Mental Health and Mortality Trends in the United States

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Abstract

This study examines the extent to which declining mental health may be an important source of the adverse mortality experiences of some groups at the beginning of the 21st century. This possibility is particularly salient given the recent emphasis on the role of what are sometimes referred to as "deaths of despair". Five primary findings are highlighted. First, mental health deteriorated between 1993 and 2019 for all population groups examined. Second, these declines raise predicted death rates and contribute to the adverse mortality trends experienced by prime-age non-Hispanic Whites and, to a lesser extent, Blacks from 1999-2019. Third, to extent these relationships support the general notion of "deaths of despair", the specific causes comprising them should probably be both broader and different than those previously recognized. Fourth, heterogeneity in the estimated *consequences* of given increases in poor mental health are generally more important than disparate trends in them for explaining Black-White differences in the overall effects of mental health on mortality. Finally, worsening mental health does not appear to be the predominant explanation for the higher mortality rates experienced by prime-age persons in recent years.

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It is well understood that poor mental health is associated with higher risk of death at the individual level (Forman-Hoffman et al. 2014; Walker, McGee, and Druss 2015; Plana-Ripoll et al. 2019, 2020) and there is evidence that the prevalence of psychological distress has increased over time in the United States (Blanchflower and Oswald 2020; Daly 2022; Zheng and Choi 2024). What is not currently known is to what extent the interaction of these two patterns affects aggregate mortality rates nor how any such effects differ across population groups or causes of death.

The answers to these questions are important. US life expectancy has been stagnant or falling since at least 2014 (Woolf and Schoomaker 2019; Currie and Schwandt 2021), an historically almost unprecedented trend that started well before the COVID-19 pandemic. Increases in "despair" have been hypothesized to have caused these adverse mortality trends. In their influential research, Case and Deaton (2015) highlight the role of drug, suicide, and some alcohol-related deaths (hereafter DSA) in the rising mortality rates of 45-54-year-old non-Hispanic Whites from 1999-2013. Subsequent evidence shows death rates increased over broader age ranges and may have been more pronounced for younger persons (Kochanek, Arias, and Bastian 2016; Squires and Blumenthal 2016; Kolata and Cohen 2016; Ruhm 2018; National Academies of Sciences, Engineering, and Medicine 2021).

In follow-up studies, Case and Deaton (2017, 2020) emphasize the particularly large mortality rate growth experienced by less educated Whites, which they believe reflect economic and social shocks particularly harmful to these groups. They attribute much of this to growth in DSA mortality, which they label "deaths of despair".[1] The "deaths of

[1] There are reasons to doubt that drug, suicide, and alcohol mortality should be classified together since patterns of deaths: vary substantially across geographic areas (Stein et al. 2017; Dwyer-Lindgren et al. 2018; Monnat et al. 2019); have markedly different age profiles of increased mortality (Ruhm 2022); and respond heterogeneously to a variety of economic shocks (Ruhm 2019; Brown and Wehby 2019; Pierce and Schott

despair" framing has become ubiquitous: a Google Scholar search on March 19, 2025, revealed more than 7,400 pieces using the term and a more general Google search obtained over 600,000 results.

The idea that rising despair helps to explain recent mortality trends is thought-provoking, but the nature of this connection remains unclear. At a conceptual level, "despair" does not have a clinical definition (there is no DSM-5 code for it), so it is not obvious how to rigorously test its association with mortality. This is operationalized below by examining how several measures of poor mental health are related to death rates. While a subjective definition of "despair" could be broader in some aspects than measures used here – for example, encompassing transitory periods of distress such as those occurring during the initial withdrawal from addictive drugs or the breakup of a relationship – the mental health proxies analyzed are more clearly defined and their relationship to mortality is fundamentally important.

The pathways potentially linking mental health to mortality are multi-faceted and complicated. Most obviously, poor or reduced mental health may directly elevates deaths from self-harm or do so indirectly through increases in risky behaviors or reductions in health investments (Cawley and Ruhm 2011). However, confounding factors may simultaneously drive both poor mental health and higher mortality risk. For instance, the opioid epidemic, a major cause of preventable deaths, may also have reduced the psychological health of both individuals suffering from addiction and those around them (Scherrer et al. 2016; Di Sarno et al. 2021). Similarly, physical health problems may simultaneously increase mortality and harm psychological wellbeing. This creates challenges for any analysis. For instance, it is unclear whether physical health should be

2020; Dow et al. 2020; Giles, Hungerman, and Oostrom 2023). Darke, et al. (2025) argues that the deaths of despair framing has outlived its usefulness.

controlled for in empirical investigations. Doing so may be appropriate if physical health difficulties *cause* mental health to decline. Conversely, it may be a "bad control" (Angrist and Pischke 2009) if it is mental health problems trigger reductions in physical health.[2]

These complications limit the ability to move from statistical decompositions, such as those employed here, to definitive causal relationships. Nevertheless, this study provides valuable insights given the enormous gaps in the current state of knowledge. Specifically, we have an incomplete understanding of how mental health has changed over time and know even less about overall effects of these trends on mortality, differences in the impacts across population groups or causes of death, nor to what extent they can explain the increases in death rates observed for some groups.

The current analysis proceeds in three stages. The first operationalizes and provides empirical evidence on how poor mental health in the US changed between 1993 and 2019, overall and for population subgroups. The second uses panel data econometric methods to estimate which group-specific and cause-specific mortality rates are most strongly associated with changes in mental health. Counterfactual estimates are then provided of how much mortality rates in 2019 would have differed from observed rates if poor mental health had remained at 1999 levels. As part of this, the overall effect is decomposed into the contributions of trends in mental health versus the responsiveness of mortality rates to given changes in them. The third analyzes the extent to which worsening mental health from 1999-2019 can, in a statistical sense, explain mortality trends during the same period. Particular attention is paid to 25-54 year old (hereafter also referred to as "prime-age") non-Hispanic Whites and Blacks, overall and stratified by educational attainment, as these groups have experienced the most adverse mortality trends.

[2] Mental and physical health are positively associated and evidence has been provided on causal mechanisms in both directions; however, the relative strength of these is not well understood (Prince et al. 2007; Scott et al. 2016; Ohrnberger, Fichera, and Sutton 2017).

The study uncovers five primary findings. The first is that mental health has declined over time for all population groups examined, although the extent of the deterioration varies. While previous research, particularly Blanchflower and Oswald (2020) and Daly (2022), has documented similar trends, the current study includes a wider set of mental health indicators and a more detailed investigation of differences across population subgroups.

Second, increases in poor mental health are associated with higher rates of all-cause mortality, although the estimates are not always statistically significant. The data also suggest more adverse mortality responses for younger than older adults, particularly for prime-age non-Hispanic Whites.

Third, when considering the causes commonly referred to as "deaths of despair", worsening mental health is correlated with substantial relative growth in drug and alcohol-related fatality rates, whilte the estimated effects on suicides are generally much smaller. Additionally, there are fairly strong predicted impacts on heart and lower respiratory disease mortality as well as, sometimes, homicides and cancer.[3] Translating these into absolute effects, for the full population, the counterfactual reductions in mortality rates estimated to occur if mental health had not deteriorated from 1999-2019 are largest for heart disease deaths, followed by those from drugs and lower respiratory causes.

When focusing on prime-age Whites, there are substantial predicted effects across a variety of causes, including heart, cancer, and alcohol mortality, along with extremely large but less precisely estimated impacts on drug deaths. For prime-age Blacks, counterfactual

[3] To the best of my knowledge, only one previous study has directly examined the aggregate relationship between mental health and mortality. Zheng and Choi (2024) utilize national data to estimate changes in mortality hazard rates over time for individuals with different levels of psychological distress and then compare these with corresponding trends in mortality rates from a measure of "deaths of despair". However, the national data are subject to potentially serious omitted variables biases and the effect of psychological distress on cause-specific mortality rates is not directly examined.

changes in drug and, to a lesser extent, homicide deaths are consequential, although the overall estimated effects are much smaller in absolute terms than for prime-age Whites. The predicted effects are particularly large for prime-age individuals who never attended college, which reflects relatively high baseline death rates, rather than disproportionate percentage responses.

Fourth, heterogenous *consequences* of given deteriorations in mental health are generally more important than differential trends in poor mental health in explaining the observed racial differences in the overall mortality effects. To my knowledge, this has not been examined in any prior research.

Fifth, worsening mental health is estimated to account for between 9% and 29% of the adverse mortality trends experienced by prime-age non-Hispanic Whites, and a smaller share of that for non-Hispanic Blacks, suggesting that other factors are the primary drivers of them.

To summarize, these results some support for the hypothesis that declining psychological health has contributed to the unfavorable mortality trends of some population groups, particularly prime-age non-Hispanic Whites. However, that influence is limited and not adequately captured by conventional definitions of "deaths of despair".

Data

Primary information on poor mental health comes from the *Behavior Risk Factor Surveillance System (BRFSS)*, a large ongoing telephone survey of non-institutionalized adults that collects information on health-related risk behaviors, chronic health conditions, and the use of preventive services (Centers for Disease Control and Prevention 2024a). The key question used asks "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" In addition to the number of days of poor mental health,

dichotomous variables are created indicating poor mental health in at least 15 and in all 30 days. The first of these was employed in prior research by Kessler et al. (2022) with the threshold chosen based on evidence that it has good concordance with *Patient Health Questionnaire-4 (PHQ-4)* scores of 6 or greater, which indicate clinically significant anxiety and depression (Löwe et al. 2010). The second was previously used by Blanchflower and Oswald (2020) and Blanchflower, Bryson, and Xu (2024), and is characterized by them as an indicator of "extreme distress".[4]

The mental health questions were initially introduced in the *BRFSS* in 1993 and so that is the starting point for the investigation of mental health trends. The final year analyzed is 2019, since there could be strong idiosyncratic effects on both poor mental health and mortality of the COVID-19 pandemic, which began in the U.S. early in 2020.

Data on state and national populations are from the *Surveillance Epidemiology and End Results (SEER)* program (National Cancer Institute 2024a). The *SEER* data are designed to supply more accurate population estimates for intercensal years than standard census projections, and to adjust for population shifts in 2005, resulting from Hurricanes Katrina and Rita. In addition to total population, counts are constructed for demographic subgroups stratified by sex, age, race/ethnicity, and some interactions between them. Since the *SEER* data do not contain information on education, education-specific populations are computed using *SEER* populations multiplied by education shares from the *Current Population Survey Merged Outgoing Rotation Group* (*CPS-MORG*) files (National Bureau of Economic Research 2024).

The outcomes include total, group-specific, and cause-specific mortality rates. Information on deaths comes from the *Multiple Cause of Death (MCOD)* files which cover

[4] National trends in these variables are also compared with those based on the Kessler K6 scale using data from the *National Health Interview Survey*. (See Appendix C).

the universe of U.S. deaths and supply information on demographic variables and the underlying cause of death (Centers for Disease Control and Prevention n.d.).[5] Classifications of the underlying cause of death are based on *International Classification of Diseases, Ninth Revision* (ICD-9) codes through 1998 and corresponding ICD-10 codes starting in 1999. Information on state of residence, age, race/ethnicity, gender, education, and year of death are also utilized in this analysis. Special permission was obtained to use restricted data, which provide full individual data on these characteristics for all deaths.[6]

This analysis uses data on the universe of deaths occurring to US residents from 1993-2019.[7] Death counts are converted into mortality rates per 100,000 using the *SEER* population data. Unless otherwise noted, all mortality rates are age-standardized using 2000-year standard population weights for 19-age groups: <1, 1-4, 5-9, five-year intervals through 80-84, and ≥85 years old (National Cancer Institute 2024b). In addition to total death rates, mortality rates are separately calculated for males and females, non-Hispanic Whites (hereafter "Whites"), non-Hispanic Blacks (hereafter "Blacks"), Hispanics, three age groups (20-34, 35-54, and ≥55 year olds) and, for persons 25 and older, three education categories (no college, some college but no four-year degree, and college graduates), as well as some interactions between race, age, and education groups.[8]

Crosswalks have been established between the ICD-9 and ICD-10 coding systems, used before and after 1999 but the correspondence in causes of deaths is imperfect, partly because the categorizations have become more detailed over time. To examine the

[5] Additional information available on contributory causes of death is not used in this analysis.

[6] Publicly available information on mortality, available from *CDC Wonder* (Centers for Disease Control and Prevention n.d.), is aggregated and does not provide counts when the number of deaths is less than 10 for the specified cell.

[7] Foreign residents dying in the US are excluded.

[8] Several factors complicate the calculation of education-specific mortality rates and trends in these rates will at least partially reflect compositional changes in the education groups. These issues are discussed in Appendix B.

importance of these issues, the National Center for Health Statistics has calculated "estimated comparability ratios", indicating the relative number of deaths in 1996 attributed to a specific cause using the ICD-9 and ICD-10 classifications (Anderson et al. 2001). Comparability ratios close to one indicate that data comparability issues between the two coding systems are likely to be minor.[9] This is frequently the case. For example, the comparability ratios for deaths from heart disease, cancer, diabetes, transport accidents, suicides, and homicides are 0.998, 1.007, 1.008, 0.998, 0.996, and 0.998. The ratios deviate slightly more from one for causes such as lower respiratory diseases (1.048) and strokes (1.059). However, they differ drastically for influenza/pneumonia (0.699), kidney diseases (1.232), and Alzheimer's disease (1.554), indicating difficulty in obtaining equivalent estimates for those causes across the two ICD coding systems.[10] In addition, the coding of alcohol-related fatalities changed between the two systems in ways that make them difficult to compare.[11] Three strategies are used to address these potential problems. First, the three major causes of death (influenza/pneumonia, kidney disease, and Alzheimer's disease) not comparable over time are excluded from the analysis. Second, robustness of the results relating specific causes of death to poor mental health is examined when limiting the analysis period to 1999-2019, when the ICD-10 coding system is used throughout. Third, the analysis of alcohol mortality is restricted to 1999-2019, when the ICD-10 system was in place.

[9] Comparability ratios greater (less) than one indicate that more deaths are reported using the ICD-10 (ICD-9) system.

[10] Anderson et al., (2001) discuss sources of the differences for many of these causes of deaths. Importantly: a lower number of influenza/pneumonia deaths occurs using the ICD-10 system because when deaths involving pneumonia also involved another cause, they became more likely to be attributed to that other cause; a higher number of kidney deaths is observed because end-stage renal disease was grouped in this category in the ICD-10 but not the ICD-9 system; a large increase in Alzheimer's disease deaths takes place because of a broadening of the set of conditions classified into this cause of death in the ICD-10 system.

[11] This includes changes in the procedures used to code deaths for causes classified in both the ICD-9 and ICD-10 systems as well as additional ICD-10 codes (e.g. degeneration of the nervous system due to alcohol and alcohol-induced pancreatitis) that did not have equivalent ICD-9 codes.

Mortality rates are analyzed for six of the 10 leading causes of death in 2019: heart disease, malignant neoplasms (cancer), chronic lower respiratory disease, cerebrovascular disease (stroke), diabetes mellitus, and intentional self-harm (suicide). As just mentioned, deaths from influenza/pneumonia, kidney diseases, and Alzheimer's disease, are excluded. Four additional causes of mortality are also studied: alcohol deaths, drug poisonings (drugs), transport accidents (transport), and assault (homicides). The first and second of these have previously been represented as two of the three causes included in "deaths of despair" by Case and Deaton and others.[12] Transport accidents and homicides are examined since they represent external causes of death that might be particularly important for prime-age individuals.[13] Although most of these causes are mutually exclusive, some drug and alcohol fatalities are also classified as suicides. Appendix Table A1 details the ICD-9 and ICD-10 codes corresponding to each cause.

Methods

Poor Mental Health

The key explanatory variables are days of poor mental health in the last 30 and dichotomous measures of poor mental health in at least 15 of the last 30 days or in all 30 of them. In each case, annual national and state averages are calculated for persons aged 20 and over from 1993-2019, using the *BRFSS* data, with the exception of 2002, where the question providing this information is not included in the core questionnaire.[14] When

[12] In their earlier research, Case and Deaton (2015, 2017, 2020) actually examine chronic liver disease, which includes some deaths that are not alcohol related and excludes others that are. Ruhm (2022) provides a detailed discussion of this issue. This has been corrected in later research and the current analysis includes in this category deaths that are 100% attributable to alcohol (Centers for Disease Control and Prevention 2024b).

[13] Accidents are also a leading cause of death. This analysis focuses on two key components of them: drug deaths and transport fatalities. Accidents as a group were considered in preliminary estimates but including them did not add value.

[14] In that year the question is in an optional module included by only 22 states. Data on mental health are also missing in Rhode Island for 1993-1994, DC for 1995, Hawaii for 2004, and New Jersey for 2019.

computing these averages, sampling weights are incorporated to obtain results representative of the state or national population. The poor mental health variables are constructed for the full population (20 and older) in the country or state, as well as for groups stratified by sex (male vs. female), race/ethnicity (White, Black, Hispanic), education (no college, some college, college graduate), and age (20-34, 35-54, and 55+).[15] Interactions between race, education and age are also sometimes incorporated.

State average values of poor mental health could vary over time because of changes in the demographic composition of the population (e.g. age, sex, race/ethnicity). This is partially accounted for by constructing age-standardized measures. For national estimates, this is done using 2000-year standard population weights for 5-year age groups for 20-74 year olds, plus a single category for persons 80 and older (13 groups). For states, since these narrow age-categories result in no survey respondents for some state-year cells, age-standardization is done using three age-categories: 20-34, 35-54, and 55+. A further check of the national results is performed using a procedure providing a more detailed accounting of the potential role of demographic characteristics.[16]

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[15] The some college group includes those who attended college but did not receive a Bachelor's degree, while the college graduate group includes those with at least a Bachelor's degree.

[16] In the procedure, probit models first regress the poor mental health measure on sex, race/ethnicity (non-Hispanic Black, Hispanic, non-Hispanic other race, race/ethnicity missing), age (5-year categories from 25-79 and ≥80), and education (high school graduate, some college, college graduate, education missing), with predicted values then calculated for each person. *BRFSS* sample sizes increase over time: from approximately 100,000 in 1993 to more than 400,000 in each year after 2006. To avoid having these predictions be overly influenced by the larger sample sizes in later years, inverse weights are applied when estimating the probit models, computed as the total number of observations over the entire period divided by the corresponding number in the survey year. Residual values are then calculated by subtracting actual from predicted values. The demographic characteristic-adjusted poor mental health variables are then aggregated to year-specific national and state levels, with *BRFSS* sampling weights incorporated to obtain representative estimates. Finally, the demographic characteristic-adjusted residuals are renormalized to have the same average value as the age-standardized measures while preserving the computed changes over time. This is done by taking the residual value in the given year and state and adding the difference in average values for the age-standardized and residual values for the same location and over the entire (1993-2019) period.

Differences in levels and changes of poor mental health from 1993-2019 are then examined descriptively, with trend differences also more formally investigated by regressing levels and natural logs of them on a linear time trend.

Poor Mental Health and Mortality

Primary econometric estimates of the relationship between poor mental health and mortality come from Poisson models of the form:

$$M_{ijt} = P_{jt}\alpha_i + X_{jt}\beta_i + S_{ij} + \mathrm{T}_{it} + \epsilon_{ijt}, \qquad (1)$$

where M_{ijt} indicates the natural log of the age-standardized mortality rate for group or cause i in state j at year t, P_{jt} is the proxy of poor mental health, transformed to have a population-weighted standard deviation of one,[17] X_{jt} indicates the state-year population share of Blacks, other races, and Hispanics (three variables), S_{ij} and T_{it} are vectors of state and time dummy variables, and ϵ_{ijt} is the regression error term.[18] Some models also include the number of poor physical health days in the last 30 as a supplementary covariate, as well as other potential confounding factors.[19] The state fixed-effects control for all time-invariant location-specific influences on mortality rates and the year dummy variables for time-varying nationwide factors. The main estimates are obtained using data for the 1993-2019 period, except for alcohol mortality where they are for 1999-2019; models covering only 1999-2019 are also estimated for the other death rates to examine whether there are substantial differences when limiting this analysis to the ICD-10 period.

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[17] This is done by dividing the poor mental health variable by the standard deviation of that variable for the entire U.S. from 1993-2019. The standard deviations for days of poor mental health, 15+, and all 30 days are 0.6013, 0.02114, and 0.01311. These full population standard deviations are also used when examining population subgroups, so that effects of the same size changes in mental health are evaluated.

[18] The race-ethnicity population shares are excluded when the dependent variable is a race-specific death rate. This model treats poor mental health as having an immediate effect on mortality. In alternative specifications, I experimented with including lagged mental health variables. The results are discussed below.

[19] The survey question asks: "Now thinking about your physical health, which includes physical illness and injury, during how many days during the past 30 was your physical health not good?"

Most regression models weight observations by the average state population during the 1993-2019 period, with confidence intervals based on robust standard errors clustered at the state level.[20] The predicted effect of a one standard deviation change in poor mental health on the age-standardized mortality rate is $\exp(\hat{\alpha}_i) - 1$.

The difference between actual 2019-year mortality rates and those predicted if poor mental health had remained at 1999 levels, $M'_{i,2019}$, frequently referred to below as "Constant MH" reductions or changes, are computed as:

$$M'_{i,2019} = M_{i,2019} \times [\exp(-\Delta P_i \times \hat{\alpha}_i) - 1] \tag{2}$$

where $M_{i,2019}$ is the national mortality rate in 2019 for cause or group i and ΔP_i is the national change in poor mental health (in standard deviation units) from 1999-2019.[21] Similarly the disparity of actual mortality rates in 1999 to those predicted if poor mental health had taken 2019 values is calculated as:

$$M''_{i,1999} = M_{i,1999} \times [\exp(\Delta P_i \times \hat{\alpha}_i) - 1]. \tag{2'}$$

M' and M'' are distinguished by the choice of base years. If mental health changes were the sole determinant of mortality rate changes, the two measures would be equal in magnitude but opposite in sign (negative for M' and positive for M'', given an upward trend in poor mental health). If other factors also determine mortality rates, the absolute value of M' will exceed (fall short of) M'' if these factors increase (decrease) mortality rates. The main analysis uses 2019 as the base year since I am primarily interested in evaluating the determinants of recent mortality rates; however, estimates of M'' are included for some specifications below.

[20] The population weights refer to the group-specific population when estimating models for subgroups.
[21] Standard errors for the Constant MH changes are calculated assuming that mortality rates and changes in poor mental health are measured without error, meaning they depend only on the standard errors of the estimated α coefficient.

If $\Delta P_i \times \hat{\alpha}_i$ is near zero, (2) can be closely approximated by:

$$M'_{i,2019} \approx M_{i,2019} \times (-\Delta P_i \times \hat{\alpha}_i).^{22} \quad (3)$$

We can use (3) to decompose sources of differences in the Constant MH changes across groups. For example, using the subscripts w and b to indicate Whites and Blacks, the ratio of White versus Black Constant MH changes is:

$$\frac{M'_{w,2019}}{M'_{b,2019}} \approx \frac{M_{w,2019} \times (-\Delta P_w \times \hat{\alpha}_w)}{M_{b,2019} \times (-\Delta P_b \times \hat{\alpha}_b)},$$

(4)

or equivalently

$$\frac{M'_{w,2019}}{M'_{b,2019}} \approx \left(\frac{M_{w,2019}}{M_{b,2019}}\right) \times \left(\frac{\Delta P_w}{\Delta P_b}\right) \times \left(\frac{\hat{\alpha}_w}{\hat{\alpha}_b}\right). \quad (5)$$

(5) indicates that ratio of Constant MH changes between the two groups (the left-hand-side of the equation) can be divided into the portions due to ratios of: 2019 mortality rates (the first term on the right-hand-side), changes in mental health from 1999-2019 (the second term), and mortality *responses* to given changes in poor mental health (the third term).[23]

Contribution of Declining Mental Health to Mortality Trends

Finally, the analysis examines how increases in poor mental health are related to the adverse mortality trends from 1999-2019, paying particular attention to 25-54 year old Whites and Blacks, overall and by education group, because prime-age individuals,

[22] This assumption is always reasonable. For example, when considering all-cause mortality for Whites and using days of poor mental health as the proxy, $\hat{\alpha}_i = 0.0126$ and $\Delta P_i = 2.791$ standard deviations, so that $\Delta P_i \times \hat{\alpha}_i = 0.0352$, while $\exp(\Delta P_i \times \hat{\alpha}_i) - 1 = 0.0358$. Thus, the approximation is quite close in this case and is closer still in most others. For instance, corresponding values of $\Delta P_i \times \hat{\alpha}_i$ and $\exp(\Delta P_i \times \hat{\alpha}_i) - 1$ are both 0.0076 for Blacks.

[23] Equation (5) still applies when considering causes of death but the change in mental health (the middle term on the right-hand-side) is the same for all causes.

especially less educated Whites, have experienced exceptionally unfavorable mortality changes that have been the focus of considerable prior research.

Since mortality rates have been declining over time for most groups (e.g. see Appendix Figure A1), simple comparisons of 2019 versus 1999 rates are misleading. This is addressed by constructing the counterfactual 2019 rates expected if prior mortality trends had continued. Specifically, national average annual changes in mortality rates from 1980-1999 for group i, T_i, are calculated as:

$$T_i = \left(\frac{M_{i,1999}}{M_{i,1980}}\right)^{\frac{1}{19}} \tag{6}$$

and counterfactual mortality rates in 2019, $C_{i,2019}$, as:

$$C_{i,2019} = M_{i,1999} \times T_i^{20}. \tag{7}$$

Thus, the counterfactual rates are based on trends from 1980-1999. Using a shorter period might provide erroneous estimates due to transitory idiosyncratic influences. For instance, overall death rates *increased* from 1992 to 1993 (see Figure A1), largely because of the adverse effects of a severe flu season and the HIV/AIDS epidemic (Centers for Disease Control and Prevention 1996). Similarly, the mortality rates of Blacks were flat or possibly rising during the 1980s, which may have reflected timing of the crack epidemic (Fryer et al. 2013).

A difficulty with using 1980-1999 for calculating annual trend growth in mortality rates is that Hispanic origin was not collected in some states prior to 1990, and so is not identified in the *MCOD* files before that year. Since Hispanics typically have relatively low death rates, including them in the race-specific rates before 1990 but excluding them thereafter implies that the mortality rates of non-Hispanic Whites and Blacks will likely be understated in the early years, leading to an underestimate (overestimate) of any trend decline (increase) in mortality rates over the entire period. The following procedure is used

to address this: 1) average annual mortality changes from 1990-1999 are separately calculated for race groups that include and exclude Hispanics; 2) ratios of the annual changes with Hispanics excluded and included are computed; 3) the actual race-specific average annual rate change from 1980-1999 with Hispanics included is calculated, and this is multiplied by the ratio calculated in step 2) to provide adjusted annual changes which are then used to project 2019 race-specific mortality rates.[24]

An additional issue is that information on education is not provided in the *MCOD* files prior to 1990, and is initially quite incomplete thereafter. Therefore, counterfactual mortality rates cannot be calculated using the procedure just detailed when considering education subgroups. In these cases, counterfactual rates are based on the trend changes in mortality rates for all persons in the same race-age group (for instance, prime-age Whites or Blacks) regardless of education. This introduces error to the extent that the trends differ with education. For example, the counterfactual mortality rates of non-college educated prime-age Whites will be overestimated (underestimated) if the trend decline in mortality is larger (smaller) for them than for Whites with more education.

The difference between actual and counterfactual 2019 mortality rates, $M_{i,2019} - C_{i,2019}$, referred to below as the "adjusted mortality rate change", indicates the amount by which death rates differ from those expected based on prior trends. The Constant MH change, $M'_{i,2019}$, discussed above, shows how much lower estimated mortality rates in 2019 would have been if poor mental health had not increased over time. Therefore, the extent to which deteriorating mental health explains rising mortality, E_i, can be calculated as:

[24] An example helps to illustrate. The average mortality rate trend factor from 1990-1999 for 25-54 year old White males was 0.98388 (a 1.61% mortality rate reduction per year) with Hispanics excluded versus 0.981581 (a 1.84% annual decrease) with them included. The ratio of these, 1.002345, is multiplied by the average annual mortality trend factor of 0.9850261 from 1980-1999 for all Whites (including Hispanics), to obtain an adjusted trend factor for White non-Hispanic males in this age group of 0.987336 (a 1.27% annual decrease).

$$E_i = \frac{-M'_{i,2019}}{M_{i,2019} - C_{i,2019}} \ . \tag{8}$$

Results

Disparities and Trends in Poor Mental Health

Mental health deteriorated substantially from 1993-2019. Figure 1 illustrates this, providing descriptive information on national average values of each of the proxies for poor mental health and demonstrating that all three rose steadily over time.[25] The number of poor mental health days in the last 30 grew 53% (from 2.84 to 4.34) between 1993 and 2019. Probabilities of poor mental health in at least 15 and in all 30 days increased by 68% and 69% (from 7.7% and 3.7% to 13.0% and 6.3%).[26] The overall patterns are quite similar without age-standardization or when more broadly accounting for changes in demographic factors (Appendix Figure A2), although possibly with marginally larger growth in poor mental health in the last case (Figure A3).

Mental health worsened over time for all population groups examined.[27] Figure 2 shows the average number of poor mental health days (in the last 30) for groups stratified by sex, age, education, race/ethnicity, and race-education interactions. It illustrates the relatively high rates of poor mental health for females, prime-age individuals, and the less educated, compared to their counterparts. Appendix Figures A4 and A5 indicate substantially the same patterns using the 15+ and all 30 days measures of poor mental health. The findings, when stratified by race/ethnicity, are more complicated. Whites had

[25] The mental health proxies are age-standardized throughout, unless otherwise noted.

[26] There was a discontinuous jump in the poor mental health measures between 2010 and 2011, reflecting a change in *BRFSS* weighting procedures and the inclusion of a cell-phone beginning in 2011. These raised the values of the variables by approximately 0.3 days and 1.0 and 0.5 percentage points starting in 2011. The three variables rose further during the pandemic, reaching 5.0 days, 15.2% and 7.2% in 2022. These later increases are not modeled given the unusual nature of the COVID-19 period.

[27] Other studies (Blanchflower and Oswald 2020; Daly 2022) have also uncovered widespread increases in poor mental health, although for a more limited set of mental health proxies and some differences in the groups examined.

the lowest rates of poor mental health in 1993 but larger increases over time, such that they reached or exceeded those of Blacks and Hispanics by 2019. The relative instability of results for Hispanics likely reflects small sample sizes in the early years and changes in the composition of this group over time due to immigration. For this reason, the analysis of racial differences below largely focuses on comparisons of Whites and Blacks. When doing so, there are clear education gradients in levels and probably growth rates of poor mental health, particularly for Whites, but with little indication of "threshold" effects – e.g. discontinuous changes for those with a four-year degree.

Trends in poor mental health, overall and for population subgroups, are further examined by regressing the mental health proxies on linear time trends, with 95% confidence intervals computed based on robust standard errors. Primary results are summarized in Figure 3. The left-hand-side of the figure shows findings for groups separated by sex, age, education, and race/ethnicity. The right-hand-side documents those for White and Black 25-54 and 55+ year olds, with the further stratification by education for the prime-age group. Detailed regression results are provided in Appendix Tables A2 and A3.

The estimates confirm that poor mental health became more common over time for virtually all groups. For the full population, the number of poor mental health days increased by an estimated 0.049 days per year and the likelihood of having at least 15 and all 30 poor mental health days grew by 0.17 and 0.08 percentage points annually. The trend coefficients are positive and statistically significant at the 0.05 level for almost all groups, but differences between them are generally not statistically distinguishable, except that young adults experienced larger deteriorations in mental health than their older counterparts and the mental health of college graduates and Hispanics worsened more slowly than those of their peers. For instance, poor mental health days and 15+ or all 30 poor

mental health days increased by 0.065 days and 0.24 and 0.12 percentage points per year for 20-34 year olds, versus 0.042 days and 0.13 and 0.05 points for persons 55 and older.

The mental health of 25-54 year old Whites deteriorated faster than for similarly aged Blacks: poor mental health rose by 0.064 days, and 0.23 and 0.12 percentage points for the 15+ and all 30 days measures annually for Whites versus 0.053 days, and 0.18, and 0.09 percentage points for comparable Blacks. Mental health worsened more for less educated individuals than for their counterparts and, within education categories, for Whites than Blacks.

The results just described refer to absolute increases in poor mental health. Percentage changes are examined by using natural logs, rather than levels, of the mental health proxies as the dependent variables in the regression analysis (Appendix Figure A6). The patterns are generally similar to those for levels, with two exceptions. First, males have, if anything, smaller absolute trend growth in poor mental health than females but the percentage changes are larger for them. Second, the 55+ age group have lesser increases than their younger counterparts but, in percentage terms, the rise is more comparable and, sometimes, larger than for 35-54 year olds.

Total Mortality Rates

The relationship between poor mental health and age-standardized total mortality rates is next examined through estimates of Equation (1), using different specifications and methods. Year and state fixed-effects are included in all models, the mental health proxies are transformed to show the effects of a one standard deviation change, and robust standard errors clustered at the state level are shown in parentheses. Poisson regressions are estimated throughout, except for column (4), where a log-linear model is used. Table 1 summarizes the results.

In a basic specification, with time and year fixed-effects, but without supplementary covariates or weighted data, a one standard deviation increase in poor mental health is predicted to raise total mortality rates by 1.2% to 1.4%, depending on the mental health proxy (model 1). Adding controls for the state population share of Blacks, other races, and Hispanics – which may be important if mortality rates differ across race/ethnicity groups and their population shares change substantially over time – lowers the estimated poor mental effect to 0.7% to 0.9% (column 2). Weighting observations by average state populations further decreases this estimate to a statistically insignificant 0.5% to 0.7% (model 3). Essentially identical estimates are obtained when instead using a log-linear model (column 4), as anticipated since no state-year cells have zero deaths (which would be excluded from the log-linear models).

Model (5) adds supplementary covariates for state poverty rates, average per capita personal incomes, the percentage of persons 20 and over with health insurance, and a dichotomous variable indicating whether the state had expanded their Medicaid program under the Affordable Care Act.[28] These represent potentially important confounding factors given the possibility that economic status and health insurance coverage influence mortality rates and are correlated with mental health. However, including these variables has virtually no impact on the estimated mental health effects (compare column 5 to column 3). For this reason, the "preferred" specifications focused upon below correspond to those in column (3).

Group-Specific Mortality Rates

Figure 4 provides results of the preferred model for population groups. Figure 4A shows standard deviation changes in poor mental health from 1999-2019 and confirms the

[28] Poverty rate and Medicaid expansion data come from the University of Kentucky Center for Poverty Research (2024), per capita personal incomes from the Bureau of Economic Analysis (2024), and health insurance coverage from the Current Population Survey Annual Social and Economic Supplement (Flood et al. 2024). Health insurance coverage refers to persons with insurance from private sources, Medicare, Medicaid, or military coverage.

previous findings of particularly adverse trends for females, 20-34 year olds, those with some college but no 4-year degree, and Whites.

Figure 4B summarizes the relationship between poor mental health and mortality obtained from the econometric models. The findings are generally similar using any of the three mental health proxies; howevever, imprecision of the estimates implies that caution is needed when interpreting the results.[29] With that said, poor mental health is associated with higher mortality rates for all groups, with the point estimates suggesting especially adverse effects for females, 20-34 and 35-54 year olds, Whites, and those with some college but no degree: a one standard deviation increase in poor mental health is predicted to raise age-standardized death rates by around 0.7, 0.9, 0.7, 1.3, and 1.0 percentage points for these groups, compared to 0.3, 0.3, 0.4, and 0.3 percentage points for males, 55+ year olds, Blacks, and the non-college educated.[30] Appendix Table A4 further details these estimates. While these groups are generally the same as those experiencing the largest increases in poor mental health from 1999-2019, changes in mental health and their effects on deaths are conceptually distinct. The relative importance of each is investigated below.

Figure 4C translates the changes in poor mental health (shown in Figure 4A) and mortality responses to them (Figure 4B) into Constant MH reductions – the decreases in age-standardized mortality rates that would have been expected if poor mental health had remained at its 1999 level in 2019. Since mental health worsened over time and poor mental health is positively associated with mortality rates, the Constant MH changes indicate that age-standardized death rates would have been *lower* if mental health had not deteriorated.

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[29] As is apparent from the figure, few of the estimates are statistically significant at the 0.05 level, nor are most of the differences between groups. P-values for the full sample estimates range from 0.11 to 0.23 and, for at least one of the mental health proxies are: <0.001 for Whites; <0.10 for females, Blacks, and 20-34 year olds; and <0.20 for men, 35-year olds, those without college or some college but no degree, and Hispanics.

[30] The exact estimates depend somewhat on the poor mental health proxy used.

The Constant MH estimates also depend on actual 2019 death rates. Thus, it is possible for a group with relatively high mortality rates to have big Constant MH changes even with relatively small trend changes in poor mental health and mortality responses to it. This occurs for 55+ year olds, compared to younger individuals, where the estimated Constant MH reduction is relatively large but imprecisely estimated (Figure 4C),[31] driven by high age-related baseline death rates.[32]

However, for most groups, the Constant MH estimates are fairly closely (inversely) aligned with the mortality responses to poor mental health. For instance, using the 15+ days proxy, the point estimates indicate larger Constant MH reductions for females than males (-11.0 vs. -4.1 per 100,000), those attending college but not receiving a 4-year degree compared with those who never went to college or who graduated from it (-20.1 vs. -7.9 and -3.1 per 100,000), and for Whites versus Blacks or Hispanics (-27.3 vs. -6.7 and -1.2 per 100,000).[33] Again, caution is needed when interpreting these findings given the frequently large standard errors.[34]

As shown earlier (in Figures 2, A4, and A5), 20-34 year olds experienced particularly sharp increases in poor mental health, driven by growth towards the end of the analysis

[31] The point estimates for the Constant MH reductions in mortality rates are -10.9, -14.6, and -7.3 per 100,000 for those 55 and older, using number of days, 15+ days, all 30 days of poor mental health as the mental health proxy. For 20-34 year olds, the corresponding estimates are -4.1, -4.0, and -2.6 per 100,000 and for those aged 35-54 they are -2.1, -3.3, and -2.3 per 100,000.

[32] Age-standardized mortality rates in 2019 are 117.0, 280.9, and 2,826.0 per 100,000 for 20-34, 35-54, and ≥55 year olds (Table A4). The Constant MH estimate for 20-34 year olds is relatively small because mortality rates are so low for them, despite their having a relatively large deterioration in poor mental health and a greater mortality response to it than the other two age groups.

[33] That patterns across groups are substantially similar when adding controls for poor physical health days to the models. For instance, using the 15+ day proxy for poor mental health, the point estimates for the Constant Mental reductions are 8.6, 3.1, 9.8, 4.5, 1.5, and 15.5 per 100,000 for all individuals, males, females, 20-34, 35-54, and 55+ year olds (see Appendix Table A4 for details).

[34] As a robustness check, the mortality responses to worsening mental health are estimated from regressions that used data for only the 1999-2019 period (when cause of death is identified using ICD-10 codes). These estimates are substantially similar to those for the full 1993-2019 period, except for some possibility of more beneficial effects for college graduates (see Appendix Figure A7).

period. To further examine age differences in the outcomes, Figure 5 provides results separately for Whites and Blacks by age (with details in Appendix Table A5). Despite the particularly rapid growth in poor mental health for 20-34 year old Whites, as documented above and in Figure 5A, they have smaller Constant MH increases than their 35-54 year old counterparts: -4.0 to -9.5 versus -10.1 to – 20.0 per 100,000 (Figure 5C). This occurs because of the much larger estimated mortality response to change in poor mental health for them (Figure 5B).[35] For comparison, the changes in both poor mental health and the responsiveness of predicted mortality to it are lower for Blacks than Whites for each of the three age groups, resulting in much smaller Constant MH changes.

Figure 6 and Appendix Table A6 provide results for 25-54 year olds stratified by race (White vs. Black) and education (No College, Some College, College Graduate). These findings are relevant since the original research on "deaths of despair" focused on "midlife" Whites (e.g. 35-54 year olds), with follow-up studies often also highlighting effects for younger adults.

Among prime-age individuals, mental health deteriorated by particularly large amounts for the less educated and more so for White than Blacks: e.g. by 3.5 to 4.0 and 2.3 to 3.0 standard deviations for non-college Whites and Blacks compared to 0.7 to 1.9 and 0.8 to 1.7 standard deviations for corresponding college graduates (Figure 6A). Mortality is also especially responsive to changes in mental health for non-college Whites: a one standard deviation increase in poor mental health raises their predicted mortality rates by 1.3% to 2.0%, versus 0.3% to 0.5% for non-College Blacks, although, interestingly, the estimated responses are actually somewhat higher for prime-age White college graduates than for those attending but not completing college (Figure 6B).

[35] Constant MH changes of White 55+ year olds are large in some specifications but extremely imprecisely estimated.

Combining these effects, Figure 6C indicates the very large 2019 Constant MH decreases for 25-54 year old non-college Whites (-22.4 to -38.5 per 100,000), which dwarf the estimates for other prime-age individuals: the corresponding decrease for 25-54 year old non-college Blacks is -4.4 to -8.1 per 100,000, which is modestly higher than for Whites with some college but no degree (-2.8 to -5.4 per 100,000). The Constant MH changes are of small magnitude, and often statistically insignificant, for Whites with a college degree and Blacks with at least some college (3 per 100,000 or less).

Cause-Specific Mortality Rates

This section examines the relationship between mental health and specific causes of mortality for the full population. The methods are identical to those used above and the results are summarized in Figure 7, with details in Appendix Table A7. Trends in poor mental health between 1999-2019 are not displayed since they are the same for all causes of death for a given population group.[36]

Predicted death rates from all causes examined rise in response to worsening mental health, although the percentage changes are often small and statistically insignificant. A one standard deviation increase in poor mental health is estimated to increase all-cause mortality by a statistically insignificant 0.5% to 0.7%, drug mortality by an imprecisely estimated 1.8% to 3.2%, alcohol deaths by a statistically significant 2.7% to 4.0%, and by a much smaller 0.6% to 0.7% for suicides, the other component of DSA deaths (Figure 7A). Predicted effects are. The associations are also substantial for some other causes of death: the one standard deviation growth in poor mental health is estimated to raise mortality rates from heart disease and homicides by 1.0% to 1.2% and 2.9% to 3.8%, lower respiratory disease and diabetes by a statistically insignificant 1.3% to 1.6% and 0.9% to 1.5%, with

[36] For the full population, the number of days, 15+ days, and all 30 days proxies of poor mental health rose by 2.23, 2.25, and 1.49 standard deviations respectively from 1999-2019.

minimal (0.1% to 0.5%) and imprecisely measured increases for deaths from cancer, stroke, and transport accidents.

Figure 7B shows corresponding Constant MH mortality reductions. By far the largest counterfactual drop in mortality rates predicted if poor mental health had remained at 1999 levels is for heart disease (-2.7 to -4.4 per 100,000). As just documented, homicides are most responsive to changes in poor mental health in relative terms but the Constant MH decreases are fairly small (-0.2 to -0.5 per 100,000) because deaths from this cause are relatively rare. Constant MH changes in drug and alcohol mortality rates are -0.9 to -1.0 and -0.4 to -0.9 per 100,000, with a substantial (-0.8 to -1.4 per 100,000) decrease also observed for respiratory disease mortality. Conversely, the predicted decrease is modest for suicides, with point estimates smaller than those from diabetes, strokes, or lower respiratory causes.

Prime-Age Whites and Blacks

Prior research and the findings above suggest the particular importance of mental health changes for 25-54 year olds, especially Whites. This is further investigated by examining cause-specific death rates for prime-age Whites and Blacks, overall and for those without college educations.[37] As shown above, poor mental health grew considerably more from 1999-2019 for prime-age Whites than for either corresponding Blacks or the full population, and all-cause mortality rates also responded more to changes in mental health for them. Corresponding results by specific cause of deaths for 25-54 year old Whites and Blacks are summarized in Figures 8 and 9, with additional details on Appendix Tables A8 through A11. In these and most later figures, the Constant MH changes in all-cause

[37] As mentioned, prime-age Hispanics are not examined here because compositional changes in this group are likely to be difficult to address and since the estimated Constant MH reductions in all-cause mortality are always small and statistically insignificant for them.

mortality are divided by 5, so as to make more visually apparent the changes for specific causes of death that are an often small fraction of the total change.

A one standard deviation rise in poor mental health predicts statistically significant 2% to 3% increases in prime-age White death rates from heart disease and diabetes, and approximately 2% higher cancer mortality rates (Figure 8A), all substantially exceeding the corresponding full population estimates. Responsiveness is even higher for lower respiratory disease mortality (5% to 7%), homicides (3% to 5%), and drug deaths (4% to 6%), although the confidence interval on the last of these is large. Worsening mental health raises alcohol deaths by 2% to 3%, but suicides are again not very responsive (less than 1%), smaller than for a wide variety of other causes.

Transforming these responses into Constant MH effects, if poor mental health had remained at 1999 levels in 2019, the drug mortality rates of prime-age Whites would have been an imprecisely estimated 3.1 to 7.2 per 100,000 lower than those actually observed (Figure 8B). The Constant MH decreases in heart and cancer deaths are also substantial (-1.4 to -2.5 and -1.1 to -2.1 per 100,000) and precisely estimated. The impacts are smaller (although often still statistically significant) for other causes, with the most consequential being the 0.4 to 0.9 per 100,000 reduction in alcohol mortality rates and the 0.4 to 0.7 per 100,000 drop in death rates from lower respiratory diseases.

The patterns of mortality responses to declining mental health are fairly similar for prime-age Whites without college educations, although with modestly smaller estimates for homicides and most natural causes of mortality (other than those from lower respiratory disease) and more precisely estimated increases in drug deaths (Figure 8C). However, because the baseline mortality rates are so much higher for this group, these result in large Constant MH reductions: -22.4 to -37.0 per 100,000 for all-cause mortality compared to -

11.7 to -20.0 per 100,000 for all prime-age Whites (Figure 8D).[38] Similarly, the point estimates for drug mortality are -8.2 to -18.7 per 100,000 for those without college versus -3.1 to -6.7 per 100,000 for all 25-54 year old Whites, and those for alcohol deaths are -0.9 to -2.2 versus -0.4 to -0.9 per 100,000. The Constant MH reductions are also substantially greater for the non-college group for virtually all other causes of death. For example, the estimates for lower respiratory disease mortality are -0.9 to 1.7 per 100,000 for them compared to -0.4 to -0.7 for all prime-age Whites.

The results differ sharply for prime-age Blacks. The estimated responsiveness of mortality rates to worsening mental health is generally similar to the full population and considerably less than for prime-age Whites: a one standard deviation increase in the poor mental health predicts less than a 1% increase in age-standardized death rates from most causes (Figure 9A). The predicted growth in death rates from lower respiratory disease is more substantial (1% to 2%) and there is an estimated 2% rise in drug fatalities, but heart disease deaths respond much less than for either the full population or prime-age Whites. Notably, essentially no growth is predicted for either suicides or alcohol deaths.

Figure 9B summarizes the corresponding Constant MH mortality reductions. For all-cause mortality, these are estimated to be less than one-third as large for 25-54 year old Blacks (-3.3 to -5.8 per 100,000) as Whites (-11.7 to -20.9 per 100,000), with predicted decreases in drug deaths (-1.2 to -1.7 per 100,000) and homicides (-0.3 to -0.8 per 100,000) being the most important contributors. Constant MH changes for other causes are modest. Magnitudes of the Constant MH reductions are considerably larger for non-college prime-age Blacks than for this group as a whole, while almost always being much smaller than for corresponding 25-54 year old non-college Whites. For example, the estimated changes for all causes of death range from -4.4 to -8.1 per 100,000, which is only around one-quarter to

[38] Results for all-cause mortality are again divided by 5 in these figures.

one-third as large as for corresponding Whites (Figure 9D). One exception to this is the relatively large 0.6 to 2.0 per 100,000 reduction for homicides.

Additional Estimates

Next, I explore the sensitivity of results to the use of alternative specifications or the choice of base years for calculating Constant MH changes, focusing on prime-age Whites since declining mental health has the strongest predicted effects on mortality rates for them.

Up to this point, mortality rates have been related to poor mental health measured during the same year. While this does not constrain the mental health effects to be contemporaneous, since values of this key explanatory variable are highly correlated across time, dynamic effects are next examined by estimating specifications that include lagged, as well as current, values of the mental health proxies, with the total impact calculated as the sum of the coefficients on these variables. Adding a one-year lag of poor mental health to the models increases the impact on all-cause mortality rates by 23% to 30%, with fairly similar changes for most causes of death (see Appendix Table A12). However, differences in predicted effects, compared to controlling only for contemporaneous mental health, are never statistically significant. Adding a second lag slightly increases the magnitude of most estimated effects, again by statistically insignificant amounts.[39]

Next, I incorporated controls for days of poor physical health as a supplementary covariate. As discussed, doing so is appropriate if physical health problems cause mental health to decline but will be problematic to the extent that mental health problems lead to poor physical health. This addition cuts the predicted mental health effects on all-cause mortality roughly in half (by 47% to 52%), with even greater attenuation for deaths from natural causes or transport accidents, smaller relative decreases for suicides or alcohol

[39] For example, predicted effects on all-cause mortality rates are 30% to 37% larger in the specification with poor mental health in year *t, t-1*, and *t-2,* versus only year *t,* controlled for.

related deaths, and slight increases for homicides (Appendix Table A13). These patterns make sense since poor physical health is likely to be more directly related to and caused by diseases than external causes of mortality. Importantly, they raise the possibility the primary estimates substantially overstate the role of declining mental health in raising mortality rates.

Finally, the previous Constant MH changes indicate the reductions in 2019 year mortality rates predicted if the poor mental health variables had remained at their 1999 values. As discussed, an alternative is to calculate expected changes in 1999 mortality rates if poor mental health had been at 2019 (rather than 1999) levels. Table A14 compares results using the two alternative base years. As expected, the Contant MH changes have opposite signs and are of approximately equal size for most causes of death.[40] The key exception is for drug fatality rates, where the predicted effect is three to four times with 2019 rather than 1999 as the base year (-3.1 to -7.2 versus 0.8 to 2.1 per 100,000). This occurs because drug mortality rates were so much higher in the later year (47.2 vs. 11.4 per 100,000), with most of the increase occurring for reasons unrelated to mental health (such as efforts of suppliers to increase opioid use).

Decomposition of Racial Differences in Counterfactual Mortality Changes

Disparities in Constant MH changes across groups reflect the combined effects of heterogeneity in: 1) actual 2019 mortality rates, 2) poor mental health trends from 1999-2019, and 3) the responsiveness of mortality rates to changes in poor mental health. The methods detailed in equation (4) are used here to identify the importance of each of these, focusing on differences between prime-age Whites and Blacks. Particular attention is paid to the second and third components, since their roles are likely to be less well understood

[40] As a reminder, Constant MH changes will be negative when the base year is 2019 and positive when it is 1999 since the poor mental health increased over time.

than general differences in mortality rates. The mortality responses are based on point estimates from regressions of equation (1) and should be interpreted with caution when the associated confidence intervals are large. The results are summarized in Table 2 for 25-54 year olds as a group, as well as for those without college educations. The table cells present White-Black ratios. Ratios above (below) one therefore indicate higher (lower) values or rates for Whites than Blacks.[41]

As shown in the first row of the table, prime-age Whites have lower 2019 mortality rates than their Black counterparts for most causes and the differences are often quite large. For instance, they die from homicides around one-eight as often and less than two-thirds as frequently from heart disease, strokes, or diabetes. Conversely, Whites have higher death rates for all three DSA components.

The key result of this analysis is that the larger Constant MH reductions for Whites than Blacks primarily result from heterogenous *consequences* of given increases in poor mental health, rather than differential trends in it. To see this, note that poor mental health grows 25% to 38% faster, from 1999 to 2019 for prime-age Whites than Blacks. However, White-Black responsiveness ratios for all causes of death are much larger (3.75 to 4.25) and, in combination, these two factors far overwhelm the approximately one-third lower 2019 mortality rates of 25-54 year old Whites than Blacks.

For many causes, the higher mortality response for Whites is even more pronounced. For example, the mortality rate coefficient for alcohol deaths is substantial for prime-age Whites (0.0168 to 0.0258) but only one-tenth as large (0.0016 to 0.0021) for analogous Blacks, and this accounts for almost the entire disparity in the associated Constant MH changes.

[41] For example, all-cause mortality rates in 2019 were 247.7 for prime-age Whites and 360.2 for 25-54 year old blacks, yielding a ratio of 0.688 (247.7/360.2). The full set of mortality rates for prime-age Whites and Blacks are contained in Appendix Tables A8 and A10.

For drug deaths, the Constant MH effects are three to four times greater for prime-age Whites than Blacks, with contributions from all three factors: 2019 mortality rates, trend increases in poor mental health, and estimated effects of a one standard deviation increase in poor mental health are 24%, 25% to 38%, and 78% to 175% higher for Whites of this age.

The results for homicides are noteworthy. Death rates in 2019 are more than eight times higher for 25-54 year old Blacks than same age Whites (31.6 vs. 3.8 per 100,000), which overwhelms the greater growth in poor mental health for Whites and their bigger mortality response to it. As a result, the Constant MH estimates are 1.5 to 2.0 times larger for prime-age Blacks than Whites.

The patterns are substantially similar when focusing on the non-college group, with bigger estimated mortality responses to specified declines in mental health generally being the key factor driving the larger Constant MH reductions of Whites. The White-Black responsiveness ratios for all causes of death are again around four, while the growth in poor mental health is 33% to 54% larger for Whites. These effects are even more pronounced for drug deaths, where the responsiveness ratios range from 3.3 to 6.4. On the other hand, these ratios for homicides and heart mortality are smaller for the non-college group than for all 25-54 year olds.[42]

Do Increases in Poor Mental Health Explain Mortality Trends?

Lastly, I examine the extent to which changes in poor mental health from 1999-2019 explain key mortality trends over the same period. Death rates historically decline over time, so the focus is on comparing actual 2019 death rates to those expected if trends from 1980-1999 had continued over the next 20 years: the adjusted mortality rate changes. To illustrate, all-cause mortality rates fall by 150.2 per 100,000 between 1999 and 2019, from

[42] Corresponding results for other comparisons are summarized in Appendix Table A15.

875.4 to 725.2 per 100,000 but this entirely represents a continuation of prior trends. The corresponding death rate is 1,036.1 per 100,000 in 1980, and the counterfactual 2019 mortality rate (if previous trends had continued) is 733.1 per 100,000, or 7.9 per 100,000 *higher* than the actual death rate in that year. Thus, the adjusted mortality rate change (the actual minus counterfactual 2019 rate) is slightly negative. Adjusted mortality rate changes are similarly small, and often negative, for most population subgroups, with substantial declines for Blacks and persons 55 and older (see Appendix Table A16).

The important exceptions are for White and, to a lesser extent, Black 25-54 year olds where the results, summarized in Table 3, indicate large *positive* adjusted mortality rate changes. For example, the actual 2019 mortality rate for prime-age Whites is 42% higher than the counterfactual rate (243.4 versus 171.9 per 100,000), a difference of 71.5 per 100,000. Adjusted mortality rates changes are also positive for prime-age Blacks, but of smaller magnitude (24.1 per 100,000). Given these patterns, a more detailed analysis of prime-age Whites and Blacks is provided below, with education-specific results also presented.[43]

Adjusted changes are also positive and substantial for non-college Whites and Blacks (251.4 and 167.5 per 100,000). However, as already noted, data limitations require the counterfactual mortality rates to be based on changes for *all* prime-age Whites and Blacks, rather than education-specific groups, making these estimates less certain. This is particularly true for non-college Blacks, where actual mortality rates were essentially the same in 1999 and 2019, so that assumptions about counterfactual trends are critical.

[43] International comparisons confirm that the these patterns are fairly unique to the US, with trend reductions in mortality rates (or increases in life expectancy) continuing in other industrialized countries during the anlaysi period, whereas they have slowed or halted, at least for prime-age Whites, in the US (National Academies of Sciences, Engineering, and Medicine 2021; Case and Deaton 2023).

The main findings are summarized in Figure 10, with additional information in Appendix Table A17. Point estimates suggest that worsening mental health accounts for 16% to 29% of the adjusted mortality rate changes for 25-54 year old Whites and 9% to 15% of the larger overall change for non-college prime-age Whites.[44] Drug deaths are the single biggest contributor: point estimates range from 4% to 10% for all 25-54 year old Whites and 3% to 7% for those never attending college. The other two components of "deaths of despair", alcohol and suicide mortality, explain relatively little: <2% for alcohol and <1% for suicides. The combined contributions of effects channeled through heart disease and cancer mortality are 3% to 6% for all prime-age Whites and 2% to 4% for the non-college educated members of this group.

Changes in mental health account for a reasonably similar 14% to 24% of the much smaller overall mortality trend for Blacks, but with minimal contributions operating through most causes of death, with the exceptions of drug deaths (5% to 7%) and homicides (1% to 3%). The shares of mortality changes related to declining mental health are uniformly smaller for non-college Blacks than for other prime-age individuals; however, as discussed, these estimates are particularly sensitive to the assumptions used to construct the counterfactual trends.

An overall assessment is that increases in poor mental health, play some role in explaining the adverse mortality trends of 25-54 year olds but other factors are far more important. The causes of death through which deteriorating mental health operates extend well beyond those previously labeled as "deaths of despair". In particular, for prime-age Whites, effects working through heart disease and cancer are relatively substantial while those due to homicides are important for Blacks.

[44] If the Constant MH changes are compared to actual, rather than adjusted, mortality rate changes worsening health accounts for between 12% and 21% (8% to 15%) of the increase in death rates for the no college group.

Discussion

Declines in population-wide mental health raise death rates and almost certainly contribute to the adverse mortality trends experienced by prime-age non-Hispanic Whites and, to a lesser extent, non-Hispanic Blacks from 1999-2019. However, worsening mental health is not the predominant explanation for these trends; point estimates from the primary specifications suggest it accounts for 9% to 29% (10% to 24%) of the increase for 25-54 year old Whites (Blacks) and 6% to 15% of the growth for prime-age non-college Whites. Whether these impacts are viewed as "large" or "small" may depend on the specific context in which they are considered.

For the full population, the biggest percentage mortality responses to declining mental health are predicted for alcohol, homicide, drug, and lower respiratory causes deaths. The largest estimated absolute changes in death rates are for most of the same causes, but with heart disease and cancer replacing homicides. Among 25-54 year old non-Hispanic Whites, drug, heart, and cancer mortality are particularly important, with drug and homicide deaths predominating in the smaller overall effects for corresponding non-Hispanic Blacks. To the extent these findings support the general idea behind the "deaths of despair" hypothesis, they also suggest that the specific causes comprising it should be both different and broader than previously understood: still including drug mortality and possibly alcohol deaths but replacing suicides with mortality from heart disease, lower respiratory causes, homicides, and perhaps cancer.

A negative relationship between mental health and homicides might be obvious and, *ex post*, it is possible to come up with reasons why worsening mental health raises heart and lower respiratory disease deaths. Conversely, it may seem surprising that suicides are so weakly related to changes in population mental health. However, the pathways leading to deaths from self-harm are complex, with mental health being only one input and an

important role also played by the means available (Yip et al. 2012; Martínez-Alés et al. 2022). Famously, suicides in the United Kingdom decreased substantially during the 1960s as natural stoves replaced those using coal, without obvious changes in mental health (Kreitman 1976).[45] While not an issue for the US during the analysis period, other factors, such as the increasing availability of guns, may be significant (Miller and Hemenway 2008).

Some researchers (Case and Deaton 2020, 2022) have emphasized the particularly adverse mortality experiences of less educated prime-age individuals. This study confirms that declining mental health is associated with large increases fatality rates for them but shows that this reflects their high baseline death rates, rather than any disproportionate impact of worsing mental health.

The larger overall effects of poor mental health on White than Black mortality rates primarily results from differences in the *consequences* of a given increases in the former, rather than in the size of the mental health changes themselves. Understanding why is a useful future research topic, but prior studies suggest some possibilities. Poor mental health may have weaker effects for Blacks because they more frequently live in extended families (D'Vera Cohn and Passel 2018) and since Black churches often provide key community support (Brewer and Williams 2019), both of which may buffer the effects of mental health problems at the individual level. Conversely, rising mortality among less educated Whites may partially reflect a loss of "White privilege" due to improvements in the relative positions of other groups (Metzl 2019; Wilkerson 2020), even while these inequities have not been eliminated. More generally, Whites (particularly White males) may have developed fewer resilience-based coping strategies to mitigate the effects of negative experiences (Smith and Read 2024).

[45] Coal stoves were frequently used in suicide attempts due to the high levels of carbon monoxide emissions. Natural gas stoves emit much less carbon monoxide.

Several potential limitations of the analysis deserve mention. First, potential errors in the predicted consequences of poor mental health on mortality may extend beyond the (frequently substantial) confidence intervals. The estimates may be overstated if spurious factors influencing both are not adequately controlled for or if there is reverse causality where increased death rates lead to worse mental health. This concern is somewhat alleviated by the absence of any effect of adding potentially important controls for economic factors and health insurance availability to the estimation model. However, including supplemental covariates for poor physical health attenuates the predicted mental health impacts by half or more in most cases although, as discussed, it is unclear when these are appropriate to control for. Conversely, the role of poor mental health could be underestimated if some dimensions of it are not captured by the proxies used here or if the estimation models to not sufficiently account for dynamic effects. Supporting this possibility, incorporating lagged mental health into the estimation models moderately increases the predicted effects.

Second, the key explanatory variables may measure poor mental health with error and be less informative for minorities than Whites (Zuvekas and Fleishman 2008), possibly contributing to the Black-White differences observed above. More generally, it would be desirable to replicate this analysis using other potential measures of poor mental health, such as the Kessler-6 psychological distress scale (Kessler et al. 2003), although this would require different data sources with other shortcomings.[46]

Third, there could be heterogeneity in the effects across a variety of dimensions. For instance, the estimated mortality responses to poor mental health are larger in the unweighted than the weighted estimates, which suggests stronger impacts in small than

[46] National trends in poor mental health based on the *BRFSS* measures and Kessler K6 scores, obtained from the *National Health Interview Survey (NHIS)* are reasonably similar (see Appendix C). However, sample sizes in the *NHIS* are not large enough to perform the type of analysis undertaken here.

large states. This could reflect the "rural mortality penalty" (James et al. 2022) or other factors.

Fourth, the adjusted 2019 mortality rate changes depend upon counterfactual death rates projected from historical trends. This could be problematic if developments from the the 1980s and 1990s, such as demographic shifts or rapid progress in preventing and treating major causes of death, are unlikely to continue during the analysis period.

These limitations and the more general paucity of prior research on this topic suggest numerous avenues for future investigation. The current estimates are often less precise than ideal, raising the possibility of potential of benefits using finer units of geographic aggregation than the state-level approach taken here. When constructing the counterfactual mortality rates that would have been expected in the absence of changes in mental health, alternative approaches could involve modeling cause-specific mortality trends rather than projecting from all-cause rates, as was done here, or incorporating cross-country comparisons, although either would introduce significant methodological challenges. More generally, there may also be value in identification strategies that exploit policy changes occurring during the analysis period – such as introduction of Medicare Part D in 2006, the Mental Health Parity and Addiction Equity Act of 2008, or the Affordable Care Act Medicaid expansions starting in 2014.[47]

Evidence that worsening mental health is not the primary cause of adverse mortality experiences of prime-age individuals at the beginning of the 21st century raises questions about what is? The answers, while likely heterogeneous, may be linked to more general failures of the US medical and public health infrastructure. For instance, the role of supply-

[47] Numerous other sources of variation may be of interest. For example, recent evidence by Arteaga and Barone (National Academies of Sciences, Engineering, and Medicine 2021; Case and Deaton 2023) indicates that differences in initial cancer mortality across geographic areas causally influenced opioid exposure, through supplier marketing strategies, which in turn affected subsequent drug mortality rates.

factors in driving the fatal drug epidemic has been extensively documented (Ruhm 2019; Case and Deaton 2020; Currie and Schwandt 2021; Maclean et al. 2021) and suggest the need for changes in public policy approaches to balance the benefits of medical and recreational drug use against the associated harms. In this regard, it is noteworthy that while opioids have received most of the recent attention, deaths from other drugs categories, particularly stimulants, are now rising extremely rapidly (Spencer, Garnett, and Miniño 2023). Possibly even more important is the reduction in progress since at least 2010 in reducing deaths from heart disease and related causes (Mehta, Abrams, and Myrskylä 2020; National Academies of Sciences, Engineering, and Medicine 2021; Case and Deaton 2022). Potential reasons for this include rising obesity rates, and the lifestyles associated with them, as well as fewer or less effective medical innovations. In these cases and many others, there may be heterogeneous consequences across individuals and groups, including the likelihood that those in poor mental health are most susceptible to any added health risks. If so, declining mental health may play a mediating role without being the primary cause.

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Appendix A: Additional Tables and Figures

Table 1: Estimated Effects of Poor Mental Health on Total Mortality Rates

Mental Health Proxy	(1)	(2)	(3)	(4)	(5)
Days	0.0117***	0.0073*	0.0046	0.0045	0.0045
	(0.0040)	(0.0041)	(0.0038)	(0.0037)	(0.0038)
15+ Days	0.0140***	0.0088**	0.0062	0.0060	0.0062
	(0.0043)	(0.0043)	(0.0042)	(0.0041)	(0.0042)
All 30 Days	0.0116**	0.0076*	0.0069	0.0070	0.0067
	(0.0052)	(0.0042)	(0.0043)	(0.0042)	(0.0044)
Population Shares	N	Y	Y	Y	Y
Weights	N	N	Y	Y	Y
Covariates	N	N	N	N	Y
Model	Poisson	Poisson	Poisson	Log-linear	Poisson

Note: Table shows coefficients from regressing the mental health proxy on the natural log of age-standardized total mortality rates (n=1,321). These are estimated as Poisson models, except in column (4) where log-linear models are estimated. Population shares refer to the shares of the state population that are non-Hispanic black, non-Hispanic other nonwhite, and Hispanic (3 variables). In models (3) through (5), observations are weighted by the average state population over the 1993-2019 period. Covariates refer to controls for state poverty rates, average per capita personal incomes, Medicaid expansion status under the Affordable Care Act, and percentage of persons 20 and over with health insurance from private sources, Medicare, Medicaid or military plans. Each coefficient shows results of a different regression. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Ratios of Mortality Rates and Mortality Responses to Changes in Poor Mental Health for 25-54 Year Old Whites vs. 25-54 Year Old Blacks, By Cause of Death and Education

Ratio	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Trans-port	Homi-cide	Suicide	Alcohol	Drug
All Education Groups											
2019 Mortality Rate	0.688	0.494	0.800	0.773	0.386	0.435	0.757	0.120	2.250	1.677	1.243
Mortality Response											
Days	3.75	6.89	∗	4.03	4.18	4.93	5.39	3.00	∗	16.43	2.58
15+ Days	4.49	11.47	∗	6.12	7.12	5.53	3.66	4.40	∗	11.33	2.75
All 30 Days	4.25	11.28	54.78	4.66	∗	14.50	0.65	4.66	∗	8.20	1.78
Non-College											
2019 Mortality Rate	0.861	0.643	0.956	1.121	0.489	0.576	0.980	0.149	2.850	1.840	1.537
Mortality Response											
Days	4.14	2.68	13.59	4.26	3.48	7.24	1.62	2.11	13.40	4.32	6.40
15+ Days	4.64	2.59	4.64	4.58	1.27	6.01	1.46	2.40	63.58	3.66	5.31
All 30 Days	3.95	2.41	∗	2.99	∗	∗	0.64	3.41	7.48	2.92	3.28

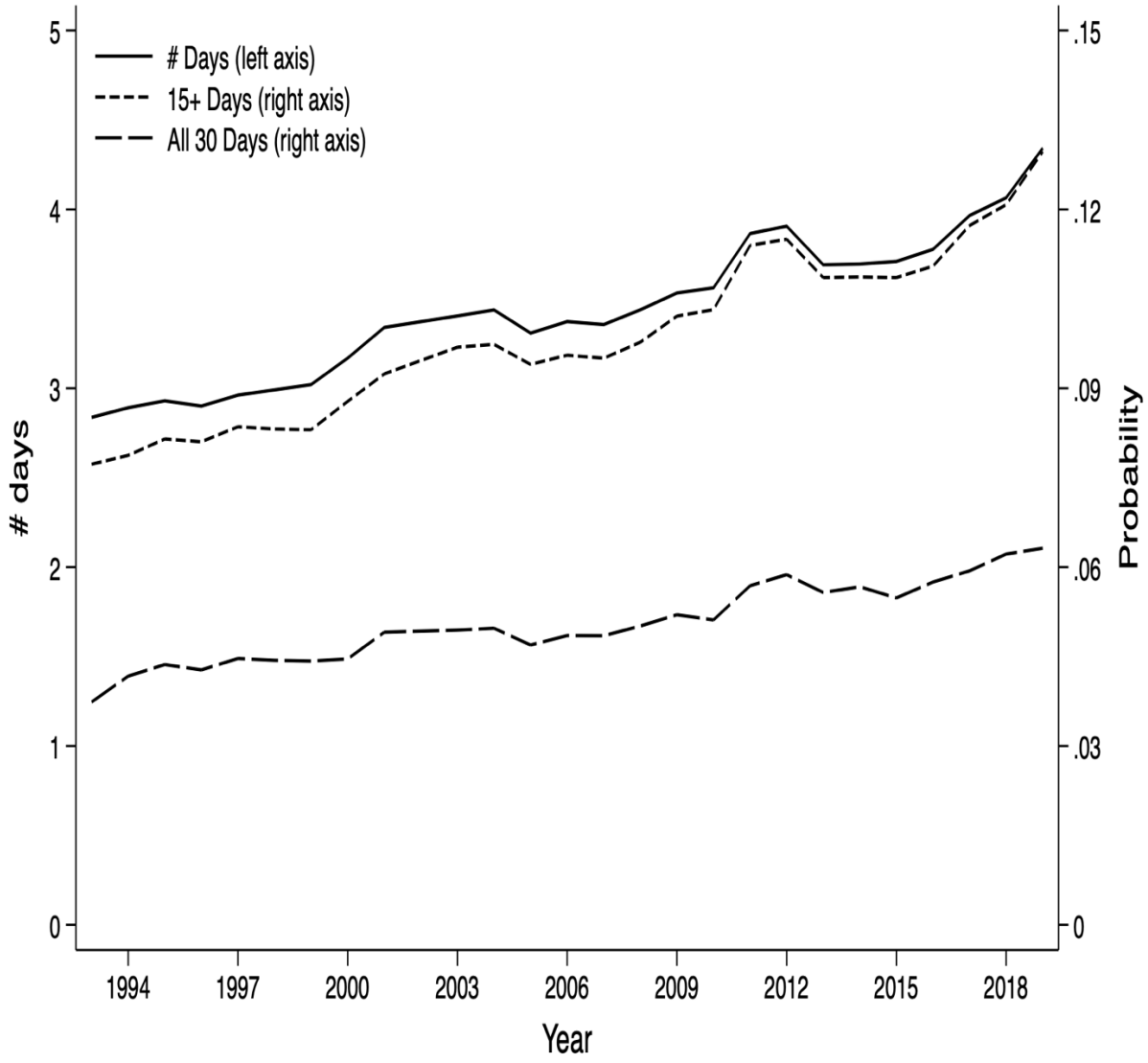
Note: Top row in each panel shows ratio of 2019 mortality rates. Next three rows display ratio of the estimated effects of a one standard deviation increase in the mental health proxy on mortality rates for the specified cause. White and black refer to non-Hispanics. ∗ indicates cases where the mortality response to worse mental health is positive for whites but negative for blacks. Top panel shows results for all 25-54 year old Whites and Blacks. Bottom panel displays findings for non-college 25-54 year old Whites and Blacks. The white vs. black ratio of changes in poor mental health from 1999-2019 is 1.38, 1.31, and 1.25 for mental health days, 15+ days, and all 30 days for all education groups combined and 1.33, 1.36, and 1.54 for non-college individuals.

Table 3: Mortality Rates and Changes for 25-54 Year Olds, by Race and Education

	All	No College	Some College	College Graduate
Non-Hispanic Whites				
Actual Mortality Rates				
1999	215.2	333.2	146.8	109.0
2019	243.4	517.6	219.5	84.1
Counterfactual 2019 Rate	171.9	266.1	117.2	87.1
Mortality Rate Δ: 1999-2019				
Actual	28.2	184.4	72.7	-25.0
Adjusted	71.5	251.4	102.2	-3.0
Non-Hispanic Blacks				
Actual Mortality Rates				
1999	456.4	601.6	261.7	202.0
2019	353.3	601.4	277.9	113.7
Counterfactual 2019 Rate	329.2	433.9	188.8	145.7
Mortality Rate Δ: 1999-2019				
Actual	-103.1	-0.2	16.2	-88.3
Adjusted	24.1	167.5	89.2	-32.0

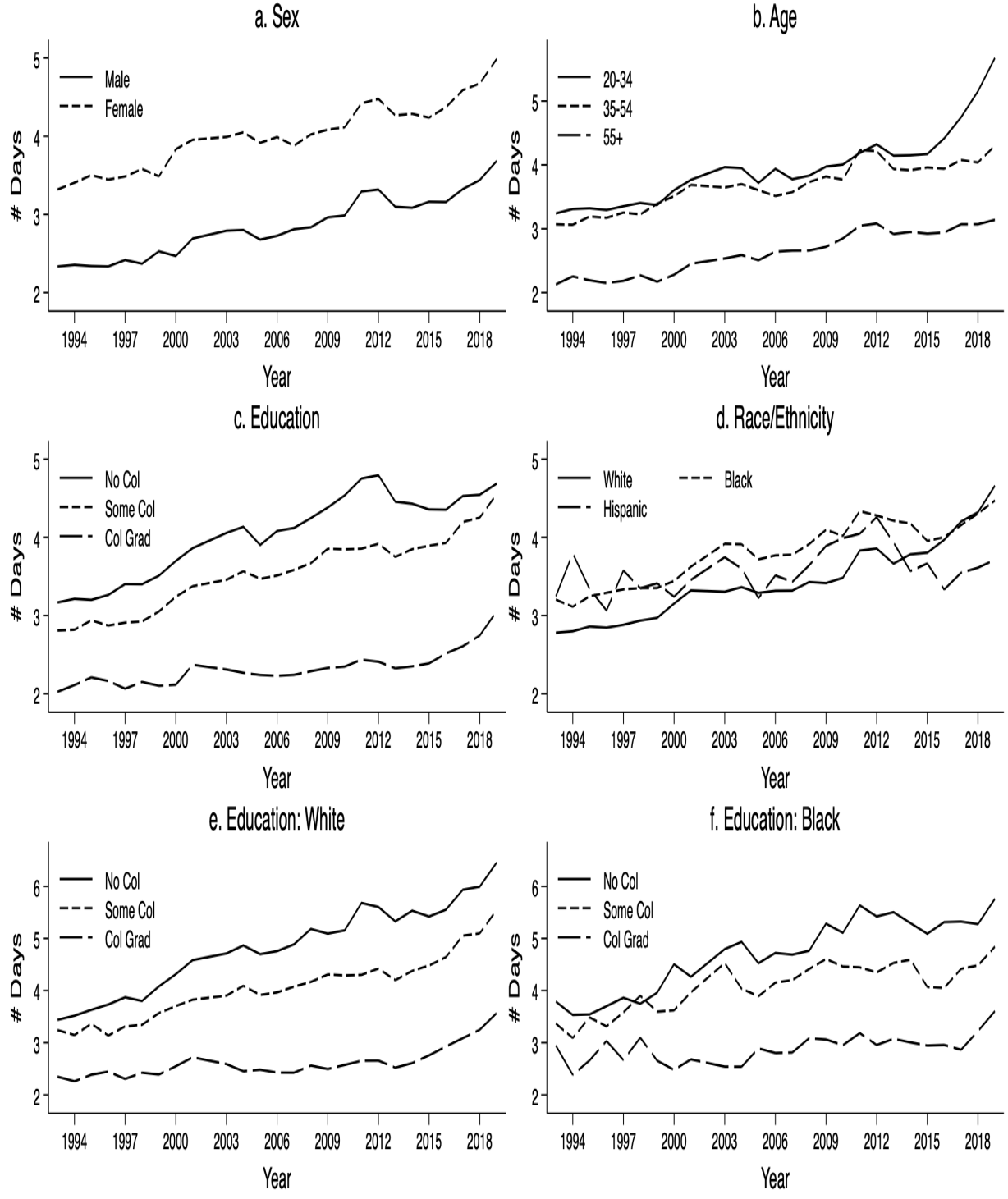
Note: Mortality rates are age-standardized and per 100,000 persons. The Counterfactual 2019 mortality rate is that predicted if average annual mortality rate changes from 1980-1999, calculated for all 25-54 year olds of the specified race, had continued through 2019. Adjusted Mortality Rate Change is the difference between the actual and counterfactual 2019 rate. Mortality rates in 1980 include Hispanics. This is adjusted for when computing adjusted mortality rate changes using the methods discussed in the text.

Figure 1: Poor Mental Health Days in the U.S. 1993-2019



Note: Figure shows average number of age-standardized poor mental health days in the last 30 and the probability of poor mental health in 15+ or all 30 days during the period using data from the *BRFSS* from 1993-2019.

Figure 2: Days of Poor Mental Health, By Subgroup



Note: Figure shows age-standardized number of poor mental health days in the last 30 days using data from the *BRFSS* from 1993-2019. White and Black refer to Non-Hispanics.

Figure 3: Trend Coefficients on Poor Mental Health 1993-2019, By Subgroup

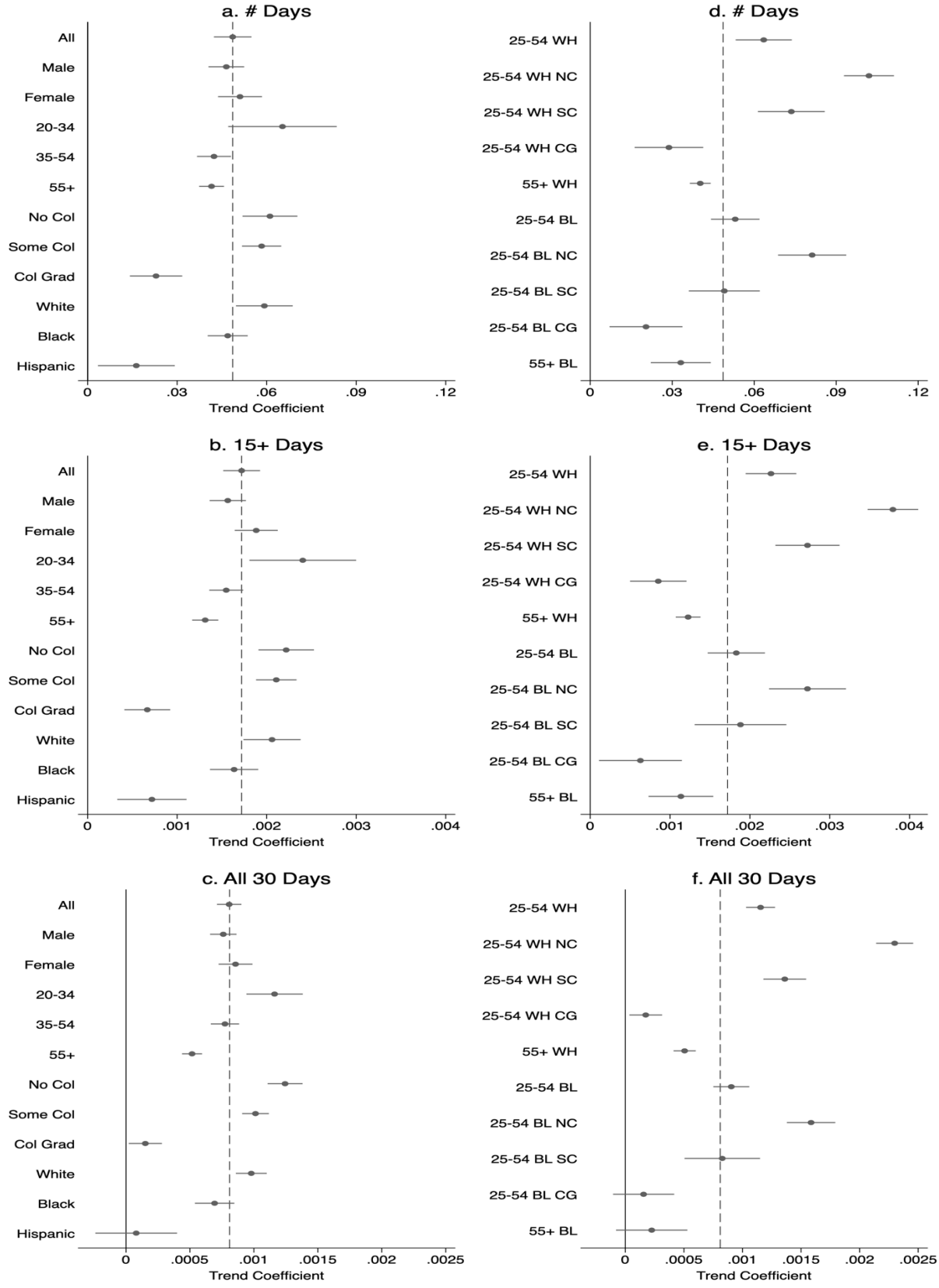
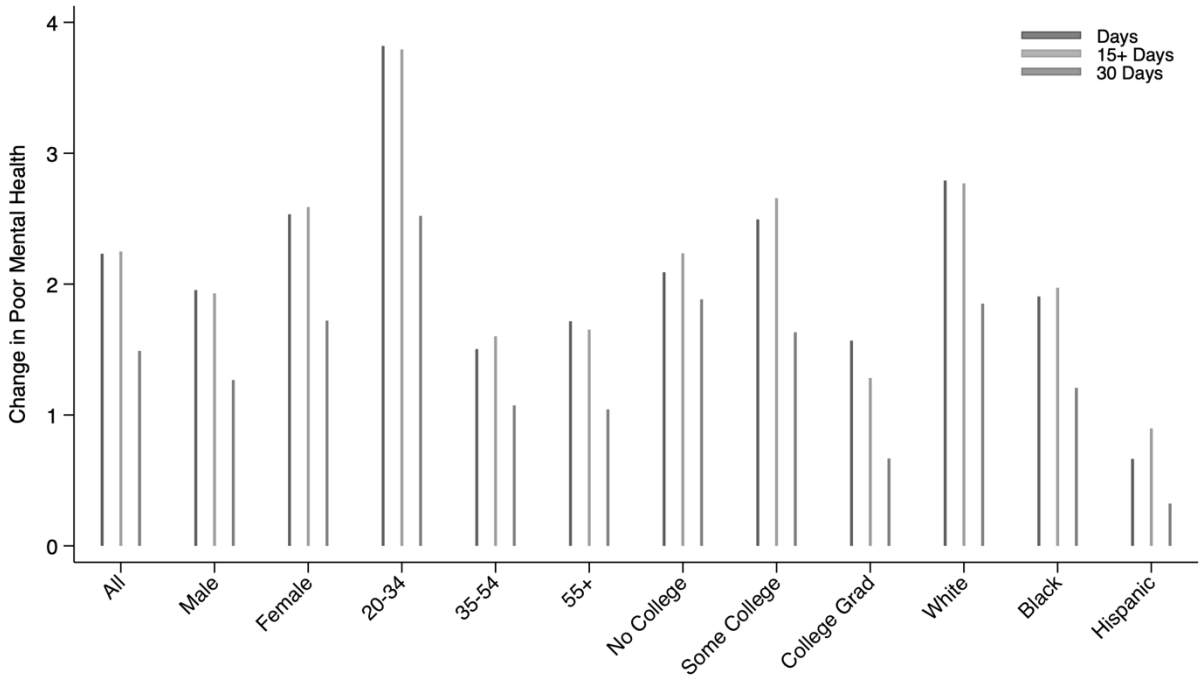


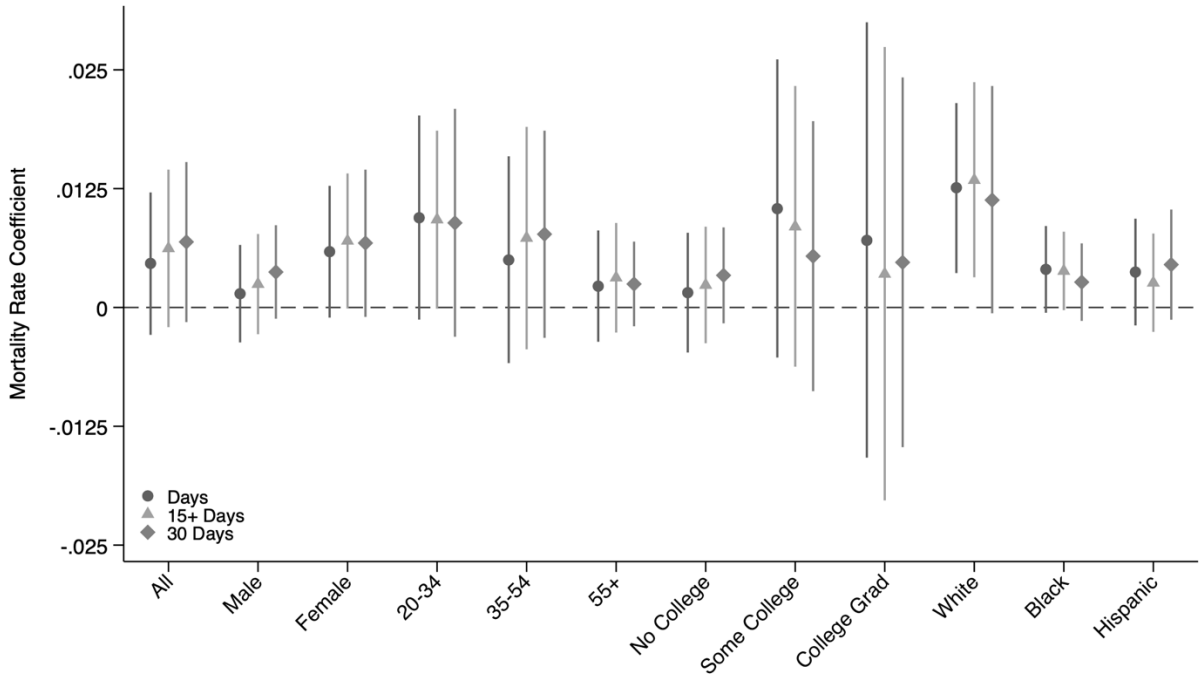
Figure shows coefficient estimates from regressing the proxy for age-standardized poor mental health on a linear time trend using data from the *BRFSS* from 1993-2019. Error bars show 95 percent confidence intervals based on robust standard errors. Vertical dashed lines show the full sample trend coefficient. The dependent variables refer to number of poor mental health days in last the 30. WH, BL, NC, SC, and CG refer to Whites, Blacks, no college, some college, and college graduate, and 25-54 and 55+ to age ranges.

Figure 4: Changes in Poor Mental Health and Predicted Effects On Age Standardized Mortality Rates for Population Groups

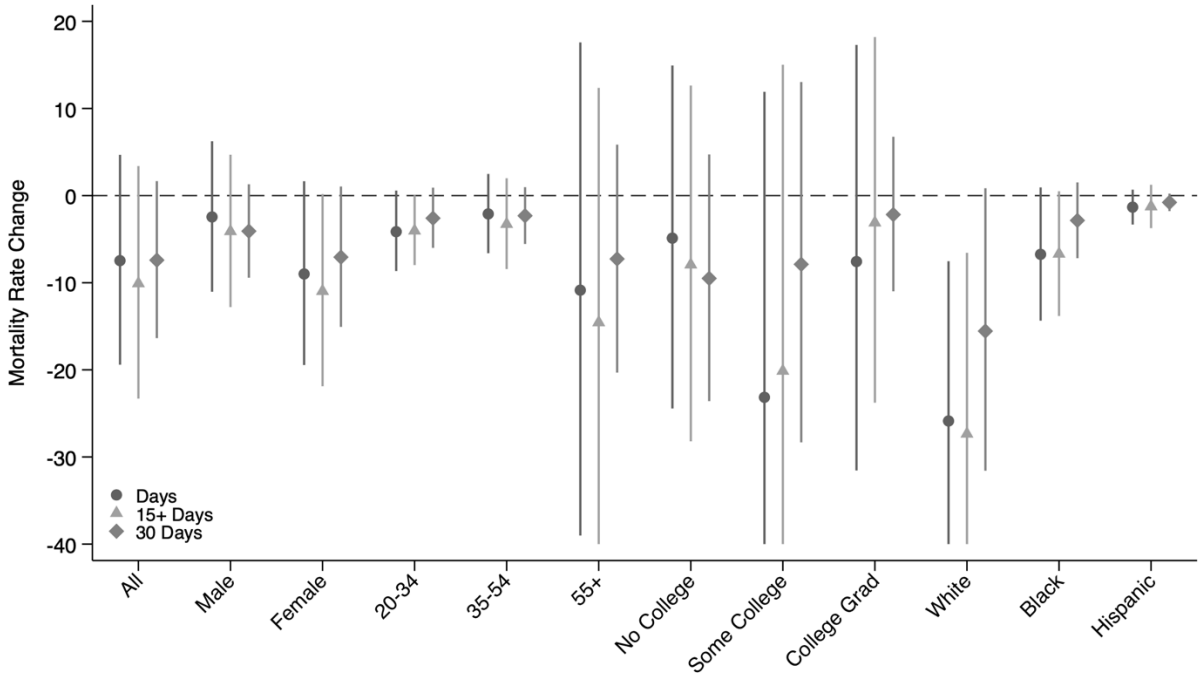
A. Change in Standardized Poor Mental Health, 1999-2019



B. Mortality Response to a One Standard Deviation Increase in Poor Mental Health



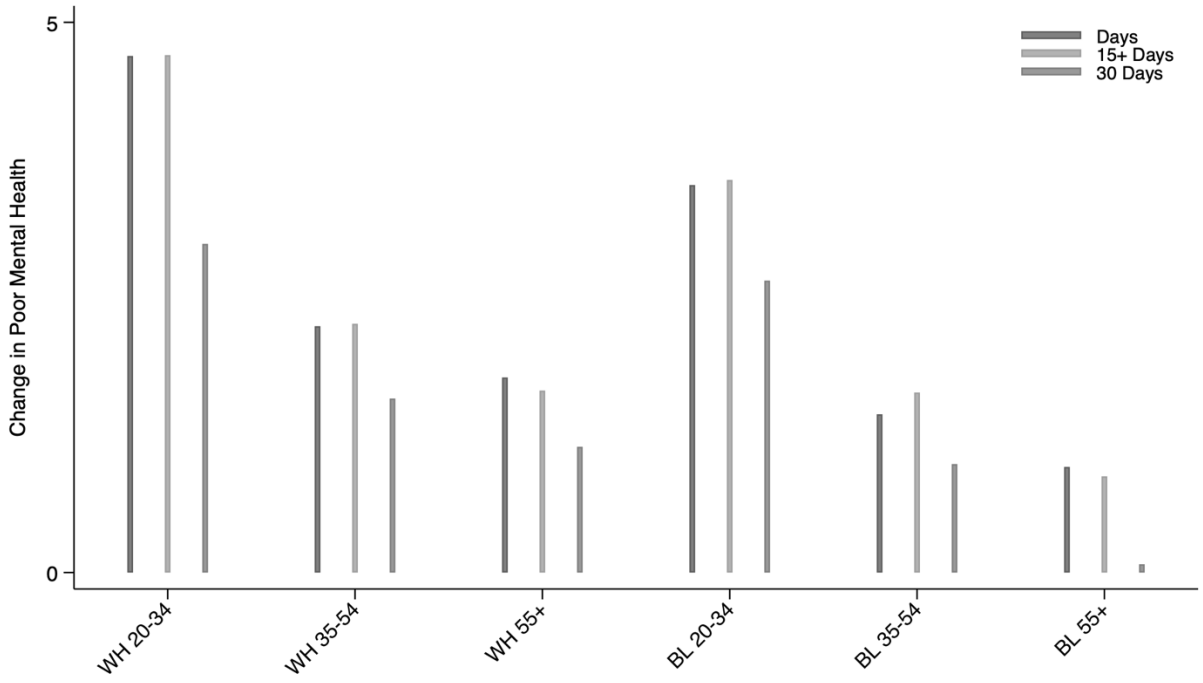
C. Constant Mental Health Δ in 2019 Mortality Rates



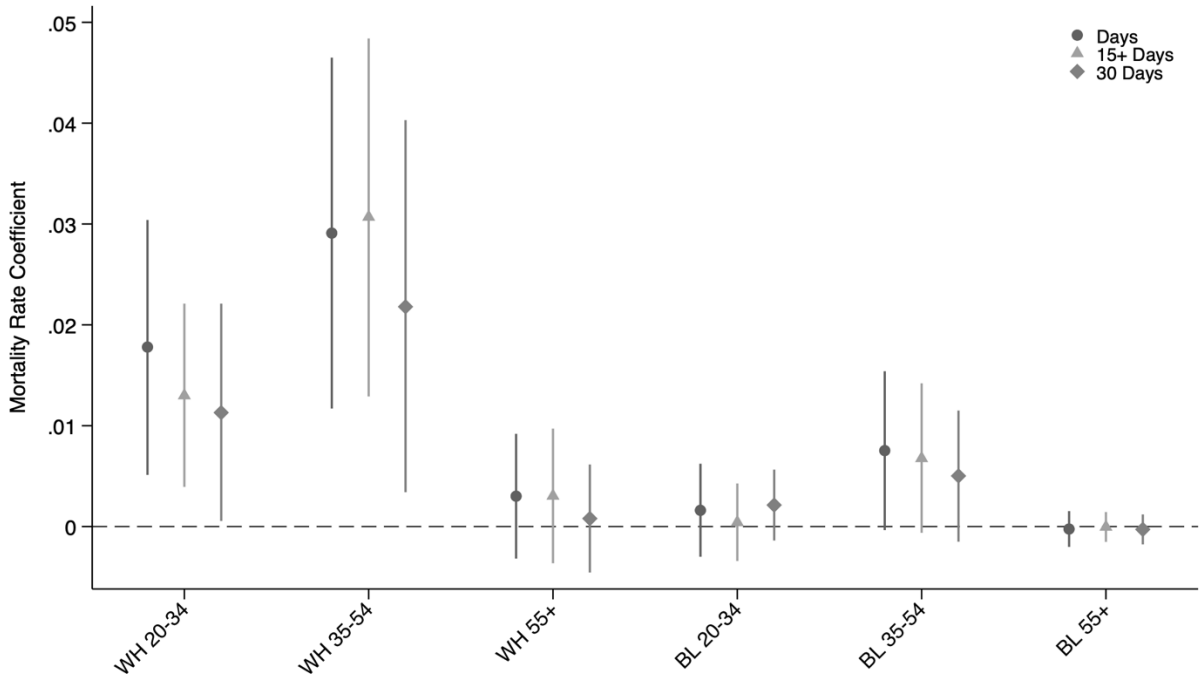
Top figure shows change in poor mental health from 1999 to 2019, measured in standardized units (standard deviations based on national data). Middle figure shows mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects and, except for race groups, the state population shares of non-Hispanic Blacks, Hispanics, and non-Hispanic other races The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figure shows estimated reductions in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. Whites and Blacks refer to non-Hispanics. Cells are weighted by average state populations for the specific group over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files. For clarity of display, the lower bounds of the CI's are censored at -40 in the lower figure.

Figure 5: Changes in Poor Mental Health and Predicted Effects On Age Standardized Mortality Rates for Race-Age Subgroups

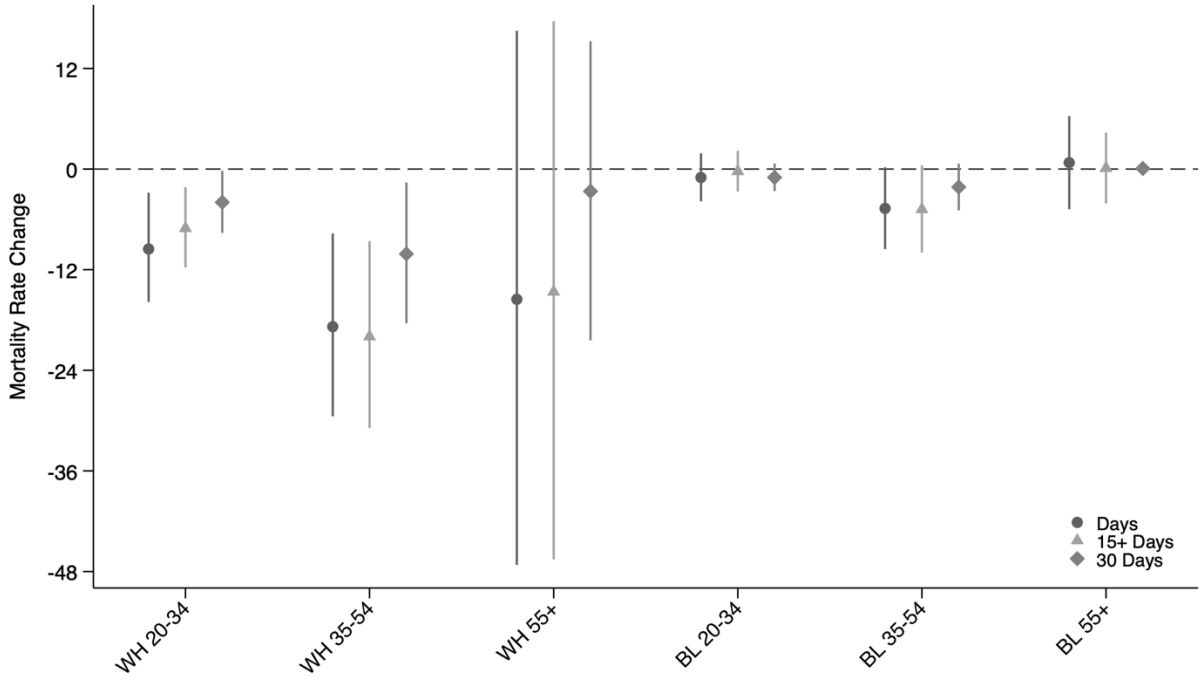
A. Change in Standardized Poor Mental Health, 1999-2019



B. Mortality Response to a One Standard Deviation Increase in Poor Mental Health



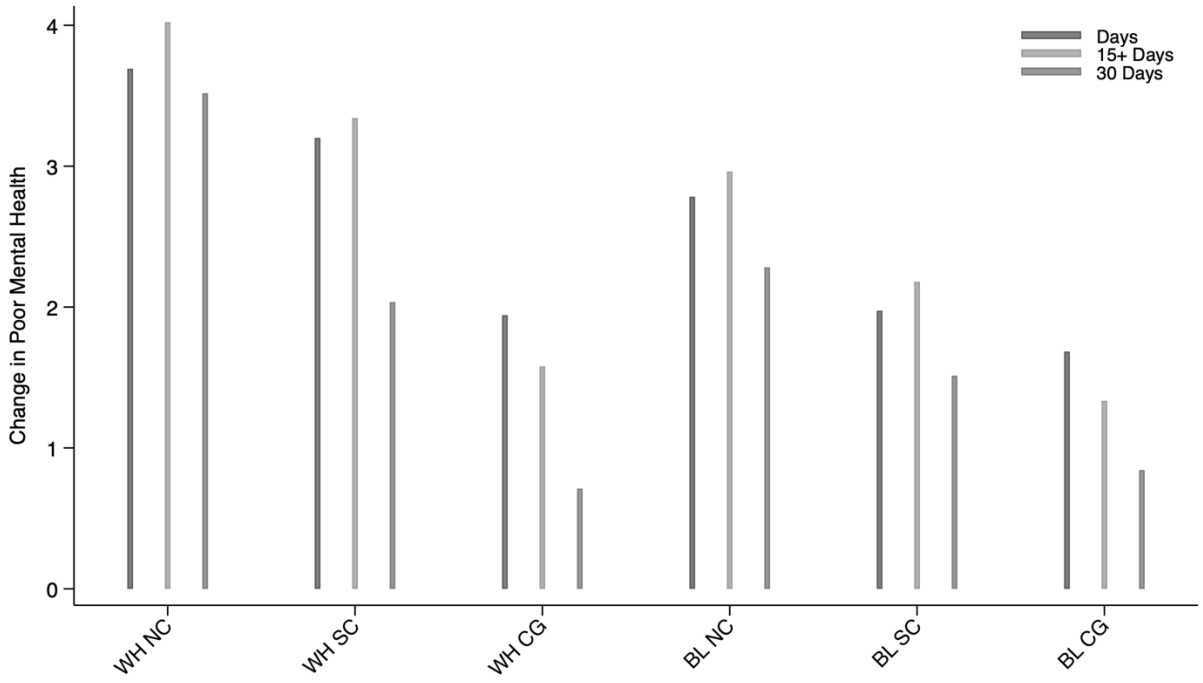
C. Constant Mental Health Δ in 2019 Mortality Rates



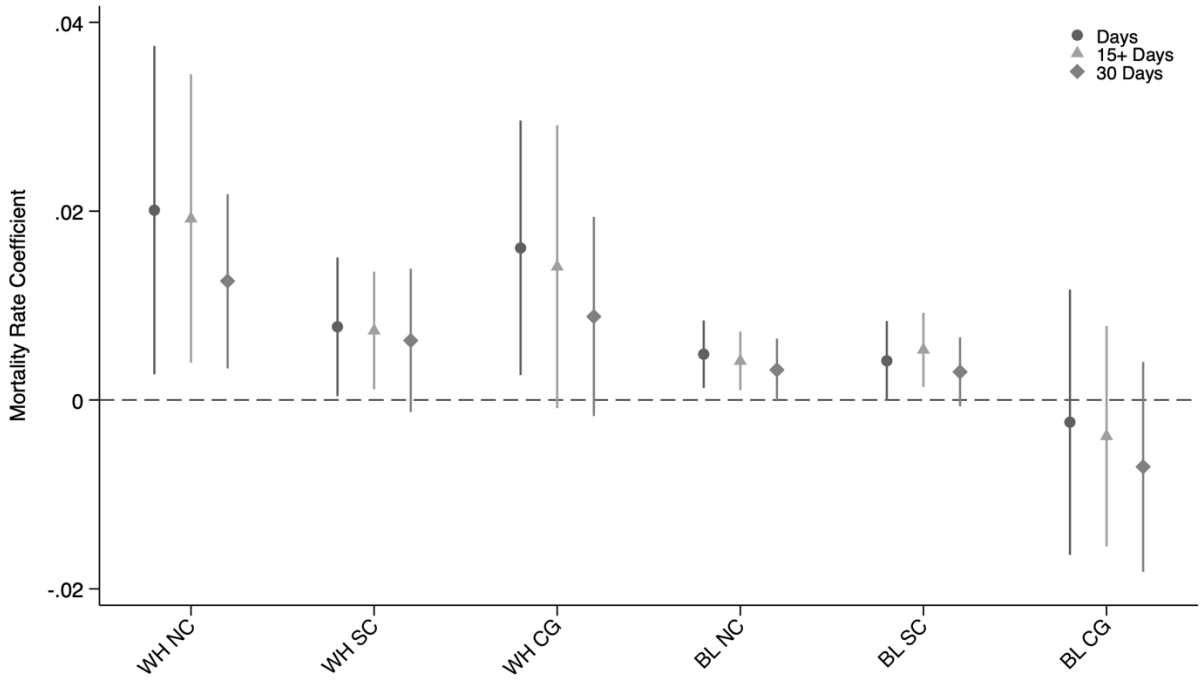
Top figure shows change in poor mental health from 1999 to 2019, measured in standardized units (standard deviations based on national data). Middle figure shows mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figure shows estimated reductions in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. WH and BL refer to Whites and Blacks. Cells are weighted by average state populations for the age-race group over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files

Figure 6: Changes in Poor Mental Health and Predicted Effects On Age Standardized Mortality Rates for 25-54 Year Olds for Race-Education Subgroups

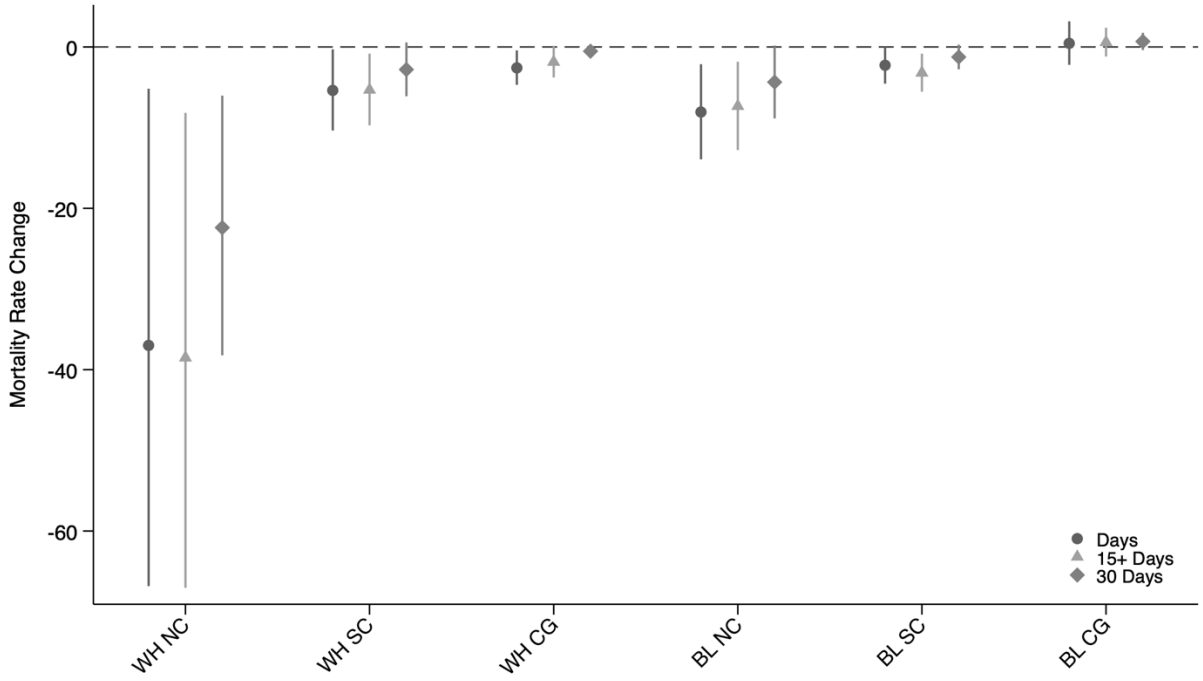
A. Change in Standardized Poor Mental Health, 1999-2019



B. Mortality Response to a One Standard Deviation Increase in Poor Mental Health



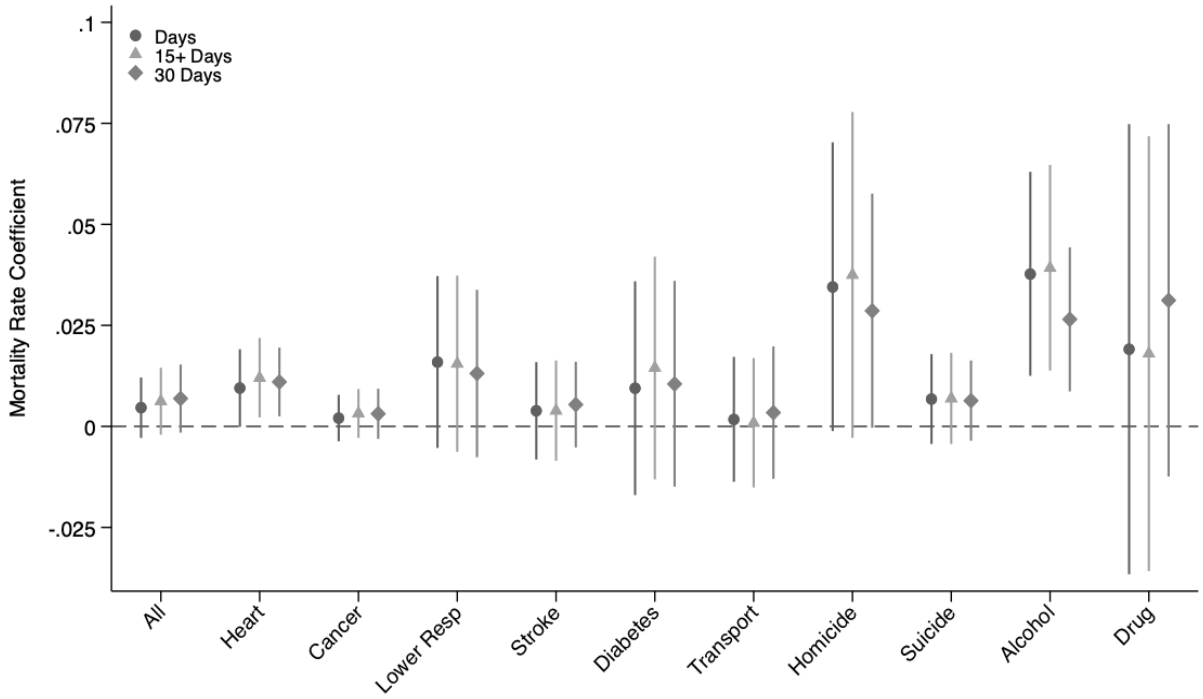
C. Constant Mental Health Δ in 2019 Mortality Rates



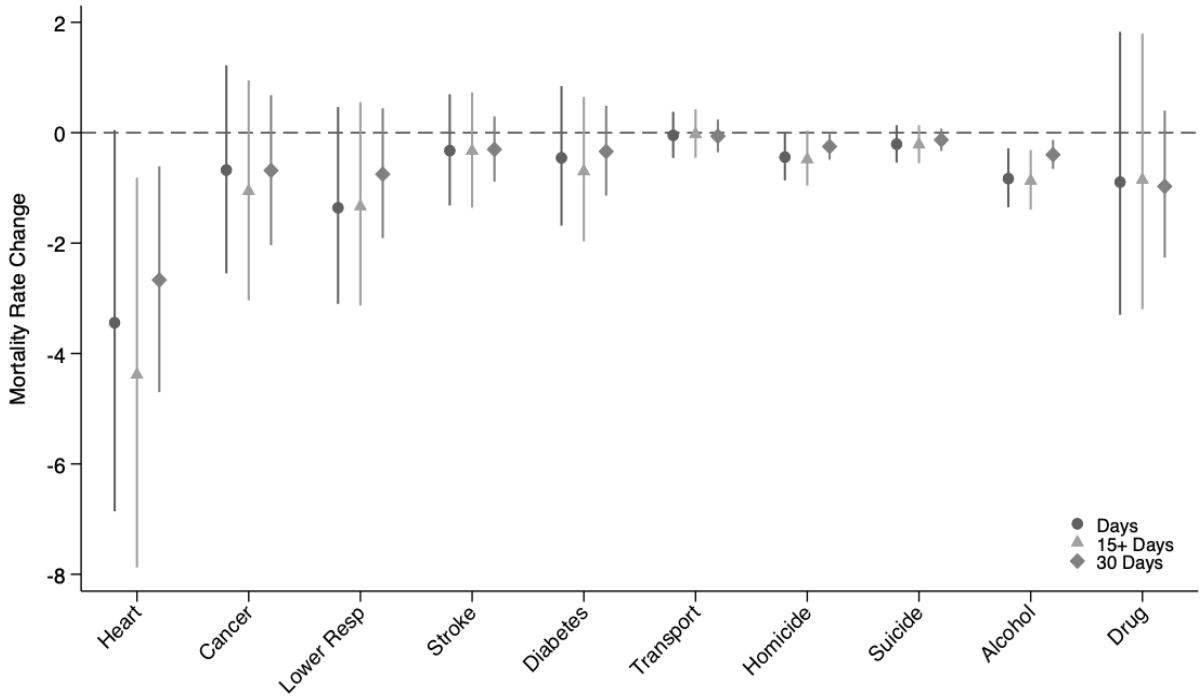
Top figure shows change in poor mental health from 1999 to 2019, measured in standardized units (standard deviations based on national data). Middle figure shows mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figure shows estimated reductions in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. WH and BL refer to Whites and Blacks and NC, SC, and CG refer to no college, some college, and college graduate. Cells are weighted by average state populations for the age-race group over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files.

Figure 7: Predicted Effects of Poor Mental Health On Cause-Specific Mortality Rates

A. Mortality Response to a One Standard Deviation Increase in Poor Mental Health

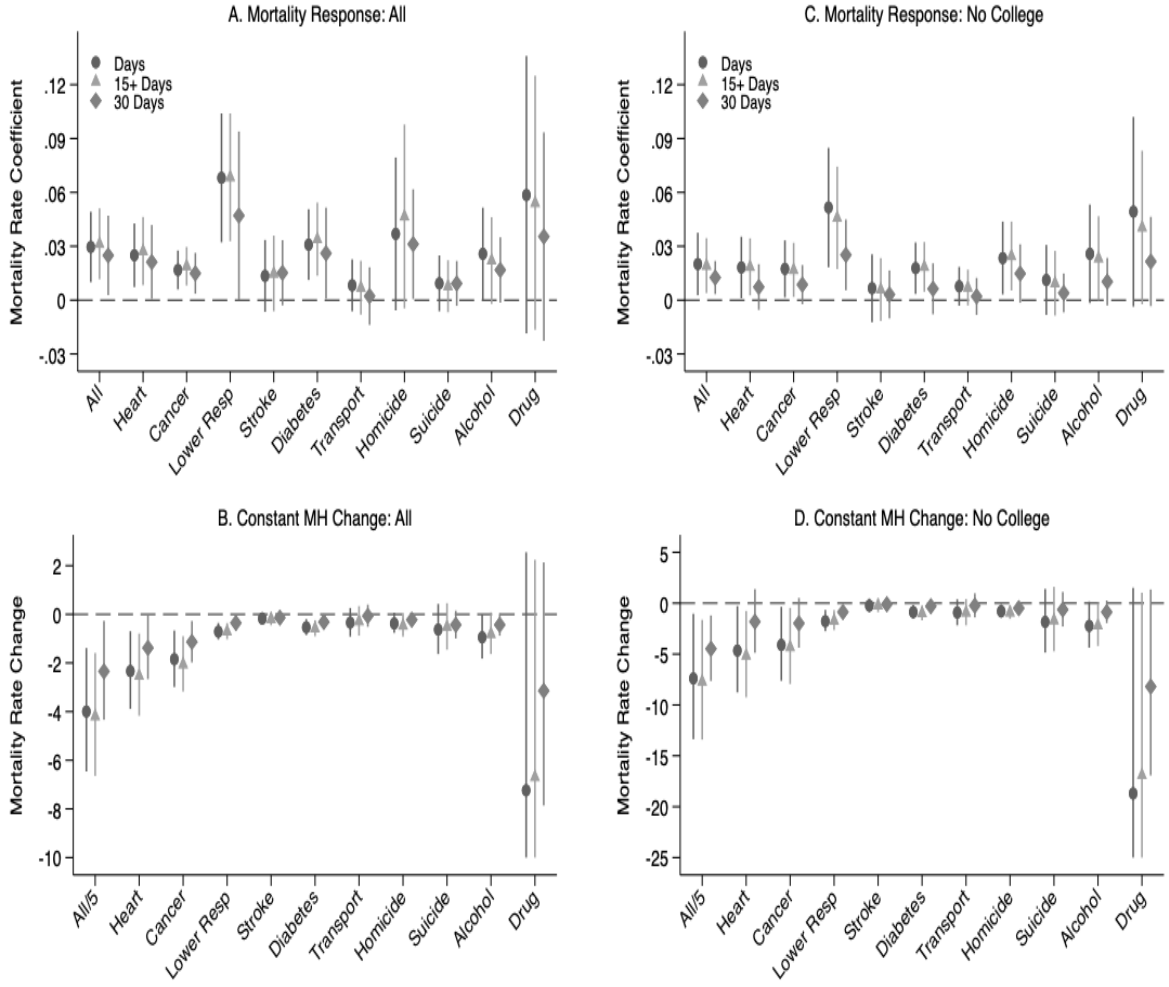


B. Constant Mental Health Δ in 2019 Mortality Rates



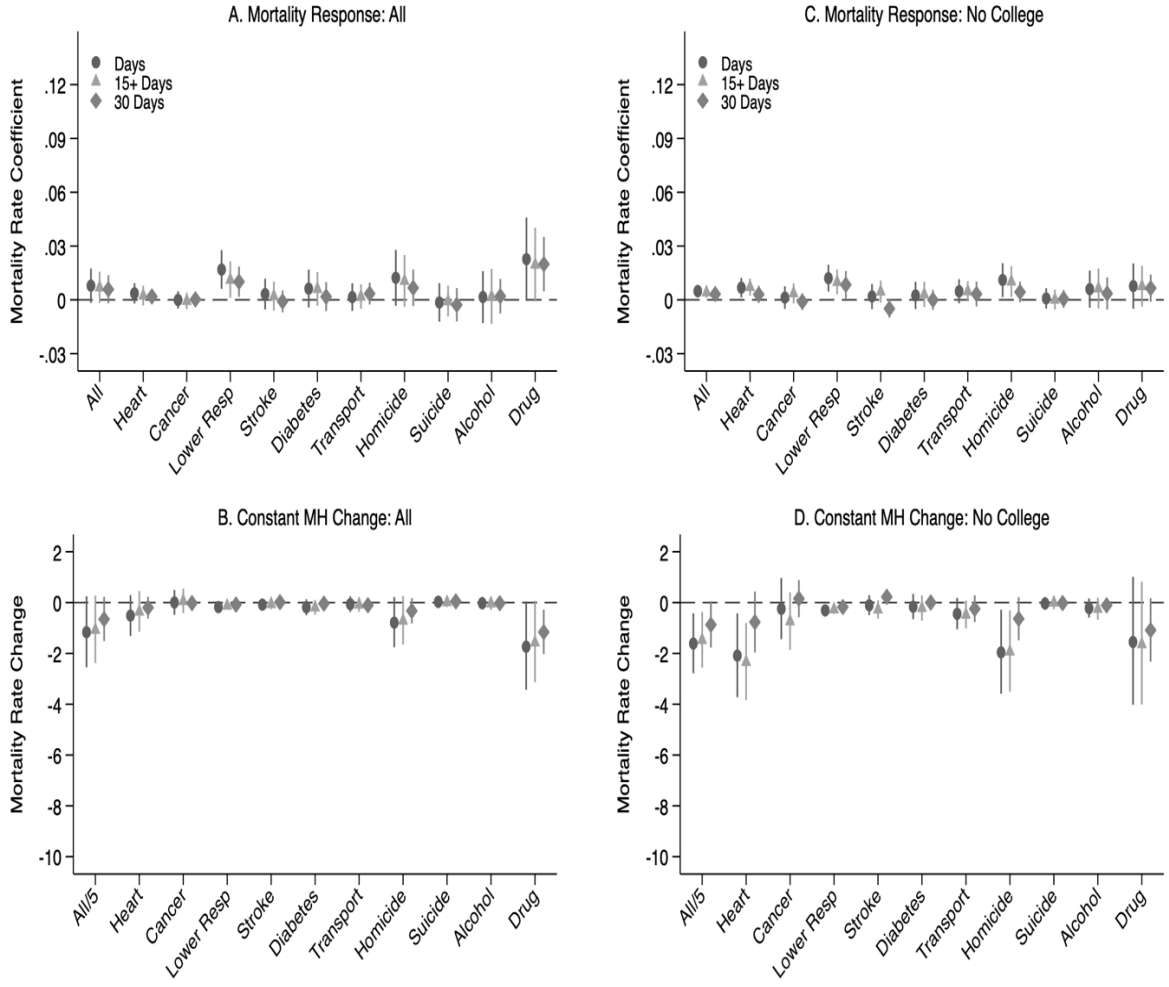
Top figure shows mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects and the state population shares of non-Hispanic Blacks, Hispanics, and non-Hispanic other races. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figure shows estimated reduction in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. Cells are weighted by average state populations over the 1993-2019 period. Error bars show 95 percent confidence intervals based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files.

Figure 8: Predicted Effects of Poor Mental Health On Age Standardized Mortality Rates for 25-54 Year Old Non-Hispanic Whites



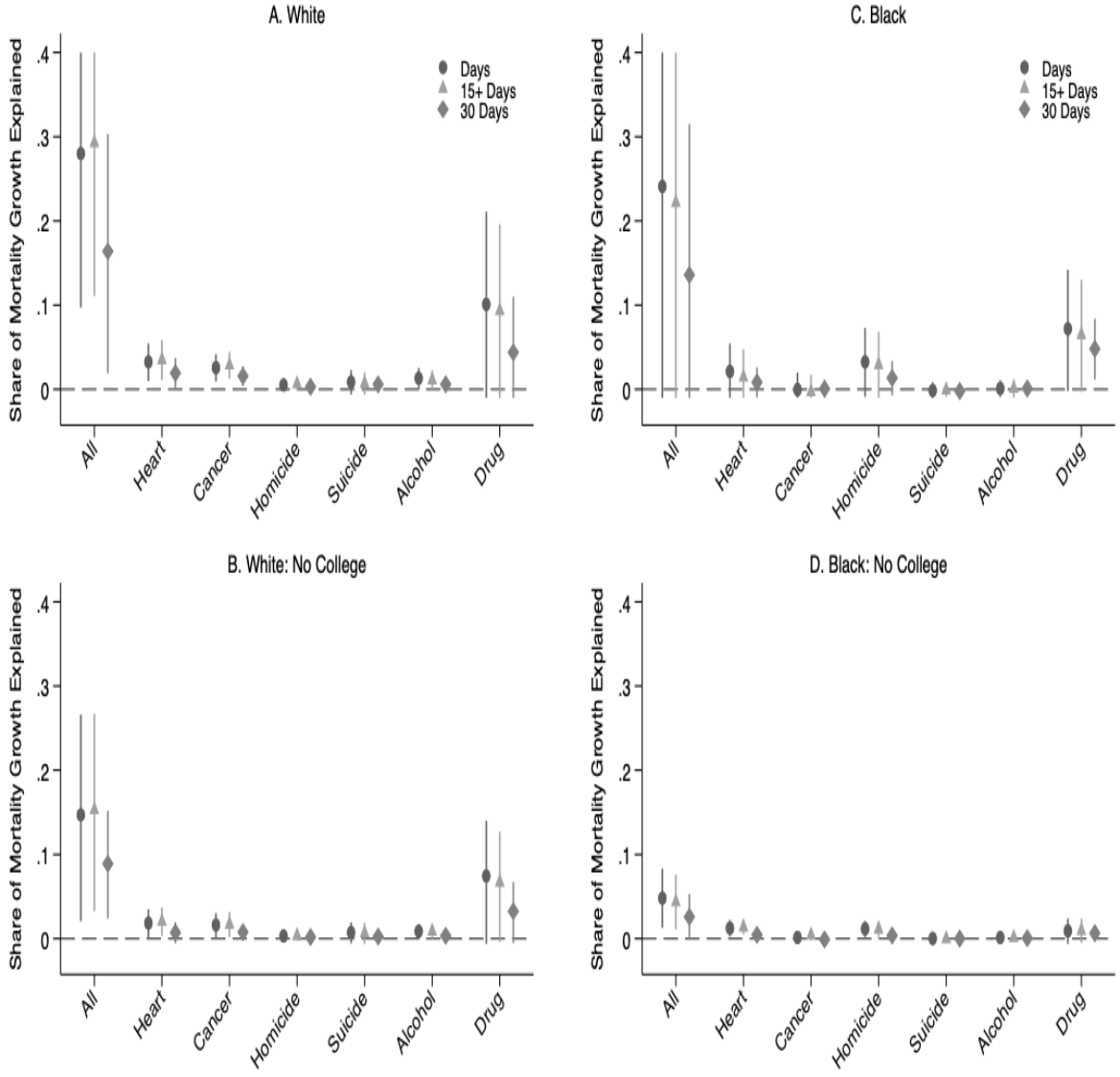
Top figures show mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figures show estimated reductions in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. Cells are weighted by race-age specific average state populations over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files. For clarity of display, estimated Constant MH Δ's are divided by 5 for all-cause mortality, the upper bound of the CI is censored at 2 in sub-figure B and the lower bounds at -10 and -25, respectively in sub-figures B and D.

Figure 9: Predicted Effects of Poor Mental Health On Age Standardized Mortality Rates for 25-54 Year Old Non-Hispanic Blacks



Top figures show mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1993-2019 period, plus state and time fixed-effects. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy. Bottom figure show estimated reductions in 2019 age-standardized mortality rates (per 100,000) if poor mental health had remained at 1999 levels. Sub-Figures A and B include all prime-age non-Hispanic Blacks, while C and D are restricted to those without college educations. Cells are weighted by race-age specific average state populations over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files. For clarity of display, estimated Constant MH Δ's are divided by 5 for all-cause mortality.

Figure 10: Share of Adjusted Mortality Rate Changes From 1999-2019 for 25-54 Year Old Explained by Increases in Poor Mental Health, Overall and For Selected Causes of Death



Mortality rates are per 100,000 and age-standardized. Adjusted mortality rate changes are actual minus counterfactual 2019 mortality rates. Counterfactual 2019 mortality rate is that predicted if average annual mortality rate changes from 1980-1999, calculated for all 25-54 year olds of the specified race, had continued through 2019. The shares accounted for are calculated by dividing the Constant MH changes, described above, by the adjusted mortality rate changes and reversing the sign. Whites and Blacks refer to non-Hispanics. Error bars show 95 percent confidence intervals. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files. For clarity of display, lower (upper) bounds of the CI's are censored at -.01 (0.4).

Appendix A: Additional Tables and Figures

Table A1: ICD-9 and ICD-10 Codes for Underlying Causes of Deaths Analyzed

Cause of Death	ICD-9 Codes	ICD-10 Codes
Heart	390-398, 402, 404-429	I00-I09, I11, I13, I20-I51
Cancer	140-208	C00-C97
Accidents	E800-E949	V01-X59, Y85-Y86
Chronic Lower Respiratory	490-496	J40-J47
Stroke	430-438	I60-I69
Diabetes Mellitus	250	E10-E14
Chronic Liver	571	K70, K73, K74
Alcohol		F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70.0-70.4, K70.9, K85.2, K86.0, X45, X65, Y15
Transport Accidents	E800-E849, E929.0, E929.1	V01-V99, Y85
Suicide	E950-E959	X60-X84, Y87.0
Homicide	E960-E969	X85-Y09, Y87.1
Drugs	E850-E858, E950.0-E950.5, E962.0, E980.0-E980.5	X40-X44, X60-X64, X85, Y10-Y14

Note: Table shows ICD-9 and ICD-10 underlying cause of death codes for mortality outcomes.

Table A2: Trend Coefficients for Population Groups

Outcome	All	Male	Female	20-34	35-54	55+	No College	Some College	College Grad	White	Black	Hispanic
# Days	0.04861***	0.04649***	0.05107***	0.06530***	0.04235***	0.04153***	0.06161***	0.05996***	0.02561***	0.05922***	0.04695***	0.01632**
	(0.00305)	(0.00290)	(0.00357)	(0.00881)	(0.00276)	(0.00202)	(0.00400)	(0.00418)	(0.00512)	(0.00461)	(0.00325)	(0.00623)
Log # Days	0.01417***	0.01638***	0.01278***	0.01611***	0.01170***	0.01601***	0.01552***	0.01673***	0.01016***	0.01704***	0.01257***	0.00460**
	(0.00073)	(0.00083)	(0.00078)	(0.00170)	(0.00078)	(0.00080)	(0.00107)	(0.00094)	(0.00178)	(0.00099)	(0.00087)	(0.00174)
15+ Day Rate	0.00172***	0.00157***	0.00188***	0.00240***	0.00155***	0.00131***	0.00224***	0.00218***	0.00078***	0.00206***	0.00164***	0.00072***
	(0.00010)	(0.00010)	(0.00012)	(0.00029)	(0.00009)	(0.00007)	(0.00013)	(0.00015)	(0.00016)	(0.00015)	(0.00013)	(0.00019)
Log 15+ Day Rate	0.01752***	0.01911***	0.01655***	0.02188***	0.01477***	0.01679***	0.01868***	0.02121***	0.01231***	0.02079***	0.01501***	0.00681***
	(0.00079)	(0.00095)	(0.00087)	(0.00186)	(0.00089)	(0.00092)	(0.00122)	(0.00110)	(0.00218)	(0.00107)	(0.00117)	(0.00173)
30 Day Rate	0.00081***	0.00076***	0.00086***	0.00116***	0.00077***	0.00052***	0.00124***	0.00102***	0.00017**	0.00098***	0.00069***	0.00008
	(0.00005)	(0.00005)	(0.00006)	(0.00011)	(0.00005)	(0.00004)	(0.00007)	(0.00006)	(0.00006)	(0.00006)	(0.00007)	(0.00015)
Log 30 Day Rate	0.01607***	0.01781***	0.01496***	0.02370***	0.01423***	0.01136***	0.01893***	0.02011***	0.00629**	0.01967***	0.01197***	0.00184
	(0.00098)	(0.00105)	(0.00133)	(0.00172)	(0.00116)	(0.00087)	(0.00128)	(0.00116)	(0.00225)	(0.00097)	(0.00140)	(0.00278)

Note: Table shows coefficient estimates from regressing the measure of poor mental on a linear time trend, with robust standard errors shown in parentheses. The dependent variables refer to number of poor mental health days in last 30. Analysis period is 1993-2019. *p<0.10, **, p<0.05, ***p<0.01

Table A3: Trend Coefficients for Race by Age, Education and Sex Groups

Outcome	White: 25-54	White 25-54 No Col	White 25-54 Some Col	White 25-54 Col Grad	White 55+	Black 25-54	Black 25-54 No Col
# Days	0.06349***	0.10199***	0.07359***	0.02881***	0.04026***	0.05306***	0.08120***
	(0.00497)	(0.00443)	(0.00593)	(0.00608)	(0.00184)	(0.00430)	(0.00604)
Log # Days	0.01677***	0.02170***	0.01817***	0.01049***	0.01622***	0.01334***	0.01790***
	(0.00100)	(0.00097)	(0.00116)	(0.00198)	(0.00066)	(0.00108)	(0.00142)
15+ Day Rate	0.00226***	0.00379***	0.00272***	0.00085***	0.00123***	0.00183***	0.00272***
	(0.00015)	(0.00015)	(0.00019)	(0.00017)	(0.00008)	(0.00017)	(0.00023)
Log 15+ Day Rate	0.02117***	0.02636***	0.02356***	0.01292***	0.01649***	0.01577***	0.01992***
	(0.00100)	(0.00110)	(0.00132)	(0.00234)	(0.00091)	(0.00146)	(0.00173)
30 Day Rate	0.00115***	0.00230***	0.00136***	0.00017**	0.00051***	0.00090***	0.00159***
	(0.00006)	(0.00008)	(0.00009)	(0.00007)	(0.00005)	(0.00007)	(0.00010)
Log 30 Day Rate	0.02182***	0.02983***	0.02408***	0.00626**	0.01169***	0.01481***	0.02083***
	(0.00102)	(0.00167)	(0.00140)	(0.00239)	(0.00100)	(0.00124)	(0.00143)

Outcome	Black 25-54 Some Col	Black 25-54 Col Grad	Black 55+	White 25-54 Male	White 25-54 Female	Black 25-54 Male	Black 25-54 Female
# Days	0.04906***	0.02042***	0.03314***	0.05899***	0.06833***	0.05892***	0.05145***
	(0.00629)	(0.00646)	(0.00531)	(0.00474)	(0.00571)	(0.00544)	(0.00478)
Log # Days	0.01247***	0.00706***	0.01083***	0.01913***	0.01520***	0.01830***	0.01123***
	(0.00164)	(0.00218)	(0.00176)	(0.00114)	(0.00103)	(0.00176)	(0.00105)
15+ Day Rate	0.00188***	0.00063**	0.00114***	0.00202***	0.00252***	0.00195***	0.00183***
	(0.00028)	(0.00025)	(0.00020)	(0.00015)	(0.00018)	(0.00022)	(0.00017)
Log 15+ Day Rate	0.01661***	0.00852**	0.01226***	0.02311***	0.01990***	0.02084***	0.01364***
	(0.00257)	(0.00331)	(0.00217)	(0.00124)	(0.00111)	(0.00239)	(0.00129)
30 Day Rate	0.00083***	0.00016	0.00023	0.00103***	0.00129***	0.00105***	0.00084***
	(0.00016)	(0.00013)	(0.00015)	(0.00007)	(0.00008)	(0.00012)	(0.00013)
Log 30 Day Rate	0.01461***	0.00448	0.00429	0.02331***	0.02085***	0.02119***	0.01204***
	(0.00288)	(0.00354)	(0.00280)	(0.00132)	(0.00149)	(0.00257)	(0.00199)

Note: Table shows coefficient estimates from regressing the measure of age-standardized poor mental on a linear time trend, with robust standard errors shown in parentheses. Analysis period is 1993-2019. *p<0.10, **, p<0.05, ***p<0.01

Table A4: Mortality Rates, Changes in Poor Mental Health, and Counterfactual Mortality Rate Changes for Population Groups

Outcome/ Mental Health Proxy	All	Male	Female	20-34	35-54	55+	No College	Some College	College Grad	White	Black	Hispanic
Age-Standardized Mortality Rate												
Rate: 1999	875.4	1,072.0	731.2	98.62	298.5	3,496.6	1,489.2	921.5	988.0	861.5	1,159.4	683.7
Rate: 2019	725.2	864.7	609.2	117.0	280.9	2,825.9	1,499.0	900.6	687.8	749.7	886.7	537.2
Δ: 1999-2019	-150.2	-207.3	-122.0	18.4	-17.6	-670.7	9.8	-20.9	-300.2	-111.8	-272.7	-146.5
Δ in Poor Mental Health Variable: 1999-2019												
Days	2.23	1.95	2.53	3.82	1.50	1.72	2.09	2.49	1.57	2.79	1.91	0.66
15+ Days	2.25	1.93	2.59	3.79	1.60	1.65	2.24	2.66	1.28	2.77	1.97	0.90
All 30 Days	1.49	1.27	1.72	2.52	1.07	1.04	1.88	1.63	0.67	1.85	1.21	0.32
Mental Health Regression Coefficient												
Days	0.0046	0.0015	0.0059*	0.0094*	0.0050	0.0022	0.0016	0.0104	0.0071	0.0126***	0.0040*	0.0037
	(0.0038)	(0.0026)	(0.0035)	(0.0055)	(0.0055)	(0.0030)	(0.0032)	(0.0080)	(0.0117)	(0.0046)	(0.0023)	(0.0031)
15+ Days	0.0062	0.0025	0.0070*	0.0093*	0.0073	0.0031	0.0024	0.0085	0.0035	0.0134**	0.0038*	0.0026
	(0.0042)	(0.0027)	(0.0036)	(0.0048)	(0.0060)	(0.0029)	(0.0031)	(0.0075)	(0.0122)	(0.0052)	(0.0021)	(0.0028)
All 30 Days	0.0069	0.0037	0.0068*	0.0089	0.0077	0.0025	0.0034	0.0054	0.0048	0.0113*	0.0027	0.0044
	(0.0043)	(0.0025)	(0.0040)	(0.0061)	(0.0056)	(0.0023)	(0.0026)	(0.0072)	(0.0099)	(0.0061)	(0.0021)	(0.0031)
Constant Mental Health Δ in 2019 Mortality Rates												
Days	-7.5	-2.4	-9.0	-4.1	-2.1	-10.9	-4.9	-23.2	-7.6	-25.9	-6.7	-1.3
15+ Days	-10.1	-4.1	-11.0	-4.0	-3.3	-14.6	-7.9	-20.1	-3.1	-27.4	-6.7	-1.3
All 30 Days	-7.4	-4.1	-7.1	-2.6	-2.3	-7.3	-9.5	-7.9	-2.2	-15.6	-2.9	-0.8

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. Second panel shows changes 1999-2019 in the mental health proxies, in standardized units, constructed as unstandardized measures divided by the full population standard deviation (0.6013,

0.02114, and 0.01311, respectively, for days, 15+ days, and all 30 days). Third panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period and estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01.

Table A5: Mortality Rates, Changes in Poor Mental Health, and Counterfactual Mortality Rate Changes for Blacks and Whites, By Age

Outcome/Mental Health Proxy	White			Black		
	20-34	35-54	55+	20-34	35-54	55+
Age-Standardized Mortality Rate						
Rate: 1999	88.2	272.8	3,488.4	179.5	569.2	4,300.7
Rate: 2019	119.1	298.2	2,923.1	177.4	435.8	3,254.4
Δ: 1999-2019	30.9	25.4	-565.3	-2.1	-133.4	-1,046.3
Δ in Standardized Poor Mental Health Variable: 1999-2019						
Days	4.69	2.24	1.77	3.52	1.44	0.96
15+ Days	4.70	2.26	1.65	3.57	1.64	0.87
All 30 Days	2.99	1.58	1.14	2.65	0.99	0.08
Mental Health Regression Coefficient						
Days	0.0178***	0.0291***	0.0030	0.0016	0.0075*	-0.0002
	(0.0065)	(0.0089)	(0.0032)	(0.0024)	(0.0040)	(0.0009)
15+ Days	0.0130***	0.0307***	0.0030	0.0004	0.0068*	-0.0000
	(0.0046)	(0.0090)	(0.0034)	(0.0020)	(0.0038)	(0.0008)
All 30 Days	0.0113**	0.0218**	0.0008	0.0021	0.0050	-0.0003
	(0.0055)	(0.0094)	(0.0027)	(0.0018)	(0.0033)	(0.0008)
Constant Mental Health Δ in 2019 Mortality Rates						
Days	-9.5	-18.8	-15.5	-1.0	-4.7	0.8
15+ Days	-7.1	-20.0	-14.6	-0.3	-4.8	0.1
All 30 Days	-4.0	-10.1	-2.7	-1.0	-2.2	0.1

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. Second panel shows changes 1999-2019 in the mental health proxies, in standardized units, constructed as unstandardized measures divided by the full population standard deviation (0.6013, 0.02114, and 0.01311, respectively, for days, 15+ days, and all 30 days). Third panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period and estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. White and Black refer to non-Hispanics. Robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01.

Table A6: Mortality Rates, Changes in Poor Mental Health, and Counterfactual Mortality Rate Changes for Prime-Age Whites and Blacks, By Education

Outcome/Mental Health Proxy	White				Black			
	All	No Col	Some Col	Col Grad	All	No Col	Some Col	Col Grad
Age-Standardized Mortality Rate								
Rate: 1999	216.2	333.2	146.8	109.0	450.0	601.6	261.7	202.0
Rate: 2019	247.7	517.6	219.5	84.1	360.2	601.4	277.9	113.7
Δ: 1999-2019	31.5	184.4	72.7	-24.9	-89.8	-0.2	16.2	-88.3
Δ in Standardized Poor Mental Health Variable: 1999-2019								
Days	2.84	3.69	3.20	1.94	2.06	2.78	1.97	1.68
15+ Days	2.82	4.02	3.34	1.58	2.15	2.96	2.18	1.33
All 30 Days	1.95	3.52	2.04	0.71	1.56	2.28	1.51	0.84
Mental Health Regression Coefficient								
Days	0.0296***	0.0201**	0.0078**	0.0161**	0.0079	0.0048***	0.0042*	-0.0024
	(0.0100)	(0.0089)	(0.0037)	(0.0069)	(0.0049)	(0.0018)	(0.0021)	(0.0072)
15+ Days	0.0313***	0.0192**	0.0073**	0.0141*	0.0070	0.0041***	0.0053***	-0.0038
	(0.0101)	(0.0078)	(0.0032)	(0.0076)	(0.0044)	(0.0016)	(0.0020)	(0.0060)
All 30 Days	0.0249**	0.0126***	0.0063	0.0088	0.0059	0.0032*	0.0030	-0.0071
	(0.0113)	(0.0047)	(0.0039)	(0.0054)	(0.0040)	(0.0017)	(0.0019)	(0.0057)
Constant Mental Health Δ in 2019 Mortality Rates								
Days	-20.0	-37.0	-5.4	-2.6	-5.8	-8.1	-2.3	0.5
15+ Days	-20.9	-38.5	-5.3	-1.9	-5.3	-7.3	-3.2	0.6
All 30 Days	-11.7	-22.4	-2.8	-0.5	-3.3	-4.4	-1.2	0.7

Note: Top panel shows age-standardized national mortality rates (per 100,000) for 20-54 year olds in specified years and changes between them. Second panel shows changes 1999-2019 in the mental health proxies, in standardized units, constructed as unstandardized measures divided by the full population standard deviation (0.6013, 0.02114, and 0.01311, respectively, for days, 15+ days, and all 30 days). Third panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period and estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. White and Black refer to non-Hispanics. Education groups are for persons aged 25 and older. Robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01

Table A7: Age-Standardized Mortality Rates and Changes for Causes of Death

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Trans-port	Homicide	Suicide	Alcohol	Drug
Age-Standardized Mortality Rate											
Rate: 1999	875.4	266.4	200.7	45.4	61.6	25.0	16.6	6.0	10.5	7.1	6.0
Rate: 2019	725.2	164.2	147.8	38.9	37.7	21.8	12.2	6.0	13.8	10.3	21.5
Δ: 1999-2019	-150.2	-102.2	-52.9	-6.5	-23.9	-3.2	-4.4	0.0	3.4	3.2	15.4
Mental Health Regression Coefficient											
Days	0.0046	0.0095*	0.0021	0.0159	0.0039	0.0094	0.0017	0.0345*	0.0068	0.0377***	0.0191
	(0.0038)	(0.0049)	(0.0029)	(0.0109)	(0.0062)	(0.0135)	(0.0079)	(0.0182)	(0.0057)	(0.0129)	(0.0284)
15+ Days	0.0062	0.0120**	0.0032	0.0155	0.0039	0.0145	0.0009	0.0375*	0.0069	0.0392***	0.0180
	(0.0042)	(0.0050)	(0.0031)	(0.0111)	(0.0063)	(0.0141)	(0.0082)	(0.0206)	(0.0057)	(0.0130)	(0.0274)
All 30 Days	0.0069	0.0110**	0.0031	0.0131	0.0054	0.0105	0.0034	0.0286*	0.0064	0.0265***	0.0312
	(0.0043)	(0.0043)	(0.0032)	(0.0106)	(0.0054)	(0.0130)	(0.0084)	(0.0148)	(0.0051)	(0.0091)	(0.0223)
Constant Mental Health Δ in 2019 Mortality Rates											
Days	-7.5	-3.4	-0.7	-1.4	-0.3	-0.5	0.0	-0.4	-0.2	-0.8	-0.9
15+ Days	-10.1	-4.4	-1.1	-1.3	-0.3	-0.7	0.0	-0.5	-0.2	-0.9	-0.9
All 30 Days	-7.4	-2.7	-0.7	-0.8	-0.3	-0.3	-0.1	-0.2	-0.1	-0.4	-1.0

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. First six rows of the lower panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The last three rows show the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Poor mental health days, 15+ days, and all 30 days increase by 2.23, 2.25, and 1.49 standard deviations, respectively, from 1999-2019.

Table A8: Age-Standardized Mortality Rates and Changes for Causes of Death, 25-54 Year Old Non-Hispanic Whites

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Age-Standardized Mortality Rate											
Rate: 1999	216.2	40.2	55.9	3.4	5.5	5.1	16.9	3.8	16.1	8.0	11.4
Rate: 2019	247.7	34.0	39.6	4.0	4.7	6.4	14.7	3.8	23.9	13.4	47.2
Δ: 1999-2019	31.5	-6.1	-16.3	0.6	-0.8	1.2	-2.2	0.0	7.8	5.3	35.9
Mental Health Regression Coefficient											
Days	0.0296***	0.0250***	0.0168***	0.0681***	0.0135	0.0309***	0.0082	0.0369*	0.0094	0.0258**	0.0585
	(0.0100)	(0.0090)	(0.0055)	(0.0183)	(0.0102)	(0.0101)	(0.0074)	(0.0217)	(0.0079)	(0.0131)	(0.0393)
15+ Days	0.0313***	0.0273***	0.0189***	0.0685***	0.0148	0.0339***	0.0069	0.0466*	0.0077	0.0221*	0.0541
	(0.0101)	(0.0097)	(0.0055)	(0.0183)	(0.0107)	(0.0104)	(0.0076)	(0.0261)	(0.0074)	(0.0123)	(0.0360)
All 30 Days	0.0249**	0.0212**	0.0149***	0.0471**	0.0152	0.0261**	0.0023	0.0312**	0.0093	0.0168*	0.0354
	(0.0113)	(0.0105)	(0.0058)	(0.0239)	(0.0093)	(0.0129)	(0.0082)	(0.0156)	(0.0064)	(0.0093)	(0.0296)
Constant Mental Health Δ in 2019 Mortality Rates											
Days	-20.0	-2.3	-1.8	-0.7	-0.2	-0.5	-0.3	-0.4	-0.6	-0.9	-7.2
15+ Days	-20.9	-2.5	-2.1	-0.7	-0.2	-0.6	-0.3	-0.5	-0.5	-0.8	-6.7
All 30 Days	-11.7	-1.4	-1.1	-0.4	-0.1	-0.3	-0.1	-0.2	-0.4	-0.4	-3.1

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. First three rows of the lower panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The last three rows of the lower panel show the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Poor mental health days, 15+ days, and all 30 days increase by .84, 2.82, and 1.95 standard deviations, respectively, from 1999-2019.

Table A9: Age-Standardized Mortality Rates and Changes for Causes of Death, 25-54 Year Old Non-College Educated Non-Hispanic Whites

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Age-Standardized Mortality Rate											
Rate: 1999	333.2	61.4	75.6	6.1	8.3	7.9	25.9	23.3	12.5	6.5	18.5
Rate: 2019	517.6	71.7	66.0	10.2	9.8	13.8	32.9	45.3	24.5	9.6	112.5
Δ: 1999-2019	184.4	10.3	-9.6	4.2	1.5	5.8	6.9	22.0	12.1	3.1	94.0
Mental Health Regression Coefficient											
Days	0.0201**	0.0182**	0.0174**	0.0516***	0.0066	0.0178**	0.0077	0.0112	0.0258*	0.0234**	0.0493*
	(0.0089)	(0.0087)	(0.0081)	(0.0170)	(0.0096)	(0.0073)	(0.0055)	(0.0099)	(0.0140)	(0.0103)	(0.0270)
15+ Days	0.0192**	0.0185**	0.0168**	0.0458***	0.0059	0.0185***	0.0070	0.0094	0.0233*	0.0245**	0.0405*
	(0.0078)	(0.0081)	(0.0077)	(0.0145)	(0.0089)	(0.0070)	(0.0051)	(0.0092)	(0.0120)	(0.0098)	(0.0218)
All 30 Days	0.0126***	0.0073	0.0087	0.0252**	0.0031	0.0063	0.0021	0.0040	0.0103	0.0148*	0.0215*
	(0.0047)	(0.0065)	(0.0055)	(0.0100)	(0.0068)	(0.0072)	(0.0053)	(0.0055)	(0.0068)	(0.0083)	(0.0127)
Constant Mental Health Δ in 2019 Mortality Rates											
Days	-37.0	-4.7	-4.1	-1.8	-0.2	-0.9	-0.9	-0.8	-1.8	-2.2	-18.7
15+ Days	-38.5	-5.1	-4.3	-1.7	-0.2	-1.0	-0.9	-0.9	-1.7	-2.2	-16.9
All 30 Days	-22.4	-1.8	-2.0	-0.9	-0.1	-0.3	-0.2	-0.5	-0.6	-0.9	-8.2

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. First three rows of the lower panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The last three rows of the lower panel show the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Poor mental health days, 15+ days, and all 30 days increase by 3.69, 4.02, and 3.52 standard deviations, respectively, from 1999-2019.

Table A10: Age-Standardized Mortality Rates and Changes for Causes of Death, 25-54 Year Old Non-Hispanic Blacks

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Age-Standardized Mortality Rate											
Rate: 1999	450.0	90.1	87.7	7.1	19.9	14.3	19.8	26.1	7.7	11.8	14.9
Rate: 2019	360.2	68.9	49.5	5.2	12.2	14.6	19.4	31.6	10.6	8.0	38.0
Δ: 1999-2019	-89.8	-21.2	-38.2	-1.9	-7.8	0.3	-0.4	5.5	2.9	-3.8	23.1
Mental Health Regression Coefficient											
Days	0.0079	0.0036	-0.0000	0.0169***	0.0032	0.0063	0.0015	0.0123	-0.0014	0.0016	0.0227*
	(0.0049)	(0.0029)	(0.0024)	(0.0055)	(0.0044)	(0.0054)	(0.0039)	(0.0079)	(0.0055)	(0.0074)	(0.0119)
15+ Days	0.0070	0.0024	-0.0006	0.0112**	0.0021	0.0061	0.0019	0.0106	-0.0007	0.0020	0.0197*
	(0.0044)	(0.0028)	(0.0023)	(0.0052)	(0.0041)	(0.0048)	(0.0035)	(0.0074)	(0.0044)	(0.0078)	(0.0105)
All 30 Days	0.0059	0.0019	0.0003	0.0101**	-0.0009	0.0018	0.0035	0.0067	-0.0028	0.0021	0.0199**
	(0.0040)	(0.0021)	(0.0016)	(0.0043)	(0.0031)	(0.0041)	(0.0031)	(0.0052)	(0.0048)	(0.0049)	(0.0077)
Constant Mental Health Δ in 2019 Mortality Rates											
Days	-5.8	-0.5	0.0	-0.2	-0.1	-0.2	-0.1	-0.8	0.0	0.0	-1.7
15+ Days	-5.3	-0.4	0.1	-0.1	-0.1	-0.2	-0.1	-0.7	0.0	0.0	-1.6
All 30 Days	-3.3	-0.2	0.0	-0.1	0.0	0.0	-0.1	-0.3	0.0	0.0	-1.2

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. First three rows of the lower panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The last three rows of the lower panel show the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Poor mental health days, 15+ days, and all 30 days increase by 2.06, 2.15, and 1.56 standard deviations, respectively, from 1999-2019.

Table A11: Age-Standardized Mortality Rates and Changes for Causes of Death, 25-54 Year Old Non-College Educated Non-Hispanic Blacks

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Age-Standardized Mortality Rate											
Rate: 1999	601.6	111.7	101.9	9.6	24.0	17.9	24.6	9.1	16.7	38.1	20.8
Rate: 2019	601.4	111.5	69.1	9.1	20.1	23.9	33.5	15.9	13.3	64.6	73.2
Δ: 1999-2019	-0.2	-0.2	-32.9	-0.5	-3.9	6.0	9.0	6.8	-3.4	26.5	52.4
Mental Health Regression Coefficient											
Days	0.0048***	0.0068**	0.0013	0.0121***	0.0019	0.0025	0.0048	0.0111**	0.0008	0.0060	0.0077
	(0.0018)	(0.0028)	(0.0032)	(0.0038)	(0.0036)	(0.0039)	(0.0034)	(0.0048)	(0.0029)	(0.0053)	(0.0064)
15+ Days	0.0041***	0.0071***	0.0036	0.0100***	0.0046	0.0031	0.0048*	0.0102**	0.0001	0.0064	0.0076
	(0.0016)	(0.0024)	(0.0029)	(0.0035)	(0.0032)	(0.0036)	(0.0029)	(0.0044)	(0.0028)	(0.0057)	(0.0058)
All 30 Days	0.0032*	0.0030	-0.0010	0.0084**	-0.0049*	-0.0000	0.0032	0.0043	0.0005	0.0035	0.0065*
	(0.0017)	(0.0024)	(0.0024)	(0.0039)	(0.0026)	(0.0028)	(0.0035)	(0.0029)	(0.0025)	(0.0046)	(0.0039)
Constant Mental Health Δ in 2019 Mortality Rates											
Days	-8.1	-2.1	-0.2	-0.3	-0.1	-0.2	-0.4	-2.0	0.0	-0.2	-1.6
15+ Days	-7.3	-2.3	-0.7	-0.3	-0.3	-0.2	-0.5	-1.9	0.0	-0.2	-1.6
All 30 Days	-4.4	-0.8	0.2	-0.2	0.2	0.0	-0.2	-0.6	0.0	-0.1	-1.1

Note: Top panel shows age-standardized national mortality rates (per 100,000) in specified years and changes between them. First three rows of the lower panel displays coefficient estimates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The last three rows of the lower panel show the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Poor mental health days, 15+ days, and all 30 days increase by 2.78, 2.96, and 2.28, respectively, from 1999-2019.

Table A12: Estimated Mortality Rate Responses to Changes in Poor Mental Health for 25-54 Year Whites Using Different Lag Structures

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Days											
t	0.0296	0.025	0.0168	0.0681	0.0135	0.0309	0.0082	0.0094	0.0258	0.0369	0.0585
	(0.0100)	(0.0090)	(0.0055)	(0.0183)	(0.0102)	(0.0101)	(0.0074)	(0.0079)	(0.0131)	(0.0217)	(0.0393)
t, t-1	0.0364	0.0293	0.0214	0.0829	0.0168	0.0403	0.0138	0.00914	0.0262	0.0506	0.0822
	(0.0130)	(0.0121)	(0.0075)	(0.0254)	(0.0138)	(0.0133)	(0.0092)	(0.0100)	(0.0176)	(0.0296)	(0.0545)
t, t-1, t-2	0.0386	0.033	0.0238	0.0941	0.018	0.0472	0.0173	0.00705	0.0323	0.0503	0.0843
	(0.0140)	(0.0138)	(0.0085)	(0.0293)	(0.0149)	(0.0137)	(0.0105)	(0.0103)	(0.0206)	(0.0322)	(0.0635)
15+ Days											
t	0.0313	0.0273	0.0189	0.0685	0.0148	0.0339	0.0069	0.0077	0.0221	0.0466	0.0541
	(0.0101)	(0.0097)	(0.0055)	(0.0183)	(0.0107)	(0.0104)	(0.0076)	(0.0074)	(0.0123)	(0.0261)	(0.0360)
t, t-1	0.0408	0.0339	0.025	0.0855	0.0197	0.0467	0.0135	0.00747	0.0225	0.0644	0.0835
	(0.0141)	(0.0138)	(0.0079)	(0.0278)	(0.0151)	(0.0145)	(0.0100)	(0.0099)	(0.0181)	(0.0363)	(0.0524)
t, t-1, t-2	0.043	0.0384	0.0279	0.0973	0.0224	0.0536	0.0158	0.00571	0.0312	0.0682	0.0868
	(0.0157)	(0.0164)	(0.0092)	(0.0334)	(0.0166)	(0.0163)	(0.0121)	(0.0103)	(0.0210)	(0.0422)	(0.0619)
All 30 Days											
t	0.0249	0.0212	0.0149	0.0471	0.0152	0.0261	0.0023	0.0093	0.0168	0.0312	0.0354
	(0.0113)	(0.0105)	(0.0058)	(0.0239)	(0.0093)	(0.0129)	(0.0082)	(0.0064)	(0.0093)	(0.0156)	(0.0296)
t, t-1	0.0319	0.0262	0.0195	0.0603	0.0213	0.0354	0.00554	0.00988	0.0132	0.0512	0.0555
	(0.0166)	(0.0161)	(0.0090)	(0.0367)	(0.0130)	(0.0195)	(0.0112)	(0.0086)	(0.0130)	(0.0262)	(0.0449)
t, t-1, t-2	0.0327	0.0291	0.0225	0.0678	0.0221	0.0403	0.00546	0.00652	0.0158	0.059	0.0576
	(0.0195)	(0.0200)	(0.0112)	(0.0449)	(0.0150)	(0.0225)	(0.0136)	(0.0090)	(0.0164)	(0.0361)	(0.0544)

Note: Table shows predicted effects of a one standard deviation increase in the poor mental health proxy on the log of age-standardized rates from Poisson regressions with cells weighted by average state populations over the 1993-2019 period. The first row of each panel controls only for the contemporaneous mental health variable, while the second and third include one and two lags of it respectively. In these rows, the one standard deviation increase occurs in all years controlled for, the table displays the sum of these coefficient estimates, with the standard error of the sum shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01.

Table A13: Estimated Mortality Rate Responses to Changes in Poor Mental Health for 25-54 Year Old Non-Hispanic Whites Without and With Controls for Physical Health

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Without Physical Health Controls											
Days	0.0296***	0.0250***	0.0168***	0.0681***	0.0135	0.0309***	0.0082	0.0369*	0.0094	0.0258**	0.0585
	(0.0100)	(0.0090)	(0.0055)	(0.0183)	(0.0102)	(0.0101)	(0.0074)	(0.0217)	(0.0079)	(0.0131)	(0.0393)
15+ Days	0.0313***	0.0273***	0.0189***	0.0685***	0.0148	0.0339***	0.0069	0.0466*	0.0077	0.0221*	0.0541
	(0.0101)	(0.0097)	(0.0055)	(0.0183)	(0.0107)	(0.0104)	(0.0076)	(0.0261)	(0.0074)	(0.0123)	(0.0360)
All 30 Days	0.0249**	0.0212**	0.0149***	0.0471**	0.0152	0.0261**	0.0023	0.0312**	0.0093	0.0168*	0.0354
	(0.0113)	(0.0105)	(0.0058)	(0.0239)	(0.0093)	(0.0129)	(0.0082)	(0.0156)	(0.0064)	(0.0093)	(0.0296)
With Physical Health Controls											
Days	0.0143*	0.0063	0.0072	0.0386**	0.0048	0.0062	0.0031	0.0303	0.0065	0.0315***	0.0314
	(0.0081)	(0.0074)	(0.0044)	(0.0184)	(0.0092)	(0.0087)	(0.0095)	(0.0224)	(0.0078)	(0.0115)	(0.0373)
15+ Days	0.0163*	0.0095	0.0099**	0.0383**	0.0064	0.0107	0.0010	0.0432	0.0039	0.0259**	0.0276
	(0.0087)	(0.0082)	(0.0042)	(0.0187)	(0.0091)	(0.0093)	(0.0096)	(0.0273)	(0.0065)	(0.0103)	(0.0347)
All 30 Days	0.0133	0.0081	0.0079*	0.0227	0.0099	0.0091	-0.0029	0.0237*	0.0071	0.0179**	0.0141
	(0.0100)	(0.0090)	(0.0046)	(0.0231)	(0.0083)	(0.0116)	(0.0093)	(0.0141)	(0.0054)	(0.0075)	(0.0277)

Note: Table displays coefficient estimates on the proxies for poor mental health from Poisson regressions with cells weighted by average state populations over the 1993-2019 period, with robust standard errors clustered at the state level shown in parentheses. *p<0.10, **, p<0.05, ***p<0.01. The lower panel also includes the number of days in the last 30 of poor physical health as a supplementary regressor, whereas the upper panel does not. Poor mental health days, 15+ days, and all 30 days increase by .84, 2.82, and 1.95 standard deviations, respectively, from 1999-2019.

Table A14: Constant Mental Health Changes in the 2020 and 1999 Year Mortality Rates of 25-54 Year Old Non-Hispanic Whites

	All	Heart	Cancer	Lower Resp	Stroke	Diabetes	Transport	Homicide	Suicide	Alcohol	Drug
Constant MH Δ in 2019 Mortality Rates											
Days	-20.0	-2.3	-1.8	-0.7	-0.2	-0.5	-0.3	-0.4	-0.6	-0.9	-7.2
15+ Days	-20.9	-2.5	-2.1	-0.7	-0.2	-0.6	-0.3	-0.5	-0.5	-0.8	-6.7
All 30 Days	-11.7	-1.4	-1.1	-0.4	-0.1	-0.3	-0.1	-0.2	-0.4	-0.4	-3.1
Constant MH Δ in 1999 Mortality Rates											
Days	19.0	3.0	2.7	0.7	0.2	0.5	0.4	0.4	0.4	0.6	2.1
15+ Days	20.0	3.2	3.1	0.7	0.2	0.5	0.3	0.5	0.4	0.5	1.9
All 30 Days	10.8	1.7	1.6	0.3	0.2	0.3	0.1	0.2	0.3	0.3	0.8

Note: Top panel shows the estimated counterfactual reduction in 2019 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had remained at its value in 1999. Bottom panel shows the estimated counterfactual reduction in 1999 age-standardized mortality rates, relative to actual levels, if the specified mental health proxy had its value in 2019.

Table A15: Ratios of Mortality Rates, Changes in Poor Mental Health and Mortality Responses for Population Groups

	Age 20-34 vs.		Some College vs.		White vs. Black						
Ratio	35-54	55+	No College	College Grad	All Ages	20-34	35-44	25-54: All	25-54: No College	25-54: Some College	25-54: College Grad
2019 Mortality Rate	0.417	0.041	0.601	1.309	0.845	0.67	0.68	0.688	0.861	0.790	0.740
Δ in Poor Mental Health											
Days	2.54	2.23	1.19	1.59	1.47	1.33	1.56	1.38	1.33	1.62	1.15
15+ Days	2.37	2.30	1.19	2.07	1.40	1.32	1.38	1.31	1.36	1.53	1.18
All 30 Days	2.35	2.42	0.87	2.45	1.53	1.13	1.61	1.25	1.54	1.35	0.84
Mortality Responses											
Days	1.89	4.21	6.67	1.47	3.14	11.06	3.86	3.75	4.14	1.87	∗
15+ Days	1.26	2.96	3.59	2.41	3.49	30.73	4.53	4.49	4.64	1.38	∗
All 30 Days	1.15	3.60	1.60	1.14	4.23	5.31	4.34	4.25	3.95	2.11	∗

Note: First row shows ratio of 2019 mortality rates. Next three rows display ratio of the change in the poor mental health proxy from 1999 to 2019. *Mortality responses* display the ratio of the estimated effects of a one standard deviation increase in the mental health proxy on mortality rates. White and Black refer to non-Hispanics. ∗ indicates cases where the mortality response to worse mental health is positive (negative) for treatment group but negative for the comparison group.

Table A16: Actual and Adjusted Mortality Rate Changes by Population Group

Outcome/Group	All	Male	Female	White	Black	20-34	35-54	55+
Mortality Rate: 1980	1,036.1	1,351.2	812.9	1,009.5	1,316.8	133.8	385.9	4,032.8
Mortality Rate: 1999	875.4	1,072.0	731.2	861.1	1,162.2	98.6	298.5	3,496.6
Mortality Rate: 2019	725.2	864.7	609.2	747.8	883.7	117.0	280.9	2,825.9
Counterfactual MR: 2019	733.1	840.1	654.1	725.0	999.0	71.5	227.7	3,009.0
MR Δ: 2019 - 1999	-150.2	-207.2	-122.1	-113.3	-278.5	18.3	-17.6	-670.7
Adjusted MR Δ	-7.9	24.6	-45.0	22.8	-115.2	45.4	53.1	-183.1

	White: 25-54				Black: 25-54			
Outcome/Group	All	No College	Some College	College Grad	All	No College	Some College	College Grad
Mortality Rate: 1980	274.1				604.2			
Mortality Rate: 1999	215.2	333.2	146.8	109.0	456.4	601.6	261.7	202.0
Mortality Rate: 2019	243.4	517.6	219.5	84.1	353.3	601.4	277.9	113.7
Counterfactual MR: 2019	171.9	266.1	117.2	87.1	329.2	433.9	188.8	145.7
MR Δ: 2019 - 1999	28.2	184.4	72.7	-25.0	-103.1	-0.2	16.2	-88.3
Adjusted MR Δ	71.5	251.4	102.2	-3.0	24.1	167.5	89.2	-32.0

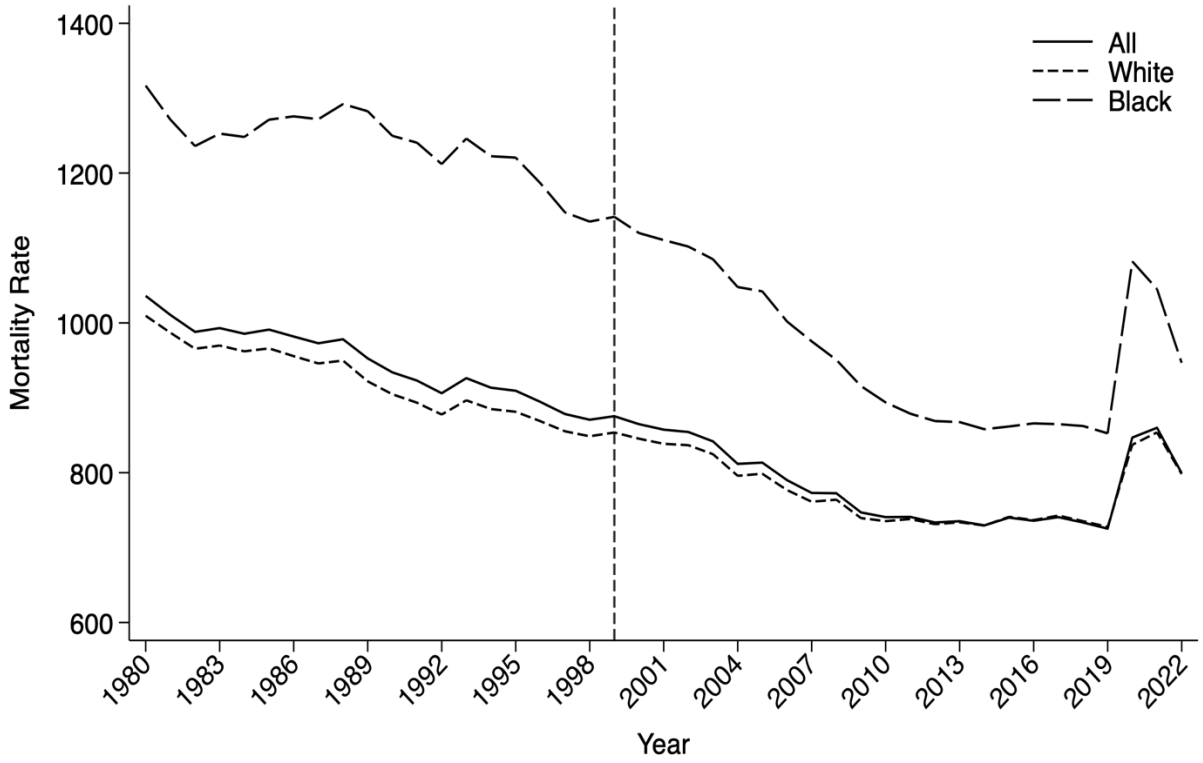
Note: Mortality rates are per 100,000 and age-standardized. Counterfactual 2019 mortality rate is that predicted if average annual mortality rate changes from 1980-1999 had continued through 2019. Adjusted Mortality Rate Change is the difference between the actual and counterfactual 2019 rates. Race-specific mortality rates in 1980 include Hispanics. This is adjusted for when computing adjusted mortality rate changes, as discussed in the text.

Table A17: Share of Adjusted Mortality Rate Changes From 1999-2019 for 25-54 Year Olds Resulting from Increases in Poor Mental Health, Overall and By Selected Causes of Death

	White			Black			White: No College			Black No College		
Cause of Death	# Days	15+ Days	All 30 Days	# Days	15+ Days	All 30 Days	# Days	15+ Days	All 30 Days	# Days	15+ Days	All 30 Days
Heart	3.3%	3.5%	1.9%	2.1%	1.5%	0.8%	1.9%	2.1%	0.7%	1.3%	1.4%	0.5%
Cancer	2.6%	2.9%	1.6%	0.0%	-0.3%	0.1%	1.6%	1.7%	0.8%	0.1%	0.4%	-0.1%
Homicide	0.5%	0.7%	0.3%	3.3%	2.9%	1.4%	0.3%	0.4%	0.2%	1.2%	1.2%	0.4%
Suicide	0.9%	0.7%	0.6%	-0.1%	-0.1%	-0.2%	0.7%	0.7%	0.3%	0.0%	0.0%	0.0%
Alcohol	1.3%	1.1%	0.6%	0.1%	0.1%	0.1%	0.9%	0.9%	0.3%	0.1%	0.1%	0.1%
Drug	10.1%	9.4%	4.4%	7.2%	6.5%	4.8%	7.4%	6.7%	3.3%	0.9%	1.0%	0.6%

Note: The shares of mortality rate changes accounted for are calculated by dividing the Constant MH changes, described above, by the adjusted mortality rate changes and reversing the sign. White and Black refer to non-Hispanics.

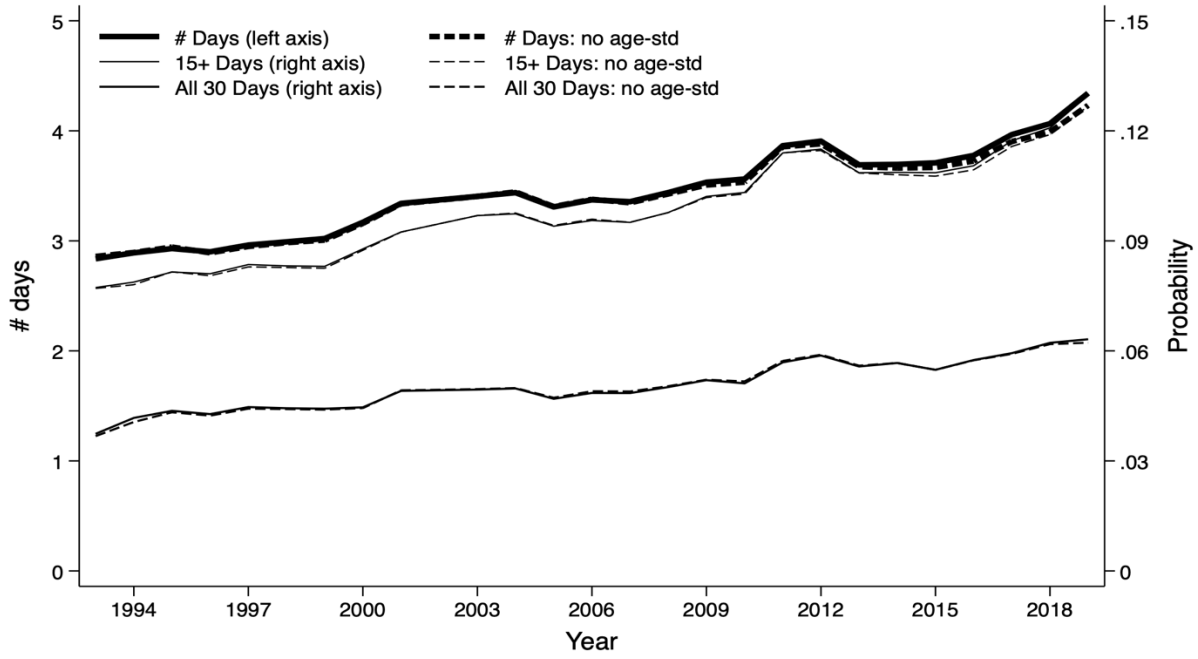
Figure A1: Age-Standardized Mortality Rates for Selected Groups, 1980-2022



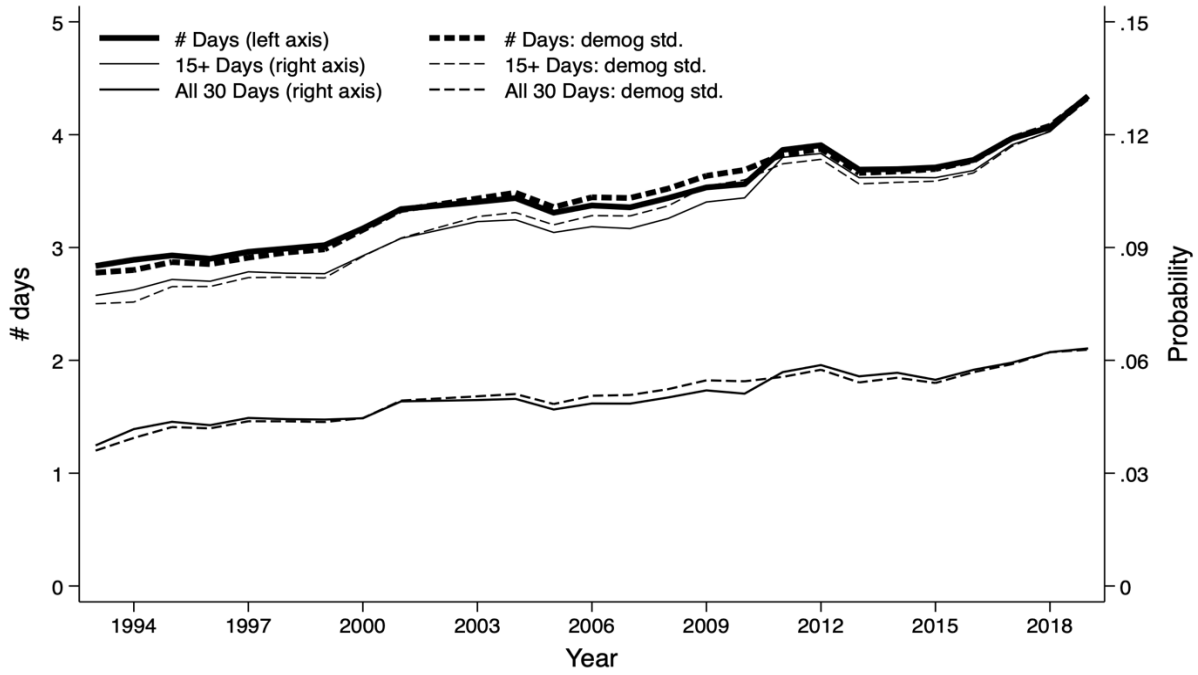
Note: Figure shows national age-standardized rates per 100,000 from 1980-2022. Mortality data are from *MCOD* files. Unlike most other results, Whites and Blacks include both Hispanics and Non-Hispanics of the specified race. This is done because prior to 1990 Hispanic origin was often not identified. The vertical line shows 1999, the beginning of the primary analysis period.

Figure A2: Poor Mental Health Days in the U.S. With and Without Adjustments

a. With and Without Age-Standardization

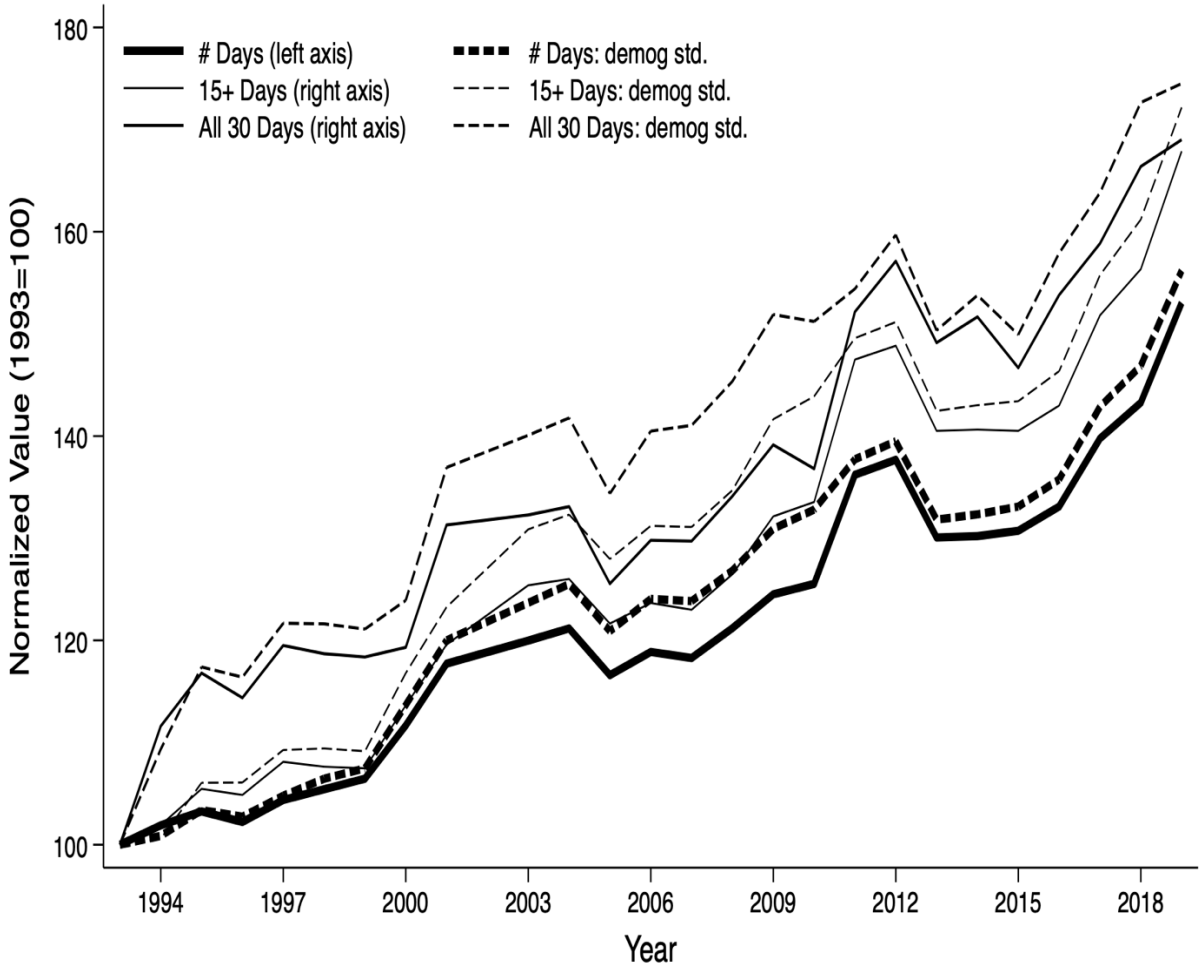


b. With and Without Demographic Standardization



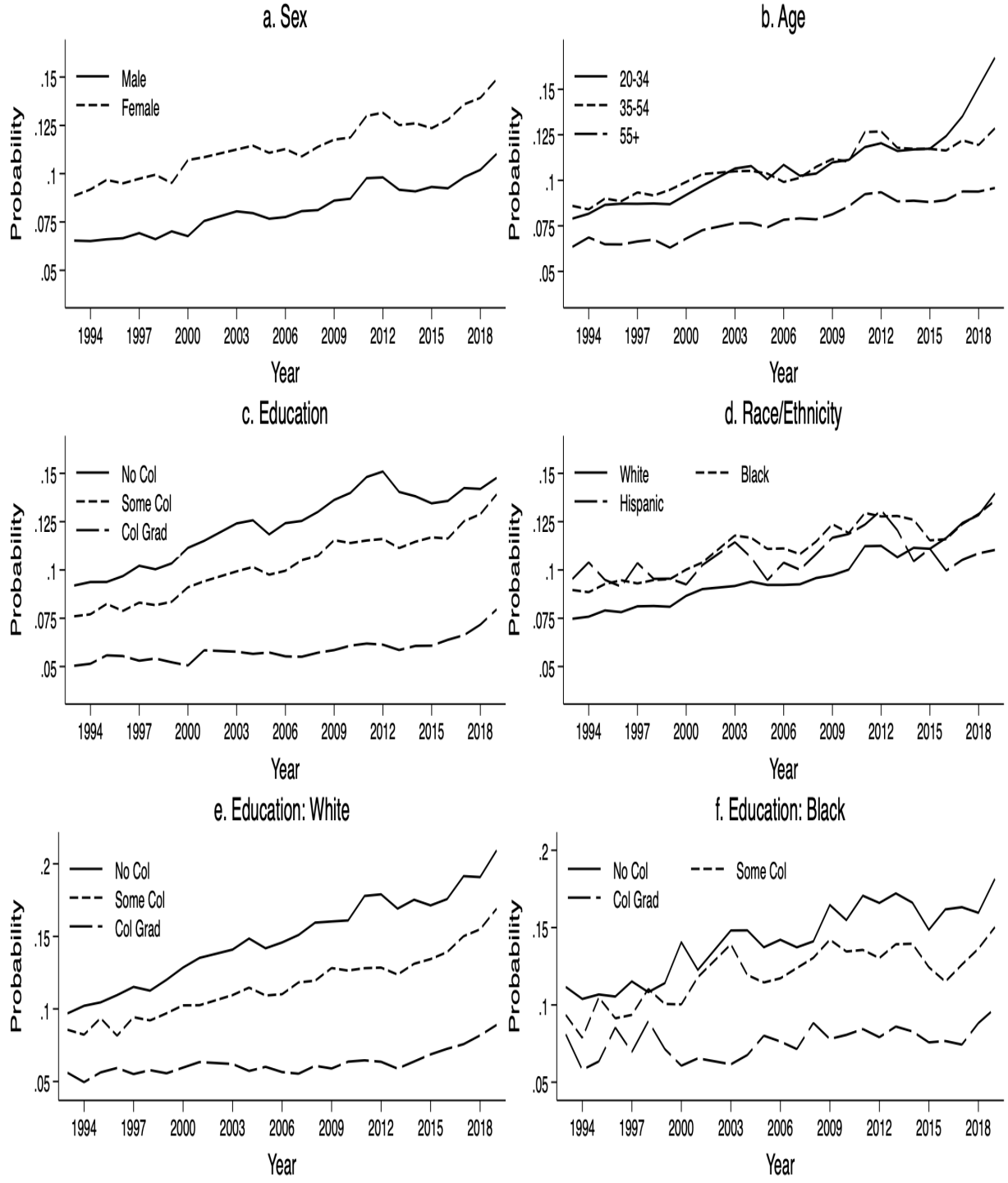
Note: Figure shows values of poor mental health proxies with and without age standardization (top figure) and with and without also accounting for differences in sex, race/ethnicity, and education (bottom figure) using data from the *BRFSS* from 1993-2019.

Figure A3: Change in National Poor Mental Health Days in the U.S. Relative to 1993



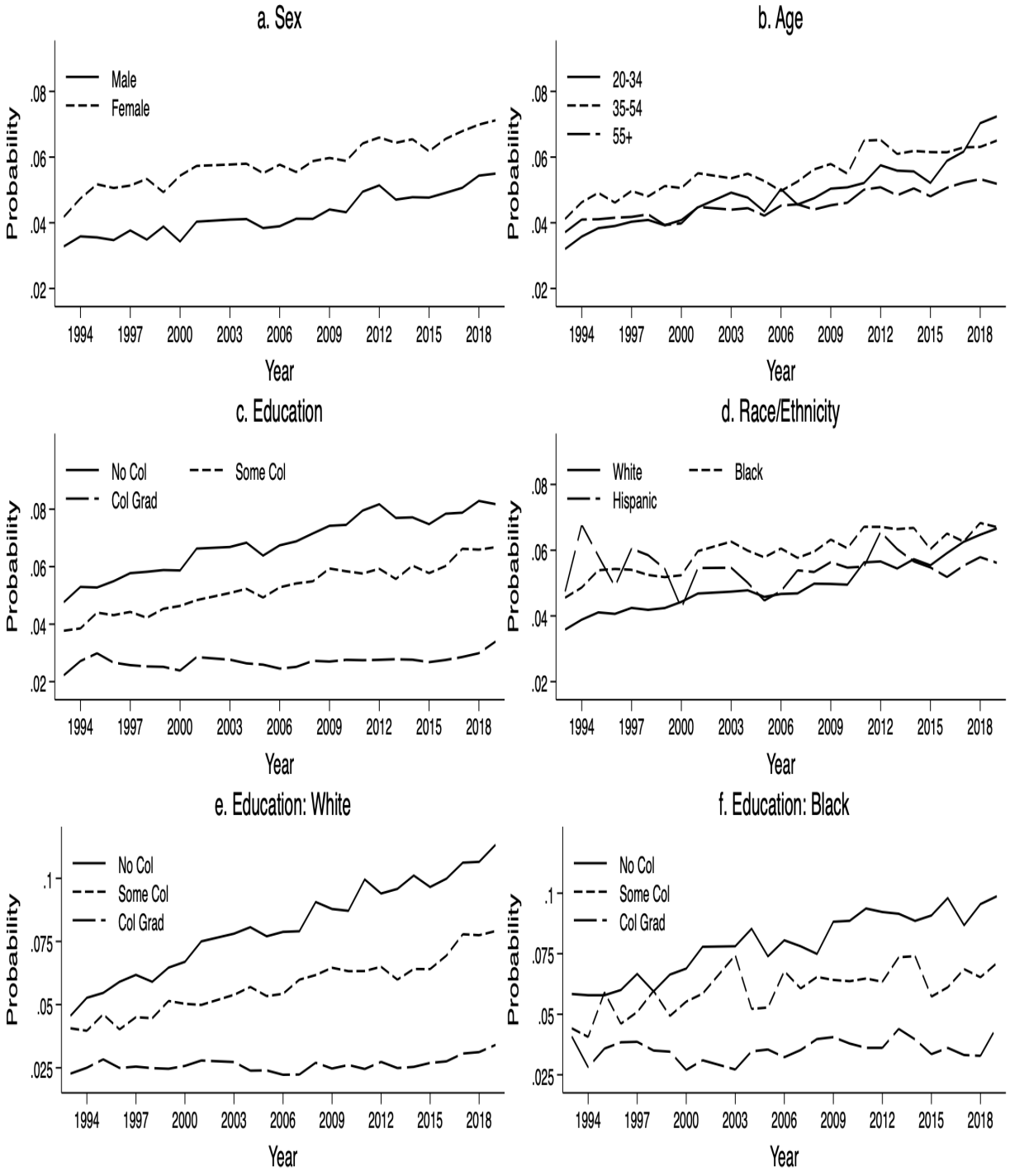
Note: Figure shows changes in age-standardized poor mental health days in the last 30 and probability of poor mental health in ≥15 or all 30 days, relative to 1993 using data from the *BRFSS* from 1993-2019. Standardized changes also account for differences in sex, race/ethnicity, and education.

Figure A4: 15+ Days of Poor Mental Health, By Subgroup



Note: Figure shows the age-standardized percentage of group with poor mental health in at least 15 of last 30 days using data from the *BRFSS* from 1993-2019. White and Black refer to Non-Hispanics.

Figure A5: Poor Mental Health in All of Past 30 Days, By Subgroup



Note: Figure shows age-standardized percentage of group with poor mental health in all of the last 30 days using data from the *BRFSS* from 1993-2019. White and Black refer to Non-Hispanics.

Figure A6: Trend Coefficients on the Natural Log of Poor Mental Health 1993-2019, By Subgroup

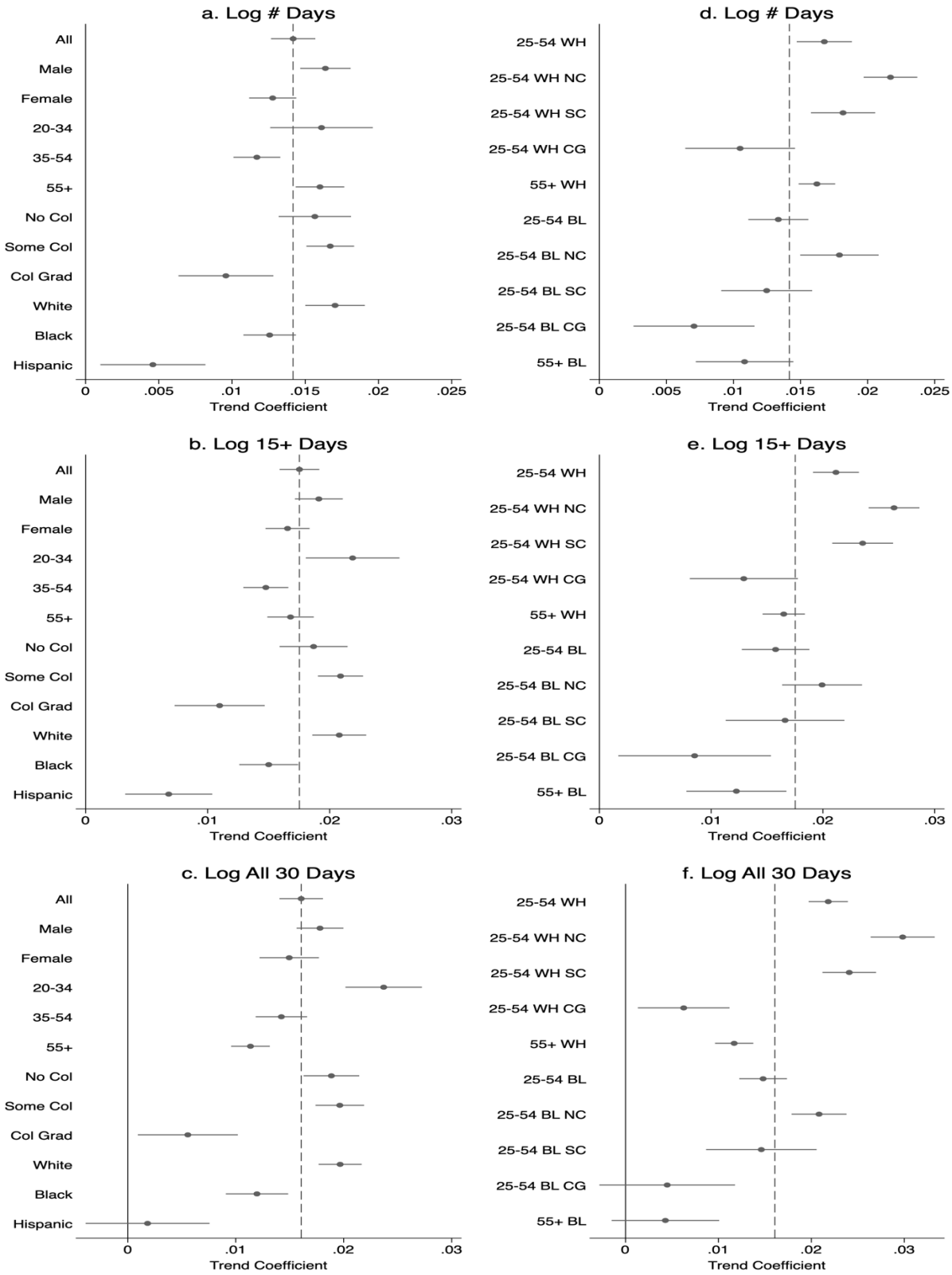
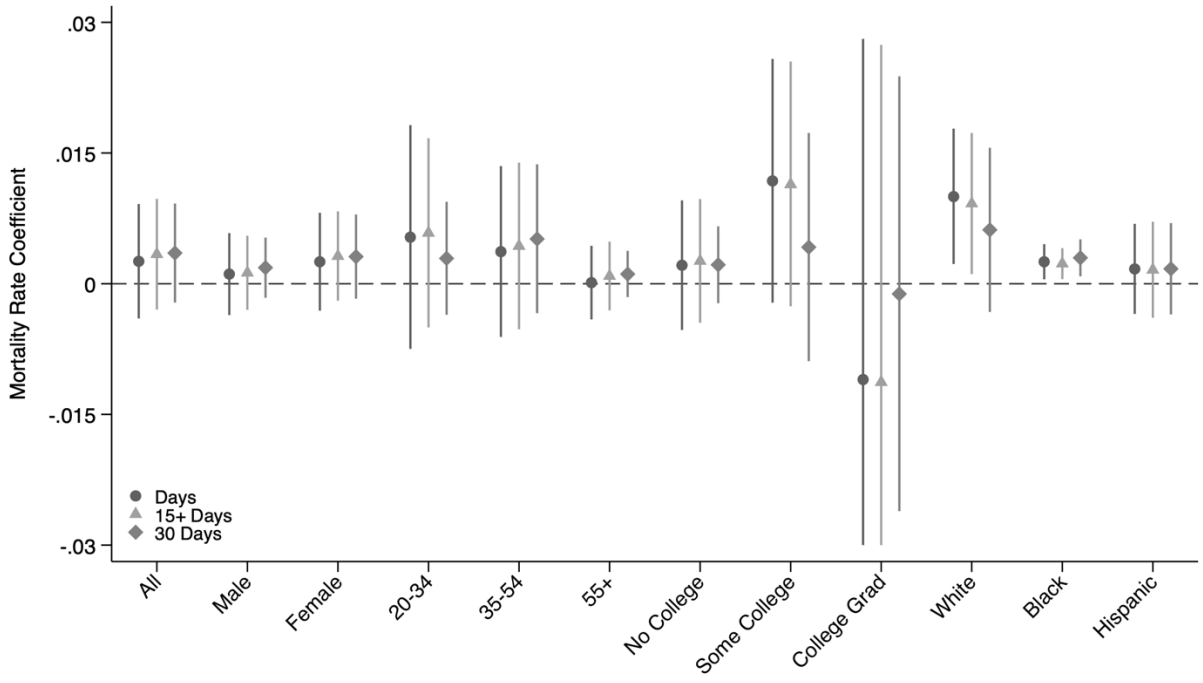


Figure shows coefficient estimates from regressing the natural log of the proxy for age-standardized poor mental health on a linear time trend using data from the *BRFSS* from 1993-2019. Error bars show 95 percent confidence intervals based on robust standard errors. Vertical dashed lines show the full sample trend coefficient. The dependent variables refer to number of poor mental health days in last the 30. WH, BL, NC, SC, and CG refer to Whites, Blacks, no college, some college, and college graduate, and 25-54 and 55+ to age ranges.

Figure A7: Predicted Effects of Poor Mental Health On Age Standardized Mortality Rates Using 1999-2019 Data

A. Groups



B. Causes

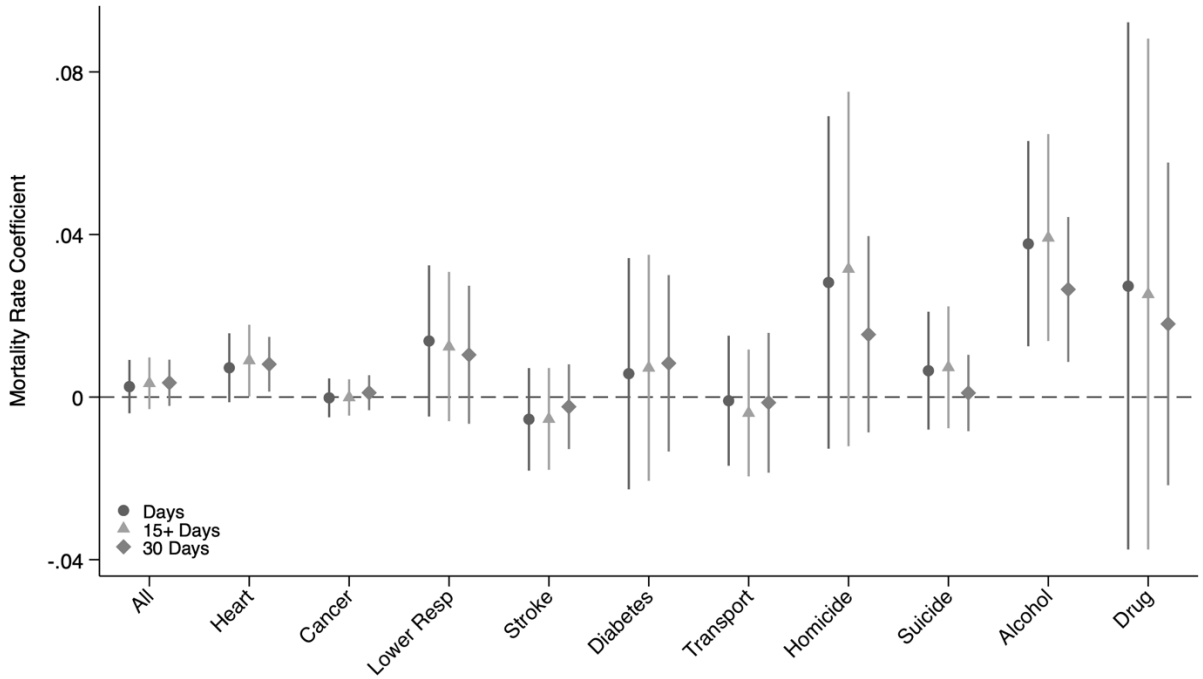


Figure shows mental health coefficient estimates from Poisson regressions of age-standardized mortality rates (per 100,000) on poor mental health over the 1999-2019 period, plus state and time fixed-effects, and, except in the race-specific models, the state population shares of non-Hispanic Blacks, Hispanics, and non-Hispanic other races. The mental health coefficients are standardized to indicate effect sizes based on a one-standard deviation change in the national value of the poor mental health proxy from 1993-2019. Cells are weighted by average state populations over the 1993-2019 period. Error bars show 95 percent confidence intervals (CI's) based on robust standard errors clustered at the state level. Mental health data are from the *BRFSS* and mortality data are from the *MCOD* files. For clarity of display, the lower bound of the CI's are censored at -0.03 in the upper figure.

Appendix B: Education-Specific Mortality Rates

There are multiple challenges in calculating levels and changes in education-specific mortality rates. First, education is sometimes reported as completed years of schooling, rather than for specific thresholds. Difficulties introduced by this have been discussed elsewhere (Jaeger 1997; Rostron, Boies, and Arias 2010). In these cases, ≤12, 13–15 and ≥16 years are classified as high school graduate or less, some college and college graduate.

Second, information on education is missing for some deaths, particularly early in the sample period (e.g. for 17% of deaths in 1993 and 4% in 2019). Education-specific mortality rates are computed by assuming that the state-specific distribution of educational attainment is the same for the missing and non-missing cases, provided that at least half of deaths in the state-year have education recorded on the death certificate. If this condition is not met, the education-specific mortality rates are coded as missing.

Third, since the *SEER* data do not provide education-specific population estimates, these are calculated by multiplying *SEER* total or group-specific populations by the relevant state education share, obtained from the *CPS-MORG* files discussed above.

Fourth, for the state-level analysis, the *BRFSS* sometimes does not have any observations for a given race-age cell. This is rarely occurs for non-Hispanic Whites, but is more frequent for other race/ethnicity groups. The measures of poor mental health will be unavailable in these cases and so will be coded as missing.

Fifth, educational attainment is not available in the *MCOD* data before 1990. This means that it is not possible to calculate education-specific adjusted 2019 mortality rate changes based on projections of annual rate changes from 1980-1999, as is done elsewhere. Therefore, in the analysis of 25-54 year old non-Hispanic Whites and Blacks, trends are calculated for the entire group, regardless of education.

Finally, this analysis focuses on specific education categories because this has frequently been done in the prior literature (Case and Deaton 2020, 2022) but it is important to recognize that the results may be affected by changes in the composition of these groups over time, due to the overall increase in educational attainment.[48] Assuming increasing education results in the lowest educational category becoming more negatively selected over time, rising mortality rates may fully or partially result from compositional changes in the group, rather than changes in mortality probabilities for individuals at the same place in the educational distribution.[49]

This issue has long been recognized (Dowd and Hamoudi 2014; Bound et al. 2015) and researchers have addressed this it by examining changes in mortality rates over time for persons at the same rank in the educational distribution (Leive and Ruhm 2020, 2022; Novosad, Rafkin, and Asher 2022). Although it would be interesting to incorporate such comparisons in the analysis, this has not been done so as to provide the most direct comparisons with the prior literature, which has focused on absolute levels of educational attainment.

[48] For example, in 1999, 49% of adults aged 25 and over had not attended college and 26% had four year degrees. In 2019, the corresponding percentages were 38% and 36%.

[49] Interestingly, the highest educational group may also become more negatively selected for the same reason.

Appendix C: Alternative Measures of Poor Mental Health

The primary explanatory variables in this analysis are obtained from responses to a question about poor mental during the last 30 days. This appendix compares the resulting national trends in poor mental health to those obtained from the widely used Kessler 6 (K6) scale, constructed using data from the *National Health Interview Survey* (*NHIS*) from 1997-2018 (Centers for Disease Control and Prevention 2024c).[50] The K6 scale is based on six questions asking how often in the last 30 days the respondent felt: "so sad nothing could cheer you up", "nervous", "restless or fidgety", "hopeless", "that everything was an effort", and "worthless". Each question in scored on a scale of 0-4, corresponding to "none of the time", "a little of the time", "some of the time", "most of the time", or "all of the time". The scores for each question are then summed to provide a total score ranging from 0 to 24.[51] Scores of 5 of higher are taken to indicate psychological distress (Prochaska et al. 2012) while those 13 or greater indicate serious psychological distress (Kessler et al. 2002). Although the K6 scale has been validated and widely used, two factors make it less appropriate for use as the primary mental health measure in this study. First, as mentioned, the data are available for a shorter period of time than the *BRFSS* mental health questions. Second, the sample sizes are much smaller (approximately 30 thousand observations per year versus an average of around 300 thousand annually in the *BRFSS*). These smaller sample sizes lead to noisier estimates and preclude a state-level analysis, particularly for population subgroups.

Figure C1 shows annual national averages of the three variables, normalized such that values in 2000 equal 100. The averages are fairly noisy across years, as might be expected

[50] The questions used to construct the K6 score were first asked was 1997. In 2019 an abbreviated version of the questions were included which might not yield comparable findings to those in the earlier years.

[51] Sample weights are used to provide nationally representative estimates.

given the relatively small samples. There is an sharp decline in measured psychological distress between 1997 and 1999. This does not have an obvious source but may reflect changes in procedures or other issues during the early years of the Kessler 6 questions. After 1999 there is a fairly steady upwards trend in all three Kessler measures, with values 30%, 35%, and 39% higher in 2018 than 2000 for the K6 score, psychological distress and serious psychological distress.[52] The correlations between these variables are high – ranging between 0.90 and 0.99.

It is instructive to compare these results with corresponding patterns for the three poor mental health variables obtained from the *BRFSS*, again focusing on annual national averages of persons 20 and older from 1997 to 2018. The national average values over the entire period are 2.43, 18.8%, and 3.22% for K6 scores, psychological distress, and serious psychological distress and 3.50 days, 10.1%, and 5.17% for poor mental health days, 15+ days, and all 30 days. These results suggest that the last two of these measures correspond to severity somewhere between moderate and serious psychological distress using the Kessler measures. Correlations between the poor mental health and psychological distress measures are moderately high, ranging from 0.55 to 0.67 over the full sample period and 0.61 to 0.68 from 2000-2017.

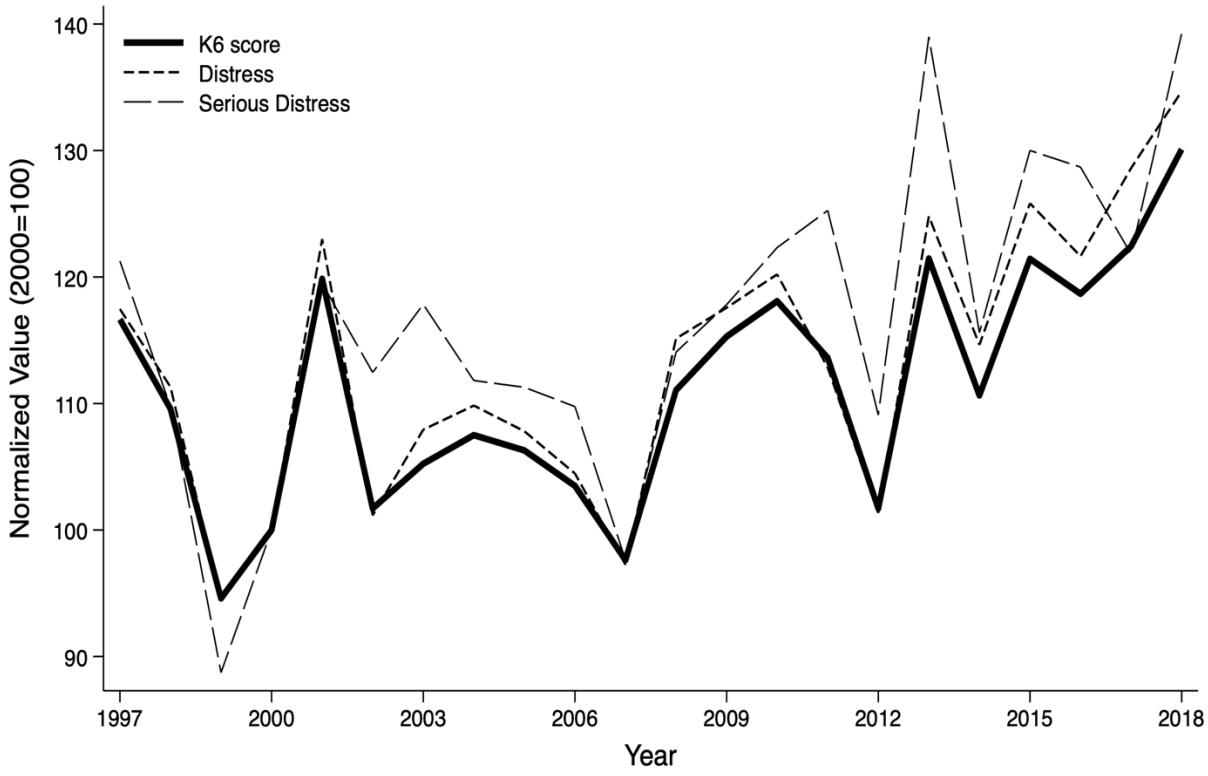
Further evidence on these relationships is provided in Figure C2, which shows annual averages, again with values in 2000 normalized to 100. There are some differences across the measures particularly, as already noted, with the greater noise and initial declines in the distress measures in the first couple of years. However, since 2000, the patterns of increases in poor mental and psychological distress are similar. As noted above, K6 scores, psychological distress, and serious psychological distress rose by 30%, 35%, and 39%

[52] Average K6 scores rise from 2.18 to 2.84 from 2000-2018. Those for distress and serious distress increase from 16.6% to 22.3% and 2.77% to 3.85% respectively.

between 2000 and 2018. The corresponding increases in poor mental health days, 15+ days, and all 30 days over the same period were 28%, 38%, and 39%.

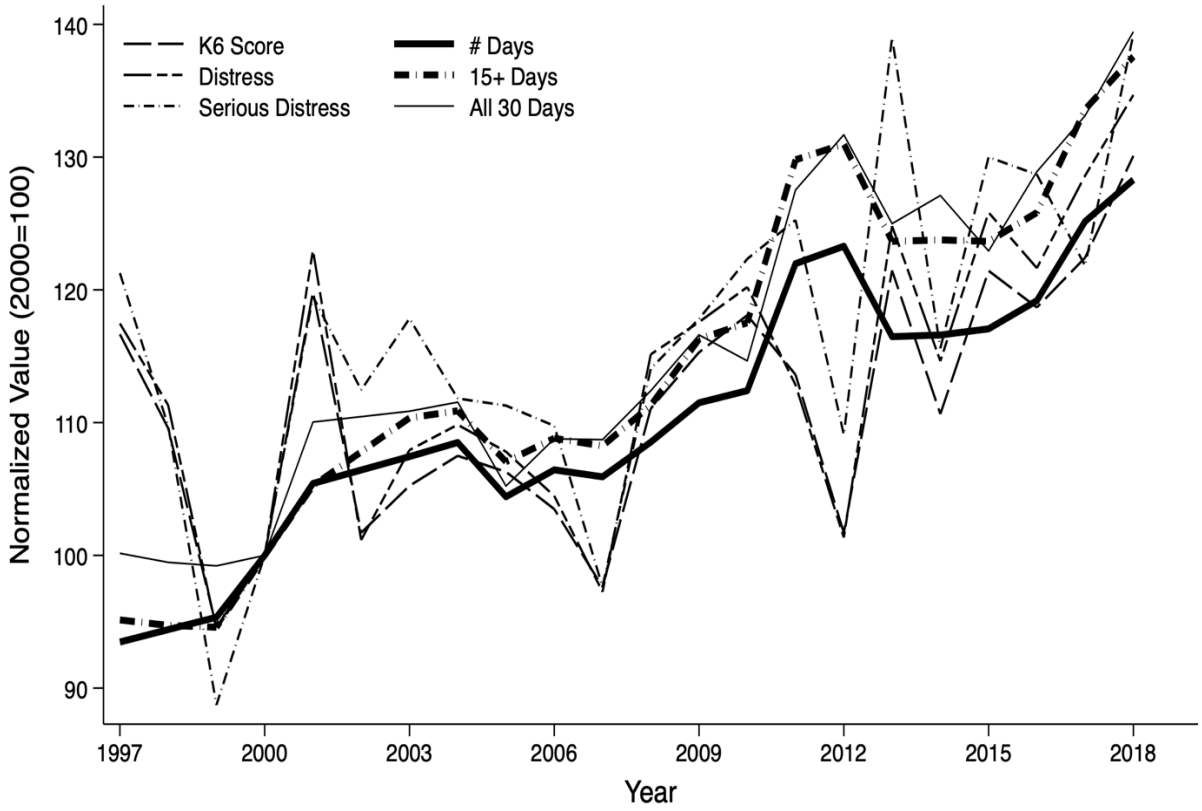
The overall conclusion is that the poor mental health variables obtained from the *BRFSS* are likely to be measuring "despair" in a similar way as the K6 psychological distress variables obtained from the *NHIS*.

Figure C1: Change in Psychological Distress in the U.S. Relative to 2000



Note: Figure shows national average Kessler-6 (K6) scores, psychological distress (K6 score ≥ 5), and series psychological distress (K6 score ≥ 13) for persons 20 and over from the *NHIS* from 1997-2018, normalized so that values were 100 in 2000.

Figure C2: Change in Psychological Distress and Poor Mental Health in the U.S. Relative to 2000



Note: Figure shows national average Kessler-6 (K6) scores, psychological distress (K6 score $\geq$ 5), and serious psychological distress (K6 score $\geq$ 13) from the *NHIS* as well as poor mental health days in the last 30 for persons 20 and over from the *BRFSS*, for 1997-2018, normalized so that values were 100 in 2000.