Online Appendix for "Effects of School-Based Mental Health Services on Youth Outcomes"

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1. Supplemental Methods Materials

Minn-LInK Administrative Data

Many of our outcomes are derived from administrative data, which were obtained from Minn-LInK. Through ongoing governance arrangements with state agencies, it creates linked databases from administrative data sources in Minnesota and allows for tracking unique children over time using anonymized child identifiers.

Test Score Data

To construct measures of academic achievement, we harness any state-mandated standardized achievement test scores for each student. We do not seek to test theory on SBMH affecting achievement in different subjects differently, so our measure pools information across subjects to reduce measurement error. For each test, the state publishes a normed mean and a standard deviation. We convert each score to a z-score using its norm. The average of all scores available for each student-year measures academic achievement. The state has updated the versions of its mandated tests over time, moving from the Minnesota Comprehensive Assessment II to the Minnesota Comprehensive Assessment III in 2012–2013. We rely on norming to deal with any equivalency issues.

Mental Health Service Use Outcomes in Administrative Medicaid Data

Our main approach to identifying outpatient mental health services is to identify claims with procedure codes that correspond to psychotherapy or psychosocial services, which do not have an inpatient, ED, or residential treatment place of service code. The following codes fit this description:

Psychotherapy CPT codes (Hoagwood et al. 2016): 90801, 90802, 90804, 90805, 90806, 90807, 90808, 90809, 90810, 90811, 90812, 90813, 90814, 90815, 90816, 90817, 90818, 90819, 90820, 90821, 90822, 90823, 90824, 90826, 90827, 90828, 90829, 90845, 90846, 90847, 90849, 90853, 90857, 90875, 90876, 90880, 90882, 90841, 90842, 90843, 90844, 90855

Psychosocial services HCPC codes (Finnerty et al. 2016): H2017, H2018, H2019, H2020, H0032, H0035, H0036, H0037, H0038, H0039, H0040, H0045, H0046, H2001, H2010, H2011, H2012, H2013

As an alternative approach to measuring mental health services in the Medicaid claims data, we rely on ICD-9 and ICD-10 diagnosis codes to identify mental health services. A claim was

categorized as a mental health service if it had an ICD-9 diagnosis code of 295-302, 295-309, 311-315, or 317-319, or suicide-related E-codes E950–E959. The corresponding ICD-10 diagnosis codes were F20–F48, F50–F51, F54, F59, F90–F99, R45, T14, T36–T71, or suicide-related X71–X83.

Predictive Model of Mental Health Problems

To identify children who were most at risk of mental health problems, and thus more likely to receive mental health services and possibly to benefit from SBMH, we estimated a predictive model of mental health problems with a separate data set. We used the 2001–2017 National Health Interview Survey, which included two measures of mental health problems among youth aged 4–17. One of these measures comes from four questions from the Strength and Difficulties Questionnaire in which parents assess elements of child behaviors and emotional health. Scores from these four items were summed with a range of 0 (least likely to have a psychological problem) to 10 (most likely to have a psychological problem). We use a threshold of 6 or higher to predict serious psychological problems. The other measure was a single item that had parents assess the degree to which their child had difficulties with emotions, concentration, behavior, or not getting along with others. We code a child as having emotional difficulties if the parent indicated either definite or severe difficulties.

Our outcome of interest was whether a child met either of those thresholds for a serious psychological problem or emotional difficulty, with a sample average of 7.4 percent. We then used all of the variables that were common between the NHIS and MinnLInK data (age, sex, race/ethnicity, and Medicaid enrollment) and estimated a LASSO model of that outcome using tenfold cross validation and the full set of interactions as possible "donor" variables. The LASSO model was run for 98,938 observations in a random 75 percent "training" sample.

To assess whether the LASSO model was able to meaningfully predict mental health problems, we calculated the actual prevalence of mental health problems in the 25 percent "holdout" sample. The proportion of children with mental health problems was 3.5 percent in the lowest quartile of predicted mental health problem quartile, 6.6 percent in the middle two quartiles, and 13.1 percent in the uppermost quartile, indicating that the predictive model does reasonably capture variation in risk of mental health problems.

Matched Sample of Schools

We use nearest-neighbor matching method to reduce the effect of possible differential trends between the schools that implement and do not implement the program. We match the schools based on a fuzzy match on the observable school characteristics: percentage of minority students, percentage of students eligible for free or reduced-price lunch, percentage of Limited English Proficient students, and percentage of students enrolled in special education programs.

Appendix Table 1 Summary Statistics—Minn-LInK Variables

	Full Sample		Matched Sample	
	Mean or proportion	*N*	Mean or proportion	N
Individual-level Covariates/Stratifying Variables				
Gender		2,494,797		1,963,163
Women	0.491		0.489	
Men	0.509		0.511	
Race/Ethnicity		2,494,797		1,963,163
American Indian/Alaskan Native	0.018		0.017	
Black (not of Hispanic origin)	0.225		0.092	
Hispanic or Latino/x	0.096		0.081	
Asian/Pacific Islander	0.095		0.214	
White (not of Hispanic origin)	0.566		0.596	
Age Category		2,494,797		1,963,163
4–6 years	0.150		0.150	
7–9 years	0.244		0.246	
10–12 years	0.222		0.228	
13–15 years	0.228		0.227	
16–18 years	0.156		0.149	

Eligible for free/reduced price lunch	0.377	2,494,797	0.346	1,963,163
Mental Health Problem Risk		2,494,797		1,963,163
Low	0.252		0.250	
Medium	0.515		0.516	
High	0.233		0.234	
Child protection services or out-of-home placement	0.147	2,494,797	0.138	1,963,163
Outcome Variables:				
Average daily attendance (SD)	0.942	2,494,797	0.945	1,963,163
MCA standardized z-scores (SD)	-0.039	1,754,574	0.016	1,559,180
Any out-of-school suspension	0.040	1,222,124	0.037	796,191
Any juvenile justice involvement	0.006	1,086,305	0.004	685,120
Medicaid enrollment	0.191	2.199.966	0.165	1,963,163
Prescription drugs		419,226		323,049
Any antidepressant prescription	0.039		0.040	
Any antipsychotic prescription	0.014		0.014	
Any anxiolytic prescription	0.024		0.023	
Any mood stabilizer prescription	0.016		0.016	
Any stimulant prescription	0.067		0.068	
Any psychotropic drug prescription	0.112		0.112	

Outpatient service use		419,226		323,049
Any psychotherapy services use	0.123		0.112	
Any psychosocial services use	0.030		0.030	
Any psychotherapy, psychosocial services, or MH drug use	0.181		0.179	
Any psychotherapy or psychosocial services use at school	0.008		0.007	
Hospital-based (inpatient and ED) services		314,412		283,029
Any hospital-based services related to suicide	0.025		0.018	
Any hospital-based mental health services	0.035		0.028	

SOURCE: Data are from administrative Minn-LInK data available on all students for all schools.

Appendix Table 2 Summary Statistics—Minnesota Student Survey Variables

	Full Sample		Matched Sample	
	Mean or proportion	*N*	Mean or proportion	*N*
Individual-level Covariates/Stratifying Variables				
Gender		196,090		139,620
Women	0.494		0.506	
Men	0.506		0.494	
Race/Ethnicity		196,323		139,785
American Indian/Alaskan Native	0.040		0.039	
Black	0.121		0.114	
Hispanic or Latino/x	0.080		0.074	
Asian	0.086		0077	
White	0.600		0.621	
Mixed/Not reported	0.074		0.075	
Grade level		196,323		139,785
Grade 5	0.110		0.125	
Grade 6	0.203		0.213	

Grade 8	0.129		0.136	
Grade 9	0.326		0.313	
Grade 11	0.096		0.085	
Grade 12	0.136		0.127	
Outcome Variables:				
Suicidal thoughts, 12-month	0.138	158,080	0.134	108,168
Suicide attempt, 12-month	0.037	158,283	0.035	108,419
Alcohol use, 30-day	0.177	150,936	0.166	105,971
Marijuana use, 30-day	0.104	151,701	0.096	106,495
Cigarette use, 30-day	0.077	177,513	0.068	126,744
General well-being score (SD)	14.42 (3.64)	97,977	14.49 (3.60)	69,432
Mental health service use, 12-month	0.098	96,796	0.102	67,235

SOURCE: Data are from Minnesota Student Survey data available every three years for some grades and schools.

Appendix Table 3a. School Characteristics by Implementation Time, full sample

	Never implemented SBMH (n = 140)	Implemented SBMH (n = 123)	Early implementers (≤ 2010) (n = 35)	Late implementers (> 2010) (n = 88)
Type of school				
Elementary	0.71	0.62	0.63	0.61
Middle	0.19	0.21	0.11	0.25
Junior High	0.02	0.02	0.00	0.04
Senior High	0.08	0.15	0.26	0.10
% minority	0.39	0.46	0.49	0.44
% LEP	0.08	0.12	0.12	0.12
% FRPL	0.34	0.40	0.42	0.48
% special education	0.11	0.1	0.12	0.10

NOTE: School-level characteristics are given for the earliest time in which the school appears in the data.

Appendix Table 3b. School Characteristics by Implementation Time, matched sample

	Never-implemented SBMH (n=81)	Implemented SBMH (n=98)	Early-Implementers (≤2010) (n=26)	Late-implementers (>2010) (n=72)
Type of school:				
Elementary	0.65	0.68	0.58	0.72
Middle	0.21	0.20	0.19	0.20
High	0.14	0.12	0.23	0.08
% Minority	0.37	0.42	0.46	0.40
% LEP	0.08	0.11	0.11	0.11
% FRPL	0.31	0.37	0.40	0.35
% Special Education	0.11	0.11	0.12	0.10

Note: School-level characteristics are given for the earliest time when the school appears in the data.

Appendix Table 4a: Estimated Treatment Effects of SBMH on Any Suicide Attempts in Past 12 Months, Comparing Alternative Estimators

	Borusyak, Jaravel, & Speiss (ATT, as in main manuscript)		Callaway & Sant'Anna (2021) (ATT, using not-yet treated as comparison)		Two-Way Fixed Effects (ATT)	
ATT	-0.0038	-0.0053	-0.0078	-0.0092	-0.0039	-0.0049
Standard error	(0.0019)	(0.0025)	(0.0032)	(0.0039)	(0.0023)	(0.0029)
p-value	0.050	0.034	0.014	0.017	0.096	0.088
Matched Sample		x		x		x
N	156,511	110,672	158,283	110,726	158,202	112,363

NOTE: Data are from Minnesota Student Survey data available every three years for some grades and schools. All results are from models with individual-level covariates (grade, race/ethnicity, sex), and include grade-level by year fixed effects. Callaway & Sant'Anna models are unable to include the individual-level covariates.

Appendix Table 4b: Estimated Treatment Effects of SBMH on Any Outpatient Mental Health Services or Prescription Drug Use, Comparing Alternative Estimators

	Borusyak, Jaravel, & Speiss (ATT, as in main manuscript)		Callaway & Sant'Anna (2021) (ATT, using not-yet treated as comparison)		Two-Way Fixed Effects (ATT)	
ATT	0.0137	0.0129	0.0134	0.0063	0.0078	0.0086
Standard error	0.0049	0.0050	0.0081	0.0084	0.0038	0.0046
p-value	0.005	0.009	0.097	0.451	0.042	0.060
Matched Sample		x		x		x
N	401,387	301,443	416,426	302,643	419,226	310,133

NOTE: All mental health services use data are from administrative data available on Medicaid-enrolled students. All results are from models with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and include grade-level by year fixed effects. Callaway & Sant'Anna models are unable to include the individual-level covariates.

Appendix Table 5: Estimated ATT Effects of SBMH on Other Mental Health Services Administrative Data Outcomes

	Psychosocial services		Outpatient MH Services at School		Hospital-Based Services for Suicidality		Medicaid Enrollment	
ATT	0.0029	0.0020	0.0037	0.0039	0.0032	0.0040	0.0289	0.0246
Standard error	(0.0019)	(0.0023)	(0.0011)	(0.0013)	(0.0017)	(0.0020)	(0.0045)	(0.0039)
p-value	0.116	0.369	0.001	0.003	0.060	0.040	<0.001	<0.001
Matched sample		x		x		x		x
Sample mean	0.0301	0.0305	0.0077	0.0076	0.0247	0.0239	0.1949	0.1843
N	401,387	301,443	401,387	301,443	258,284	134,022	2,059,015	1,635,622

NOTE: All mental health services use data are from administrative data available on Medicaid-enrolled students. All results are from models with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and include grade-level by year fixed effects.

Appendix Table 6. Prescription Drug Use by Drug Class: Estimated ATT Effects

	Antidepressants		Antipsychotics		Anxiolytics		Mood stabilizers		Stimulants	
ATT	0.0037	0.0031	0.0030	0.0033	0.0010	0.0009	0.0024	0.0029	-0.0023	-0.0014
Standard error	(0.0022)	(0.0023)	(0.0014)	(0.0017)	(0.0013)	(0.0013)	(0.0016)	(0.0018)	(0.0024)	(0.0027)
p-value	0.094	0.173	0.034	0.045	0.479	0.465	0.132	0.106	0.344	0.613
Matched Sample		x		x		x		x		x
Sample mean	0.0392	0.0404	0.0141	0.0146	0.0238	0.0239	0.0155	0.0164	0.0667	0.0698
N	401,387	301,443	401,387	301,443	401,387	301,443	401,387	301,443	401,387	301,443

NOTE: All mental health services use data are from administrative data available on Medicaid-enrolled students. All results are from models with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and include grade-level by year fixed effects.

Appendix Table 7. Individual Education Plan (IEP) Use: Estimated ATT Effects

	Receives special education		Receives special education for emotional/behavioral disability	
ATT	0.0037	0.0078	-0.0018	-0.0002
Standard error	0.0028	0.0029	0.0007	0.0006
p-value	0.186	0.007	0.014	0.725
Matched Sample		X		X
Sample mean	0.109	0.108	0.0143	0.0130
N	2,405,211	1,873,627	2,405,211	1,873,627

NOTE: IEP data are from administrative data available on all students. Results are from models with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and include grade-level by year fixed effects.

Appendix Table 8. Secondary Survey Data Outcomes from MSS: Estimated ATT Effects

Outcomes	General Wellbeing Scale		Past 12 Month Mental Health Treatment	
ATT	-0.0836	-0.0054	-0.0064	-0.0074
Std. error	(0.0692)	(0.0948)	(0.0040)	(0.0045)
p-value	0.227	0.955	0.109	0.087
Matched Sample		X		x
Sample mean	14.424	14.491	0.098	0.103
N	97,977	69,432	89,799	61,206

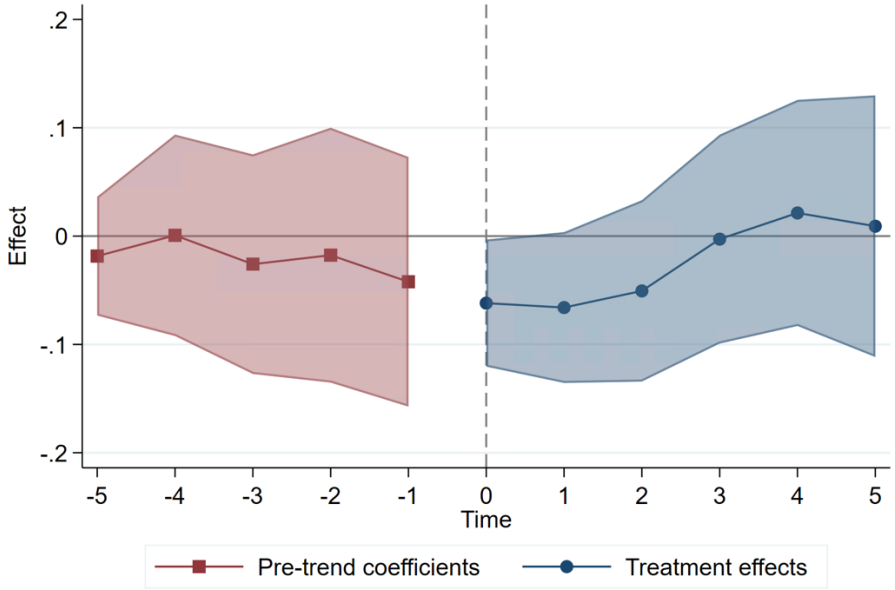
NOTE: Data are from Minnesota Student Survey data available every three years for some grades and schools. All results are from models with individual-level covariates (grade, race/ethnicity, sex), and include grade-level by year fixed effects.

Appendix Table 9. Effects of SBMH by Prior Exposure to SBMH

	Middle school		High school	
	No prior SBMH exposure	Prior SBMH exposure	No prior SBMH exposure	Prior SBMH exposure
Average daily attendance	-0.0005 (p = 0.703) [0.05%]	0.0029 (p = 0.425) [0.3%]	–0.0022 (p = 0.374) [–0.2%]	0.0404 (p < 0.01) [4.4%]
Standardized Test z-Score	0.0300 (p = 0.100)	–0.0057 (p = 0.879)	–0.0011 (p = 0.978)	0.0155 (p = 0.860)
Any Out-of-School Suspension	–0.0105 (p = 0.032) [–17.0%]	–0.0138 (p = 0.443) [–13.1%]	–0.0060 (p = 0.071) [–10.4%]	–0.1079 (p < 0.01) [–215.8%]
Any Juvenile Justice Involvement	–0.0008 (p =0.132) [–16.7%]	–0.0060 (p < 0.01) [–68.1%]	0.0015 (p = 0.200) [11.8%]	0.0022 (p = 0.666) [19.8%]
Any Outpatient MH Services or Psychotropic Drug	0.0128 (p = 0.056) [6.3%]	0.0374 (p < 0.01) [17.6%]	0.0123 (p = 0.350) [5.5%]	0.0643 (p = 0.259) [27.8%]
Any Inpatient or ED MH Services	0.0034 (p = 0.315) [10.4%]	0.0053 (p = 0.259) [22.9%]	–0.0020 (p = 0.729) [–3.9%]	0.0361 (p < 0.01) [91.6%]

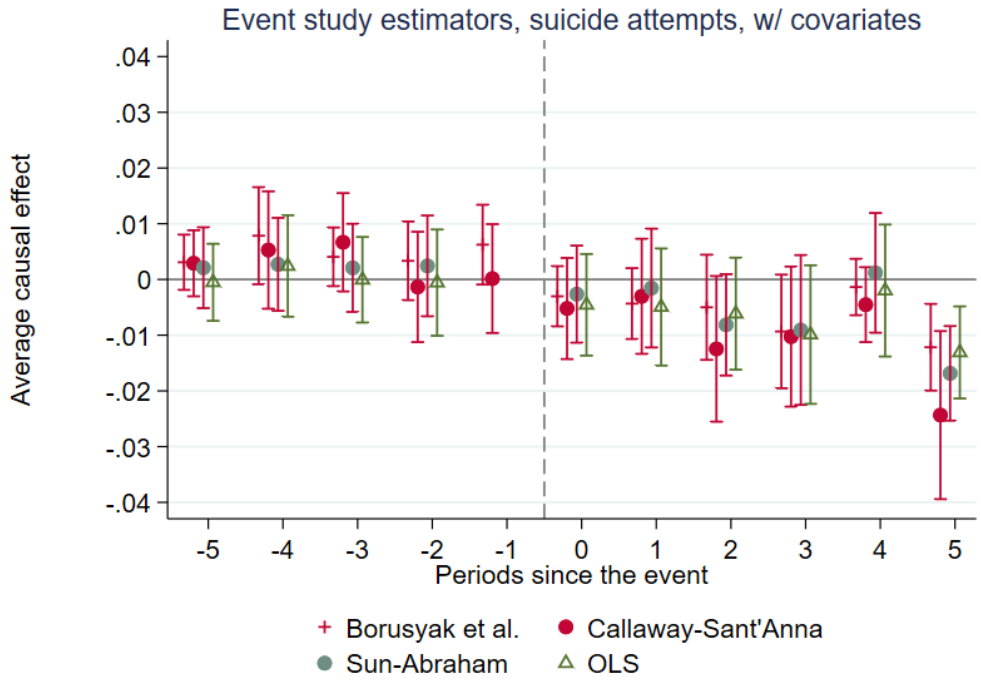
NOTE: Each cell contains the ATT estimate of SBMH from a separate model. All results are from models with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and include grade-level by year fixed effects.

Appendix Figure 1. Event Study Model of Student Support Staffing per 100 Students

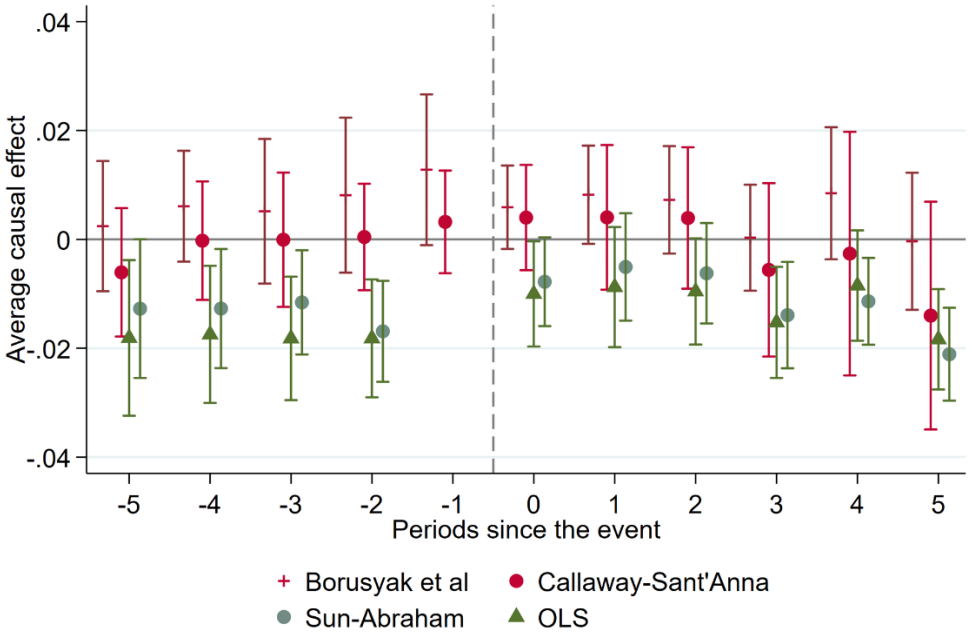


NOTE: Unit of analysis is the school year, and data are available from 2007 to 2019 from the Minnesota Department of Education. Staffing includes school counselors, social workers, and psychologists. Significance of test of pre-intervention trends: p=0.589.

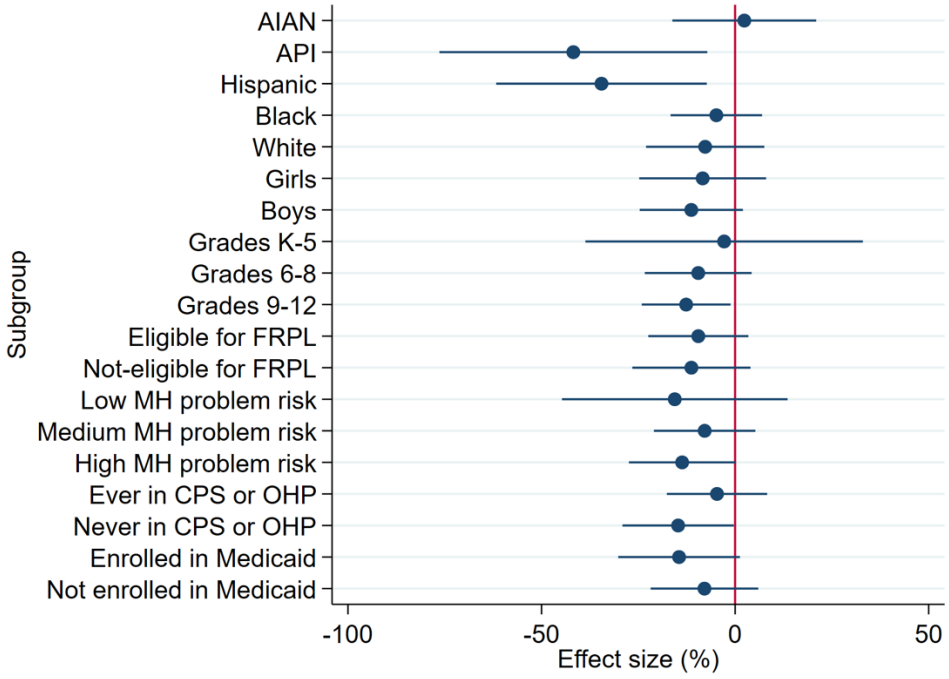
Appendix Figure 2a. Event Study Estimates of SBMH on Any Suicide Attempts in Past 12 Months, Comparing Alternative Estimators



Appendix Figure 2b. Event Study Estimates of SBMH on Any Outpatient MH Services or Prescription Drugs, Comparing Alternative Estimators

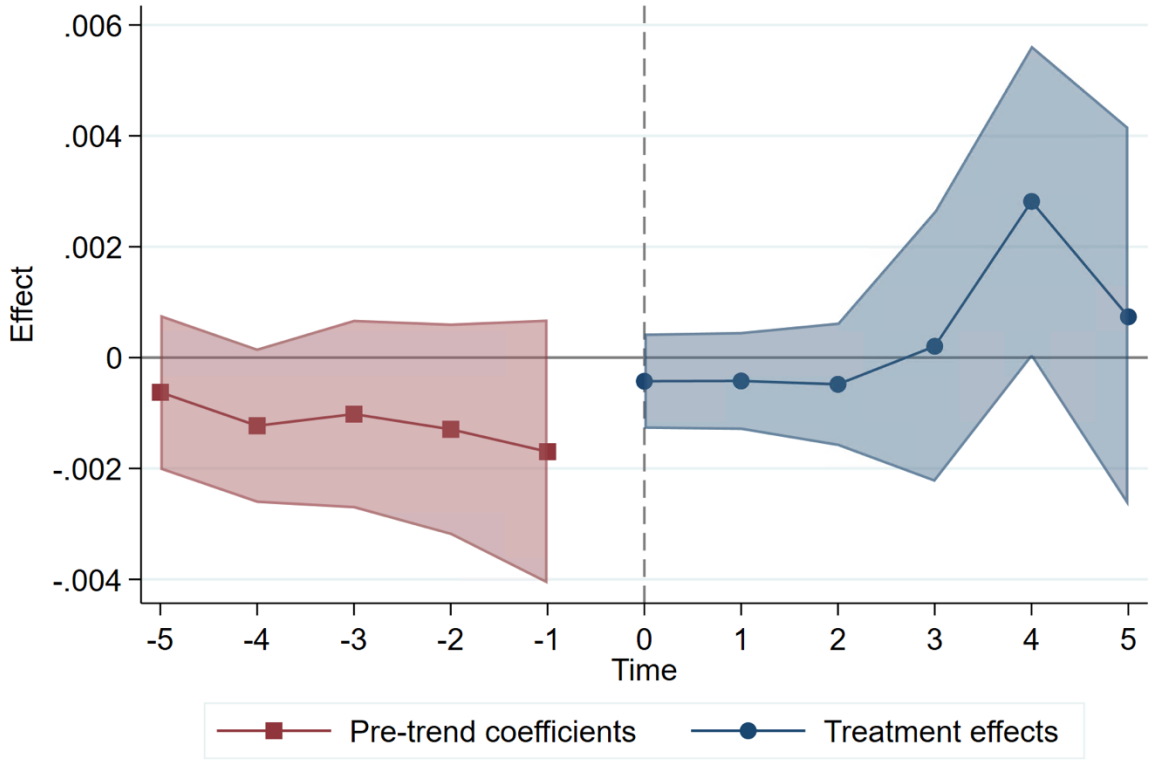


Appendix Figure 3. Estimated ATT Effect and 95 Percent Confidence Interval of SBMH on Probability of Suspension, by Subgroup



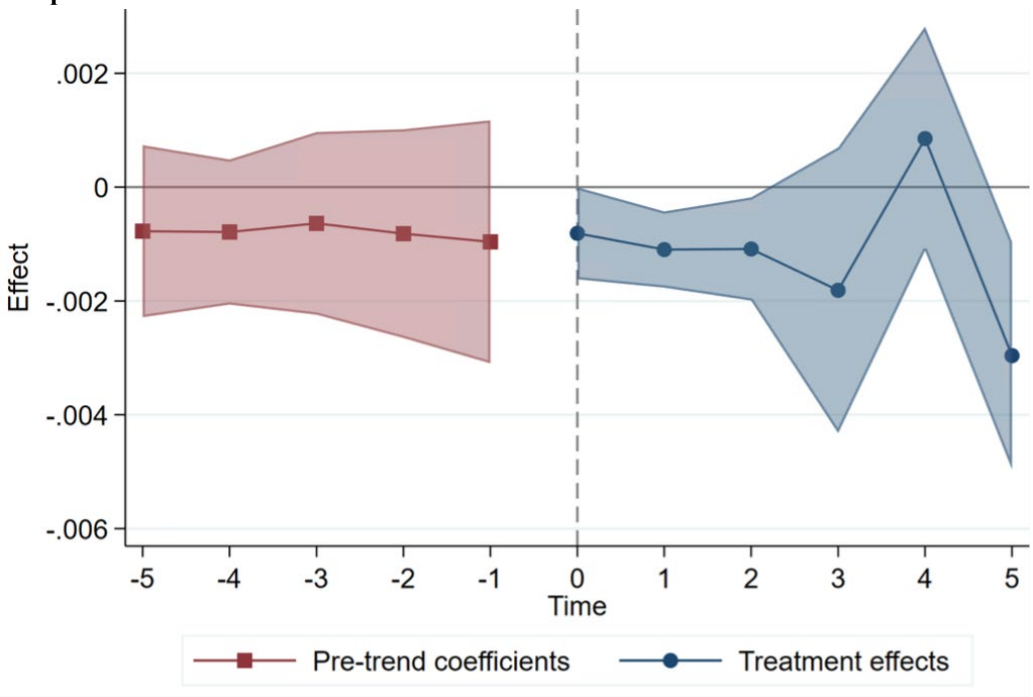
NOTE: AIAN is American Indian or Alaska Native. API is Asian or Pacific Islander. FRPL is free or reduced-price lunch, and FRPL eligibility is a proxy for low family income. MH is mental health. The risk model is based on predictions made from a model trained in a separate, nationally representative sample. CPS represents a Child Protective Services investigation, and OHP is out-of-home (foster care) placement; these two things proxy for child welfare system involvement.

Appendix Figure 4. Event Study Model of Probability of Any Juvenile Justice Case Initiation, Full Sample

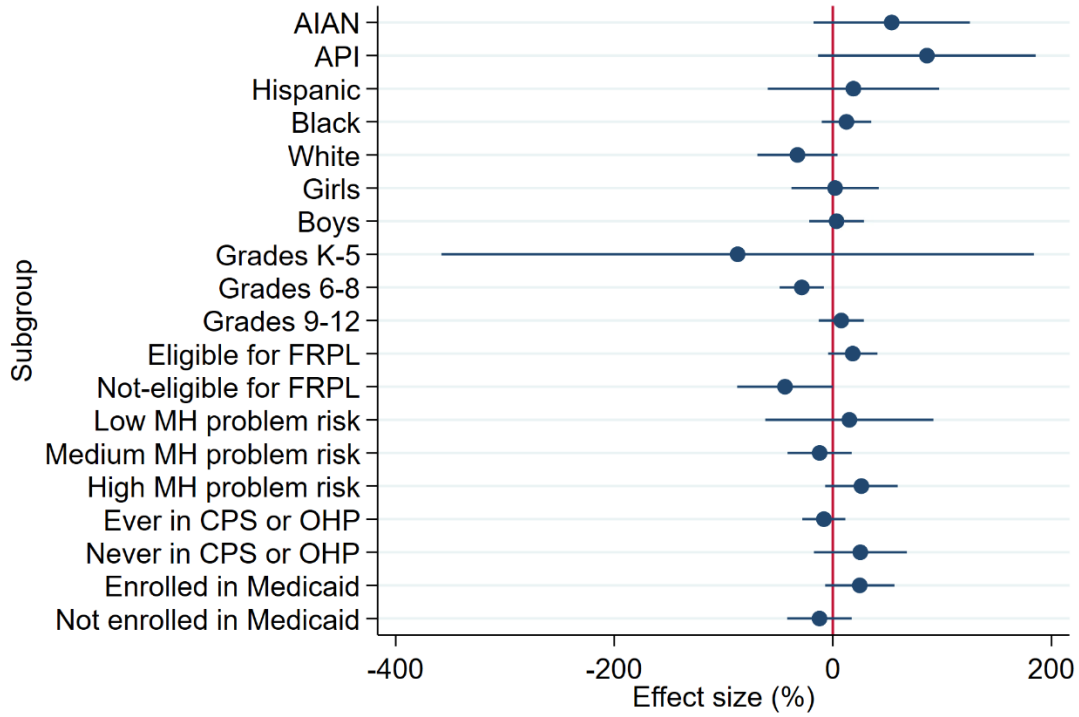


NOTE: Data are from administrative data on all students. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.554.

Appendix Figure 5. Event Study Model of Probability of Any Juvenile Justice Case Initiation, Matched Sample

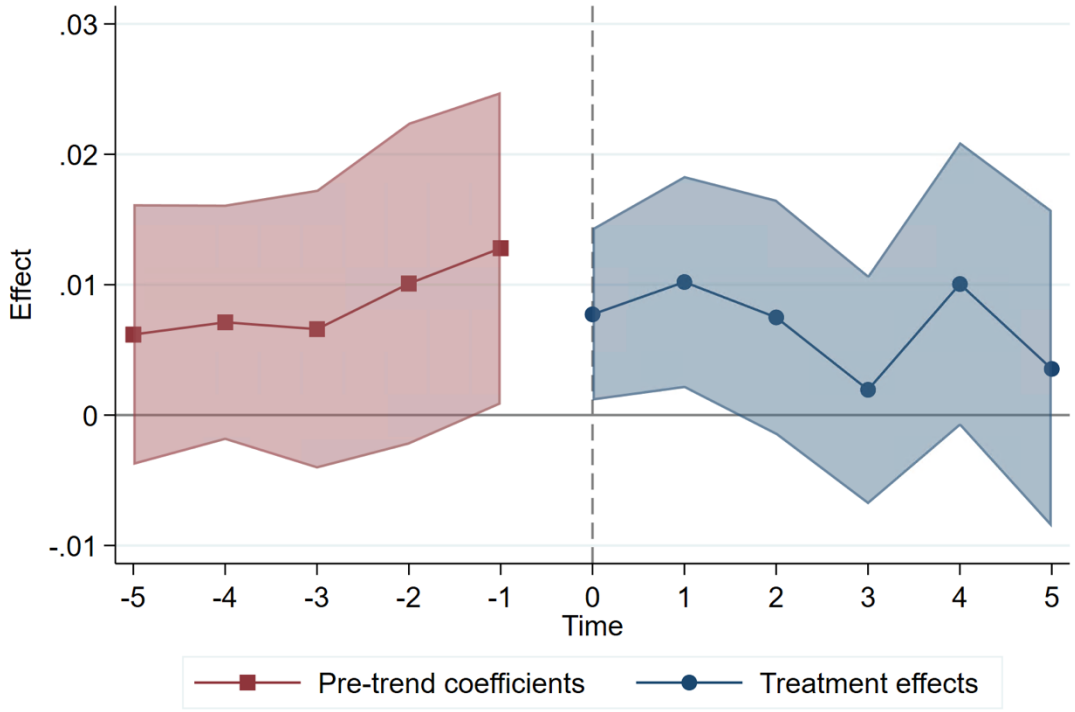


Appendix Figure 6. Estimated ATT Effect and 95 Percent Confidence Interval of SBMH on Probability of Juvenile Justice Involvement, by Subgroup



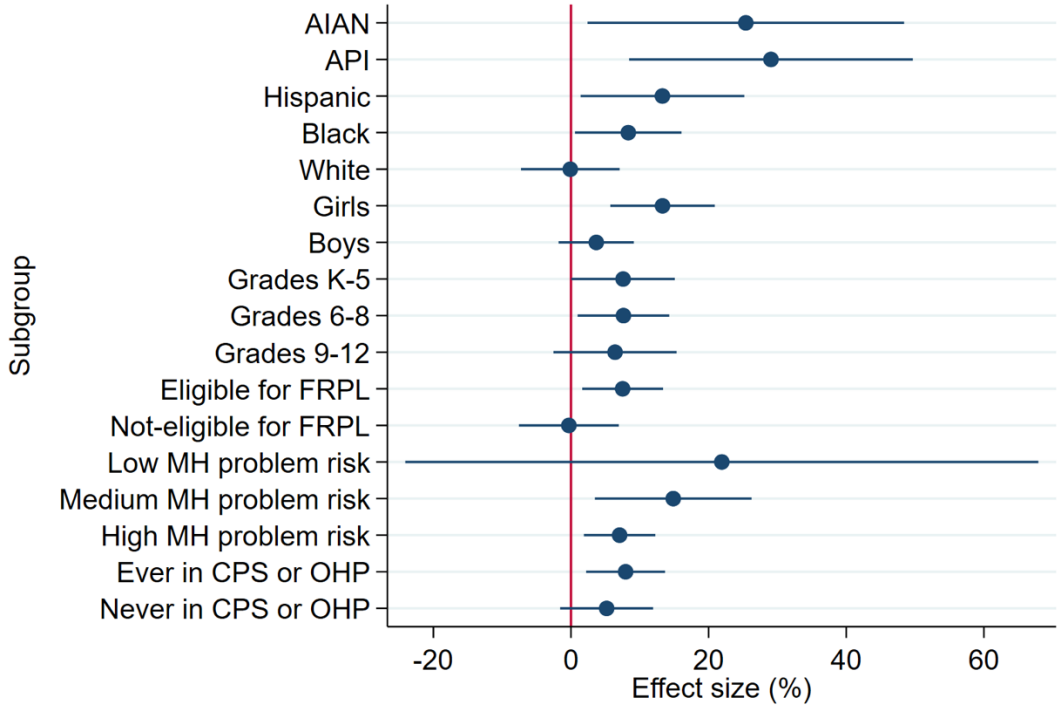
NOTE: AIAN is American Indian or Alaska Native. API is Asian or Pacific Islander. FRPL is free or reduced-price lunch, and FRPL eligibility is a proxy for low family income. MH is mental health. The risk model is based on predictions made from a model trained in a separate, nationally representative sample. CPS represents a Child Protective Services investigation, and OHP is out-of-home (foster care) placement; these two things proxy for child welfare system involvement.

Appendix Figure 7. Event Study Model of Use of Outpatient Mental Health Services or Psychotropic Drugs



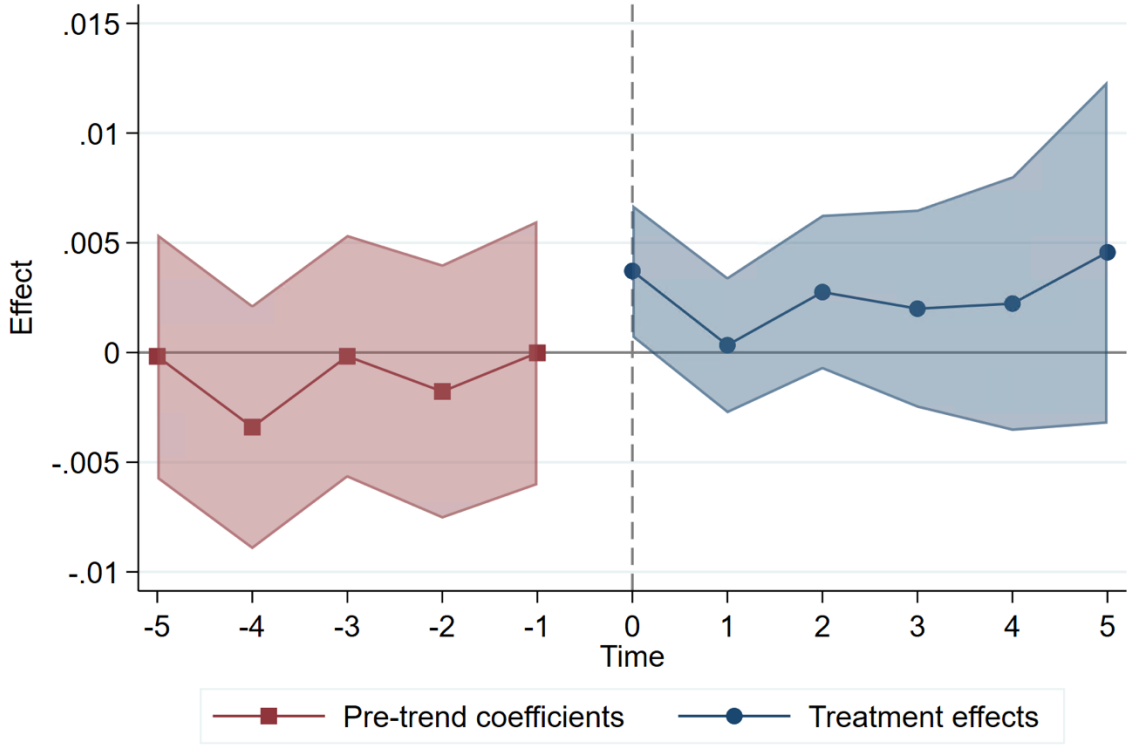
NOTE: Data are from administrative data on all students enrolled in Medicaid. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.433.

Appendix Figure 8. Estimated ATT Effect and 95 Percent Confidence Interval of SBMH on Use of Outpatient Mental Health Services or Psychotropic Drugs



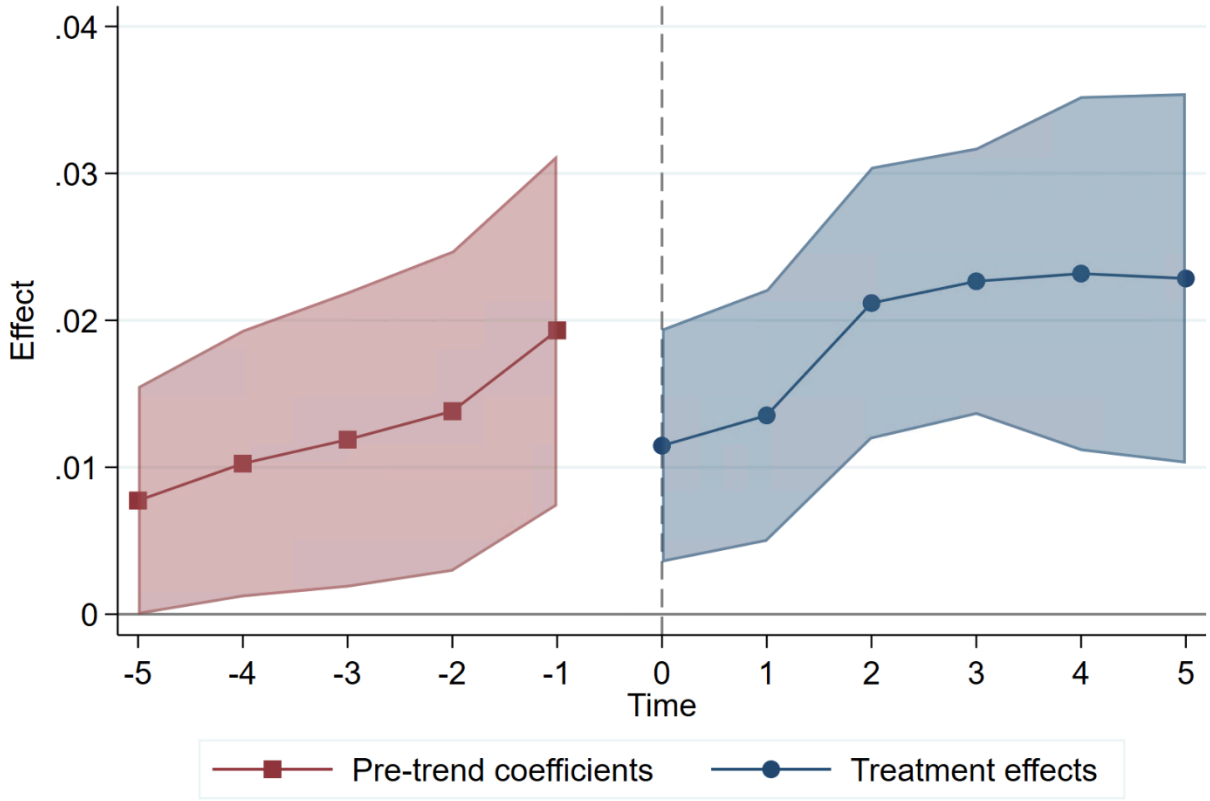
NOTE: AIAN is American Indian or Alaska Native. API is Asian or Pacific Islander. FRPL is free or reduced-price lunch, and FRPL eligibility is a proxy for low family income. MH is mental health. The risk model is based on predictions made from a model trained in a separate, nationally representative sample. CPS represents a Child Protective Services investigation, and OHP is out-of-home (foster care) placement; these two things proxy for child welfare system involvement.

Appendix Figure 9. Event Study Model of Inpatient or ED Use for a Mental Health Diagnosis



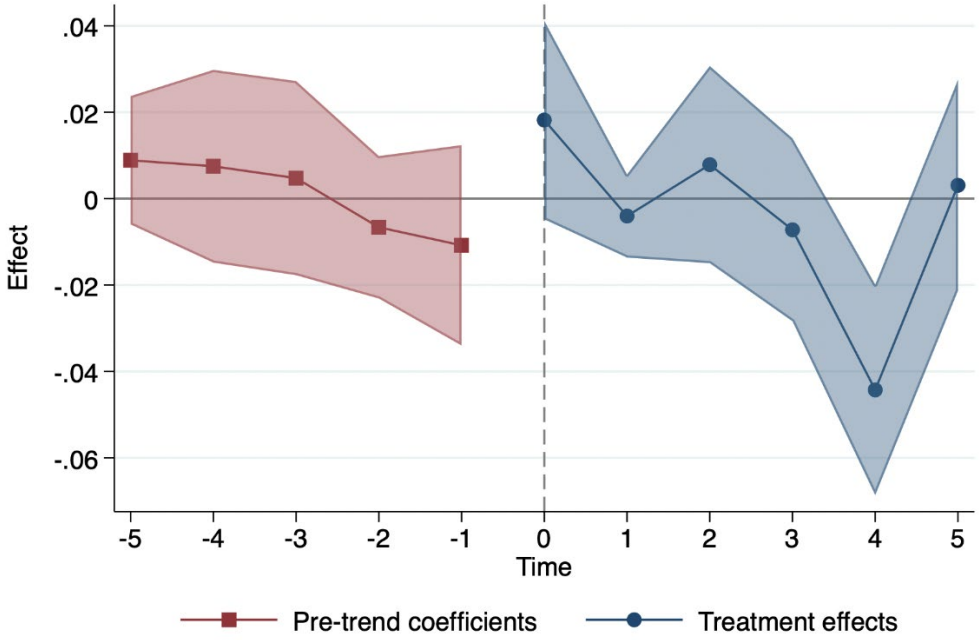
NOTE: Data are from administrative data on all students enrolled in Medicaid. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.689.

Appendix Figure 10. Event Study Model of Medicaid Enrollment



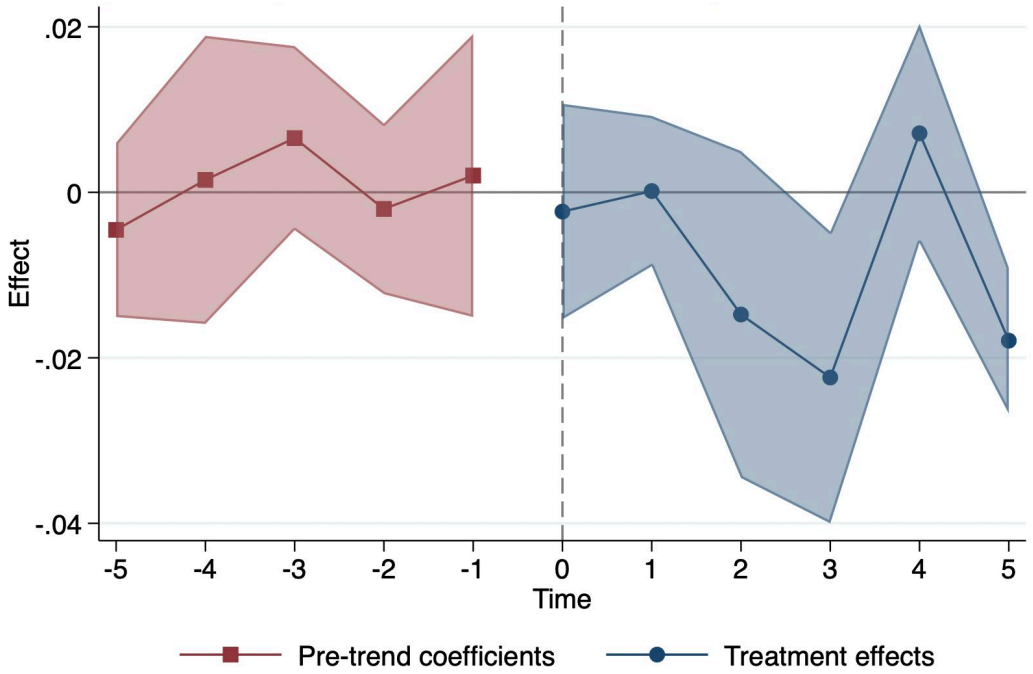
NOTE: Data are from administrative data on all students. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex, free/reduced-price lunch status), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.034.

Appendix Figure 11. Event Study Model of Probability of Any Past-30-Day Substance Use



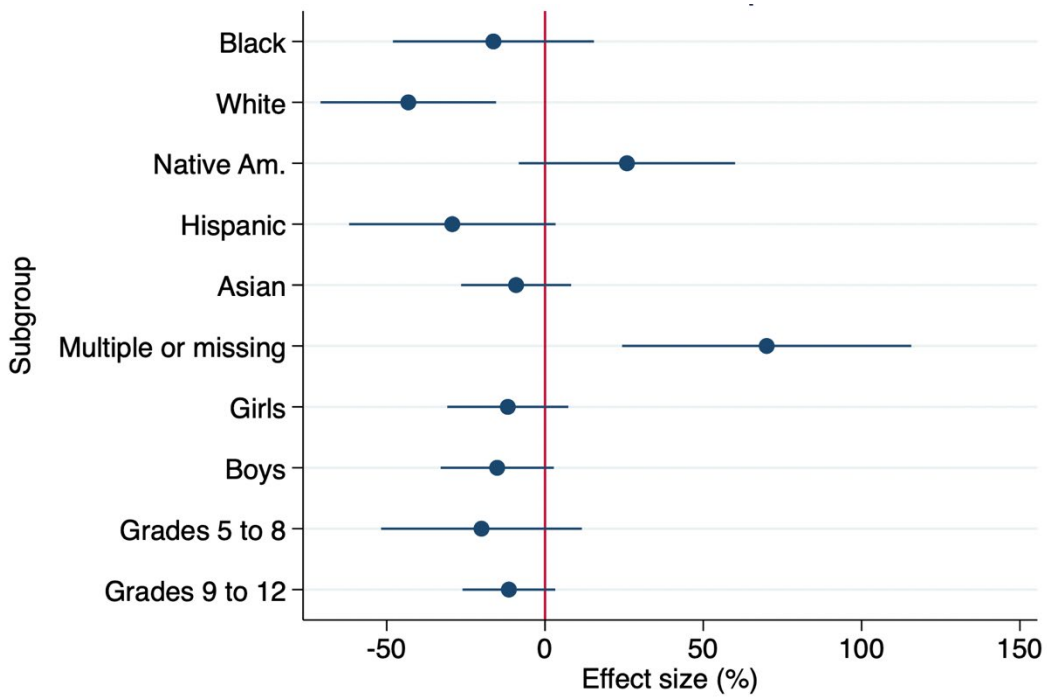
NOTE: Data are from Minnesota Student Surveys. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.173.

Appendix Figure 12. Event Study Model of Any 12-Month Suicide Ideation



NOTE: Data are from Minnesota Student Surveys. Results are from an event study model with individual-level covariates (age, race/ethnicity, sex), and grade-level by year fixed effects. Significance of test of pre-intervention trends: p=0.814.

Appendix Figure 13. Estimated ATT Effect and 95 Percent Confidence Interval of SBMH on Probability of Past-12-Month Suicide Attempt, by Subgroup



Notes: Data are from Minnesota Student Surveys.