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Statin under-use and low prevalence of LDL-C control among U.S. adults at high risk of coronary heart disease

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Abstract

Background—Statins reduce the risk of coronary heart disease (CHD) in individuals with a history of CHD or risk equivalents. A 10-year CHD risk >20% is considered a risk equivalent but is frequently not detected. Statin use and low density lipoprotein cholesterol (LDL-C) control were examined among participants with CHD or risk equivalents in the nationwide Reasons for Geographic and Racial Differences in Stroke (REGARDS) study (n=8,812).

Methods—Participants were categorized into 4 mutually exclusive groups: (1) history of CHD (n=4,025), (2) no history of CHD but with a history of stroke and/or abdominal aortic aneurysm (AAA) (n=946), (3) no history of CHD or stroke/AAA but with diabetes mellitus (n=3,134), or (4) no history of the conditions in (1) through (3) but with 10-year Framingham CHD risk score (FRS) >20% calculated using the ATP-III point scoring system (n=707).

Results—Statins were used by 58.4% of those in the CHD group and 41.7%, 40.4%, and 20.1% of those in the stroke/AAA, diabetes, and FRS>20% groups, respectively. Among those taking statins, 65.1% had LDL-C <100mg/dL, with no difference between the CHD, stroke/AAA, or diabetes groups. However, compared to those in the CHD group, LDL-C <100mg/dL was less common among participants in the FRS>20% group (multivariable adjusted prevalence ratio:

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Dr. Safford reported consulting for diaDexus and receiving salary support from diaDexus. Dr. Woolley is employed by Amgen, Inc. Dr. Rosenson serves a consultant to Amgen, Inc, and the Mount Sinai School of Medicine receives research support from Amgen, Inc. Dr. Muntner reported serving on an Amgen advisory board; serving as a consultant to Amgen; and receiving grants from Amgen. No other authors reported any disclosures.

0.72; 95% CI: 0.62 – 0.85). Results were similar using the 2013 ACC/AHA cholesterol treatment guideline.

Conclusions—These data suggest many people with high CHD risk, especially those with a FRS>20%, do not receive guideline-concordant lipid-lowering therapy and do not achieve an LDL-C <100mg/dL.

Keywords

cardiovascular disease; risk assessment; prevention; population health; epidemiology

Introduction

Cholesterol treatment guidelines provide risk-stratified guidelines for the initiation of statin therapy.^{1,2} In the third Adult Treatment Panel (ATP-III) guideline, people with CHD or a CHD risk equivalent were considered to be “high-risk” and were recommended treatment to achieve low density lipoprotein cholesterol (LDL-C) <100mg/dL (<70mg/dL considered optional for some very high-risk patients).¹ According to ATP-III, CHD risk equivalents include abdominal aortic aneurysm (AAA), diabetes, and other conditions that indicate a risk similar to a person with a history of CHD. Recent evidence also indicates stroke should be considered a CHD risk equivalent.^{3,4} For individuals without CHD or risk equivalents who have multiple CHD risk factors, the ATP-III guidelines recommended using the Framingham CHD risk calculator to determine 10-year risk for CHD events.⁵ A Framingham 10-year CHD risk score >20% (FRS>20%) was also considered to confer a risk similar to a history of CHD and the guidelines recommended an intensive therapeutic approach to lower LDL-C.^{1,5,6} Recently updated guidelines (2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol) expanded the focus on CHD prevention to cardiovascular disease (CVD) prevention, and included a new risk estimation method called the Pooled Cohort 10-year Atherosclerotic CVD (ASCVD) risk equations; a 10-year ASCVD predicted risk ≥7.5% is considered high and calls for a discussion about initiating statin therapy.⁷

The benefit of treating high LDL-C on the prevention of future events in people with CHD or risk equivalents is well recognized.^{6,8,9} While the majority of people with a history of CHD are taking statins, the use of statins may be lower for those with CHD risk equivalents.¹⁰ Additionally, there is evidence that the FRS is not calculated routinely in clinical practice, potentially leaving patients without CHD or risk equivalents but with a FRS>20% under-treated.¹¹

Most prior studies on statin use and LDL-C control among high-risk populations have not investigated differences between people with CHD, CHD risk equivalents, or with a high predicted risk.^{12,13} Identifying sub-groups of people with high CHD risk who are less likely to receive treatment may provide the framework for targeted improvement efforts. The REasons for Geographic And Racial Differences in Stroke (REGARDS) cohort study offers an opportunity to study treatment patterns by CHD risk group. At the time of study enrollment, 2003–7, the ATP-III guidelines were in force. Therefore, the goal of the current analysis was to examine differences in the use of statins among people at high risk for CHD

according to the reason they are considered high-risk, including a history of CHD, history of stroke/AAA, diabetes, or FRS>20%. Additionally, we examined differences in the prevalence of LDL-C control to <100mg/dL and <70mg/dL among people in these high-risk groups taking statins. We also examined the percentage of participants with a 10-year predicted ASCVD risk $\geq 7.5\%$ taking statins and, among those taking statins, the percent with LDL-C control to <100mg/dL and <70mg/dL.

Methods

Study Population

The REGARDS study has been described previously.¹⁴ In brief, the REGARDS study is a population-based cohort that includes 30,239 adults ≥ 45 years of age from all 48 continental U.S. states and the District of Columbia. Participants were enrolled between January 2003 and October 2007. By design, blacks and residents of Southeastern U.S. were oversampled. The “stroke buckle” was defined as coastal North Carolina, South Carolina, and Georgia and the “stroke belt” as the remainder of North Carolina, South Carolina, and Georgia as well as Alabama, Mississippi, Tennessee, Arkansas, and Louisiana. The current cross-sectional analysis was restricted to REGARDS study participants with CHD or CHD risk equivalents (defined below, $n=11,611$). Participants who were missing information on medication they had taken in the 2 weeks prior to an in-home study visit ($n=292$), missing LDL-C or with serum triglycerides ≥ 400 mg/dL ($n=794$), or did not fast overnight prior to their study visit ($n=1,713$) were excluded, leaving 8,812 participants for the current analyses. The REGARDS study protocol was approved by the Institutional Review Boards governing research in human subjects at the participating centers and all participants provided informed consent.

Data Collection

Baseline data were collected through telephone interviews, self-administered questionnaires and in-home examinations. After obtaining consent, trained interviewers conducted computer-assisted telephone interviews to obtain information on participants’ age, race, gender, region of residence, education, household income, cigarette smoking status, alcohol consumption, marital status, cognitive function, symptoms of depression, current antihypertensive (AHT) medication use, use of diabetes pills or insulin, and self-report of a prior diagnosis of myocardial infarction, coronary revascularization, stroke, AAA, or diabetes. Heavy alcohol consumption was defined as >14 drinks/week for men and >7 drinks/week for women. Cognitive impairment was considered to be present when the Six-Item Cognitive Screener score was ≤ 4 and depressive symptoms were considered to be present when the score on the Center for Epidemiologic Studies Depression scale was ≥ 4 .

Trained staff then conducted in-home study visits where prescription and over-the-counter medications were documented via pill bottle review, and medication adherence was assessed using the 4-item Morisky Medication Adherence Scale, which we categorized into 4 groups: score = 0 (highest medication adherence), 1, 2, or 3–4 (lowest medication adherence). A physical examination was performed, blood and urine samples were collected, and a resting electrocardiogram (ECG) was recorded. Systolic blood pressure (BP) was estimated based

on the average of 2 measurements after a seated 5 minute rest with both feet on the floor. Height and weight were measured during the study visit and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Using isotope-dilution mass spectrometry (IDMS) traceable serum creatinine, estimated glomerular filtration rate (eGFR) was calculated using the CKD-EPI equation.¹⁵ Albuminuria was defined as a urinary albumin-to-creatinine ratio $\geq 30\text{mg/g}$.¹⁶ Chronic kidney disease (CKD) was defined as being present for those with $\text{eGFR} < 60\text{ml/min/1.73m}^2$ or albuminuria.¹⁷

High Risk Groups

We created 4 mutually exclusive high-risk groups of participants. Those with a history of CHD were grouped into the “CHD group”. Those with no history of CHD but a history of stroke and/or AAA were grouped into the “stroke/AAA group”. Those with no history of CHD or stroke/AAA but with diabetes were grouped into the “diabetes group”. Those with no history of CHD, stroke/AAA, or diabetes but with $\text{FRS} > 20\%$ were grouped into the “ $\text{FRS} > 20\%$ group”. A history of CHD was defined by a self-reported history of myocardial infarction, coronary revascularization (coronary angioplasty or bypass surgery) or ECG evidence of a prior myocardial infarction (pathological Q-waves in 2 or more contiguous ECG leads using the Minnesota code). History of stroke and/or AAA relied on self-report. Diabetes was defined as self-report of a prior diagnosis of diabetes with current use of insulin or oral hypoglycemic medications, or fasting serum glucose $\geq 126\text{mg/dL}$. Serum glucose was measured using colorimetric reflectance spectrophotometry. $\text{FRS} > 20\%$ was calculated using sex, age, total cholesterol, smoking status, HDL-C, and systolic BP and the point scoring system (which incorporates AHT medication) in the ATP-III guidelines.¹

To facilitate comparisons with the 2013 ACC/AHA cholesterol treatment guidelines, we calculated the Pooled Cohort 10-year ASCVD risk score for participants without a history of CHD, stroke, AAA, or diabetes. This risk score uses the same risk factors as the FRS and race.⁷

Study Outcomes

We studied 2 outcomes, statin use and LDL-C control, reflecting the emphasis of ATP-III. During the in-home visit, participants were asked to provide the pill bottles for all medications they had taken in the past 2 weeks, and medication names were recorded and subsequently coded into drug classes. Statin use was defined on the basis of the pill bottle review. Total medication count, beyond statin use, included all other prescription and over-the-counter medications. Total- and HDL-cholesterol, and triglycerides were measured by colorimetric reflectance spectrophotometry. LDL-C was calculated using the Friedewald equation for participants with serum triglycerides $< 400\text{mg/dL}$.¹⁸ For the primary analyses, LDL-C control was defined as $< 100\text{mg/dL}$.⁶ In secondary analyses, LDL-C $< 70\text{mg/dL}$ was considered to be controlled.⁶

Statistical Analysis

Characteristics of participants were calculated overall and by high-risk group. The proportion of participants taking statins was calculated by high-risk group. Using Poisson regression with sandwich estimators, minimally adjusted (age, race, sex, region of residence,

and year of data collection) and fully multivariable adjusted prevalence ratios for statin use were calculated among those in the stroke/AAA, diabetes, or FRS>20% groups each compared to participants in the CHD group. Next, among high-risk participants taking statins, the prevalence of LDL-C <100mg/dL was calculated overall and by high-risk group. Minimally and fully multivariable adjusted prevalence ratios for LDL-C <100mg/dL were calculated for those in the stroke/AAA, diabetes, or FRS>20% groups each compared to participants in the CHD group. The prevalence and prevalence ratios for LDL-C <70mg/dL were also calculated. Full multivariable adjustment included age, race, sex, stroke region of residence, year of data collection, education, income, smoking status, alcohol consumption, marital status, BMI, CKD, cognitive impairment, depressive symptoms, total number of medications being taken, and medication adherence. To examine the similarity of the ASCVD risk score 7.5% group to the FRS>20% group, the proportion of participants in the FRS>20% group with a 10-year ASCVD predicted risk 7.5% by the Pooled Cohorts risk equations was estimated; among this group, the prevalence of statin use, LDL-C <100mg/dL, and LDL-C <70mg/dL was calculated.

Descriptive statistics were calculated using non-imputed data and all remaining analyses used multiple imputation. Multiple imputation of missing covariate information and all analyses were performed in Stata 11 (Stata Corp, College Station, TX). Missing information was imputed by chained equations with $m = 20$ imputations.¹⁹ Separate imputation models were used for each outcome; all covariates that were adjusted for in analyses and the outcome were included in each imputation model.

Results

Of the 8,812 REGARDS study participants at high risk for CHD, 4,025 (45.7%) were in the CHD group, 946 (10.7%) were in the stroke/AAA group, 3,134 (35.6%) were in the diabetes group, and 707 (8.0%) were in the FRS>20% group (Table 1). Participants in the diabetes group were younger while participants in the FRS>20% group were older than the sample average. A higher proportion of the CHD group was men, while a higher proportion of the diabetes group was women. The FRS>20% group predominantly consisted of men. More black participants were part of the diabetes group, but fewer blacks were in the FRS>20% group. Those in the FRS>20% group were older, more likely to be male and had higher SBP and lower HDL-C levels.

Among all high-risk individuals, 47.1% were taking statins. Statin use was highest in the CHD group (58.4%), lower in the stroke/AAA (41.7%) and diabetes (40.4%) groups, and lowest in the FRS>20% group (20.1%; Figure 1). After age, race, sex, region of residence, and year of data collection adjustment, and full multivariable adjustment, those in the stroke/AAA, diabetes and FRS>20% groups were less likely to be taking statins compared to the CHD group (Table 2). The percent of participants taking statins by each covariate in the multivariable adjusted model is presented in Supplemental Table 1.

Among all high-risk participants taking statins ($n = 4,154$), 65.1% had LDL-C <100mg/dL, and 18.7% had LDL-C <70mg/dL (Table 3). A similar percentage of those in the CHD, stroke/AAA, or diabetes groups had LDL-C <100 or LDL-C <70mg/dL. In contrast, a

substantially lower percentage of the FRS>20% group taking statins had LDL-C <100mg/dL or <70mg/dL. After multivariable adjustment and compared to the CHD group taking statins, those in the FRS>20% group taking statins remained significantly less likely to have an LDL-C <100mg/dL (prevalence ratio: 0.73, 95% CI: 0.62 – 0.86) or <70mg/dL (prevalence ratio: 0.33, 95% CI: 0.17 – 0.64). The proportions of participants taking statins with LDL-C <100mg/dL and <70mg/dL are presented in Supplemental Table 2 by each covariate in the multivariable adjusted model, with prevalence ratios from the multivariable adjusted model presented in Supplemental Table 3.

The comparison between high risk groups identified by the FRS equation in the ATP-III guidelines and the ASCVD risk equation in the 2013 AHA/ACC cholesterol treatment guidelines revealed that 95.9% (n=678/707) of participants in the FRS>20% group also had an ASCVD risk score >7.5%. Of these 678 participants, 137 (20.2%) were taking statins. Of the 137 participants taking statins, 68 (49.6%) had LDL-C <100mg/dL and 8 (5.8%) had LDL-C <70mg/dL.

Discussion

In the current study, we found a substantial treatment gap for U.S. adults at high risk for future CHD events. Less than half of high-risk participants were taking statins. The use of statins was particularly low among adults with CHD risk equivalents (stroke, AAA, and/or diabetes) and only 1 in 5 participants with a FRS>20% and without a history of CHD, stroke/AAA, or diabetes was taking a statin. Even among the high-risk participants taking statins, many did not have an LDL-C level in the range recommended by guidelines (LDL-C <100mg/dL). This was particularly true for the FRS>20% group, among whom less than half of those taking statins had an LDL-C <100mg/dL.

Of the individuals with a history of CHD in the current study, 41.6% were not taking statins. A recent analysis of the National Cardiovascular Data Registry found that 82% – 94% of patients received a statin prescription when discharged from the hospital for acute coronary syndrome.²⁰ Individuals not filling their first statin prescription (primary non-adherence) or discontinuing their statin (secondary non-adherence) may have accounted for the sub-optimal use identified in the current study. Primary non-adherence of statins has been estimated to range from 5% to 20% depending on the population studied.²¹ In addition, within 2 years of a CHD event, 36.1% of patients in an elderly Canadian cohort had discontinued their statins.²² In the current study of individuals at high risk for CHD events, several factors were associated with not taking statins, including being black, a woman, and residing in the stroke belt. Interventions to increase primary and secondary adherence, especially among high risk individuals, are needed to close this treatment gap.

Compared to those with a history of CHD, people with CHD risk equivalents were less likely to be taking statins. CHD risk equivalents are important because of their high prevalence and associated increased risk for cardiovascular disease.^{1,6,23} In 2010, over 25 million U.S. adults had diabetes and 7 million had a history of stroke.²³ Randomized controlled trials and meta-analyses of statin therapy have demonstrated substantial CHD risk

reduction among people with history of stroke and/or diabetes suggesting the under-treatment of these populations represent a missed treatment opportunity.²³

An especially noteworthy high-risk group that was under treated were those with FRS>20%. Four of five participants in this group were not taking statins. The Framingham 10-year CHD risk prediction tool is recommended to assist healthcare providers in accurately assessing patients' CHD risk, has been validated in several populations, and can be generalized using a correction factor.²⁴ While there are multiple formulas available to calculate 10-year CHD risk, we used the approach outlined in the ATP-III cholesterol treatment guidelines. Physicians may underestimate risk when they do not utilize risk prediction tools. For example, a study of a national sample of U.S. physicians reported low concordance between physicians' perception of their patients' risk and the risk calculated by the FRS equation, with CHD risk consistently underestimated when the risk prediction tool was not used.²⁵ Indeed, many of the individuals in the FRS>20% group were individuals over age 70 without multiple risk factors, thus treating clinicians may underestimate the risk among the elderly. Additionally, the FRS is under-used for clinical management decisions by primary care physicians despite high awareness and appreciation of its utility. In a recent national survey of U.S. family physicians, internists, and cardiologists, 92% of physicians were aware of the FRS prediction tool and 80% reported that risk assessment was useful, but only 41% used an assessment tool and only 40% of those that used a tool routinely reported the risk level to their patients.¹¹ When physicians did identify high-risk participants, statin therapy was recommended by 80% of primary care physicians, 58% of obstetricians/gynecologists, and 87% of cardiologists, speaking to the great importance of accurate risk assessment and highlighting the need for more feasible point-of-service assessment tools.²⁵

Our analysis showed that the vast majority of the group identified as being at high risk a FRS > 20% would also be identified to be at high risk using the Pooled Cohorts risk equation. Importantly, a low percentage of these individuals were treated with statins. The same barriers to identifying high risk individuals that we have discussed above persist with the 2013 ACC/AHA cholesterol treatment guidelines, which also requires the calculation of risk using an equation.⁷

Strengths of the current analysis include the large population-based sample of U.S. adults, the rigorous data collection following a study protocol, and the availability of fasting blood samples and pill bottle review to identify the use of statins. The large population-based sample of REGARDS permits inferences about the use of statins and LDL control among black and white American adults ages 45 and older. The results from this analysis should be interpreted in the context of known and potential limitations. The current analysis relied on data collected at a single point in time. There is day-to-day variation in LDL-C and there may be some misclassification of individuals with respect to having an LDL-C <100mg/dL or <70mg/dL. Electronic data on statin prescriptions were not available in the REGARDS study. We assumed that participants without a statin pill bottle were not taking them. Information on contraindication to statins was not available. Additionally, statin dose was not recorded. Individuals at high risk of CHD are recommended lifestyle modification and we did not have data on whether participants had changed their diet, increased their exercise regimen or undertook other therapeutic lifestyle changes to lower their LDL-C.

In conclusion, we identified suboptimal statin use and LDL-C control among a large population-based sample of U.S. adults at high risk of CHD, especially among those with CHD risk equivalents. Of particular importance, individuals with FRS>20% but without CHD or risk equivalents were substantially less likely to be taking statins than their counterparts with CHD or risk equivalents. Also, among those on statins, less than 2/3 of individuals overall and less than 1/2 of those in the FRS>20% group had an LDL-C <100mg/dL. The current study identifies opportunities for improvement in the appropriate use of statins and lowering LDL-C among people with CHD or CHD risk equivalents.

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Figure 1. Percent of “high-risk” REGARDS participants taking statins. Abbreviations: CHD - coronary heart disease; AAA - abdominal aortic aneurysm.

Table 1

Characteristics of “high-risk” REGARDS participants^a, overall and by reason they were categorized as “high-risk”.

Characteristics	Overall (N=8,812)				History of CHD (N = 4,025)				Stroke/AAA without CHD ^b (N = 946)				Diabetes without CHD or Stroke/AAA ^c (N = 3,134)				FRS>20% without CHD, Stroke/AAA, or Diabetes ^d (N = 707)			
	n	(%) ^e	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Age 65	5,240	(59.5)	2,596	(64.5)	580	(61.3)	1,499	(47.8)	565	(79.9)										
Women	3,999	(45.4)	1,583	(39.3)	501	(53.0)	1,807	(57.7)	108	(15.3)										
Black	4,018	(45.6)	1,410	(35.0)	475	(50.2)	1,886	(60.2)	247	(34.9)										
Region of residence																				
Non-belt	3,824	(43.4)	1,788	(44.4)	422	(44.6)	1,261	(40.2)	353	(49.9)										
Belt	3,041	(34.5)	1,355	(33.7)	331	(35.0)	1,129	(36.0)	226	(32.0)										
Buckle	1,947	(22.1)	882	(21.9)	193	(20.4)	744	(23.7)	128	(18.1)										
Year data collected																				
2003	1,640	(18.6)	754	(18.7)	199	(21.0)	493	(15.7)	194	(27.4)										
2004	2,903	(32.9)	1,357	(33.7)	308	(32.6)	964	(30.8)	274	(38.8)										
2005	1,883	(21.4)	871	(21.6)	196	(20.7)	744	(23.7)	72	(10.2)										
2006	1,293	(14.7)	556	(13.8)	140	(14.8)	509	(16.2)	88	(12.4)										
2007	1,093	(12.4)	487	(12.1)	103	(10.9)	424	(13.5)	79	(11.2)										
Less than high school education	1,474	(16.8)	619	(15.4)	193	(20.4)	546	(17.4)	116	(16.4)										
Annual household income <\$20,000	1,978	(25.4)	858	(24.1)	272	(33.5)	727	(26.4)	121	(18.8)										
Current smoking	1,460	(16.6)	619	(15.4)	178	(18.9)	429	(13.7)	234	(33.1)										
Heavy alcohol consumption	263	(3.1)	134	(3.4)	26	(2.8)	66	(2.2)	37	(5.4)										
Married	5,111	(58.0)	2,478	(61.6)	498	(52.6)	1,684	(53.7)	451	(63.8)										
Body mass index (kg/m ²)																				
<25	1,671	(19.1)	945	(23.6)	250	(26.7)	311	(10.0)	165	(23.5)										
25 to <30	3,105	(35.5)	1,502	(37.6)	368	(39.2)	913	(29.4)	322	(45.8)										
30	3,966	(45.4)	1,553	(38.8)	320	(34.1)	1,877	(60.5)	216	(30.7)										
SBP (mmHg), mean ± SD	131.7 ± 17.7		130.0 ± 17.6		130.8 ± 17.7		131.3 ± 16.7		144.2 ± 17.0											
SBP 140 mmHg	2,492	(28.3)	1,015	(25.3)	237	(25.1)	859	(27.4)	381	(53.9)										
HDL-C (mg/dL), mean ± SD	47.7 ± 14.6		48.0 ± 15.0		50.5 ± 15.1		48.4 ± 14.2		38.9 ± 8.8											

Characteristics	Overall (N=8,812)				History of CHD (N = 4,025)				Stroke/AAA without CHD ^b (N = 946)				Diabetes without CHD or Stroke/AAA ^c (N = 3,134)				FRS>20% without CHD, Stroke/AAA, or Diabetes ^d (N = 707)			
	n (%) ^e	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
HDL-C <40mg/dL	2,791 (31.7)	1,250 (31.1)	226 (23.9)	865 (27.6)	450 (63.6)															
Chronic kidney disease	2,892 (33.9)	1,339 (34.2)	318 (35.0)	1,007 (33.3)	228 (32.9)															
Cognitive impairment	700 (10.1)	307 (9.7)	111 (15.5)	232 (9.1)	50 (10.3)															
Depressive symptoms	1,173 (13.4)	538 (13.4)	160 (17.0)	417 (13.4)	58 (8.3)															
Total number of medications being taken																				
<5	2,442 (27.7)	908 (22.6)	257 (27.2)	915 (29.2)	362 (51.2)															
5 to 9	4,105 (46.6)	1,884 (46.8)	451 (47.7)	1,504 (48.0)	266 (37.6)															
10	2,265 (25.7)	1,233 (30.6)	238 (25.2)	715 (22.8)	79 (11.2)															

Abbreviations: CHD – coronary heart disease, AAA – abdominal aortic aneurysm, FRS - Framingham 10-year CHD risk score, SBP - systolic blood pressure, HDL-C - high-density lipoprotein cholesterol

^a High-risk individuals defined as a history of coronary heart disease, stroke, abdominal aortic aneurysm, diabetes mellitus, or a 10-year coronary heart disease risk >20% by the Framingham Coronary Heart Disease Risk Score as outlined in the ATP-III guidelines.

^b No history of CHD.

^c No history of CHD or stroke/AAA.

^d No history of CHD, stroke/AAA, or diabetes.

^e Column percentages reported.

Table 2

Factors associated with taking statins among high-risk REGARDS participants, n=8,812.

Characteristics	Prevalence ratio (95% CI)	
	Age, race, sex, region, year of data collection-adjusted	Multivariable adjusted ^a
Reason for being a high-risk individual		
History of CHD	1 (ref)	1 (ref)
History of stroke/AAA without CHD	0.74 (0.68 – 0.80)	0.76 (0.71 – 0.82)
History of diabetes without CHD or stroke/AAA	0.73 (0.70 – 0.77)	0.73 (0.69 – 0.77)
FRS>20% without CHD, stroke/AAA, or diabetes	0.33 (0.28 – 0.38)	0.37 (0.32 – 0.43)
Age, per 10 years	1.04 (1.01 – 1.06)	1.03 (1.00 – 1.06)
Women versus men	0.91 (0.86 – 0.95)	0.88 (0.84 – 0.92)
Blacks versus whites	0.86 (0.82 – 0.90)	0.94 (0.89 – 0.98)
Region of residence		
Non-belt	1 (ref)	1 (ref)
Belt	0.94 (0.89 – 0.99)	0.94 (0.90 – 0.99)
Buckle	1.01 (0.96 – 1.07)	1.00 (0.95 – 1.06)
Year data collected		
2003	1 (ref)	1 (ref)
2004	1.05 (0.98 – 1.12)	1.02 (0.96 – 1.09)
2005	1.07 (0.99 – 1.15)	1.01 (0.94 – 1.08)
2006	1.10 (1.01 – 1.19)	1.05 (0.97 – 1.13)
2007	1.12 (1.04 – 1.22)	1.07 (0.99 – 1.16)
Education, less versus more than high school	0.92 (0.86 – 0.98)	0.95 (0.89 – 1.02)
Annual household income < versus \$20,000	0.94 (0.89 – 1.00)	0.94 (0.88 – 1.00)
Smoking, current versus former/never	0.82 (0.77 – 0.88)	0.94 (0.88 – 1.01)
Alcohol consumption, heavy versus no/moderate	0.90 (0.78 – 1.03)	0.96 (0.84 – 1.09)
Married versus not married	1.05 (1.00 – 1.10)	1.01 (0.96 – 1.06)
Body mass index in kg/m ²		
<25	1 (ref)	1 (ref)
25 to <30	1.22 (1.14 – 1.31)	1.22 (1.14 – 1.30)
30	1.27 (1.19 – 1.36)	1.23 (1.15 – 1.31)
Chronic kidney disease (yes versus no)	1.09 (1.04 – 1.14)	1.04 (0.99 – 1.09)
Cognitive impairment (yes versus no)	0.94 (0.87 – 1.03)	0.96 (0.88 – 1.04)
Depressive symptoms (yes versus no)	0.98 (0.91 – 1.05)	0.95 (0.89 – 1.02)
Total number of medications being taken besides statins		
<5	1 (ref)	1 (ref)
5 to 9	1.58 (1.49 – 1.68)	1.47 (1.39 – 1.56)
10	1.72 (1.61 – 1.84)	1.54 (1.44 – 1.64)

Abbreviations: CHD – coronary heart disease, AAA – abdominal aortic aneurysm, FRS - Framingham 10-year CHD risk score as outlined in the ATP-III guidelines

^a Multivariable adjustment includes all characteristics simultaneously.

Prevalence ratios < 1 indicate individuals were less likely to be taking statins. Prevalence ratios > 1 indicate individuals were more likely to be taking statins.

Table 3

Percentage and prevalence ratio for LDL-cholesterol <100mg/dL and <70mg/dL among statin users by high-risk group in REGARDS, n= 4,154.

Reason categorized “high-risk”	Statin users (n= 4,154)			
	LDL-C <100mg/dL		LDL-C <70mg/dL	
	%	Adjusted prevalence ratio (95% CI)*	%	Adjusted prevalence ratio (95% CI) ^a
Overall	65.1		18.7	
History of CHD	67.7	1 (ref)	19.9	1 (ref)
History of stroke/AAA but not CHD	63.5	1.02 (0.94 – 1.10)	18.2	1.04 (0.83 – 1.31)
Diabetes without history of CHD or stroke/AAA	62.7	1.03 (0.97 – 1.09)	18.2	1.06 (0.91 – 1.23)
FRS > 20% without history of CHD, stroke/AAA, or diabetes	48.6	0.73 (0.62 – 0.86)	5.6	0.33 (0.17 – 0.64)

Abbreviations: LDL-C – low density lipoprotein cholesterol, CHD – coronary heart disease, AAA – abdominal aortic aneurysm, FRS - Framingham 10-year CHD risk score as outlined in the ATP-III guidelines

^a Adjusted models include age, race, sex, geographic region of residence, year data collected, education, income, smoking status, alcohol consumption, marital status, body mass index, chronic kidney disease, cognitive impairment, depressive symptoms, total number of medications being taken, and medication adherence.