SPECIAL ARTICLE

Mortality and Access to Care among Adults after State Medicaid Expansions

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ABSTRACT

BACKGROUND
Several states have expanded Medicaid eligibility for adults in the past decade, and the Affordable Care Act allows states to expand Medicaid dramatically in 2014. Yet the effect of such changes on adults' health remains unclear. We examined whether Medicaid expansions were associated with changes in mortality and other health-related measures.

METHODS
We compared three states that substantially expanded adult Medicaid eligibility since 2000 (New York, Maine, and Arizona) with neighboring states without expansions. The sample consisted of adults between the ages of 20 and 64 years who were observed 5 years before and after the expansions, from 1997 through 2007. The primary outcome was all-cause county-level mortality among 68,012 year- and county-specific observations in the Compressed Mortality File of the Centers for Disease Control and Prevention. Secondary outcomes were rates of insurance coverage, delayed care because of costs, and self-reported health among 169,124 persons in the Current Population Survey and 192,148 persons in the Behavioral Risk Factor Surveillance System.

RESULTS
Medicaid expansions were associated with a significant reduction in adjusted all-cause mortality (by 19.6 deaths per 100,000 adults, for a relative reduction of 6.1%; P=0.001). Mortality reductions were greatest among older adults, nonwhites, and residents of poorer counties. Expansions increased Medicaid coverage (by 2.2 percentage points, for a relative increase of 24.7%; P=0.01), decreased rates of uninsurance (by 3.2 percentage points, for a relative reduction of 14.7%; P<0.001), decreased rates of delayed care because of costs (by 2.9 percentage points, for a relative reduction of 21.3%; P=0.002), and increased rates of self-reported health status of "excellent" or "very good" (by 2.2 percentage points, for a relative increase of 3.4%; P=0.04).

CONCLUSIONS
State Medicaid expansions to cover low-income adults were significantly associated with reduced mortality as well as improved coverage, access to care, and self-reported health.

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Medicaid currently insures 60 million people, and the Affordable Care Act (ACA) will extend Medicaid eligibility to millions more starting in 2014.[1] The recent Supreme Court ruling enables states to choose whether to expand Medicaid under the ACA, and many states facing budget pressures are considering cutbacks instead.[2] Yet evidence regarding Medicaid's effect on health remains surprisingly sparse, particularly for adults. Previous research showed that Medicaid expansions in the 1980s reduced mortality among infants and children,[3,4] though other studies showed little effect.[5-7] Numerous observational studies have documented a correlation between Medicaid coverage and adverse outcomes among adults,[8,9] prompting some observers to claim that Medicaid coverage is worse than no coverage.[10,11] However, such studies are plagued by unmeasured confounders that make Medicaid patients sicker than others.[12] One ongoing randomized trial of an expansion of Medicaid in Oregon showed significant improvements in self-reported health and access to care in the first year.[13,14]

Traditionally, Medicaid covers only low-income children, parents, pregnant women, and disabled persons. During the past decade, however, several states have expanded Medicaid to cover nondisabled adults without dependent children ("childless adults"), a group that is similar to the population gaining eligibility under the ACA (i.e., all adults with incomes up to 138% of the federal poverty level). We used this natural experiment to determine whether state expansions of Medicaid were associated with decreased mortality. We hypothesized that Medicaid expansions would reduce mortality, rates of uninsurance, and cost-related barriers to care and would improve self-reported health, particularly among minority and lower-income populations.

METHODS

STUDY DESIGN

We used a differences-in-differences quasi-experimental design that incorporated data before and after Medicaid expansions in both the expansion states and the control states. We identified states that had implemented major Medicaid expansions to cover childless adults (19 to 64 years of age) between 2000 and 2005, allowing analysis of multiple years of post-expansion data.[15] Three states met our criteria: Arizona, which expanded eligibility to childless adults with incomes below 100% of the federal poverty level in November 2001 and to parents with incomes up to 200% of the federal poverty level in October 2002[16]; Maine, which expanded eligibility to childless adults with incomes up to 100% of the federal poverty level in October 2002[17]; and New York, which expanded eligibility to childless adults with incomes up to 100% of the federal poverty level and parents with incomes up to 150% of the federal poverty level in September 2001.[18]

Our study period included 5 years before and 5 years after each state's expansion, with the postintervention period beginning the first full year after the expansion to cover childless adults and the preintervention period covering the immediately preceding 5 years. We selected as controls neighboring states without major Medicaid expansions that were closest in population and demographic characteristics to the three states with Medicaid expansions[15]: New Hampshire (for Maine), Pennsylvania (for New York), and Nevada and New Mexico (for Arizona). (Details are provided in the Supplementary Appendix, available with the full text of this article at NEJM.org.)

OUTCOMES AND DATA

The primary outcome was annual county-level all-cause mortality per 100,000 adults between the ages of 20 and 64 years (stratified according to age, race, and sex), obtained from the Compressed Mortality File of the Centers for Disease Control and Prevention (CDC) from 1997 through 2007, totaling 68,012 observations specific to an age group, race, sex, year, and county. County-level, year-specific rates of poverty and unemployment, as well as median household income, were obtained from the Area Resource File.[19] In the primary analysis, we excluded 19-year-olds (since they are grouped by the CDC with teenagers, 15 to 19 years of age), although 19-year-olds were included in subsequent analyses.

Secondary outcomes were the percentages of persons with Medicaid, without any health insurance, and in "excellent" or "very good" health (from the Current Population Survey, a total of 169,124 persons) and the percentage unable to obtain needed care in the past year because of cost (from the Behavioral Risk Factor Surveillance System, a total of 192,148 persons). Both data sets are nationally representative annual household surveys. The study sample included adults between the ages of 19 and 64 years. The outcome among persons in the Behavioral Risk Factor Surveillance System was not measured in the 2001 and 2002 surveys, so we added years to maintain 5 years of data before and after Medicaid expansions for this measure.

STATISTICAL ANALYSIS

We examined unadjusted and adjusted results for our primary and secondary outcomes over time, comparing expansion and control states. For our core analyses, we used multivariable regression, with a generalized linear model and Huber–White robust standard errors clustered at the state level, to account for the state-level intervention and serial autocorrelation.[20] The independent variable of interest was the interaction between timing after Medicaid expansion and expansion state, which compared the average difference in mortality between expansion and control states in the period before Medicaid expansion with that after expansion, with adjustment for covariates and county and year fixed effects.

We analyzed the primary outcome on the basis of annual county-level mortality data (stratified according to age, sex, and race), since the CDC does not release individual-level mortality data. Regression equations for analysis of mortality were adjusted for age, sex, and race; for the Latino proportion of each county's population; for county–year economic covariates; and for a set of interactions between each pair of expansion–control states and year, allowing each expansion–control pairing to have its own time trend (for details, see the Supplementary Appendix). We adjusted for time-invariant confounders, such as rural versus urban setting and environmental factors, through the use of county fixed effects. All analyses were weighted according to population size.

We conducted prespecified subgroup analyses, with the sample divided according to race (white vs. nonwhite; Latino ethnic background was not measured in mortality data before 1999), age (20 to 34 years vs. 35 to 64 years, since mortality rises significantly after the age of 35 years) (Table S1 in the Supplementary Appendix), county poverty rate (divided at the population mean of 10%), and each expansion state. We compared causes of death, using the CDC's classification of external causes (injuries, suicide, homicide, complications of medical treatment, and substance abuse) versus internal causes (all other causes).[21]

For secondary outcomes, the unit of analysis was the individual. We adjusted for age, sex, race or ethnic group, income, state, and interactions between year and expansion–control pairing, using a generalized linear model and robust standard errors clustered at the state level.

Lastly, we used Current Population Survey data to derive descriptive statistics for the additional persons who enrolled in Medicaid as a result of the expansions, in order to assess which persons were most likely to enroll during an eligibility expansion. We compared the mean age, sex, race or ethnic group, and self-reported health status of persons enrolled before expansion and those enrolled after expansion, imputing the characteristics of new enrollees on the basis of changes in those measures.

We conducted several sensitivity analyses of mortality, including an examination of differences between expansion and control states before Medicaid expansion, alternative regression models, state-level instead of county-level mortality, and exclusion of particular years (for details, see the Supplementary Appendix). We explored potential bias from the CDC's bottom-coding of county subsamples with low death counts, which occurs for any subsample with one to five deaths per year to protect confidentiality (i.e., 4.7% of our weighted sample), by testing alternative imputation methods.[22] Although the Huber–White correction has a number of advantages[20] and is often used in similar circumstances,[23-28] it does not perform optimally with small numbers of clusters (i.e., the seven states in our analysis). To investigate the sensitivity of the statistical significance of our findings, we tested several alternative standard errors.[29]

As an additional test of our quasi-experimental design, we repeated our main analyses among adults who were 65 years of age or older, whose Medicaid eligibility was not affected by the expansions. We then estimated a differences-in-differences-in-differences model to assess changes in mortality, in expansion states versus control states, among persons between the ages of 20 and 64 years as compared with those 65 years of age or older. Given the markedly different baseline rates of death between the younger and older age groups (320 vs. 4800 deaths per 100,000), this analysis used a logarithmic regression model.

Table 1. Characteristics of the Study Sample at Baseline.*

Characteristic	Medicaid Expansion States	Control States
Mean (±SD) age (yr)	39.7±12.2	40.4±12.0
Age group (%)		
19–24 yr	13.4±0.3	12.3±0.3
25–34 yr	23.9±0.4	21.6±0.4
35–44 yr	26.8±0.4	27.9±0.4
45–54 yr	21.4±0.3	22.9±0.4
55–64 yr	14.5±0.3	15.3±0.4
Male sex (%)	48.2±0.2	48.8±0.3
Race or ethnic group (%)†		
White	81.2±0.5	88.6±0.5
Nonwhite	18.8±0.5	11.4±0.5
Latino	16.1±0.4	7.4±0.2
Income (%)		
<100% of FPL	13.1±0.3	10.1±0.3
100–200% of FPL	28.9±0.4	24.3±0.5
Mortality (deaths/100,000 population)‡		
Total	320±2.8	344±2.8
From internal causes	275±2.7	288±2.7
From external causes	50±0.6	67±0.7

* Plus–minus values are means ±SE unless otherwise indicated. Between-group differences in all categories were significant (P<0.01). Demographic data are from the Current Population Survey (70,016 persons from years before Medicaid expansion). FPL denotes federal poverty level.
† Race and ethnic group were reported separately in Census data.
‡ Mortality data were obtained from the Compressed Mortality File at the county level in 32,752 county–year subsamples. External causes included injuries, suicide, homicide, complications of medical treatment, and substance abuse, and internal causes included all other causes. The numbers of deaths that are listed according to diagnosis do not sum to the total number of deaths because of imputation of bottom-coded values.

RESULTS

CHANGES IN MORTALITY

The demographic characteristics of expansion and control states were substantively similar but differed statistically because of the large sample (Table 1). Baseline mortality was 320 deaths per 100,000 adults in expansion states and 344 per 100,000 in control states, with more than 80% of deaths from internal causes (as defined in the Methods section). Figure 1 presents unadjusted results for all-cause mortality and Medicaid coverage in the expansion and control states (see Fig. S1, S2, and S3 in the Supplementary Appendix for other outcomes). The Medicaid expansion was associated with a significant decrease in unadjusted mortality (by 25.4 deaths per 100,000, P=0.02) and a significant increase in Medicaid coverage (by 2.2 percentage points, P=0.01).

Table 2 presents the net change after Medicaid expansion in adjusted all-cause mortality in expansion states, as compared with control states. Mortality declined significantly (by 19.6 deaths per 100,000, for a relative reduction of 6.1%; P=0.001). Reductions were greatest among nonwhites and older adults, with smaller but significant reductions among whites and no effect among persons under the age of 35 years. Counties with higher poverty rates had larger mortality reductions. Single-state analyses showed significant effects only in the largest state, New York. For each of the three states, the 95% confidence interval included the estimate for the overall sample (although Maine's imprecise estimate differed significantly from that of New York).

In sensitivity analyses, there were small, nonsignificant differences in mortality trends between expansion and control states before Medicaid expansion, with a reduction of 1.0 death per 100,000 per year (P=0.07) and a reduction of 1.6 deaths per 100,000 per year with the exclusion of year 0 as a transitional year (P=0.23) (Table S2 in the Supplementary Appendix). Results were robust with respect to alternative functional forms, analysis of state-level versus county-level mortality, exclusion of year 0, imputation methods for bottom-coded death counts, alternative approaches to calculating standard errors, and restricted subsamples of years to limit serial autocorrelation (P<0.05 for all comparisons). The interrupted time-series model showed an increasing effect of Medicaid expansion over time, with a reduction of 6.5 deaths per 100,000 per year (P=0.006). Analyses that were performed according to the cause of death showed significant reductions in both deaths from internal causes (by 13.2 deaths per 100,000, for a relative reduction of 4.8%; P=0.001) and deaths from external causes (by 3.8 deaths per 100,000, for a relative reduction of 7.6%; P=0.001).

OTHER CHANGES ASSOCIATED WITH EXPANSION

Table 3 presents changes in insurance, access to care, and health. Medicaid expansions were associated with a significant increase in Medicaid coverage (by 2.2 percentage points, for a relative increase of 24.7%; P=0.01), a significant decrease in uninsurance (by 3.2 percentage points, for a relative decrease of 14.7%; P<0.001), a significant decrease in the rate of delayed care because of cost (by 2.9 percentage points, for a relative decrease of 21.3%; P=0.002), and a significant increase in rates of "excellent" or "very good" health (by 2.2 percentage points, for a relative increase of 3.4%; P=0.04). Increases in Medicaid coverage in the expansion states were concentrated among low-income adults, whereas reductions in uninsured rates were significant for both lower- and higher-income groups. Reductions in cost-related delays in care were significant for all subgroups.

NEW ENROLLEES

Table 4 provides imputed statistics for the additional persons who enrolled in Medicaid because of the expansions, as compared with the general adult population (see the Supplementary Appendix for calculations). New Medicaid enrollees were older than the general population (mean age, 40.6 vs. 40.0 years), disproportionately male (57% vs. 49%), nonwhite (27% vs. 20%), and in fair or poor health (20% vs. 11%) (P<0.001 for all comparisons).

ELDERLY ADULTS

Among persons 65 years of age or older, Medicaid expansions were associated with a small but significant reduction in the uninsured rate (by 0.4 percentage points, P=0.007), a significant decline in cost-related delays in care (by 2.3 percentage points, P=0.001), and a significant reduction in absolute mortality (by 127 deaths per 100,000, for a relative reduction of 2.6%; P<0.001) (Table S3 in the Supplementary Appendix). The inclusion of elderly adults as an additional control group for nonelderly adults in a differences-in-differences-in-differences model decreased the estimated mortality reduction among the nonelderly by approximately one third, and the effect remained significant (P=0.03).

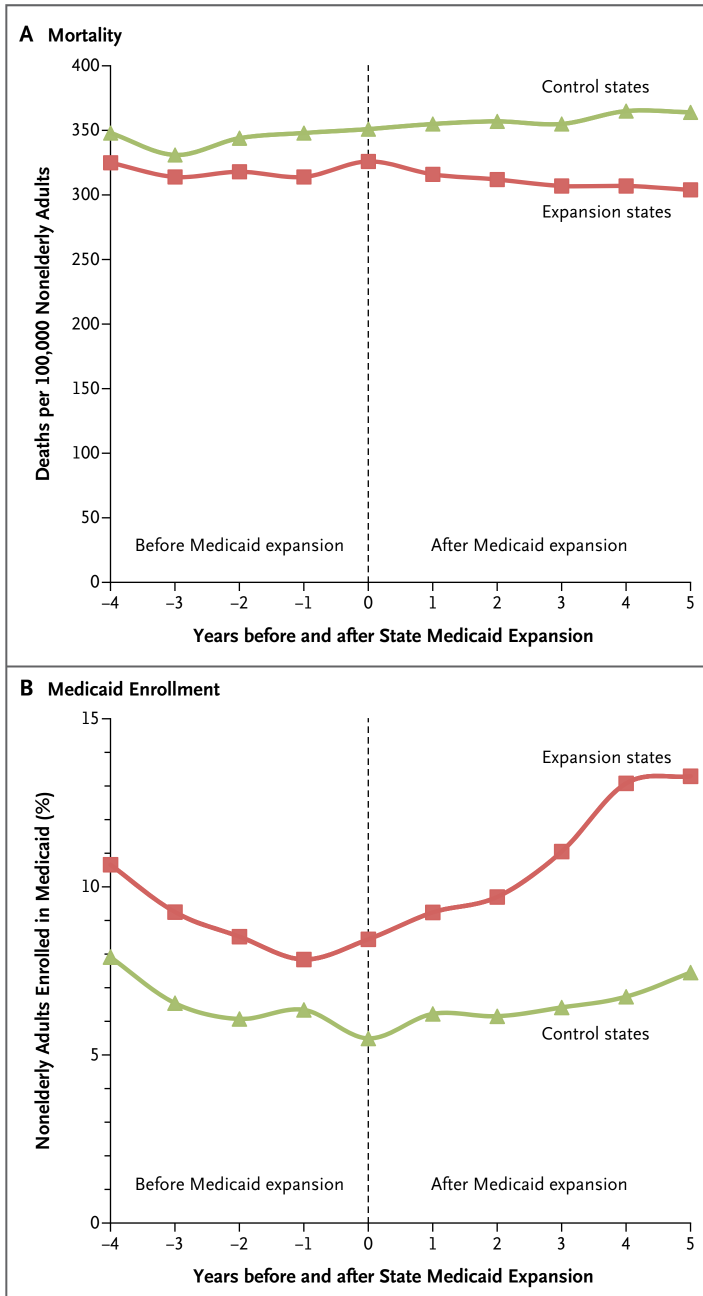

Figure 1. Unadjusted Mortality and Rates of Medicaid Coverage among Nonelderly Adults before and after State Medicaid Expansions (1997–2007).

The vertical line represents the year during which the Medicaid expansions were implemented, meaning that year 1 was the first full year after the expansions (2002 for Arizona and New York and 2003 for Maine). In unadjusted models, the expansions were associated with a significant decrease in all-cause mortality in expansion states, as compared with control states (−25.4 deaths per 100,000 population; 95% confidence interval [CI], −46.0 to −4.8; P=0.02) (Panel A) and a significant increase in Medicaid coverage (by 2.2 percentage points; 95% CI, 0.7 to 3.7; P=0.01) (Panel B). Data for adults between the ages of 20 and 64 years are included in Panel A and data for those between the ages of 19 and 64 years in Panel B, owing to differences in the two data sets.

DISCUSSION

Our study documents that large expansions of Medicaid eligibility in three states were associated with a significant decrease in mortality during a 5-year follow-up period, as compared with neighboring states without Medicaid expansions. Mortality reductions were greatest among adults between the ages of 35 and 64 years, minorities, and residents of poor counties. These findings may influence states' decisions with respect to Medicaid expansion under the ACA.

Table 2. Changes in All-Cause Mortality among Adults between the Ages of 20 and 64 Years in States with Medicaid Expansions.*

Variable	Baseline Mortality in States with Expansion	Net Change in Mortality after Expansion†	P Value for Difference between Subgroups
	no. of deaths/100,000	*no. of deaths/100,000 (95% CI)*	
Full sample	320	−19.6 (−27.3 to −11.9)‡	NA
Race§			
White	309	−14.0 (−19.8 to −8.2)‡	0.04
Nonwhite	361	−41.0 (−64.7 to −17.3)¶	Reference
Age			
20–34 yr	83	1.0 (−12.8 to 14.8)	0.006
35–64 yr	446	−30.4 (−41.0 to −19.9)‡	Reference
Level of poverty in county			
High	334	−22.2 (−31.0 to −13.5)‡	0.01
Low	283	−11.3 (−19.2 to −3.3)‖	Reference
State			
Maine (vs. New Hampshire)	306	13.4 (−27.5 to 54.3)	0.01
Arizona (vs. Nevada and New Mexico)	332	−10.2 (−32.7 to 12.3)	0.18
New York (vs. Pennsylvania)	317	−22.2 (−39.1 to −5.2)‖	Reference

* The primary outcome was all-cause county-level mortality among 68,012 county–year subsamples in the Compressed Mortality File of the CDC. All analyses were adjusted for race, sex, age, county poverty rate, county median income, county unemployment rate, Latino proportion of county's population, year, county, state of residence, and interactions between year and expansion–control pairing. Full regression equations and coefficients for covariates are reported in the Supplementary Appendix. NA denotes not applicable.

† The data that are shown represent the net change in mortality after the Medicaid expansion was implemented (i.e., the adjusted before–after change in the expansion states minus the before–after change in the control states).

‡ P<0.001.

§ Latino ethnic background was not reported in mortality statistics before 1999, so listed data were not stratified according to this variable. However, adjustments were made for the Latino proportion of each county's population.

¶ P<0.01.

‖ P<0.05.

Our study shows a mortality reduction associated with state Medicaid expansions to cover adults. Using state-level differences in Medicaid expansion as a natural experiment avoids the confounding between insurance and individual characteristics (e.g., poverty or health status) that plagues cross-sectional observational studies. These results build on previous findings that Medicaid coverage reduces mortality among infants and children[3,4] and are consistent with preliminary results of a randomized, controlled trial of Medicaid in Oregon, which showed significant improvement in self-reported health during the first year (although objective measures of health are not yet available and 1-year mortality effects were not significant and were imprecisely estimated).[14]

We observed reductions in deaths from both internal and external causes. The relative mortality reduction was higher for external causes of death than for internal causes, though this difference was not significant. We hypothesized that internal causes would be more amenable to intervention through improved risk-factor management and medication adherence,[30] though a study involving persons who were hospitalized after accidental injuries showed a reduction of nearly 40% in mortality among insured adults, as compared with uninsured adults, because of a greater intensity of care and longer lengths of stay.[31]

Our secondary analyses provide a plausible causal chain for reduced mortality that is consistent with previous research,[32,33] with eligibility expansions associated with a 25% increase in Medicaid coverage, 15% lower rates of uninsur-

Table 3. Changes in Insurance Coverage, Access to Care, and Health among Adults between the Ages of 19 and 64 Years after State Medicaid Expansions.*

Variable	Net Change after Expansion			
	Medicaid Coverage†	No Health Insurance†	Delayed Care Because of Cost‡	Self-Reported Excellent or Very Good Health†
	percentage points (95% CI)			
Full sample	2.2 (0.1 to 3.8)§	−3.2 (−4.0 to −2.4)¶	−2.9 (−4.2 to −1.5)¶	2.2 (0.0 to 4.3)§
Race				
White non-Latino	2.0 (0.6 to 3.4)§	−3.3 (−4.9 to −1.8)¶	−3.2 (−4.7 to −1.6)¶	2.0 (0.0 to 4.0)§
Nonwhite and Latino	2.6 (0.1 to 5.2)§	−2.8 (−5.9 to 0.0)	−2.4 (−3.7 to −1.0)¶	2.3 (−0.1 to 5.6)
Age				
19–34 yr	2.6 (0.1 to 4.7)§	−2.7 (−4.1 to −1.4)¶	−3.4 (−3.9 to −1.2)¶	1.7 (−0.1 to 4.4)
35–64 yr	2.0 (0.1 to 3.3)§	−3.5 (−4.6 to −2.3)¶	−2.6 (−3.9 to −1.2)¶	2.5 (0.4 to 4.5)§
Income (%)‖				
<200% of FPL or <$35,000	5.4 (1.1 to 9.8)§	−4.5 (−7.2 to −1.8)¶	−2.9 (−5.3 to −0.1)§	4.1 (0.0 to 8.2)
≥200% of FPL or ≥$35,000	1.1 (−0.1 to 2.2)	−2.5 (−3.8 to −1.3)¶	−2.8 (−3.9 to −1.8)¶	1.3 (−0.1 to 3.1)

* The data shown represent the net change in each outcome after the Medicaid expansion was implemented (i.e., the adjusted before–after change in the expansion states minus the before–after change in the control states). All analyses were adjusted for year, state of residence, sex, race or ethnic group, age, family income (as a percentage of the federal poverty level [FPL] in the Current Population Survey), total household income and family size (in the Behavioral Risk Factor Surveillance System), and interactions between year and expansion–control pairing.

† Results are based on an evaluation of 169,124 persons in the Current Population Survey.

‡ Results are based on an evaluation of 192,148 persons in the Behavioral Risk Factor Surveillance System.

§ P<0.05.

¶ P<0.01.

‖ The Current Population Survey provides income data as a percentage of the FPL, but this information is not available in the Behavioral Risk Factor Surveillance System, which provides household income only in increments of $10,000 to $15,000. For the Current Population Survey, the cutoff of 200% of FPL was used. For Behavioral Risk Factor Surveillance System, $35,000 in annual income was selected as the cutoff, and Current Population Survey data suggest that this cutoff should capture nearly 93% of families at or below 200% of FPL in the sample.

ance, a 21% reduction in cost-related delays in care, and a 3% increase in self-reported excellent or very good health. However, it is not clear whether the magnitude of these changes is sufficient to account for the observed mortality reduction, and these associations do not prove causality.

Our estimate of a 6.1% reduction in the relative risk of death among adults is similar to the 8.5% and 5.1% population-level reductions in infant and child mortality, respectively, as estimated in analyses of Medicaid expansions in the 1980s.[3,4] Our results correspond to 2840 deaths prevented per year in states with Medicaid expansions, in which 500,000 adults acquired coverage.[15] This finding suggests that 176 additional adults would need to be covered by Medicaid in order to prevent 1 death per year.

A relative reduction of 6% in population mortality would be achieved if insurance reduced the individual risk of death by 30% and if the 1-year risk of death for new Medicaid enrollees was 1.9% (Table S4 in the Supplementary Appendix). This degree of risk reduction is consistent with the Institute of Medicine's estimate that health insurance may reduce adult mortality by 25%,[34] though other researchers have estimated greater[35] or much smaller[36] effects of coverage. A baseline risk of death of 1.9% approximates the risk for a 50-year-old black man with diabetes[37,38] or for all men between the ages of 35 and 49 years who are in self-reported poor health.[39] The lower end of our confidence interval implies a relative reduction in the individual risk of death of 18%.

For Medicaid expansions to produce effects of this size, new enrollees must have had a higher-than-average risk of death that was responsive to medical care. We found that new Medicaid enrollees were older, disproportionately minorities, and

Table 4. Imputed Characteristics of New Medicaid Enrollees after Medicaid Expansions, as Compared with the General Population.*

Variable	New Medicaid Enrollees (N=9431)	General Population (N=67,837)
Mean (±SD) age (yr)	40.6±12.2	40.0±12.2
Age group (%)		
19–24 yr	13.8±0.4	13.5±0.2
25–34 yr	21.0±0.4	23.2±0.2
35–44 yr	22.0±0.4	25.7±0.2
45–54 yr	29.4±0.5	22.1±0.2
55–64 yr	13.7±0.4	15.6±0.2
Male sex (%)	57.0±0.5	48.6±0.2
Self-reported health status (%)		
Excellent	24.5±0.4	30.3±0.2
Very good	34.6±0.5	34.6±0.2
Good	21.0±0.4	24.4±0.2
Fair or poor	20.0±0.4	10.8±0.1
Race or ethnic group (%)		
White	73.2±0.5	79.9±0.2
Nonwhite	26.8±0.5	20.1±0.2
Latino	27.4±0.5	16.9±0.1

* Plus–minus values are means ±SE unless otherwise indicated. All differences between new Medicaid enrollees and the general population were significant ($P<0.001$). New enrollees were identified on the basis of differences in the demographic characteristics of adults before and after expansion in the Medicaid expansion states, according to data from the Current Population Survey. The general population refers to all adults between the ages of 19 and 64 years in expansion states during the study period. P values were calculated with the use of survey-weighted Pearson chi-square tests for categorical variables and with the use of t-tests for age as a continuous variable.

twice as likely to be in fair or poor health as the general population, all of which suggest higher mortality,[39] and these findings are consistent with previous expansions.[40] Furthermore, Medicaid enrollment often occurs at the point of care for patients with acute illnesses — in emergency departments, doctors' offices, and hospitals[41,42] — when the risk of death (and benefits of coverage) may be particularly high.

Our study has several limitations. We examined three expansion states, and the results are largely driven by the largest (New York), so our results may not be generalizable to other states. Common methods for estimating standard errors are imperfect when applied to a small number of states, although our findings were robust with the use of alternative methods. The mortality data set did not allow us to control for individual-level characteristics other than race, sex, and age (e.g., socioeconomic status or health status with respect to specific chronic diseases). We had to impute values for small subsamples after stratification according to county, race, sex, and age, although the results were robust with different imputation approaches.

Most important, our analysis is a nonrandomized design and cannot definitively show causality. Rates of insurance coverage and access to care increased in expansion states for both high-income persons and the elderly, even though the Medicaid eligibility expansions did not apply to them directly. Rates of death also declined among elderly adults, though the relative changes represented only one third of the mortality decline among adults between the ages of 20 and 64 years, leaving a significant mortality reduction among nonelderly adults that was independent of this trend. One possible explanation for these findings is that expanding coverage had positive spillover effects through increased funding to providers, particularly safety-net hospitals and clinics.[43] Publicity about the expansion may also have encouraged uninsured higher-income and elderly persons to obtain insurance from other sources, including those over the age of 65 years who did not meet lifetime earnings requirements for Medicare.[44]

Alternatively, states may choose to expand Medicaid when their economies are thriving, and economic prosperity broadly improves coverage and access, which could produce a spurious association between eligibility expansions and health. However, our analysis of mortality was adjusted for a comprehensive list of economic measures that were specific to the county and year, and the results were not changed by these covariates. Similarly, states expanding Medicaid may simultaneously invest in public health or the health care workforce in other ways that could reduce mortality. However, we are unaware of any other contemporaneous large-scale changes in health policies in the states we studied. Moreover, the fact that mortality changes were largest in expected subpopulations offers some reassurance that we have isolated the effect of Medicaid expansions. Nonetheless, we cannot rule out other, concurrent trends that may have confounded our results.

In conclusion, our results offer new evidence that the expansion of Medicaid coverage may reduce mortality among adults, particularly those between the ages of 35 and 64 years, minorities, and those living in poorer areas. Ongoing research on the basis of randomized data[13,45] will be invaluable in expanding on these findings. The Medicaid program is slated to expand coverage to millions of adults in 2014 under the ACA, though the recent Supreme Court ruling enables states to choose whether they will do so, and some states may instead consider program cuts. Policymakers should be aware that major changes in Medicaid — either expansions or reductions in coverage — may have significant effects on the health of vulnerable populations.

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Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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