**The Minimum Wage and Children’s Mental Health**

**Online Appendix**

**Table of Contents**

[Outcome Variables in NSCH 2](#_Toc138880494)

[Other State Policy Controls 11](#_Toc138880495)

[Two-Way Fixed Effects (TWFE) Specifications 11](#_Toc138880496)

[TWFE Multiple Comparisons Corrections 12](#_Toc138880497)

[TWFE Sub-Population Analyses 14](#_Toc138880498)

[TWFE Robustness Analyses 17](#_Toc138880499)

[Event Study Specifications 18](#_Toc138880500)

[References 19](#_Toc138880501)

# Outcome Variables in NSCH

Below, we provide the question wording (per the NSCH and YRBSS documentation) and coding of all outcomes. Note that the code evaluates the first condition for a match; if and only if a match is not made on the first condition does it proceed to the next. Thus, respondents could only meet one condition. Any respondents missing a given outcome were dropped pairwise from analyses.

Table A1. Question wording and coding of all mental health outcomes.

| **Survey** | **Outcome** | **Question wording** | **Coding** |
| --- | --- | --- | --- |
| **NSCH**  **(All children)** | **Depression** | Variable name: K2Q32A  “Has a doctor or other health care provider EVER told you that this child has?...Depression?”  1 = Yes  2 = No  Variable name: K2Q32B  “If yes, does this child CURRENTLY have the condition?”  1 = Yes  2 = No  Skip logic: Skip if K2Q32A=2 | 1 if K2Q32B = 1  Otherwise,  0 if K2Q32B = 2 or  if K2Q32A = 1 or 2  That is, a child who currently has depression is coded as “1”; any child who otherwise answered the questions about depression is coded as “0”. |
| **NSCH**  **(All children)** | **Anxiety** | ***Variable name: K2Q33A***  “Has a doctor or other health care provider EVER told you that this child has?...Anxiety Problems?”  1 = Yes  2 = No  ***Variable name: K2Q33B***  “If yes, does this child CURRENTLY have the condition?”  1 = Yes  2 = No  *Skip logic: Skip if K2Q33A=2* | 1 if K2Q33B = 1  Otherwise,  0 if K2Q33B = 2 or  if K2Q33A = 1 or 2 |
| **NSCH**  **(All children)** | **ADD/ADHD** | ***Variable name: K2Q31A***  “Has a doctor or other health care provider EVER told you that this child has?...Attention Deficit Disorder or Attention-Deficit/Hyperactivity Disorder, that is, ADD or ADHD?”  1 = Yes  2 = No  ***Variable name: K2Q31B***  “If yes, does this child CURRENTLY have the condition?”  1 = Yes  2 = No  *Skip logic: Skip if K2Q31A=2* | 1 if K2Q31B = 1  Otherwise,  0 if K2Q31B = 2 or  if K2Q31A = 1 or 2 |
| **NSCH**  **(All children)** | **Behavioral prob.** | ***Variable name: K2Q34A***  “Has a doctor, other health care provider, or educator EVER told you that this child has?...Behavioral or Conduct Problems?...Examples of educators are teachers and school nurses.”  1 = Yes  2 = No  ***Variable name: K2Q34B***  “If yes, does this child CURRENTLY have the condition?”  1 = Yes  2 = No  *Skip logic: Skip if K2Q34A=2* | 1 if K2Q34B = 1  Otherwise,  0 if K2Q34B = 2 or  if K2Q34A = 1 or 2 |
| **NSCH**  **(All children)** | **Digestive issues** | ***Variable name: STOMACH***  “DURING THE PAST 12 MONTHS, has this child had FREQUENT or CHRONIC difficulty with any of the following?...Digesting food, including stomach/intestinal problems, constipation, or diarrhea”  1 = Yes  2 = No | 1 if STOMACH = 1  Otherwise,  0 if STOMACH = 2 |
| **NSCH**  **(All children)** | **Any unmet care** | ***Variable name: K4Q27***  “DURING THE PAST 12 MONTHS, was there any time when this child needed health care but it was not received?...Health care includes medical care, dental care, vision care, and mental health services.”  1 = Yes  2 = No | 1 if K4Q27 = 1  Otherwise,  0 if K4Q27 = 2 |
| **NSCH**  **(All children)** | **Unmet mental care** | ***Variable name: K4Q27***  “DURING THE PAST 12 MONTHS, was there any time when this child needed health care but it was not received?...Health care includes medical care, dental care, vision care, and mental health services.”  1 = Yes  2 = No  ***Variable name: K4Q28X04***  “Which types of care was/were not received?...Mental Health Services”  1 = selected  2 = not selected  *Skip logic: Skip if K4Q27=2* | 1 if K4Q28X04 = 1  Otherwise,  0 if K4Q27 = 1 or 2 |
| **NSCH**  **(All children)** | **7+ school absences** | ***Variable name: K7Q02R\_R***  “DURING THE PAST 12 MONTHS, about how many days did this child miss school because of an illness or injury? Include days missed from any formal home schooling.”  1 = No missed school days  2 = 1 - 3 days  3 = 4 - 6 days  4 = 7 - 10 days  5 = 11 or more days  6 = This child was not enrolled in school  *Skip logic: If FORMTYPE in (‘T2’,‘T3’)* | 1 if K7Q02R\_R = 4–5  Otherwise,  0 if K7Q02R\_R = 1–3, 6 |
| **NSCH**  **(All children)** | **Child employment** | ***Variable name: K7Q38***  “DURING THE PAST 12 MONTHS, did this child participate in:...Any paid work including regular jobs as well as babysitting, cutting grass, or other occasional work?”  1 = Yes  2 = No  *Skip logic: If FORMTYPE in (‘T2’,‘T3’)* | 1 if K7Q38 = 1  Otherwise,  0 if K7Q48 = 2 |
| **YRBSS**  **(Adolescents)** | **Sad or hopeless** | ***Variable name: Q25***  “During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a  row that you stopped doing some usual activities?”  A. Yes  B. No | 1 if Q25 = A (1)  Otherwise,  0 if Q25 = B (2) |
| **YRBSS**  **(Adolescents)** | **Considered suicide** | ***Variable name: Q26***  “During the past 12 months, did you ever seriously consider attempting suicide?”  A. Yes  B. No | 1 if Q26 = A (1)  Otherwise,  0 if Q26 = B (2) |
| **YRBSS**  **(Adolescents)** | **Attempted suicide** | ***Variable name: Q28***  “During the past 12 months, how many times did you actually attempt suicide?”  A. 0 times  B. 1 time  C. 2 or 3 times  D. 4 or 5 times  E. 6 or more times | 1 if Q28 = B–E (2–5)  Otherwise,  0 if Q28 = A (1) |
| **YRBSS**  **(Adolescents)** | **Physical fight** | ***Variable name: Q17***  “During the past 12 months, how many times were you in a physical fight?”  A. 0 times  B. 1 time  C. 2 or 3 times  D. 4 or 5 times  E. 6 or 7 times  F. 8 or 9 times  G. 10 or 11 times  H. 12 or more times | 1 if Q17 = B–H (2–8)  Otherwise,  0 if Q17 = A (1) |
| **YRBSS**  **(Adolescents)** | **Recent alcohol** | ***Variable name: Q41***  “During the past 30 days, on how many days did you have at least one drink of alcohol?”  A. 0 days  B. 1 or 2 days  C. 3 to 5 days  D. 6 to 9 days  E. 10 to 19 days  F. 20 to 29 days  G. All 30 days | 1 if Q47 = B–G (2–7)  Otherwise,  0 if Q41 = A (1) |
| **YRBSS**  **(Adolescents)** | **Recent marijuana** | ***Variable name: Q47***  “During the past 30 days, how many times did you use marijuana?”  A. 0 times  B. 1 or 2 times  C. 3 to 9 times  D. 10 to 19 times  E. 20 to 39 times  F. 40 or more times | 1 if Q47 = B–F (2–6)  Otherwise,  0 if Q47 = 1 |

# Other State Policy Controls

We control for several competing state-level policies that vary over time and could affect the financial well-being of low-income families. These data were collected from numerous sources, which we document below alongside any decisions we made regarding these covariates. The raw and cleaned data tables are provided with the paper’s replication materials.

The Medicaid income eligibility limits were sourced from the Kaiser Family Foundation (<https://www.kff.org/statedata/collection/trends-in-medicaid-income-eligibility-limits/>). Data for 2001 and 2007 were unavailable, so we used the income limits from October 2000 and July 2006, respectively. For 2009, we used the limits from January, not December, in keeping with the other years. Tennessee had no upper limit for some years, so we used a value of 400% FPL.

The earned income tax credit (EITC) covariates were based on data from the Tax Policy Center, run by the Urban Institute and Brookings Institution (<https://www.taxpolicycenter.org/statistics/state-eitc-percentage-federal-eitc>). For the presence of a state EITC, we coded any state that had a non-zero ratio of state-to-federal EITC as “yes” and all other states as “no.” For states with multiple rates, we used the most generous benefit for which a household with children might be eligible. For example, for many years, Wisconsin had three rates corresponding to the number of dependent children, so we used the highest of the three. Any state without an EITC was assigned a rate of 0. The Tax Policy Center was missing data for 2011, so we used those from 2010. When coding whether a state’s EITC was refundable, any state that was at least “partially” refundable was coded as 1; all other states (including those without an EITC) were coded as 0.

The Temporary Assistance for Needy Families (TANF) benefits were adapted from the Urban Institute’s Welfare Rules Database (<https://wrd.urban.org/wrd/Query/query.cfm>). We triangulated the maximum benefits (in dollars) for a family of 3 by using the database itself and a summary table compiled through 2020 (Table L5). In cases of uncertainty or disagreement between the two, we typically used the values reported in the summary table. The database was missing values for Colorado from 2001 to 2007; since the summary table reported the same value in both 1996 and 2004 ($365), we used $365 for 2001 to 2007. All other decisions regarding the TANF benefits are documented in the cleaned data table in the replication package.

# Two-Way Fixed Effects (TWFE) Specifications

The main TWFE models were specified as follows:

where *Yist* is the mental health outcome for individual *i* in state *s* in year *t*; *(min. wage)st* is the effective minimum wage in a state-year, *Xist* is a vector of individual-level controls (which vary by survey; listed below); *Zst* is a vector of time-variant state-level policies (described above); *Δs* is the time-invariant state fixed effect; *τt* is the year fixed effect; and *εist* is the error term.

The respondent- and state-level controls included in the fully adjusted TWFE models are listed below. Note that the YRBSS has fewer available covariates than the NSCH.

Table A2. Covariates included in TWFE models.

|  |  |  |
| --- | --- | --- |
| **Level** | **NSCH models** | **YRBSS models** |
| **Individual** | Child’s age  Child’s sex  Child’s race/ethnicity  Family structure  Highest education of any adult in household  Household nativity | Adolescent’s age  Adolescent’s sex  Adolescent’s race/ethnicity  Adolescent’s grade |
| **State** | Medicaid income limits for ages 1–5\*  Medicaid income limits for ages 6–18\*  Presence of state EITC  State EITC as percent of federal EITC\*  State EITC refundability  Maximum TANF benefit for family of 3\* | Medicaid income limits for ages 1–5\*  Medicaid income limits for ages 6–18\*  Presence of state EITC  State EITC as percent of federal EITC\*  State EITC refundability  Maximum TANF benefit for family of 3\* |
| **Fixed**  **effects** | State  Year | State  Adolescent’s age-by-year\*\* |

**Notes:**

\*Treated as continuous variables. All other variables are treated as categorical.

\*\*The age-by-year control was constructed by interacting the adolescent’s age with the year of the survey. For example, it had levels for “age 12 in 2001,” “age 12 in 2003,” “age 12 in 2005,” etc., to reflect the distinct generational experiences throughout the 19-year study period. That is, it reflects the fact that the experience of being a 12-year-old is different in 2001 than in 2019.

# TWFE Correction for Multiple Comparisons

The risk of type I errors, or false positives due to chance, increases with the number of statistical tests. Given that we examine 15 outcomes, many sub-populations, and several alternate specifications, the risk of a false positive in our study is considerably greater than 5%.

To reduce this risk, we implement a Bonferroni correction of the TWFE confidence intervals (CIs). This procedure caps the family-wise error rate at 5% without assuming independence across the outcomes. The Bonferroni correction is known to be conservative, resulting in a true family-wise error rate likely lower than 5%,1 but it allows us to rule out the largest possible associations between the minimum wage and each mental health outcome. We use an alpha of 0.05/15 = 0.00333 for these tests, or a 99.7% CI, corresponding to a critical value of 2.94.

The Bonferroni-corrected CIs for the main models are presented in **Figures A1** and **A2**. They are moderately wider than the uncorrected CIs. Importantly, we can continue to rule out meaningfully large associations between the minimum wage and all our mental health outcomes. For all other analyses in the appendix, we include both the uncorrected and corrected CIs.



Figure A1. Main TWFE models with Bonferroni corrections for the NSCH.

**Notes:** Re-estimation of the paper’s main OLS TWFE models with Bonferroni corrections for 15 outcomes. The thick lines provide the uncorrected 95% CIs (i.e. with critical values of 1.96), while the thin ones provide the Bonferroni-corrected 99.7% CIs (i.e. with critical values of 2.94). All models include state and year fixed effects; fully adjusted models add individual- and state-level covariates per **Table A3**. Standard errors are clustered by sampling strata nested within states.



Figure A2. Main TWFE models with Bonferroni corrections for the YRBSS.

**Notes:** Re-estimation of the paper’s main OLS TWFE models with Bonferroni corrections for 15 outcomes. The thick lines provide the uncorrected 95% CIs (i.e. with critical values of 1.96), while the thin ones provide the Bonferroni-corrected 99.7% CIs (i.e. critical values of 2.94). All models include state and age-by-year fixed effects; fully adjusted models add individual- and state-level covariates per **Table A3**. SEs are clustered by sampling strata nested within each state’s primary sampling units.

# TWFE Sub-Population Analyses

We tested the association between the minimum wage and the mental health of several vulnerable sub-populations that were most likely to earn near the minimum wage (and, therefore, most likely to experience a corresponding improvement in their health after it was raised):

Table A3. List of sub-population analyses for TWFE models.

|  |  |  |
| --- | --- | --- |
| **Survey** | **Sub-population** | **Reference group** |
| **NSCH** | Less than 200 FPL% | Households earning ≥200% FPL |
| **NSCH** | Adults with high school or less  *That is, all households for which no adult completed more than H.S.* | All other adult education levels |
| **NSCH** | Black or Hispanic/Latino | All other races/ethnicities |
| **NSCH** | First- or second-generation | Third- or higher-generation children |
| **NSCH** | Adolescents, age 13–17 | Children aged 3–12 |
| **YRBSS\*** | Black or Hispanic/Latino | All other races/ethnicities |

**Notes:** \*The YRBSS has fewer available demographic and socioeconomic characteristics than the NSCH, so we cannot replicate most of the sub-population analyses with the YRBSS.

These sub-population analyses were formalized as interaction models:

where a binary variable, *groupist*, was defined for each sub-population of interest with inclusion = 0 and non-inclusion = 1. For example, in one analysis, Black and Hispanic/Latino children were coded as 0 and all other children who had complete information on race/ethnicity were coded as 1. As a result, provides the association for the sub-population of interest, i.e. Black and Hispanic/Latino children. The remaining terms are defined as in the main models above.

We provide these subgroup analyses below (**Figure A3** and **A4**). There is little evidence of meaningful improvements for any one outcome or any one vulnerable group. There are occasional 95% CIs that are statistically significant from zero, but these models (1) do not show a consistent pattern within outcomes, e.g. raising the minimum wage is negatively associated with rates of ADD/ADHD for low-income children in the NSCH but no other sub-populations; (2) do not show a consistent direction within sub-populations, e.g. for low-income children, raising the minimum wage is negatively associated with rates of ADD/ADHD yet positively associated with rates of depression; (3) do not use a causal design; and (4) are no longer statistically significant under the 99.7% CIs. As a result, our interpretation of these models is as generally null.



Figure A3. TWFE models for vulnerable sub-populations in the NSCH.

**Notes:** Based on OLS TWFE models with interaction terms for several sub-populations of interest. All models are adjusted for state and year fixed effects, as well as individual- and state-level covariates per **Table A3**. SEs are clustered by the survey’s sampling strata nested within states. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.



Figure A4. TWFE models for a vulnerable sub-population in the YRBSS.

**Notes:** Based on OLS TWFE models with interaction terms for a sub-population of interest. All models are adjusted for state and age-by-year fixed effects, as well as individual- and state-level covariates per **Table A3**. SEs are clustered by sampling strata nested within each state’s primary sampling units. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.

# TWFE Robustness Analyses

We also examined the robustness of our analyses to several alternative specifications: (1) inflation-adjusted minimum wages (in 2020 dollars), in case only changes in a household’s real income are associated with improved mental health; (2) wages lagged by 1 year, in case gains in mental health take time to manifest; and (3) estimations by binomial logistic regression, which provide the odds ratio for each outcome given a $1 increase in the minimum wage (the logistic regression models were estimated using the “survey” package in R). For all three, the associations are virtually the same as in the main, fully adjusted models (**Figures A5** to **A8**).



Figure A5. TWFE models with alternative specifications for the NSCH.

**Notes:** Based on OLS TWFE models using (1) the state’s effective minimum wage adjusted for inflation in 2020 dollars and (2) the state’s minimum wage lagged by one year, compared to the main TWFE models. All models are adjusted for individual- and state-level covariates per **Table A3**, as well as state and year fixed effects. SEs are clustered by sampling strata nested within states. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.



Figure A6. TWFE models with alternative specifications for the YRBSS.

**Notes:** Based on OLS TWFE models using (1) the minimum wage adjusted for inflation in 2020 dollars and (2) the minimum wage lagged by one year, compared to the main TWFE models. All models are adjusted for individual- and state-level covariates per **Table A3**, as well as state and age-by-year fixed effects. SEs are clustered by sampling strata nested within each state’s primary sampling units. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.



Figure A7. Main TWFE models using logistic regression for the NSCH.

**Notes:** Re-estimation of the paper’s main TWFE models using binomial logistic regression in the “survey” package in R. All models include state and year fixed effects; fully adjusted models add individual- and state-level covariates per **Table A3**. SEs are clustered by sampling strata nested within states. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.

Next, we drew on the example of Wehby and colleagues, who found that the minimum wage earlier in a child’s life predicted their physical health later.2 The same could be the case for mental health. For example, it could be that a family’s wage in previous years granted them access to structural opportunities, such as higher-quality schools or neighborhoods, that had a lasting impact on their child’s mental health. Or it could be that families were better able to accumulate wealth that they could later tap if and when their child’s well-being was threatened.

As such, we also tested the average minimum wage to which a child was exposed throughout their life as a predictor in our models. To construct this variable, we averaged the minimum wage in a child’s state of residence for all ages from 0 until when surveyed. Given the absence of data on a household’s movement in the NSCH and YRBSS, we assumed that a child remained in the same state since birth. In reality, 2–3% of households move between states in a typical year, per the American Community Survey, so our lifetime minimum wage variable is measured with modest error. Even so, it allows us to approximate the association between cumulative exposure to a state’s minimum wages and a child’s mental health later in life. These models are also adjusted for the same individual- and state-level covariates as the main models.

The lifetime minimum wage models are presented in **Figures AX** and **AY**. They are less well-specified than the main models. Even so, they provide little evidence that higher minimum wages, even when sustained throughout a child’s life, are associated with better mental health.



Figure A7. TWFE models using lifetime minimum wages for the YRBSS.

**Notes:** Based on OLS TWFE models using the average minimum wage to which a child was exposed throughout their life. All models include state and year fixed effects; fully adjusted models add individual- and state-level covariates per **Table A3**. SEs are clustered by sampling strata nested within states. 95% CIs (thick) and 99.7% CIs for Bonferroni corrections (thin) are provided.



Lastly, we present models that cluster the standard errors at the state level, rather than using the nested errors recommended by the NSCH and YRBSS (**Figures AX** and **AY**). Given that the treatment, i.e. minimum wage, is assigned at the state level, clustering at this level would traditionally be considered appropriate for TWFE and other difference-in-differences analyses. Recent econometric evidence suggests that typical estimators for cluster-robust standard errors are overly conservative when a non-negligible fraction of clusters (in our case, states) in the population are sampled, as we have here.3 As such, these CIs likely overstate the true uncertainty in the association between the minimum wage and children’s mental health. Even so, they are substantively similar in magnitude to the nested errors recommended by the two surveys.

# Event Study Specifications

Recent advancements in the econometrics literature on TWFE and difference-in-differences have highlighted the potential biases in these models when units adopt policies at different times and experience dynamic treatment effects over time.4–6 Consequently, our standard TWFE models may not provide direct causal interpretations. Given that a causal interpretation is most valuable for policy makers and public health professionals, we also specify event study models to evaluate whether raising the minimum wage causally affects children’s mental health.

For our causal analyses, we focused on the years following the last major increase in the federal minimum wage, i.e. post–2010. We used the YRBSS outcomes since they provided suitable data coverage during this period. To define a suitable set of treatment and control states, we coded all 22 states that remained at the federal minimum wage of $7.25 from 2011 to 2019 as control states, and all 11 states that raised their minimum wage from $7.25 to something higher from 2012 onward as treatment states (**Figure AX**). All states that already had a minimum wage above $7.25 in 2011 were excluded from the analysis. During this period, treated states implemented a range of minimum wage increases, as shown in **Figure AX**. Consequently, these event studies estimate the causal effect of raising the minimum wage above the federal minimum in the index year (i.e. year “0,” or the year that a state first raised its wage) and all subsequent years for which we have YRBSS data. Unlike the TWFE models, they do not necessarily reflect the effect of a $1 change, although the median treated respondent in our data was exposed to a $XX increase during this period. Because many states continued to raise their minimum wage even after the index year, we should expect the effect on mental health to grow over time.

To implement the event studies, we subsetted the data to 2011–2019. Since the YRBSS is collected every other year, we coarsened the treatment years to the next closest survey wave. For example, if a state raised its wage in 2012, we coded 2013 as that state’s index year. Meanwhile, if a state raised its wage in 2013, its index year remained 2013. To estimate the models, we used the newly developed Callaway and Sant’Anna estimator, which is robust to staggered treatment timing and dynamic effects.5 We included respondent-level controls (i.e. adolescents’ age, sex, race/ethnicity, and grade) but not state policy controls, as they fully identified some of the models. Never-treated states served as the control group, and we computed 95% CIs using bootstraps with 1,000 iterations and the YRBSS’s nested clusters. We also estimated versions with errors clustered at the state level, although these errors are likely overly conservative.3

For all 6 outcomes, the event studies provide little to no evidence that raising a state’s minimum wage improves adolescents’ mental health. The average There is little evidence of non-parallel pre-trends (except possible for a physical fight at school) or anticipation

# References

1. Curran-Everett D. Multiple comparisons: philosophies and illustrations. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*. 2000;279(1):R1-R8. doi:10.1152/ajpregu.2000.279.1.R1

2. Wehby GL, Kaestner R, Lyu W, Dave DM. Effects of the Minimum Wage on Child Health. *American Journal of Health Economics*. 2022;8(3):412-448. doi:10.1086/719364

3. Abadie A, Athey S, Imbens GW, Wooldridge JM. When Should You Adjust Standard Errors for Clustering? *The Quarterly Journal of Economics*. Published online October 6, 2022:qjac038. doi:10.1093/qje/qjac038

4. Goodman-Bacon A. Difference-in-differences with variation in treatment timing. *Journal of Econometrics*. 2021;225(2):254-277. doi:10.1016/j.jeconom.2021.03.014

5. Callaway B, Sant’Anna PHC. Difference-in-Differences with multiple time periods. *Journal of Econometrics*. 2021;225(2):200-230. doi:10.1016/j.jeconom.2020.12.001

6. Sun L, Abraham S. Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*. 2021;225(2):175-199. doi:10.1016/j.jeconom.2020.09.006