Medicaid Expansion and Racial and Ethnic Disparities in Access to Health Care: Applying the National Academy of Medicine Definition of Health Care Disparities

Supplementary materials

Section 1. Data, Variables, Descriptive Statistics

Table S1a. Sample Size by Restriction and Missing Data

Restriction and Missing		**Sample size remained**	**Sample size removed**
NHIS pooled data 2010-2016		717,513	
Restriction	Adults aged 19 to 64	427,898	289,615
	U.S. citizen	374,638	53,260
	Non-recipients of Social Security Income (SSI) or Social Security Disability Income (SSDI)	364,318	10,320
	Non-Active duty members of the Armed Forces	362,163	2,155
	Low-income Adults (below 138% FPL)[1]	69,129	293,034
Missing Data	Education	68,080	1,049
	Employment Status	67,385	695
	Unemployment rate	67,384	1
Final Dataset	**Outcome variable**	**Sample size**	**NHIS File name**
Low-income nonelderly, adults	No insurance	66,404	Person file
	Medicaid	66,404	Person file
	No usual source of care	33,346	Sample Adult file
	Delayed care due to cost	67,341	Person file
	Unmet need for Medical care	67,323	Person file
	Unmet need for Mental health care	33,270	Sample Adult file
	Unmet need for Specialty care	29,369	Sample Adult file
	No visits to Physician	33,143	Sample Adult file
	No visits to Mental health providers	33,177	Sample Adult file
	No visits to Specialists	33,160	Sample Adult file

Note. [1] Federal Poverty Level (FPL) refers to the poverty guidelines, defined each year in the Federal Register by the Department of Health and Human Services (HHS). As a simplification of the poverty thresholds, the guidelines are used for administrative purposes, such as determining financial eligibility for certain federal programs. 2014 FPL for the 48 contiguous states and the District of Columbia: $11,670 for individuals, $15,730 for a family of 2, $19,790 for a family of 3, $23,850 for a family of 4, $27,910 for a family of 5, $31,970 for a family of 6, $36,030 for a family of 7, $40,090 for a family of 8, for families/households with more than 8 persons, add $4,060 for each additional person. (http://aspe.hhs.gov/poverty/14poverty.cfm)

Table S1a presented the size of sample removed and the size of the remaining sample due to restriction and missing data. The sample restrictions, U.S. citizens aged 19 to 64 with income below 138% of the FPL without SSI and SSDI recipients and the Armed Forces, leave 69,129 NHIS respondents in the pooled sample between 2010 to 2016. Active duty members of the Armed Forces were not counted in this survey weighted estimation since the value of the final annual person weight (WTFA) for these military persons is zero. There remain 67,384

respondents after 1,745 respondents were removed from the sample due to missing data in education and employment status variables. Final sample size ranged from 66,404 to 67,341 for respondents due to missing values in outcome variables derived from the Person file (no insurance, Medicaid, delayed care, unmet need for medical care). Sample size of other outcomes derived from the Sample Adult file (usual source of care, unmet need for mental health care and specialty care, and visits to physicians, mental health providers, specialists) ranged from 29,369 to 33,346. The respondents in the Sample Adult file are one family member, who is randomly selected from each family.

Table S1b. Variable Specification and Definition for Outcomes

Outcomes	Coding	Definition
Uninsured	1=not covered; 0=covered	The uninsured are persons who did not report having health insurance at the time of the interview under private health insurance, Medicare, Medicaid, State Children's Health Insurance Program (SCHIP), a State-sponsored health plan, other government programs, or military health plan (includes TRICARE, VA, and CHAMP-VA).
Medicaid	1=yes; 0=no	Medicaid coverage
No usual source of care[1]	1= no; 0=yes	No place that you usually go to when you are sick or need advice about your health or a place you usually go when you routine or preventive care, such as a physical examination or check up
Delayed care	1=yes; 0=no	Medical care has been delayed because of worry about the cost, except dental care, during the past 12 months
Unmet need for care due to cost	1=yes; 0=no	There was any time when you needed medical care, but did not get it because you couldn't afford it, during the past 12 months.
Unmet need for specialty care due to cost	1=yes; 0=no	There was any time when you needed to see a specialist, but didn't get it because you couldn't afford it, during the past 12 months. Data year: 2011-2016
Unmet need for mental care due to cost	1=yes; 0=no	There was any time when you needed to mental health care or counseling, but didn't get it because you couldn't afford it, during the past 12 months.
No physician visits [2]	1=no; 0=yes	You have not seen or talked to a general doctor about your own health during the past 12 months.
No specialist visits [3,5]	1=no; 0=yes	You have not seen or talked to specialist about your own health during the past 12 months.
No mental health provider visits [4,5]	1=no; 0=yes	You have not seen or talked to mental health professional about your own health during the past 12 months.

Note. [1] Hospital emergency room as a usual place for medical care or preventive care were excluded from usual source of care. [2] Physician here means a doctor in general practice, family medicine, or internal medicine. [3]Specialist is a medical doctor who specializes in a particular medical disease or problem other than obstetrician/gynecologist, psychiatrist or ophthalmologist. [4] Mental health professionals include a psychiatrist, psychologist, psychiatric nurse, or clinical social worker. [5] Visiting a specialist or mental health provider is a valid indicator of access to care by considering that reductions in out-of-pocket cost of all types of care through Medicaid will increase utilization. Uninsured low-income adults who should seeing a specialist but who could not due to cost prior to the expansion, will visit specialists after gaining the coverage through Medicaid expansion. However, there is limitation in these indicators, since visiting a specialist or mental health provider will rarely happen for healthy people, while they commonly visit a physician for preventive care such as annual check-up or health counseling once a year.

Table S1c. Detailed Classification of Expansion and Non-Expansion States by Prior Expansion and by Implementation Date

Expansion decision in 2014	Expansion States	Non-Expansion States
Prior expansion before 2014 *Implementation date		
Limited or No expansion in pre-2014	Arkansas, Colorado, Illinois, Kentucky, Maryland, New Jersey, Nevada, New Mexico, North Dakota, Ohio, Oregon, Rhode Island, West Virginia (13 states)	Alabama, Florida, Georgia, Idaho, Kansas, Mississippi, Missouri, Nebraska, North Carolina, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wyoming (17 states)
Partial expansion in pre-2014 (Any Prior Expanders)	Arizona, California, Connecticut, Hawaii, Iowa, Minnesota, Washington (7 states)	Maine, Wisconsin (2 states)
Expansion states with Full prior expansion (Full Prior Expanders)	Delaware, District of Columbia, Massachusetts, New York, Vermont (5 states)	
Expansion after 2014 (Late Expanders)	Alaska, Michigan, New Hampshire, Pennsylvania, Indiana, Montana, Louisiana (7 states)	

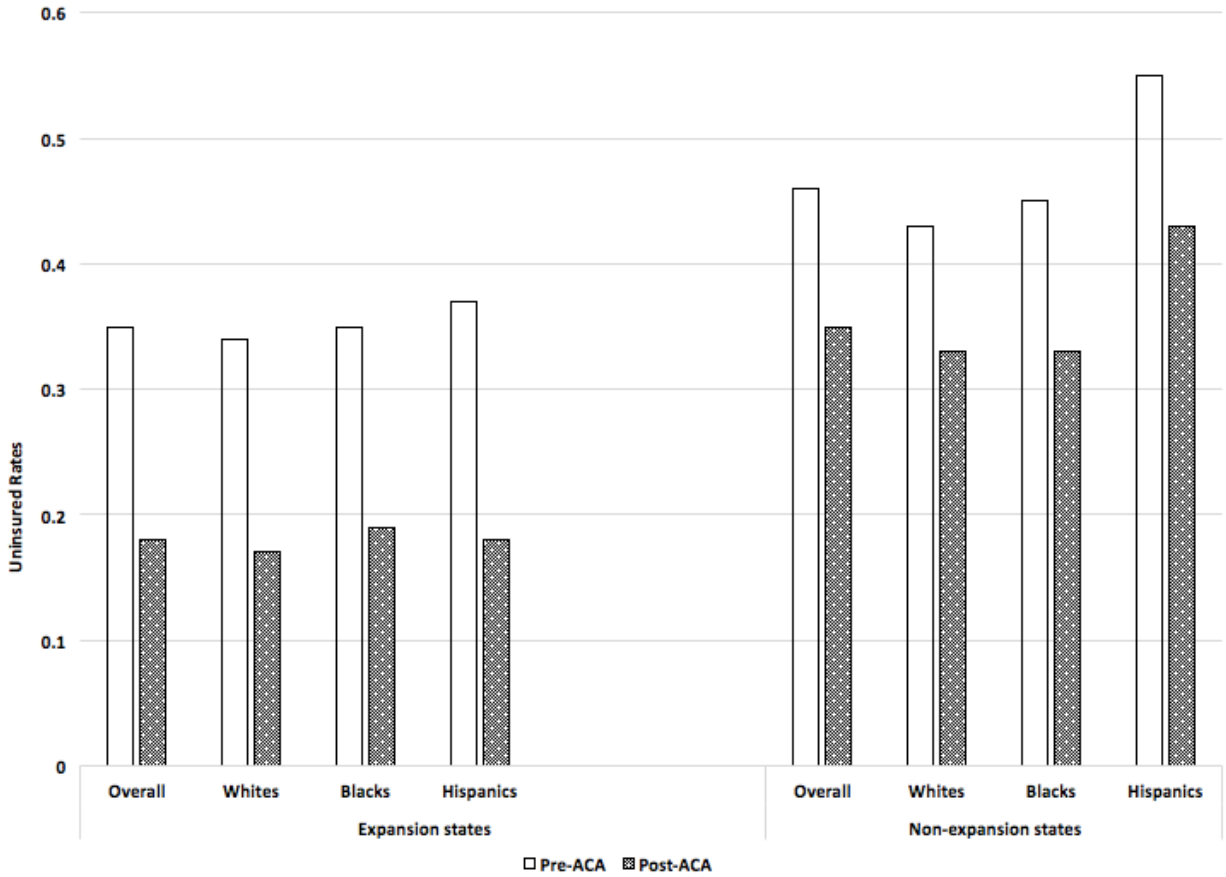
Source: Classification of treatment and control group. Adapted from "The Effect of the Patient Protection and Affordable Care Act Medicaid Expansions on Financial Well-Being, National Bureau of Economic Research" by Kaestner et al. (2017).

Table S1c shows a detailed classification of expansion and non-expansion state by prior expansion and by implementation date for sensitivity analysis. Some states extended Medicaid eligibility for low-income adults under the Section P1115 waivers before the formal ACA Medicaid expansion start date of January 1, 2014. Delaware, District of Columbia, Massachusetts, New York, and Vermont provided both low-income adults with income at or below 138% of the FPL with coverage equivalent to that under ACA Medicaid expansion before 2014 ('Full Prior Expanders'). Arizona, California, Connecticut, Hawaii, Iowa, Minnesota, and Washington either provided more limited coverage to low-income adults, or coverage equivalent to full Medicaid expansion only to low-income adults with income that were well below 138% of the FPL before 2014 ('Any Prior Expanders'). Among thirty-two expansion states, twenty-five states expanded Medicaid as of January 1, 2014. The remaining seven 'Late Expanders' are

Michigan (April 1, 2014), New Hampshire (August 15, 2014), Pennsylvania (January 1, 2015), Indiana (February 1, 2015), Alaska (September 1, 2015), Montana (January 1, 2016) and Louisiana (July 1, 2016).

Table S1d. Definition of Independent Variables

	Definition	Form of variable
Age	Age	Number of years (continuous variable)
Female	Gender is Female	1 = female; 0 = male
Elementary School	Highest level of school completed is… Never attended/kindergarten only or grade 1-8	1 = yes; 0 = no
Middle School	Grade 9-11	1 = yes; 0 = no
High School	12th grade, no diploma, GED or equivalent, high School graduate, some college but no degree, or associate degree: occupational, technical, or vocational program, academic program	1 = yes; 0 = no
Bachelor/ Graduate School	Bachelor's degree (Example: BA, AB, BS, BBA), Master's degree (Example: MA, MS, MEng, MEd, MBA), Professional School degree (Example: MD, DDS, DVM, JD), Doctoral degree (Example: PhD, EdD)	1 = yes; 0 = no
Married	Married: married-spouse in household/not in household/household unknown Not married: widowed, divorced, separated, never married, living with partner, or unknown marital status	1 = married 0 = not married
Employed	Worked for pay at any time in last calendar year	1 = Work for pay last year; 0 = no
Family Size	Size of family	Count of family members (continuous variable)
Number of child	Number of family members under 18 years of age	Number of children (continuous variable)
White	Non-Hispanic White	1 = yes; 0 = no
Black	Non-Hispanic Black	1 = yes; 0 = no
Hispanics	Hispanics	1 = yes; 0 = no
Others	Non-Hispanic Asian or all other race groups	1 = non-Hispanic Asian or all other race groups
Activity Limitation	Functionally Limited in any way	1 = Any functional limitation - all persons, all conditions; 0 = no
Rural	Residence in rural area	1 = rural; 0 = urban
Unemployment rate	Annual county unemployment rate	County-level annual unemployment rate (continuous variable)
Fair or Poor Health Status	Self-reported health in general is fair, or poor	1=poor and fair; 0=good, very good, excellent
K-6 scale of psychological distress	The Kessler 6 (K6) nonspecific distress scale (Weissman, Pratt, Miller, & Parker, 2015) is regarding to six symptoms (so sad that nothing could cheer you up; nervous; restless or fidgety; hopeless; that everything was an effort; and worthless). The K6 asks about the frequency (5 scale: All/most/some/a little/none of the time) of each of the six symptoms of mental illness or nonspecific psychological distress during the past 30 days.	'All of the time' is scored as 4, 'most of the time' as 3, 'some of the time' as 2, 'a little of the time' as 1, and 'none of the time' as 0. Scores of six symptoms were summed to create the K6 scale, ranged from 0 to 24.



Note. Bars show the unadjusted, survey weighted means of uninsured rate of each racial/ethnic group for expansion and non-expansion states and pre- and post-ACA Medicaid expansion (See Table 1). Expansion and non-expansion state categories are shown in Table S1c in Supplementary materials. For 25 expansion and 19 non-expansion states, pre-ACA period is 2011 to 2013 and post-ACA period is 2014 to 2016. For seven expansion states, Michigan (4/1/2014), New Hampshire (8/15/2014), Pennsylvania (1/1/2015), Indiana (2/1/2015), Alaska (9/1/2015), Montana (1/1/2016), Louisiana (7/1/2016) the pre-ACA period is the period before ACA Medicaid expansion was implemented. ***p<0.01; **p<0.05; *p<0.1.

Figure S1a. Changes in unadjusted uninsured rates before and after the ACA Medicaid expansion for expansion and non-expansion states among low-income adults

Section 2. Parallel Trend Assumption Test

The key assumption of DD models estimating the effects of the ACA Medicaid expansion is that trends in outcomes would not differ between expansion and non-expansion states in the absence of "treatment" such as the expansion (Angrist & Pischke, 2008; Dimick & Ryan, 2014). The pre-expansion common trends between expansion and non-expansion states should be similar before the Medicaid expansion. To see if the groups have the equivalent pre-ACA trends, first, we created plots of unadjusted year-quarter trends for access and health outcomes for all poor adults, and for Whites, Hispanics, and Blacks (Section 2).

The parallel trend assumption test can be indirectly tested with the expanded DD model using a series of interaction terms between year dummies and treatment variable shown in Equation 2 (Kaestner et al., 2017; Courtemanche et al., 2017a, 2017b):

$$\begin{aligned} Y_{icst} = {} & \beta_0 + \beta_1 \text{Expansion}_s * 2010 + \beta_2 \text{Expansion}_s * 2011 + \beta_3 \text{Expansion}_s * 2012 \\ & + \beta_4 \text{Expansion}_s * 2014 + \beta_5 \text{Expansion}_s * 2015 + \beta_6 \text{Expansion}_s * 2016 \\ & + \beta_7\, 2010 + \beta_8\, 2011 + \beta_9\, 2012 + \beta_{10}\, 2014 + \beta_{11}\, 2015 + \beta_{12}\, 2016 \\ & + \lambda_t + \gamma_s + \beta_{13} X_{icst} + \beta_{14} \text{UnempRate}_{ct} + \varepsilon_{icst} \end{aligned} \quad (2)$$

Here, Y_{icst} is the outcome for individual i in county c in state s in year t. Expansion_s is a dummy variable, which equals one for individuals residing in an expansion state (32 states) and zero otherwise. 2010, 2011, 2012, 2014, 2015, and 2016 are year dummies. 2013 year dummy is omitted as a reference group. λ_t is a vector of quarterly time fixed effects, which capture nationwide differences in outcomes for each year-quarter during the study period. γ_s is a vector of state fixed effects, which captures state-level time invariant differences in outcomes across the full study period. X_{icst} is a vector of individual-level covariates (e.g., age, gender, education) and UnempRate_{ct} is annual county unemployment rate.

To test equivalence of pre-treatment trends, we performed a joint test of the statistical significance of the estimated coefficients for interaction terms between pre-expansion time period and expansion group variables (e.g., 2010*Expansion) in the DD model in equation 2. The null hypothesis of the joint test is that all β_1, β_2, and β_3 equal zero. If the null hypothesis is accepted, pre-treatment trends would not be different between expansion and non-expansion states.

Table S2a through S2d show the results of joint statistical tests of the parallel trend assumptions for all low-income nonelderly adults and for racial/ethnic groups. As shown in row 7 in Table S2a through S2c, there was no p-value smaller than 0.05 in joint statistical tests (F-statistic) for each outcome. The results of the joint test statistical tests support the parallel trend assumption for all models among all low-income adults, and separately for Whites, and Blacks. Among low-income Hispanics, with the exception of the uninsured rates ($p = 0.028 < 0.05$), delayed care due to cost ($p = 0.038 < 0.05$), and unmet mental health care due to cost ($p = 0.003 < 0.05$) (Table S2d), statistical tests support the parallel trend assumption for all other models.

As shown in rows 4 to 6 in Table S2a, parallel trend assumption tests also provide post-expansion trends in the effects of ACA Medicaid expansion in 2014, 2015, and 2016. Effects of the Medicaid expansion on outcomes might be expected to increase over time from 2014 because gaining insurance coverage may not be immediately accompanied by better access to care and health outcomes. There was a roughly consistent temporal trend of increase in the significance and the magnitude of estimated Medicaid expansion effects on most access outcomes among all nonelderly low-income adults. For example, the estimated 2016 greater increase in Medicaid coverage rates in expansion states (15.8 percentage points, $p < .01$) is much larger than for 2014

Medicaid coverage rates (5.2 percentage points, $p<.05$). There was 6.5 percentage points of decrease in rates of delayed care in 2016, while there was no statistical significance in 2014 rates. Similar increasing trends over time were found in racial/ethnic groups analyses as shown in Table S2b to S2c. However, for Hispanics, Medicaid expansion effects on some access outcomes were statistically significant in 2014 or 2015 but not in 2016, such as delayed care, unmet needs due to cost for specialty health care. Despite the exceptions, the estimates of post-expansion trends in the effects of ACA Medicaid expansion suggest that in general, the impacts either got larger over time or emerged in later years.

Table S2a. Parallel Trends between Expansion and Non-Expansion States during Pre-Reform Period for Low-Income Nonelderly Adults

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Expansion *2010 (1)	0.006 (0.020)	-0.023 (0.020)	-0.046 (0.029)	-0.031* (0.016)	-0.015 (0.013)	0.013 (0.017)	N/A	-0.012 (0.028)	0.007 (0.015)	0.002 (0.027)
Expansion *2011 (2)	0.017 (0.017)	-0.003 (0.017)	-0.026 (0.029)	-0.006 (0.013)	-0.006 (0.011)	-0.013 (0.010)	0.007 (0.014)	-0.020 (0.025)	0.018 (0.012)	0.007 (0.017)
Expansion *2012 (3)	0.007 (0.019)	0.001 (0.014)	-0.015 (0.028)	-0.004 (0.013)	0.010 (0.011)	0.006 (0.013)	0.017 (0.018)	-0.021 (0.024)	0.017 (0.011)	0.002 (0.019)
Expansion *2014 (4)	-0.032 (0.026)	0.052** (0.026)	0.003 (0.026)	-0.003 (0.013)	-0.016 (0.012)	-0.003 (0.012)	0.012 (0.010)	-0.046* (0.025)	0.036** (0.014)	-0.004 (0.021)
Expansion *2015 (5)	-0.060** (0.027)	0.137*** (0.032)	-0.012 (0.027)	-0.041*** (0.015)	-0.033** (0.013)	-0.012 (0.010)	-0.023 (0.015)	-0.018 (0.031)	0.021 (0.016)	-0.024 (0.020)
Expansion *2016 (6)	-0.076*** (0.028)	0.158*** (0.032)	-0.057** (0.023)	-0.065*** (0.015)	-0.055*** (0.016)	-0.020 (0.018)	-0.009 (0.014)	-0.085*** (0.026)	-0.010 (0.018)	-0.017 (0.017)
F-Statistic (F-value/ p-value) (7)	0.39 (0.764)	0.59 (0.627)	1.13 (0.345)	1.29 (0.287)	1.10 (0.358)	1.68 (0.183)	0.48 (0.620)	0.33 (0.807)	1.09 (0. 362)	0.09 (0.968)
Sample size	66,404	66,404	33,346	67,341	67,323	33,270	29,369	33,143	33,177	33,160

Notes: Rows 1 to 6 display adjusted mean differences from year 2013 and standard errors are in parentheses. Rows 7 displays the result of joint test of Expansion*2010, Expansion*2011, Expansion*2012 and p-values are in parentheses. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. ***p<0.01; **p<0.05; *p<0.1.

Table S2b. Parallel Trends between Expansion and Non-Expansion States during Pre-Reform Period for Low-Income Whites

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Expansion *2010 (1)	-0.007 (0.024)	-0.003 (0.028)	-0.046 (0.037)	-0.043** (0.021)	-0.028 (0.017)	0.008 (0.021)	N/A	-0.010 (0.048)	0.025 (0.021)	0.000 (0.032)
Expansion *2011 (2)	-0.006 (0.027)	0.000 (0.021)	-0.048 (0.04)	-0.028 (0.021)	-0.024 (0.017)	-0.018 (0.018)	0.030 (0.024)	-0.012 (0.038)	0.032 (0.020)	0.029 (0.026)
Expansion *2012 (3)	-0.012 (0.022)	0.004 (0.016)	-0.030 (0.039)	-0.023 (0.019)	-0.007 (0.016)	0.020 (0.021)	0.045 (0.027)	-0.012 (0.041)	0.037* (0.019)	0.009 (0.030)
Expansion *2014 (4)	-0.054 (0.033)	0.044* (0.024)	0.007 (0.032)	-0.009 (0.020)	-0.023 (0.019)	-0.010 (0.02)	0.041** (0.02)	-0.047 (0.038)	0.047** (0.022)	0.003 (0.029)
Expansion *2015 (5)	-0.070** (0.035)	0.148*** (0.029)	-0.009 (0.034)	-0.044** (0.019)	-0.043** (0.017)	-0.019 (0.017)	0.007 (0.022)	-0.036 (0.046)	0.060*** (0.021)	-0.050* (0.027)
Expansion *2016 (6)	-0.091*** (0.03)	0.154*** (0.035)	-0.050* (0.029)	-0.075*** (0.023)	-0.056** (0.024)	-0.027 (0.024)	0.004 (0.023)	-0.119*** (0.034)	0.002 (0.021)	-0.013 (0.027)
F-Statistic (F-value/ p-value) (7)	0.10 (0.959)	0.05 (0.987)	0.75 (0.526)	1.66 (0.187)	1.45 (0.238)	1.88 (0.145)	1.35 (0.269)	0.04 (0.988)	1.37 (0.261)	0.77 (0.515)

Notes: Rows 1 to 6 display adjusted mean differences from year 2013 and standard errors are in parentheses. Rows 7 displays the result of joint test of Expansion*2010, Expansion*2011, Expansion*2012 and p-values are in parentheses. All regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. Sample size is not allowed to be disclosed. ***p<0.01; **p<0.05; *p<0.1.

Table S2c. Parallel Trends between Expansion and Non-Expansion States during Pre-Reform Period for Low-Income Blacks

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Expansion *2010 (1)	-0.005 (0.038)	-0.011 (0.033)	-0.002 (0.043)	-0.018 (0.027)	0.013 (0.023)	0.035 (0.024)	N/A	-0.007 (0.045)	-0.055** (0.024)	0.023 (0.036)
Expansion *2011 (2)	0.023 (0.027)	-0.004 (0.035)	0.078* (0.042)	0.019 (0.028)	0.022 (0.023)	-0.001 (0.014)	-0.012 (0.028)	-0.028 (0.042)	-0.011 (0.022)	-0.027 (0.025)
Expansion *2012 (3)	0.024 (0.032)	0.008 (0.026)	0.038 (0.031)	0.007 (0.026)	0.043* (0.022)	0.003 (0.021)	-0.014 (0.028)	-0.020 (0.054)	-0.028 (0.023)	0.015 (0.03)
Expansion *2014 (4)	0.004 (0.026)	0.012 (0.024)	0.016 (0.037)	0.029 (0.029)	0.025 (0.019)	0.012 (0.018)	0.009 (0.026)	0.024 (0.041)	0.043** (0.017)	-0.010 (0.025)
Expansion *2015 (5)	-0.047 (0.030)	0.121*** (0.032)	0.009 (0.039)	-0.022 (0.022)	0.008 (0.019)	0.012 (0.016)	-0.037 (0.032)	0.042 (0.049)	-0.023 (0.025)	0.021 (0.047)
Expansion *2016 (6)	-0.083* (0.046)	0.122*** (0.040)	-0.020 (0.046)	-0.061** (0.030)	-0.065*** (0.023)	-0.008 (0.024)	-0.033 (0.041)	-0.066 (0.05)	-0.051 (0.036)	-0.006 (0.036)
F-Statistic (F-value/ p-value) (7)	0.490 (0.688)	0.14 (0.937)	2.12 (0.110)	0.99 (0.406)	1.39 (0.257)	0.97 (0.414)	0.15 (0.865)	0.16 (0.920)	1.80 (0.160)	0.93 (0.435)

Notes: Rows 1 to 6 display adjusted mean differences from year 2013 and standard errors are in parentheses. Rows 7 displays the result of joint test of Expansion*2010, Expansion*2011, Expansion*2012 and p-values are in parentheses. All regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. Sample size is not allowed to be disclosed. ***p<0.01; **p<0.05; *p<0.1.

Table S2d. Parallel Trends between Expansion and Non-Expansion States during Pre-Reform Period for Low-Income Hispanics

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Expansion *2010 (1)	0.056* (0.032)	-0.032 (0.024)	-0.101* (0.052)	-0.020 (0.034)	-0.007 (0.017)	-0.036 (0.026)	N/A	0.013 (0.034)	0.047** (0.019)	-0.012 (0.049)
Expansion *2011 (2)	0.088*** (0.028)	-0.014 (0.025)	-0.072* (0.037)	0.018 (0.024)	0.005 (0.016)	-0.019 (0.013)	-0.027 (0.022)	0.002 (0.06)	0.034 (0.03)	-0.002 (0.030)
Expansion *2012 (3)	0.034 (0.038)	-0.030 (0.021)	-0.041 (0.031)	0.031 (0.025)	0.026 (0.021)	-0.036** (0.015)	-0.019 (0.02)	0.002 (0.058)	0.031 (0.024)	0.004 (0.028)
Expansion *2014 (4)	-0.035 (0.034)	0.106*** (0.033)	-0.012 (0.052)	-0.046** (0.023)	-0.050* (0.026)	-0.008 (0.027)	-0.060** (0.029)	-0.075 (0.047)	0.022 (0.025)	0.009 (0.04)
Expansion *2015 (5)	-0.041 (0.033)	0.185*** (0.063)	-0.049 (0.065)	-0.100** (0.043)	-0.078*** (0.027)	-0.036** (0.014)	-0.099*** (0.030)	-0.025 (0.063)	-0.002 (0.023)	-0.021 (0.028)
Expansion *2016 (6)	-0.007 (0.049)	0.198*** (0.071)	-0.091** (0.042)	-0.055 (0.04)	-0.042 (0.026)	-0.027* (0.014)	-0.010 (0.031)	0.019 (0.043)	-0.015 (0.031)	-0.017 (0.043)
F-Statistic (F-value/ p-value) (7)	3.30 (0.028)	1.09 (0.363)	1.42 (0.248)	3.02 (0.038)	0.81 (0.496)	5.44 (0.003)	0.91 (0.409)	0.06 (0.980)	1.99 (0.128)	0.07 (0.976)

Notes: Rows 1 to 6 display adjusted mean differences from year 2013 and standard errors are in parentheses. Rows 7 displays the result of joint test of Expansion*2010, Expansion*2011, Expansion*2012 and p-values are in parentheses. All regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. Sample size is not allowed to be disclosed. ***p<0.01; **p<0.05; *p<0.1.

Section 3. Robustness Check

The empirical results were tested to assess robustness of the base model (Equation 1) to changes in the specification of expansion states, age and income groups, as well as alternative models. Three robustness checks of the empirical results were performed.

In the first set of sensitivity analyses, the fully-specified DD model was estimated by excluding the following subgroup states from the analysis: 1) states that fully expanded their Medicaid program before 2014, 'full prior expanders' (DE, DC, MA, NY, VT)[1]; 2) states that expanded their Medicaid program with full or partial benefit packages, 'any prior expanders'[2] (AZ, CA, CT, DC, DE, HI, IA, MA, ME, MN, NY, VT, WA, WI); 3) Wisconsin; 4) states that expanded their Medicaid program later than January 2014, 'late expanders'[3] (AK, NH, PA, IN, MO, LA), 5) Louisiana. While results in Table S3a suggest that excluding early Medicaid expansion states or late expanders generally produced coefficient estimates are larger in absolute value, overall the empirical results were very robust to these changes. The estimated changes in expansion states regardless of early or late expansion reported in rows 1(Baseline) in Table S3a are from rows 1 in Table 2. As shown in rows 2 and 3 in Table S3a, the estimated effects of

[1] Delaware, District of Columbia, Massachusetts, New York, and Vermont provided low-income adults with income at or below 138% of the FPL with coverage equivalent to that under ACA Medicaid expansion before 2014 (Table S1c).

[2]Arizona, California, Connecticut, Hawaii, Iowa, Minnesota, Washington either provided more limited coverage to low-income adults, or coverage equivalent to full Medicaid expansion only to low-income adults with income that were well below 138% of the FPL before 2014. In addition Maine and Wisconsin also partially expanded their Medicaid programs although these two states opted out the 2014 ACA Medicaid expansion (Table S1c).

[3] Among thirty-two expansion states, twenty-five states expanded Medicaid as of January 1, 2014. The remaining seven states, late expanders, are Michigan (April 1, 2014), New Hampshire (August 15, 2014), Pennsylvania (January 1, 2015), Indiana (February 1, 2015), Alaska (September 1, 2015), Montana (January 1, 2016) and Louisiana (July 1, 2016).

Medicaid expansion excluding five full or any early expanders show much larger changes in rates of the uninsured and Medicaid coverage. However, there were marginal or no differences in decrease in other access and p-values except delayed care due to cost. The results reported in rows 4 to 6 suggested that the estimated Medicaid impacts were robust to exclusion of Wisconsin, six late expanders, or Louisiana, except no visit of specialist doctor.

In the second set of sensitivity analyses, we examined the effect of the Medicaid expansion using the narrow range of age and income group: 1) low-income adults aged 26-64; 2) adults with income less than 100% of the FPL; 3) childless adults. As shown in Rows 2 in Table S3b, the estimated changes among low-income adults aged 26-64 are, on average, a little larger coefficient for rates of uninsured, Medicaid coverage, and visit of physician in absolute values than baseline (aged 19 to 64). Moreover, the estimated changes in unmet need for mental health and specialty care were not statistically significant among this age subgroup. Since the dependent mandate provision, as of September 23, 2010, allowed young adults aged 19-25 to remain their parents' insurance coverage, the larger effects of the Medicaid expansion are expected for the study sample excluding these young adults. The estimated Medicaid effects among adults with income less than 100% of the FPL are larger on rates of the uninsured, delayed care and unmet care needs due to cost, and smaller rates of Medicaid coverage than the baseline estimates (change among adult with income less than 138% of the FPL). The decrease in having no visit of physician is not statistically significant among this income group. Finally, low-income childless adults are more likely to experience significant insurance gain after the expansion than any other groups, since poor childless adults, as distinct from poor parents, were not generally eligible for Medicaid before the expansion regardless of their income.

The third set of sensitivity analyses compared results between the stratified DD models across race/ethnicity and the Difference-in-Difference-in-Differences (DDD) models to check whether the estimates are robust depending on the assumption on the marginal effect of control variables. Stratified DD models allow the marginal effects of covariates to differ among race/ethnicity while DDD models assume that each race/ethnicity has the same marginal effect of covariates to examine the effects of the Medicaid expansion on racial/ethnic disparities in access and health outcomes. As shown in equation 3 which specified the DDD models, the interaction terms between expansion dummy and race/ethnicity dummy variables (*$Expansion_{st}$*Blacks, $Expansion_{st}$*Hispanics, $Expansion_{st}$*Others*) are the key variable for estimating the change in disparities between Whites and Hispanics and between Whites and Blacks after the Medicaid expansion.

$$\begin{aligned} Y_{icst} = {} & \beta_0 + \beta_1 Expansion_{st} * Blacks + \beta_2 Expansion_{st} * Hispanics + \beta_3 Expansion_{st} * Others \\ & + \beta_4 Expansion_{st} + \beta_5 Blacks + \beta_6 Hispanics + \beta_7 Others \\ & + \beta_8 \lambda_t * Blacks + \beta_9 \lambda_t * Hispanics + \beta_{10} \lambda_t * Others \\ & + \lambda_t + \gamma_s + \beta_{11} Need_{icst} + \beta_{13} UnempRate_{ct} + \varepsilon_{icst} \end{aligned} \quad (3)$$

where y_{ist} is the outcome for individual i in county c in state s in year t. Interaction terms between *$Expansion_{st}$* and the race/ethnicity dummy variables are the primary explanatory variables, which estimate the change in disparities between Whites and Hispanics and between Whites and Blacks after the Medicaid expansion. Blacks, Hispanics, and Others are dummy variables of race/ethnicity. The white dummy is omitted as a reference group. Interaction terms between quarter fixed effects and race/ethnicity (*λ_t *Blacks, λ_t *Hispanics, λ_t *Others)* capture nationwide differences in outcomes for each year-quarter for each race/ethnicity. λ_t are quarterly time fixed effects, and γ_s are state fixed effects. Unconditional treatment and post-period dummy

variables are not specified in the models because quarter and state fixed effects capture their effects. $Need_{icst}$ is a vector of need factors for individual respondents (e.g., age, gender, self-reported general health status). $UnempRate_{ct}$ is the annual county unemployment rate. $UnempRate_{ct}$ is annual county unemployment rate.

The estimated effects of Medicaid expansion on disparities reported in Rows 1 and 2 in Table S3c are from adjusted DID in Table 4. The estimated effects using the DDD model is different from the estimates using the stratified DD models in terms of statistical significance. In the stratified DD models, the estimated decreases in Hispanic-White disparities in delayed care and unmet need for medical care due to cost, and no visit mental health provider were statistically significant. In the DDD models, Hispanic-White disparities in rates of Medicaid coverage (9.2 percentage points, $p<.01$) increased after Medicaid expansion. Also, Black-White disparities in rates of visiting physician increased (5.4 percentage points, $p<.1$), while Hispanic-White disparities in delayed care decreased (3.4 percentage points, $p<.1$) in the DDD models. Although there were differences in the results as above, we used the stratified DD models rather than the DDD models since it is plausible that the marginal effect of control variables may vary among race/ethnic subgroups.

As the fourth set of sensitivity analyses, we redefined the difference-in-differences Medicaid expansion indicator (expansion) for unmet needs of care due to cost and doctor visits by to occur one year later than the actual expansion quarter. In other words, expansion equals one if the interview month is at least one year after the month that Medicaid expansion occurred. As shown in the table below, most of estimated coefficients for Medicaid expansion impacts on outcomes were larger than the estimates assuming expansion happened one year later.

Interestingly, when we redefined the effective expansion date to be one year later than actual expansion date, the estimate for Whites suggest much larger post-expansion decreases in rates of unmet needs of medical care (-6.4 percentage points, $p<.05$) and unmet needs of specialty care (-5.0 percentage points, $p<.01$). In turn, the change produced in a increase in Hispanic-White disparities in rates of unmet needs of care (-13.0 percentage points, $p<.05$) and unmet needs of specialty care (-10.6 percentage points, $p<.01$) and Black-White disparities in unmet needs of specialty care (-13.5 percentage points, $p<.01$). In addition, with the redefined effective expansion date, the estimate for Hispanics suggest much larger post-expansion decrease in unmet needs of mental care (-4.7 percentage points, $p<.01$) and produced a decrease in Hispanic-White disparities in unmet needs of mental care (-3.5 percentage points, $p<.1$). Considering that most recent ACA literature using these two outcomes (Courtemanche et al. 2017, Simon et al., 2016) did not redefine "effective" expansion dates in this way, we felt that it was better not to define effective expansion dates in this study for indicators based on experience in the past 12 months, for the sake of comparability with prior work.

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Table S3a. Effects of the ACA Medicaid Expansion on Outcomes for Low-Income Adults: Variations in Set of Expansion States

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Baseline (1)	-0.065*** (0.017)	0.117*** (0.023)	0.000 (0.015)	-0.020 (0.012)	-0.026*** (0.008)	-0.012** (0.006)	-0.023* (0.012)	-0.030* (0.016)	0.003 (0.009)	-0.012 (0.012)
Pre- Mean	0.345 (0.476)	0.283 (0.451)	0.211 (0.408)	0.211 (0.408)	0.184 (0.388)	0.068 (0.252)	0.117 (0.322)	0.432 (0.495)	0.873 (0.332)	0.808 (0.394)
Sample size	66,404	66,404	33,346	67,341	67,323	33,270	29,369	33,143	33,177	33,160
No Full early expansion (2)	-0.079*** (0.016)	0.130*** (0.022)	0.001 (0.016)	-0.023* (0.012)	-0.029*** (0.008)	-0.012* (0.006)	-0.024* (0.012)	-0.033* (0.017)	0.001 (0.009)	-0.013 (0.013)
Pre- Mean	0.37 (0.483)	0.256 (0.437)	0.22 (0.414)	0.222 (0.416)	0.195 (0.396)	0.071 (0.258)	0.123 (0.329)	0.443 (0.497)	0.875 (0.331)	0.817 (0.386)
No early expansion (3)	-0.103*** (0.022)	0.147*** (0.022)	-0.004 (0.019)	-0.024* (0.014)	-0.027** (0.010)	-0.016* (0.008)	-0.022 (0.016)	-0.036* (0.021)	0.003 (0.011)	-0.017 (0.013)
Pre- Mean	0.382 (0.486)	0.259 (0.438)	0.224 (0.417)	0.226 (0.418)	0.203 (0.402)	0.071 (0.257)	0.121 (0.327)	0.442 (0.497)	0.876 (0.33)	0.818 (0.386)

Notes. Shaded rows 1 to 6 displays marginal effects and standard errors are in parentheses. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. Row 1 shows baseline model using 32 states as an expansion states, 19 states as a non-expansion states (See Table S1c in Supplementary materials). Row 2 shows estimates after excluding full expansion states (DC, DE, MA, NY, VT). Row 3 shows estimates after excluding any prior expansion states (AZ, CA, CT, DC, DE, HI, IA, MA, ME, MN, NY, VT, WA, WI). Row 4 shows estimates after excluding Wisconsin from the analysis. Row 5 shows estimates after excluding late expanders (AK, MI, NH, PA, IN, MO, LA) from the analysis. Row 6 shows estimates after excluding Louisiana from the analysis. Pre-treatment means are the weighted means of outcomes before ACA Medicaid expansion was implemented in expansion states and standard deviations are in parentheses. Sample size is not allowed to be disclosed except main study sample. ***p<0.01; **p<0.05; *p<0.1.

Table S3a. Effects of the ACA Medicaid Expansion on Outcomes for Low-Income Adults: Variations in Set of Expansion States (continued)

	Insurance Status		Usual Source	Unmet Care Needs due to cost				No Visit Doctor		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
No Wisconsin (4)	-0.067***	0.121***	-0.002	-0.020	-0.025***	-0.012*	-0.023*	-0.031*	0.004	-0.012
	(0.017)	(0.023)	(0.016)	(0.013)	(0.008)	(0.006)	(0.012)	(0.016)	(0.009)	(0.012)
Pre- Mean	0.345	0.283	0.211	0.211	0.184	0.068	0.117	0.432	0.873	0.808
	(0.476)	(0.451)	(0.408)	(0.408)	(0.388)	(0.252)	(0.322)	(0.495)	(0.332)	(0.394)
No Late-expanders (5)	-0.070***	0.135***	-0.004	-0.021	-0.026**	-0.011*	-0.027**	-0.037**	0.003	-0.021*
	(0.020)	(0.027)	(0.016)	(0.013)	(0.009)	(0.006)	(0.012)	(0.015)	(0.008)	(0.012)
Pre- Mean	0.330	0.292	0.209	0.202	0.175	0.065	0.117	0.439	0.878	0.813
	(0.470)	(0.455)	(0.407)	(0.401)	(0.380)	(0.247)	(0.321)	(0.496)	(0.328)	(0.39)
No Louisiana (6)	-0.063***	0.122***	0.001	-0.021*	-0.025***	-0.012**	-0.024**	-0.029*	0.003	-0.012
	(0.018)	(0.023)	(0.015)	(0.012)	(0.008)	(0.006)	(0.012)	(0.016)	(0.009)	(0.012)
Pre- Mean	0.339	0.286	0.208	0.211	0.183	0.069	0.117	0.43	0.873	0.808
	(0.473)	(0.452)	(0.406)	(0.408)	(0.387)	(0.253)	(0.322)	(0.495)	(0.333)	(0.394)

Notes. Shaded rows 1 to 6 displays marginal effects and standard errors are in parentheses. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. Row 1 shows baseline model using 32 states as an expansion states, 19 states as a non-expansion states (See Table S1c in Supplementary materials). Row 2 shows estimates after excluding full expansion states (DC, DE, MA, NY, VT). Row 3 shows estimates after excluding any prior expansion states (AZ, CA, CT, DC, DE, HI, IA, MA, ME, MN, NY, VT, WA, WI). Row 4 shows estimates after excluding Wisconsin from the analysis. Row 5 shows estimates after excluding late expanders (AK, MI, NH, PA, IN, MO, LA) from the analysis. Row 6 shows estimates after excluding Louisiana from the analysis. Pre-treatment means are the weighted means of outcomes before ACA Medicaid expansion was implemented in expansion states and standard deviations are in parentheses. Sample size is not allowed to be disclosed except main study sample. ***p<0.01; **p<0.05; *p<0.1.

Table S3b. Effects of the ACA Medicaid Expansion on Outcomes for Low-Income Adults: Variation in Age Range, Income, and Number of Child

	Insurance Status		Usual Source	Unmet Care Needs due to cost				No Visit Doctor		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Baseline (1)	-0.065*** (0.017)	0.117*** (0.023)	0.000 (0.015)	-0.020 (0.012)	-0.026*** (0.008)	-0.012** (0.006)	-0.023* (0.012)	-0.030* (0.016)	0.003 (0.009)	-0.012 (0.012)
Pre- Mean	0.345 (0.476)	0.283 (0.451)	0.211 (0.408)	0.211 (0.408)	0.184 (0.388)	0.068 (0.252)	0.117 (0.322)	0.432 (0.495)	0.873 (0.332)	0.808 (0.394)
Sample size	66,404	66,404	33,346	67,341	67,323	33,270	29,369	33,143	33,177	33,160
Low-income adults aged 26-64 (2)	-0.071*** (0.020)	0.131*** (0.022)	-0.006 (0.015)	-0.016 (0.013)	-0.026** (0.011)	-0.007 (0.007)	-0.021 (0.015)	-0.042** (0.016)	0.008 (0.012)	-0.014 (0.013)
Pre- Mean	0.359 (0.48)	0.298 (0.457)	0.204 (0.403)	0.241 (0.428)	0.212 (0.409)	0.077 (0.267)	0.143 (0.35)	0.406 (0.491)	0.861 (0.346)	0.772 (0.42)
Income less than 100% FPL (3)	-0.080*** (0.021)	0.105*** (0.028)	0.003 (0.018)	-0.028** (0.013)	-0.038*** (0.009)	-0.023*** (0.007)	-0.029** (0.012)	-0.021 (0.018)	0.004 (0.009)	-0.012 (0.014)
Pre- Mean	0.338 (0.473)	0.329 (0.470)	0.210 (0.407)	0.202 (0.401)	0.181 (0.385)	0.072 (0.259)	0.121 (0.326)	0.431 (0.495)	0.868 (0.338)	0.811 (0.392)
Childless adults (4)	-0.082*** (0.016)	0.148*** (0.020)	-0.010 (0.018)	-0.035*** (0.012)	-0.045*** (0.010)	-0.018* (0.011)	-0.012 (0.013)	-0.007 (0.020)	0.014 (0.011)	-0.022 (0.018)
Pre- Mean	0.372 (0.483)	0.163 (0.37)	0.223 (0.416)	0.265 (0.441)	0.225 (0.418)	0.08 (0.271)	0.127 (0.333)	0.43 (0.495)	0.851 (0.357)	0.773 (0.419)
Excluding self-reported health status (5)	-0.065*** (0.017)	0.117*** (0.023)	0.001 (0.015)	-0.021 (0.013)	-0.026*** (0.008)	-0.012* (0.006)	-0.023* (0.013)	-0.031* (0.016)	0.005 (0.009)	-0.013 (0.012)
Pre- Mean	0.345 (0.476)	0.283 (0.451)	0.211 (0.408)	0.211 (0.408)	0.184 (0.388)	0.068 (0.252)	0.117 (0.322)	0.432 (0.495)	0.873 (0.332)	0.808 (0.394)

Notes. Shaded rows 1 to 3 displays marginal effects and standard errors are in parentheses. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. Row 1 shows baseline model using adults aged 19 to 64 with income below 138 % FPL. Rows 2 shows estimates using adults aged 26 to 64 with income below 138 % FPL. Row 3 show estimates using adults aged 19 to 64 with income below 100% of the FPL. Row 4 show estimate using childless adults aged 19 to 64 with income below 138% FPL. Row 5 show estimate controlling for full covariates except self-reported health status. Pre-treatment means are the weighted means of outcomes before ACA Medicaid expansion was implemented in expansion states and standard deviations are in parentheses. Sample size is not allowed to be disclosed except main study sample. ***p<0.01; **p<0.05; *p<0.1.

Table S3c. Comparison between Stratified Models with Difference-in-Difference-in-Differences in Estimated Effects of the ACA Medicaid Expansion on Disparities in Outcomes among Low-Income Whites, Hispanics, and Blacks

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Stratified DD Model										
Blacks-Whites (1)	-0.006 (0.022)	-0.025 (0.021)	-0.051 (0.036)	-0.003 (0.018)	-0.009 (0.017)	0.017 (0.011)	0.011 (0.027)	0.059 (0.042)	0.006 (0.022)	0.013 (0.020)
Hispanics-Whites (2)	-0.009 (0.025)	0.055 (0.040)	-0.002 (0.038)	-0.062*** (0.021)	-0.046** (0.018)	0.019 (0.014)	-0.025 (0.024)	0.027 (0.041)	-0.033** (0.016)	0.021 (0.023)
DDD Model										
Blacks-Whites (3)	0.018 (0.014)	0.010 (0.024)	-0.002 (0.022)	0.022 (0.015)	0.007 (0.013)	0.010 (0.01)	0.021 (0.02)	0.054* (0.029)	0.012 (0.013)	0.008 (0.015)
Hispanics-Whites (4)	-0.028 (0.026)	0.092*** (0.026)	-0.038 (0.031)	-0.034* (0.020)	-0.021 (0.017)	0.018 (0.014)	0.003 (0.017)	0.008 (0.035)	-0.010 (0.015)	0.031 (0.019)

Notes: Rows 1 to 4 displays marginal effects and standard errors are in parentheses. The estimated changes in absolute disparities (Rows 1 and 2) are from adjusted DID in Table 3. All regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. ***p<0.01; **p<0.05; *p<0.1.

Table S3d. Comparison of the estimated effects on lagged outcomes of experiences in the past 12 months with non-lagged outcomes

	Unmet Care Needs due to cost				No Visit Doctor		
	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Current Model							
Overall	-0.020	-0.026***	-0.012**	-0.023*	-0.030*	0.003	-0.012
(1)	(0.012)	(0.008)	(0.006)	(0.012)	(0.016)	(0.009)	(0.012)
Whites	-0.012	-0.018	-0.020**	-0.019	-0.050**	0.008	-0.020
(2)	(0.011)	(0.011)	(0.009)	(0.014)	(0.021)	(0.014)	(0.018)
Blacks	-0.015	-0.027*	-0.002	-0.008	0.010	0.015	-0.007
(3)	(0.017)	(0.015)	(0.009)	(0.021)	(0.037)	(0.014)	(0.018)
Hispanics	-0.074***	-0.064***	-0.001	-0.045	-0.022	-0.024**	0.000
(4)	(0.026)	(0.014)	(0.009)	(0.028)	(0.037)	(0.011)	(0.016)
Blacks-Whites	-0.003	-0.009	0.017	0.011	0.059	0.006	0.013
(1)	(0.018)	(0.017)	(0.011)	(0.027)	(0.042)	(0.022)	(0.020)
Hispanics-Whites	-0.062***	-0.046**	0.019	-0.025	0.027	-0.033**	0.021
(2)	(0.021)	(0.018)	(0.014)	(0.024)	(0.041)	(0.016)	(0.023)
Model with redefined expansion date							
Overall	0.011	-0.039*	-0.014	-0.017	0.037	0.020	-0.019
(1)	(0.006)	(0.023)	(0.009)	(0.017)	(0.049)	(0.016)	(0.026)
Whites	0.016	-0.064**	-0.013	-0.050***	0.052	0.051	-0.017
(2)	(0.019)	(0.026)	(0.013)	(0.019)	(0.063)	(0.041)	(0.051)
Blacks	0.008	0.004	-0.017	0.085	0.017	-0.020	-0.029
(3)	(0.042)	(0.034)	(0.015)	(0.059)	(0.047)	(0.03)	(0.03)
Hispanics	0.062	0.067	-0.047***	0.056*	0.121***	-0.113	-0.035
(4)	(0.044)	(0.044)	(0.015)	(0.033)	(0.031)	(0.082)	(0.088)
Blacks-Whites	0.008	-0.068	0.004	-0.135*	0.035	0.071	0.012
(1)	(0.057)	(0.042)	(0.023)	(0.071)	(0.082)	(0.066)	(0.065)
Hispanics-Whites	-0.046	-0.130**	0.035*	-0.106***	-0.068	0.164	0.018
(2)	(0.059)	(0.056)	(0.019)	(0.031)	(0.081)	(0.109)	(0.135)

Note: Marginal effects and standard errors are in parentheses. For overall sample, regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. For each racial/ethnic group, regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. ***p<0.01; **p<0.05; *p<0.1.

Section 4. Falsification test

We performed three falsification tests in which the fully specified DD models were estimated for subgroups who were very unlikely to be affected by ACA Medicaid expansion: nonelderly adults with income exceeding 400% of the FPL, low-income adults over age 65, and nonelderly low-income non-U.S. citizens. Nonelderly adults with income above 400% of the FPL are ineligible for ACA Medicaid and Marketplace subsidies, the elderly ages over 65 are most likely to be eligible for Medicare, and non-U.S. citizens are generally not eligible for Medicaid regardless of parental status or income-level. As shown in Table S4a, there were marginal increase in rates of Medicaid coverage (0.8 percentage points, $p<.01$) and unmet need for specialty health care due to cost (0.8 percentage points, $p<.05$) among nonelderly adults with income above 400% of the FPL. The estimated effects of ACA Medicaid expansion for the elderly over age 65 were not statistically significant for any outcome. There was a marginal increase in unmet need for mental health care due to cost (0.7 percentage points, $p<.1$). These findings suggest that it is unlikely that the estimated effects of Medicaid expansion on outcomes among nonelderly adults with income below 138% of the FPL come from other public policies or coincident changes in the expansion states. Surprisingly, among low-income non-U.S. citizens, there were decreases in rates of the uninsured (-9.0 percentage points, $p<.01$) and Medicaid coverage (10.4 percentage points, $p<.01$). There were also marginal decreases in rates of unmet mental health care due to cost (-1.7 percentage points, $p<.01$), having no visit of mental health providers (-1.2 percentage points, $p<.05$), having no visit of specialists (-1.9 percentage points, $p<.05$). One explanation for large increase in rates of Medicaid coverage is that immigrants who are “qualified non-citizens”, such as green card holder, are generally eligible for Medicaid coverage with a 5-year waiting period after receiving qualified immigration status

(Healthcare.gov). In consistent with my expectation that non-U.S. citizen were least likely to be affected by Medicaid expansion, theses qualified non-U.S. citizen seems to gain coverage through Medicaid. Given that among nonelderly low-income adults, non-U.S. citizens (61.4 percent) had much higher unadjusted uninsured rates prior to expansion than citizens (34.5 percent), improvement in insurance status among non-U.S. citizen indicates that Medicaid expansion might mitigate disparities in insurance status by citizenship status.

Table S4a. Effects of the ACA Medicaid Expansion on the Changes in Outcomes for High-Income Adults and Low-Income Elderly

	Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
Income above 400% (1)	-0.002 (0.003)	0.008*** (0.002)	0.000 (0.006)	0.001 (0.002)	0.002 (0.003)	0.002 (0.002)	0.008** (0.003)	-0.012 (0.010)	-0.001 (0.005)	-0.015 (0.011)
Pre- Mean	0.052 (0.223)	0.007 (0.081)	0.052 (0.222)	0.052 (0.223)	0.028 (0.164)	0.012 (0.11)	0.019 (0.135)	0.277 (0.448)	0.916 (0.277)	0.706 (0.456)
Adults older than 65 (2)	0.000 (0.004)	0.007 (0.014)	0.014 (0.009)	-0.006 (0.014)	-0.001 (0.013)	0.007* (0.004)	0.008 (0.009)	0.017 (0.021)	-0.014 (0.010)	-0.030 (0.029)
Pre- Mean	0.011 (0.107)	0.168 (0.374)	0.034 (0.18)	0.083 (0.276)	0.061 (0.239)	0.006 (0.079)	0.026 (0.16)	0.161 (0.367)	0.952 (0.213)	0.645 (0.478)

Notes. Shaded Rows 1 to 3 displays marginal effects and standard errors are in parentheses. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. Row 1 shows estimates using nonelderly adults with income more than 400 % FPL. Row 2 shows estimates using adults older than 65-year-old with income below 138 % FPL. Row 3 shows estimates using non-U.S citizen aged 19 to 64 with income below 138% of the FPL. Pre-treatment means are the weighted means of outcomes before ACA Medicaid expansion was implemented in expansion states and standard deviations are in parentheses. Sample size is not allowed to be disclosed except main study sample. ***p<0.01; **p<0.05; *p<0.1.

Table S4b. Effects of the ACA Medicaid Expansion on Disparities in Outcomes Among Non-U.S. Citizen Low-income Adults, and for Whites, Hispanics, and Blacks

	No insurance	Medicaid	No usual source of care	Delayed care due to cost	Unmet need for medical care due to cost	Unmet need for mental health care due to cost	Unmet need for specialty health care due to cost	No visit of physician	No visit of mental health providers	No visit of specialists
Overall (1)	-0.084***	0.103***	0.042	-0.008	-0.001	-0.018***	-0.015	-0.028	-0.011*	-0.019**
	(0.030)	(0.035)	(0.028)	(0.010)	(0.012)	(0.006)	(0.024)	(0.023)	(0.006)	(0.009)
Whites (2)	-0.060	0.013	-0.077	-0.099	-0.076	0.006	0.044	-0.122	0.008	0.071
	(0.061)	(0.063)	(0.113)	(0.075)	(0.052)	(0.067)	(0.082)	(0.173)	(0.044)	(0.062)
Blacks (3)	-0.014	0.076**	-0.119	-0.001	0.068	0.033	0.057	0.052	-0.043	-0.019
	(0.065)	(0.034)	(0.080)	(0.033)	(0.047)	(0.026)	(0.059)	(0.093)	(0.047)	(0.040)
Hispanics (4)	-0.077**	0.099***	0.073**	-0.006	0.005	-0.018***	-0.025	-0.013	-0.007*	-0.025***
	(0.038)	(0.036)	(0.035)	(0.012)	(0.012)	(0.006)	(0.027)	(0.028)	(0.004)	(0.009)
Pre-treatment Means										
Overall	0.614	0.199	0.365	0.154	0.138	0.035	0.117	0.597	0.977	0.921
	(0.487)	(0.399)	(0.482)	(0.361)	(0.345)	(0.183)	(0.322)	(0.491)	(0.15)	(0.27)
White	0.402	0.295	0.316	0.183	0.173	0.036	0.067	0.535	0.978	0.856
	(0.491)	(0.457)	(0.467)	(0.388)	(0.379)	(0.187)	(0.251)	(0.501)	(0.148)	(0.353)
Blacks	0.471	0.249	0.295	0.144	0.149	0.013	0.128	0.444	0.954	0.872
	(0.5)	(0.433)	(0.457)	(0.352)	(0.356)	(0.114)	(0.336)	(0.498)	(0.209)	(0.335)
Hispanics	0.682	0.18	0.385	0.158	0.14	0.034	0.129	0.618	0.977	0.931
	(0.466)	(0.385)	(0.487)	(0.365)	(0.347)	(0.182)	(0.335)	(0.486)	(0.151)	(0.253)

Notes: Marginal effects and standard errors are in parentheses. Regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects. Pre-treatment means are the weighted mean of outcomes before the ACA Medicaid was implemented in the expansion states and standard deviations are in parentheses. ***p<0.01; **p<0.05; *p<0.1.

Section 5. IOM vs. RDE

We compared the IOM estimates with the Residual Direct Effect (RDE). RDE is residual direct effects estimating using fully-specified DD models with all controls. Although previous findings that the measured disparities were greater using the IOM approach than the RDE estimates (Cook et al., 2010; Cook 2009a & 2009b), we had mixed findings. In this study, the estimated ACA Medicaid expansion impacts on Hispanic-White disparities were marginally smaller in the IOM models for delayed care due to cost but slightly greater for visiting mental health providers among low-income adults, compared to the RDE. The decrease in disparities in the rates of unmet needs of care due to cost in the IOM estimates is equal to the decrease in the RDE estimates (-4.6 percentage points, $p<.05$). Statistical significance are similar with those in the RDE estimates, except for no usual source of care among Blacks and unmet needs of specialty care for Hispanics. This similarity between the IOM and the RDE estimates might come from health care needs factors (e.g. age, gender, health status) and non-health care needs factors (e.g., education, income). While among overall population, there were severe health disparities between Whites and Hispanics or Blacks (CDC, 2013), when we restricted the sample to those with income less than 138% FPL, we did not find an evidence of racial/ethnic health disparities. As shown in Table S1f, among our study sample of low-income adults, Whites have similar rates of having activity limitation, fair or poor health status, and serious psychological distress, compared to Blacks. Hispanics have better health status compared to Whites in terms of less activity limitation and less fair/poor health status. Blacks and Hispanics are younger than Whites. The health care needs index for Whites with less females, order adults, and worse health status, might be higher than the index for Blacks or

Hispanics. The similarity between the IOM and RDE estimates might come from these low-income Whites with more health care needs.

Table S5a. Comparison between Effects of the ACA Medicaid Expansion on Absolute Disparities and Relative Disparities among Low-Income Whites, Hispanics, and Blacks

		Insurance Status		**Usual Source**	**Unmet Care Needs due to cost**				**No Visit Doctor**		
		No insurance	Medicaid	No usual source of care	Delayed care due to cost	Medical care	Mental health care	Specialty health care	Physician	Mental health provider	Specialist doctor
IOM[†]	Whites	-0.060***	0.111***	0.014	-0.012	-0.018	-0.020**	-0.019	-0.050**	0.008	-0.020
		(0.019)	(0.019)	(0.022)	(0.011)	(0.011)	(0.009)	(0.014)	(0.021)	(0.014)	(0.018)
	Blacks	-0.067***	0.086***	-0.037	-0.015	-0.027*	-0.002	-0.008	0.010	0.015	-0.007
		(0.020)	(0.021)	(0.023)	(0.017)	(0.015)	(0.009)	(0.021)	(0.037)	(0.014)	(0.018)
	Hispanics	-0.070***	0.166***	0.012	-0.074***	-0.064***	-0.001	-0.045	-0.022	-0.024**	0.000
		(0.026)	(0.049)	(0.034)	(0.026)	(0.014)	(0.009)	(0.028)	(0.037)	(0.011)	(0.016)
	Blacks-Whites	-0.006	-0.025	-0.051	-0.003	-0.009	0.017	0.011	0.059	0.006	0.013
		(0.022)	(0.021)	(0.036)	(0.018)	(0.017)	(0.011)	(0.027)	(0.042)	(0.022)	(0.020)
	Hispanics-Whites	-0.009	0.055	-0.002	-0.062***	-0.046**	0.019	-0.025	0.027	-0.033**	0.021
		(0.025)	(0.040)	(0.038)	(0.021)	(0.018)	(0.014)	(0.024)	(0.041)	(0.016)	(0.023)
RDE[‡]	Whites	-0.062***	0.111***	0.015	-0.010	-0.017	-0.020**	-0.020	-0.049**	0.007	-0.020
		(0.020)	(0.019)	(0.022)	(0.011)	(0.011)	(0.009)	(0.014)	(0.021)	(0.013)	(0.017)
	Blacks	-0.067***	0.090***	-0.041*	-0.016	-0.027*	-0.003	-0.008	0.005	0.012	-0.008
		(0.020)	(0.020)	(0.023)	(0.016)	(0.014)	(0.009)	(0.020)	(0.036)	(0.014)	(0.017)
	Hispanics	-0.069***	0.169***	-0.000	-0.074***	-0.063***	-0.003	-0.055**	-0.026	-0.025**	0.000
		(0.025)	(0.046)	(0.036)	(0.025)	(0.014)	(0.009)	(0.027)	(0.039)	(0.012)	(0.016)
	Blacks-Whites	-0.005	-0.020	-0.056	-0.006	-0.010	0.018	0.011	0.054	0.005	0.012
		(0.022)	(0.021)	(0.036)	(0.017)	(0.016)	(0.011)	(0.026)	(0.041)	(0.022)	(0.019)
	Hispanics-Whites	-0.007	0.058	-0.015	-0.064***	-0.046**	0.017	-0.035	0.023	-0.032*	0.020
		(0.024)	(0.039)	(0.039)	(0.021)	(0.018)	(0.014)	(0.024)	(0.041)	(0.016)	(0.023)

Notes: Rows 1 to 4 display marginal effects and standard errors are in parentheses. The estimated changes in absolute disparities (Rows 1 and 2) are from adjusted DID in Table 3. ***p<0.01; **p<0.05; *p<0.1. [†]IOM is the estimated effects using adjusted data for need variables to make all racial/ethnic groups have equivalent distributions. For IOM, regressions control for unemployment rate, state-fixed effects, and quarter/year-fixed effects and the health care need index. [‡]RDE is residual direct effects estimating using fully-specified DD models with all controls. All regressions control for age, gender, race, education, marital status, employment status, family size, number of child, functional limitation, fair/poor health status, K-6, rural/urban residence, unemployment rate, state-fixed effects, and quarter/year-fixed effects.