

Cost of Medication Nonadherence Associated With Diabetes, Hypertension, and Dyslipidemia

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Medication nonadherence, defined as a failure to consume medication as prescribed, is recognized as an important impediment to effective treatment.¹ Recent studies have demonstrated that poor adherence is associated with lower success rates for treatment to target levels, increased adverse clinical outcomes, and overall mortality.^{2,3} Poor adherence is also associated with increased utilization of healthcare resources and intensification of medical therapy as providers strive to reach desired clinical outcome goals for their patients.^{4,6} Two recent studies by Sokol et al⁴ and Roebuck et al⁵ have quantified the impact of nonadherence at the micro level, demonstrating that poor patient adherence to medications leads to a significant increase in healthcare costs. These estimates cannot be directly extrapolated to the United States population to obtain a national cost of nonadherence, as these estimates do not take into account recent changes in disease prevalence and insurance status. Published studies of specific populations are limited in generalizability to similar patients only.^{4,5} Given the fragmentation of insurance providers in the United States, a large uninsured population, and the lack of prospective measurement of the cost of nonadherence at the national level, there are no directly measured estimates of the national cost of medication nonadherence.

BACKGROUND

A number of studies and independent reports have attempted to measure the macro-level costs of nonadherence. In 1994, the National Pharmaceutical Council's Task Force for Compliance estimated the national cost of nonadherence to be approximately \$100 billion across all chronic diseases,⁷ half of which was attributed to direct medical costs. Osterberg and Blaschke⁸ used the 1994 report as the basis for an inflation-adjusted estimate⁹ of the direct medical cost of nonadherence totaling \$109 billion in 2010. More recently, a report published by the New England Healthcare Institute (NEHI) in 2008 estimated that \$290 billion in avoidable medical spending across

ABSTRACT

Objectives: To develop a methodology to estimate the national and state-level annual cost associated with nonadherence to medications for diabetes, hypertension, and dyslipidemia.

Study Design: Economic cost model.

Methods: A review of factors impacting the cost of nonadherence was undertaken. Based on the factors identified in the review, a methodology incorporating information about national and state estimates of current nonadherence rates, health insurance status, disease prevalence and comorbidity, and per patient disease-specific adherence-related cost savings was used to estimate the total and per adult national and state-level direct cost of nonadherence in diabetes, hypertension, and dyslipidemia.

Results: The total direct national cost of nonadherence for adults diagnosed with diabetes, hypertension, or dyslipidemia was \$105.8 billion, or an average of \$453 per adult, in 2010. The average per-adult nonadherence cost by state was found to vary from \$284 to \$634.

Conclusions: In the absence of a directly measured national cost of nonadherence across multiple disease states, this estimate updates and refines the methodology used to derive indirect estimates. Using a systematic and transparent approach based on information from standard national and state-level data sources, we demonstrate that nonadherence has a significant direct cost in 3 chronic conditions where medication plays an important part in therapy.

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PRACTICAL IMPLICATIONS

Medication nonadherence leads to higher direct medical costs. To date, there is little published work that quantifies the cost of nonadherence in a transparent fashion. This study seeks to quantify the cost of nonadherence using reputable data sources and published evidence on the costs of nonadherence from recent literature.

- The total cost of nonadherence across patients with diabetes, hypertension, or dyslipidemia is \$105.8 billion, or \$453 per adult.
- Due to individual state characteristics, the per adult cost of nonadherence varies widely across the United States.
- Plan sponsors should be aware that medication nonadherence could lead to higher overall healthcare costs.

all chronic diseases could be attributed to drug-related problems (DRPs) such as nonadherence.¹⁰ This estimate was based on event rates of negative outcomes from various DRPs.

Although several attempts have been made to estimate the national cost of nonadherence, no single estimate has combined a transparent and replicable modeling methodology, relevant determinants of nonadherence, and publicly available sources of national and state-level data. Our objective was to develop an estimate of the national and state-level costs of nonadherence associated with diabetes, hypertension, and dyslipidemia which used a transparent, population-based methodology reflecting the current understanding of the factors that influence adherence.

DATA AND METHODS

The steps and sources of data used in this estimation are depicted in **Figure 1**. Estimates of the number of adults with diabetes, hypertension, or dyslipidemia were created. In order to do this, national- and state-specific population estimates for the number of adults 18 years and older were collected from the 2010 US Census.¹¹ State-specific and national-level estimates of disease prevalence from 2009 were collected from the Behavioral Risk Factor Surveillance System (BRFSS) prevalence and trends database.¹² The BRFSS is a nationally representative telephone survey of the US adult population (18 years or older) living in households which collects uniform, state-specific data on chronic diseases and measures behavioral risk factors for those diseases. Details about the survey sample frame, instruments, and data collection techniques are provided elsewhere.¹³ Then, the prevalence rates were multiplied by the number of adults in each state to estimate the number of adults with diabetes, hypertension, or dyslipidemia at the state and national level. Pharmacy claims data from a large national

pharmacy benefits manager, representing 50 million patients serviced through approximately 60,000 pharmacies nationwide, were used to calculate the percentage of commercially insured patients who were adherent to diabetes, hypertension, or dyslipidemia medications in 2010 at the state and national levels. Adherence was defined as a medication possession ratio (MPR) of 80% or greater, which is the most common threshold for adequate adherence to chronic medications.^{8,14,15}

Rates of adherence among uninsured adults were not available because these individuals do not typically generate pharmacy claims. In order to estimate the extent of nonadherence among the uninsured, we obtained estimates of the number of uninsured adults in each state using Kaiser Family Foundation (KFF) data for the most recent year available (2008-2009).¹⁶ The KFF is a non-profit foundation that synthesizes and collects data about the US healthcare system. We assumed that 50% of the uninsured had an MPR less than 80% and were therefore nonadherent. In the commercially insured population, the average nonadherence rate across maintenance medications used to treat diabetes, hypertension, or dyslipidemia is approximately 31%. Recently published studies have found that uninsured patients are more likely to be nonadherent to medication,¹⁷⁻¹⁹ although these studies do not measure the magnitude of medication nonadherence among the uninsured. A recent report by Levine et al indicated that the nonadherence rate for the uninsured ranged from 39% in 1998-2002 to about 60% in 2006-2009.²⁰ A nonadherence rate of 50% for the uninsured was used as a reasonable approximation.

Using an approximation of 50% for the rate of nonadherence among the uninsured, a weighted national and state level rate of nonadherence was calculated for each disease category using Equation 1. Using Equation 2, we calculated the number of adults who were nonadherent to diabetes, hypertension, and dyslipidemia medications.

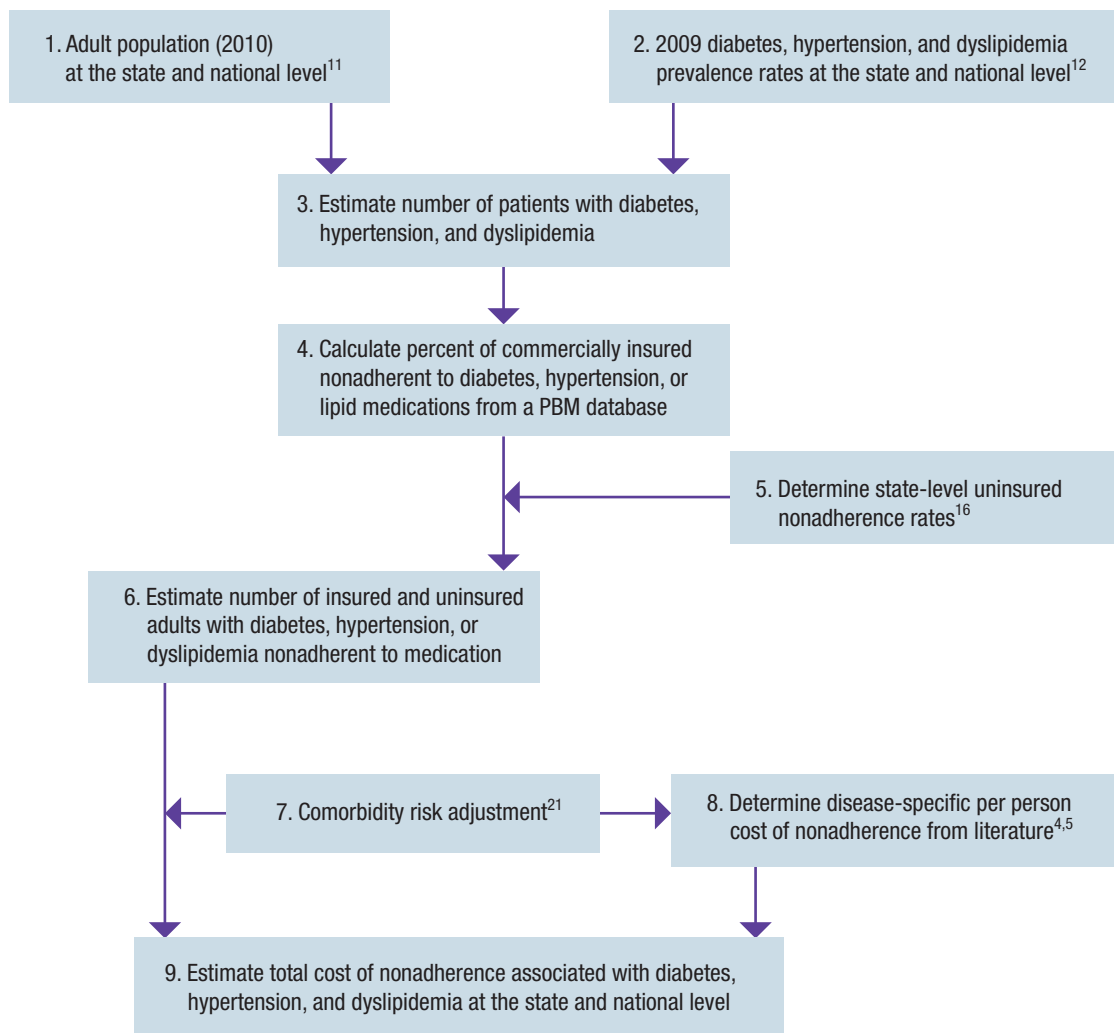
Equation 1:

$$\text{Weighted Rate of Nonadherence} = (\text{Percent Nonadherent}) \times (\text{Percent Insured}) + (50\%) \times (\text{Percent Uninsured})$$

Equation 2:

$$\text{Number of Nonadherent Patients} = (\text{Weighted Rate of Nonadherence}) \times (\text{Adult Population With Disease})$$

To account for patients with more than 1 of the 3 conditions under study, national estimates of disease co-prevalence from the CDC²¹ were applied to the population of nonadherent patients to minimize double counting

Figure 1. Derivation of the Cost of Nonadherence at the State and National Level

PBM indicates pharmacy benefits manager.

nonadherence costs for multiple conditions. From the nonadherent diabetes, hypertension, and dyslipidemia population, we estimated the number of nonadherent patients with only 1 of the conditions and those with all combinations of 2 or 3 of the comorbid conditions. We then applied inflation-adjusted,⁹ disease-specific nonadherence cost estimates from **Table 1**. The estimates^{4,5} from Table 1 are significantly different due to differences in estimation methodology and data sources.

To minimize the double counting of costs, we used a “weakest dollar” or most conservative nonadherence cost estimate and applied that estimate to patients with comorbidities. For example, for nonadherent patients with comorbid diabetes and dyslipidemia, using disease-specific nonadherence cost estimates from a previous study,⁵ we estimated the per adult cost of nonadherence to be

\$1342, even though the cost of diabetes nonadherence was \$4007 (Table 1). In the same nonadherent comorbid diabetes and dyslipidemia population, using disease-specific nonadherence cost estimates from another previous study,⁴ we estimated the per adult cost of nonadherence to be \$2306 despite the fact that the estimated cost of diabetes nonadherence was \$6100 (Table 1). We applied the same “weakest dollar” methodology to obtain the most conservative estimates for nonadherence costs in other nonadherent single disease and comorbid populations. Summing the cost of nonadherence across the diabetes, hypertension, and dyslipidemia population, we estimated the total cost of nonadherence at the state and national level. The separate estimates from Table 1 were averaged to derive a final total cost of nonadherence at the state and national level. The per adult cost of nonadherence

Table 1. Inflation-Adjusted Per Capita Nonadherence Cost Estimates From Sokol et al³ and Roebuck et al⁴

Disease	Sokol et al Estimates	Roebuck et al Estimates
Diabetes	\$6100	\$4007
Hypertension	\$1836	\$4170
Dyslipidemia	\$2306	\$1342

in each geographic region was calculated by dividing the total cost of nonadherence by the adult population for each region.

RESULTS

For 3 highly prevalent disease states the total national cost of nonadherence in 2010 was \$105.8 billion, or \$453 per adult. **Table 2** lists the total and per adult cost of nonadherence for the United States by state. There was significant variation in the per adult cost of nonadherence across states, ranging from the highest in Mississippi (\$634 per adult) to the lowest in Vermont (\$284 per adult). Southern states, in particular Mississippi, Louisiana, Alabama, and Arkansas, had the highest per adult cost of nonadherence. Minnesota, Massachusetts, Vermont, and North Dakota had the lowest per adult cost of nonadherence. **Figure 2** depicts the quartiles of nonadherence waste by state. States in red have the highest per adult costs associated with nonadherence while states in green have the lowest per adult costs associated with nonadherence.

We conducted a univariate sensitivity analysis to quantify changes in model output based on the ranges of our assumptions and inputs. Based on a report by Levine et al,²⁰ nonadherence rates among the uninsured varied from 39% to 60% holding other model inputs fixed. The total cost of nonadherence was found to vary from \$98.3 billion (\$420.50 per adult) to \$112.6 billion (\$481.81 per adult). Substituting national prevalence rates from the 2005 to 2008 National Health and Nutrition Examination Survey (NHANES)²² in place of the BRFSS estimates, the cost of nonadherence across diabetes, hypertension, and dyslipidemia was found to be \$103.6 billion, or \$442.95 per adult. When we used a “strongest dollar” assumption in place of the “weakest dollar” estimate for disease-specific costs among patients with comorbid diabetes, hypertension, and dyslipidemia, the estimated national cost of nonadherence rose to \$146.5 billion, or \$626.58 per adult.

DISCUSSION

Using a novel and comprehensive approach based

on current scientific evidence, we estimated the national cost of nonadherence to medications used for 3 highly prevalent chronic conditions—diabetes, hypertension, and dyslipidemia—to be \$105.8 billion, or \$453 per adult in the United States. Our estimate took into account only the direct medical costs associated with nonadherence, and not the additional indirect costs associated with lost days at work and diminished productivity as a result of nonadherence. Osterberg and Blaschke⁸ approximated the cost of nonadherence to be \$100 billion. This estimate factored in the costs associated with hospital admissions, nursing home admissions, and the indirect costs from lost productivity, but unlike our estimate, did not factor in current rates of disease prevalence or recent per person nonadherence cost estimates from the literature. NEHI cited that \$290 billion in avoidable medical spending across all chronic conditions could be attributed to DRPs such as nonadherence,¹⁰ but unlike our study, they did not distinguish the cost of nonadherence alone. While these estimates show that the financial impact from medication nonadherence is large, they fail to specify these costs in a way that allows for state-by-state comparisons while taking into account the unique attributes of each state’s population.

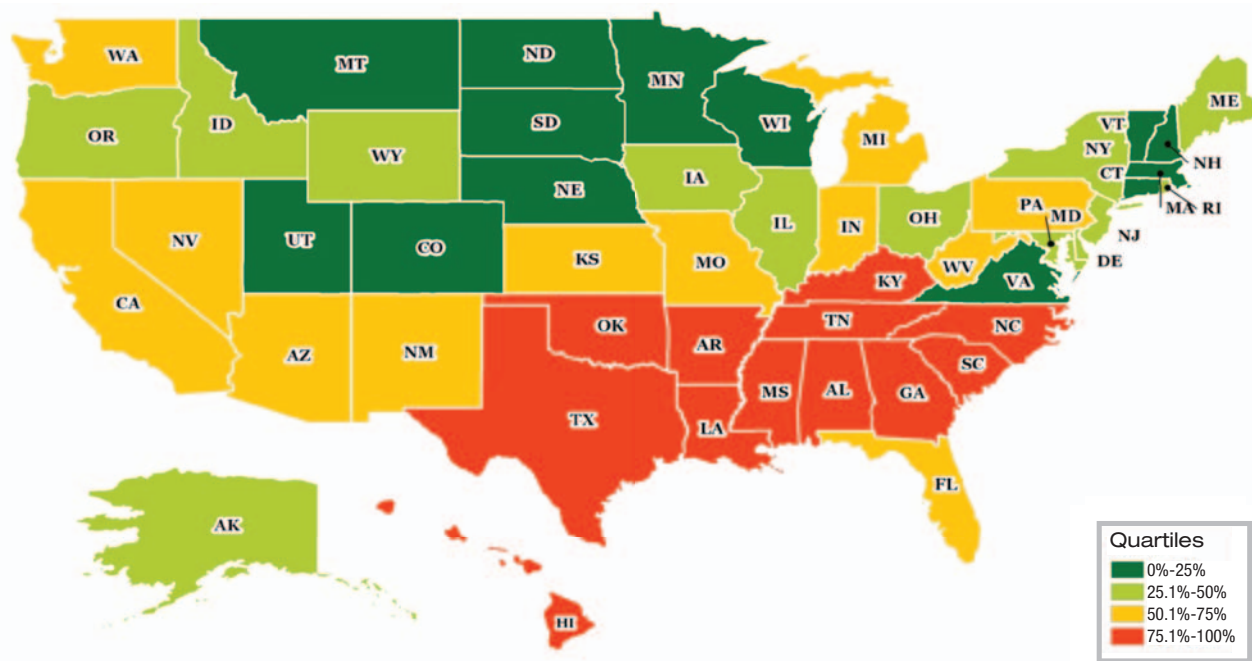
Our study improves upon existing estimates in a number of ways, despite limitations. We used actual disease prevalence estimates from the 2009 BRFSS, which was the latest available.¹² Estimates from the BRFSS are subject to a number of limitations, including those inherent to phone surveys, as summarized elsewhere.^{23,24} We accounted for nonadherence among the uninsured and assumed that the rate of nonadherence among the uninsured was higher than among the insured, an assumption driven by some recent studies.¹⁷⁻¹⁹ Due to the lack of direct published evidence on the rates of nonadherence among the insured and uninsured, we relied on a recent study by Levine et al to make the assumption that approximately 50% of the uninsured population is nonadherent to medication.²⁰ Lastly, we were unable to estimate the cost of adherence directly using a nationally representative sample of adults, a limitation shared by all previous estimates of the national cost of nonadherence.

While our estimate takes into account directly measured inputs at the national level, it was designed to be conservative in its estimate of nonadherence cost. We used a “weakest dollar” estimate to avoid double counting the costs of comorbid conditions by using the lowest disease-specific cost of nonadherence. We also made the assumption that all insured individuals in the United States have the same level of adherence as patients

Table 2. Adult Population, Per Adult, and Total Cost of Nonadherence by State in 2010

State	Adult Population	Per Adult Cost of Nonadherence, \$	Total Cost of Nonadherence, \$
Alabama	3,633,844	575.87	2,092,615,602.41
Alaska	523,595	392.49	205,507,527.73
Arizona	4,713,505	486.31	2,292,242,857.78
Arkansas	2,199,447	565.93	1,244,739,044.98
California	27,743,657	440.44	12,219,446,344.59
Colorado	3,800,346	374.29	1,422,430,155.07
Connecticut	2,753,295	386.18	1,063,268,466.34
Delaware	687,945	409.80	281,921,402.56
Florida	14,685,894	503.23	7,390,333,256.90
Georgia	7,141,072	524.53	3,745,670,895.28
Hawaii	1,055,340	520.72	549,535,492.96
Idaho	1,142,485	393.93	450,056,163.00
Illinois	9,672,889	411.26	3,978,078,824.95
Indiana	4,879,420	468.02	2,283,689,147.53
Iowa	2,324,072	396.08	920,528,757.13
Kansas	2,139,571	461.96	988,402,670.68
Kentucky	3,319,106	542.88	1,801,874,643.32
Louisiana	3,399,659	578.09	1,965,296,042.70
Maine	1,055,116	392.75	414,393,811.17
Maryland	4,404,046	412.16	1,815,186,239.11
Massachusetts	5,124,615	349.96	1,793,407,960.85
Michigan	7,554,039	437.04	3,301,402,863.43
Minnesota	4,034,100	298.87	1,205,654,908.86
Mississippi	2,195,576	633.68	1,391,293,513.26
Missouri	4,557,267	460.26	2,097,521,323.52
Montana	766,334	381.68	292,493,385.32
Nebraska	1,367,228	356.09	486,855,918.37
Nevada	2,004,711	465.86	933,909,156.59
New Hampshire	1,029,168	366.71	377,410,596.36
New Jersey	6,726,274	413.61	2,782,035,036.63
New Mexico	1,536,371	454.97	699,003,099.83
New York	14,991,001	399.90	5,994,943,405.42
North Carolina	7,219,975	505.56	3,650,123,055.25
North Dakota	522,889	305.75	159,872,984.85
Ohio	8,823,607	414.01	3,653,068,023.06
Oklahoma	2,816,478	551.93	1,554,509,830.33
Oregon	2,957,027	408.60	1,208,244,028.86
Pennsylvania	9,905,756	423.02	4,190,331,808.40
Rhode Island	825,880	410.29	338,846,665.69
South Carolina	3,529,439	548.88	1,937,245,457.57
South Dakota	614,122	391.24	240,268,043.04
Tennessee	4,841,030	514.34	2,489,935,422.43
Texas	18,148,511	544.90	9,889,086,786.15
Utah	1,901,516	360.52	685,542,871.74
Vermont	498,657	284.32	141,776,624.45
Virginia	6,126,089	387.69	2,375,052,012.83
Washington	5,140,735	419.88	2,158,479,933.63
Washington DC	487,294	461.62	224,943,771.48
West Virginia	1,459,491	479.56	699,912,682.23
Wisconsin	4,369,272	357.71	1,562,919,286.94
Wyoming	426,906	394.57	168,443,294.20
United States TOTAL	233,775,057	452.61	105,809,751,097.76

Figure 2. State Level Per Adult Cost of Nonadherence Associated With Diabetes, Hypertension, and Dyslipidemia by Quartile



enrolled with a large pharmacy benefits manager. This assumption may overestimate adherence, because many Americans do not have a managed care pharmacy benefit or access to home delivery pharmacy. Our assumption underestimates the prevalence of nonadherence, and therefore provides a more conservative estimate of the cost of nonadherence.

While we did not explicitly model the cost of nonadherence in Medicare and Medicaid patients, recent studies have shown that Medicare and Medicaid beneficiaries also experience cost savings with increased adherence and these savings are similar in range to those observed for commercially insured patients.^{6,25,26} Finally, the current cost estimates only take into account 3 chronic conditions: diabetes, hypertension, and dyslipidemia.

CONCLUSIONS

Our economic model, which estimates the national cost of nonadherence to be \$105.8 billion across 3 highly prevalent conditions, is among the first to use existing cost estimates from the literature and a transparent approach. We used disease prevalence and coprevalence data from the CDC, population estimates from the US Census, adherence rates of commercially insured patients, estimated percentages of the uninsured, and cost estimates from peer-reviewed published literature. Additional research needs to determine whether there are significant medical savings from improving adherence to

medications used to treat asthma, depression, and other chronic diseases. Understanding the causes and costs associated with nonadherence will aid plan sponsors and policy makers in improving adherence and controlling healthcare costs.

With the passage of the Patient Protection and Affordable Care Act (PPACA) in 2010, policy makers and plan sponsors are looking for ways to control healthcare costs,²⁷ especially the costs associated with nonadherence to chronic medications. As healthcare reform is implemented up to 2014, uninsured patients will have the opportunity to buy insurance through healthcare exchanges. This may give insured patients better access to prescription medications and less risk of discontinuing their chronic medications due to financial reasons.

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Authorship Information: Concept and design (KN, SGF, JV); acquisition of data (KN, YT); analysis and interpretation of data (KN, JV, AV); drafting of the manuscript (KN, JV, SGF, AV, YT); critical revision of the manuscript for important intellectual content (JV, SGF, AV); provision of study materials or patients (YT); administrative, technical, or logistic support (SGF); and supervision (SGF).

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