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High Cholesterol Awareness, Treatment, and Control Among Hispanic/Latinos: Results From the Hispanic Community Health Study/Study of Latinos

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***Background*—**We assessed high cholesterol (HC) awareness, treatment, and control rates among US Hispanic/Latino adults and describe factors associated with HC awareness and management.

***Methods and Results*—**Baseline data (collected 2008–2011) from a multisite probability sample of Hispanic/Latino adults in the Hispanic Community Health Study/Study of Latinos (18 to 74 years old; N=16 207) were analyzed. HC was defined as low-density lipoprotein-cholesterol ≥130 mg/dL and/or total cholesterol ≥240 mg/dL or use of cholesterol-lowering medication. Among Hispanic/Latino adults with HC, almost half (49.3%) were not aware of their condition and only 29.5% were receiving treatment. Men had a higher HC prevalence than women (44.0% versus 40.5%) but a lower rate of treatment (28.1% versus 30.6%). Younger adults were significantly less likely to be HC aware compared to those who were older. Those with hypertension, diabetes, and high socioeconomic position were more likely to be HC aware. US-born Hispanic/Latino were more likely to be HC unaware than foreign-born Hispanics/Latinos, but longer US residency was significantly associated with being HC aware, treated, and controlled. Cholesterol control was achieved among 64.3% of those who were HC treated. However, younger adults, women, those with lower income, those uninsured, and more recent immigrants were less likely to be HC controlled. Individuals of Puerto Rican or Dominican background were most likely to be HC aware and treated, whereas those of Mexican or Central American background were least likely to be HC treated. Individuals of Cuban and South American background had the lowest rates of HC control, whereas Puerto Ricans had the highest.

***Conclusions*—**Understanding gaps in HC awareness, treatment, and control among US Hispanic/Latino adults can help inform physicians and policymakers to improve disease management and patient education programs. **(*J Am Heart Assoc*. 2015;4: e001867 doi: 10.1161/JAHA.115.001867)**

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According to 2005–2008 National Health and Nutrition Examination Survey data, Mexican Americans ages 20 and older, have a high prevalence (between 30% and 50%) of high cholesterol (HC) defined by total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels.[1,2] The 1982–1984 Hispanic Health and Nutrition Examination Survey demonstrated variation in HC prevalence among the 3 Hispanic background groups studied—Mexicans, Cubans, and Puerto Ricans.[3] Substantially lower rates of HC screening, awareness, treatment, and control have been described among Hispanics compared to non-Hispanic whites.[4–7] Unfortunately, Hispanic cohorts in these prior studies were relatively small, lacked adequate representation of diverse Hispanic background groups for comparisons, and were not necessarily representative of nor generalizable to the Hispanic population. Fifty-two million Hispanics residing in the United States represent the largest and fastest-growing racial/ethnic minority group. Given the impact of HC on cardiovascular disease outcomes, further knowledge of HC awareness, treatment, and control rates among Hispanics could inform public health strategies and facilitate prevention guidelines.

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The landmark Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is the largest and most comprehensive multicenter community-based cohort study of US Hispanic adults. We assessed HC awareness, treatment, and control prevalence rates among US Hispanics in the baseline HCHS/SOL and evaluated whether HC awareness, treatment, and control patterns vary according to Hispanic background groups. Lastly, we compared rates of awareness, treatment, and control of HC according to demographic, clinical, acculturation, and socioeconomic factors.

Methods

Study Population

The HCHS/SOL is a multicenter epidemiologic study of US Hispanic/Latino adults living in 4 specific communities in the United States. Participants were examined at 4 field centers affiliated with San Diego State University, Northwestern University in Chicago, Albert Einstein College of Medicine in the Bronx area of New York, and the University of Miami. The University of North Carolina serves as the coordinating center. Details of the sampling methods and design have been published.[8,9]

HCHS/SOL recruited a total of 16 415 participants (9835 women and 6580 men) aged 18 to 74 years at the time of screening from June 2008 to July 2011. The HCHS/SOL sampling design ensured significant representation of major US Hispanic/Latino background groups including Mexicans, Puerto Ricans, Cubans, Central Americans, Dominicans, and South Americans (by self-reported national origin). Participants were recruited through a stratified multistage area probability sample design from communities surrounding the 4 field centers listed above. Eligibility criteria included Hispanic/Latino ethnicity, ability to travel to the local field center, English or Spanish language proficiency, and no plans to move from the area. There were no other exclusion criteria based upon health status, comorbidities, legal residency, or other factors, making HCHS/SOL representative of the noninstitutionalized Hispanic/Latino adult population at these 4 major US communities.

HCHS/SOL procedures and examination during the baseline visit have been previously described.[10,11] Information pertaining to demographic characteristics and medical history was obtained using interviewer-administered questionnaires by trained staff. Medication use was assessed by participants bringing all medications and supplements used during the last 4 weeks; these were reviewed and coded by clinic staff. Diabetes was defined based on American Diabetes Association definition[12] using 1 or more of the following criteria: (1) fasting serum glucose ≥126 mg/dL, (2) oral glucose tolerance test ≥200 mg/dL, (3) self-reported diabetes, (4) Hb A1C ≥6.5%, or (5) taking antidiabetic medication or insulin. Trained and certified clinic staff obtained blood samples, anthropometric and blood pressure measurements on all HCHS/SOL participants. Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg with the use of a balanced scale. Body mass index was calculated as weight in kilograms divided by height in meters squared. After a 5-minute rest, blood pressure was measured 3 times at 1-minute intervals using an automated oscillometric device with the participant in a seated position. The average of the second and third blood pressure measurements was used for this analysis. Hypertension was defined as a systolic blood pressure of 140 mm Hg or higher, diastolic blood pressure of 90 mm Hg or higher, or on antihypertensive treatment.

Blood lipids and lipoproteins were measured on samples obtained after an overnight fast. Specimens were stored at −20°C and shipped weekly to the Lipoprotein Analytical Laboratory at the HCHS/SOL Central Lab at the University of Minnesota Medical Center. This laboratory participates in the Lipid Standardization Program of the Centers for Disease Control and Prevention. TC was measured using a cholesterol oxidase enzymatic method and high-density lipoprotein cholesterol with a direct magnesium/dextran sulfate method. Triglyceride levels were measured in EDTA plasma with the use of TG GB reagent (Roche Diagnostics) on a centrifugal analyzer. High-density lipoprotein cholesterol was measured with an enzymatic method after precipitation of non–high-density lipoprotein cholesterol with heparin and magnesium dextran sulfate. Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald equation.[13]

Laboratory measurements of TC and LDL-C were obtained for all participants at baseline. Participants were classified as having prevalent HC if they were currently using of cholesterol-lowering medication or if their LDL-C and/or TC exceeded risk thresholds defined by the National Cholesterol Education Program/Adult Treatment Panel III (NCEP/ATP III),[14,15] as LDL-C ≥130 mg/dL and/or TC ≥240 mg/dL. NCEP/ATP III defined individuals with normal LDL-C levels as those with <130 mg/dL. Consequently, prevalent HC includes participants who were treated with a lipid-lowering drug and those who qualified for treatment according to above thresholds but were not treated. Awareness of HC was defined as an affirmative response to the question, “Have you ever been told by a doctor or other healthcare professional that you had high cholesterol?” Treatment of HC was defined as a positive response to the question, “Because of your high cholesterol, are you now taking prescribed medicine?” This was verified using information collected on medications brought in by participants. Control of HC was defined as meeting NCEP/ATP III guideline levels for TC and LDL-C among those who were HC treated.

Socioeconomic position (SEP) was assessed using years of educational attainment defined as highest degree or level of

school completed (less than high school; completed high school or high school equivalent; and education beyond high school) and household income level, classified into groups (< $20 000; $20 000 to $39 999; $40 000 to $75 000 and > $75 000). Acculturation was defined using multiple proxy indicators, including nativity, duration of residence in the United States, and language preference based on language used for the interviews (English versus Spanish). Greater years of residence in the United States and English language preference indicated higher levels of acculturation.

Statistical Analysis

We applied survey methods using sampling weights to provide weighted frequencies of descriptive variables and population estimates of HC prevalence rates, as well as HC awareness, treatment, and control rates in the HCHS/SOL target population. Descriptive characteristics are age-standardized to the Census 2010 US population. We compared rates of awareness, treatment, and control of HC by demographic factors, anthropometric measurements, lifestyle factors, and clinical and sociocultural profiles. Continuous variables were compared using regression analysis and categorical variables were compared using Rao–Scott χ^2. We used Rao–Scott χ^2 analysis to explore whether the prevalence of established HC awareness, treatment, and control varied significantly among Hispanic/Latino groups and across categories of SEP and acculturation. To assess whether health insurance status confounds the association of SEP on HC awareness, treatment, and control, we constructed logistic regression models controlling for the effect of health insurance. To examine whether interrelations exists between acculturative factors (language, nativity, and length of time in the United States) and HC status, we performed additional sensitivity analysis looking at the association of time in the United States and HC control stratified by language preference and nativity, as well as looking at the inverse association of language and HC awareness stratified by time in the United States and nativity.

The above analyses were performed with SAS version 9.3 (SAS Institute Inc, Cary, NC) and SUDAAN release 10.0.0 (RTI). All analyses were weighted to adjust for sampling probability and nonresponse, to make the estimates applicable to the target population from which the HCHS/SOL sample was drawn in accordance with guidelines suggested by the HCHS/SOL Steering and Data Analysis Committees.

Results

Of 39 384 individuals who were screened, selected, and met eligibility criteria, 41.7% were enrolled, representing 16 415 persons from 9872 households. Baseline demographics of the HCHS/SOL population have been previously described.[10] In the target population, the prevalence of hypertension was 25%; 40% were obese and 17% had diabetes. Mean levels of TC, non-high-density lipoprotein cholesterol, and LDL-C were 196.0, 145.8, and 120.9 mg/dL, respectively. Forty-eight percent of the population had no health insurance coverage. Among those insured, most were at least partially covered by public health insurance (Medicaid and/or Medicare). Seventeen percent of those ages 65 years and older were uninsured compared to 45% to 58% of those in younger age groups (Table 1). There was differential health insurance coverage across Hispanic background group ranging from 33% to 80%; it was highest among Puerto Ricans and lowest among South Americans. Acculturation factors also varied, preferential English being highest among Puerto Ricans and lowest among Cubans; time residing in the mainland United States being highest among Puerto Ricans and lowest among Cubans. Health Insurance coverage was more common among preferential English speakers; among those participants residing in the mainland US >10 years and among the US born (Table 2).

The overall prevalence of HC was 45%; 15% had a high TC, 35% had elevated non-high-density lipoprotein cholesterol levels, and 37% had elevated LDL-C levels. HC was seen in significantly higher proportions among males and those in older age groups. In addition, proportions of those with HC were significantly higher among those with concomitant hypertension, diabetes, and those who were overweight/obese compared to those without. Proportions of those with HC were not significantly different across the Hispanic/Latino background groups or among those with or without self-reported coronary heart disease (Table 1).

HC Awareness

HC awareness was defined as ever being told by a health professional of having HC. Among those with HC, almost half (49%) were not aware of their condition. Among those with LDL-C ≥190 mg/dL, only 63% were HC aware. A significantly higher proportion of Hispanic/Latinos were HC aware in the older age groups. Despite a higher prevalence of HC in men, rates of HC awareness were higher among women than men across all age groups, but this difference was most pronounced among those middle-aged and older (Figure 1A). Significantly higher proportions of those who have hypertension, higher body mass index, or diabetes were HC aware. US-born Hispanic/Latinos had significantly lower rates of being HC aware compared to those who were foreign born. A proportion of those who were HC aware was significantly higher among preferential Spanish speakers compared to those who preferred English. The lowest and highest SEP categories (by educational attainment or income) had the

Table 1. Prevalence of High Cholesterol* Among Hispanics According to Descriptive Characteristics

Characteristic	Sample Size† (N)	High Cholesterol‡ (N=7837)		*P*-Value
Age (y)				
18 to 44	9815	2000	29%	<0.001
45 to 64	5202	4905	59%	
65+	1401	932	71%	
Hispanic/Latino background group				0.126
Dominican	1472	690	43%	
Central American	1731	798	46%	
Cuban	2347	1304	48%	
Mexican	6468	2995	45%	
Puerto Rican	2727	1300	43%	
South American	1071	520	45%	
Mixed/other	503	197	48%	
Gender				
Female	9829	4652	43%	≤0.001
Male	6577	3185	47%	
Hypertension				
Yes	4460	2899	53%	<0.001
No	11 944	4938	43%	
BMI, kg/m^2				
<25	3320	1162	38%	<0.001
25 to 29.9	6113	3153	47%	
30+	6902	3496	48%	
Diabetes				
Yes	3210	2146	58%	<0.001
No	13 174	5691	43%	
Prevalent CHD				
Yes	856	528	44%	0.561
No	15 473	7283	45%	

BMI indicates body mass index; CHD, coronary heart disease; HCHS/SOL, Hispanic Community Health Study/Study of Latinos; LDL, low-density lipoprotein; TC, total cholesterol.

*Defined as LDL ≥130, TC ≥240, or on cholesterol medications.

†N's presented are unweighted counts of total participants in the HCHS/SOL with respective characteristic.

‡N's presented are unweighted counts of participants with high cholesterol. Percentages are weighted row percentages and age-adjusted to a standardized population using 2010 US Census.

highest rates of HC awareness. Those with insurance coverage had significantly higher rates of being HC aware compared to those who were insured (Table 3). Logistic regression models controlling for health insurance to address confounding did not attenuate the effect of SEP (either income or education) on HC awareness. Individuals of Central American and Cuban heritage had the lowest rates of being HC aware, while those of Puerto Rican and Dominican backgrounds were more likely to be aware than other groups (Figure 2).

HC Treated

Treatment of HC was defined as taking prescribed cholesterol medicine. Among those who either had laboratory values indicating HC or had been told by a health professional that they had HC, less than a third (30%) were HC treated. Among those with an LDL-C ≥190 mg/dL, only 14% were HC treated. Although the likelihood of being HC treated increased with age, only 32% and 54% of middle-aged and older Hispanic/Latinos, respectively, with HC were actually being treated. A larger proportion (>90%) of HC-eligible Hispanic/Latinos <45 years of age were not receiving HC treatment. A trend was observed where rates of HC treatment were higher among Hispanic/Latino men versus women in the older age groups, particularly among those 65+ years of age (Figure 1B). Those with diabetes, the lowest SEP (by either education or income), and insurance coverage were more likely to be among those HC treated. Controlling for health insurance did not attenuate the effect of SEP on HC treatment. US-born Hispanic/Latinos had lower rates of being HC treated than those who were foreign born. Among the foreign born, rates of being HC treated increased with longer duration of US residence (Table 2). Higher proportions of individuals of Dominican or Puerto Rican background were receiving treatment for HC, whereas Hispanic/Latinos of Mexican or Central American background had lower rates of treatment (Figure 2).

HC Control

HC control was defined as meeting NCEP/ATP III guidelines for TC and LDL-C. Among those with HC using cholesterol-lowering medications, 64.3% were HC controlled. Older Hispanic/Latinos tended to have a higher rate of being HC controlled than those who were younger. Women had lower rates of being HC controlled than men. This sex difference persisted across all ages but was most pronounced among those 65 years and older (Figure 1C). The presence of diabetes, higher income levels, and insurance coverage was associated with being HC controlled. Controlling for health insurance did attenuate the effect of SEP on HC control. Those with greater duration of US residence had significantly higher rates of HC control than more recent immigrants (Table 2). Rates of adequate HC control varied significantly across Hispanic/Latinos background groups ranging from 54% to 71%, with Cubans and South Americans having the lowest HC control rates, whereas Puerto Ricans had the highest (Figure 2).

Table 2. Differential Insurance Status and Measures of Acculturation Across Hispanic Background Group*

	Dominican	Central American	Cuban	Mexican	Puerto Rican	South American
Health insurance coverage	511 (71.5%)	267 (33.0%)	535 (45.2%)	1385 (43.6%)	1075 (80.4%)	197 (42.9%)
Acculturation factors						
Preferential Spanish speaker	54 (12.0%)	37 (8.8%)	45 (4.3%)	355 (15.9%)	572 (51.5%)	25 (5.4%)
Years in the US ≥10	554 (80.3%)	580 (68.4%)	690 (52.2%)	2484 (78.7%)	1261 (95.4%)	371 (65.3%)
US born	26 (7.5%)	17 (3.7%)	35 (3.7%)	322 (15.4%)	416 (37.8%)	13 (3.1%)

*N's presented are unweighted counts of total participants in the Hispanic Community Health Study/Study of Latinos; weighted row percentages.

Discussion

To our knowledge, there have been no previous studies of diverse Hispanic/Latino representation comparing HC awareness, treatment, and control among diverse Hispanic/Latino background groups. Our findings show that HC is highly prevalent among US Hispanic/Latino adults and that less than half of those with HC were aware of their condition (ie, reported being told by a doctor or health professional that their cholesterol level was high). Moreover, less than a third of those with HC were being treated. Among those receiving treatment, only 64% had cholesterol concentrations that were adequately controlled. Gender disparities were observed in that men had higher HC prevalence rates than women but were less likely to be HC aware. Although Hispanic/Latino women with HC had similar rates of HC treatment compared to men, women were less likely to be HC controlled. Hispanic/Latinos ages 18 to 44 years with HC were more likely to be unaware of having HC and to be untreated for this condition compared to those ages 45 and older. HC treatment rates and optimal cholesterol goal attainment rates for all Hispanic/Latino background groups were suboptimal.

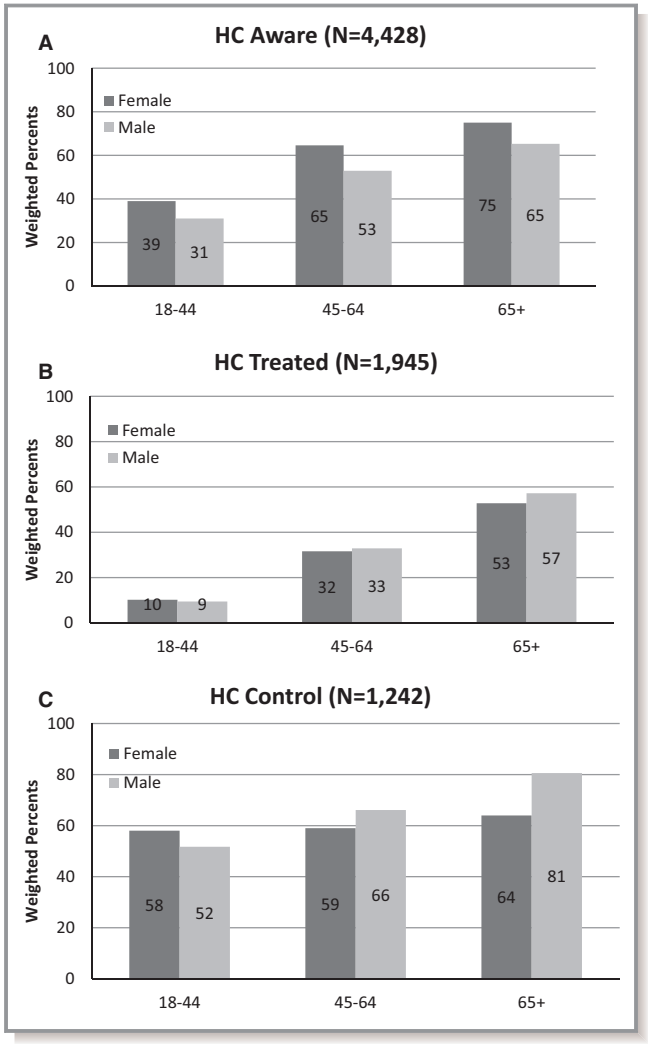

Figure 1. Percentage of participants (stratified by age and sex) who were (A) HC aware; (B) HC treated; and (C) HC controlled. HC indicates high cholesterol, defined as treated with a lipid-lowering drug or those who qualified for treatment according to LDL-C ≥130 mg/dL and/or TC ≥240 mg/dL but were not treated; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol.

Our study found that among Hispanic/Latino adults, prevalence of HC was higher among those with hypertension or diabetes, and the presence of these comorbid conditions increased the likelihood of being HC aware, treated, and controlled. Both diabetes and hypertension are associated with substantially increased risk of developing coronary heart disease.[16] Thus, it is encouraging that among Hispanic/Latinos with these comorbid conditions, rates of HC treatment and control were among the highest. The presence of more comorbidities probably increases the likelihood of having received the attention of the healthcare system and being HC treated. However, it creates a gap with regard to primary prevention, making those with HC and fewer comorbidities less likely to be among those HC aware, treated, or controlled. Furthermore, our findings showed that even among Hispanic/Latino individuals with these comorbid conditions, only slightly more than half of those with diabetes and two thirds of those with hypertension were HC aware.

Several studies have examined awareness, treatment, and control of HC in the United States (Table 4) but most have focused on non-Hispanic whites or blacks. The Cardiovascular Health Study[18] found that among adults ages 65 to 75 years, HC treatment was 8.1% in men and 10.0% in women in

Table 3. High Cholesterol Awareness, Treatment, and Control Rates According to Descriptive Characteristics*

	Awareness			Treatment			Control		
	Yes (n)	%	*P*- Value	Yes (n)	%	*P*- Value	Yes (n)	%	*P*- Value
Mean age (SE)	52.1 (0.35)		<0.001	58.7 (0.37)		<0.001	59.4 (0.41)		0.003
Men	1564	43	<0.001	685	28	0.12	470	69	0.009
Women	2864	58		1260	31		772	61	
Hypertension	2022	66	<0.001	1276	49	<0.001	837	65	0.49
No hypertension	2406	43		669	16		405	63	
BMI									
<25	582	46	0.02	207	24	0.003	128	61	0.64
25 to 29.9	1733	51		728	29		451	64	
30+	2096	53		996	32		655	66	
Diabetes	1572	71	<0.001	1059	54	<0.001	742	70	<0.001
No diabetes	2856	45		886	19		500	57	
Education									
<High school	1862	55	<0.001	956	39	<0.001	623	66	0.31
High school	946	45		377	26		240	65	
>High school	1524	50		565	24		349	61	
Income									
<20 K	2059	53	0.006	970	33	<0.001	628	66	0.002
20 to 40 K	1268	46		504	26		297	57	
40 to 75 K	531	50		203	24		147	74	
>75 K	179	55		79	28		55	76	
Health insurance									
Yes	2710	61	<0.001	1483	41	<0.001	1002	68	<0.001
No	1654	40		430	13		220	49	
Language									
Spanish	3802	52	0.02	1649	30	0.17	1032	64	0.28
English	626	46		296	27		210	68	
Years in US (foreign born)									
<10 years	784	43	<0.001	226	17	<0.001	119	53	<0.001
10+ years	3184	57		1518	36		988	67	
US born									
Yes	447	41	<0.001	190	24	0.007	128	62	0.59
No	3978	52		1748	30		1109	65	

BMI indicates body mass index; HCHS/SOL, Hispanic Community Health Study/Study of Latinos.
*N's presented are unweighted counts of total participants in the HCHS/SOL; percentages are weighted row percentages.

1995–1996. The Minnesota Heart Survey[19] showed that among non-Hispanic whites in 2002, 55% were HC unaware, and 33% were aware and untreated. The Genoa Study[20] looked at 2 US communities of non-Hispanic/Latino whites and blacks and found that fewer than 1 in 3 of these adults were HC treated and fewer than half of those treated had achieved recommended goals. Studies that included Hispanic/Latinos primarily involved Mexican heritage participants or considered Hispanic/Latinos as a single aggregate group. Data from the National Health and Nutrition Examination Survey demonstrated substantially lower rates of awareness, diagnosis, treatment, and control among Mexican Americans compared to non-Hispanic whites.[6,7] Less than half of National Health and Nutrition Examination Survey Mexican Americans had been screened for HC compared to 65.2% and 57.7% of non-Hispanic whites and non-Hispanic blacks, respectively.[6] In the

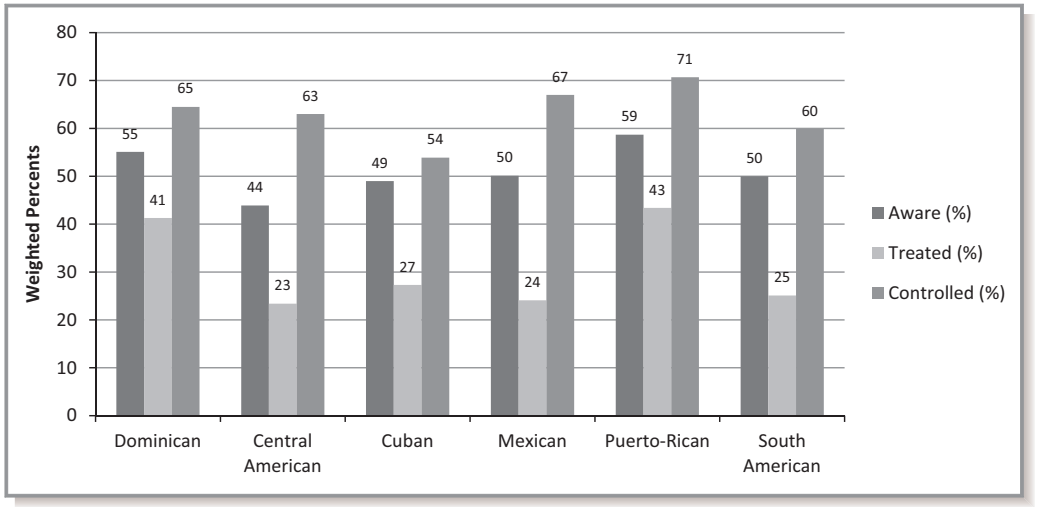

Figure 2. High cholesterol awareness, treatment, and control rates according to Hispanic background group.

Multiethnic Study of Atherosclerosis,[5] Hispanic participants were significantly less likely to be HC treated and controlled than non-Hispanic whites; however, these differences were attenuated by adjustment for healthcare access variables. We also noted HC gender disparities in our study. There is prior data suggesting less intensive cholesterol management in women than men, resulting in a similar disparity in cholesterol control[24,25]; however data across racial/ethnic groups are somewhat limited. In National Health and Nutrition Examination Survey 2005–2006, women were less likely to be HC controlled than men (56.9% versus 72.1%), and this trend was present across non-Hispanic whites, non-Hispanic blacks, and Mexican Americans (although seemingly most disparate among non-Hispanic blacks).[6]

Our study illustrates that among Hispanic/Latinos who are HC treated, the rates of HC control are fairly high (ranging from 54% to 71% among the various Hispanic/Latino background groups). However, a sizeable gap between HC awareness and HC treatment exists. Studies suggest that gaps in HC treatment and control are often related to gaps in availability of, access to, or continuity of health care.[26–28] The Affordable Care Act is intended to reduce some of these gaps[29] by both increasing insurance coverage among the nonelderly US population and by providing coverage for cholesterol screening with no cost-sharing. However, access to care alone may not resolve gaps in HC treatment and control completely. Other factors that may affect HC treatment and control in the US Hispanic/Latino population include primordial risks (eg, diet), language barriers, poor patient–provider communication, and insufficient treatment (eg, provider clinical inertia) and/or patient medication adherence.[30,31] Lower out-of-pocket costs, improved patient–provider communication, and simplification of the drug regimen generally are associated with better adherence.[32] The fact that there is a large gap between HC awareness and subsequent treatment and control underscores the need to go beyond screening programs and health fairs to improve the health of the Hispanic/Latino population.

Those with the lowest SEP (by household income), while more likely to be HC aware, had a markedly lower prevalence of HC control. Furthermore, the lowest and highest SEP groups (by educational attainment or income) had the highest rates of HC awareness, suggesting a disparity gap among "working poor" and "middle-class" Hispanic/Latinos. It may be that Hispanic/Latinos in the lowest and highest SEP categories are more likely to have health insurance, due to Medicaid for those with low SEP and more wealth resources for those with higher SEP, respectively. Hispanic/Latinos in the middle SEP group, however, may be more likely to fall through gaps. Higher rates of HC awareness, treatment, and control were related to having health insurance. Controlling for health insurance did not remove the effect of SEP on HC awareness and treatment but did remove the effect of SEP on HC control. Compared with non-Hispanic whites, Hispanics are less likely to have health insurance or a regular source of care, and less likely to receive preventive services.[33] Increased acculturation (by nativity and preferential English speaking) was associated with decreased HC awareness. However, among immigrants, increasing years in the United States did increase the likelihood of HC treatment and control, perhaps due to increasing ability to navigate the US healthcare system and establishment a social support system to do so. This highlights a complicated relationship of acculturation and health. Being a more recent immigrant was a more dominant acculturative factor in determining HC awareness than being able to dominate the English language.

Table 4. Prior Studies of High Cholesterol Awareness, Treatment, and Control in the United States

Reference	Year	Sample Size/ Population	Age Range/Mean	Major Findings
Studies that did not include Hispanics				
The Atherosclerosis Risk in Communities study[17]	1995	African Americans and Caucasians	15 739 individuals aged 45 to 64 years	25% of African American men and 27% of African American women with hypercholesterolemia were aware of their condition; of these, only 20% and 21%, respectively, were undergoing treatment, and only 32% and 45%, respectively, achieved treatment goals
Cardiovascular Health Study[18]	1995–1996	African Americans and whites	65 to 75	The prevalence of cholesterol-lowering drug use in 1995–1996 was 8.1% among men and 10.0% among women
Minnesota Heart Survey[19]	2000–2002	Whites	35 to 74	The mean prevalence of hypercholesterolemia in 2000 to 2002 was 54.9% for men and 46.5% for women. More than half of those at borderline-high risk remain unaware of their condition
Genoa Study[20]	2004	Non-Hispanic hypertensive blacks and whites	Women, 59.8±9.4 vs 57.8±10.0; and men, 60.8±9.5 vs 57.4±10.1 years	Dyslipidemia prevalence ranges 50% to 78% and more prevalent among whites than blacks. Less than one third are treated (treatment was more common among whites than blacks), and fewer than half of those treated achieve goal (control was seen more among black men vs white men)
Studies that did include Hispanics				
MESA[5]	2000	Non-Hispanic whites, blacks, Chinese, and Hispanic Americans	45 to 84	Hispanic Americans had prevalence of dyslipidemia that was comparable to that of non-Hispanic whites but were less likely to be treated and controlled
NHANES[6]	1999–2006	Non-Hispanic whites, African Americans, and Mexican Americans	≥20 years	Lower rates of having cholesterol check, reporting being told about hypercholesterolemia; hypercholesterolemia treatment and control among Mexican Americans than whites
NHANES[7]	1988–1994	Non-Hispanic whites, African Americans, and Mexican Americans	≥25 years	Mexican Americans were less likely to report cholesterol screening than whites. Even when identified as having high cholesterol, Mexican Americans were less likely to be on cholesterol-lowering agents
NHANES[23]	1999–2000 to 2009–2010	Non-Hispanic whites, African Americans, and Mexican Americans	≥25 years	Prevalence of high cholesterol did not change from 1999–2000 (37.2%) to 2009–2010 (37.8%). Awareness increased from 48.9% in 1999–2000 to 61.5% in 2009–2010 (61.5%). Treatment increased from 41.3% in 1999–2000 to 70.0% in 2009–2010. The percentage with controlled cholesterol increased from 45.0% in 1999–2000 to 63.6% by 2009–2010

MESA indicates Multi-Ethnic Study of Atherosclerosis; NHANES, National Health and Nutrition Examination Survey.

Similarly, increasing time in the United States portends a greater likelihood of HC control among those who were less acculturated (preferential Spanish speakers and those foreign born) but was not a factor among the more acculturated (preferential English speakers and those US born). This acculturation–health relationship differential effect was also seen in a prior study.[34]

Our findings of variation in HC awareness, treatment, and control across the different background groups provide further evidence of the complexity and heterogeneity of the Hispanic/Latino population; thus, HC awareness, treatment, or control rates for 1 group cannot be extrapolated to represent all Hispanic/Latinos. Hispanic/Latinos of Puerto Rican and Dominican background seem to fare better with regard to higher rates of HC awareness, treatment, and control whereas those of Mexican, Cuban, and Central and South American backgrounds seem to fare worse. US Hispanic/Latinos have differential regional patterns of settlement in the United

States, with Mexicans concentrated in the Southwest, Cubans in the Southeast, Central/South Americans in the Midwest and South, and Puerto Ricans and Dominicans in the Northeast. Thus, some of these differences in HC treatment and control observed among Hispanic/Latino background groups may be geographical in nature, given differences in medical coverage across state lines. State laws governing medical coverage for low-income individuals vary and these differences are likely to worsen, with some states having declined to adopt the Medicaid expansion provisions of the Affordable Care Act.

Our results should be interpreted in light of several limitations. While HCHS/SOL is the largest epidemiologic study of diverse community-dwelling US Hispanic/Latinos, it was not designed to be nationally representative but is representative of the communities sampled; thus, our findings may not be generalizable to all US Hispanic/Latinos. Our findings may underestimate the prevalence of HC, since older persons residing in nursing homes or other institutions (with potentially a higher prevalence of age-related HC) were not included in the HCHS/SOL. Data regarding awareness was based on self-report and could be subject to recall bias. The NCEP/ATP III report identifies concentrations of LDL-C rather than TC as the primary target of treatment. However, insights about TC are still of value and participants may not have been able to distinguish between TC and LDL-C when asked whether they had their cholesterol checked and/or had been told by a physician that their cholesterol is high. Our definition of treatment included coding of medications reviewed by study staff; thus, our measure is more robust than that of several prior studies of HC treatment that used medication self-report only. This study was initiated, laboratory samples were collected, and management strategies examined under the older NCEP/ATP III guidelines, which focused on target levels rather than atherosclerotic risk to determine who is treated. It is likely that under the new, broader American Heart Association/American College of Cardiology cholesterol treatment guidelines,[35] an even larger number of Hispanic/Latinos will be undertreated, further highlighting this health disparity.

In conclusion, we found high rates of HC and a very low prevalence of HC awareness among Hispanic/Latino adults and a major gap between HC awareness and HC treatment that bodes poorly for the public health of this large and growing segment of the US population. Not surprisingly, our observational data indicated that once treated, achievement of optimal HC control is possible among Hispanic/Latinos. Complementary and targeted public health programs to raise HC awareness and increase the proportion of Hispanic/Latinos receiving HC treatment and achieving HC control are needed to reduce healthcare disparities in this population. Our findings fill major gaps in understanding HC awareness, treatment, and control among US Hispanic/Latino adults, and will help guide and inform physicians and policymakers toward improving patient education programs and disease management.

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