JAMA Cardiology | Original Investigation

National Trends in Statin Use and Expenditures in the US Adult Population From 2002 to 2013
Insights From the Medical Expenditure Panel Survey

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IMPORTANCE Statins remain a mainstay in the prevention and treatment of atherosclerotic cardiovascular disease (ASCVD).

OBJECTIVE To detail the trends in use and total and out-of-pocket (OOP) expenditures associated with statins in a representative US adult population from 2002 to 2013.

DESIGN, SETTING, AND PARTICIPANTS This retrospective longitudinal cohort study was conducted from January 2002 to December 2013. Demographic, medical condition, and prescribed medicine information of adults 40 years and older between 2002 and 2013 were obtained from the Medical Expenditure Panel Survey database.

MAIN OUTCOMES AND MEASURES Estimated trends in statin use, total expenditure, and OOP share among the general adult population, those with established ASCVD, and those at risk for ASCVD. Costs were adjusted to 2013 US dollars using the Gross Domestic Product Index.

RESULTS From 2002 to 2013, more than 157 000 Medical Expenditure Panel Survey participants were eligible for the study (mean [SD] age, 57.7 [39.9] years; 52.1% female). Overall, statin use among US adults 40 years of age and older in the general population increased 79.8% from 21.8 million individuals (17.9%) in 2002-2003 (134 million prescriptions) to 39.2 million individuals (27.8%) in 2012-2013 (221 million prescriptions). Among those with established ASCVD, statin use was 49.8% and 58.1% in 2002-2003 and 2012-2013, respectively, and less than one-third were prescribed as a high-intensity dose. Across all subgroups, statin use was significantly lower in women (odds ratio, 0.81; 95% CI, 0.79-0.85), racial/ethnic minorities (odds ratio, 0.65; 95% CI, 0.61-0.70), and the uninsured (odds ratio, 0.33; 95% CI, 0.30-0.37). The proportion of generic statin use increased substantially, from 8.4% in 2002-2003 to 81.8% in 2012-2013. Gross domestic product–adjusted total cost for statins decreased from $17.2 billion (OOP cost, $7.6 billion) in 2002-2003 to $16.9 billion (OOP cost, $3.9 billion) in 2012-2013, and the mean annual OOP costs for patients decreased from $348 to $94. Brand-name statins were used by 18.2% of statin users, accounting for 55% of total costs in 2012-2013.

CONCLUSION AND RELEVANCE Statin use increased substantially in the last decade among US adults, although the uptake was suboptimal in high-risk groups. While total and OOP expenditures associated with statins decreased, further substitution of brand-name to generic statins may yield more savings.

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JAMA Cardiol. 2017;2(1):56-65. doi:10.1001/jamacardio.2016.4700
Published online November 14, 2016.

Statins are one of the most well-established measures for the prevention and treatment of atherosclerotic cardiovascular disease (ASCVD). Guidelines released by the American Heart Association and the American College of Cardiology broadened the proportion of US adults in whom statins are indicated from 37.5% (43.2 million) to 48.6% (56 million).[1,2] These guidelines also included specific recommendations about using high-intensity statins among select high-risk individuals. However, contemporary data on national patterns for statin use are limited.

Previous analyses have shown that pharmaceutical products are a significant driver of health care costs.[3] As the health care system evolves, patients face higher out-of-pocket (OOP) expenditures,[4] contributing to increased financial burden.[5] Statins are the most commonly prescribed medications in the United States,[6] and while their cost-effectiveness has been established in several subgroups,[7,8] these results are as sensitive to the cost of statins as they are to users' risk level. While the recent introduction of generic statins has led to a decrease in the cost of statins, to our knowledge, trends of the intensity or expenditures on statins have not been robustly examined.

In this study, we analyzed the nationally representative Medical Expenditure Panel Survey (MEPS) data from 2002 to 2013 to delineate trends in statin use and costs. These results could have important insights for guidelines and public health discussions aimed at improving the efficiency and cost-effectiveness of statin use in appropriate primary and secondary prevention populations.

Key Points

Question What are the trends in statin use and expenditure in the US adult population?

Findings This cohort study found that statin use among adults 40 years and older increased from 17.9% in 2002-2003 to 27.8% in 2012-2013, with significantly lower use among women, racial/ethnic minorities, and the uninsured. The gross domestic product–adjusted total cost for statins decreased from $17.2 billion (out-of-pocket cost, $7.6 billion) to $16.9 billion (out-of-pocket cost, $3.9 billion), with brand-name statins accounting for 55% of total costs in 2012-2013.

Meaning In the US adult population, while statin use increased substantially over the last decade, disparities and suboptimal uptake in higher-risk groups, along with significant costs, persisted in this time frame.

Methods

Study Design and Population

We performed a 12-year retrospective, longitudinal cohort study of US adults 40 years and older using the 2002-2013 MEPS database. The database is sponsored by the Agency for Healthcare Research and Quality and is a national survey of individuals and families, clinicians, and employers for medical conditions and health care resource use and costs. Each year, the MEPS Household Components' sample is drawn from respondents of the previous year's National Health Interview Survey. It has an overlapping panel design, with each panel composed of randomly sampled, noninstitutionalized US civilians. Participants are interviewed every 6 months over 30 months and their responses are reported annually to provide nationally representative estimates of sociodemographic characteristics, medical conditions, and health care use and costs.[9] Interviews are conducted over the telephone, and further information is obtained from physicians, hospitals, and pharmacies to supply additional information on health care use and cost data. After data collection, Agency for Healthcare Research and Quality researchers assign person-weights and variance estimation stratum to reflect survey nonresponse and population totals from the participants surveyed.[10] Because the MEPS consists of publicly available, deidentified data files, this current study was exempted from institutional review board approval, per the US Department of Health and Human Services guidelines. Written consent was obtained from participants to be contacted for interviews and to contact their clinicians and pharmacies.

We merged the MEPS Household Components' full-year consolidated, medical conditions, and prescribed medicines files for each year from 2002 to 2013 to create annual files with sociodemographic characteristics, medical conditions, and medication use and expenditures. For ease of analysis and reporting, we pooled data into 2-year cycles and adjusted the person-level weight accordingly to reflect the mean annual population size and medication use and expenditures of the 2 years in each cycle. Individuals included in our analysis were 40 years of age and older at the time of the survey, had a body mass index (calculated as weight in kilograms divided by height in meters squared) of 18.5 or more (underweight individuals generally represent a sicker population),[11] and with a final survey person-weight greater than 0 to be representative of the national population at the time of the survey (eFigure 1 in the Supplement).

Our study population was stratified into 2 ASCVD risk groups[1,2]: participants with known ASCVD included (1) those with coronary heart disease (CHD) and (2) those with stroke and/or peripheral arterial disease and participants without known ASCVD substratified into (1) those with diabetes and (2) those with dyslipidemia and without diabetes. Participants were classified into these groups if they had an *International Statistical Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis of the condition (eTable 1 in the Supplement) and/or self-reported history of the diagnosis.

Statin Use and Expenditures

During the household interview, MEPS respondents were asked to supply the name of any prescribed medicine they or their family members purchased or otherwise obtained in the reference period. The interviewers entered verbatim the names of the prescription and other information as reported by the respondents,[12] who were also asked for permission to obtain payment data from pharmacies. With written permission from participants, pharmacies were contacted to obtain information on the date filled, national drug code, and medication

name, strength of medicine, quantity, amount payed, and source of payments. In 2011, 69.7% of Household Components respondents granted permission to contact pharmacies, and 73.3% of pharmacies responded. For those with missing data, the payment information was imputed from the pharmacy data for another person's purchase of the same drug (see eAppendix in the Supplement for more details). When compared with the Medicare Part D claims record, MEPS was not different in the proportion of beneficiaries reporting any prescription drug use, with an agreement rate of 0.97 (95% CI, 0.96-0.98), and a κ of 0.66.[12] The multisourced, person-level medication information was then included in the MEPS Prescribed Medicine Files and linked to the Multum Lexicon database by Agency for Healthcare Research and Quality researchers,[13] which gives the class of drug. In this study, the Multum code 173 for 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors was classified as statins. Because all lipid-lowering combinations (Multum drug code 317) surveyed in MEPS contained an 3-hydroxy-3-methylglutaryl coenzyme A agent, we included them in the medications we identified as statins. For each year, we used the variable specifying the drug names to identify the major types of statins. We also used drug names to classify statins as brand name or generic. The strength of each prescribed medicine was used to generate the dose intensity of statin used; atorvastatin, 40 to 80 mg, and rosuvastatin, 20 to 40 mg, daily were classified as high-intensity statins, while all others were classified as moderate-to-low intensity.[1]

For each drug prescribed, the exact dollar amount paid was reported, as well as the source of payment, which included OOP (individual or family) or specific insurance coverage. Using these variables, we calculated drug-specific expenditures (overall expenditure and OOP). All expenditures were adjusted using the gross domestic product deflator to adjust annual expenditures from 2002 to 2013 to constant 2013 US dollars.

Covariates

We considered age, sex, race/ethnicity, family income, cardiovascular disease modifiable risk factors, and Charlson Comorbidity Index (CCI) score as factors that affect the time trends in statin use and expenditure and therefore were treated as covariates in our analyses. Participants' age as of the last day of the survey year were grouped into 3 categories: 40 to 64, 65 to 74, and 75 years and older. We had 5 categories of race and ethnicity: non-Hispanic white, non-Hispanic black, Hispanic, Asian, and other (American Indian, Alaska Native, and those who reported multiple races/ethnicities) categories. There were 5 categories of family income level as a proportion of the federal poverty level (FPL): poor (<100% of FPL), near poor (100%-<125% of FPL), low income (125%-<200% of FPL), middle income (200%-<400% of FPL), and high income (≥400% of FPL). We estimated participants' comorbidity burden using the Grouped CCI (GCCI), which has been described extensively elsewhere.[14,15] For our analysis, however, we modified the GCCI by excluding acute myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, and diabetes from our estimating GCCI score to avoid collinearity in our regression analyses. There were 3 categories for GCCI: 0, no comorbidity; 1, 1 long-term condition; and 2, 2 or more long-term conditions present other than CVD and/or diabetes. Hypertension, diabetes, and hyperlipidemia were determined using *International Statistical Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis or self-report (eTable 1 in the Supplement).

Statistical Analysis

All analyses were conducted using Stata version 14 (StataCorp). Using the final person-weight and variance estimations (person sampling units and stratum), we accounted for the complex sampling design of the MEPS in all analyses to estimate nationally representative totals, means, and rates for persons in the civilian noninstitutionalized population. We applied the final person-weight adjusted for the 2-year cycles to the data and we used the *svy: proportion* command in Stata to estimate the proportion of the population using any, high-intensity, generic, and brand-name statin per cycle; the *svy: total* command to estimate the total number of persons reporting statin use, the total number of prescriptions, and the total expenditures; and the *svy: mean* command to estimate the average expenditures on any statin. Our trend analysis over the 12-year period was done using weighted linear regression models with estimated means or proportions as outcome variables and survey cycle as predictor. We determined the predictors of statin use using 3 different logistic regression models of statin use (yes vs no) on possible predictors. We performed a univariate logistic regression first, followed by model 1, which included the univariate predictors, and adjusted for age, sex, and race/ethnicity. Model 2 was a multivariate logistic regression consisting of all the predictor variables. We reported odd ratios (ORs) of statin use comparing other cycles with 2002-2003, the referent cycle. In all analyses, 95% CIs were reported, and 2-sided $P < .05$ was considered statistically significant.

Results

Overall, from 2002 to 2013, 157 719 MEPS participants were eligible for the study (mean age [SD], 57.7 [39.9] years; 52.1% female) (eFigure 1 in the Supplement). **Table 1** describes characteristics of the entire study population. Of these, 24.6% (95% CI, 24.2%-25.0%) reported any statin use, with 9% of all statin users reporting only 1 prescription. The characteristics of those taking vs not taking statins over the 12-year period are detailed in eTable 2 and eTable 3 in the Supplement, respectively. Most statin users were non-Hispanic white males with health insurance. During this period, statins users were primarily patients diagnosed as having hyperlipidemia, representing 93% in 2002-2003 and 96% in 2012-2013.

Trends in Statin Use

The estimates of statin use (%) in the general adult population and in different risk groups are shown in **Figure 1**. The number of adults in the general population who reported using any statin increased from 21.8 million (17.9%) in 2002-2003 to 39.2 million (27.8%) in 2012-2013, representing a 79.8%

Table 1. Characteristics of US Adults Aged 40 Years and Older, MEPS 2002-2013

Characteristic	Adults, %						*P* Value[a]
	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	
No. of adults, millions	121	126	129	133	136	141	
Age, mean (SE), y	56.9 (0.2)	57.1 (0.2)	57.4 (0.2)	57.7 (0.2)	58.1 (0.2)	58.5 (0.2)	<.001
Age category, y							
40-64	73.0	73.0	72.9	72.6	71.6	69.9	<.001
65-74	14.6	14.4	14.3	14.8	15.9	17.4	
≥75	12.4	12.6	12.8	12.6	12.5	12.7	
Sex							
Male	47.6	47.9	48.1	47.9	48.1	47.8	.85
Female	52.4	52.1	51.9	52.1	51.9	52.2	
Race/ethnicity							
Non-Hispanic white	75.8	74.7	73.9	73.4	72.5	71.1	.008
Non-Hispanic black	10.3	10.2	10.5	10.3	10.6	10.8	
Asian	3.6	3.7	4.1	4.0	4.4	4.9	
Hispanic	8.6	9.3	9.9	10.4	10.9	11.4	
Other	1.7	2.1	1.7	1.8	1.7	1.8	
Insurance status							
Uninsured	9.1	9.7	10.3	11.1	10.4	11.2	<.001
Private only	57.2	56.0	55.7	54.0	53.7	51.3	
Medicaid	3.3	3.7	3.2	3.5	5.6	7.6	
Medicare	12.6	12.7	14.1	15.6	22.0	29.7	
Other (public/private)	18.0	17.9	16.8	15.7	8.2	0.3	
Family income level							
Poor	8.9	8.9	8.7	9.3	10.1	10.3	.007
Near poor	3.8	3.8	4.1	4.2	4.1	4.3	
Low	12.3	12.6	12.0	12.6	12.8	12.8	
Middle	28.6	29.4	29.1	29.1	29.0	28.6	
High	46.3	45.2	46.1	44.9	44.0	43.9	
Region							
Northeast	22.0	20.8	21.5	19.4	19.7	18.7	.45
Midwest	23.4	24.4	22.3	23.3	23.1	23.5	
South	37.2	34.7	36.8	37.2	37.5	37.7	
West	17.5	20.1	19.5	20.2	19.8	20.2	
GCCI score[b]							
0	86.7	86.2	85.4	82.1	81.8	83.6	<.001
1	8.9	9.4	9.9	11.1	11.4	11.1	
2	4.4	4.4	4.8	6.9	6.8	5.4	
History							
CHD	9.3	9.3	9.4	12.6	12.2	12.0	<.001
Stroke	4.6	4.4	4.7	5.9	5.8	5.9	<.001
PAD	0.3	0.3	0.2	0.1	0.1	0.1	<.001
Diabetes	10.7	12.1	13.5	14.8	15.4	15.5	<.001
Dyslipidemia	45.1	43.2	40.0	46.6	46.0	47.1	<.001

Abbreviations: CHD, coronary heart disease; GCCI, Grouped Charlson Comorbidity Index; MEPS, Medical Expenditure Panel Survey; PAD, peripheral arterial disease.

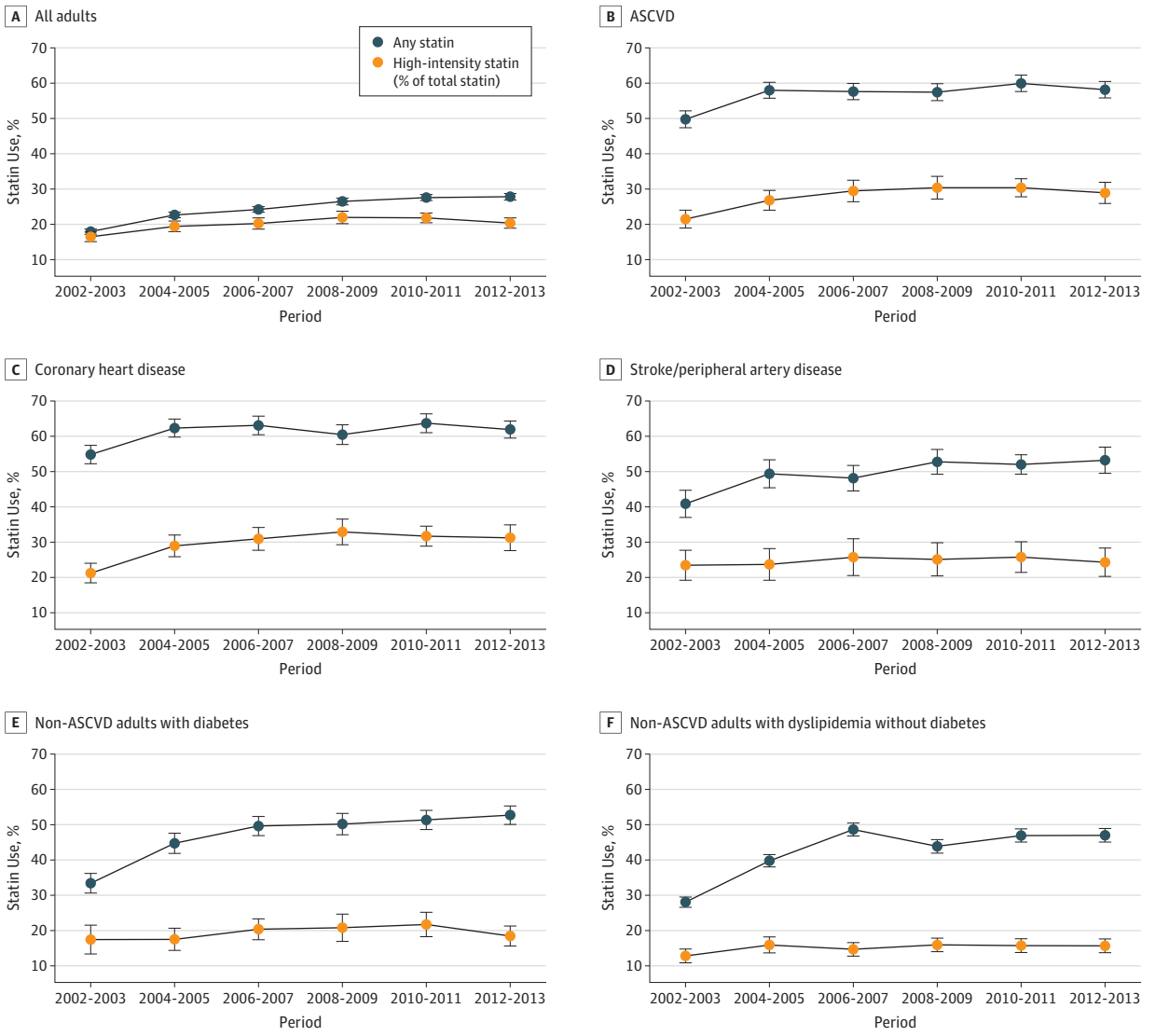
[a] *P* value for year effect on population characteristics were computed using linear regression for mean age and Pearson χ^2 test for proportions.

[b] GCCI was modified for this study by excluding any cardiovascular disease or diabetes from the comorbidity index computation.

increase, with the largest increase seen between 2002-2003 and 2004-2005. Annual statin prescriptions increased from 134 million to 221 million (64.9% increase) over this period. A similar increase in statin use was also observed among patients with ASCVD, although statin use appeared to plateau between 2004-2005 and 2008-2009 before slightly increasing again in 2010-2011. Statin use steadily increased from 13.4% to 22.2% among those without ASCVD, 33.4% to 52.7% among those with diabetes, and 28.1% to 47.0% among those with hyperlipidemia and not diabetes over the 12-year period.

Overall, the proportion of statin as high intensity increased from 16.5% in 2002-2003 to 20.4% in 2012-2013 in

Figure 1. Trends in Statin Use, Medical Expenditure Panel Survey 2002-2013



ASCVD indicates atherosclerotic cardiovascular disease.

the general adult population, peaking at 21.9% in 2008-2009 (Figure 1). Among participants with ASCVD, statin use was most prevalent among patients with CHD, 31% of whom reported using high-intensity dose statins in 2012-2013. Of those without established ASCVD, 18.4% of participants with diabetes reported high-intensity statin use in 2012-2013.

Table 2 details 12-year statin use patterns across participants' characteristics. Statin use was least among adults aged 40 to 64 years, consistently higher among males and non-Hispanic white patients. Similar patterns of statin use were noted in the different subgroups over the years (eTable 4 in the Supplement).

Distribution of Branded and Generic Statins

In 2002-2003, 19.9 million adults used brand-name statins, accounting for 91.6% of all statin prescriptions (n = 126 million). By 2012-2013, brand-name statins were only used by 18.2% of users (7.8 million adults; 44.4 million prescriptions), while 31.4 million adults were using generic statins (177 million prescriptions). A similar pattern was observed across all subgroups (eFigure 2 in the Supplement). Among available statins, atorvastatin remained the most commonly prescribed through 2006-2007, after which it was surpassed by simvastatin. In 2012-2013, simvastatin (41.4%) and atorvastatin (28.3%) were the most commonly used statins, followed by pravastatin (16.2%), rosuvastatin (11.2%), and lovastatin (7.0%) (eFigure 3 in the Supplement).

Predictors of Statin Use

The likelihood of any statin use in the general US population increased with calendar year (expressed as 2-year cycles) (**Table 3**). In a multivariable-adjusted analysis, compared with those aged 40 to 64 years, adults aged 65 to 74 years and adults aged 74 years or older were more likely to report

Table 2. Variation in Trends in Any Statin Use Among US Adults Aged 40 Years and Older, MEPS 2002-2013

	% (95% CI)					
Cycle	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013
No. of adults, millions	121	126	129	133	136	141
Age category, y						
40-64	12.9 (12.2-13.7)	16.4 (15.5-17.2)	17.3 (16.5-18.1)	19.0 (18.2-19.9)	19.9 (19.0-20.8)	19.0 (18.2-19.9)
65-74	32.7 (30.6-34.8)	41.0 (38.7-43.3)	41.8 (39.7-44.0)	44.3 (42.0-46.8)	46.1 (43.9-48.4)	47.8 (45.4-50.2)
≥75	30.0 (27.6-32.4)	38.1 (35.8-40.6)	43.9 (41.3-46.5)	48.5 (45.3-51.7)	47.9 (45.3-50.6)	48.6 (45.9-51.3)
Sex						
Male	20.0 (19.0-21.0)	24.4 (23.3-25.5)	26.1 (24.9-27.3)	28.2 (26.9-29.5)	30.3 (29.2-31.4)	30.0 (28.8-31.2)
Female	16.1 (15.1-17.0)	21.1 (20.1-22.1)	22.5 (21.5-23.5)	24.9 (23.7-26.0)	25.1 (24.1-26.1)	25.8 (24.6-27.0)
Race/ethnicity						
Non-Hispanic white	19.4 (18.5-20.3)	24.6 (23.6-25.6)	25.9 (24.9-26.8)	28.6 (27.4-29.8)	29.8 (28.8-30.9)	30.0 (28.8-31.3)
Non-Hispanic black	13.9 (12.4-15.5)	16.7 (15.3-18.3)	19.4 (17.6-21.4)	21.4 (19.9-23.0)	22.8 (21.0-24.8)	23.5 (21.8-25.2)
Asian	13.6 (11.1-16.5)	18.1 (14.9-21.9)	22.3 (18.7-26.4)	23.3 (20.0-27.1)	24.2 (20.8-27.9)	21.5 (21.8-25.2)
Hispanic	10.8 (9.6-12.1)	15.5 (13.8-17.4)	17.8 (16.0-19.8)	17.4 (15.9-19.1)	18.8 (17.2-20.5)	20.6 (19.2-22.0)
Other	21.5 (17.2-26.7)	21.7 (17.0-27.4)	24.1 (18.5-30.7)	28.7 (22.6-35.8)	27.1 (21.7-33.3)	29.6 (24.4-35.5)
Insurance status						
Uninsured	4.7 (3.8-5.9)	6.9 (5.7-8.3)	8.5 (7.3-10.0)	8.7 (7.6-10.0)	10.7 (9.3-12.3)	8.2 (7.1-9.5)
Private only	13.3 (12.4-14.1)	17.0 (16.0-18.0)	17.5 (16.6-18.5)	19.7 (18.7-20.7)	20.4 (19.4-21.5)	19.8 (18.8-20.9)
Medicaid	16.7 (13.7-20.2)	19.7 (16.7-23.1)	22.2 (19.1-25.7)	23.7 (20.6-27.1)	26.8 (24.4-29.3)	29.6 (26.9-32.5)
Medicare	27.6 (25.6-29.7)	35.3 (33.0-37.7)	38.0 (35.8-40.3)	43.4 (40.8-46.0)	45.5 (43.8-47.3)	48.2 (46.4-50.1)
Other (public/private)	32.8 (30.9-34.8)	40.5 (38.3-42.6)	44.7 (42.5-46.9)	46.1 (43.6-48.7)	48.3 (45.3-51.2)	48.7 (34.5-63.2)
Family income level						
Poor (<100% of FPL)	17.2 (15.6-18.9)	21.5 (19.7-23.4)	25.0 (23.0-27.1)	26.5 (24.4-28.8)	27.8 (26.0-29.7)	27.5 (25.2-29.9)
Near poor (100%-124% of FPL)	20.4 (17.6-23.5)	20.8 (18.0-23.9)	30.7 (27.8-33.7)	30.2 (26.5-34.1)	30.1 (27.1-33.2)	31.0 (27.7-34.6)
Low (125%-199% of FPL)	20.7 (18.7-22.8)	25.2 (23.4-27.0)	24.2 (22.5-26.1)	27.8 (25.7-30.0)	28.1 (26.0-30.4)	30.2 (28.2-32.4)
Middle (200%-399% of FPL)	17.1 (16.0-18.4)	21.4 (20.1-22.8)	23.1 (21.8-24.4)	25.1 (23.6-26.6)	27.3 (25.8-28.8)	26.7 (25.0-28.5)
High (≥400% of FPL)	17.6 (16.6-18.7)	23.1 (21.9-24.4)	24.2 (23.1-25.4)	26.6 (25.3-28.0)	27.3 (25.9-28.8)	27.6 (26.4-28.8)
Region						
Northeast	19.9 (18.3-21.5)	24.2 (22.4-26.1)	26.8 (25.1-28.6)	27.1 (25.2-29.2)	28.8 (26.8-30.9)	28.1 (25.8-30.5)
Midwest	18.3 (16.9-19.8)	24.4 (22.6-26.2)	24.5 (22.8-26.2)	27.8 (25.8-29.8)	28.8 (26.8-30.9)	29.9 (27.9-32.1)
South	18.6 (17.1-20.1)	21.8 (20.6-23.2)	24.6 (23.3-26.0)	26.9 (25.2-28.6)	28.1 (26.8-29.5)	28.1 (26.529.7)
West	14.6 (13.1-16.2)	20.8 (19.3-22.5)	21.1 (19.7-22.5)	23.9 (22.1-25.9)	24.5 (22.9-26.1)	25.0 (23.4-26.7)
GCCI score[a]						
1	17.2 (16.5-18.0)	21.5 (20.7-22.4)	22.6 (21.7-23.4)	24.2 (23.3-25.2)	25.4 (24.5-26.3)	25.6 (24.6-26.5)
2	21.1 (19.1-23.1)	27.8 (25.4-30.4)	33.3 (31.2-35.5)	33.1 (30.3-36.1)	35.4 (32.8-38.1)	36.7 (34.2-39.3)
3	25.5 (22.1-29.2)	33.7 (30.2-37.4)	35.0 (31.3-38.8)	42.3 (38.6-46.1)	41.2 (38.2-44.3)	44.0 (40.0-48.2)

Abbreviations: FPL, federal poverty level; GCCI, Grouped Charlson Comorbidity Index; MEPS, Medical Expenditure Panel Survey.

[a] GCCI was modified for this study by excluding any cardiovascular disease or diabetes from the comorbidity index computation.

statin use, with ORs of 1.95 (95% CI, 1.81-2.11) and 1.80 (95% CI, 1.66-1.96), respectively. Females vs males (OR, 0.81; 95% CI, 0.79-0.85); racial/ethnic minorities (vs non-Hispanic white individuals), including non-Hispanic black (OR, 0.65; 95% CI, 0.61-0.70) and Hispanic (OR, 0.68; 95% CI, 0.64-0.73) individuals; and the uninsured vs those with public insurance (OR, 0.33; 95% CI, 0.30-0.37) were significantly less likely to report statin use in the 12-year period. Similar differences were noted among those with ASCVD as well as high-risk populations without ASCVD (eg, those with diabetes) (eTable 5 in the Supplement).

Trends in Statin Expenditure

In 2002-2003, annual total expenditures for statins were $17.2 billion, peaking at $22 billion in 2008-2009 and trending down to $16.9 billion in 2012-2013 (**Figure 2**). A similar trend was noted for OOP expenditures, which increased from $7.6 billion to $8.8 billion from 2002-2003 to 2004-2005 (Figure 2), before decreasing to $3.9 billion in 2012-2013. Brand-name statins accounted for 94% of statin-related expenditures in 2002-2003, significantly declining to 55% in 2012-2013. The trends of total and OOP statin expenditures in the different subgroups are shown in

Table 3. Odds Ratios for Statin Use Among US Adults Aged 40 Years and Older, MEPS 2002-2013

Variable	Odds Ratio (95% CI)		
	Univariate	Model 1[a]	Model 2[b]
Cycle			
2002-2003	1 [Reference]	1 [Reference]	1 [Reference]
2004-2005	1.34 (1.27-1.42)	1.37 (1.29-1.45)	1.39 (1.31-1.49)
2006-2007	1.46 (1.37-1.56)	1.50 (1.40-1.60)	1.51 (1.42-1.62)
2008-2009	1.65 (1.54-1.77)	1.71 (1.59-1.83)	1.61 (1.50-1.74)
2010-2011	1.74 (1.63-1.86)	1.81 (1.69-1.93)	1.71 (1.59-1.83)
2012-2013	1.76 (1.65-1.89)	1.81 (1.68-1.94)	1.72 (1.60-1.85)
Age, y			
40-64	1 [Reference]	1 [Reference]	1 [Reference]
65-74	3.52 (3.35-3.70)	3.51 (3.34-3.70)	1.95 (1.81-2.11)
≥75	3.58 (3.38-3.79)	3.61 (3.41-3.83)	1.80 (1.66-1.96)
Sex			
Male	1 [Reference]	1 [Reference]	1 [Reference]
Female	0.81 (0.78-0.84)	0.74 (0.71-0.77)	0.81 (0.79-0.85)
Race/ethnicity			
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	0.69 (0.65-0.73)	0.76 (0.72-0.81)	0.65 (0.61-0.70)
Hispanic	0.58 (0.54-0.61)	0.66 (0.62-0.70)	0.68 (0.64-0.73)
Asian	0.73 (0.65-0.82)	0.81 (0.73-0.90)	0.89 (0.80-1.00)
Family income level			
Poor (<100% of FPL)	1 [Reference]	1 [Reference]	1 [Reference]
Near poor (100%-124% of FPL)	1.17 (1.07-1.27)	0.93 (0.85-1.01)	0.95 (0.86-1.04)
Low (125%-199% of FPL)	1.09 (1.02-1.16)	0.90 (0.84-0.96)	0.99 (0.92-1.07)
Middle (200%-399% of FPL)	0.95 (0.90-1.00)	0.89 (0.84-0.95)	1.04 (0.97-1.11)
High (≥400% of FPL)	1.00 (0.93-1.06)	1.01 (0.96-1.09)	1.27 (1.18-1.37)
Health insurance			
Uninsured	1 [Reference]	1 [Reference]	1 [Reference]
Any public (Medicare/Medicaid)	7.44 (6.88-8.04)	5.21 (4.77-5.68)	3.00 (2.73-3.29)
Private Only	2.48 (2.30-2.68)	2.39 (2.21-2.58)	2.26 (2.09-2.44)
Education			
<High school	1 [Reference]	1 [Reference]	1 [Reference]
High school/GED equivalent	0.89 (0.84-0.95)	1.01 (0.94-1.08)	1.09 (1.01-1.18)
≥Some college	0.79 (0.74-0.84)	0.98 (0.92-1.05)	1.05 (0.97-1.14)
Region			
Northeast	1 [Reference]	1 [Reference]	1 [Reference]
Midwest	0.99 (0.92-1.07)	0.98 (0.92-1.06)	0.97 (0.91-1.05)
South	0.95 (0.89-1.02)	0.96 (0.91-1.03)	0.96 (0.89-1.03)
West	0.80 (0.75-0.86)	0.84 (0.78-0.91)	0.86 (0.80-0.92)
History			
CHD	6.28 (5.94-6.63)	4.64 (4.37-4.92)	3.74 (3.50-3.98)
Stroke	3.23 (3.03-3.44)	2.21 (2.05-2.38)	1.42 (1.31-1.54)
PAD	6.30 (4.41-9.00)	5.02 (3.34-7.54)	2.68 (1.66-4.31)
Diabetes	4.69 (4.46-4.92)	4.46 (4.23-4.70)	3.75 (3.54-3.97)
GCCI score[c]			
0	1 [Reference]	1 [Reference]	1 [Reference]
1	1.58 (1.51-1.66)	1.54 (1.46-1.62)	1.18 (1.12-1.25)
≥2	2.09 (1.93-2.25)	1.52 (1.41-1.64)	1.13 (1.04-1.23)

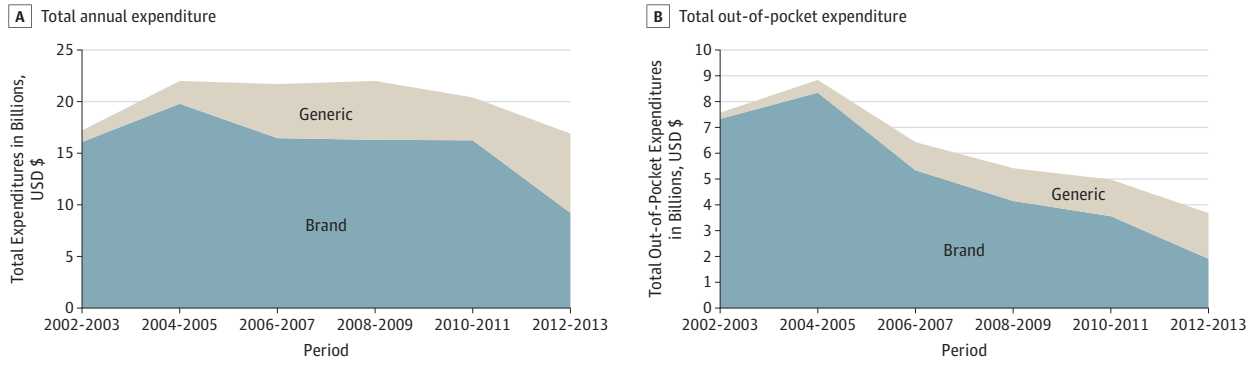
Abbreviations: CHD, coronary heart disease; FPL, federal poverty level; GCCI, Grouped Charlson Comorbidity Index; GED, general education development; MEPS, Medical Expenditure Panel Survey; PAD, peripheral arterial disease.

[a] Model 1: age, sex, and race/ethnicity along with the univariate predictor of statin use included in the model.

[b] Model 2: all predictor variables were included in this model.

[c] GCCI was modified for this study by excluding any cardiovascular disease or diabetes from the comorbidity index computation.

Figure 2. Trends in Statin Expenditures in the General Adult Population, Medical Expenditure Panel Survey 2002-2013



The graphs show the (A) total annual expenditures on statins and (B) total out-of-pocket expenditures on statins in the general US adult population.

eFigure 4 and eFigure 5 in the Supplement. Among US adults, mean per-user annual expenditures (in constant 2013 dollars) for all statins fell from $791 in 2002-2003 to $409 in 2012-2013. However, over the same time frame, mean per-user annual expenditures for branded statins rose from $808 to $1188, whereas the respective costs for generic statins fell from $498 to $227 (eFigure 6 in the Supplement).

Discussion

Our study provides detailed insights into trends in use, disparities in uptake, and costs associated with statin use between 2002 and 2013. We observed a significant increase in statin use among the US general population; however, the observed uptake among individuals with established ASCVD—a group that derives the greatest benefit from statins—was suboptimal. Furthermore, the use of high-intensity statins among patients with established ASCVD was particularly low. Our study also found that despite improvement in statin use, significant inequities persist in various subgroups such as women, racial/ethnic minorities, and the uninsured. Last, while significant reductions in costs were associated with increased use of generic statins, branded statins continued to account for a larger portion of overall and OOP costs.

Overall, statin use increased by 79% among the US adult population, rising from 17.9% to 27.8% from 2002-2003 to 2012-2013. A similar increase in statin use has been noted in other nationally representative studies from both developed and developing countries.[16-18] While these figures represent modest success in improving statin uptake in the general population, the trends in high-risk groups, such as those with ASCVD and diabetes, remain suboptimal. Since 2004-2005, statin use in those with CHD essentially remained unchanged, increasing slightly from 60% to 63%. This finding is consistent with insights from National Health and Nutrition Examination Survey data showing that only 60% of US adults with CHD were taking lipid-lowering medications in 2005-2006[19] compared with 70.8% in 2012.[20] Similar trends were noted in Medicare patients with CHD, who also showed a modest rise in statin use from 61% in 2004[21] to 66% in 2007-2008.[22]

While high-intensity statins improve outcomes in high-risk populations and their use is a class 1A recommendation, we noted significant underuse of high-intensity statins among selected population groups. In those with established ASCVD, high-intensity statins were used by only 21.5% patients in 2002-2003, rising to 28.9% in 2012-2013. These findings are consistent with recent findings from a national registry reporting that only 1 in 5 patients with myocardial infarction were discharged with high-intensity statins.[23,24] Of Medicare beneficiaries who were discharged from a hospital after an acute myocardial infarction, only 27% of patients' first prescription after discharge was for a high-intensity statin.[25] Factors noted to be associated with reduced uptake of appropriate high-intensity statin use include a focus on low-density lipoprotein cholesterol goals and patient concerns regarding adverse effects.[25] The suboptimal use of intensive statin therapy among 21.9 million US adults in 2012-2013 with established ASCVD raises concerns about missed opportunities for intensive secondary prevention in high-risk patients and highlights an important opportunity to improve care and reduce recommended treatment gaps. While statin use is a commonly used quality metric to assess optimal care of patients with ASCVD,[26] it is necessary to also include dose intensity as a quality metric to maximize the myriad benefits of statin therapy in high-risk patients. Increased education is needed to have physicians prescribe recommended statin doses to high-risk patients independent of low-density lipoprotein cholesterol levels.

Inequalities in high-value treatment gaps have generated significant interest in recent years from investigators and policy makers. Previous cross-sectional studies have suggested widespread inequities in statin use among select demographic groups.[20,27,28] We expand on this work, showing that while statin use among younger patients; women; racial/ethnic minorities, especially black and Hispanic individuals; and the uninsured have improved over time, practice gaps persisted over the 12-year study period. Although disparities in insurance coverage have been identified by the Institute of Medicine as a key driver of persistent health care discrepancies among these vulnerable groups, our findings demonstrate differential uptake of statins among different demographics groups not fully explained by insurance characteristics. This suggests that

equitable access to health care might not equate to uniform quality of care.[29] These findings should stimulate policymakers and clinicians to enact resolute efforts allowing consistent adoption of guidelines in these vulnerable populations to eliminate this variance.[29] Detailed future insights into factors contributing to existing gaps in well-established care pathways, such as statin use in high-risk groups, are critical to assembling pragmatic actions to address these persistent health disparities.

Our comprehensive analysis of trends in total statin drug costs for the US adult population provides valuable insights for policy makers with regard to projecting the cost of cardiovascular care. Our data show that the introduction of generic statins had a pronounced effect on the cost associated with statin use in the last 12 years. Over the study period, the gross domestic product–adjusted cost for statins went from $17.2 billion in 2002-2003, peaking at $22 billion in 2008-2009, followed by a downward trend to $16.9 billion in 2012-2013. Over the same period, patient cost-share for statins decreased from 44.2% ($7.6 billion) to 23.1% ($3.9 billion), with the mean annual OOP cost per user reduced by 75% from $348 to $94. While the reduction in costs since 2008-2009 is encouraging, further gains can be achieved by expanding the use of generic statins. With most major statins coming off patent during the study period, an increase in generic statin use was noted. In the general population, brand-name statin use decreased from 91.6% to 18.2% over the study period. Similar reductions were noted among all study subgroups (eFigure 2 in the Supplement). All statins that became generic saw increases in their prescription, reflecting appropriate clinician market response (eFigure 3 in the Supplement). However, despite these impressive reductions, 1 in 5 patients in 2013 continued to take brand-name statins despite equivalent generic alternatives, blunting additional potential cost reductions. Therapeutic substitution from brand-name to generic statins, which is influenced by the preferences of physicians and/or patients, is of paramount importance in the current climate of cost-containment.

Limitations

The present findings should be interpreted in the context of the following limitations. First, because the MEPS was carried out in a noninstitutionalized adult population, our results are only generalizable to adults dwelling in communities and not those living in nursing homes. Second, our classification of adults into ASCVD risk groups was partly based on self-report, which could result in possible underestimation of risk groups' sizes. Third, any statin use was considered regardless of the number of prescriptions to ensure accurate estimation of expenditures and this could potentially overestimate statin use. However, when statin use was considered to be restricted to individuals with at least 2 prescriptions, it did not affect the results, but we observed lesser statin use as we increased the threshold for the number of prescriptions in our description of statin use. Of note, when limited to 2 or more prescriptions, the proportion of the population using statins was 22.4%, and it was 20.0% when limited to 3 or more prescriptions. It is important to note that our results do not reflect patterns of adherence and long-term use. Finally, our study lacked insight into the status of statin use following the adoption of the American College of Cardiology/American Heart Association guidelines in 2013 as the MEPS Prescribed Medicine File was not released at the time of the current study. However, previous goal-directed guidelines would necessitate high-intensity statin use in most high-risk patients regardless.

Conclusions

In conclusion, while use of statins has increased substantially in the general population from 2002 to 2013, appropriate uptake in high-risk groups remains suboptimal, with persistent disparities noted among women, racial/ethnic minorities, and the uninsured. We noted that high-intensity statin use remains an important gap that needs to be more aggressively targeted by policy makers. Although significant temporal reduction in drug costs continues to be realized with broader generic substitution, in 2013, almost 1 in 5 prescriptions were branded and accounted for 55% of total statin-related expenditures. These findings have important public health implications and should stimulate further discussions among stakeholders for pragmatic patient-centered interventions to improve appropriate statin use and manage associated costs.

ARTICLE INFORMATION

Accepted for Publication: October 14, 2016.

Published Online: November 14, 2016. doi:10.1001/jamacardio.2016.4700

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Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for

Disclosure of Potential Conflicts of Interest. Dr Rana reported receiving institutional research grants from Regeneron/Sanofi. Dr Blaha has received grants and/or personal fees from the National Heart, Lung, and Blood Institute; American Heart Association; US Food and Drug Administration; Aetna Foundation; Novartis; and Amgen. Dr Nasir is on the advisory board for Quest Diagnostic and a consultant for Regeneron. No other disclosures were reported.

Previous Presentation: This study was presented at the American Heart Association Scientific Conference; November 14, 2016; New Orleans, Louisiana.

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