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Awareness of Cardiovascular Risk Factors in U.S. Young Adults Aged 18–39 Years

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Abstract

Introduction—Young adults with hyperlipidemia, hypertension, and diabetes are at increased risk of developing heart disease later in life. Despite emphasis on early screening, little is known about awareness of these risk factors in young adulthood.

Methods—Data from the nationally representative cross-sectional survey National Health and Nutrition Examination Survey 2011–2014 were analyzed in 2017 to estimate the prevalence of self-reported awareness of hypercholesterolemia, hypertension, and diabetes in U.S. young adults aged 18–39 years ($n=11,083$). Prevalence estimates were weighted to population estimates using survey procedures, and predictors of awareness were identified using weighted logistic regression.

Results—Among U.S. young adults, the prevalence of hypercholesterolemia, hypertension, and diabetes was 8.8% (SE=0.4%), 7.3% (SE=0.3%), and 2.6% (SE=0.2%), respectively. The prevalence of borderline high cholesterol, blood pressure, and blood glucose were substantially higher (21.6% [SE=0.6%], 26.9% [SE=0.7%], and 18.9% [SE=0.6%], respectively). Awareness was low for hypercholesterolemia (56.9% [SE=2.4%]) and moderate for hypertension and diabetes (62.7% [SE=2.4%] and 70.0% [SE=2.7%]); <25% of young adults with borderline levels of these risk factors were aware of their risk. Correlates of risk factor awareness included older age, insurance status, family income above the poverty line, U.S. origin, having a usual source of health care, and the presence of comorbid conditions.

Conclusions—Despite the high prevalence of cardiovascular risk factors in U.S. young adults, awareness remains less than ideal. Interventions that target access may increase awareness and facilitate achieving treatment goals in young adults.

INTRODUCTION

Atherosclerosis begins early in life and can lead to coronary heart disease (CHD) in older adulthood.^{1,2} Young adults with cardiovascular risk factors are at increased risk of CHD later in life, and even borderline levels of these risk factors are associated with atherosclerotic changes that persist into adulthood.^{1,3-9} Moreover, studies have shown that individuals who reach middle- age with favorable levels of major cardiovascular risk factors have a significantly lower incidence of cardiovascular disease and greater longevity, highlighting the imperative for recognizing and treating cardiovascular risk factors early in life.¹⁰⁻¹² As a result, many guidelines now recommend universal screening for hypertension and hyperlipidemia in children and adolescents.^{13,14} By contrast, screening for cardiovascular risk factors in young adults is recommended primarily among patients with identified CHD risk factors.^{15,16}

Despite the emphasis on early but selective screening, little is known about patient awareness of these risk factors in young adulthood. Prior literature suggests that the prevalence of suboptimal cholesterol, blood pressure, and blood glucose in young adults may be as high as 38%, 7%, and 4.5%, respectively.¹⁷⁻²¹ Although a few studies have examined undiagnosed hypercholesterolemia, hypertension, and diabetes in U.S. adults,^{19,21-27} no studies have evaluated awareness across multiple risk factors, in patients with borderline levels of these risk factors, or in young adults specifically.

Accordingly, this study aims to quantify the prevalence of self-reported awareness among U.S. young adults with hypercholesterolemia, hypertension, or diabetes, and to identify sociodemographic and clinical correlates of awareness. Such information is critical to identifying gaps in screening and education in order to better target populations who are undiagnosed or unaware of their cardiovascular risk.

METHODS

Study Sample

Data from the 2005–2014 National Health and Nutrition Examination Survey (NHANES) were used to evaluate the prevalence of self-reported awareness of high and borderline cholesterol, blood pressure, and blood glucose in U.S. young adults aged 18 to 39 years. Conducted by the National Center for Health Statistics, NHANES uses a stratified, multistage sampling design to obtain a nationally representative sample of the U.S. non-institutionalized civilian population. It collects detailed information on participant demographic, socioeconomic, and health-related characteristics through in-home interviews and clinical assessments. All non-pregnant participants aged 18 to 39 years were included in this sample ($n=11,083$).

Measures

Detailed descriptions about blood collection and processing are provided in the NHANES Laboratory/Medical Technologists Procedures Manual. Specimens for total cholesterol, glycosylated hemoglobin, and serum glucose were stored under refrigerated conditions and shipped weekly to the University of Minnesota or the University of Missouri-Columbia for

processing. Blood pressure was measured by auscultation three consecutive times after participants had been seated for 5 minutes.

High and borderline levels of blood cholesterol, blood pressure, and blood glucose were defined using the 2013 American Heart Association/American College of Cardiology Guidelines²⁸ and prior studies using NHANES.^{17,19,24,26,29,30} Hypercholesterolemia was defined as total cholesterol \geq 240 mg/dL or current self-reported use of cholesterol-lowering medications. Borderline high cholesterol was defined as total cholesterol between 200 and 239 mg/dL. Consistent with the definition at the time of the analysis, hypertension was defined as an average systolic blood pressure \geq 140 mmHg or diastolic blood pressure \geq 90 mmHg or current self-reported use of antihypertensive medication. Borderline hypertension was defined as an average blood pressure of 120–139 mmHg systolic or 80–89 mmHg diastolic. Because 56.9% of participants were missing fasting plasma glucose (FPG), both FPG and hemoglobin A1c (HbA1c) were used to identify individuals with diabetes and borderline diabetes. Type 1 or Type 2 diabetes was defined as FPG \geq 126 mg/dL or HbA1c \geq 6.5%, or self-reported use of insulin or oral agents. Borderline diabetes was defined as FPG 100–125 mg/dL or HbA1c 5.7%–6.5%. Missing total cholesterol, blood pressure measurements, and FPG or HbA1c accounted for 1,139 (10.3%), 946 (8.5%), and 1,069 (9.7%) of observations, respectively.

Participants were asked if they had ever been told by a doctor or health professional that their blood cholesterol level was high, that they had hypertension or high blood pressure, or that they had diabetes, prediabetes, impaired glucose tolerance, or borderline diabetes. Those responding affirmatively were categorized as being aware of having hypercholesterolemia, hypertension, and diabetes, respectively.

Several sociodemographic and clinical variables were examined including age, sex, race/ethnicity, poverty, insurance status, education, place of birth, usual source of care, and other cardiovascular risk factors, including hypercholesterolemia, hypertension, diabetes, BMI (healthy BMI [<25 kg/m²], overweight [25 – 29.9 kg/m²] and obese [≥ 30 kg/m²]), smoking status (never, past, and current), and family history of early cardiovascular disease. Poverty was defined as the ratio of family income to geographic poverty level $<133\%$.³¹ Usual source of care was categorized as no usual source, hospital emergency room or outpatient department, and doctor's office or clinic/health center. Family history of cardiovascular disease was defined as having a close family relative with a heart attack or angina aged <50 years.

Statistical Analysis

NHANES data were analyzed in 2017 using the survey procedures in SAS, version 9.4 to account for the complex survey design.³² The prevalence of hypercholesterolemia, hypertension, and diabetes and borderline levels of these risk factors were estimated in the U.S. young adult population. Awareness for these risk factors was calculated among those with high or borderline levels and compared across participant characteristics using Rao–Scott modified chi-square tests. Multivariable logistic regression analyses were used to identify covariates associated with hypercholesterolemia, hypertension, and diabetes

awareness. Covariates were selected using a backwards elimination model and retained in the final model if they were associated with risk factor awareness at the $p < 0.05$ level.

Missing covariate data were rare. There was missing data for $\cong 13\%$ of participants on one variable, 10% of participants on two variables, and 1% of participants on three or more variables. Missing covariate data were imputed using a single imputation approach. Outcome data (i.e., awareness) were missing in 33.9%, 0%, and 0.3% of participants with high or borderline cholesterol, blood pressure, and blood glucose, respectively. Outcome data were not imputed. Participants with missing cholesterol awareness data were more likely to be younger, uninsured, and to lack a usual source of care. Consent for participation in NHANES was obtained during the initial screening visit. This analysis was deemed exempt under federal regulation 45 CFR §46.101(b).

RESULTS

Among U.S. young adults aged 18 to 39 years, 8.8% (SE=0.4%) had hypercholesterolemia and 21.6% (SE=0.6%) had borderline high cholesterol (Figure 1). An estimated 7.3% (SE=0.3%) of young adults had hypertension and 26.9% (SE=0.7%) had borderline hypertension. There were 2.6% (SE=0.2%) of young adults that had Type 1 or Type 2 diabetes and 18.9% (SE=0.6%) had borderline diabetes. Approximately 18.9% (SE=1.6%) of adults with hypercholesterolemia, 43.9% (SE=2.3%) of adults with hypertension, and 53.4% (SE=3.1%) of adults with diabetes reported taking medications to treat these conditions. The prevalence of comorbid hypercholesterolemia, hypertension, and diabetes are provided in Appendix Figures 1 and 2. The majority of young adults with hypercholesterolemia, hypertension, or diabetes had only a single risk factor; however, there was significant overlap among individuals with borderline levels of these risk factors. Of those with hypercholesterolemia, 56.9% (SE=2.4%) were aware of their elevated cholesterol, whereas 62.7% (SE=2.4%) of young adults with hypertension were aware of having hypertension, and 70.0% (SE=2.7%) of those with diabetes knew of their diagnosis (Figure 2). Awareness among individuals with borderline high levels of cholesterol, blood pressure, and blood glucose was significantly lower (22.5% [SE=1.4%], 12.3% [SE=0.8%], and 5.7% [SE=0.7%], respectively). In general, awareness was higher in young adults with more than one risk factor compared with those with only one risk factor (Appendix Figure 3).

Factors associated with hypercholesterolemia, hypertension, and diabetes awareness are provided in Table 1. After multivariable adjustment, insurance status and having a usual source of care were independent correlates of hypercholesterolemia, hypertension, and diabetes awareness (Table 2). Other correlates of hypercholesterolemia awareness included older age and concurrent diabetes. Similarly, older age, female gender, U.S. origin, concurrent diabetes, and current smoking were significantly associated with hypertension awareness, and non-Hispanic white race/ethnicity was associated with diabetes awareness. Relative to non-Hispanic white adults, non-Hispanic black adults and Hispanic adults were significantly less likely to be aware of their diabetes.

When analyses were repeated in young adults with borderline risk factors, associations between sociodemographic and clinical factors with risk factor awareness were generally

weaker (Appendix Table 1). Among young adults with borderline high cholesterol, correlates of awareness included higher education and family history of cardiovascular disease (Appendix Table 2). Correlates of awareness in individuals with borderline high blood pressure included older age, race/ethnicity, U.S. origin and overweight or obesity, and correlates of awareness in individuals with borderline diabetes included older age, race/ethnicity, and family history of cardiovascular disease.

DISCUSSION

Despite the high prevalence of cardiovascular risk factors in this nationally representative sample of U.S. young adults, risk factor awareness remained less than ideal. Approximately 30% of young adults with diabetes, 37% with hypertension, and 43% with hypercholesterolemia were unaware of their condition. Awareness was substantially lower in young adults with borderline levels of these risk factors; more than 75% of young adults with borderline hypercholesterolemia, hypertension, and diabetes were unaware that they were at risk. Although predictors of awareness varied across risk factors, young adults with younger age, no insurance, or without a usual source of care were, in general, less likely to be aware of their risk factors. These findings suggest that targeting interventions to screen and raise awareness among these individuals may facilitate achieving treatment goals in this young adult population.

These findings are consistent with prior NHANES studies in older adult populations demonstrating suboptimal hypercholesterolemia, hypertension, and diabetes awareness. These studies have reported the prevalence of undiagnosed hypercholesterolemia, hypertension, and diabetes to be as high as 65%, 28%–31%, and 30%, respectively.^{19,23,24,33} Estimates of hypercholesterolemia awareness in this study were comparable to those in prior studies,³³ but the prevalence of hypertension and diabetes awareness was higher possibly due to the use of more contemporary data or greater insurance coverage under the Affordable Care Act.^{19,33} Other studies using NHANES data have also explored predictors of risk factor awareness in older populations but only examined a few demographic characteristics.^{22,26} The current study extends these findings to a contemporary population of U.S. young adults, for whom risk factor awareness is critical to the prevention of future CHD, and examines a wide range of both sociodemographic and clinical correlates of awareness among individuals with both borderline and high levels of cardiovascular risk factors.

Individuals without insurance and without a usual source of care were more likely to be unaware of their risk factors. In fact, these variables were more consistent predictors of unawareness than most of the clinical variables examined. This observation is particularly concerning given prior reports showing higher cardiovascular morbidity and mortality in poor and less educated patients^{34–36} and lower treatment rates for coronary artery disease among the uninsured.^{37,38} Not surprisingly, prior studies have also found lower rates of treatment and control for hypercholesterolemia, hypertension, and diabetes among poor and uninsured patients.³⁹ Despite racial/ethnic differences in the prevalence of cardiovascular risk factors in the general population, there were no differences in awareness of hypercholesterolemia or hypertension by race/ethnicity in multivariable analyses. The

absence of an association is likely because of the inclusion of other variables, such as healthcare access and insurance, in the models. Only diabetes awareness differed by race/ethnicity with lower awareness among non-Hispanic and Hispanic adults. These data demonstrate the need for increased risk factor screening and education efforts among low-income and underinsured young adults and the urgency of such efforts in a time of healthcare reform.

Interestingly, the presence of multiple cardiovascular risk factors augmented awareness only moderately. Among young adults with more than one risk factor, 26%, 27%, and 23% were unaware of having hypercholesterolemia, hypertension, and diabetes, respectively. In multivariable models, comorbid diabetes was a significant correlate of both hypercholesterolemia and hypertension awareness possibly because the American Diabetes Association has been advising clinicians to identify and treat additional cardiovascular risk factors in patients with diabetes for decades.⁴⁰ Neither hypercholesterolemia, hypertension, obesity, nor family history of early cardiovascular disease emerged as significant predictors of awareness for any risk factor, and smoking was only associated with hypertension awareness. This observation may be because of the fact that greater cardiovascular risk factor clustering tends to occur in Americans with low SES, which may prevent many individuals from obtaining screening or counseling for these risk factors.⁴¹ The association of smoking with increased hypertension awareness may be because of more targeted screening and education of smokers by clinicians given their elevated risk of cardiovascular disease.

This study also found very low awareness in individuals with borderline levels of these risk factors. Only 22%, 12%, and 6% of young adults with borderline hypercholesterolemia, hypertension, and diabetes, respectively, recalled having ever been told that they were at risk of these conditions. This low prevalence is especially concerning given the high prevalence of borderline risk factors in the young adult population and the likelihood that these individuals will go on to develop hypercholesterolemia, hypertension, and diabetes in the future if no intervention occurs. As the prevalence of cardiovascular disease continues to climb, there is an even greater imperative to focus on prevention earlier in life, particularly among those with borderline risk factors. Data from the Coronary Artery Risk Development in Young Adults study demonstrated that individuals with risk factors above optimal levels were two- to three-fold more likely to have subclinical atherosclerosis,⁴ and individuals who develop cardiovascular risk factors early in life are more likely to have a persistence of these factors into older adulthood.^{6–8} Early education and lifestyle modifications have been shown to reduce the development of these risk factors^{42–46}; however, these interventions are contingent upon effectively screening and diagnosing these at-risk populations. Young adults with borderline risk factor levels are precisely the population who might benefit from simple inexpensive interventions to prevent the development of these risk factors and their sequelae.

Taken together, this study's findings suggest that targeting educational and screening interventions at young adults with barriers to care may lower the prevalence of undiagnosed cardiovascular risk factors and improve treatment goals in this population. Unrecognized cardiovascular risk factors place individuals at risk for developing CHD and stroke later in life, in addition to being costly and disabling diseases in and of themselves. These findings

are particularly timely given recent changes in the hypertension guidelines now defining hypertension as blood pressure greater than 130/80 mmHg, which is estimated to expand the percentage of young adults with hypertension from 11% to 30% in men and 10% to 19% in women.⁴⁷

Recent guidelines recommend universal screening for cholesterol and blood pressure in all children between the ages of 17–21 years, which may improve diagnosis and identification of at risk youth.^{13,14} However, adherence to these guidelines amongst pediatricians is low,⁴⁸ and many youth are lost to follow-up as they transition from pediatric to adult-centered care.⁴⁹ Therefore, these guidelines are not likely to benefit adolescents or young adults with limited access to care who are most likely to be unaware of their risk factors. At present, the U.S. Preventive Services Task Force recommends selective cholesterol and diabetes screening for men and women at increased risk of CHD but does not advise routine cholesterol screening until age 35 years in men and age 45 years in women. Given the high prevalence of borderline and high cholesterol in young adults coupled with the low awareness of these risk factors observed in this study, more liberal screening of cholesterol may be warranted particularly in adults with interrupted access to care who may have infrequent opportunities for screening. Although the U.S. Preventive Services Task Force does recommend routine screening for hypertension in young adults, individuals with limited access to care are unlikely to benefit from these recommendations. As such, this study highlights the importance of community outreach efforts, such as mobile screening units.

Limitations

This study has its limitations. First, as with any self-reported questionnaire, participant answers may be subject to imperfect recall or social desirability bias. Second, data on cholesterol awareness was missing in approximately 34% of participants with high or borderline cholesterol. Compared with participants with recorded awareness data, participants with missing data were younger and more likely to be uninsured and lack a usual source of care. Therefore, cholesterol awareness may be even lower than those reported in this study. Third, NHANES uses three repeated measures on a single day (rather than multiple days) to diagnose hypertension. Although this is not the standard in clinical practice, the Centers for Disease Control and Prevention and multiple other studies have used these data to estimate the prevalence of hypertension.^{19,22} Similarly, the use of a single fasting glucose test and HbA1c to diagnose diabetes is not typically used in clinical practice; however, this method has also been used to estimate the population prevalence of both Type 1 and Type 2 diabetes.^{23,26} Fourth, information on health literacy or knowledge of cardiovascular disease was not available and may be important contributors to risk factor awareness. Fifth, participant access to care was evaluated at a single timepoint, when, in fact, many people routinely cycle in and out of coverage or between providers. Sixth, it was not possible to differentiate between Type 1 and Type 2 diabetes given the absence of laboratory data such as C-peptide levels or insulin antibody testing; however, both Type 1 and Type 2 diabetes confer an elevated risk of cardiovascular disease and mortality. Finally, lack of awareness could be a result of not having been screened, or alternatively, not receiving, or not understanding abnormal results. Because clinicians often use a risk score

approach to evaluate patient risk, some participants may be aware that they are at increased risk of cardiovascular disease but unaware of individual cardiovascular risk factors.

CONCLUSIONS

Awareness of hypercholesterolemia, hypertension, and diabetes is suboptimal in U.S. young adults. Young adults with barriers to health care such as lack of insurance and no usual source of care were more likely to be unaware of their CHD risk factors. Future studies are needed to better understand impediments to awareness about CHD risk factors among young adults, and to develop and evaluate interventions that target screening in young adults with limited access to care. In the meantime, clinicians should continue to improve patient education around the risks and consequences of borderline and elevated levels of cardiovascular risk factors.

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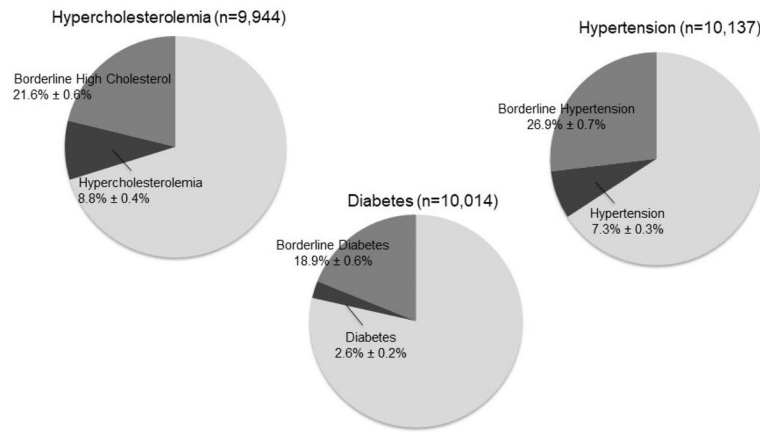


Figure 1. Prevalence of cardiovascular risk factors in U.S young adults aged 18–39 years from the National Health and Nutrition Examination Survey 2005–2014.
^aBorderline high cholesterol was defined as total cholesterol (fasting or nonfasting [2.2%]) 200–239mg/dL and high cholesterol was defined as total cholesterol ≥240mg/dL or self-reported use of cholesterol-lowering agent. Hypertension was defined as blood pressure ≥140/90mmHg averaged over three measurements or self-reported use of blood pressure lowering agent. Borderline hypertension was defined as average blood pressure 120–139/80–89mmHg. Diabetes was defined as fasting blood glucose ≥126mg/dL or hemoglobin A1c ≥6.5%. Or self-reported use of insulin or oral agents. Borderline diabetes was defined as fasting blood glucose 100–125mg/dL or hemoglobin A1c 5.7–6.4%.

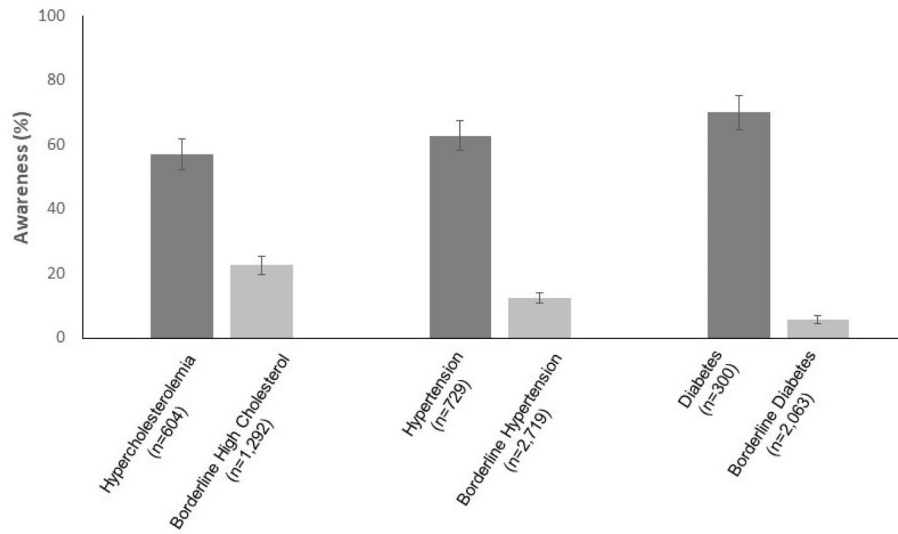
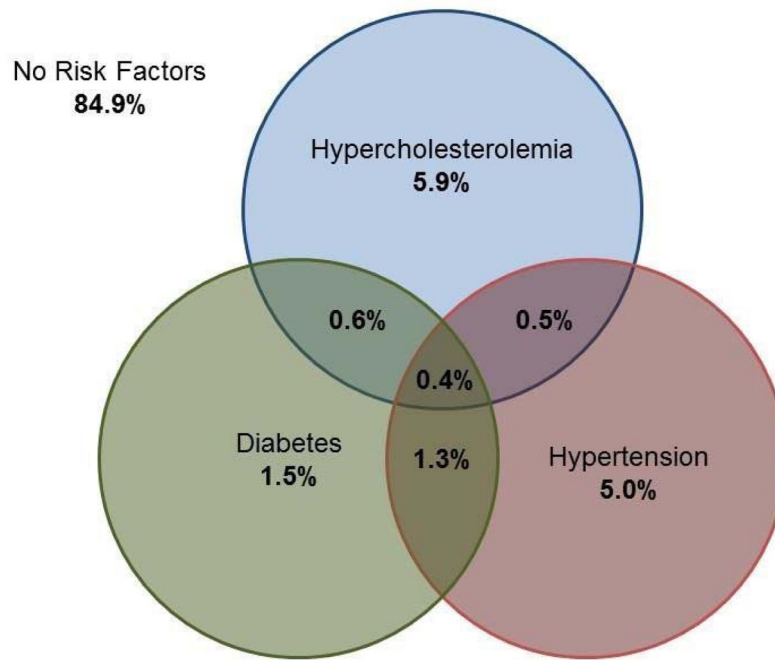
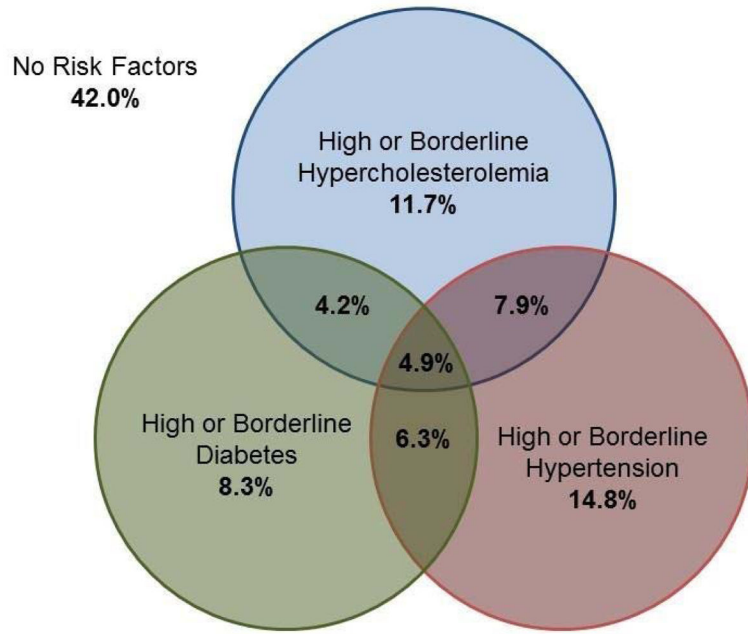


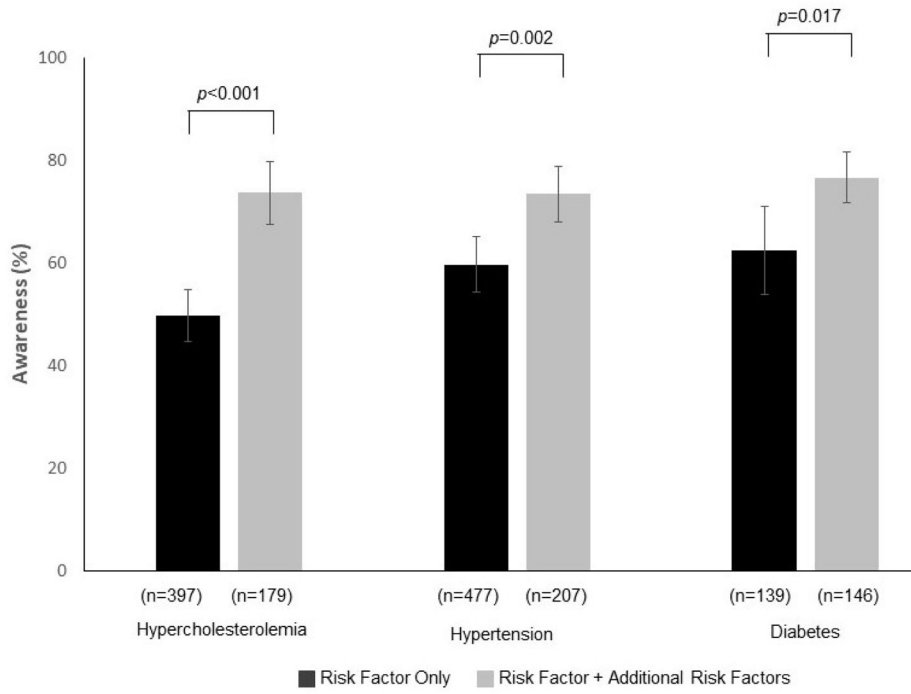
Figure 2. Percentage of young adults (aged 18 to 30 years) with high or borderline levels of cholesterol, blood pressure, and blood glucose reporting awareness of their risk factor from the National Health and Nutrition Examination Survey 2005–2014.



Appendix Figure 1. Overlap of hypercholesterolemia, hypertension, and diabetes in U.S. young adults aged 18–39 years.



Appendix Figure 2. Overlap of high and borderline hypercholesterolemia, hypertension, and diabetes in U.S. young adults aged 18–39 years.



Appendix Figure 3.
 Percentage of young adults with a single or multiple risk factors reporting awareness of hypercholesterolemia, hypertension, or diabetes.

Table 1

Percentage of U.S. Young Adults (Aged 18 to 39 Years) With Hypercholesterolemia, Hypertension, and Diabetes Reporting Awareness of Their Risk Factor by Participant Characteristics From NHANES 2005–2014^a

Characteristic	Awareness of hypercholesterolemia (n=604)			Awareness of hypertension (n=729)			Awareness of diabetes (n=300)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Age			<0.001			<0.001			0.759
18–29 years	151	40.6 ± 3.8		200	46.1 ± 4.5		89	68.7 ± 4.5	
30–39 years	453	62.9 ± 2.7		529	69.4 ± 2.3		211	70.4 ± 3.3	
Gender			0.167			<0.001			<0.001
Male	347	54.2 ± 3.1		463	53.4 ± 2.8		165	59.8 ± 4.1	
Female	257	60.6 ± 3.5		266	80.2 ± 2.9		135	81.1 ± 3.6	
Race/Ethnicity			0.077			0.121			<0.001
Non-Hispanic white	301	60.0 ± 3.2		295	63.4 ± 3.5		101	81.8 ± 3.6	
Non-Hispanic black	101	57.8 ± 4.0		248	68.3 ± 2.9		75	69.2 ± 5.6	
Mexican American or other Hispanic	138	47.5 ± 4.5		123	54.7 ± 5.0		89	50.3 ± 5.6	
Other race/ethnicity	64	49.6 ± 8.1		63	55.0 ± 7.5		35	60.0 ± 9.5	
Education			0.344			0.782			0.004
Less than high school	108	50.1 ± 5.2		141	60.9 ± 4.7		72	56.6 ± 6.8	
High school graduate	125	61.6 ± 5.1		188	65.3 ± 3.9		79	63.5 ± 5.2	
College graduate	364	57.3 ± 3.1		367	62.9 ± 3.2		133	77.2 ± 3.4	
Missing	7	–		33	–		16	–	
Poverty			0.106			0.841			0.001
No	370	58.9 ± 3.0		431	62.9 ± 2.9		148	75.9 ± 2.9	
Yes	185	49.4 ± 4.8		251	62.1 ± 3.2		123	59.4 ± 5.1	
Missing	49	–			–		29	–	
Insured			<0.001			<0.001			<0.001
No	165	38.0 ± 5.5		206	47.2 ± 4.1		117	53.1 ± 4.0	
Yes	439	62.0 ± 2.7		523	67.7 ± 2.5		183	78.8 ± 3.4	
Foreign born			0.085			<0.001			0.001
No	460	58.5 ± 2.5		614	65.1 ± 2.6		226	74.8 ± 2.9	
Yes	144	49.8 ± 4.9		115	46.3 ± 4.4		74	48.3 ± 7.4	

Characteristic	Awareness of hypercholesterolemia (n=604)			Awareness of hypertension (n=729)			Awareness of diabetes (n=300)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Usual source of care			<0.001			<0.001			<0.001
None	132	34.7 ± 4.7		171	35.6 ± 4.6		66	42.6 ± 5.6	
Hospital or health center	120	55.9 ± 5.5		142	67.8 ± 4.9		77	68.3 ± 7.0	
Private clinic or doctor's office	352	64.4 ± 2.8		416	70.9 ± 2.9		157	80.0 ± 3.4	
Cholesterol						0.091			0.011
Normal	-	-		351	61.9 ± 3.1		131	70.3 ± 4.6	
Borderline hypercholesterolemia	-	-		175	60.2 ± 4.1		71	55.4 ± 6.7	
Hypercholesterolemia	-	-		157	71.8 ± 4.1		96	79.6 ± 3.8	
Missing	-	-		46	-		2	-	
Blood pressure			<0.001						0.027
Normal	276	53.4 ± 3.0		-	-		101	66.7 ± 5.4	
Borderline hypertension	164	48.1 ± 4.3		-	-		93	60.7 ± 4.8	
Hypertension	135	73.1 ± 5.2		-	-		86	79.7 ± 4.6	
Missing	29	-		-	-		20	-	
Glucose intolerance			0.003			<0.001			-
Normal	342	53.5 ± 3.2		368	57.1 ± 3.3		-	-	
Borderline diabetes	178	53.3 ± 5.4		235	68.4 ± 3.0		-	-	
Diabetes	75	81.8 ± 4.7		86	82.7 ± 4.1		-	-	
Missing	9	-		40	-		-	-	
BMI (kg/m ²)			0.124			0.001			0.503
Healthy BMI (<25kg/m ²)	137	51.8 ± 4.6		107	53.9 ± 5.3		44	74.1 ± 8.2	
Overweight (25-30kg/m ²)	185	53.9 ± 4.4		156	52.9 ± 4.5		65	75.2 ± 5.6	
Obese (>30kg/m ²)	282	62.1 ± 3.3		466	68.8 ± 2.6		191	67.3 ± 3.6	
Smoking			0.287			0.047			0.112
Never	333	58.0 ± 3.0		400	57.8 ± 3.2		164	70.2 ± 4.1	
Past	90	62.9 ± 5.4		94	72.5 ± 6.2		35	81.7 ± 5.4	
Current	180	51.5 ± 5.2		204	68.1 ± 4.1		86	62.6 ± 5.6	
Missing	1	-		31	-		15	-	
Family history of cardiovascular disease			0.916			0.081			0.043
No	487	56.9 ± 2.8		566	61.4 ± 2.7		230	66.9 ± 3.0	

Characteristic	Awareness of hypercholesterolemia (n=604)			Awareness of hypertension (n=729)			Awareness of diabetes (n=300)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Yes	91	57.8 ± 7.5		115	70.9 ± 4.5		44	81.4 ± 5.8	
Missing	26	–		48	–		26	–	

^aAll percentages are row percentages. Boldface indicates statistical significant ($p < 0.05$).

NHANES, National Health and Nutrition Examination Survey

Table 2

Sociodemographic and Clinical Correlates of Cardiovascular Risk Factor Awareness in U.S. Young Adults (Aged 18 to 30 Years) From NHANES 2005–2014

Characteristic	Awareness of hypercholesterolemia (n=604)		Awareness of hypertension (n=729)		Awareness of diabetes (n=300)	
	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a
Age						
18–29 years	1.00	1.00	1.00	1.00	1.00	1.00
30–39 years	2.48 (1.68, 3.65)	2.35 (1.53, 3.61)	2.65 (1.83, 3.84)	2.05 (1.36, 3.09)	1.08 (0.64, 1.84)	
Gender						
Male	1.00		1.00	1.00	1.00	1.00
Female	1.30 (0.89, 1.90)		3.53 (2.37, 5.24)	2.89 (1.80, 4.66)	2.89 (1.57, 5.31)	
Race/Ethnicity						
Non-Hispanic white	1.00		1.00		1.00	1.00
Non-Hispanic black	0.91 (0.61, 1.38)		1.24 (0.88, 1.76)		0.50 (0.24, 1.04)	0.51 (0.24, 1.07)
Mexican American or other Hispanic	0.60 (0.40, 0.92)		0.69 (0.42, 1.16)		0.23 (0.12, 0.44)	0.35 (0.16, 0.76)
Other race/ethnicity	0.66 (0.32, 1.33)		0.71 (0.36, 1.38)		0.33 (0.14, 0.81)	0.41 (0.15, 1.10)
Education						
Less than high school	1.00		1.00		1.00	
High school graduate	1.27 (0.76, 2.13)		1.45 (0.92, 2.28)		1.82 (0.94, 3.35)	
College graduate	1.62 (0.98, 2.69)		0.97 (0.54, 1.39)		1.89 (0.91, 3.92)	
Poverty						
No	1.00		1.00		1.00	
Yes	0.73 (0.45, 1.17)		0.98 (0.70, 1.37)		0.52 (0.32, 0.84)	
Insured						
No	1.00		1.00		1.00	1.00
Yes	2.66 (1.57, 4.51)	2.14 (1.25, 3.65)	2.35 (1.61, 3.43)	1.93 (1.23, 3.00)	3.29 (1.89, 5.74)	1.99 (1.01, 3.89)
Foreign born						
No	1.00		1.00		1.00	
Yes	0.71 (0.47, 1.05)		0.46 (0.31, 0.69)	0.51 (0.32, 0.82)	0.32 (0.16, 0.63)	
Usual source of care						

Characteristic	Awareness of hypercholesterolemia (n=604)			Awareness of hypertension (n=729)			Awareness of diabetes (n=300)		
	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	Unadjusted Weighted OR (95% CI)	Adjusted Weighted OR (95% CI) ^a	
None	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Hospital or health center	2.38 (1.35, 4.20)	1.62 (0.92, 2.85)	3.81 (1.98, 7.31)	3.09 (1.56, 6.09)	2.91 (1.27, 6.66)	1.91 (0.87, 4.22)			
Private clinic or doctor's office	3.40 (2.13, 5.44)	2.09 (1.24, 3.55)	4.41 (2.78, 6.99)	2.60 (1.56, 4.33)	5.40 (3.07, 9.51)	2.72 (1.26, 5.89)			
Cholesterol									
Normal	-	1.00	0.94 (0.62, 1.44)	1.00	0.52 (0.25, 1.06)	1.00			
Borderline hypercholesterolemia	-		1.67 (1.05, 2.67)		1.62 (0.84, 3.14)				
Hypercholesterolemia	-								
Blood pressure									
Normal	1.00	-	-	-	1.00	-	-	-	
Borderline hypertension	0.85 (0.58, 1.25)	-	-	-	0.81 (0.43, 1.52)	-	-	-	
Hypertension	2.33 (1.29, 4.22)	-	-	-	1.61 (0.85, 3.07)	-	-	-	
Glucose intolerance									
Normal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Borderline diabetes	1.03 (0.61, 1.75)	1.11 (0.62, 1.99)	1.56 (1.10, 2.21)	1.68 (1.16, 2.45)	1.06 (0.38, 2.96)	1.00			
Diabetes	3.92 (1.88, 8.14)	3.90 (1.86, 8.17)	3.84 (2.16, 6.80)	3.94 (2.05, 7.57)	0.72 (0.28, 1.87)				
BMI (kg/m ²)									
Healthy BMI (<25kg/m ²)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Overweight (25–30kg/m ²)	1.09 (0.64, 1.84)	1.09 (0.64, 1.84)	0.96 (0.63, 1.47)	1.83 (0.91, 3.68)	1.93 (0.79, 4.75)				
Obese (>30kg/m ²)	1.52 (1.01, 2.30)	1.52 (1.01, 2.30)	1.89 (1.19, 3.01)	1.81 (1.06, 3.08)	0.69 (0.37, 1.27)				
Smoking									
Never	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Past	1.23 (0.75, 2.02)	1.23 (0.75, 2.02)	1.80 (0.92, 3.49)	1.83 (0.91, 3.68)	1.93 (0.79, 4.75)				
Current	0.77 (0.48, 1.26)	0.77 (0.48, 1.26)	1.56 (0.99, 2.47)	1.81 (1.06, 3.08)	0.69 (0.37, 1.27)				
Family history of cardiovascular disease									
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Yes	1.06 (0.54, 2.07)	1.06 (0.54, 2.07)	1.55 (0.94, 2.55)	1.55 (0.94, 2.55)	1.83 (0.86, 3.87)				

^aMultivariate models used a backwards elimination approach evaluating changes in likelihood ratios. Final model included only those variables associated ($p<0.10$) with risk factor awareness. Variables that were not included in the multivariate model are left blank.

NHANES, National Health and Nutrition Examination Survey

Appendix Table 1

Percentage of Young Adults With Borderline Hypercholesterolemia, Hypertension, and Diabetes Reporting Awareness of Their Risk Factor by Participant Characteristics^a

Characteristic	Awareness of borderline hypercholesterolemia (n=1,292)			Awareness of borderline hypertension (n=2,719)			Awareness of borderline diabetes (n=2,063)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Age			0.177			0.001			<0.001
18–29 years	438	20.3 ± 1.8		1,501	9.9 ± 0.9		933	3.1 ± 0.8	
30–39 years	854	23.7 ± 1.9		1,218	15.1 ± 1.2		1,130	7.6 ± 1.0	
Gender			0.824			0.305			<0.001
Male	680	22.2 ± 1.8		1,970	11.8 ± 0.9		1,273	3.7 ± 0.7	
Female	612	22.8 ± 2.3		749	13.7 ± 1.5		790	9.1 ± 1.2	
Race/Ethnicity			0.845			0.128			0.023
Non-Hispanic white	537	22.7 ± 2.1		1,041	12.6 ± 1.2		637	5.1 ± 1.0	
Non-Hispanic black	267	21.6 ± 2.7		737	13.2 ± 1.3		559	6.0 ± 0.9	
Hispanic	299	20.9 ± 2.6		707	9.2 ± 1.3		643	4.1 ± 0.8	
Other race/ethnicity	189	25.1 ± 4.2		234	16.6 ± 3.4		224	12.2 ± 3.3	
Education			0.758			0.081			0.144
Less than high school	221	20.8 ± 3.2		520	11.2 ± 1.6		460	4.5 ± 1.1	
High school graduate	235	22.2 ± 2.9		563	10.6 ± 1.4		453	4.6 ± 1.4	
College graduate	809	23.3 ± 1.7		1,234	14.1 ± 1.1		899	7.1 ± 1.1	
Missing	27	–		402	–		251	–	
Poverty			0.585			0.505			0.763
No	802	23.4 ± 1.7		1,540	12.1 ± 1.1		1,094	5.5 ± 1.0	
Yes	417	21.8 ± 2.6		995	13.3 ± 1.2		817	6.0 ± 0.9	
Missing	73	–		184	–		152	–	
Insured			0.012			0.157			0.730
No	375	17.8 ± 2.2		1,012	11.0 ± 1.0		802	5.3 ± 1.0	
Yes	915	24.0 ± 1.6		1,700	12.8 ± 0.9		1,257	5.8 ± 0.9	
Missing	2	–		7	–		4	–	

Characteristic	Awareness of borderline hypercholesterolemia (n=1,292)			Awareness of borderline hypertension (n=2,719)			Awareness of borderline diabetes (n=2,063)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Foreign born			0.950			<0.001			0.526
No	943	22.4 ± 1.7		2,110	13.4 ± 0.9		1,441	5.4 ± 0.7	
Yes	349	22.7 ± 2.6		609	7.5 ± 1.3		622	6.4 ± 1.4	
Usual source of care			0.066			0.659			0.116
None	343	17.3 ± 2.7		957	11.8 ± 1.2		710	3.9 ± 1.2	
Hospital or health center	249	26.1 ± 3.3		534	13.8 ± 1.8		438	5.7 ± 1.1	
Private clinic or doctor's office	700	23.7 ± 1.9		1,228	12.2 ± 1.2		915	6.8 ± 1.0	
Cholesterol			-			0.188			0.734
Normal	-	-		1,654	11.5 ± 0.9		1,316	5.3 ± 0.8	
Borderline hypercholesterolemia	-	-		647	12.6 ± 1.6		510	6.2 ± 1.3	
Hypercholesterolemia	-	-		235	16.0 ± 2.4		227	6.6 ± 1.7	
Missing	-	-		183	-		10	-	
Blood pressure			0.141			-			0.035
Normal	702	21.4 ± 1.9		-	-		1,080	5.8 ± 1.0	
Borderline hypertension	398	22.1 ± 2.5		-	-		651	4.1 ± 0.9	
Hypertension	130	31.5 ± 4.9		-	-		235	10.6 ± 2.5	
Missing	62	-		-	-		97	-	
Glucose intolerance			0.434			0.069			-
Normal	908	22.4 ± 1.7		1,806	11.4 ± 0.9		-	-	
Borderline diabetes	334	23.7 ± 2.7		655	13.1 ± 1.6		-	-	
Diabetes	50	14.9 ± 4.7		93	24.1 ± 6.3		-	-	
Missing	0	-		165	-		-	-	
BMI (kg/m ²)			0.240			<0.001			0.001
Healthy BMI (<25kg/m ²)	349	19.8 ± 2.6		842	7.3 ± 1.0		504	5.2 ± 1.5	
Overweight (25-30kg/m ²)	395	21.5 ± 2.4		826	12.1 ± 1.5		600	2.5 ± 0.7	
Obese (>30kg/m ²)	548	25.0 ± 2.1		1,051	16.3 ± 1.6		959	7.8 ± 1.0	
Smoking			0.278			0.225			0.916

Characteristic	Awareness of borderline hypercholesterolemia (n=1,292)			Awareness of borderline hypertension (n=2,719)			Awareness of borderline diabetes (n=2,063)		
	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value	Overall N	Weighted % ± SE	p-value
Never	812	21.0 ± 1.5		1,382	11.4 ± 1.1		1,109	6.2 ± 1.0	
Past	172	26.6 ± 3.4		320	13.9 ± 2.3		241	5.6 ± 1.9	
Current	308	23.7 ± 3.2		675	14.8 ± 1.6		500	5.6 ± 1.1	
Missing	0	-		342	-		213	-	
Family history of cardiovascular disease			0.017			0.062			0.022
No	1,114	21.6 ± 1.5		2,030	12.2 ± 0.9		1,581	5.1 ± 0.7	
Yes	131	32.2 ± 4.2		236	17.9 ± 2.8		187	12.1 ± 2.9	
Missing	47	-		453	-		295	-	

^a All percentages are row percentages.

Appendix Table 2

Sociodemographic and Clinical Correlates of Cardiovascular Risk Factor Awareness

Characteristic	Awareness of borderline hypercholesterolemia (n=1,292)		Awareness of borderline hypertension (n=2,719)		Awareness of borderline diabetes (n=2,063)	
	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)
Age						
18–29 years	1.00		1.00	1.00	1.00	1.00
30–39 years	1.22 (0.91, 1.64)		1.63 (1.23, 2.15)	1.59 (1.19, 2.11)	2.60 (1.46, 4.63)	2.53 (1.43, 4.47)
Gender						
Male	1.00		1.00		1.00	
Female	1.04 (0.74, 1.46)		1.18 (0.86, 1.62)		2.58 (1.67, 3.98)	
Race/Ethnicity						
Non-Hispanic white	1.00		1.00	1.00	1.00	1.00
Non-Hispanic black	0.94 (0.63, 1.41)		1.06 (0.76, 1.48)	1.09 (0.78, 1.54)	1.19 (0.71, 1.99)	1.27 (0.74, 2.16)
Hispanic	0.90 (0.59, 1.36)		0.70 (0.48, 1.04)	0.91 (0.57, 1.45)	0.80 (0.44, 1.43)	0.84 (0.47, 1.53)
Other race/ethnicity	1.14 (0.69, 1.89)		1.38 (0.80, 2.38)	1.89 (1.07, 3.35)	2.58 (1.26, 5.27)	2.47 (1.20, 5.11)
Education						
Less than high school	1.00		1.00	1.00	1.00	1.00
High school graduate	0.94 (0.61, 1.44)	0.97 (0.64, 1.47)	1.38 (0.94, 2.04)		1.18 (0.68, 2.06)	
College graduate	1.48 (0.99, 2.19)	1.53 (1.05, 2.24)	1.24 (0.86, 1.79)		193 (1.02, 3.65)	
Poverty						
No	1.00		1.00		1.00	
Yes	0.90 (0.64, 1.26)		1.03 (0.75, 1.41)		1.12 (0.66, 1.91)	
Insured						
No	1.00		1.00	1.00	1.00	1.00
Yes	1.45 (1.07, 1.99)		1.16 (0.91, 1.48)		1.12 (0.67, 1.88)	
Foreign born						
No	1.00		1.00	1.00	1.00	1.00
Yes	1.02 (0.70, 1.48)		0.53 (0.35, 0.79)	0.49 (0.30, 0.81)	1.19 (0.70, 2.01)	
Usual source of care						

Characteristic	Awareness of borderline hypercholesterolemia (n=1,292)		Awareness of borderline hypertension (n=2,719)		Awareness of borderline diabetes (n=2,063)	
	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)	Unadjusted weighted OR (95% CI)	Adjusted weighted OR (95% CI)
None	1.00		1.00		1.00	
Hospital or health center	1.68 (1.00, 2.84)		1.20 (0.81, 1.79)		1.49 (0.69, 3.24)	
Private clinic or doctor's office	1.48 (1.02, 2.15)		1.04 (0.76, 1.42)		1.81 (0.89, 3.68)	
Cholesterol						
Normal	–	1.00	1.00	1.00	1.00	1.00
Borderline hypercholesterolemia	–	1.08 (0.79, 1.49)	1.17 (0.67, 2.03)			
Hypercholesterolemia	–	1.55 (1.05, 2.29)	1.27 (0.67, 2.39)			
Blood pressure						
Normal	1.00	–	–	1.00	–	1.00
Borderline hypertension	1.09 (0.76, 1.59)	–	–	0.69 (0.39, 1.24)	–	–
Hypertension	1.71 (1.04, 2.83)	–	–	1.93 (1.02, 3.66)	–	–
Glucose intolerance						
Normal	1.00	1.00	1.00	1.00	–	–
Borderline diabetes	1.08 (0.78, 1.48)	1.10 (0.81, 1.49)	1.10 (0.81, 1.49)	–	–	–
Diabetes	0.60 (0.27, 1.33)	2.28 (1.14, 4.56)	2.28 (1.14, 4.56)	–	–	–
BMI (kg/m ²)						
Healthy BMI (<25kg/m ²)	1.00	1.00	1.00	1.00	1.00	1.00
Overweight (25–30kg/m ²)	1.11 (0.73, 1.69)	1.75 (1.19, 2.58)	1.73 (1.17, 2.55)	0.47 (0.21, 1.08)		
Obese (>30kg/m ²)	1.35 (0.94, 1.95)	2.47 (1.63, 3.74)	2.34 (1.53, 3.58)	1.54 (0.79, 3.02)		
Smoking						
Never	1.00	1.00	1.00	1.00	1.00	1.00
Past	1.36 (0.94, 1.98)	1.24 (0.81, 1.90)	1.24 (0.81, 1.90)	0.89 (0.39, 2.01)		
Current	1.17 (0.80, 1.70)	1.31 (0.91, 1.88)	1.31 (0.91, 1.88)	0.88 (0.52, 1.48)		
Family history of cardiovascular disease						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.69 (1.12, 2.55)	1.74 (1.15, 2.62)	1.51 (1.01, 2.28)	2.42 (1.31, 4.46)	2.31 (1.26, 4.23)	

Notes: Multivariate models used a backwards elimination approach evaluating changes in likelihood ratios. Final model included only those variables associated (>0.10) with risk factor awareness. Variables that were not included in the multivariate model are left blank.

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