15–<20 years	25.9 (5.58) ^c	40.6 (5.32) ^a	55.5 (6.17) ^a	36.9 (6.33)	48.7 (6.01) ^b
20 years	31.2 (4.12) ^a	37.7 (3.93) ^c	53.4 (3.91) ^a	41.7 (4.05)	47.0 (3.79) ^c
Glucose medication use					
Insulin and oral (Ref)	18.0 (2.71)	47.3 (3.66)	57.8 (2.33)	41.5 (3.88)	46.4 (3.50)
Oral meds only	46.1 (2.08) ^c	47.9 (2.06)	56.2 (3.82)	39.1 (2.06)	44.0 (2.26)
None	59.5 (3.29) ^c	52.4 (3.54)	22.9 (2.98) ^c	24.3 (3.33) ^c	12.6 (2.19) ^c
Family history of diabetes					
Yes (Ref)	43.2 (1.91)	51.1 (1.97)	49.2 (2.02)	35.9 (2.04)	37.6 (1.83)
No	42.9 (2.85)	44.8 (2.73)	52.9 (3.40)	38.5 (3.01)	39.7 (3.23)
Hypertension, self-report					
Yes (Ref)	44.1 (1.93)	40.8 (1.99)	75.9 (1.69)	40.7 (2.05)	48.3 (2.07)
No	40.9 (2.95) ^c	72.7 (2.51) ^c	0.0 (0.00)	29.3 (3.19) ^c	16.7 (2.39) ^c
High cholesterol, self-report					
Yes (Ref)	44.1 (1.85)	46.5 (1.90)	57.3 (1.98)	36.3 (1.93)	52.8 (1.91)
No	40.9 (3.07)	53.8 (3.26)	33.4 (2.73) ^c	36.3 (3.15)	3.4 (0.99) ^c
Coronary heart disease, self-report					
Yes (Ref)	39.4 (3.86)	47.9 (4.00)	46.1 (1.86)	44.5 (4.81)	55.2 (4.13)
No	43.9 (1.64)	48.8 (1.94)	69.1 (3.58) ^b	34.8 (1.90)	34.2 (1.68) ^c
Stroke, self-report					

	A1c <7.0% (53 mmol/mol) n = 2,121	BP <130/80 mm Hg n = 2,143	ACE inhibitor and/or ARB medication n = 2,099	LDL-C <100 mg/dL n = 2,048	Statin use n = 2,099
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
Yes (Ref)	46.9 (7.15)	36.1 (6.74)	49.7 (1.88)	44.4 (7.52)	66.6 (6.35)
No	42.8 (1.47)	49.3 (1.69)	64.6 (7.08) ^a	36.2 (1.66)	36.6 (1.78) ^c
Kidney disease^d					
Yes (Ref)	29.6 (2.67)	33.8 (2.80)	55.1 (3.33)	37.2 (2.98)	43.1 (3.26)
No	49.9 (1.95) ^c	56.0 (2.01) ^c	47.7 (2.04)	36.2 (2.02)	35.2 (1.83)
Peripheral artery disease^e					
Yes (Ref)	44.3 (5.93)	31.2 (5.61)	56.9 (6.01)	26.2 (5.18)	39.6 (5.61)
No	44.7 (1.64)	43.7 (1.69) ^a	56.6 (1.90)	38.7 (1.96) ^a	44.2 (1.90)
Smoking Status					
Never (Ref)	44.2 (2.13)	46.8 (2.22)	51.2 (2.45) ^b	37.1 (2.43)	37.6 (2.31)
Former	42.7 (3.17)	46.0 (2.81)	55.7 (2.82) ^c	39.7 (2.88)	43.2 (2.75) ^a
Current	40.3 (3.45)	77.9 (2.80)	40.4 (3.77)	31.4 (4.09)	31.9 (3.92)
BMI (kg/m²)					
18.5–24.9 (Ref)	43.6 (5.28)	76.6 (3.91)	38.2 (4.45)	30.6 (4.67)	28.8 (4.31)
25.0–29.9	40.3 (3.00)	75.1 (2.40)	46.6 (2.80)	39.7 (3.09)	37.8 (2.67)
30.0–34.9	43.8 (2.99)	71.5 (2.65)	52.1 (3.72) ^a	35.6 (3.00)	41.2 (3.70) ^a
35.0	45.0 (2.83)	69.5 (2.80)	58.5 (2.87) ^c	36.3 (2.84)	38.5 (2.81)
Waist circumference					
High risk (Ref)	42.1 (1.70)	71.6 (1.70)	54.9 (2.08)	36.2 (1.88)	40.5 (1.92)
Low risk	45.2 (3.43)	76.8 (2.72)	38.6 (3.23) ^c	38.1 (3.66)	31.7 (3.13)
Percent body fat^f					
Healthy (Ref)	45.6 (4.64)	76.1 (3.76)	42.7 (4.04)	33.9 (4.67)	28.7 (3.58)
Overweight	42.0 (2.90)	68.9 (3.09)	46.3 (3.11)	40.6 (3.24)	39.9 (3.09) ^a
Obese	42.9 (1.83)	74.2 (1.89)	53.5 (2.58) ^a	34.9 (2.07)	38.6 (2.38) ^a

Abbreviations: A1c = hemoglobin A1c; ABC = hemoglobin A1c, blood pressure, low-density-lipoprotein cholesterol; ACE = angiotensin-converting enzyme; ARB = angiotensin-receptor blocker; BMI = body mass index; BP = blood pressure; CVD = cardiovascular disease; HCHS/SOL = Hispanic Community Health Study/Study of Latinos; LDL-C = low-density-lipoprotein cholesterol; Ref = reference group.

^a $P<.05$ vs. Ref.
^b $P<.01$ vs. Ref.
^c $P<.001$ vs. Ref.
^d Kidney disease: determined using the chronic kidney disease epi-equation and albuminuria (see 'Methods' section).
^e Peripheral artery disease: defined by ankle-brachial index among adults age 45 years (see 'Methods' section).
^f Percent body fat: based on age and sex.

Table 3

Prevalence of Meeting A1c Targets by Age, Macro-/Microvascular Disease, and CVD Risk Factors Among Hispanic/Latino Adults With Diabetes in the HCHS/SOL, 2008–2011

Age (years)	Target population	A1c <6.5% (48 mmol/mol) n = 2,121	A1c <7.0% (53 mmol/mol) n = 2,121	A1c <8.0% (64 mmol/mol) n = 2,121
		% (SE)	% (SE)	% (SE)
18–44	Macro-/microvascular disease ^a	16.7 (4.42)	20.7 (4.83)	38.8 (6.65)
	CVD risk factors ^b	28.0 (3.53)	37.6 (3.81)	49.2 (4.01)
	Both macro-/microvascular disease and CVD risk factors	17.8 (4.71)	22.1 (5.15)	38.4 (6.87)
45–64	Macro-/microvascular disease	20.4 (2.41)	34.9 (3.12)	54.8 (3.28)
	CVD risk factors	27.2 (1.55)	42.9 (1.79)	62.9 (2.17)
	Both macro-/microvascular disease and CVD risk factors	20.5 (2.43)	35.2 (3.13)	55.1 (3.30)
65–74	Macro-/microvascular disease	29.7 (3.45)	45.2 (3.99)	73.0 (3.56)
	CVD risk factors	32.0 (2.72)	48.6 (3.16)	77.1 (2.85)
	Both macro-/microvascular disease and CVD risk factors	29.8 (3.50)	44.6 (4.00)	72.7 (3.57)

Abbreviations: A1c = hemoglobin A1c; CVD = cardiovascular disease; HCHS/SOL = Hispanic Community Health Study/Study of Latinos.

^aMacro-/microvascular disease: history of coronary heart disease or stroke or kidney disease or peripheral artery disease.

^bCVD risk factors: hypertension (self-report or blood pressure $\geq 130/80$ mm Hg or on meds) or high cholesterol (self-report or low-density-lipoprotein cholesterol ≥ 100 mg/dL or on meds) or obesity (body mass index ≥ 30 kg/m²).