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Medical Expenditures Associated With Hypertension in the U.S., 2000–2013

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Abstract

Introduction—Trends of prevalence, treatment, and control of hypertension have been documented in the U.S., but changes in medical expenditures associated with hypertension over time have not been evaluated. This study analyzed these expenditures during 2000–2013 among U.S. adults.

Methods—Data from the Medical Expenditure Panel Survey were analyzed in 2016. The study population was non-institutionalized men and non-pregnant women aged ≥18 years. Hypertension was defined as ever been diagnosed with hypertension or currently taking antihypertensive medications. Medical expenditures included all payments to medical care providers. Expenditures associated with hypertension were estimated by two-part regression models and adjusted into 2015 U.S. dollars. Controlling variables included sociodemographic characteristics, marital status, insurance, region, smoking status, weight status, health status, and comorbidities. Trends were analyzed using joinpoint method.

Results—Total per-person annual expenditures associated with hypertension in 2000–2001 (\$1,399) were not significantly different from those in 2012–2013 (\$1,494) (average annual percent change [AAPC]=−0.6%, $p=0.794$), but annual national spending increased significantly from \$58.7 billion to \$109.1 billion (AAPC=8.3%, $p=0.015$), mainly because of the increase in the number of people treated for hypertension. Per-person outpatient payments were 22.7% higher in 2012–2013 than in 2000–2001 (\$416 vs \$322, $p<0.05$; AAPC=0.8%, p -trend 0.826). Payments for

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SUPPLEMENTAL MATERIAL

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prescription medications took up a larger proportion of the medical expenditures associated with hypertension, compared to payments for outpatient or other services (33%–46%).

Conclusions—During 2000–2013, annual national medical expenditures associated with hypertension increased significantly. Preventing hypertension could alleviate hypertension-associated economic burden.

INTRODUCTION

Hypertension is a major risk factor for cardiovascular disease (CVD) and one of the leading preventable causes of death.¹ During 2000–2013, data from the National Health and Nutrition Examination Survey (NHANES) revealed that the prevalence of hypertension among U.S. adults aged 18 years or older was largely unchanged (28.4% during 1999–2000 and 29.3% during 2013–2014).^{2–4} Among people diagnosed with hypertension, the prevalence of uncontrolled hypertension fell from 68.5% to 46% in the general population,⁵ but it remained persistently high among older adults, African Americans, and people with multiple chronic conditions.⁶ Over this period, treatment of hypertension with antihypertensive medications significantly improved, resulting in increased use of multiple antihypertensive medications and improvements in blood pressure control.^{4,6} These changes have important implications for related healthcare expenditures. It is therefore important to understand how changes in hypertension treatment, including newer medications and improved quality of care, have affected medical costs.

Although trends in prevalence, treatment, and control of hypertension have been documented, to the authors' knowledge changes in medical expenditures associated with hypertension have not yet been evaluated. In 2010, the Agency for Healthcare Research and Quality (AHRQ) reported that direct medical expenditures to treat hypertension were \$733 per person and \$42.9 billion nationwide.⁷ Expenditures to treat all forms of CVD, including heart disease and stroke, were \$193.1 billion.⁵ Because hypertension is an important risk factor for CVD,⁸ total medical expenditures associated with hypertension are expected to be much higher when spending for hypertension-associated treatment (e.g., for CVD) is added. Previous studies have shown that medication prescribed for hypertension accounted for \$68 billion in health care expenditures in the U.S. in 2007,⁹ and expenses for hypertension-related hospitalization were \$113 billion in 2008 U.S. dollars.¹⁰ However, during 2000–2013, it is not clear how much medical spending in the U.S. is associated with hypertension or to what extent expenditures in this area have changed over time. This study analyzes the trend of medical expenditures associated with hypertension from 2000 to 2013 among U.S. adults.

METHODS

Data Sample

This study used data from the Household Component of Medical Expenditure Panel Survey (MEPS), which is a nationally representative survey of civilian non-institutionalized U.S. residents that has been conducted each year by AHRQ since 1996. MEPS collects a broad range of information from individuals about their households. This information includes

respondents' and other household members' sociodemographic characteristics, health conditions, health status, use of healthcare services, medical diagnoses, expenditures for different types of services, sources of payment, and health insurance coverage. MEPS also collects data from respondents' medical care providers to supplement the household survey data.

Although survey questions and data elements have changed slightly from year to year, measures on key variables were largely the same in the samples of MEPS respondents from 2000 to 2013. MEPS has collected information as self-reported or proxy respondent-reported on whether the person had ever been diagnosed as having hypertension (other than during pregnancy) since 2000; therefore, MEPS samples from 1996 to 1999 were not used. The population for this study is men and non-pregnant women aged 18 years. People with a history of childhood hypertension or those with gestational hypertension were excluded because those conditions have different clinical implications.¹¹ To accurately identify hypertension cases, MEPS Full-Year Consolidated Data Files of household survey data from 2000 to 2013 were linked to Prescribed Medicines Files of information from medical care providers according to individual identifiers. To increase sample size for sub-population analysis, this study analyzed the data in 2-year increments (e.g., 2000–2001, 2002–2003). Missing values were dropped and the final complete sample contained 287,521 observations.

Measures

This study used total medical expenditures, and expenditures for different types of services as outcome measures. In MEPS, all medical expenditures were measured as actual payments to medical care providers. Household respondents were asked about each family member's use of medical services and corresponding medical expenditures that occurred in the year before the interview. The reported information was then ascertained through medical claims from the respondents' providers. A validation study showed that MEPS respondents accurately reported inpatient stays, but slightly underreported emergency department use and office visits.¹² Total medical expenditures included those for physician office visits, emergency room services, prescription medication, hospital stays, and other medical services within a year. Total medical expenditures were classified into three categories:

1. outpatient expenditures included expenditures for office-based services, outpatient facility expenditures, and outpatient provider expenditures;
2. medication expenditures included expenditures for prescription medications, whereas prescriptions in the inpatient setting were not included; and
3. other services included laboratory tests, hospital stays, in-hospital physician services, emergency room services, home care, dental care, and other medical services.

All expenditures were adjusted to 2015 U.S. dollar values using the Gross Domestic Product price index recommended by AHRQ for analyzing expenditure trends.¹³

Hypertension was defined as either having ever been diagnosed with hypertension or currently taking medication for hypertension.⁹ Whether the respondent was currently taking medications was determined by conditions—cited in the Prescribed Medicines File—that are

based on ICD-9 codes. This study used ICD-9 codes “401–405” to identify patients who were taking medications to treat essential hypertension, hypertensive heart disease, hypertension chronic kidney disease, hypertensive heart and chronic kidney disease, and secondary hypertension.¹⁴ This information was combined with data for respondents who reported having hypertension. The combined data were used to estimate the prevalence of hypertension in the U.S. from 2000 to 2013.

Statistical Analysis

Data were analyzed in 2016. Descriptive analyses for the prevalence of hypertension were first performed by stratifying the samples by age, sex, and race/ethnicity. Regression analyses were then conducted to estimate annual per-person medical expenditures associated with hypertension from 2000 to 2013. Because the outcome measures were medical expenditures that contained a large number of zero observations and had a skewed distribution,¹⁵ ordinary linear models based on a normal distribution assumption could have led to a biased estimation. Two-part regression models, a well-established econometric method, were applied to analyze the expenditures in two parts.^{16,17} The first part was a logit model predicting the probability of incurring any expenditure. The second part was a generalized linear regression with a log link and gamma distribution estimating the expenditures associated with hypertension among those with positive expenditures. Both parts used the same covariates. Covariates included respondents’ sociodemographic characteristics, including age in years and age squared, sex, race/ethnicity, residential region, education, income level, marital status, and health insurance status. Health insurance status was defined based on the MEPS-constructed variable, which was classified into three mutually exclusive categories:

1. any private insurance, including persons covered by private insurance (including Medigap policies for Medicare enrollees) or TRICARE (a healthcare program of the U.S. Department of Defense Military Health System)/CHAMPVA (the Civilian Health and Medical Program of the Department of Veterans Affairs) any time within a year;
2. public only, including persons covered only by public insurance (excluding TRICARE and CHAMPVA); and
3. uninsured, including those without coverage.¹⁸

Other controlling variables were respondents’ health conditions and behaviors, including smoking status, weight status, and health status. This study further controlled several comorbidities of hypertension such as diabetes, emphysema, and asthma. CVDs were not adjusted in the analysis; because CVDs are disease outcomes attributable to hypertension, including them may potentially result in double counting issues.¹⁹ Survey weights were applied in all descriptive and regression analyses.

Based on the regression models, per-person expenditures associated with hypertension were calculated through several steps. First, every observation was set to have hypertension (hypertension=1) while every covariate was kept at its current value, and the average expenditure was then predicted by multiplying it by the probability of incurring any

expenditure (A). Second, every observation was counterfactually set to have no hypertension (hypertension=0) while every covariate was kept at its current value, and the average expenditure was then predicted by multiplying it by the probability of incurring any expenditure (B). Finally, the predicted expenditure for the sample where no one had hypertension was subtracted from the sample where everyone had hypertension (A – B). This approach accounted for the secular trend that would have existed in the study population in the absence of hypertension. National estimates of medical expenditures associated with hypertension were then calculated by the estimated per-person cost (A – B) times the number of people with hypertension. The number of people with hypertension was estimated from MEPS by applying sampling weights. All statistical analyses were conducted in Stata, version 14.2.

Because the trend in hypertension prevalence and control varied in different subgroups,³ medical expenditures were also analyzed by subpopulations to explore possible differences in the estimates by age, sex, and types of services. Two-part regression analysis was performed by restricting the analytic sample to each subpopulation and applying the same model specification. Trend analyses for medical expenditure estimates plotted over time by year were conducted using Joinpoint software, version 4.4.0.0, developed by the National Cancer Institute.²⁰ The expected percent change in the rate over a year (i.e., average annual percent change [AAPC]) was estimated from zero joinpoint regressions to quantify the average trend over this period. All trend analyses were conducted with statistical significance at $p < 0.05$.

RESULTS

Prevalence of hypertension among U.S. adults by age, sex, and race/ethnicity from 2000 to 2013 is shown in Table 1. The hypertension prevalence increased from 23.5% to 34.5% during this 13-year period. Hypertension prevalence increased in all age groups, both sexes, and in all racial and ethnic groups.

Table 2 presents the estimates of per-person medical expenditures associated with hypertension by age, sex, and health insurance status. These expenditures were higher in 2012–2013 than in 2000–2001, but not statistically significant (\$1,494 vs \$1,399 in 2015 U.S. dollars). Trend analysis showed the AAPC was –0.6% ($p = 0.794$). Expenditures in 2012–2013 were significantly lower than those in 2000–2001 for the group aged 18–44 years (\$870 vs \$1,025, $p < 0.05$; AAPC = –7.6%, p -trend = 0.033), and no different from those in 2000–2001 among adults aged 45–64 years (\$1,726 vs \$1,613, AAPC = –1%, p -trend = 0.781), but they were significantly higher than those in 2000–2001 among adults aged 65 years (\$2,507 vs \$1,782, $p < 0.05$; AAPC = 1.7%, p -trend = 0.427). Expenditures did not increase for males, but they did increase significantly for females (AAPC = 7.3%, p -trend = 0.010). Expenditures for females in 2012–2013 were much higher than they were in 2000–2001 (\$2,096 vs \$1,132, $p < 0.05$).

Table 3 shows the annual per-person medical expenditures for outpatient services, prescription medications, and other services. Total outpatient payments were 22.7% higher in 2012–2013 than in 2000–2001 (\$416 vs \$322, $p < 0.05$; AAPC = 0.8%, p -trend = 0.826).

Payments for prescription medications in 2012–2013 were not significantly different from those in 2000–2001 (\$557 vs \$549, AAPC= -3.6%, p -trend=0.347), and so were payments for other services (\$521 vs \$528, AAPC=1.2%, p -trend=0.479). Payments for prescription medications took up a relatively larger proportion of the per-person medical expenditures associated with hypertension, compared to payments for outpatient or other services (33%–46%).

Table 4 presents the annual national medical expenditures associated with hypertension. The estimated number of people with hypertension increased from 42 million to 73 million (AAPC=9.8%, p -trend<0.001). The national spending associated with hypertension increased consistently from \$58.7 billion in 2000–2001 to \$109.1 billion in 2012–2013 (AAPC=8.3%, p -trend=0.015).

DISCUSSION

Using a nationally representative survey on medical expenditures, this study documented the changes in hypertension-associated medical expenditures over the period of 2000–2013. The results showed that annual per-person medical expenditures associated with hypertension did not significantly increase during this time, but national medical expenditures increased significantly. This finding is consistent with medical costs associated with hypertension reported in a 2010 study that used the Chronic Disease Cost Calculator, which found that the per-person costs associated with hypertension were around \$1,500.²¹ This study also found that the percentage of people knowing that they had hypertension or were under treatment for hypertension increased from 2000 to 2013 in the U.S. (p -trend <0.05). This finding was not the same as the prevalence of hypertension reported in the NHANES studies, which is a measure of people's blood pressure. NHANES data show the prevalence has not changed from 2000 to 2013. But the NHANES data have shown that the percentage of U.S. adults with hypertension under control has increased in the past decade, possibly because more people are taking antihypertensive medications.^{4,6}

Among types of healthcare services, only payments for outpatient services were significantly higher in 2012–2013 than in 2000–2001. A recent study reported that national healthcare spending has been growing at a steady rate, but personal healthcare expenditures, particularly physician services, were growing faster.²² Payments for prescribed medication increased considerably from 2000–2001 to 2004–2005 and decreased from 2006–2007 to 2012–2013, though neither were statistically significant (AAPC= -3.6%, p =0.347). The increase in drug expenditures during 2000–2005 may be related with changes in the guideline for hypertension treatment (published in 2003) that suggested most patients with hypertension will require more than one drug class of antihypertensive medications to achieve blood pressure control.²³ The decrease in drug expenditures from 2006 through 2013 may be related to more generic substitutions for antihypertensive drugs that occurred during this period, which was estimated to save about \$133 per person in 2008 from the 2000 level.²⁴ Longer-term cost reduction is expected as more generic drugs and more affordable drugs that improve medication adherence enter the market.²⁵ In addition, the economic downturn that started in 2008, combined with cost regulation from Medicare, likely contributed to the stagnation of medical spending associated with hypertension.²⁶

This study also found that the medical expenditures associated with hypertension increased more for adults aged 65 years or older than they did for younger age groups, but the trend did not change significantly within each age group. The risk of hypertension and hypertension-related health outcomes, including CVD and stroke, rises with advanced age,^{27,28} and a higher proportion of this population were taking antihypertensive drugs. These factors may explain why adults aged 65 years or older paid more for hypertension-associated treatment per treated patient than younger adults in recent years. This study also found that per-person medical expenditures associated with hypertension appear to be higher in women than men. Although women might be more likely than men to adhere to treatment,²⁹ it is likely that women may experience more severe hypertension-related outcomes, such as stroke, which would result in higher total expenditures associated with hypertension.³⁰

The national estimate of hypertension-associated burden of \$109.1 billion in 2012–2013 is higher than the estimate reported by the American Heart Association in their 2015 report. The American Heart Association reported the estimated national burden of hypertension was \$68 billion in 2015, although this estimate did not include the costs of complications (i.e., CVD and stroke).⁵ The national burden estimated in this study was closer to the estimate reported in an earlier study by the American Heart Association, in which costs of hypertension as a risk factor were estimated at \$131 billion, without adjustment for complications and comorbidities.³¹

This study had several strengths. First, it used a large nationally representative sample to estimate medical expenditures over several years, which allowed expenditures to be analyzed by different population groups, types of services, and sources of payment. The MEPS data also measured the actual payments received by medical care providers, which can be different from the original medical charges that varied depending on insurance plans and providers. In addition, this study used a consistent definition of hypertension and a two-part model approach to examine data across multiple years. In the previous literature, different studies used different definitions of hypertension and analytic models, which made data less comparable over time.^{7,9,10}

Limitations

This study also had several limitations. First, because cross-sectional data were used, the results can only be interpreted as medical expenditures associated with hypertension. Differentiating between expenditures for treatment of hypertension and expenditures for treatment of hypertension-related health outcomes would require following a population cohort over a long period of time. Nevertheless, the current analysis can help researchers understand the economic burden of hypertension from a payer's perspective. Second, although MEPS is a comprehensive survey measuring medical spending among the non-institutionalized U.S. population, the medical expenditures reported in this study may be underestimated because expenditures from the institutionalized population, such as spending on nursing home care, were not collected. This is especially important because nursing home residents may be more likely to have hypertension.³² Third, in MEPS, ICD-9 codes were assigned by professional coders to define up to three primary diagnoses associated with prescribed medications. It is likely that a small percentage of respondents with multiple and

more advanced chronic conditions may not have hypertension listed as one of their three primary diagnoses and would therefore not be included in this study. Fourth, because MEPS only captured a sample of respondents who ever have been diagnosed with hypertension, people with hypertension who have not been diagnosed could not be included in this study. Therefore, the estimated prevalence of hypertension in the U.S. is assumed to be lower than the actual prevalence. This implies that the estimated aggregate expenditures in this study may be too conservative because undiagnosed hypertension may trigger higher medical expenditures to treat hypertension-associated health outcomes. However, the authors' per-person estimates could be overestimated, because it is also possible that people with undiagnosed hypertension spent less money overall on treatment of hypertension and related diseases, which would make the estimated per-person costs in this study higher than the actual costs. Future studies could assess the differences in medical expenditures associated with controlled and uncontrolled hypertension.

CONCLUSIONS

This study found that national medical expenditures associated with hypertension increased from 2000 to 2013 in the U.S. As expenditures associated with hypertension have increased, this finding represents a call for urgency in prevention and control of hypertension. Furthermore, preventing hypertension could help contain costs and alleviate some of the burden of the expenditures to treat hypertension-related diseases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Prevalence (%) of Hypertension in U.S. Adults Aged 18 Years, Medical Expenditure Panel Survey, 2000–2013^a

Characteristics	2000–2001 (n=34,043)	2002–2003 (n=42,416)	2004–2005 (n=39,182)	2006–2007 (n=37,343)	2008–2009 (n=40,927)	2010–2011 (n=40,518)	2012–2013 (n=45,312)	AAPC ^b	p-value ^b
Overall	23.5	25.2	26.9	28.5	32.8	33.5	34.5	7.1	< 0.001
Age, years									
18–44	7.9	8.6	8.8	9.8	13.1	13.0	13.9	11.2	< 0.001
45–64	32.3	33.7	35.7	37.2	42.2	42.4	42.1	5.2	< 0.001
65	56.3	60.2	64.0	66.6	70.0	70.5	71.3	4.0	< 0.001
Sex									
Male	22.9	24.9	26.8	28.5	33.4	34.8	36.5	8.5	< 0.001
Female	24.0	25.4	27.0	28.6	32.2	32.2	32.6	5.8	< 0.001
Race/ethnicity									
Non-Hispanic white	24.4	26.2	28.1	29.5	33.7	34.8	35.8	7.1	< 0.001
Non-Hispanic black	28.2	32.2	33.3	36.1	40.1	41.2	43.3	7.1	< 0.001
Hispanic	15.0	14.9	17.1	19.8	24.5	23.6	25.6	11.0	< 0.001
Other races ^c	16.8	20.3	22.0	22.8	28.3	28.0	27.2	8.6	0.001

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Population weights were adjusted for all statistics.

^b Average annual percent change (AAPC) and p -value for AAPC were calculated by using Joinpoint regression analysis.

^c Other races included Asians, American Indians, and other defined races.

Annual Per-Person Medical Expenditures (2015 Dollars) Associated With Hypertension by Age and Sex, Medical Expenditure Panel Survey, 2000–2013^a

Table 2

Variables	2000–2001 (n=34,043)	2002–2003 (n=42,416)	2004–2005 (n=39,182)	2006–2007 (n=37,343)	2008–2009 (n=40,927)	2010–2011 (n=40,518)	2012–2013 (n=45,312)	AAPC (%) ^b	p-value ^b
Overall	1,399	1,632	1,925	1,675	1,524	1,562	1,494	-0.6	0.794
Age, years									
18–44	1,025	1,466	1,318	807	1,099	851	870 ^c	-7.6	0.033
45–64	1,613	1,678	2,489	2,290	1,633	1,850	1,726	-1.0	0.781
65	1,782	2,410	2,452	2,804	2,387	2,303	2,507 ^c	1.7	0.427
Sex									
Male	1,692	1,835	2,097	1,564	1,419	1,422	1,051 ^c	-7.8	0.017
Female	1,132	1,545	1,716	1,795	1,593	1,915	2,096 ^c	7.3	0.011

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Estimated by two-part models: adjusting for age in years, age square, sex, race/ethnicity (non-Hispanic white versus non-Hispanic black, Hispanic, and other races); residential region (Northeast, Midwest, or South versus West); educational attainment (less than high school, high school, or some college versus college and above); income levels (poor/near poor, low income, or middle income versus high income); insurance coverage (private or public versus uninsured); smoking status (currently smoking versus not currently smoking); weight status (overweight or obese versus normal weight); marital status (currently married versus not married); diabetes diagnosis; emphysema diagnosis; asthma diagnosis; and self-reported health status (excellent/very good or good versus fair/poor). Population weights were adjusted for all statistics.

^b Average annual percent change (AAPC) and p -value for AAPC were calculated by using Joinpoint regression analysis.

^c Significantly different compared with the 2000–2001 time point at the $p < 0.05$ level.

Annual Per-Person Medical Expenditures (2015 Dollars) Associated With Hypertension by Types of Services, Medical Expenditure Panel Survey, 2000–2013^a

Variables	2000–2001 (n=34,043)	2002–2003 (n=42,416)	2004–2005 (n=39,182)	2006–2007 (n=37,343)	2008–2009 (n=40,927)	2010–2011 (n=40,518)	2012–2013 (n=45,312)	AAPC (%) ^b	p-value ^b
Types of services, ^c \$ (%)									
Outpatient	322 (23)	394 (24)	489 (25)	406 (24)	290 (19)	404 (26)	416 ^d (28)	0.8	0.826
Medication	549 (39)	662 (41)	821 (43)	767 (46)	593 (39)	519 (33)	557 (37)	-3.6	0.347
All others	528 (38)	576 (35)	614 (32)	503 (30)	641 (42)	639 (41)	521 (35)	1.2	0.479

^a Estimated by two-part models: adjusting for age in years, age square, sex, race/ethnicity (non-Hispanic white versus non-Hispanic black, Hispanic, and other races); residential region (Northeast, Midwest, or South versus West); educational attainment (less than high school, high school, or some college versus college and above); income levels (poor/near poor, low income, or middle income versus high income); insurance coverage (private or public versus uninsured); smoking status (currently smoking versus not currently smoking); weight status (overweight or obese versus normal weight); marital status (currently married versus not married); diabetes diagnosis; emphysema diagnosis; asthma diagnosis; and self-reported health status (excellent/very good or good versus fair/poor). Population weights were adjusted for all statistics.

^b Average annual percent change (AAPC) and p-value for AAPC were calculated by using Joinpoint regression analysis.

^c Outpatient expenditures included total expenditures for office-based services, outpatient facility expenditures, and outpatient provider expenditures. Medication expenditures included total expenditures for prescribed medication, whereas prescriptions in the inpatient setting are not included under prescribed medication. Expenditures for other services included laboratory tests, hospital stays, in-hospital physician services, emergency room services, home care, dental care, and other medical services within a year. The percentage in the parentheses represents a proportion of expenditures for each type of services in relation to the total per-person expenditures.

^d significantly different compared with the 2000–2001 time point at the $p < 0.05$ level.

Table 4
Annual National Medical Expenditures (2015 Dollars) Associated With Hypertension, Medical Expenditure Panel Survey, 2000–2013

Total	2000–2001	2002–2003	2004–2005	2006–2007	2008–2009	2010–2011	2012–2013	AAPC (%) ^a	<i>p</i> -value ^d
No. with hypertension (million)	42	48	52	55	67	69	73	9.8	< 0.001
National spending (billion) ^b	58.7	78.3	100.1	92.1	102.1	107.8	109.1 ^c	8.3	0.015

Note: Boldface indicates statistical significance ($p < 0.05$).

^a Average annual percent change (AAPC) and *p*-value for AAPC were calculated by using Joinpoint regression analysis.

^b Calculated as per person cost times the estimated number of people with hypertension.

^c Significantly different compared with the 2000–2001 time point at the $p < 0.05$ level.

No., number.