Title: Impact of Medicaid Expansion and Methadone Coverage as a Medication for Opioid Use Disorder on Foster Care Entries during the Opioid Crisis

**Appendix**

 **1. Data and Measures**

Data from 2007-2016 Adoption and Foster Care Analysis and Reporting System (AFCARS), an administrative data that collects case-level information on all children in foster care from all 50 states and the District of Columbia, were used.

**1.1. Dependent Variable**

Although the AFCARS database is collected by fiscal year, foster care entries in this study were recoded based on calendar year. The outcome variable is the annual number of foster care entries per 100,000 children. We further focused on those who entered the foster care system with “parental drug abuse” as one of the reasons for removal, referred to in this study as “parental drug use disorder” (N=600,056). AFCARS does not specify which drug was involved in the removals. “Parental drug abuse” is labeled “Removal Reason – Drug Abuse Parent” and defined in the survey as: “As a condition associated with a child's removal from home and contact with the foster care system, the principal caretaker's compulsive use of drugs that is not of a temporary nature.” Please note that a clinical diagnosis of substance use disorder was not available in the dataset. The number of entries per year was aggregated at the state level.

**1.2. Independent Variable**

The Medicaid expansion variable was obtained from multiple sources to ensure accuracy (see Table A3) (Golberstein et al., 2015; Meinhofer & Witman, 2018; Sommers et al., 2014; The Henry J. Kaiser Family Foundation, 2019; Wen et al., 2017). States expanded Medicaid under the ACA starting in January 2014, with a small number expanding earlier through Section 1115 waivers. The year in which Medicaid expansion was effective for at least half the year was used as the starting point for any given state(Soni et al., 2017). For instance, Michigan expanded Medicaid on April 1, 2014, so the expansion year of Michigan is 2014.

Medicaid coverage of methadone as a Medication for Opioid Use Disorder (MOUD) data was based on coverage in September 2015 from the Medicaid and CHIP Payment and Access Commission (see Table A4) that reflects the coverage status as of September 2015(The Medicaid and CHIP Payment and Access Commission, 2016). This coverage status is consistent with the data collected by The American Society of Addiction Medicine(The American Society of Addiction Medicine, 2013).

**1.3. Covariates**

The child protective service (CPS) response time was compiled based on the *Child Maltreatment* annual reports and used to control for capacity of the foster care system in each state. The CPS response time is defined as “the time from the CPS agency’s receipt of a referral to the initial face-to-face contact with the alleged victim wherever this is appropriate, or with another person who can provide information on the allegation(s)” (Child Maltreatment report, 2017). Data from some states are missing in some years (AL, AK, AZ, CA, CO, CT, GA, ID, IL, IN, KY, LA, MA, MD, MI, MO, MT, NC, NE, NH, NM, NY, ND, OH, OR, PA, TN, VA, WV partially or fully have missing data in CPS response time). To resolve this issue, we estimate these missing data based on the existing data. For states that missed some years, we replaced the closest available CPS response time for the missing years (if there are two closest available year, we calculated the average of the two). For the five states that missed all years, we replaced the average CPS response time of other states in each year for the missing.

The availability of buprenorphine/methadone MOUD treatment facilities that accept Medicaid in each state were calculated based on the data from National Survey of Substance Abuse Treatment Services (N-SSATS) (*National Survey of Substance Abuse Treatment Services (N-SSATS) 2007-2016*, 2017). The OUD facility availability is calculated by counting the total number of OUD facilities in each state and dividing it by the state’s adult population. The number of OUD facilities was obtained from the N-SSATS. The adult population data was compiled by the Annie E. Casey Foundation, Kids Count Data Center from the Population Division, U.S. Census Bureau (The Annie E. Casey Foundation). They were included to control for variations in the availability of MOUD treatment at the state level.

State-level buprenorphine license limits were drawn from Substance Abuse and Mental Health Services Administration’s (SAMHSA) Drug Addiction Treatment Act of 2000 (DATA 2000) practitioner waiver database(Substance Abuse and Mental Health Services Administration). Potential buprenorphine treatment capacity was calculated using data from the SAMHSA DATA 2000 by determining the maximum number of patients who could be treated by providers with buprenorphine-prescribing waivers per 10,000 adults. This covariate was included to control for capacity of buprenorphine treatment.

State-level drug mortality rate and Medicaid opioid prescription rate were from the CDC WONDER online database (*CDC WONDER*, 2017) and Centers for Medicare & Medicaid Services (CMS) State Drug Utilization database (Centers for Medicare & Medicaid Services), respectively. These control variables were included to control for changes in the opioid overdose epidemic over time. The Medicaid opioid prescription rate data are missing for Arizona from 2007 to 2009, so an average of Medicaid opioid prescription rate of 2010 to 2013 was calculated to fill in the missing data. Since Arizona expanded its Medicaid in 2014, the average was only calculated over 2010 to 2013. The Medicaid opioid prescription rate for South Dakota in 2007 was replaced with the average of the rate in 2006 and 2008 as the rate for 2007 is extremely large and may be due to input errors.

The other demographic control variables including state-level child poverty rate, percentage of non-Hispanic white population, percentage of the population between 25 and 65 years who graduated high school, and uninsured rate were compiled from the U.S. Census Bureau (2017), and states’ annual unemployment rate was compiled from and the U.S. Bureau of Labor Statistics (2016) for each year from 2007 to 2016.

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Table A1 (Full Results for Table 2): Estimated Impact of Medicaid Expansion on First-Time Foster Care Entries due to Parental Drug Use Disorder by Race/Ethnicity and by Age Group, 2007-2016

|  |
| --- |
| First-time foster care entries due to parental drug use disorder per 100,000 a |
|  | **Overall** | **By Race/Ethnicity** | **By Age** |
|  | All race (0-17)  | Non-Hispanic-Black | Non-Hispanic-White | Hispanic | 0-1 | 2-5 | 6-17 |
| **Equation 1** |  |  |  |  |  |  |  |
| Expansion ($β\_{1})$ | -6.2 (-24.9, 12.4) | -36.2 (-105.7, 33.2) | -8.6(-28.9, 11.6) | -13.1(-38.7, 12.6) | -10.9 (-58.9, 37.1) | -7.0 (-34.0, 20.0) | -5.7 (-17.6, 6.3) |
| *n* | 509 b | 509 b | 509 b | 509 b | 509 b | 509 b | 509 b |

**SOURCE:** State level data from Adoption and Foster Care Analysis and Reporting System, 2007-2016 was used.

**NOTES: Equation 1**controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, methadone MOUD facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment and at the state level. aThe number of foster care entries was divided by the child (17 years old or younger) population (or child population by race/ethnicity if necessary) in that state each year. The child population data by different age groups is from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htmb>50 States and the District of Columbia were examined from 2007 to 2016 except that North Dakota was missing the data for 2011 for drug death rate. The values in parentheses are 95% confidence interval. Boldface indicates statistical significance. \**p*<0.05, \*\**p*<0.01

Table A2 (Full Results for Table 3): Estimated Impact of Medicaid Expansion and Methadone MOUD Coverage on First-Time Foster Care Entries due to Parental Drug Use Disorder by Race/Ethnicity and by Age Group, 2007-2016

|  |
| --- |
| First-time foster care entries due to parental drug use disorder per 100,000 a |
|  | **Overall** | **By Race/Ethnicity** | **By Age** |
|  | All race (0-17) | Non-Hispanic-Black | Non-Hispanic-White | Hispanic | 0-1 | 2-5 | 6-17 |
| **Equation 2** |  |  |  |  |  |  |  |
| Expansion ($β\_{1})$ | 39.9 (-6.6, 86.4) | 86.2 (-64.6, 237.0) | 34.8 (-18.4 88.0) | 19.8 (-17.6, 57.4) | 102.8 (-16.3, 222.0) | 56.8 (-8.7, 122.3) | 22.1 (-7.1, 51.4) |
| Expansion × Methadone ($β\_{2})$ | **-67.4\***(-120.2, -14.7) | **-179.0**\*(-339.2, -18.7) | **-63.5**\* (-124.7, -2.3) | **-48.2**\*(-86.9, -9.5) | **-166.2**\*(-304.5, -28.0) | **-93.4**\* (-167.4, -19.3) | **-40.7**\*(-73.5, -7.8) |
| $$β\_{1}+β\_{2}$$ | **-27.5\*\***(-47.2, -7.9) | **-92.8\*** (-168.2, -17.3) | **-28.7\*** (-50.6, -6.8) | **-28.3\*** (-55.3, -1.3) | **-63.4\***(-118.3, -8.5)  | **-36.5\*\***(-63.4, -9.6)  | **-18.5\*\*** (-31.4, -5.6)  |
| Mean of outcomeb | 84.6 | 202.1 | 81.5 | 70.7 | 270.8 | 111.3 | 44.9 |
| *n* | 509 c | 509 c | 509 c | 509 c | 509 c | 509 c | 509 c |

**SOURCE:** State level data from Adoption and Foster Care Analysis and Reporting System, 2007-2016 was used.

**NOTES:** Equation 2 controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, MOUD methadone facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment and at the state level. a The number of foster care entries was divided by the child (different age groups) population in that state each year. The child population data by different age groups is from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm>. The child population data by different age groups are from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm> b The baseline mean is the average of the outcome prior to the expansion for non-expansion states. c 50 States and the District of Columbia were examined from 2007 to 2016 except that North Dakota was missing the data for 2011 for drug death rate. The values in parentheses are 95% confidence interval. Boldface indicates statistical significance. \**p*<0.05, \*\**p*<0.01.

Table A3: Medicaid Expansion Status by State

|  |  |  |
| --- | --- | --- |
| Type | State | Expansion Date |
| **Early expansion** | CT | 4/1/2010 1 |
|  | DC | 7/1/2010 1 |
|  | CA | 7/1/2011 2 |
|  | MN | 3/1/2011 1 |
|  |  |  |
| **2014 expansion a** | AZ, AR, CO, DE, HI, IL, IA, KY, MD, MA, NV, NJ, NM, NY, ND, OH, OR, RI, VT, WA, WV | 1/1/2014 3 |
|  | MI | 4/1/2014 3 |
| **Late expansion** | NH | 8/15/2014 3 |
|  | PA | 1/1/2015 3 |
|  | IN | 2/1/2015 3 |
|  | AK | 9/1/2015 3 |
|  | MT | 1/1/2016 3 |
|  | LA | 7/1/2016 3 |
| **No expansion** | AL, FL, GA, ID, KS, ME, MS, MO, NE, NC, OK, SC, SD, TN, TX, UT, VA, WI, WY | N/A 3 |
|  |  |  |

**SOURCE:** The data are from the following sources: 1 Sommers et al. (2014); Meinhofer & Witman (2018). 2 Sommers et al. (2014); Golberstein et al. (2015); Wen et al. (2017). 3 The Henry J. Kaiser Family Foundation

**NOTES:** aNew Jersey and Washington also expanded their Medicaid before 2014 but the eligibility was not expanded so no increase in insurance coverage. (Sommers et al., 2014)

Table A4

|  |  |  |
| --- | --- | --- |
| Methadone Coverage 1 | Medicaid Expansion  a ; 2, 3, 4 | State |
| **Not covered**  | **Expanded**  | AR, CO, IL, IN, IA, KY, ND, WV  |
|  | **Not Expanded**  | AK b, ID, KS, LA b, MS, MT b, NE, OK, SC, SD, TN, WY  |
|  |  |  |
| **Covered**  | **Expanded**  | AZ, CA, CT, DC, DE, HI, MD, MA, MI, MN, NV, NH, NJ, NM, NY, OH, OR, PA, RI, VM, WA  |
|  | **Not Expanded**  | AL, FL, GA, ME, MO, NC, TX, UT, VA, WI  |
|  |  |  |

**SOURCE:** The data are from the following sources: 1 Medicaid and CHIP Payment and Access Commission, 2016. State Policies for Behavioral Health Services Covered Under the State Plan. <https://www.macpac.gov/publication/behavioral-health-state-plan-services/> 2 Sommers et al. (2014); Meinhofer & Witman (2018) 3 Sommers et al. (2014); Golberstein et al. (2015); Wen et al. (2017) 4 The Henry J. Kaiser Family Foundation

**NOTES:** a In this table,a state is defined as an expansion state if the expansion year of the state is before 2016. b Since Alaska expanded Medicaid on 9/1/2015 and thus the expansion was effective for less than half a year in 2015, so the expansion year for Alaska is 2016. Hence, Alaska is a non-expansion state. Louisiana and Montana both expanded their Medicaid in 2016, so they are non-expansion states.

Table A5: Estimated Association of State Medicaid Coverage of Methadone MOUD with First-Time Foster Care Entries due to Parental Drug Use Disorder, 2007-2016

|  |
| --- |
| First-time foster care entries due to parental drug use disorder per 100,000 a |
|  |  |
| Methadone coverage | -12.9 (-51.2, 25.4) |
| *n* | 509 b |

**SOURCE:** The Adoption and Foster Care Analysis and Reporting System, 2007-2016.

**NOTES:** This model controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, methadone MOUD facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment and at the state level. A one-way fixed effect model (controlling for year fixed effect) was estimated as the state Medicaid coverage of methadone MOUD is a time-constant variable and thus state fixed effect would be absorbed in a two-way fixed effect model. a The number of foster care entries was divided by the child (different age groups) population in that state each year. The child population data by different age groups are from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm>. b 50 States and the District of Columbia were examined from 2007 to 2016 except that North Dakota was missing the data for 2011 for drug death rate. Boldface indicates statistical significance. \**p*<0.05, \*\**p*<0.01

Table A6: Sensitivity Analysis: Estimated Impact of Medicaid Expansion on First-Time Foster Care Entries due to Parental Drug Use Disorder by Race/Ethnicity and by Age Group, 2007-2016

|  |
| --- |
| First-time foster care entries due to parental drug use disorder per 100,000 a |
|  | **Overall** | **By Race/Ethnicity** | **By Age** |
|  | All Race (0-17) | Non-Hispanic-Black | Non-Hispanic-White | Hispanic | 0-1 | 2-5 | 6-17 |
| **Equation 1** |  |  |  |  |  |  |  |
| Expansion ($β\_{1})$ | -2.1(-24.8, 20.7) | -40.5 (-128.7, 47.6) | -3.3 (-27.1, 20.6) | -10.1 (-40.6, 20.4) | 3.7 (-52.2, 59.5) | 0.8 (-32.4, 33.9) | -4.7 (-19.4, 9.9) |
| *n* | 448 b | 448 b | 448 b | 448 b | 448 b | 448 b | 448 b |

**SOURCE:** State level data from Adoption and Foster Care Analysis and Reporting System, 2007-2016 was used.

**NOTES:** This model (Equation 1) controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, methadone MOUD facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment and at the state level. aThe number of foster care entries was divided by the child (17 years old or younger) population (or child population by race/ethnicity if necessary) in that state each year. The child population data by different age groups are from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm> bNorth Dakota was missing the data for 2011 for drug death rate; New Hampshire, Illinois, Louisiana, California, Delaware, District of Columbia, and Arizona in 2013 were excluded due to an unusual low proportion of foster care entries due to parental drug use disorder, so the sample size drops to 448 from 509. The values in parentheses are 95% confidence interval. Boldface indicates statistical significance. \**p*<0.05, \*\**p*<0.01

Table A7: Sensitivity Analysis: Estimated Impact of Medicaid Expansion and Methadone MOUD Coverage on First-Time Foster Care Entries due to Parental Drug Use Disorder by Race/Ethnicity and by Age Group, 2007-2016

|  |
| --- |
| First-time foster care entries due to parental drug use disorder per 100,000 a |
|  | **Overall** | **By Race/Ethnicity** | **By Age** |
|  | All Race (0-17) | Non-Hispanic-Black | Non-Hispanic-White | Hispanic | 0-1 | 2-5 | 6-17 |
| **Equation 2** |  |  |  |  |  |  |  |
| Expansion ($β\_{1})$ | 48.3 (-4.2, 100.9) | 94.9 (-81.4, 271.2) | 43.8 (-16.5, 104.3) | 25.7 (-18.4, 69.8) | 127.4 (-4.4, 259.4) | 69.4 (-4.7, 143.4) | 26.3 (-7.3, 59.9) |
| Expansion × Methadone ($β\_{2})$ | **-75.7\***(-132.2 -19.3) | **-203.4**\*(-378.4, -28.5) | **-70.9**\* (-137.0, -4.7) | **-53.8**\*(-97.6, -10.1) | **-186.0**\*(-330.1, -41.9) | **-103.0**\* (-183.4, -22.7) | **-46.6**\*(-82.3, -11.0) |
| $$β\_{1}+β\_{2}$$ | **-27.4\*\***(-47.3, -7.5) | **-108.6\*** (-195.6, -21.5) | **-27.0\*** (-48.2, -5.7) | -28.1 (-58.0, 1.7) | **-58.5\*** (-112.1, -5.0)  | **-33.7\*** (-62.4, -4.9)  | **-20.3\*\*** (-33.1, -7.4)  |
| Mean of outcome | 100.1 | 242.5 | 97.3 | 83.8 | 320.0 | 132.0 | 53.3 |
| *n* | 448 b | 448 b | 448 b | 448 b | 448 b | 448 b | 448 b |

**SOURCE:** State level data from Adoption and Foster Care Analysis and Reporting System, 2007-2016 was used.

**NOTES:** This model (Equation 2) controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, methadone MOUD facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment and at the state level. a The number of foster care entries was divided by the child (different age groups) population in that state each year. The child population data by different age groups is from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm>. The child population data by different age groups is from National Center for Health Statistics. Bridged-race population estimates—data files and documentation. <http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm>bNorth Dakota was missing the data for 2011 for drug death rate. New Hampshire, Illinois, Louisiana, California, Delaware, District of Columbia were excluded and Arizona in 2013 were also excluded due to an unusual low proportion of foster care entries due to parental drug use disorder. The values in parentheses are 95% confidence interval. Boldface indicates statistical significance.\**p*<0.05, \*\**p*<0.01.

Table A8: Sensitivity Analysis: Falsification Test Using Other Removal Reasons (Age <18): Adoption and Foster Care Analysis and Reporting System, United States, 2007-2016

|  |  |
| --- | --- |
| Foster care entries by removal reasons  | Expansion and methadone ($β\_{1}+β\_{2}$) |
|  |  |
| Sex abuse | 1.1 (-1.3, 3.6) |
| Physical abuse | 0.9 (-5.5, 7.3)) |
| Neglect | 30.9 (-0.4, 62.3) |
| Parental alcohol use disorder  | 1.7 (-3,2, 6.7) |
| Child alcohol use disorder | -0.49 (-2.2, 1.2) |
| Child drug use disorder | -2.2 (-5.7, 1.4) |
| Child disability | 0.4 (-2.4, 3.2) |
| Child behavior problem | -0.5 (-13.2, 12.2) |
| Parent death | 0.2 (-0.1, 0.6) |
| Parent incarceration | 0.2 (-3.7, 4.0) |
| Caretaker inability to cope | -7.9 (-17.4, 1.7) |
| Abandonment  | 0.01(-1.8, 1.8) |
| Relinquishment | 0.3 (-0.9, 1.5) |
| Inadequate housing | -1.2 (-7.5, 5.2) |
| *n* | 448 a |

:

**SOURCE:** State level data from Adoption and Foster Care Analysis and Reporting System, 2007-2016 was used.

**NOTES:** Equation 2 was used to conduct the falsification test controls for drug mortality rate, CPS response time, DATA2000 buprenorphine license limit, methadone MOUD facility availability, buprenorphine MOUD facility availability, Medicaid opioid prescription rate, race, child poverty, education, uninsured rate, unemployment at the state level. The estimated coefficients correspond to the estimate of $β\_{1}+β\_{2}$ in Equation 2. aNorth Dakota was missing the data for 2011 for drug death rate. New Hampshire, Illinois, Louisiana, California, Delaware, District of Columbia, and Arizona in 2013 were also excluded due to an unusual low proportion of foster care entries due to parental drug use disorder. The values in parentheses are 95% confidence interval. Boldface indicates statistical significance. \**p*<0.05, \*\**p*<0.01

Figure A1: Medicaid Expansion and Methadone MOUD Coverage Status in the United States



**SOURCE:** The data are from the following sources: Medicaid and CHIP Payment and Access Commission, 2016. State Policies for Behavioral Health Services Covered Under the State Plan. <https://www.macpac.gov/publication/behavioral-health-state-plan-services/> ;Sommers et al. (2014); Meinhofer & Witman (2018);Sommers et al. (2014); Golberstein et al. (2015); Wen et al. (2017) ;The Henry J. Kaiser Family Foundation

**NOTES:** In this figure,a state is defined as an expansion state if the expansion year of the state is before 2016. Since Alaska expanded Medicaid on 9/1/2015 and thus the expansion was effective for less than half a year in 2015, so the expansion year for Alaska is 2016. Hence, Alaska is a non-expansion state. Louisiana and Montana both expanded their Medicaid in 2016, so they are non-expansion states.