Counties with More Vietnam Veterans Have Higher Suicide Rates

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Abstract

Despite a deep concern from policymakers and the public alike, detailed records linking military service records and suicide do not exist on a national scale. Here, we determine how suicide rates are related to the veteran population by linking data from the Centers for Disease Control (CDC) at the county-level with estimates of veteran populations by service period from the American Community Survey. While this is an indirect approach, this panel analysis allows us to uncover a robust and persistent finding: counties with larger Vietnam veteran populations have higher suicide rates. Our modeling strategy includes standard panel data methodology, sub-state analysis based on the adoption of Child Access Prevention laws governing firearms, and a recent innovation in instrumental variables methodology coupled with county birth records from lottery years as an instrument. Ultimately, we find that a standard deviation increase in the Vietnam veteran population is associated with 1.9 to 6 additional suicides per 100,000 people.

1 Introduction and Background

Veterans face challenges that are far different from most civilians including issues related to post-traumatic stress disorder, persistent pain, and difficulty in acclimatizing to civilian settings during their career transitions. While there is substantial literature on suicide among veterans, much of this research focuses on factors related to mental health and psychological distress, ignoring their synergies with other chronic issues. Moreover, contradictory findings exist because "while national-level mortality data provide an important surveillance tool for understanding changes in overall and group-specific U.S. rates of suicide, veteran-specific data are limited" (Bossarte et al. (2010)). In this research, we are able to link county suicide rates with the veteran population by service period. To do this, we use microdata from the Centers for Disease Control (CDC) which has information on the specific cause of death. We connect these data with estimates on the veteran population living in each county to determine if larger veteran populations are associated with higher suicide rates while controlling for changes in economic circumstances, average presence of firearms and policy differences in gun safe storage laws, and opioid prescriptions at the county level. Additionally, we adopt a novel instrumental variables approach to address limitations encountered by scholars in prior studies. Across modeling strategies we persistently find that there is a descriptive relationship between counties with larger Vietnam veteran populations and higher suicide rates.

Establishing a clear link between veteran status and cause of death has been a challenging task. Huguet et al. (2014) show that prior contradictory results exist due to both inaccuracy in ascertainment of veteran status on the death certificate and misclassification of suicides as other manners of death. Nonetheless, several studies have been able to make connections by period of service. For example, Kramer et al. (1994) show that Vietnam war veterans have higher levels of mortality from suicide when compared with age cohorts who did not serve in the military or were not involved in combat. Bullman and Kang (1996) show this was related to increased occurrence of combat trauma – mortality among Vietnam veterans with post-traumatic stress

disorder (PTSD) was 71% higher compared to veterans without PTSD. Hendin and Haas (1991) investigated 100 individuals with PTSD related to combat experience in Vietnam and found that combat guilt was the most significant predictor of both suicide attempts and preoccupation with suicide after service (also see Beckham et al. (1997); Fontana et al. (1992)). Watanabe and Kang (1995) found an excess of all-cause mortality among Vietnam veterans caused by external causes of death, which included death by suicide. Among more recent cohorts of veterans, Lubens and Silver (2019a) find that grief is a neglected consequence of combat exposure, and that as the number of troops killed in action declined during the Iraq war, "the military suicide rate has at times surpassed the combat casualty rate" (Lubens and Silver (2019a)). This is a striking finding because it shows that some of the most lethal periods of this war have been post-combat. In another study, Lubens and Silver (2019b) observed that suicide death among veterans is unexpected and can make acceptance of loss harder, whereas combat death is expected and can ease acceptance of loss. The concern is that these unexpected deaths can cause as much or more harm to the mental states of those who have seen combat and could lead to contagion effects. Overall, we see that while it has been difficult to establish a clear link between veteran status and cause of death, several studies have made significant strides in understanding the complex relationships between combat, PTSD, and suicide mortality rates.

Studying the causes and determinants of suicide is not new to the field of economics. Hamermesh and Soss (1974) were among the first to formalize the connection between economic circumstances and suicide. Abdou et al. (2020) discuss how business success relates to suicidality, and Rambotti (2020) discusses how economic strain and state welfare policies impact suicides. These authors both find that economic factors matter, especially among men. Much like we do, Rambotti (2020) makes use of two-way state and year fixed effects models to show that SNAP participation reduces suicides – even during economic downturns.

If the cause of suicide is economic, then some argue in favor of a policy response to reduce suicides including laws limiting access to firearms, but this view is controversial. Kellermann et al. (1992) find that the presence of one or more firearms in the home is associated with an increased risk of suicide. Edwards et al. (2018) use the staggered state-level adoption purchase delay laws to determine the effect of mandatory wait periods following the purchase of firearms on suicide rates. They find that a wait period reduces firearm related suicides by about 3% while finding no evidence of substitution towards non-firearm suicides. However, Levine and McKnight (2017) do not find an increase in the suicide rate due to the sudden increase in firearm purchases following the Sandy Hook school shooting, and Duggan et al. (2011) do not find any connection between firearm-shows and suicide. While there is not a consensus on the exact relationship between firearm prevalence in the community and suicide, these studies are limited by their inability to address whether there is a difference based on firearm policy changes and veteran status. Our contribution to this literature is to discern if suicide rates and Vietnam-era veteran presence differs by state gun storage laws, specifically 'Child-Access Prevention' (CAP) laws. We choose to focus on this relatively more targeted initiative because the Second Amendment curtails legislation that restricts firearm access in the United States. Policy makers have deemed that practices involving securely storing guns (such as locking guns and ammunition, and keeping guns unloaded) may be a more effective strategy to reduce self-harm among adolescents and adults. Prior work has found that firearm storage practices matter, and that firearm suicides occur more often in homes where guns are not stored securely (Conwell et al. (2002); Shenassa et al. (2004); Grossman et al. (2005)). MMonuteaux et al. (2019) find that storage could save hundreds of lives. The mechanism governing the nexus between storage laws and suicide may be driven by a "dose-response"-type mechanism (Monuteaux et al. (2019)). This is important because prior work has shown that there is essentially no difference in storage practices between those that have thought about or attempted suicide and those who have not (Smith et al. (2015); Betz et al. (2016)).

Policy is not panacea, though, as Hebert et al. (2018) claimed that suicide can be the unintended consequence of poorly designed policies intended to prevent suicide. The authors highlight how Apple responded to suicides in Foxconn's assembly plants in 2010 by pressuring Foxconn to compensate the victims' families, raise wages, and stop its abusive practices. Paradoxically, this policy response led to an increase in suicides instead of the anticipated decline. The compensation offered by Foxconn was substantial given the daily wages of these workers (amounted to about 14-15 years of their wages). Therefore, the company soon found that some employees committed suicide explicitly to secure the compensation payments for their families. To combat the situation, the CEO of Foxconn announced they would raise the wages of the employees, but no longer pay condolence money. As the cost of committing suicide increased, the suicide rate at the

firm returned to pre-2010 levels. If we assume that those who attempt suicide follow the logic of 'rational' choice, then having child access prevention laws in place can make suicide more costly. However, in the case of veteran suicides, this explanation would be difficult to justify because while some states have laws that impose a criminal liability when an adult fails to secure a weapon, others merely prohibit an adult from providing a firearm to a child (that is, there is significant variation in the "costs" involved, and in many cases, the costs are quite "low"). Perhaps, it might be argued that just having the CAP laws in place can create a perception that suicide would be more costly.

Another potential explanation for suicide using the rational choice perspective would involve financial hardship. Becker and Posner (2004) posited that unhappy people are also rational actors and seek to "maximize their utility in a forward-looking fashion, taking account of the uncertainty of future events, and the consequences of their actions" (p. 2). Setting aside the causal explanation of mental disorders, variables like bankruptcy, unemployment, divorce, widowhood, disappointment, etc. could all potentially affect the utility of living. Relatedly, Korhonen et al. (2016) analyzed consumption and suicide trends in Finland from 1875 to 2010 and advanced a theory that it might be rational for a consumer facing economic hardship over a long time to commit suicide if they perceive the act to maximize their utility and subjective well-being. Using an economic explanation, the authors suggest that significant deterioration in anticipated consumption was potentially linked to a higher incidence of suicides in Finland. Attesting to this relationship between economic conditions and suicide, Hamermesh and Soss (1974) found that "suicide behavior of older people is significantly more sensitive to variations in unemployment than is that of younger people" (p. 97). To address this issue where suicide becomes a "rational choice" for some unhappy individuals, Helliwell (2007) pointed out that people may be less unhappy and have higher levels of life satisfaction if their communities have more social capital and higher levels of trust.

In order to unpack whether there is an economic explanation for veterans' suicide, we accounted for several indicators of local economic conditions including per capita GDP and county-level unemployment rates as control variables in all models. Though not presented here, we have also considered models that specifically account for differences in local 'social capital' by including estimates of a Social Capital Index from the Joint Economic Committee and from Rupasingha et al. (2006), with updates). On the empirical side, this is tougher to measure because we don't have time varying captures of these indices that overlap with our sample period so they are perfectly correlated with the county-level fixed effect already included. In essence, the fixed effect should already be capturing this unobserved heterogeneity in social capital availability. When we test this, we find that the model without county-level controls is much weaker.[1]

War trauma can interfere with veterans' ability to form and maintain meaningful relationships, which can exacerbate feelings of isolation and loneliness. The burden of unresolved grief and trauma can also contribute to a sense of hopelessness, leading to a higher risk of suicide. Pivar and Field (2004) noted that the Vietnam War involved some unique conditions, where many of our soldiers were engaged in a long-drawn conflict involving guerrilla warfare and faced alienation when they returned home for being part of the first major war lost abroad in our history. In their study, they found that Vietnam veterans experienced chronic grief-specific symptoms stemming from particular experiences involving attachment to and loss of comrades during the Vietnam war. Pivar and Field (2004) called for conceiving unresolved grief as a separate diagnostic category from anxiety and depressive disorders. Such prolonged grief can lead to adverse physical and mental health, as well as poor family relationships (Currier and Holland (2012)), thereby impacting veterans' level of life satisfaction. Lubens and Silver (2019a) found in their study that "the level of acceptance of a comrade's death depends on the mode of death, with combat deaths being easier to accept than suicide deaths" (p. 395). The possibility of a contagion effect also exists, where knowing someone who died by suicide increases one's own risk of suicidality (Abrutyn and Mueller (2014)). Miklin et al. (2019) also suggested that through exposure to someone who committed suicide, the act of suicide itself might become more acceptable as part of one's cultural repertoire.

In this work, we also investigate intentional and unintentional overdose deaths and their link to veteran

[1]For example, when we replace the county fixed effect with a state fixed effect and include the Social Capital Index, we see that our main effect size is attenuated by about half, and that the social capital index is not statistically significant. The social capital index is not soaking up this variation, though. Instead, it is the case that when we swap the county fixed effect for the state fixed effect (and leave out social capital entirely) we get nearly identical results to when we include the social capital index. Thus, we believe that the county fixed effect is important and is already picking up unobserved factors (like social capital factors).

Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
Suicide Rate	16.81862	14.76956	0	313.81
Gun Suicide Rate	10.36073	11.6544	0	217.39
Veteran Population	5392.042	9522.267	0	84876
Vietnam Veterans	1915.663	3248.794	0	24983
Iraq Veterans	671.7215	1576.417	0	34338
Gulf Veterans	921.2249	1922.766	0	32520
Korea Veterans	595.3237	1099.864	0	13163
WW Veterans	419.5248	927.9303	0	16772
ln GDP	13.8614	1.507415	9.3	20.2
Prescribing Rate	82.77413	46.73345	0	583.8
Unemp. Rate	6.761996	3.331086	1.1	29.4

Notes: Unit of observation is a county year; Suicide, Gun suicide, and Prescribing rates on a per 100,000 people basis.

populations. Opioids are narcotic pain relievers and are only (legally) available by prescription, but have been widely abused and the death rate per 100,000 people has doubled in less than two decades (Evans et al. (2019)). **?** argue that a major contributing factor to the unprecedented rise in all-cause mortality for middle-aged non-Hispanic whites is the prevelance of opioids. Pain resulting from combat trauma and PTSD can lead to "alterations in the neurocircuitry related to reward, which result in vulnerability to suicide and potentially to riskier use of opioids" (**?**). We find no evidence that areas with larger veteran populations have greater rates of death by overdose for any service-period, but do consistently find that the prescribing rate is positively associated with intentional and unintentional deaths by overdose.

2 Methodology

In this study we investigate the number of suicides in a county in relation to the veteran population.

$$E(Suicides_{it}|X_{it}) = X'_{it}\beta + \varepsilon_{it} \tag{1}$$

Where $X'_t\beta$ includes information on the veteran population by service-period for each county-year, controls that account for changes in economic activity, and variables that account for previously determined correlates of suicide. We also include county and time fixed effects in all models, and toggle state-specific linear trends and fixed effects. These additional variables capture remaining unobserved heterogeneity and potential effects of state-specific shocks or pre-existing trends in the outcome variable.

2.1 Data

Data are gathered for the years 2010-2017. The number of suicides in a county are aggregated from microdata available from the CDC. We limit the geographic resolution to the county-level and aggregate to a yearly interval to preserve anonymity according to CDC guidelines. We also transform the aggregated data to the suicide rate per 100,000 people in the county in the 2010 census so that estimates are conformable across rural and densely populated areas. Auxiliary data is collected on the veteran population in each county by service-period from the American Community Survey. We use the 5-year ACS estimates in all estimates for larger county coverage, however we note that our results are not sensitive to using ACS 1- or 3-year estimates which provide a more precise count at the expense of reduced county coverage. We also include county-level

real GDP data (in logarithm) from the Bureau of Economic Analysis as a measure of economic activity. We also make use of data from the BLS on monthly county unemployment rates. This control variable captures localized changes in unemployment and hardship which could be a driver of suicide. Moreover, this variable offers useful variation in local economic conditions that may not be captured by controlling for county-level GDP which is a more steady metric of county economic activity. We note, that this variable is positive and statistically significant in models that exclude state-specific fixed effects or trends, but is attenuated and no longer statistically significant in the more complete models that include these state-specific trend and fixed effects. Additional regressions we considered make use of proxies for firearm ownership. These are available through the RAND Gun Policy in America at a state-wide resolution. Another more geographically distinct option is to use new firearm registrations. Ultimately, neither of these inclusions changed our primary results, and depending on the model specification, are partialed out with the inclusion of county fixed effects or state-year fixed effects. In our instrumental variables model we use historical birth records from the Vital Statistics of the United States report published by the Federal Security Agency's Public Health Service. In modern day, this is maintained through the CDC. Importantly, we use 'Part II' of the yearly reports which aggregate data by county of residence, not the county of birth.[2]

Figure 1 shows the spatial distribution of Vietnam-era veterans in 2017. Here we see that this population is greatest in urban centers, but that there is also a wide dispersion in non-major metropolitan areas.[3] Figure 2 shows how the suicide rate varies by county over the United States for the year 2017. Taken together, these figures hint at our eventual findings - that counties with larger Vietnam veteran populations have higher suicide rates.

3 Reduced Form Specification

Our descriptive model is equation (2).

$$SuicideRate_{it} = \beta_0 + \beta_2 Vietnam_{it} + \beta_3 Iraq_{it} + \beta_4 Gulf_{it} + \beta_5 Korea_{it} + \beta_6 WW_{it} + X'_{it}\Gamma + \varepsilon_{it} \quad (2)$$

$SuicideRate_{it}$ is the amount of suicides per 100,000 people in county i and year t.[4] Our coefficients of interest are those attached to the variables that denote the number of veterans by service-period (Vietnam War: $Vietnam_{it}$, Post-9/11 Gulf War: $Iraq_{it}$, and so on). These variables show the marginal effect of a larger veteran population for each period of service on county suicide rates, all else equal. We also include a vector of control variables, $X'_{it}\Gamma$, which include: the natural logarithm of real GDP and its square to capture potential non-linear effects; the county unemployment rate; the opioid prescribing rate in the county. We account for unobserved heterogeneity by including fixed effects by county, year, and toggle the inclusion of state-by-year fixed effects and state-specific linear trends.[5] These latter variables capture remaining unobserved effects such as policy changes that occur and differ by state (but are consistent across counties in the state). Robust standard errors are clustered at the county-level.

3.1 Reduced Form Results

We begin by describing the relationship between the total veteran population and the county suicide rate (e.g. all service periods). Here, we see some evidence that the veteran population is positively associated with suicide rates.[6] We first find that larger veteran populations are associated with higher suicide rates. When we include state-year fixed effects or trends, however, we no longer notice a statistically discernible difference. Columns 4-6 include each service period as separate regressors. Vietnam-era veterans make up more than 37% of the veteran population on average, and 10% of the veteran population is comprised of

[2]Our identifying assumption below is that today's Vietnam-era veteran population is positively correlated with past birth totals, i.e. the first stage regression's sign is positive.

[3]For example, most of the state of Florida is in the upper quantile of Vietnam veterans, and there are multiple counties in Oklahoma that are in the top two quantiles.

[4]We use a constant base population to calculate the suicide rate that is equal to the County's population in 2010.

[5]We also considered models that included state-level proxies of gun ownership (explained below).

[6]Columns 1-3 of Table 1 show these results, with column 2 including state-year fixed effects and column 3 including state-linear trends.

Table 2: Results by Service Period

	(1)	(2)	(3)	(4)	(5)	(6)
Veteran Population	0.00014***	0.00004	0.00004			
	(0.00005)	(0.00006)	(0.00006)			
Vietnam				0.00068***	0.00060***	0.00059***
				(0.00017)	(0.00020)	(0.00021)
Iraq				0.00034**	0.00023	0.00020
				(0.00014)	(0.00016)	(0.00016)
Gulf				0.00024	0.00029	0.00027
				(0.00025)	(0.00026)	(0.00027)
Korea				-0.00052	-0.00075	-0.00078
				(0.00041)	(0.00042)	(0.00043)
WW				0.00029	0.00016	0.00015
				(0.00021)	(0.00023)	(0.00023)
Presc. Rate	-0.00522	-0.00404	-0.00382	-0.00490	-0.00364	-0.00338
	(0.00654)	(0.00728)	(0.00742)	(0.00656)	(0.00729)	(0.00744)
Unemp. Rate	0.17416**	0.10641	0.09472	0.18347**	0.10530	0.09528
	(0.08870)	(0.10947)	(0.12410)	(0.08911)	(0.11007)	(0.12491)
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
State x Year FE	N	Y	N	N	Y	N
State-specific Trend	N	N	Y	N	N	Y
R^2	0.330	0.339	0.348	0.330	0.339	0.348
N	22175	22029	22029	22175	22029	22029

Notes: Dependent variable is suicide rate per 100,000 people in 2010 census; Robust standard errors clustered by county (shown in parentheses); All models also include ln(RGDP) and its square; **, *** indicate statistical significance at the 5% and 1% levels, respectively.

Post-9/11-era veterans, but both groups faced entirely different environments in their service and in their reception when coming home. We see that the prior result is almost entirely driven by the Vietnam-era veteran population, and that this is now consistently statistically significant across all modeling strategies.[7] Estimates in column 5 and 6, our preferred specifications, show that a standard deviation increase in the Vietnam-era population is associated with an additional 1.9 suicides per 100,000 – an 11% increase relative to the mean. This is substantial, especially given that our outcome variable is measuring this change in all suicides in a county.[8]

We are also interested in the effects that firearms and opioids have in conjunction with the veteran population. We begin by exploring the role that Child-Access Prevention (CAP) laws have in conjunction with veteran populations.[9] During our sample period there have not been any state law changes governing

[7]We are thankful for comments from researchers with the Healthy Minds Policy Initiative who suggested considering the proportion of veterans from each period relative to the county population (e.g. $\frac{Vietnam_{it}}{Population_i}$). In these specifications we still find that the proportion of Vietnam veterans is positively associated with higher suicide rates, and that other service periods are not statistically different from zero.

[8]Estimates from the same model specifications with the firearm suicide rate used as the dependent variable instead are available on request and haven't been presented here for brevity. We find consistent evidence with the prior results when limiting our outcome variable to suicides completed by firearm.

[9]As an example, Texas Penal Code §46.13. states that, "A person commits an offense if a child gains access to a readily dischargeable firearm and the person with criminal negligence: (1) failed to secure the firearm; or (2) left the firearm in a place to which the person knew or should have known the child would gain access."

Table 3: Results by CAP Law Coverage

Dep. Var:	Suicide Rate		Firearm-Suicide Rate	
Panel A: States without CAP Law				
Vietnam Veterans	0.00080***	0.00078**	0.00056**	0.00053**
	(0.00031)	(0.00032)	(0.00023)	(0.00023)
R^2	0.336	0.343	0.299	0.309
N	14673	14673	14673	14673
Panel B: States with CAP Law				
Vietnam Veterans	-0.00001	0.00001	0.00006	0.00007
	(0.00023)	(0.00024)	(0.00018)	(0.00019)
R^2	0.335	0.344	0.342	0.350
N	7356	7356	7356	7356
County FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
State x Year FE	Y	N	Y	N
State-specific Trend	N	Y	N	Y

Notes: Dependent variable is suicide rate per 100,000 people in 2010 census in first two columns, and firearm suicides per 100,000 in second two columns; CAP = Child-Access Prevention; All models include vector of control variables; Robust standard errors clustered by county (shown in parentheses); **, *** indicate statistical significance at the 5% and 1% levels, respectively.

CAP laws, however, we are able to tackle this question by re-estimating equation (2) using only states without negligent storage laws (Panel A of Table 3) and those with such laws (Panel B of Table 3).[10] Panel A (without CAP law) shows a clear pattern across all specifications: counties with more Vietnam-era veterans have higher suicide rates. Across Panel B (with CAP law), we see no such effect. Indeed, the coefficient in all cases is very small and close to zero.[11] Comparing between the two estimates, coefficients in Panel A are an order of magnitude larger than that of Panel B.[12]

Looking to the role of opioids, we find no evidence that prescribing rates are statistically meaningful in describing differences in county suicide rates (shown in Table 2). In alternative models that we estimate but are not presented here, we find no evidence that veteran population is a statistically meaningful factor in determining overdose deaths – neither intentional nor unintentional. We do find evidence that greater prescribing rates are associated with more deaths (unlike Table 2). We also considered the role of firearm ownership in multiple ways. RAND has measures of firearm ownership that are available at a state-wide resolution. When we included any of these state-wide proxies for firearm ownership we find nearly identical results to Table 2.[13] We believe this is because much of the variation in suicide rates due to gun ownership are being captured by the various fixed effects that are included to control for this 'unobserved' heterogeneity.

[10] In these models we continue to include veterans from other service periods and all other control variables.
[11] The lack of statistical significance is not driven by wide standard errors.
[12] Hausman tests confirm their difference by strongly rejecting the null that these coefficients are the same.
[13] The model with state-year fixed effects soaks up the state-year differences in gun ownership.

4 Instrumental Variables Specification

The prior analysis brought to light the importance of controlling for the service-era of each veteran group. While we are confident in the validity of this descriptive model, here we seek to investigate the role that Vietnam-era veteran populations have on county suicide rates in a model that can address endogeneity concerns. For instance, perhaps the presence of Vietnam veterans has affected policy decisions that influence gun ownership which is a correlate of suicide risk. To do this, we make use of the first draft lottery period (1944-50) and use county birth records during this time period as an instrument for the Vietnam-era veteran population during our sample period (2010-2017). Our identifying assumption is that the number of births in a county during the draft period is positively correlated with the eventual Vietnam-era veteran population. We believe this assumption is valid because private surveys have found that upwards of 60% of respondents live within the same city of town that they grew up. A 2010 Census report on lifetime mobility found that found that, across all ages, 58.8% still lived in the same state as they were born.[14] First-stage results confirm this expectation. We find that the coefficient on the birth count for this period is positive and statistically significant at the 1% level.[15] For our instrument to be valid we must satisfy the classic conditions: that the instrument is related to our outcome variable only through its relationship with the endogenous regressor - e.g. historic birth counts from 1944-1950 cannot affect present suicide rates except through the presence of Vietnam veterans. This is commonly known as the exclusion restriction. We must also expect that the relationship between historic county birth rates and present Vietnam veteran populations is monotonic.

The conventional IV estimator may be badly biased in overidentified models with weak instruments. In our case, we use only one instrument for the amount of Vietnam veterans so it is not overidentified but instead 'exactly' identified. However, the first stage F statistic is 36.61 which is above what was once 'conventional' wisdom of a strong instrument ($F = 10$) and below what newer research has found to be more indicative of a strong instrument ($F = 104.7$).[16] The traditional IV estimator has better performance in exactly identified cases like ours because the median quickly approaches the true value as instruments become strong. However, if the sample size is not particularly large, then the use of IV in exactly identified models is problematic. In fact, Hirano and Porter (2015) show that without additional information from the first-stage, an unbiased estimator of the linear IV model does not exist. Our sample is rather large with county data at a monthly interval for seven years.[17]

For our IV specification, we present traditional IV models but mostly make use of an innovation in the IV literature brought forward by Andrews and Armstrong (2017).[18] The estimator is an unbiased IV estimator for an exactly identified model with one endogenous variable and one instrument. The Andrews and Armstrong (2017) procedure relies on a sign restriction in the first stage. If we know the sign of the effect of the instrument on the endogenous treatment variable, we can construct an unbiased estimate of the effect of treatment on the treated. In our case, the assumption necessary is that county birth totals during Vietnam draft lottery years is positively related to the current Vietnam veteran population which we believe to be true given the evidence of limited lifetime mobility.

Table 4 shows traditional IV estimates side-by-side with the Andrews and Armstrong (2017) unbiased IV estimates for our major outcome variables. Columns 1 and 4 show the effect on the overall suicide rate for the entire country, columns 2 and 5 show how the effect on the overall suicide rate for states without CAP laws, and columns 3 and 6 show how the firearm suicide rate is effected by the presence of Vietnam veterans in states without CAP laws. Here, we see that the traditional IV estimates are larger than the prior reduced form estimates, and that the associated standard errors are larger, too. Indeed, these models indicate that there is not a relationship. However, using the Armstrong and Andrews refinement, we find that there is a link between the presence of Vietnam veterans and county suicide rates. The coefficient estimate is slightly attenuated compared to the traditional IV estimates, but it is now statistically significant. Moreover, the estimated effect size is larger than those in the reduced form models. Here, we find that a standard deviation increase in the Vietnam veteran population is associated with approximately 6 additional suicides per 100,000

[14] The report found that Louisiana had a very high stay-rate of 78%, and the lowest stay-rates are in Nevada (24.3%) and Arizona (37.7%).

[15] F statistic is 36.61.

[16] Lee et al. (2021)

[17] More than 22,000 observations

[18] See Millimet (2020) for a useful explanation of the method.

Table 4: Instrumental Variables

	Traditional IV			Armstrong & Andrews		
Vietnam Veterans	0.00559	0.00328	0.00621	0.00204**	0.00157*	0.00035
	(0.00409)	(0.07508)	(0.01014)	(0.00081)	(0.00092)	(0.00073)
Overall suicide rate	Y	Y	N	Y	Y	N
Firearm-suicide rate	N	N	Y	N	N	Y
States without CAP law	N	Y	Y	N	Y	Y

Notes: Robust standard errors clustered by county (shown in parentheses); *, ** denote statistical significance at the 10% and 5% levels, respectively

people. This effect remains, and is a similar magnitude, when we limit the sample to states without CAP laws. When we separate down to only suicides by firearm in states without CAP laws, we no longer find a link between the Vietnam veteran population and suicide rates.

5 Conclusion

In this paper, we document how county-level suicide rates are affected by the presence of Vietnam veterans. We undertake this indirect approach because detailed records connecting military service with cause-of-death do not exist. Across all modeling strategies we find evidence that counties with more Vietnam veterans have higher suicide rates. This finding is robust to state-specific fixed effects and trends in our reduced form models, and persists in our instrumental variables model that uses the new Andrews and Armstrong (2017) methodology.

Our findings have implications for the allocation of funding for mental health services and other efforts aimed at reducing suicidal ideation, though we must emphasize that we present strong correlational evidence and not pure causal evidence. Even without knowledge of exact mechanisms for 'why' this population is specifically at risk, our results imply that targeting funding toward counties with larger Vietnam veteran populations could be helpful in reducing mortality. And if the findings of Lubens and Silver (2019a) are applicable to Vietnam veterans like they are for post 9-11 veterans, then any reduction in the amount of suicides among Vietnam veterans could reduce contagion effects.

Finally, we acknowledge that this study has several limitations. First, officially published suicide rates are often under-reported because "determining intent is particularly difficult in some instances" (Campbell et al. (2011)), such as in deaths due to poisoning or drowning.[19] Moreover, some physicians "may be reluctant to report suicide as the cause of death due to stigma or financial implications for family members" (Campbell et al. (2011)). Second, due to data limitations, we are unable to directly account for the impact of gun ownership levels, as opposed to the effect of state gun storage laws. Higher violence rates in a particular county can drive up gun ownership levels (compared to another county in the same state), as more people acquire guns for self-protection (Kleck and Kovandzic (2009)). Our inclusion of county and state-specific indicators and trend variables help to reduce this, but does not necessarily ameliorate the issue completely.

6 Conflict of Interest

Saheli Nath and Travis Roach declare that they have no conflict of interest.

[19]Deaths due to gunshot wounds or hanging are more likely to be reported as suicide compared to deaths by drowning or poisoning.

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