Increasing Copayments and Adherence to Diabetes, Hypertension, and Hyperlipidemic Medications

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Objective: To examine the impact of a medication copayment increase on adherence to diabetes, hypertension, and hyperlipidemic medications.

Study Design: Retrospective pre–post observational study.

Methods: This study compared medication adherence at 4 Veterans Affairs medical centers between veterans who were exempt from copayments and propensity-matched veterans who were not exempt. The diabetes sample included 1069 exempt veterans and 1069 nonexempt veterans, the hypertension sample included 3545 exempt veterans and 3545 nonexempt veterans, and the sample of veterans taking statins included 2029 exempt veterans and 2029 nonexempt veterans. The main outcome measure was medication adherence 12 months before and 23 months after the copayment increase. Adherence differences were assessed in a difference-in-difference approach by using generalized estimating equations that controlled for time, copayment exemption, an interaction between time and copayment exemption, and patient demographics, site, and other factors.

Results: Adherence to all medications increased in the short term for all veterans, but then declined in the longer term (February-December 2003). The change in adherence between the preperiod and the postperiod was significantly different for exempt and nonexempt veterans in all 3 cohorts, and nonadherence increased over time for veterans required to pay copayments. The impact of the copayment increase was particularly adverse for veterans with diabetes who were required to pay copayments.

Conclusion: A $5 copayment increase (from $2 to $7) adversely impacted medication adherence for veterans subject to copayments taking oral hypoglycemic agents, antihypertensive medications, or statins.

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For author information and disclosures, see end of text.

Diabetes and hypertension are among the most common chronic conditions in the United States, with prevalence rates of 9.6% and 29.7% for individuals age 20 years and over in 1999-2001.[1,2] Between 20% and 40% of patients with these conditions receive no medication management.[3-6] Pharmacologic therapy is a mainstay in the management of both conditions, but only 50% to 70% of patients receiving medication management are adherent to medications.[7,8]

Improving medication adherence for individuals with diabetes or hypertension has been challenging as health plans and employers increase medication copayments,[9-16] lower limits on the number or total reimbursement of covered medications,[17,18] and introduce tiered benefits.[19-23] Between 2000 and 2005, average copayments for commercially insured individuals increased from $7 to $10 for generic medication, $13 to $22 for preferred medications, and $17 to $35 for nonpreferred medications.[24] Cost-related nonadherence has increased with higher copayments.

The Department of Veterans Affairs (VA) copayment policy mirrored these market trends by increasing medication copayments from $2 to $7 for a 30-day fill on February 4, 2002. In 1999-2000, 19.6% of veterans had diagnosed diabetes[25] and 36.8% had diagnosed hypertension.[26] Lipid-lowering medications are indicated for nearly all of these veterans. This study examined the impact of the VA medication copayment increase on adherence to diabetes, hypertension, and hyperlipidemic medications by veterans with diabetes or hypertension during a 35-month period (February 2001-December 2003).

This analysis contributes to the extensive literature on the effect of copayments on medication adherence by assessing several therapeutic classes across several conditions, allowing us to examine whether copayment increases have a differential impact across conditions. In addition, we assessed a copayment increase in a population with higher comorbidity and lower income than those in many prior studies, which is critical to clarify whether copayment impacts vary by income.[27]

A recent review article of interventions to impact medication adherence found that many evaluations of formulary and cost-sharing changes lacked control groups or pre–post comparisons, which limited their internal validity.[28] We included a colocated control group that controlled for site effects not included in other studies,[11-13,15,16] compared adherence before and

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after the copayment increase,[12,13,15,29] and reduced potential bias from the nonequivalent control group with propensity score matching and covariate adjustment that could have confounded copayment effects in prior studies.[30-32] This longitudinal comparison provides information on additional decrements in adherence that might occur with further copayment increases in the VA or private insurers. Identifying patients with chronic conditions who might be especially adversely impacted by copayment increases also could suggest targets for interventions to offset the adherence impacts of increased copayments.

Take-Away Points

Adherence to diabetes, hypertension, and hyperlipidemic medications among veterans exempt from copayments and propensity-matched nonexempt veterans was examined at 4 Veterans Affairs medical centers.

- A $5 copayment increase (from $2 to $7) adversely impacted medication adherence for veterans subject to copayments.
- Copayment increases need to be considered carefully by the Department of Veterans Affairs to ensure that veterans who have greater comorbidity and lower incomes than the general US population do not forgo needed medications.

METHODS

VA Copayment Increases

The systemwide increase in the VA medication copayment[33] from $2 to $7 in February 2002 created a natural experiment to examine changes in medication adherence for veterans with diabetes or hypertension. Prior to this medication copayment increase, the VA implemented $15 copayments for primary care, $50 copayments for specialty care, and $10 per diem copayments for inpatient care effective December 6, 2001.[34,35] On January 1, 2006, the medication copayment was increased again to $8 for a 30-day fill.[35]

Design and Study Populations

We used a retrospective, pre–post cohort design with a nonequivalent, colocated control group at 4 large tertiary Veterans Affairs medical centers (VAMCs). We identified 60,017 veterans with diabetes (n = 23,182) or hypertension (n = 51,503) who were diagnosed and prescribed a medication for either of these conditions in 2000. Veterans were included in the analysis if they (1) were alive during the entire study period, (2) had a majority of their primary care visits at 1 of the 4 VAMCs, (3) had complete information on level of military service–connected disability to determine exemption from drug copayments, (4) were not hospitalized when the copayment increase went into effect or for more than 1 year during the study period, (5) had at least 1 fill in a relevant drug class during the quarter prior to the copayment change, and (6) had at least 1 fill during the second, third, and fourth quarters prior to the copayment change.[19-23] We excluded subjects on non-NPH insulin therapy that would preclude taking oral hypoglycemic agents. We did not exclude patients on NPH, because NPH insulin may be added to oral regimens in a stepped approach. The application of these criteria resulted in analytic samples of 7852 veterans with hypertension, 4407 veterans with diabetes, and 4217 veterans with diabetes or hypertension who were taking statins.

A veteran's obligation to pay medication (and healthcare) copayments is determined by priority group assignment, based on military service–connected disability for each diagnosed condition, and on income. In 2002, veterans were exempt from medication copayments if (1) their annual income was less than $9556 if single and $12,516 if married; (2) their diabetes, hypertension, or hyperlipidemia was a service-connected disability; or (3) their diabetes, hypertension, or hyperlipidemia was not a service-connected disability, but they exceeded the $840 copayment cap in a given year. Priority group 1 veterans are exempt from all healthcare and medication copayments because the VA has determined that 50% or more of their overall disability is due to their military service, whereas priority group 7 and 8 veterans are required to pay all healthcare and medication copayments because they have no military service–related disability and have income and/or net worth above the VA national income threshold. We excluded veterans in priority groups 2 to 6 from the study because we were unable to determine whether they were required to pay medication copayments.

Unadjusted comparisons of exempt and nonexempt veterans demonstrated significant differences in every observed characteristic. To reduce potential bias from imbalance in observed covariates between exempt and nonexempt veterans and to improve equivalence of the control groups, we conducted 1-to-1 nearest-neighbor propensity score matching with replacement.[36-38] After running 3 logistic regressions to generate propensity scores and matching exempt and nonexempt veterans, 762 exempt veterans with hypertension, 317 exempt veterans with diabetes, and 159 exempt veterans taking statins were excluded because there were no nonexempt veterans with similar propensity scores.

Our final hypertension matched sample included 3545 exempt veterans and 3545 nonexempt veterans. Our final diabetes matched sample included 1069 exempt veterans and 1069 nonexempt veterans. Our final matched sample of veterans with diabetes or hyperlipidemia taking statins included 2029 exempt veterans and 2029 nonexempt veterans. The unit of analysis was person-month with each veteran having up to 35 repeated measures. Human Subjects committees for all coinvestigators' facilities (Ann Arbor, MI, Durham, NC, Hines, IL, Little Rock, AR, and Seattle, WA, VAMCs) reviewed and approved this study.

Data Sources

We used 4 VA datasets for 2001-2003. All medications dispensed from the VA are recorded in the national Pharmacy Benefits Management database; data elements include drug name, date dispensed, number of days of medication supplied, and dosage.[39] The VA inpatient and outpatient care files provided information on veteran demographic characteristics and diagnoses for every inpatient hospitalization and outpatient visit in the national VA system. Benefit Identification and Record Locator System death record data identified which veterans died during the study period. Finally, the Diagnostic Cost Group Hierarchical Cost Category (DCG/HCC) version 6.0 score was used to adjust for overall comorbidity; this measure has been shown to predict veterans' total costs[40,41] and risk of hospitalization or death.[42]

Prescription Drug Use and Assessment of Medication Adherence

We calculated monthly medication adherence using the validated ReComp algorithm, a modification of a widely used method that is correlated with a variety of clinical outcomes.[43-45] This algorithm estimates the proportion of days covered for a given measurement interval using the date dispensed and the number of days supplied with each fill. Subjects were considered adherent if they had medications available for at least 80% of each month, which is a conventional threshold that was used to maintain congruence with prior studies.[46-49]

For adherence to oral hypoglycemic agents (OHAs) (sulfonylureas, metformin, thiazolidinediones) and antihypertensive medications (angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, calcium channel blockers, beta-blockers, and alpha-1 antagonists), we calculated refill adherence separately for each class of medications. We averaged scores to produce a monthly composite OHA adherence score among the diabetes cohort and a monthly composite antihypertensive adherence score among the hypertension cohort. Adherence in veterans with diabetes and/or hypertension taking HMG-CoA reductase inhibitors (statins) was calculated by combining all statin drugs in a single adherence measurement.

Covariates

There were 3 explanatory variables of interest in the medication adherence analysis using the propensity-matched cohorts: (1) an indicator of whether a veteran was required to make copayments; (2) time indicators for the 12-month preperiod before the copayment increase (February 2001-January 2002), the 12 months (short-term postperiod) just after the copayment increase (February 2002-January 2003), and the subsequent 11-month longer-term postperiod (February 2003-December 2003); and (3) an interaction of the copayment exemption and time indicators to enable a difference-in-difference analysis. The postperiod was subdivided to examine whether adherence differed in the short term and longer term.

All models also were adjusted for age, sex, race, marital status, patient comorbidity measured as DCG/HCC score, whether a veteran was hospitalized in prior or current months, presence of a depression diagnosis at baseline, presence of comorbid diabetes (if hypertension cohort) or hypertension (if diabetes cohort), and the number of all other medications that the patient was prescribed during the preperiod. To adjust for the impact of the December 2001 outpatient visit copayment increases, we adjusted for the number of primary care, specialty care, and mental health visits 90 to 180 days prior to the current month. It is possible that the increase in healthcare copayments would decrease outpatient visits and decrease prescription renewals; the lagged visit counts attempted to control for these cross-price effects.[50] Models that included a pre–post indicator for initiation of the healthcare copayment generated similar results (results not presented).

Analysis

Logistic regressions were estimated to identify whether a veteran was exempt or nonexempt from copayments and to generate predicted probabilities of being nonexempt, which served as the propensity scores for matching exempt and nonexempt veterans in the diabetes, hypertension, and statin cohorts. The propensity score model for the diabetes cohort included 19 main effects related to demographics, comorbidity, and medication burden and 18 interactions, because this specification reduced covariate imbalance within propensity score quintiles better than other specifications. Similar iterative specification tests were conducted for the logistic regressions on the hypertension cohort with a final specification including 11 main effects and 18 interactions, and the statin cohort with a final specification including 20 main effects and 28 interaction terms. Detailed results are given in **Appendices A through C**.

Bivariate statistics (*t* tests, χ^2 test) were estimated to compare patient characteristics between matched exempt and nonexempt veterans, and to compare medication adherence at baseline (February 2001) and the last month of the study period (December 2003). To examine pre–post differences between propensity-matched exempt and nonexempt veterans in medication refill adherence over 35 months (12 preperiod and 23 postperiod months), we used generalized estimating equations assuming a binomial distribution, logit link, and independent working covariance structure with person-month as the unit of analysis. The working covariance structure was specified to obtain unbiased parameter estimates for the time-varying covariates.[51,52] Detailed results are given in **Appendices C through F**.

To estimate first differences, predictions from these generalized estimating equations were obtained to identify the proportion of exempt and nonexempt veterans in each cohort who were adherent in the preperiod, the immediate postperiod, and the longer-term postperiod. Confidence intervals (CIs) for these proportions were estimated through 1000 bootstrap iterations. All analyses used Stata software (StataCorp, College Station, TX). All reported *P* values are 2-sided, and significance was lowered to *P* = .01 to account for multiple comparisons.

RESULTS

Descriptive Statistics

Propensity matching eliminated imbalance in several covariates (proportion of veterans with diabetes, hypertension, or both; marital status, sex, race, baseline hospitalization rates, and number of diabetes medications) across all 3 cohorts, but did not eliminate imbalance in site composition (**Table**). Nonexempt veterans with diabetes were slightly older than exempt veterans with diabetes (*P* <.001) and were taking more hypertension medications (*P* <.001) but fewer medications of all kinds (*P* <.0001). Nonexempt veterans with diabetes had slightly fewer primary care and specialty care visits on average than exempt veterans (both *P* <.001).

Nonexempt veterans with hypertension were older than exempt veterans with hypertension (*P* <.0001), had slightly higher DCG/HCC risk scores (*P* <.01), and fewer specialty care visits (*P* <.0001). Nonexempt veterans with diabetes and/or hypertension taking statins were older than exempt veterans taking statins (*P* <.0001), were taking fewer medications overall (*P* <.001), had slightly fewer primary care, specialty care, and mental health visits on average (all *P* <.0001), and slightly fewer mental health visits (*P* <.001).

Changes in Medication Adherence

The unadjusted proportion of nonexempt and exempt veterans with diabetes who were adherent to their OHAs at baseline (February 2001) was similar, but the proportion adherent in the last month of the study period (December 2003) was significantly lower among nonexempt veterans with diabetes (60% vs 69%; *P* <.0001). A greater proportion of nonexempt veterans with hypertension were adherent to their antihypertensive medication at baseline (80% vs 76%; *P* <.0001), but there were no differences in adherence in December 2003. Unadjusted adherence rates were similar between nonexempt and exempt veterans taking statins.

After covariate adjustment, OHA adherence among exempt veterans with diabetes increased 4.1 percentage points in the year after the copayment increase (February 2002-January 2003) compared with the preperiod, while adherence remained constant for nonexempt veterans subject to copayments (first difference –3.8%; 95% CI = –3.7%, –3.9%). In the longer-term postperiod (February-December 2003), OHA adherence declined for both diabetes cohorts compared with the preperiod but significantly more so for nonexempt veterans (–10.3% vs –0.9%; *P* <.001) (first difference –9.6%; 95% CI = –9.5%, –9.8%). See **Figure 1**.

Adherence to antihypertensive medications increased for exempt and nonexempt veterans in the year after the copayment increase (4.1% vs 5.9%; first difference –1.8%; 95% CI = –1.8%, –1.9%) compared with the preperiod, but decreased thereafter for both groups compared with the preperiod. The decline in adherence to antihypertensive medications was greater for nonexempt veterans (–5.4% vs –2.3%; first difference –3.2%; 95% CI = –3.1%, –3.3%). See **Figure 2**.

Adherence to statins increased for exempt and nonexempt veterans in the year after the copayment increase compared with the preperiod, but more so for exempt veterans (3.5% vs 6.6%; first difference –3.0%; 95% CI = –2.9%, –3.1%). Statin adherence continued to increase (1.2%) for exempt veterans in the longer-term postperiod (February-December 2003) compared with the preperiod, but decreased for nonexempt veterans (–1.9%; first difference –3.1%; 95% CI = –3.0%, –3.2%). See **Figure 3**.

DISCUSSION

Adherence to OHAs, antihypertensive medications, and statins by veterans with diabetes or hypertension increased in the year after a $5 medication copayment increase (from $2 to $7), but subsequently declined. The change in adherence between the preperiod and postperiod (as indicated by the first differences) was significantly different for exempt and nonexempt veterans in all 3 cohorts, which indicates that the medication copayment increase had adverse effects on medication adherence, as has been found in similar studies. The longer-term impact of this policy change was particularly adverse for veterans with diabetes who were required to make copayments, because their adherence to OHAs 13 to 23

■ **Table.** Characteristics of the Diabetes, Hypertension, and Statin Cohorts

Characteristic	Diabetes Cohort		Hypertension Cohort		Statin Cohort	
	Exempt (n = 1069)	Nonexempt (n = 1069)	Exempt (n = 3545)	Nonexempt (n = 3545)	Exempt (n = 2029)	Nonexempt (n = 2029)
Diabetes only, %	33.8	34.5	—	—	10.7	11.1
Hypertension only, %	—	—	69.8	71.7	59.0	60.8
Diabetes and hypertension, %	66.2	65.5	30.2	28.3	30.3	28.0
Mean age, y (SD)	64.8[a] (9.5)	66.2 (9.4)	66.2[b] (9.8)	67.4 (9.3)	66.4[b] (8.8)	67.6 (8.3)
Married, %	76.6	76.6	73.9	73.7	79.0	78.9
Male, %	98.9	98.9	97.7	97.7	99.2	99.2
White, %	56.6	56.1	53.3	52.4	54.9	53.5
Nonwhite, %	8.6	8.6	8.0	7.9	5.9	5.8
Unknown race, %	34.8	35.2	38.7	39.6	39.2	40.7
Hospitalized in 2000, %	13.4	7.1	14.2	8.3	16.6	7.7
Mean DCG/HCC risk score in 2000 (SD)	0.6 (1.0)	0.7 (1.1)	0.5 (1.0)[c]	0.6 (1.0)	0.5 (0.9)	0.5 (1.0)
Mean number of medications (SD)	7.5 (3.4)[b]	7.0 (3.7)	6.2 (3.4)	6.1 (3.6)	7.0 (3.3)[a]	6.6 (3.6)
Mean number of diabetes medications (SD)	1.5 (0.6)	1.5 (0.7)	0.3 (0.6)	0.3 (0.7)	0.4 (0.7)	0.5 (0.8)
Mean number of hypertension medications (SD)	1.9 (1.3)[a]	2.1 (1.4)	2.4 (1.2)	2.4 (1.2)	2.3 (1.2)	2.3 (1.3)
Mean number of primary care visits in prior 90-180 days (SD)	0.8 (0.9)[a]	0.7 (0.8)	0.7 (0.8)	0.7 (0.8)	0.8 (0.1)[b]	0.7 (0.8)
Mean number of specialty care visits in prior 90-180 days (SD)	1.6 (2.1)[a]	1.3 (2.1)	1.3 (2.3)[b]	1.0 (2.1)	1.4 (2.0)[b]	1.1 (2.3)
Mean number of mental health visits in prior 90-180 days (SD)	0.3 (1.4)	0.2 (1.7)	0.2 (1.1)	0.1 (1.6)	0.2 (1.0)[a]	0.1 (0.7)
Study site A, %	15.6	12.1	14.1	12.9	18.8[b]	12.3
Study site B, %	22.0[b]	51.6	42.5[b]	50.1	34.9[b]	54.4
Study site C, %	40.6[b]	24.7	28.0[b]	24.0	29.4[b]	21.6
Study site D, %	21.8[b]	11.6	15.4[c]	13.1	16.9[b]	11.7
Unadjusted proportion of cohort adherent at baseline	87.4	84.3	80.4[b]	76.4	92.4	92.9
Unadjusted proportion of cohort adherent at study end	68.8[b]	59.5	56.7	56.0	79.5	80.3

DCG/HCC indicates Diagnostic Cost Group Hierarchical Cost Categories.
[a] $P < .001$.
[b] $P < .0001$.
[c] $P < .01$.

months after the copayment increase was 10.3% lower than their preperiod adherence and 9% lower than the adherence of comparable veterans who were exempt.

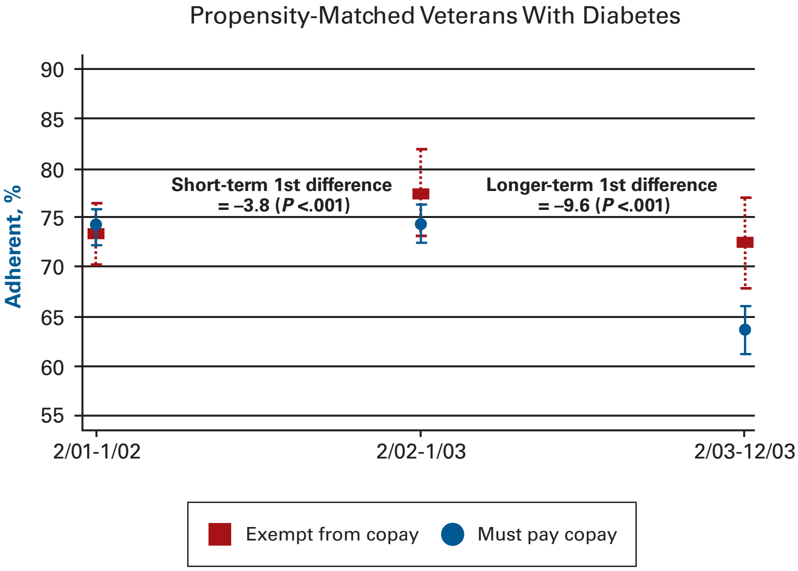
The initial increase in adherence may have been due to VA physicians encouraging all of their patients (regardless of copay status) to stockpile medications in anticipation of the copayment increase, because VA physicians tend not to be aware of a veteran's copayment exemption status and to treat all veterans in their panel similarly. This initial increase and subsequent decline also could have been due to a lagged effect of the copayment increase on adherence, because veterans may initially refill medications until their budgets get stretched and cost-related nonadherence ensues.

Cost-related nonadherence may have been reinforced by the cross-price effect[50,53] of the increased primary care copayment (from $0 to $15) and specialty care copayment (from $15 to $50) that occurred 2 months prior to the medication copayment increase. Increased healthcare copayments could impact adherence rates in 2 ways. The out-of-pocket costs of outpatient visits could have reduced visit rates at which prescriptions would be initiated, modified, or renewed. (In the postperiod, we observed significantly lower rates of primary care visits for veterans in all 3 cohorts [P <.0001].) In addition, veterans with fixed incomes who were keeping their outpatient appointments might sacrifice their medications to pay for these visits.[29,54] It also is possible that the initial adherence increase and subsequent decline could have been an artifact of our inclusion criteria. In a sensitivity analysis, we included veterans with 2 or more fills in the 12 months prior to the copayment increase (instead of 1 fill in the 3 months prior and another fill 4-9 months prior), but the difference-in-difference results were unchanged because trends were similar for exempt and nonexempt veterans.

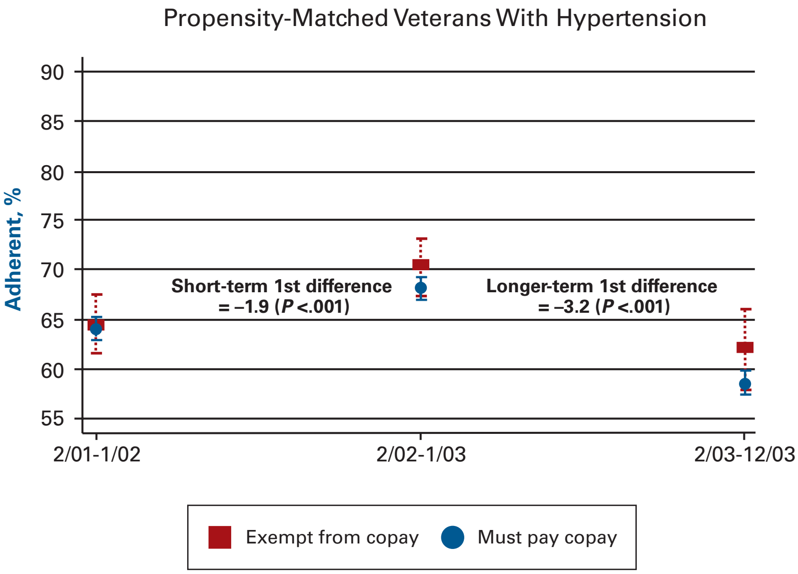
The decline in adherence to OHAs was significantly greater for veterans required to pay copayments than for exempt veterans, but the change in adherence to antihypertensives and stat–ins was more modest. It may simply be that patients value their cardiovascular medications more than their diabetes medications, as has been shown in prior studies.[13,55] A study of commercially insured populations by Goldman et al[13] found that patients with diabetes had a greater reduction in days supply in response to a doubling of copayments than patients with hypertension or hyperlipidemia (25% vs 10%), which is consistent with our results. However, a study of nonelderly, disability-eligible Medicare beneficiaries by Soumerai et al[56] reported similar rates of cost-related nonadherence for beneficiaries with diabetes and beneficiaries with hypertension. Finally, our statin findings are consistent with a recent study of veterans from 1 VAMC taking lipid-lowering medications,[32] despite several study design differences that make comparison difficult, including that study's significantly larger sample size, less equivalent control group, lack of propensity score matching, and more limited covariate adjustment.

We attempted to improve upon prior studies of cost-sharing and adherence by including a colocated control group[11-13,15,16] instead of a nonequivalent, geographically distinct control group,[10,19-23,57] by reducing potential bias through propensity score matching, and by contrasting pre–post changes of treatment and control groups.[12,13,15,29] We also examined medica-

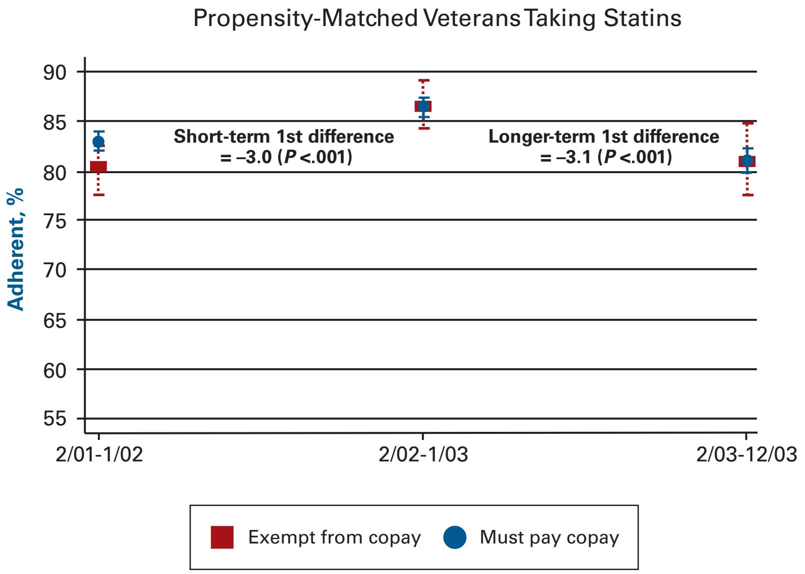
■ **Figure 1.** Adjusted Medication Adherence Trends for the Diabetes Cohort



■ **Figure 2.** Adjusted Medication Adherence Trends for the Hypertension Cohort



■ **Figure 3.** Adjusted Medication Adherence Trends for the Statin Cohort



tion adherence across a number of conditions to illustrate a range of clinical impacts of the copayment increase, which provides further evidence that the adherence decline that we observed in the diabetes sample was due to the copayment increase and not other factors.

However, several limitations remain. We were unable to track veterans' use of non-VA medications. It is possible that veterans with Medicaid or private insurance who became nonadherent to VA-acquired medications were simply obtaining them elsewhere, but this omission is likely to be minimal because VA copayments were lower than prevailing rates in commercial insurance and Medicare Part D plans at the time, and Walmart prescription drug programs were not available until 2006. The generalizability of our results is somewhat limited because our sample was drawn from 4 large VAMCs. However, we chose geographically dispersed VAMCs to reduce small area variation biases. Despite the propensity score matching, there remained a few differences in observed factors between exempt and nonexempt veterans, although we significantly reduced the extent of covariate imbalance and controlled for remaining imbalances directly in the adherence regression. However, the longitudinal natural experiment enabled us to control for fixed person-specific effects and time trends to minimize unobserved confounding, whereas propensity score matching and covariate adjustment reduced the likelihood of observed or unobserved confounding. These results appear to be robust.

It appears that a $5 copayment increase from $2 to $7 was sufficiently large to adversely impact medication adherence among veterans who have greater comorbidity and lower incomes than the general US population. The VA has since increased medication copayments to $8. Future copayment increases need to be considered carefully. If implemented, copayment increases should be matched with nonfinancial interventions to offset cost-related nonadherence. The VA may want to consider linking copayments with the clinical value of medications, because copayment reductions for high-value medications have been shown to reduce nonadherence in commercial populations.[58] Given that many veterans taking diabetes, hypertension, and hyperlipidemic medications are elderly or near elderly and are on fixed incomes, such copayment reductions may generate a sizable response if adherence changes mirror the decline observed in this analysis in response to a $5 copayment increase.

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Appendix A. Logistic Regression for Propensity Score in Diabetes Cohort

LR $\chi^2(36)$ = 1132.54
Prob > χ^2 = 0.0000
Pseudo R^2 = 0.3376

Log likelihood = –1110.872

grp	Coef.	Std. Err.	z	$P > \|z\|$	[95% Conf. Interval]	
site1	.9155974	.1900519	4.82	0.000	.5431025	1.288092
site2	2.158754	.1634759	13.21	0.000	1.838347	2.479161
site3	.5992354	.1590511	3.77	0.000	.2875009	.9109699
Categor. age	.4624414	.0520373	8.89	0.000	.3604501	.5644327
female	.246347	.4411418	0.56	0.577	–.6182751	1.110969
nonwhite	.6370286	.3790219	1.68	0.093	–.1058406	1.379898
Unknown race	.6471257	.2717873	2.38	0.017	.1144323	1.179819
married	.1468935	.1611117	0.91	0.362	–.1688795	.4626666
% Coll Grad	–1.009877	.8041794	–1.26	0.209	–2.586039	.5662861
% < HS Educ	–3.011579	1.48892	–2.02	0.043	–5.929809	–.0933489
Per Cap Inc	.37252	.1571604	2.37	0.018	.0644911	.6805488
DCG risk	.2872807	.1469619	1.95	0.051	–.0007593	.5753208
InHosp Month	.7231521	.9306189	0.78	0.437	–1.100828	2.547132
Hypertension	–.5247402	.2742285	–1.91	0.056	–1.062218	.0127378
Dx depress	–.3237749	.3692964	–0.88	0.381	–1.047583	.4000328
# DM Rx	–.295762	.1896899	–1.56	0.119	–.6675474	.0760235
# Other Rx	–.4820999	.0726293	–6.64	0.000	–.6244508	–.339749
# MH Visits	–.4212658	.2154057	–1.96	0.051	–.8434531	.0009216
# Spec visit	–.2138903	.0885567	–2.42	0.016	–.3874583	–.0403223
INTERACTION TERMS						
crxnonw	–.3656914	.1627304	–2.25	0.025	–.6846372	–.0467456
r_unknhs	1.315718	1.380817	0.95	0.341	–1.390634	4.022069
mmh	.4091005	.1750859	2.34	0.019	.0659385	.7522626
msp	–.0853686	.0532345	–1.60	0.109	–.1897064	.0189692
colldcg	–.3739589	.3247291	–1.15	0.249	–1.010416	.2624984
nhsdmrx	1.484895	.7491637	1.98	0.047	.0165616	2.953229
nhssp	.4173439	.2298321	1.82	0.069	–.0331188	.8678066
dcginhosp	–2.282797	.9808429	–2.33	0.020	–4.205214	–.36038
dcgdmrx	–.1215798	.0619323	–1.96	0.050	–.2429649	–.0001947
dcgmh	.1405923	.026197	5.37	0.000	.0892473	.1919374
dcgsp	–.0227675	.0186483	–1.22	0.222	–.0593175	.0137824
inhosphtn	–2.311749	1.21552	–1.90	0.057	–4.694124	.0706257
inhospsp	.6439543	.209079	3.08	0.002	.234167	1.053742
htndmrx	.4239849	.1685126	2.52	0.012	.0937062	.7542635
depsp	.2526892	.0759979	3.32	0.001	.1037361	.4016423
crxmh	–.2143774	.0589518	–3.64	0.000	–.3299208	–.0988341
crxsp	.0371172	.0242524	1.53	0.126	–.0104166	.084651
_cons	–1.138312	.5229405	–2.18	0.029	–2.163257	–.1133676

NUMBER OF COVARIATES REMAINING UNBALANCED IN EACH QUINTILE AFTER MATCHING

Quintile #1	Quintile #2	Quintile #3	Quintile #4	Quintile #5
0	2	1	3	0

Appendix B. Logistic Regression for Propensity Score in Hypertension Cohort

Log likelihood = –3782.806

LR $\chi^2(26)$ = 3350.40
Prob > χ^2 = 0.0000
Pseudo R^2 = 0.3069

grp	Coef.	Std. Err.	z	*P* >|z|	[95% Conf. Interval]	
site1	.7841085	.0942309	8.32	0.000	.5994194	.9687977
site2	2.061178	.0850842	24.23	0.000	1.894416	2.22794
site3	.3470616	.0783684	4.43	0.000	.1934625	.5006608
DCG risk	–.7928124	.1242208	–6.38	0.000	–1.036281	–.5493441
InHosp Month	–1.010871	.4750346	–2.13	0.033	–1.941922	–.0798208
Diabetes	.1747283	.0639628	2.73	0.006	.0493635	.3000931
Dx depress	1.276589	.5719023	2.23	0.026	.1556815	2.397497
# HTN Rx	–.0021325	.0395511	–0.05	0.957	–.0796513	.0753862
Ln(#OtherRx)	–.3280637	.055624	–5.90	0.000	–.4370848	–.2190426
# MH Visits	–.5717582	.1184218	–4.83	0.000	–.8038607	–.3396557
# Spec Visit	–.2797815	.0543868	–5.14	0.000	–.3863777	–.1731852
INTERACTION TERMS						
cdcgage	.009108	.001814	5.02	0.000	.0055526	.0126634
rxage	.0018462	.0008132	2.27	0.023	.0002524	.0034401
femmarried	1.548992	.3068173	5.05	0.000	.947641	2.150343
msp	–.0316887	.0229588	–1.38	0.168	–.0766871	.0133098
cnhsinc	.1132224	.0190832	5.93	0.000	.0758201	.1506247
cnhssp	.0006396	.0103226	0.06	0.951	–.0195924	.0208716
cdcgdep	–.4135717	.184657	–2.24	0.025	–.7754927	–.0516507
cdcgmh	.0884374	.0335272	2.64	0.008	.0227253	.1541495
cdcgsp	.0239132	.0149913	1.60	0.111	–.0054693	.0532957
inhospdm	–1.20572	.5280108	–2.28	0.022	–2.240602	–.1708381
rxinhosp	.1461617	.0512012	2.85	0.004	.0458093	.2465141
rxhtnrx	.0102715	.0055786	1.84	0.066	–.0006624	.0212054
rxsp	.0104511	.0025386	4.12	0.000	.0054756	.0154266
rxmh	–.010917	.0061518	–1.77	0.076	–.0229744	.0011403
mh_sq	.0052357	.0009154	5.72	0.000	.0034416	.0070298
_cons	.1743314	.1523677	1.14	0.253	–.1243037	.4729666

NUMBER OF COVARIATES REMAINING UNBALANCED IN EACH QUINTILE AFTER MATCHING

Quintile #1	Quintile #2	Quintile #3	Quintile #4	Quintile #5
2	1	0	1	1

Appendix C. Logistic Regression for Propensity Score in Statin Cohort

					LR $\chi^2(47)$ =	2199.86
					Prob > χ^2 =	0.0000
Log likelihood = –1842.9033					Pseudo R^2 =	0.3738
grp	**Coef.**	**Std. Err.**	**z**	**P >|z|**	**[95% Conf. Interval]**	
site1	.5100568	.1446551	3.53	0.000	.226538	.7935755
site2	2.14304	.1309808	16.36	0.000	1.886323	2.399758
site3	.302661	.1273038	2.38	0.017	.0531501	.5521719
age	.5647837	.0560054	10.08	0.000	.4550151	.6745523
Age squared	–.0044342	.0004268	–10.39	0.000	–.0052707	–.0035978
Female	–.0779066	.3805758	–0.20	0.838	–.8238215	.6680083
Nonwhite	.7305133	.4401248	1.66	0.097	–.1321154	1.593142
Unknown race	–.6253336	.7252671	–0.86	0.389	–2.046831	.7961638
Married	–.2095472	.2493685	–0.84	0.401	–.6983005	.2792061
% Coll Grad	3.458488	1.215306	2.85	0.004	1.076533	5.840444
Cnhs	.0156068	.1989384	0.08	0.937	–.3743053	.4055189
Per Cap Inc	.0928969	.1728834	0.54	0.591	–.2459483	.4317422
InHosp Month	5.224787	2.511798	2.08	0.038	.3017537	10.14782
Diabetes	–.1442354	.2779722	–0.52	0.604	–.6890509	.40058
Hypertension	.0605403	.1445203	0.42	0.675	–.2227144	.3437949
Dx depress	1.729148	.9732931	1.78	0.076	–.1784719	3.636767
# Lipid Rx	–.9430662	.5861021	–1.61	0.108	–2.091805	.2056727
# Other Rx	–.0318041	.1115384	–0.29	0.776	–.2504154	.1868071
# MH Visits	–1.565191	.5084826	–3.08	0.002	–2.561799	–.5685833
# Spec Visit	–.4250305	.1561469	–2.72	0.006	–.7310728	–.1189881
INTERACTION TERMS						
Cdcg	–.0825344	.0524877	–1.57	0.116	–.1854084	.0203395
Ageraceunk	.0250281	.0107391	2.33	0.020	.0039798	.0460763
Ageinhosp	–.0440058	.0331025	–1.33	0.184	–.1088855	.020874
Agelprx	.0176287	.0087747	2.01	0.045	.0004307	.0348268
Rxage	.0027989	.0011665	2.40	0.016	.0005125	.0050853
Agemh	.0121111	.0071651	1.69	0.091	–.0019323	.0261546
Nonwinc	–.4123967	.2480985	–1.66	0.096	–.8986608	.0738675
r_unkmh	.3841923	.1975169	1.95	0.052	–.0029338	.7713184
mcnhs	.1825464	.085736	2.13	0.033	.014507	.3505858
mmh	–.3628657	.1518421	–2.39	0.017	–.6604706	–.0652607
msp	–.0960112	.0395039	–2.43	0.015	–.1734373	–.018585
incdm	.0685279	.1226247	0.56	0.576	–.1718121	.3088678
incmh	.3541401	.1200721	2.95	0.003	.1188031	.5894771
colllprx	–.8264175	.5669683	–1.46	0.145	–1.937655	.28482
rxcoll	–.4843482	.1376239	–3.52	0.000	–.7540862	–.2146102
collmh	–1.412972	.6679975	–2.12	0.034	–2.722223	–.1037206
collsp	.3237377	.220348	1.47	0.142	–.1081365	.7556118
cnhsinc	.1397843	.0757908	1.84	0.065	–.008763	.2883316
rxcnhs	–.0519457	.0174837	–2.97	0.003	–.0862131	–.0176783
cnhssp	.0496536	.0307329	1.62	0.106	–.0105819	.1098891
cdcgdep	–.4754428	.2983827	–1.59	0.111	–1.060262	.1093766
cdcgsp	.0071815	.0219735	0.33	0.744	–.0358858	.0502487
inhosphtn	–2.188872	1.069258	–2.05	0.041	–4.28458	–.0931643
inhospdm	–1.565316	.8530771	–1.83	0.067	–3.237316	.1066845
rxsp	.0082455	.0029724	2.77	0.006	.0024197	.0140713
mh_sq	–.0014117	.0173943	–0.08	0.935	–.0355038	.0326804
sp_sq	.002794	.0018949	1.47	0.140	–.0009199	.006508
_cons	–19.3387	2.039894	–9.48	0.000	–23.33682	–15.34058

NUMBER OF COVARIATES REMAINING UNBALANCED IN EACH QUINTILE AFTER MATCHING

Quintile #1	Quintile #2	Quintile #3	Quintile #4	Quintile #5
1	0	0	1	0

Appendix D. Generalized Estimating Equation Regression of Adherence on Propensity-Matched Diabetes Sample

Link:	logit				Family:	binomial
Correlation:	exchangeable				Wald $\chi^2(26)$ =	267.97
Scale parameter:	1				Prob > χ^2 =	0.0000

(Std. Err. adjusted for clustering on study_id)

Compli	Coef.	Semi-robust Std. Err.	z	*P* >|z|	[95% Conf. Interval]	
site1	.2041306	.1560081	1.31	0.191	–.1016396	.5099008
site2	–.1556812	.1079106	–1.44	0.149	–.3671822	.0558198
site3	–.2873638	.1134986	–2.53	0.011	–.509817	–.0649106
age2001	.0057371	.003943	1.45	0.146	–.0019911	.0134653
ct_coll_g~d	–.1793013	.4807551	–0.37	0.709	–1.121564	.7629615
ct_not_hs~d	.4672691	.5558998	0.84	0.401	–.6222744	1.556813
pcapinc_r	.0721702	.0882988	0.82	0.414	–.1008922	.2452326
female	.0013875	.3716934	0.00	0.997	–.7271182	.7298932
nonwhite	–.4899978	.1115483	–4.39	0.000	–.7086286	–.2713671
race_unk	.0287397	.0900157	0.32	0.750	–.1476879	.2051673
married	.1630445	.0822517	1.98	0.047	.0018341	.3242549
pred_dcg00	.0558539	.0297534	1.88	0.060	–.0024618	.1141695
inhosp	.2301547	.1570485	1.47	0.143	–.0776547	.5379641
nhosp_pri~n	–.3217902	.1914085	–1.68	0.093	–.6969439	.0533635
hyperten	–.0304922	.0792701	–0.38	0.700	–.1858588	.1248744
bln_dep	–.2163099	.2222222	–0.97	0.330	–.6518574	.2192377
ln_all_ot~x	–.0213091	.0106847	–1.99	0.046	–.0422508	–.0003674
bln_dm_rx	–.2505258	.0585077	–4.28	0.000	–.3651988	–.1358529
pc_enct_lag	.0010189	.0192818	0.05	0.958	–.0367727	.0388106
mh_enct_lag	–.0203543	.0174019	–1.17	0.242	–.0544614	.0137528
sp_enct_lag	–.025921	.0083582	–3.10	0.002	–.0423029	–.0095392
grp	.0344829	.1068995	0.32	0.747	–.1750361	.244002
nearpost	.2161921	.1234293	1.75	0.080	–.025725	.4581091
farpost	–.0472979	.1236889	–0.38	0.702	–.2897236	.1951278
grpnearpost	–.2054616	.1320747	–1.56	0.120	–.4643233	.0534001
grpfarpost	–.4534038	.1350585	–3.36	0.001	–.7181137	–.188694
_cons	1.026697	.3365881	3.05	0.002	.3669962	1.686397

■ **Appendix E.** Generalized Estimating Equation Regression of Adherence on Propensity-Matched Hypertension Sample

Link:	logit	Family: binomial
Correlation:	exchangeable	Wald $\chi^2(26)$ = 1044.94
Scale parameter:	1	Prob $>\chi^2$ = 0.0000

(Std. Err. adjusted for clustering on study_id)

compl	Coef.	Semi-robust Std. Err.	z	*P* >|z|	[95% Conf. Interval]	
site1	–.0894111	.0856143	–1.04	0.296	–.257212	.0783898
site2	–.09024	.0746704	–1.21	0.227	–.2365914	.0561114
site3	–.2416917	.0745287	–3.24	0.001	–.3877653	–.0956181
age2001	–.011648	.0025484	–4.57	0.000	–.0166427	–.0066533
ct_coll_g~d	.247757	.3336746	0.74	0.458	–.4062332	.9017473
ct_not_hs~d	.1215925	.4267939	0.28	0.776	–.7149082	.9580932
pcapinc_r	–.095539	.0655129	–1.46	0.145	–.2239419	.0328639
female	.0094084	.1394876	0.07	0.946	–.2639822	.282799
nonwhite	–.2457719	.0846642	–2.90	0.004	–.4117107	–.0798331
race_un	.0906758	.0594186	1.53	0.127	–.0257826	.2071341
married	.0821292	.0524519	1.57	0.117	–.0206747	.184933
pred_dcg00	–.0482392	.024221	–1.99	0.046	–.0957115	–.0007668
inhosp	.1055922	.0896672	1.18	0.239	–.0701523	.2813367
Inhosp_pri~n	.0310487	.1009703	0.31	0.758	–.1668495	.2289469
diabetes	–.1626412	.0641506	–2.54	0.011	–.2883741	–.0369083
bln_dep	.1645964	.1500773	1.10	0.273	–.1295497	.4587426
ln_all_ot~x	–.0540389	.0087038	–6.21	0.000	–.0710981	–.0369798
bln_htn_rx	–.292764	.0209376	–13.98	0.000	–.3338009	–.2517271
pc_enct_lag	–.0234781	.013208	–1.78	0.075	–.0493653	.0024092
mh_enct_lag	.002373	.0077366	0.31	0.759	–.0127905	.0175364
sp_enct_lag	.0032282	.0055395	0.58	0.560	–.007629	.0140854
grp	–.0046319	.0642419	–0.07	0.943	–.1305437	.1212798
nearpost	.2778296	.048059	5.78	0.000	.1836358	.3720235
farpost	–.1076068	.0660756	–1.63	0.103	–.2371125	.021899
grpnearpost	–.0861623	.0528446	–1.63	0.103	–.1897358	.0174112
grpfarpost	–.1357915	.0715516	–1.90	0.058	–.2760301	.0044472
_cons	2.558599	.2452461	10.43	0.000	2.077925	3.039272

Appendix F. Generalized Estimating Equation Regression of Adherence on Propensity-Matched Statin Sample

Link: logit
Correlation: exchangeable
Scale parameter: 1

Family: binomial
Wald $\chi^2(26)$ = 320.97
Prob $>\chi^2$ = 0.0000

(Std. Err. adjusted for clustering on study_id)

compl	Coef.	Semi-robust Std. Err.	z	*P* >|z|	[95% Conf. Interval]	
site1	–.274633	.1688388	–1.63	0.104	–.6055509	.056285
site2	.0125914	.147026	0.09	0.932	–.2755744	.3007571
site3	–.324476	.1320598	–2.46	0.014	–.5833084	–.0656435
age2001	.0049788	.0051591	0.97	0.335	–.0051329	.0150905
ct_coll_g~d	.1357059	.6064383	0.22	0.823	–1.052891	1.324303
ct_not_hs~d	–.2596283	.5610043	–0.46	0.644	–1.359176	.8399198
pcapinc_r	–.0781596	.0970532	–0.81	0.421	–.2683803	.1120612
female	.8048089	.8800826	0.91	0.360	–.9201213	2.529739
nonwhite	.5271238	.1276184	–4.13	0.000	–.7772512	–.2769964
race_unk	.0908087	.1026999	0.88	0.377	–.1104794	.2920968
married	.2424128	.089734	2.70	0.007	.0665374	.4182881
pred_dcg00	–.0044712	.0305847	–0.15	0.884	–.0644162	.0554737
inhosp	–.2529673	.1811286	–1.40	0.163	–.6079729	.1020383
nhosp_pri~n	.0785646	.1956589	0.40	0.688	–.3049197	.4620489
hyperten	.1226684	.1528823	0.80	0.422	–.1769755	.4223123
diabetes	.0983667	.111718	0.88	0.379	–.1205965	.3173299
bln_dep	.1731196	.2234529	0.77	0.438	–.26484	.6110793
ln_all_ot~x	.0024152	.0110606	0.22	0.827	–.0192632	.0240935
bln_lipd_rx	.6715887	.0972573	6.91	0.000	.4809678	.8622096
pc_enct_lag	–.0269141	.0224859	–1.20	0.231	–.0709856	.0171575
mh_enct_lag	–.0155266	.0192496	–0.81	0.420	–.0532551	.0222019
sp_enct_lag	.0022229	.0104148	0.21	0.831	–.0181897	.0226354
grp	–.0225435	.1070742	–0.21	0.833	–.2324051	.1873182
nearpost	.5220557	.103604	5.04	0.000	.3189955	.7251158
farpost	.102949	.1423813	0.72	0.470	–.1761133	.3820112
grpnearpost	–.2468082	.1121164	–2.20	0.028	–.4665523	–.027064
grpfarpost	–.2353487	.1497051	–1.57	0.116	–.5287654	.058068
_cons	.5906382	.4607515	1.28	0.200	–.3124181	1.493694