



The role of context in shaping the relationship between physical health and suicide over the life course

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ABSTRACT

U.S. suicide rates are at a thirty-year high while physical health, as measured by life expectancy and pain, has declined, particularly for those without a college degree. We investigate how these patterns may be related by exploring the role of physical health problems in suicide deaths using 2019 data from the National Violent Death Reporting System. We estimate multilevel logistic regression models to examine (1) how individual risk factors are associated with the likelihood of a physical health circumstance underlying a suicide over the life course and (2) how context – the socioeconomic, health and policy environment of the state in which a decedent resides – may play a role. Physical health circumstances were present in about 20% of all suicides and in over half of suicide deaths for the older population in 2019. A gender crossover effect exists, in which women are more likely to have a physical health problem contribute to a suicide prior to age 60, but men surpass women after age 60 in that probability. Net of individual characteristics, we find significant variation across states in the likelihood of physical health circumstances. For all age groups, physical health circumstances are more likely in states that are less densely populated with weaker gun control laws and higher suicide rates. Among decedents younger than 65, the likelihood is elevated in states with limited health care access. This study highlights the critical interaction between physical and mental well-being, the ways in which that interaction may be experienced differently by gender, and the important role of social safety nets in prevention.

1. Introduction

The news of late about the state of Americans' health is grim, particularly for those who are less educated (Case & Deaton, 2021b). Mortality from suicide is up by 35% since 1999, with white middle-aged men and women without a college degree at particularly high risk. Other so-called deaths of despair, namely those from accidental drug poisonings and alcohol-related disease, are at extraordinarily high levels. Improvements in mortality from cardiovascular disease have slowed in recent years (Crimmins, 2021) while the prevalence of obesity and reports of chronic pain continue to rise (Stokes et al., 2019). Indeed, the extent of these deaths is so great that they are adversely affecting projections of life expectancy at birth (Murphy et al., 2018; Olshankysy et al., 2012). Today, an American can expect to live 78.9 years while those in comparable nations have a life expectancy almost four years longer at 82.3 years (Kontis et al., 2017).

1.1. Background

These mortality trends are closely intertwined. With respect to suicide deaths, significant attention has focused on the role of waning economic opportunity for some and increased social isolation in producing these patterns (Case & Deaton, 2021a; Phillips, 2014). Yet, while it is the case that mental health problems underlie the majority of suicide deaths in the United States (Cavanagh et al., 2003; O'Connor, 2021), poor physical health is a known risk factor for suicide because of the negative effect it may have on quality of life. Advocates for state right to die laws usually emphasize the burden of terminal and very painful physical illnesses on patients and their caregivers. More generally, people living with physical health problems may suffer from chronic pain, reduced mobility, loneliness, hopelessness, financial instability, and a feeling of burdensomeness, all factors that elevate suicide risk. Past research shows that functional limitations produced by chronic illness appear to be an especially strong predictor of suicide (Kaplan et al., 2007), suggesting that the social or practical consequences of

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physical health problems are relevant. A recent study using healthcare systems data (Ahmedani et al., 2017) found that conditions that are particularly painful and/or have a significant impact on one's life (e.g. cancer, brain injury, HIV/AIDS, sleep disorders) tend to have the strongest effects on the likelihood of suicide, net of other characteristics including mental health and substance abuse. Conservative estimates based on 2014 National Violent Death Reporting System (NVDRS) data indicate that about 10% of suicide decedents experienced chronic pain as a circumstance that precipitated their death (Petrosky et al., 2018), one that appears to affect women in particular (Stone et al., 2016).

While the individual risk factors that tie physical health problems to suicide are fairly well established, far less is known about the ways in which the structural and policy environment may affect the relationship. Certainly, we know that context has important implications for health and suicide, and the stronger social safety net in other developed countries is often cited as a primary explanation for poorer health outcomes among Americans relative to their European counterparts (Averdano & Kawachi, 2014). Individuals reside within families, schools, occupations, neighborhoods and states, which introduce risks or protections for population health. For example, neighborhood socioeconomic characteristics affect health outcomes, both physical and mental, through a variety of mechanisms, including employment and education opportunities, exposure to crime or pollution, and access to healthy food and exercise (Diez Roux, 2007). With respect to suicide, studies point to religious composition (Van Tubergen et al., 2005), socioeconomic conditions (Chang et al., 2013; Phillips & Nugent, 2014), availability of guns (Anestis & Houtsma, 2018) and degree of "social sameness" (Pescosolido et al., 2020) as key contextual features that can affect the risk for suicide, net of individual characteristics.

Given that both population health and suicide vary systematically across geographic areas, we might expect important contextual variation in the likelihood that physical health problems contribute to a suicide death. One recent study (Suk et al., 2021) provides some support for this notion, showing that cancer patients who live in rural and poorer counties have a significantly higher risk of suicide mortality than those in urban and wealthier counties, albeit with some differences in effects. The largest disparities in suicide mortality by county income and rural status appear for white people, men and those older than age 65. The authors conclude that policies or programs that mitigate contextual social vulnerability may be effective in reducing suicide mortality among this population.

Indeed, the policy environment of a place produces predictable variation in population health and suicide. Social welfare policies that are designed to improve the lives of individuals, such as the expansion of health insurance coverage or paid work leave, have the potential to fundamentally alter the distribution of population health. As delineated by Beckfield and colleagues (Beckfield & Bambra, 2016; Beckfield et al., 2015), such policies often have redistributive effects on income, reducing poverty and income inequality with both direct and indirect benefits for health. With respect to suicide, research shows that state welfare policies are associated with lower suicide rates across US states over time (Flavin & Radcliff, 2009; Stack, 2021; Tuttle, 2018). For example, Rambotti (2020) showed that the Supplemental Nutrition Assistance Program (SNAP) was associated with lower overall and male suicide rates between 2000 and 2015 while Gertner et al. (2019) found a negative association between minimum wages and suicide rates across states over time. The suicide rate for those with a high school education or less appears to be particularly sensitive to increases in the minimum wage, especially during periods of high unemployment (Kaufman et al., 2020). A broad review (Kim, 2018) suggests that social protection policies play some role in moderating the negative effect of the economic environment on suicide.

Yet contextual studies to date have largely examined the effect of social policies or structural characteristics on suicide at the aggregate level using US state or country data. Moreover, they have studied suicides as a whole with little attention to the circumstances and conditions

(such as physical health problems) that may underlie those deaths and be differentially affected by structural conditions and policy. Although Suk et al. (2021) adopt a multilevel approach to studying suicide mortality, they control for just a few basic individual risk factors (age, sex, and race) and examine only one type of physical health problem (cancer) and two dimensions of context (wealth and urbanicity).

1.2. Study contribution

We use NVDRS data on suicide decedents linked to states to expand our understanding of the ways in which contextual (state) factors affect the likelihood that a physical health problem contributes to a suicide death, net of a host of individual demographic, socioeconomic, and circumstantial characteristics. We contribute to the existing literature in several ways. First, this study is unusual in adopting a *multilevel* approach to investigate whether the structural characteristics and policy environment of the state in which a decedent resided influence the odds of a physical health problem contributing to a suicide. To the extent that individuals reside in places with better access to healthcare or other social welfare policies, for example, we might expect that the likelihood of physical health problems contributing to a suicide, net of the individual characteristics of the decedent, is diminished.

Second, because both physical health problems (which increase precipitously with age) and the structural and policy environment might be expected to affect the population in different ways over the life course, we examine the role of individual and contextual risk factors at three different life course stages: Adolescence and young adulthood (ages 15–34), middle age (ages 35–64), and older age (ages 65+). We anticipate that robust social policies and favorable socioeconomic environments are likely to have a greater protective effect on those younger than age 65; little contextual variation in such factors among the older population exists due to universal Medicare and Social Security programs. Prior research investigating how individual characteristics are tied to physical health problems rarely adopts a comparative life course approach, instead focusing on particular age groups (e.g. (Hempstead et al., 2013) or all age groups combined (Chen & Roberts, 2021; Karch, 2011).

2. Data and methods

2.1. Data

Data come from the NVDRS, an incident-based violent death surveillance system established by the CDC in 2003 to assist states and local communities in violence prevention efforts. The system links information on decedents who died by lethal violence (suicide, homicide, and accidents) from multiple sources, involving medical examiner and coroner reports, toxicology reports, law enforcement records, supplemental homicide reports, and death certificates. As such, the data set is considered a gold standard because the compilation of information from multiple sources can mitigate weaknesses in individual data sources, including classification problems. The program was initiated in 2003 in seven states; by 2019, the program had expanded to include forty-three U.S. states that span all regions of the United States although New York state had incomplete case reporting in 2019 and is not included for that year. The analyses are based on all individuals who died by suicide in 2019 and had complete information (N = 28,116). Data on at least some individual characteristics were missing for 14.9% of decedents, largely due to unknown information on circumstances (10.3% of cases). See Supplementary Appendix Chart A1 and Table A1 for further details on cases dropped from the analysis.

2.2. Dependent variable

The outcome is a binary variable coded as 1 if physical health problems were identified as a precipitating circumstance that

contributed to the suicide and 0 otherwise. This measure is derived from the detailed circumstance information on all violent fatalities included in the NVDRS. NVDRS staff are trained by CDC to ascertain the presence or absence of a set of defined circumstances through careful examination of detailed information from medical, hospital and police reports, among other sources. Such defined circumstances include interpersonal problems (e.g. disputes with family or friends), external problems (e.g. job or financial issues), and personal problems (e.g. substance abuse, mental or physical health issues), one or more of which may precipitate a suicide death. The dependent variable thus identifies decedents who had a physical health problem as a precipitating factor, whether alone or in combination with other circumstances.

2.3. State-level variables

To measure the effect of structural state conditions on the likelihood of physical health problems contributing to a suicide death, we control for a series of state-level characteristics linked to individual decedents according to the state in which they resided. The degree to which residents within a state have access to medical care is measured by (1) percent of state population with no regular doctor (2) percent of males (or females) with no regular doctor and (3) active physicians per 100,000. We capture socioeconomic context with measures of the state unemployment rate and poverty rate, and demographic context with a measure of population density. The policy context of the state is identified by including a scale that measures private sector labor policy (e.g. disability insurance, paid sick/family leave, unemployment compensation), health and welfare benefits (such as expanded dependent coverage, CHIP and TANF eligibility), and gun control laws (e.g. assault weapons ban, background checks, open carry) with higher values indicating a more liberal policy environment. We also consider whether a state had expanded Medicaid to the population between 100 and 138 percent of the federal poverty level by 2019. Finally, we control for various aspects of the health context of the state, with measures of (1) percent of state population reporting poor or fair health (2) age-adjusted opioid overdose mortality rate and (3) age-adjusted suicide rate. Almost all these state characteristics are measured for the year 2019 and are obtained from the state health facts provided by the Kaiser Family Foundation and the American Association of Medical Colleges. The exceptions are the scales of labor and gun control laws and health/welfare benefits, captured for 2014 and compiled by Grumbach (2018).

2.4. Control variables

We control for a series of individual level factors known to affect the likelihood of suicide decedents experiencing physical health problems as a circumstance surrounding their deaths, including age, gender, race, nativity, marital status, and educational attainment. We also consider whether the presence of other life problems, such as a diagnosed mental health issue or financial difficulties, are associated with the likelihood of physical health contributing to a suicide, anticipating that at younger stages of the life course, the presence of mental health and financial difficulties may be more common among those with a physical health circumstance.

2.5. Methods

We estimate a multilevel mixed effects logistic regression to identify factors that affect the probability of a physical health problem contributing to a suicide death. Since physical health problems increase over the life course (Niccoli & Partridge, 2012), and the likelihood of a physical health circumstance contributing to a suicide rises steadily as people age (see Table A2 in Supplementary Appendix), we conduct analyses for individuals who died from suicide during three distinct life stages: adolescence and young adulthood (15–34); middle age (35–64); and older age (65+). We present models based on complete case analysis

in the paper; models using multiple imputation to account for missing data yield substantively similar results (see Table A3 in Supplementary Appendix). The models account for the clustering of decedents within states by allowing for random variation in the intercepts across states and adjust standard errors accordingly. Sensitivity analyses estimating state fixed effects models yielded similar results, with little to no change in the odds ratios of the individual characteristics and significance thereof.

We begin by estimating multilevel models with individual level characteristics to determine how such factors may be associated with the likelihood of a physical health problem contributing to a suicide death; a random state effect captures any remaining variation across states in that likelihood, net of individual characteristics. We then explore whether different dimensions of state context can explain the likelihood of physical health circumstances and state variation therein. Because decedents are nested within just 42 states, we enter the state characteristics one at a time to investigate their possible role. The melogit command in Stata 17 is used to estimate the models.

3. Results

3.1. Descriptive statistics

Table 1 displays the characteristics of suicide decedents with a physical health circumstance across the life course. Physical health problems are most common among those aged 65 and older, contributing in some way to over half (55%) of suicide deaths in that age

Table 1
Suicide decedents with a physical health circumstance, 2019

	Ages 15-34	Ages 35-64	Ages 65+
Physical Health with Other Circumstances	4.49%	18.45%	55.04%
Only Physical Health Circumstance	0.41%	2.91%	20.63%
Gender		*	*
Male	4.23%	17.73%	57.06%
Female	5.55%	20.58%	45.18%
Race			*
White	4.62%	18.99%	55.53%
Black	3.75%	13.11%	48.18%
Other	4.29%	14.29%	45.68%
Ethnicity			*
Hispanic	3.86%	12.68%	45.63%
Non-Hispanic	4.58%	18.80%	55.23%
Education		*	
Less than high school	3.30%	17.88%	56.84%
High School degree	4.27%	18.39%	55.34%
Some college	5.16%	19.36%	54.47%
College degree or higher	6.07%	17.76%	54.28%
Marital Status		†	*
Married	5.10%	19.43%	57.51%
Separated	5.86%	19.44%	53.62%
Divorced	7.53%	9.73%	31.15%
Single/Never Married	4.23%	16.53%	51.12%
Widowed	0.00%	24.08%	54.44%
Veteran Status			*
Yes	3.83%	19.25%	61.79%
No	4.55%	18.34%	50.52%
Foreign-born			*
Yes	5.47%	15.07%	46.02%
No	4.45%	18.58%	55.44%
Current Mental Health Diagnosis		*	*
Yes	5.43%	18.28%	45.75%
No	3.57%	18.62%	61.24%
Financial Problems		*	*
Yes	7.38%	19.53%	39.24%
No	4.32%	18.32%	56.04%
N	8486	14,307	5323

Source: NVDRS. *p < 0.05 †p < 0.10.

bracket in 2019. By contrast, they are a contributing factor in about 1 in 5 (18.5%) and 1 in 20 (4.5%) suicide deaths among the middle aged and young, respectively. Among those younger than age 65, physical health circumstances are more common among female decedents, but this pattern reverses in the older age ranges, with males more likely to have a physical health circumstance present. Other demographic characteristics are related to physical health circumstances in expected ways although with some differences in the association over the life course. It is noteworthy that for 20.6% of decedents aged 65 and older, *only* physical health problems are identified as a contributing factor. Among younger decedents, other contributing factors are often detected and coded. Taken as a whole, the descriptive statistics reveal unique patterns of risk factors for physical health circumstances over the life course.

There is considerable variation in the structural context of the 42 states included in the analysis (Table 2). For example, among measures of access to health care, the percentage of the population with no personal doctor ranges from 11.6% (New Hampshire) to 33.7% (Nevada) in 2019. Males are more likely than females not to have a regular doctor (an average of 27.6% for men compared to 16.3% for women). Population density of states varies quite a bit, as observed by the large standard deviation for this measure. Private sector labor laws, gun control laws, and health/welfare benefits vary substantially across states. For example, Minnesota has the most progressive health and welfare benefits (scale = 1) while Oklahoma has the least liberal ones (scale = 0.26). Finally, in terms of the health context of states, the percentage of state residents self-reporting poor or fair health ranges from 13.7% to 26.6%, and quite a bit of variation in opioid overdose rates exists across states. Across all states, 21.2% of decedents have a physical health problem that contributed to their suicide, ranging from 11.8% of decedents in Ohio to 32% in Nevada.

3.2. Individual-level risk factors

Table 3 presents the mixed effects logistic regression results. Among those aged 15 to 34, each additional year in age elevates the risk of a physical health circumstance among young adults (OR = 1.07, CI: 1.02–1.11). For example, holding all else constant, the odds of a 34 year-old having a physical health circumstance are 3.73 (1.068²⁰) times that of a 15 year-old. No other demographic characteristic predicts the likelihood of a physical health condition contributing to a suicide death, but other circumstances are important predictors of physical health problems. Decedents with a diagnosed mental health problem or a

Table 2
State-level characteristics (N = 42).

	Mean	SD	Min	Max
<i>Access to Care</i>				
% with no regular doctor	21.9%	5.7%	11.6%	33.7%
% males with no regular doctor	27.6%	6.7%	15.2%	39.8%
% females with no regular doctor	16.3%	4.8%	8.0%	27.8%
Active physicians per 100,000	276.3	53.5	206.7	449.5
<i>Socioeconomic & Demographic Context</i>				
Unemployment rate	3.6%	0.8%	2.2%	6.2%
Poverty rate	11.8%	2.5%	7.5%	18.7%
Population density (pop/sq mile)	210.2	280.1	1.3	1198.1
<i>Policy Context</i>				
Private sector labor scale (2014)	0.52	0.24	0.00	1.00
Health and welfare scale (2014)	0.61	0.22	0.26	1.00
Gun scale (2014)	0.26	0.29	0.00	1.00
Medicaid expansion state	73.8%	44.5%		
<i>Health Context</i>				
% self-reporting poor/fair health	17.7%	3.0%	13.7%	26.6%
Opioid mortality rate per 100,000	17.3	10.2	3.5	43.0
Suicide rate per 100,000	16.5	4.9	8.0	29.6
% with physical health problem as suicide circumstance	21.2%	4.7%	11.8%	32.0%

All figures are for 2019 unless otherwise noted.
Sources: Kaiser Foundation; NVDRS; CDC; Grumbach, 2018.

financial problem have 1.54 (CI: 1.24–1.91) and 1.57 (CI: 1.08–2.27) times the odds of a physical health circumstance, respectively.

Among those in midlife (ages 35 to 64), we continue to find steady increases in the likelihood of a physical health problem with each additional year in age (OR = 1.049, CI: 1.04–1.06). Furthermore, the significant interaction between age and gender reveals that gender differences in the likelihood of physical health circumstances converge over these ages such that women enter midlife with a higher probability of a physical health circumstance than men, but by the end of midlife, men have a slightly higher probability than women (see Fig. 1; Charts A2 and A3 display confidence intervals around these probabilities). Specifically, between ages 35 and 64, the probability of a physical health circumstance increases from 0.11 to 0.29 for women and from 0.06 to 0.30 for men, with the gender crossover occurring between ages 55 and 60. We also observe important racial and ethnic differences, with Blacks (OR = 0.74, CI: 0.58–0.93) and Hispanics (OR = 0.78, CI: 0.62–0.97) exhibiting lower odds of a physical health circumstance relative to whites and non-Hispanics, respectively. Those who possess a college degree have lower odds of a physical health circumstance (OR = 0.89, CI: 0.80–0.99) as do those who are separated (OR = 0.48, CI: 0.35–0.64). Financial problems and mental health issues do not affect the odds of a physical health circumstance among the middle-aged.

Among the population aged 65 and older, we observe some similar patterns to those in middle age. The odds of physical health circumstances increase with each additional year in age (OR = 1.03, CI: 1.01–1.05), with a sharper increase for males (Fig. 1, Chart A2). Those who are separated (OR = 0.35, CI: 0.20–0.63) or widowed (OR = 0.62, CI: 0.53–0.73) have lower odds than the married of physical health circumstances. However, unlike younger decedents (<65 years of age), diagnosed mental health problems and financial problems are associated with *lower* odds of a physical health circumstance (OR = 0.58, CI: 0.52–0.66 and OR = 0.52, CI: 0.41–0.67, respectively). The racial and ethnic and educational differences in the likelihood of a physical health circumstance underlying a suicide death during midlife disappear in older age.

3.3. State-level risk factors

Across all these models, significant random variation across states in the likelihood of physical health circumstances remains net of these individual-level covariates. Table 4 presents results from models that examine whether state level characteristics measuring access to care, socioeconomic and demographic, policy and health context can explain some of that random variation across states. Several state characteristics are associated with the likelihood of physical health circumstances across all three age groups. Decedents who resided in states that are more densely populated and have stricter gun control laws have lower odds while those in states with a higher suicide rate have higher odds, respectively, of a physical health problem.

Structural characteristics that capture access to care are linked to the likelihood of physical health problems for those younger than 35 and especially so for those 35–64. More active physicians per 1000 population reduce the odds of suicide decedents dying due to a physical health problem for both the middle-aged (OR = 0.71, CI: 0.56–0.92) and younger (OR = 0.65, CI: 0.43–0.98) populations. Additionally, residing in a state where higher proportions report no access to a regular doctor elevates the odds of physical health circumstances, especially for the middle-aged (OR = 1.84, CI: 1.12–3.01). This effect appears to be driven more by limited male access to a regular doctor among young adults.

The policy context of a state is most relevant in affecting the odds of a physical health circumstance among the middle-aged population. Physical health problems underlying a suicide are less common in states with liberal labor (OR = 0.64, CI: 0.27–1.09) and strict gun control (OR = 0.57, CI: 0.37–0.88) laws, and in states with more generous health and welfare benefits (OR = 0.54, CI: 0.30–0.99) and Medicaid expansion (OR = 0.75, CI: 0.56–0.99). Gun control laws are also associated with

Table 3
Mixed effects logistic model predicting likelihood of physical health circumstances among suicide decedents, NVDRS, 2019

	Ages 15–34 (N=8486)			Ages 35–64 (N=14,307)			Ages 65+ (N=5323)		
	OR	LCL	UCL	OR	LCL	UCL	OR	LCL	UCL
Individual Characteristics									
Race (ref = white)									
Black	0.889	0.61	1.29	0.736	0.58	0.93	0.785	0.55	1.13
Other	0.890	0.62	1.29	0.877	0.70	1.10	0.849	0.59	1.22
Hispanic	0.924	0.65	1.32	0.778	0.62	0.97	0.757	0.50	1.16
Age (years)									
Male	1.068	1.02	1.11	1.049	1.04	1.06	1.028	1.01	1.05
Age(years)*Male	0.977	0.93	1.02	1.030	1.02	1.04	1.033	1.01	1.05
Education (ref = BA or more)									
College degree	1.167	0.84	1.61	0.890	0.80	0.99	0.935	0.82	1.07
Marital Status (ref = married)									
Single	1.033	0.75	1.42	1.069	0.95	1.20	0.893	0.72	1.11
Divorced	1.057	0.65	1.71	0.942	0.85	1.05	0.927	0.80	1.07
Separated	1.531	0.82	2.86	0.476	0.35	0.64	0.353	0.20	0.63
Widowed	–	–	–	0.996	0.78	1.27	0.620	0.53	0.73
Foreign-born	1.304	0.78	2.18	0.843	0.65	1.09	0.756	0.55	1.03
Veteran	0.741	0.49	1.12	0.985	0.86	1.13	1.090	0.95	1.24
Circumstances surrounding death									
Diagnosed mental health problem	1.537	1.24	1.91	1.001	0.91	1.10	0.583	0.52	0.66
Financial problem	1.566	1.08	2.27	0.977	0.85	1.13	0.522	0.41	0.67
Intercept	0.007	0.00	0.02	0.024	0.01	0.04	0.197	0.05	0.80
Random Effects: State variance	0.253	0.12	0.52	0.163	0.10	0.28	0.156	0.09	0.28
Log Likelihood	–1504.884			–6341.501			–3402.555		

OR Odds Ratio; LCL Lower Confidence Limit UCL Upper Confidence Limit; Bolded OR signifies $p < 0.05$. Italicized OR signifies $p < 0.10$. Number of states = 42.

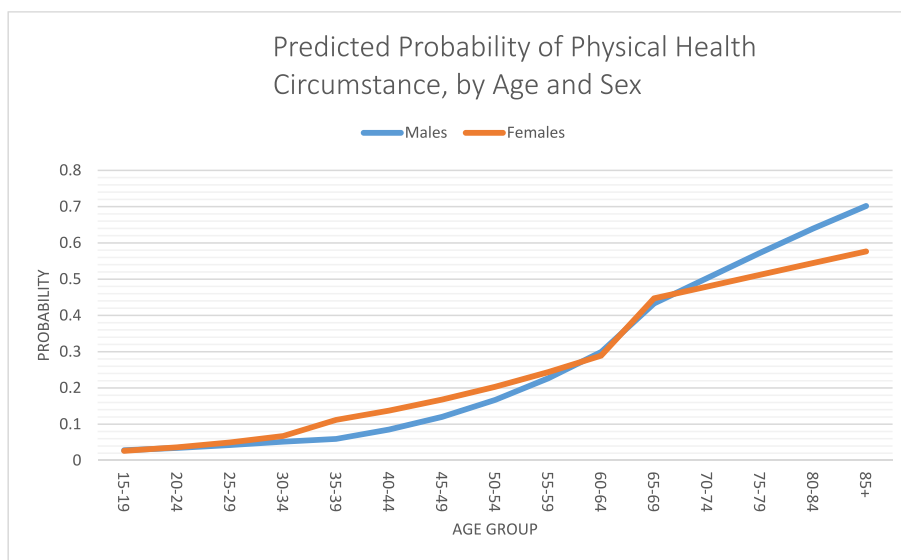


Fig. 1. Predicted probability of physical health circumstance, by age and sex.

lower odds of a physical health problem among decedents in the young and older age groups. For decedents older than 65, the odds of a physical health circumstance are approximately halved (OR = 0.47, CI: 0.28–0.78) for those residing in states with more liberal labor laws.

4. Discussion

4.1. Summary and interpretation of individual risk factors

Our results highlight the significant role of physical health problems in suicide, most especially for the older population for whom such circumstances were present in over half of suicide deaths in 2019. Older men are especially vulnerable. These findings are in line with other research indicating that poor health is a primary driver of late-life suicide (Conwell, 2014). In 2019, physical health problems were identified as the *only* circumstance underlying one in five suicide deaths among the

U.S. population aged 65 and over.

Of particular interest is the gender crossover effect in the likelihood of physical health circumstances occurring around age 60: Prior to age 60, women are more likely to have a physical health problem contributing to a suicide, but men surpass women after age 60 in that probability. This pattern is likely explained by gender differences not only in the nature of illness at different ages but also in the response to the illness. Women experience higher rates of chronic debilitating diseases related to the autoimmune system (e.g. lupus, fibromyalgia, arthritis), painful illnesses that often emerge in youth and midlife (Voskuhl, 2011). On the other hand, men are more likely to suffer from serious conditions such as heart disease and cancer in midlife with an increasing risk in the older age ranges (Rieker & Bird, 2005). The age and gender distribution of diseases offers a possible partial explanation for the patterns we observe in the different role of physical health problems over the life course by gender.

Table 4
State-level effects on the likelihood of physical health circumstances among suicide decedents, NVDRS, 2019

	Ages 15–34 (N=8486)			Ages 35–64 (N=14,307)			Ages 65+ (N=5323)		
	OR	LCL	UCL	OR	LCL	UCL	OR	LCL	UCL
<i>Access to Care</i>									
% with no regular doctor (logged)	1.87	0.86	4.03	1.84	1.12	3.01	1.18	0.69	2.05
% males with no regular doctor (logged)	2.20	0.95	5.07	2.01	1.18	3.42	1.30	0.72	2.36
% females with no regular doctor (logged)	1.48	0.75	2.91	1.60	1.03	2.47	1.05	0.65	1.68
Active physicians per 1000	0.65	0.43	0.98	0.72	0.56	0.92	0.84	0.64	1.09
<i>Socioeconomic & Demographic Context</i>									
Unemployment rate	1.20	0.95	1.51	1.09	0.92	1.29	0.88	0.74	1.06
Poverty rate (logged)	1.37	0.51	3.68	1.48	0.76	2.88	0.86	0.43	1.73
Population density (100 pop/sq mile)	0.85	0.77	0.94	0.93	0.88	0.97	0.92	0.88	0.97
<i>Policy Context</i>									
Private sector labor scale	0.75	0.34	1.68	<i>0.64</i>	<i>0.27</i>	<i>1.09</i>	0.47	0.28	0.78
Health and welfare scale	0.73	0.29	1.84	0.54	0.30	0.99	0.75	0.40	1.42
Gun scale	0.41	0.21	0.82	0.57	0.37	0.88	0.56	0.35	0.89
Medicaid expansion state	1.01	0.65	1.58	0.75	0.56	0.99	0.92	0.67	1.25
<i>Health Context</i>									
% self-reporting poor/fair health (logged)	1.06	0.31	3.61	1.20	0.52	2.74	0.50	0.21	1.18
Opioid mortality rate per 100,000	0.98	0.96	1.01	0.99	0.97	1.00	<i>0.99</i>	<i>0.97</i>	<i>1.00</i>
Suicide rate per 100,000	1.06	1.02	1.11	<i>1.03</i>	<i>1.00</i>	<i>1.06</i>	1.03	1.00	1.06

Models control for all individual characteristics in Table 2; Bold signifies $p < 0.05$; Italics signify $p < 0.10$; State variables entered independently into model. Several state variables are logged to reduce positive skew.

Yet, men and women also likely respond to illness and physical decline in older age ranges in distinct ways that produce varied outcomes with respect to suicide. For older men and particularly those who came of age prior to 1960, a masculine identity is intertwined with their social role as breadwinner and provider, a status that is diminished as men retire and lose physical strength and mobility with age (Canetto 1992, 2017; Winterrowd et al., 2017). To the extent that physical health problems make one dependent on others for support and help, they may produce feelings of burdensomeness, another powerful predictor of suicide (Joiner, 2007). Canetto and Sakinofsky (1998) assert that male hegemonic notions of the strong-and-silent, independent type predispose older men in particular to feelings of inadequacy and burdensomeness when confronted with a serious physical illness. Other societal scripts – that suicide can be a “masculine” response to such status losses or that suicide is a rational response to physical illness (Coleman et al., 2020; Phillips & Luth, 2020) – reinforce the idea that suicide under such conditions is courageous, empowering, in some cases even expected. Taken altogether, these cultural norms may cause older men to become especially vulnerable to suicide due to physical health problems at this stage of the life course.

Physical health problems are rarely the sole cause for a suicide and are often compounded by other issues. Chronic health problems can produce financial difficulties, to the extent that they prevent people from working consistently and/or require expensive treatments that are not covered by insurance (Chien et al., 2020). Moreover, to the extent that financial problems cause significant stress, they themselves may be a factor in the subsequent development of chronic physical health problems. Despite the introduction of the Affordable Care Act (ACA), medical bankruptcy remains a unique problem in the United States relative to other developed countries. A recent study estimates that 17.8% of American adults have some type of medical debt in June 2020, with higher rates for those living in the South and in states that did not expand Medicaid (Kluender et al., 2021). Furthermore, diagnosed mental health problems frequently co-occur with physical health issues, highlighting the important intersection between mind and body. While it is easy to imagine how disease can lead to depression and anxiety in patients, research increasingly demonstrates the ways in which such mental health problems can produce physical health problems (Bhattacharya et al., 2014; Kang et al., 2017; Scott et al., 2007).

4.2. Summary and interpretation of state factors

Even after controlling for a set of individual characteristics tied to

physical health circumstances, variation in this circumstance at the state level remains, pointing to the importance of structural context in affecting the likelihood of physical health circumstances. A number of state-level characteristics are associated with the odds of a physical health circumstance. Across all three age groups, decedents who resided in states that are less densely populated, have weaker gun control laws, and have a higher suicide rate are more likely to have a physical health circumstance present in their death. Not surprisingly, these characteristics (guns, population density and suicide) are highly correlated across states ($r \sim 0.7$), and the mechanisms underlying them reinforce one another. Less densely populated areas are typically rural where firearm ownership is more common, increasing access to a lethal means (Miller & Hemenway, 2008). Moreover, suicides brought about by physical health problems are disproportionately carried out with a firearm (Hempstead et al., 2013), perhaps because of selection issues (e.g. those with physical health circumstances are more likely to be gun owners) or because other methods such as hanging are more difficult to accomplish. We might also expect residents of such areas to experience more social isolation and less integration, factors that are associated not only with a higher risk for suicide overall but also with possible negative health implications (Holt-Lunstad et al., 2010; House et al., 1982).

We suspect that the state suicide rate operates similarly as a proxy for the prevalence of firearms and as an indicator that suicide may be a more normative response to difficulties in some areas more than others. In other words, people may internalize suicidal behavior as an appropriate or acceptable response to physical health problems if exposed to more suicide and cultural messages, frames and scripts that sanction such behavior (Mueller et al., 2021). Within the United States, increasing proportions find suicide acceptable in the case of a terminal illness, far more than do in the case of other circumstances, suggesting that people may be internalizing a suicidal response to physical health difficulties (Tong & Phillips, 2018).

Among the middle-aged and the young, suicide decedents living in states where access to health care is reduced have a higher likelihood of physical health circumstances. For example, decedents aged 15 to 64 residing in states with fewer active physicians per capita and where lower proportions of the population report having a regular doctor were more likely to have a physical health circumstance underlie their suicide. Numerous studies demonstrate that improved health care access is tied to a host of beneficial outcomes – appropriate and early treatment for problems, a focus on prevention, effective pain management, and enhanced trust and communication – all of which can serve as important protective factors against suicide due to physical health problems

(Millman 1993). Furthermore, screening for depression and suicidal behavior has become recommended practice at primary care physician appointments, providing another essential form of suicide prevention. Finally, for the middle-aged, a group that has experienced substantial increases in suicide in the 21st century, policies that promote affordable access to care, such as Medicaid expansion and more generous health and welfare benefits, reduce the likelihood of physical health circumstances among these decedents. Notably, access to care is not predictive of physical health circumstances among older decedents, perhaps because they face fewer barriers due to Medicare or a greater likelihood of residing in institutionalized settings with medical access.

4.3. Policy implications

Our results underscore the importance of provider awareness that poor physical health is a risk factor for suicide, especially among older men who are gun owners. A substantial proportion of suicide decedents seek out healthcare in the weeks and months before death, suggesting an important role for healthcare settings in suicide prevention (Ahmedani et al., 2017; Pearson et al., 2009). Moreover, the high prevalence of physical health problems at the older age ranges, especially for men, highlights the importance of promoting health behaviors and encouraging proactive management of diseases, especially advanced chronic diseases linked to suicide risk, among this population. As suggested by Conwell (2014), these objectives may be achieved through community-wide educational programs, exercise opportunities and good nutrition in retirement communities and accessible long-term care and support services. Among those younger than 65, our findings clearly reveal the importance of healthcare access net of individual level characteristics. Middle-aged women may particularly benefit not only because they are more likely to die by suicide due to physical health problems at this life course stage, but also because historically they have been less likely to have employer-based insurance, experience higher out of pocket costs for healthcare, and report delaying or going without needed care because of costs relative to men (Daniel et al., 2018). Adults who are approaching age 65 and lack adequate insurance would also benefit from a more robust social safety net, especially since the onset of chronic health problems often emerges during this stage of the life course.

The results also underscore the interplay between physical and mental health conditions that underlie suicide. Individuals with either depression and/or anxiety have a higher risk of many chronic physical conditions, including serious conditions like heart disease and diabetes, as well as others such as arthritis, hypertension and osteoporosis (Bhattacharya et al., 2014; Kang et al., 2017). A variety of biological and social mechanisms underlie this association. Anxiety can produce a chronic elevation of cortisol that increases risk for cardiovascular problems, and HPA (Hypothalamic-Pituitary-Adrenocortical) axis deregulation may produce diabetes or COPD, for example. Moreover, depression/anxiety can create unique barriers to medical care, to the extent that these conditions reduce motivation and follow-through in terms of making a medical appointment and keeping it, taking prescribed medications, and so forth. Finally, individuals suffering from mental health problems may develop unhealthy coping methods through substances that themselves produce physical health problems. Integrating mental health care with primary care may provide a critical entry point for intervention.

4.4. Limitations

There are several limitations to NVDRS data. The information on precipitating circumstances, while unique, is subject to reporting bias across sources and possible inconsistent coding. Most notably, precipitating circumstances are coded “yes” versus “no/not available/unknown,” so we cannot distinguish between the absence of a circumstance versus whether information is simply unavailable or

unknown. Moreover, for about 10% of suicide decedents in 2019, details on circumstances were missing altogether although sensitivity analyses using multiple imputation suggest results are not affected by excluding those cases. The NVDRS only recently expanded its coverage of states in the last several years. The 2019 analyses are thus more nationally representative than past studies using NVDRS, but we are limited in our ability to conduct longitudinal analyses of state-level factors. The counts of suicides by state in 2019 are very similar to those recorded by the Vital Registration System, but to the extent that suicides are under-reported due to social stigma or other factors and this under-reporting varies non-randomly across states, our results may be affected. Finally, although most state characteristics are measured for 2019, the indices capturing the policy environment surrounding guns, labor and health/welfare policy are not readily available after 2014. However, we do not anticipate significant change in the relative ranking of states across these dimensions.

5. Conclusion

This study sheds light on the role physical health problems play in suicide over the life course and adds to a growing body of work showing how policy and social context may affect suicidal behavior, revealing the ways in which suicides, while seemingly individual acts, are products of structural and cultural contexts. These contexts may be critical in affecting physical health – an important risk factor for suicide. Future research that illuminates the pathways through which these differences emerge, for example by drilling down to examine community level effects on suicide mortality, exploring the role of pain or support networks and conducting contextual analysis of the NVDRS narratives, would be beneficial. An in-depth analysis of the NVDRS narratives especially could shed light on how functional limitations and diminished health-related quality of life affect suicidality among decedents with known physical health conditions as well as the specific conditions that were present at the time of death by suicide, topics about which we know relatively little. Other paradoxes are also worthy of investigation, such as the pattern that Black decedents, despite the worse health status of this demographic group, are less likely to have physical health circumstances present in midlife as are middle-aged and older decedents residing in states with higher opioid mortality rates (which we hypothesized signified contexts characterized by greater physical disability and pain).

As Case and Deaton (2021a) have demonstrated, much of our current mortality and morbidity crisis emanates from psychological distress brought on by economic transition, inequality, and a loss of meaning for many. Mind and body are closely intertwined in the compelling narrative about the modern epidemic of “deaths of despair.” While the role of poor physical health as a risk factor for suicide is not a new phenomenon, this study provides another example of the powerful interaction of physical and mental well-being, and our results suggest that opportunities for prevention may come from creating a more supportive social context.

Author statement

Phillips: conceptualization, data curation and formal analysis, writing - original draft preparation, Hempstead: conceptualization, writing - review and editing.

Declarations of competing interest

None.

This manuscript has not been published previously, it is not under consideration for publication elsewhere, its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out. If accepted, it will not be published elsewhere in the same form.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2022.101059>.

References

- Ahmedani, B. K., Peterson, E. L., Hu, Y., Rossom, R. C., Lynch, F., Lu, C. Y., Waitzfelder, B. E., Owen-Smith, A. A., Hubley, S., Prabhakar, D., Williams, L. K., Zeld, N., Mutter, E., Beck, A., Tolson, D., & Simon, G. E. (2017). Major physical health conditions and risk of suicide. *American Journal of Preventive Medicine*, 53(3), 308–315.
- Anestis, M. D., & Houtsma, C. (2018). The association between gun ownership and statewide overall suicide rates. *Suicide and Life-Threatening Behavior*, 48(2), 204–217.
- Avendano, M., & Kawachi, I. (2014). Why do Americans have shorter life expectancy and worse health than do people in other high-income countries? *Annual Review of Public Health*, 35(1), 307–325.
- Beckfield, J., & Bambra, C. (2016). Shorter lives in stingier states: Social policy shortcomings help explain the US mortality disadvantage, 1982 *Social Science & Medicine*, 171, 30–38.
- Beckfield, J., Clare, B., Terje Eikemo, A., Tim, H., Courtney, M. N., & Wendt, C. (2015). An institutional theory of welfare state effects on the distribution of population health. *Social Theory & Health*, 13, 227–244.
- Bhattacharya, R., Shen, C., & Sambamoorthi, U. (2014). Excess risk of chronic physical conditions associated with depression and anxiety. *BMC Psychiatry*, 14(1), 10.
- Canetto, S. S. (1992). 6 gender and suicide in the elderly. *Suicide and Life-Threatening Behavior*, 22(1), 80–97.
- Canetto, S. S. (2017). Suicide: Why are older men so vulnerable? *Men and Masculinities*, 20(1), 49–70.
- Canetto, S. S., & Sakinofsky, I. (1998). The gender paradox in suicide. *Suicide and Life-Threatening Behavior*, 28(1), 1–23.
- Case, A., & Deaton, A. (2021a). *Deaths of despair and the future of capitalism*. Princeton University Press.
- Case, A., & Deaton, A. (2021b). Life expectancy in adulthood is falling for those without a BA degree, but as educational gaps have widened, racial gaps have narrowed. *Proceedings of the National Academy of Sciences of the United States of America*, 118(11), Article e2024777118. <https://doi.org/10.1073/pnas.2024777118>
- Cavanagh, J. T. O., Carson, A. J., Sharpe, M., & Lawrie, S. M. (2003). Psychological autopsy studies of suicide: A systematic review. *Psychological Medicine*, 33(3), 395–405.
- Chang, S.-S., Stuckler, D., Yip, P., & Gunnell, D. (2013). Impact of 2008 global economic crisis on suicide: Time trend study in 54 countries. *British Medical Journal*, 347.
- Chen, T., & Roberts, K. (2021). Negative life events and suicide in the national violent death reporting system. *Archives of Suicide Research: Official Journal of the International Academy for Suicide Research*, 25(2), 238–252.
- Chien, S.-Y., Chuang, M.-C., & Chen, I.-P. (2020). Why people do not attend health screenings: Factors that influence willingness to participate in health screenings for chronic diseases. *International Journal of Environmental Research and Public Health*, 17(10).
- Coleman, D., Feigelman, W., & Rosen, Z. (2020). Association of high traditional masculinity and risk of suicide death: Secondary analysis of the add health study. *JAMA Psychiatry*, 77(4), 435–437.
- Conwell, Y. (2014). Suicide later in life: Challenges and priorities for prevention. *American Journal of Preventive Medicine*, 47(3 Suppl 2), S244–S250.
- Crimmins, E. M. (2021). Recent trends and increasing differences in life expectancy present opportunities for multidisciplinary research on aging. *Nature Aging*, 1(1), 12–13.
- Daniel, H., Erickson, S. M., & Bornstein, S. S. (2018). Women's health policy in the United States: An American college of physicians position paper. *Annals of Internal Medicine*, 168(12), 874–875.
- Diez Roux, A. V. (2007). Neighborhoods and Health: Where are we and where do we go from here? *Revue D'Epidemiologie Et De Sante Publique*, 55(1), 13–21.
- Flavin, P., & Radcliff, B. (2009). Public policies and suicide rates in the American states. *Social Indicators Research*, 90(2), 195–209.
- Gertner, A. K., Rotter, J. S., & Shafer, P. R. (2019). Association between state minimum wages and suicide rates in the U.S. *American Journal of Preventive Medicine*, 56(5), 648–654.
- Grumbach, J. M. (2018). From backwaters to major policymakers: Policy polarization in the states, 1970–2014. *Perspectives on Politics*, 16(2), 416–435.
- Hempstead, K., Nguyen, T., David-Rus, R., & Jacquemin, B. (2013). Health problems and male firearm suicide. *Suicide and Life-Threatening Behavior*, 43(1), 1–16.
- Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, 7(7), Article e1000316.
- House, J. S., Robbins, C., & Metzner, H. L. (1982). The association of social relationships and activities with mortality: Prospective evidence from the tecumseh community health study. *American Journal of Epidemiology*, 116(1), 123–140.
- Joiner, T. (2007). *Why people die by suicide*. Cambridge, MA: Harvard University Press.
- Kang, H.-J., Bae, K.-Y., Kim, S.-W., Shin, H.-Y., Shin, I.-S., Yoon, J.-S., & Kim, J.-M. (2017). Impact of anxiety and depression on physical health condition and disability in an elderly Korean population. *Psychiatry Investigation*, 14(3), 240–248.
- Kaplan, M. S., McFarland, B. H., Huguet, N., & Newsom, J. T. (2007). Physical illness, functional limitations, and suicide risk: A population-based study. *American Journal of Orthopsychiatry*, 77(1), 56–60.
- Karch, D. (2011). Sex differences in suicide incident characteristics and circumstances among older adults: Surveillance data from the national violent death reporting system—17 U.S. States, 2007–2009. *International Journal of Environmental Research and Public Health*, 8(8), 3479–3495.
- Kaufman, J. A., Salas-Hernández, L. K., Komro, K. A., & Livingston, M. D. (2020). Effects of increased minimum wages by unemployment rate on suicide in the USA. *Journal of Epidemiology & Community Health*, 74(3), 219–224.
- Kim, C. (2018). The impacts of social protection policies and programs on suicide: A literature review. *International Journal of Health Services: Planning, Administration, Evaluation*, 48(3), 512–534.
- Kluender, R., Mahoney, N., Wong, F., & Yin, W. (2021). Medical debt in the US, 2009–2020. *JAMA*, 326(3), 250–256.
- Kontis, V., Bennett, J. E., Mathers, C. D., Li, G., Foreman, K., & Ezzati, M. (2017). Future life expectancy in 35 industrialised countries: Projections with a bayesian model ensemble. *Lancet*, 389(10076), 1323–1335.
- Miller, M., & Hemenway, D. (2008). Guns and suicide in the United States. *New England Journal of Medicine*, 359(10), 989–990–991.
- Access to health care in America. In Millman, M. (Ed.), *Institute of medicine, committee on monitoring access to personal health care services*. "Access to health care in America, (1993). Washington D.C.: National Academies Press.
- Mueller, A. S., Seth, A., Pescosolido, B., & Diefendorf, S. (2021). The social roots of suicide: Theorizing how the external social world matters to suicide and suicide prevention. *Frontiers in Psychology*, 12, 763.
- Murphy, S. L., Xu, J., Kochanek, K. D., & Arias, E. (2018). Mortality in the United States, 2017, 328 *NCHS Data Brief*, (328), 1–8.
- Niccoli, T., & Partridge, L. (2012). Ageing as a risk factor for disease. *Current Biology: CB*, 22(17), R741–R752.
- O'Connor, R. (2021). *When it is darkest: Why people die by suicide and what we can do to prevent it*. Penguin Random House.
- Olshansky, S. J., Antonucci, T., Berkman, L., Binstock, R. H., Boersch-Supan, A., Cacioppo, J. T., Carnes, B. A., Carstensen, L. L., Fried, L. P., Goldman, D. P., Jackson, J., Kohli, M., Rother, J., Zheng, Y., & Rowe, J. (2012). Differences in life expectancy due to race and educational differences are widening, and many may not catch up. *Health Affairs*, 31(2), 1803–1813.
- Pearson, A., Saini, P., Da Cruz, D., Miles, C., While, D., Nicola Swinson, Williams, A., Shaw, J., Appleby, L., & Kapur, N. (2009). Primary care contact prior to suicide in individuals with mental illness. *British Journal of General Practice*, 59(568), 825.
- Pescosolido, B. A., Lee, B., & Kafadar, K. (2020). Cross-level sociodemographic homogeneity alters individual risk for completed suicide. *Proceedings of the National Academy of Sciences of the United States of America*, 117(42), 26170–26175.
- Petrosky, E., Harpaz, R., Fowler, K. A., Bohm, M. K., Helmick, C. G., Yuan, K., & Betz, C. J. (2018). Chronic pain among suicide decedents, 2003 to 2014: Findings from the national violent death reporting system. *Annals of Internal Medicine*, 169(7), 448–455.
- Phillips, J. A. (2014). A changing epidemiology of suicide? The influence of birth cohorts on suicide rates in the United States. *Social Science & Medicine*, 114, 151–160.
- Phillips, J. A., & Luth, E. A. (2020). Beliefs about suicide acceptability in the United States: How do they affect suicide mortality? *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 75(2), 414–425.
- Phillips, J. A., & Nugent, C. C. (2014). Suicide and the great recession of 2007–2009: The role of economic factors in the 50 U.S. States. *Social Science & Medicine*, 116, 22–31.
- Rambotti, S. (2020). Is there a relationship between welfare-state policies and suicide rates? Evidence from the U.S. States, 2000–2015, 1982 *Social Science & Medicine*, 246, 112778.
- Rieker, P. P., & Bird, C. E. (2005). Rethinking gender differences in health: Why we need to integrate social and biological perspectives. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 60(2), 40–47.
- Scott, K. M., Bruffaerts, R., Tsang, A., Ormel, J., Alonso, J., Angermeyer, M. C., Benjet, C., Bromet, E., de Girolamo, G., de Graaf, R., Gasquet, I., Gureje, O., Haro, J. M., He, Y., Kessler, R. C., Levinson, D., Mneimneh, Z. N., Oakley Browne, M. A., Posada-Villa, J., ... Von Korff, M. (2007). Depression–anxiety relationships with chronic physical conditions: Results from the world mental health surveys. *Journal of Affective Disorders*, 103(1), 113–120. <https://doi.org/10.1016/j.jad.2007.01.015>
- Stack, S. (2021). Contributing factors to suicide: Political, social, cultural and economic. *Preventive Medicine*, 152(Pt 1), 106498.
- Stokes, A., Berry, K. M., Collins, J. M., Hsiao, C. W., Waggoner, J. R., Johnston, S. S., Ammann, E. M., Scamuffa, R. F., Lee, S., Lundberg, D. J., Solomon, D. H., Felson, D. T., Neogi, T., & Manson, J. E. (2019). The contribution of obesity to prescription opioid use in the United States. *Pain*, 160(10), 2255–2262.
- Stone, D. M., Holland, K. M., Schiff, L. B., & McIntosh, W. L. (2016). Mixed methods analysis of sex differences in life stressors of middle-aged suicides. *American Journal of Preventive Medicine*, 51(5 Suppl 3), S209–S218.
- Suk, R., Hong, Y.-R., Wasserman, R. M., Swint, J. M., Azenui, N. B., Sonawane, K. B., Tsai, A. C., & Deshmukh, A. A. (2021). Analysis of suicide after cancer diagnosis by US county-level income and rural vs urban designation, 2000–2016. *JAMA Network Open*, 4(10), Article e2129913–e2129913.
- Tong, Y., & Phillips, J. A. (2018). Understanding changes in attitudes toward suicide between 1980s and 2010s in the United States. *Social Science Quarterly*, 99(5), 1585–1598.
- Tuttle, J. (2018). Specifying the effect of social welfare expenditures on homicide and suicide: A cross-national, longitudinal examination of the stream analogy of lethal violence. *Justice Quarterly*, 35(1), 87–113.

Van Tubergen, F., Grotenhuis, M.te, & Ultee, W. (2005). Denomination, religious context, and suicide: Neo-durkheimian multilevel explanations tested with individual and contextual data. *American Journal of Sociology*, 111(3), 797–823.

Voskuhl, R. (2011). Sex differences in autoimmune diseases. *Biology of Sex Differences*, 2(1), 1.

Winterrowd, E., Canetto, S. S., & Benoit, K. (2017). Permissive beliefs and attitudes about older adult suicide: A suicide enabling script? *Aging & Mental Health*, 21(2), 173–181.